Exponent™

Ward Cove Sediment Remediation Project

Performance Standard Verification Plan

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Acronyms and Abbreviations

ARAR	applicable or relevant and appropriate requirement
CQAP	construction quality assurance plan
CV	coefficient of variation
DGPS	differential global positioning system
MLLW	mean lower low water
PAH	polycyclic aromatic hydrocarbon
PSVP	performance standard verification plan
TOC	total organic carbon

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Both method and performance standards will be applied to the remedial construction tasks. Method performance standards—quality assurance standards and checks to ensure that remedial construction methods are carried out as planned—are described in the construction quality assurance plan (CQAP). Performance standards—quality assurance standards and checks to verify that the desired environmental effects have been achieved—are described in this document, the performance standard verification plan (PSVP). Compliance with applicable or relevant and appropriate requirements (ARARs) for the remedial activities (i.e., Alaska water quality standards) are described in the water quality management plan.

The PSVP describes the post-construction remedial action performance standards for sediment conditions and presents the methods to verify that the standards were achieved. Whereas method standards and compliance with ARARs are evaluated using clearly defined best management practices and numerical criteria (respectively), performance standards are evaluated based on progress toward achieving the remedial action objectives (i.e., improving sediment conditions for the recolonization of benthic infauna). Verification of these performance standards is therefore to be carried out by measurement or monitoring of environmental conditions following remedial activities, and interpretation of the results of those measurements using a preestablished decision process.

1. Introduction

The major tasks of the remedial construction are as follows:

1. Remove logs and associated debris in areas to be dredged
2. Dredge the deep draft berth area, the shallow draft berth area, and the polycyclic aromatic hydrocarbon (PAH) area, with upland disposal of dredged material
3. Place a thin-layer cap where achievable
4. Place mound material where achievable.

The scope of the remedial action construction is described in detail in the design analysis report. The following paragraphs summarize these tasks and describe the nature of the performance standard for each task.

The first task in the construction work is to remove logs and associated debris in the shallow draft and deep draft berth areas and the shallow draft access channel. The dredge will be capable of removing logs and associated debris during dredging, so it is not necessary to remove 100 percent of logs and debris prior to dredging. In the shallow and deep draft berth areas, which are to be dredged, there will be no separate performance standard for log and debris removal; achievement of the performance standard for dredging will ensure that logs and debris were removed successfully. In the shallow draft access channel, which will not be dredged, the performance standard for log and debris removal will address channel depth following remedial activities.

The second task is to dredge in both the shallow and deep draft berth areas. The performance standards for this task address achievement of the design water depths for shallow and deep berth areas (unless material such as rock is encountered). In the deep draft berth area and deep draft approach channel, the mudline elevations must be at or below the required elevation of –40 or –44 ft mean lower low water (MLLW) in the areas shown on the construction drawings. In the shallow draft berth area, the mudline elevation must be at or below the required elevation of −14 ft MLLW. No dredging of the shallow draft approach channel is anticipated.

The third task is to place a thin-layer cap of imported sand in the areas specified on the construction drawings. A performance standard will be used to verify that placement of cap material has amended the sediment characteristics to improve their suitability for colonization by benthic infauna. Although the quantity of capping material is equivalent to a layer 6 in. thick over the entire remedial area, the performance standard does not focus on measurement of actual cap thickness because the remedial action objectives can be achieved with partial thin-cap cover and mixing of clean sediment in the upper surface of the organic-rich sediment.

The fourth task is to place mounds of imported sand in areas designated for mounding. A performance standard will be used to verify that placement of mound material has modified the bottom surface in a way that will foster recolonization by benthic species. As with capping, verification methods must provide data needed for another key decision during mounding.

Performance standards for dredging (including log removal), capping, and mounding are described in more detail in the following sections. Capping and mounding are treated together because the objective of both types of remediation is to improve the sediment substrate for benthic organisms, and because the two are linked by decision rules that may result in mounding being carried out in locations where capping is not entirely successful.

2. Dredging

This project element includes the removal of materials from the Ward Cove seafloor in the vicinity of the berthing areas. The total maximum *in situ* volume of sediment to be removed from the Ward Cove site is approximately 21,000 cubic yards. The dredge volume of 21,000 cubic yards includes required dredging, plus 1 ft overdepth and non-pay excess. One foot of tolerance dredging will be allowed to account for inaccuracies of the dredging equipment to excavate to a required depth. The dredging/capping contractor must pay particular attention to the accuracy of the dredging process to ensure that overdepth dredging is held to a minimum, because there is limited capacity in the final disposal area. The dredged material must be dewatered and allowed to consolidate before transport to the disposal site. Engineering estimates identify that approximately 25 percent volume reduction will occur after a minimum of 90 days in the stockpile.

A mechanical dredge clamshell bucket will remove 21,000 cubic yards of mostly fine-grained bottom materials from the shallow and deep draft areas of the Ward Cove site. The dredged material will be hauled by barge to the unloading area adjacent to the temporary stockpile site in the upper, eastern limit of Ward Cove. Maximum haul distance one-way will be less than 1 mile. Water depths at the unloading area will generally be about 10 ft MLLW. The dredged material will be rehandled into the temporary stockpile site and allowed to dewater for a period of time until it can be transported and disposed at the upland fill site. The barges for hauling the materials will be operated in such a manner that no unacceptable discharge of sediments into the water will occur.

In addition to dredging of the shallow and deep draft berthing areas, sediment will also be removed from the PAH area. PAHs are not chemicals of concern for Ward Cove, and the concentrations, constituents, and physical extent of the PAHs have not been quantified. The PAH area has been identified by the presence of a visible sheen on exposed sediments, and removal of sediments from this area will be guided by the presence of a visible sheen. Sediment will be removed from this area using a trackhoe or similar equipment operated from a barge and will be disposed of in the upland area with other sediments. A qualitative method standard has been defined for dredging of the PAH area that is consistent with the means used to identify the area (i.e., removal of sediment until no visible sheen remains), and no quantitative performance standard will be applied.

Dredging will occur during the period of November 2000 to March 2001.

2.1 Performance Requirements

2.1.1 Pre- and Post-Dredge Surveys

Pre-dredging and post-dredging bathymetric surveys will be used to verify performance standards for dredging. Because of the limited capacity of the disposal area, tight control must be maintained throughout the excavation process to ensure that pay quantities are not exceeded. An additional foot of allowable excavation is provided as a dredging tolerance but is not required to be removed in accordance with the terms of the contract.

Daily bathymetric surveys and lead line soundings will be required to ensure excavation depth does not exceed required depth. Also, daily surveys will address slope adjustment and slope sloughing contribution of sediment volume, if any, to overall dredged quantity.

Pre-dredge surveys are performed prior to dredging to determine current and existing site conditions and provide a basis of payment to the contractor. Pre-dredge surveys shall be performed in all areas within 4 weeks prior to dredging as shown on the construction drawings.

Post-dredge surveys are performed to determine quantities for payment and compliance with contract and to develop as-built drawings. Post-dredge surveys will be performed as each definable feature of work is completed or as otherwise directed by the site design engineer. The post-dredge surveys will be performed no later than 10 calendar days following the completion of a definable feature of work as shown on the construction drawings.

All pre- and post-dredge surveys of dredging areas will be performed as U.S. Army Corps of Engineers Class 1 Hydrographic surveys, as described in EM 1110-2-1003, *Hydrographic Surveying*. A copy of this document will be maintained at the site.

All surveys of dredging areas will be performed from the survey vessel using an integrated hydrographic surveying system consisting of a dual-frequency fathometer (Innerspace 449 or equivalent), sub-meter differential global positioning system (DGPS), and computer. A single-frequency fathometer may be used, depending on site conditions, if deemed adequate by the site design engineer. Data will be collected and edited using HYPACK Hydrographic surveying software.

Lines will be surveyed at 50-ft spacing intervals. Depths will be recorded in feet and tide corrected to the project datum. Horizontal coordinates will be recorded as Alaska State Plane Coordinates, Zone 1, NAD 83, also in feet.

In addition to the surveys of dredging areas, a side-scan sonar survey will be conducted of the shallow draft approach channel following log and debris removal.

A minimum of one tide gauge and one tide staff will be installed at the site. The tide staff and tide gauge will be installed using existing control data available onsite.

Collected depth data will be tide corrected and then plotted using AutoCAD to develop bathymetric survey drawings. *In situ* dredge volumes will be calculated using software with a triangulated irregular network method.

The total amount of material removed will be measured by computing the volume between the bottom surface shown by the soundings of the pre-dredge survey and the bottom surface shown by soundings of the post-dredge survey. The construction drawings represent conditions at the site based on the 1999 survey.

2.1.2 Measurement of Dredged Volumes

The primary performance requirement for dredging is removing sediment to the required design bed elevations or to refusal, and limiting the total volume of excess dredged material. Measurements will be made of the volume of dredged material removed from the dredging area and the volume in the temporary dewatering site.

The wet weight of dredged material will also be measured by recording the draft of empty and full material barges. The weight will be calculated based on the dimensions of the barges. This weight will be compared to the dredge volume as calculated by pre-dredge surveys, progress surveys, and the post-dredge survey.

The volume of dredged material in the dewatering site will be measured by pre-disposal and post-disposal topographic surveys. The surveys will be conducted by traditional land-based methods, and the data will be converted into AutoCAD maps. The volume will be calculated by the changes in surface elevation.

Records will be kept during dredging of the areas where bedrock or other hard native sediment was encountered (i.e., dredge refusal) prior to or at the designed dredging depth. Areas where bedrock or native sediment are not encountered will have a thin cap applied following dredging.

2.2 Water Quality Tests

Potential impacts to water quality will be monitored in accordance with the water quality monitoring plan.

3. Capping and Mounding

This project element includes the delivery and placement of clean cap material on the Ward Cove seafloor. If capping proves to be infeasible (i.e., due to limited bearing capacity and subsequent loss of cap material), mounding will be attempted where appropriate (e.g., where capping coverage of sediment is less than a specified threshold). Capping and mounding will both be applied in areas with sediment of high organic content; they are discussed together in this section because a choice between these methods may be made on an area-by-area basis. The general approach to be followed for application of these methods is to categorize remedial areas based on sediment characteristics, and perform the following steps for each category of areas:

1. Carry out design tests to evaluate the applicability of different remedial methods, and select a remedial method
2. Apply the selected remedial method
3. Carry out confirmation tests to assess the final effectiveness of the selected method.

Each of these steps is described in more detail in the following sections. Interpretation of both design and confirmation tests rely on the comparison of post-remediation conditions to acceptance criteria. Therefore, the acceptance criteria for both types of remediation are presented first. (Acceptance criteria for the capping and mounding material are considered with other method standards and are addressed in the CQAP.) These acceptance criteria will be applied within a well-defined decision process to select an appropriate remediation method for different categories of remedial areas. The categories of remedial areas and the procedure for selecting remedial methods are therefore described next. Finally, method requirements and performance requirements for both capping and mounding are described.

3.1 Acceptance Criteria

The success of capping and mounding efforts will be evaluated using easily measured physical characteristics of the bottom sediment. The physical characteristics to be evaluated address both the potential suitability of the remediated sediment for benthic infauna and the practical limitations associated with creating a cap or mounds in the very soft organic-rich sediment in Ward Cove. Different acceptance criteria and evaluation methods will be used for capping and mounding.

The capping acceptance criteria used during design tests will differ slightly from those used during confirmation tests. Whereas a simple pass-fail evaluation will be used for confirmation tests, an intermediate acceptance level will also be used for design tests. The additional acceptance level identifies remedial results that may be improved by a modification of the remedial method.

The quantitative acceptance criteria that are presented here are intended to be used as guidelines rather than only as strict standards for assessing remediation success. The variability of sediment conditions within Ward Cove should be taken into account when applying these acceptance criteria. The criteria should support informed judgments rather than simply dictate acceptance decisions without any consideration of other information available.

3.1.1 Capping

The objective of thin capping is to amend the existing sediment to reduce toxicity and foster colonization by benthic infauna. During the construction phase, achievement of this objective will be assessed by measuring two specific goals. These goals relate to the adequacy of the cap coverage and to the characteristics of the surface sediment after capping. Separate criteria are established for each of these goals. However, these two criteria are related because the coverage criterion depends in part on the characteristics criterion.

Both sediment characteristics and cap coverage will be evaluated using data from surface sediment samples that are collected following cap placement.

Sediment Characteristics—The adequacy of the post-remediation sediment to support benthic infauna will be assessed based on its sand content. Greater sand content will provide infauna with more substrate for attachment and for constructing tubes and burrows. An increase in the sand content will also reduce the total organic carbon (TOC) content. Lower TOC content will reduce the production of ammonia, sulfide, and 4-methylphenol. The goal of thin capping is to increase the sand content of the surface sediment (0–10 cm) to a value similar to that of reference areas and to decrease the TOC content by a substantial amount. The target sand content of post-capping surface sediment is 32 percent by weight, equivalent to sediment from Moser Bay; the target TOC content is 15 percent by weight, equivalent to a 40–50 percent reduction of the highest concentrations.

The ability of post-capping surface sediment to meet the criteria for both sand and TOC content will depend upon the extent to which capping material mixes with the organic sediment in Ward Cove. The diagonal line in Figure 1 illustrates the range of sand and TOC content that may result from the mixing of capping material and Ward Cove sediment. In this figure, Ward Cove is represented by material with a TOC content of 25 percent and a sand content of 10 percent, whereas the cap is represented by material with a TOC content of 1 percent and a sand content of 85 percent. (These values are to be considered as representative—the composition of both types of material is expected to vary somewhat.) Intermediate points on the diagonal line in Figure 1 represent different amounts of mixing between organic material and capping material. The vertical and horizontal lines in Figure 1 correspond to the criteria that have been established for sand and TOC content, respectively. The portion of the diagonal line that is below the TOC criterion and above the sand criterion therefore represents the range of conditions that are considered to indicate capping success.

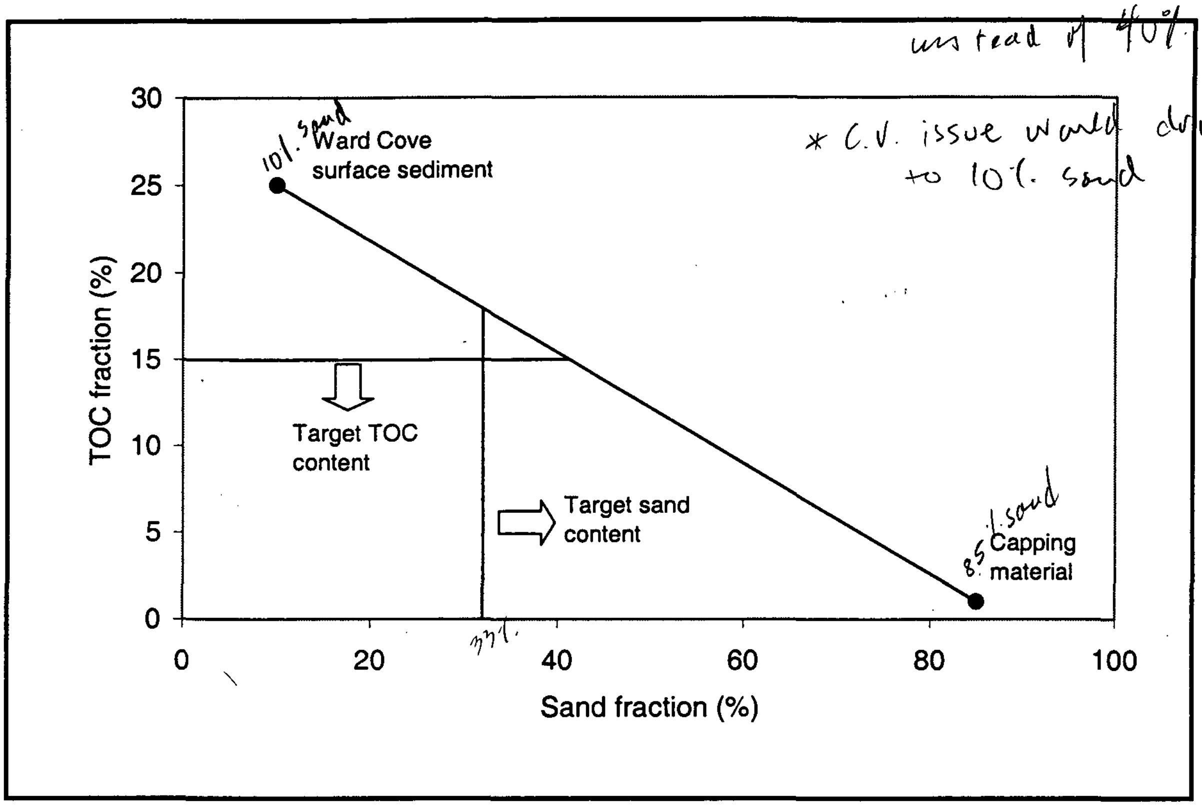


Figure 1. Sediment mixing relationship for evaluation of capping

Achievement of the criteria for sediment characteristics will be assessed by the collection of multiple surface sediment samples (0–10 cm) following capping and by comparison of a lower confidence limit for the mean measured value to the appropriate acceptance criterion. A mixing relationship such as that shown in Figure 1 allows both the sand and the TOC content to be evaluated by measuring only one of these constituents. Because a field test of sand content is more straightforward than a field test of TOC content, the mean sand fraction in post-capping sediment will be used as the measurement criterion. As Figure 1 illustrates, the sand fraction that must be found to ensure that the TOC criterion is also met may be higher than the nominal sand criterion alone (i.e., Figure 1 indicates that the sand fraction must be approximately 40 percent to ensure that both the sand and TOC criteria are met). Additional detail on sampling design is presented in a following section, and sand content testing methods are presented in Appendix A.

Coverage—The acceptance criterion for cap coverage is established as a minimum fraction of the area capped that must have acceptable sediment characteristics. Because direct measurement of the area capped is expected to be difficult (in part because of mixing of cap material with organic sediment), achievement of the coverage criterion will be evaluated by statistical analysis of the samples collected to measure sediment characteristics. Specifically, the mean and the coefficient of variation (CV) of the sand content will be used to determine whether adequate spatial coverage has been achieved.

To account for the practical difficulties of placing capping material entirely uniformly, a target of 80 percent coverage has been established. Thus, coverage will be evaluated using the 80 percent (e.g., 10 of 12) of the verification samples with the highest sand content. The distribution of sand content of these samples will be evaluated to determine if it is consistent with the distribution expected following successful capping. The characteristics of the expected distribution are based on the means and CVs of sand content of native and capping material. The CV of the percent sand content of Moser Bay sediment is 0.6 (as determined from the detailed technical studies report), and the CV of the percent sand content of the capping material is assumed to be half of that (i.e., 0.3). Assuming sand contents of 10 and 85 percent respectively (Figure 1) and additivity of variances, the CV of the sand content of the mixture (at 40 percent sand) is expected to be 0.65. Simulation of a beta distribution with a mean of 40 and a CV of 0.65 ($\nu = 0.90$, $\omega = 1.30$) indicates that the 20th percentile of this distribution is 13. Thus, no more than 20 percent (or 2 of 10) of the verification samples are expected to have a sand content less than 13 percent.

The sand coverage criterion, as well as the sand characteristics criterion, must be met for thin capping to be judged successful. Sand characteristics and coverage will be evaluated during confirmation tests following the completion of capping. The adequacy of sand coverage will also be evaluated during design tests of capping methods (described in more detail in Section 3.2.2). For design tests, sand coverage may be judged adequate even when sand characteristics are not. Therefore, the following two-part rule will be applied to the 80 percent of samples with the highest sand content to assess adequacy of sand coverage:

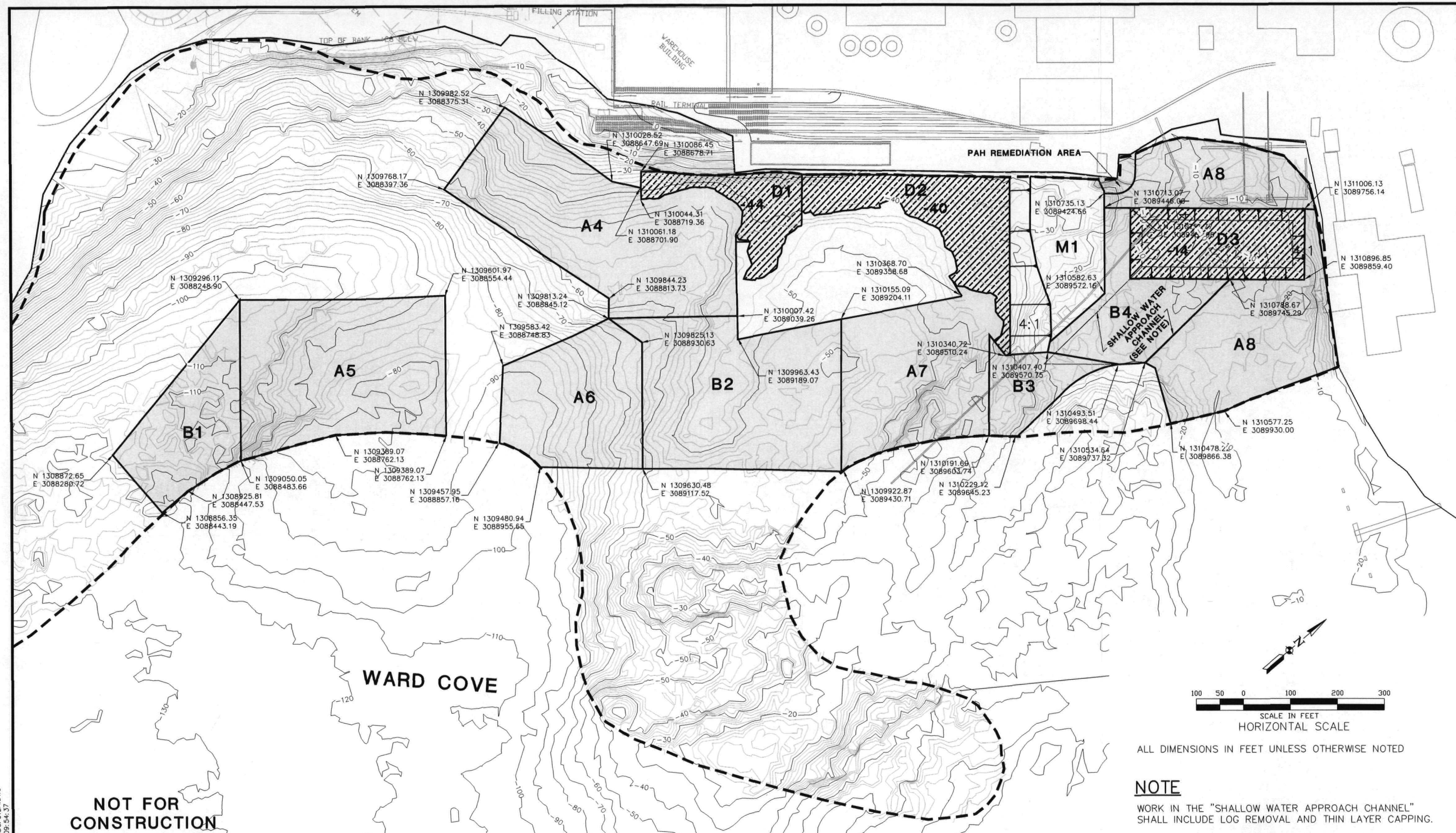
- For confirmation and design tests—When the mean sand content is 40 percent or greater, no more than 20 percent of the samples may have a sand content less than 13 percent

- For design tests only—When the sand content is less than 40 percent, the CV must be 0.65 or less.

3.1.2 Mounding

The success of mounding efforts will be assessed based on the amount of exposed sand surface, as a fraction of the remediation area. Design analyses (Section 6.4.1 of the design analysis report) indicate that approximately 20 to 30 percent of the remediation area can be replaced with sand before so much soft sediment is displaced that there is a rapid decrease in the benefit gained from further additions of sand. To account for the practical difficulties of placing mounding material in the idealized configuration used to calculate mound volumes, as well as to account for measurement uncertainty, a minimum of 80 percent of the design coverage has been established as an acceptance criterion for spatial coverage. Mounding will be considered a success when the exposed sand surface area in each mounding area (see Figure 2) is at least as great as the values shown in Table 1. The design coverage values shown in Table 1 are based on placement of mound material at a rate of 2,900 cy per acre.

Measurement of mound coverage is expected to be made using side-scan sonar, possibly augmented by diver-operated video surveys in waters that are no more than 60 ft deep. The mounds are expected to be distinctive and clearly distinguishable from the organic material by these methods because the reflective properties of sand differ from those of the surrounding organic material.



100 50 0 100 200 300
SCALE IN FEET
HORIZONTAL SCALE

ALL DIMENSIONS IN FEET UNLESS OTHERWISE NOTED

NOTE

WORK IN THE "SHALLOW WATER APPROACH CHANNEL" SHALL INCLUDE LOG REMOVAL AND THIN LAYER CAPPING.

LEGEND

A1	TYPE "A" THIN CAP AREA/OR MOUNDING	
B1	TYPE "B" THIN CAP AREA	
D1	DREDGE AND THIN CAP	
M1	MOUND AREA ONLY	
4:1	DREDGE SLOPE	

FOSTER WHEELER
AND HARTMAN CONSULTING CORPORATION

DATE: 6/7/2000
SCALE: AS NOTED
DRAWN: KSK

FIGURE 2a
KETCHIKAN PULP COMPANY
THIN CAP PLAN

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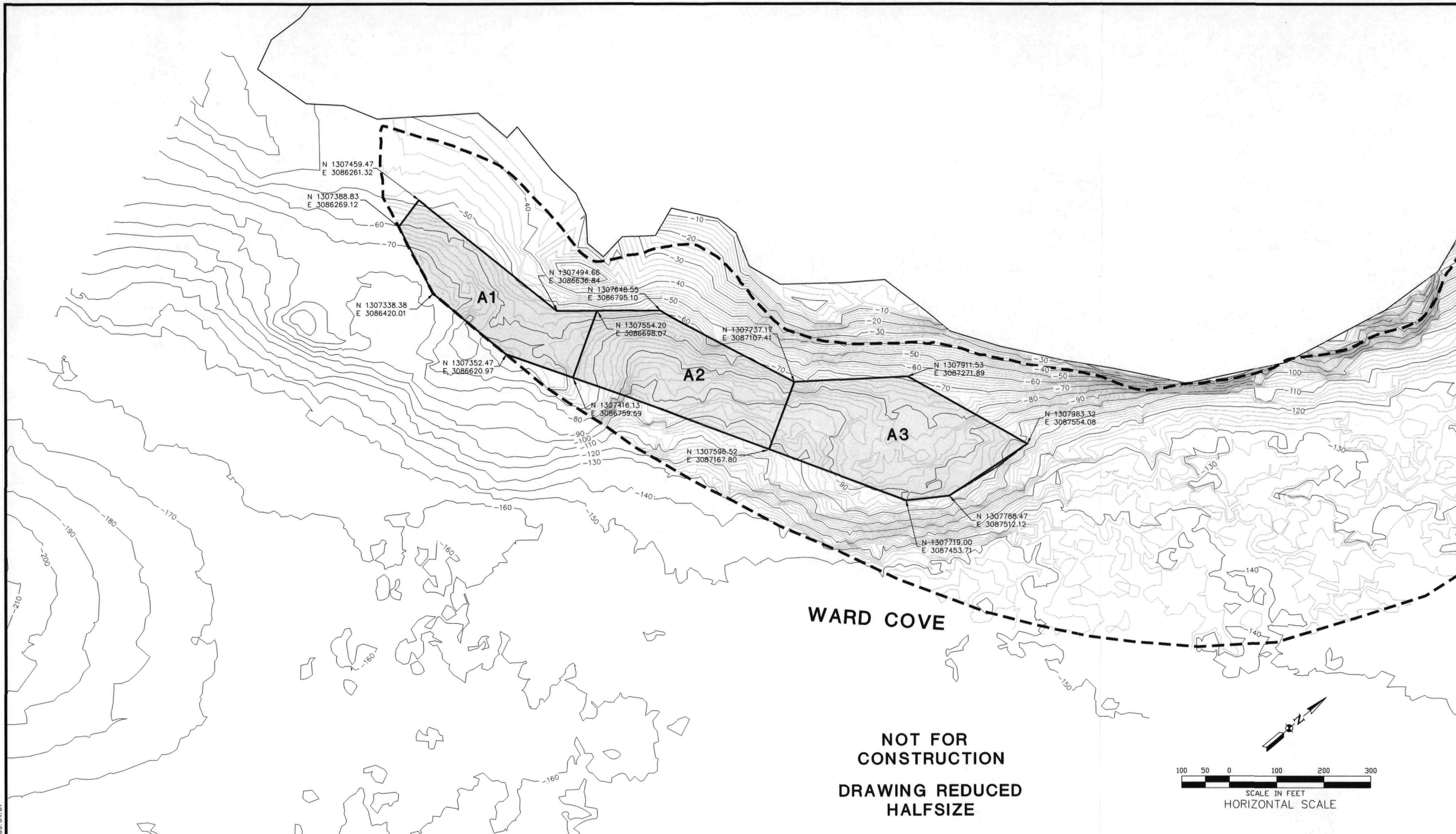

ALL DIMENSIONS IN FEET UNLESS OTHERWISE NOTED

LEGEND

A1	TYPE "A" THIN CAP AREA/OR MOUNDING	D1	DREDGE AND THIN CAP
B1	TYPE "B" THIN CAP AREA	M1	MOUND AREA ONLY
4:1	DREDGE SLOPE		

FOSTER WHEELER AND HARTMAN CONSULTING CORPORATION

DATE: 6/7/2000
SCALE: AS NOTED
DRAWN: KSK

FIGURE 2b
KETCHIKAN PULP COMPANY
THIN CAP PLAN

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Table 1. Acceptance criteria for mounding

Mound Area[a,b]	Size of Area (acres)	Organic Sediment Thickness (ft)	Mound Volume for Design Test (0.5 acre) (cy)	Design Coverage for Design Test (percent)	Acceptance Criterion for Design Test (acres)	Mound Volume for Complete Mounding (cy)	Design Coverage for Complete Mounding (percent)	Acceptance Criterion for Complete Mounding (acres)
M1	0.98	7	1,450	10	0.04	2,842	12	0.09
A1	1.38	5	1,450	15	0.06	4,002	19	0.21
A2	1.79	5	1,450	15	0.06	5,191	19	0.27
A3	2.14	5	1,450	15	0.06	6,206	20	0.34
A4	3.27	3	1,450	25	0.10	9,483	30	0.78
A5	3.03	4	1,450	19	0.076	8,787	24	0.58
A6	1.84	4	1,450	19	0.076	5,336	23	0.34
A7	2.13	4	1,450	19	0.076	6,177	24	0.41
A8a[c]	1.27	5	1,450	15	0.06	3,683	18	0.18
A8b[c]	1.91	5	1,450	15	0.06	5,539	19	0.29

[a] Figure 2 shows the mound areas.

[b] Mounding will be performed in the "A" areas only if capping does not succeed.

[c] Part a is closer to the dock, part b is the outer section.

3.2 Method Selection

The selection of capping, mounding, or natural recovery in areas of soft organic sediment depends upon the characteristics of that sediment and on a series of design tests that are to be conducted. This information will be used in conjunction with a set of decision rules to select (possibly) different remedial methods, as appropriate, for different areas of soft organic sediment.

3.2.1 Area Categorization

Areas of Ward Cove with soft organic sediment can be differentiated based on the thickness and the bearing capacity of the organic layer. These differences are important because they relate to the potential success of different remediation methods. Areas with greater bearing capacity are better candidates for thin capping. Mounding may be the only suitable remediation method in areas with thinner organic layers and less bearing capacity. Where the organic layer is very thick, mounding may also be infeasible, and natural recovery would be most suitable.

Sediments that may be capped or mounded have been divided into four categories. These categories are described in Table 2, and Figure 2 shows the locations of these area categories within Ward Cove. The success of capping and mounding will be evaluated independently for each different category of areas.

Table 2. Area categories

Area Category	Description
A	Areas with good sediment bearing capacity. Capping is the selected remediation method.
B	Areas with a thick organic layer and good sediment bearing capacity. Capping is the selected remediation method.
D	Dredging areas at which dredging does not reach bedrock or native material. Remaining organic material is to be capped.
M	Areas with a thin organic layer and low bearing capacity. Mounding is the selected remediation method.

3.2.2 Design Tests

Each of the ~~different categories of~~ capping/mounding areas will be tested to determine the appropriate remedial method to be used. These design tests will consist of the application and evaluation of one or more different remedial methods. If the initially selected remedial method (e.g., capping) is not successful, then a modification of the method or an entirely different method (e.g., mounding) may be evaluated or applied. Different decision rules will be applied during these design tests, depending on the characteristics of the sediment being tested.

Table 3 summarizes the three different decision rules to be applied, and Figures 3–5 illustrate the decision process for each of these rules. Decision Rule 1 is to be applied where the organic layer is not very thick and the bearing capacity of the sediment is good; capping is expected to be successful in these areas, but either mounding or natural recovery may be used if capping does not succeed. Decision Rule 2 is to be applied where the organic layer is thick, but the bearing capacity is good; in these areas capping is expected to be successful, but the organic layer is too thick for successful mounding. Decision Rule 3 is to be applied where capping is not expected to be feasible due to limited bearing capacity, but where the limited thickness of the organic layer suggests that mounding could be successful. Mounding will be carried out by placement of a fixed quantity of mound material, the quantity to be determined by design calculations (described in the design analysis report). Mounding will require approximately three times as much material as capping, yet produce a remediated surface area that may be only one-fourth to one-third as large. Overall remedial efforts have been laid out so that extra effort will be employed in an attempt to achieve success by capping, the most cost-effective remedy. The least cost-effective remedy, mounding, will be applied with a design volume that has been calculated using conservative assumptions. If mounding does not succeed under these conditions, further efforts devoted to mounding are not expected to be successful. The application of these decision rules to different area categories is summarized in Table 3.

Table 3. Decision rules

Decision Rule	Description
1	Capping, mounding, or natural recovery
2	Capping or natural recovery
3	Mounding or natural recovery

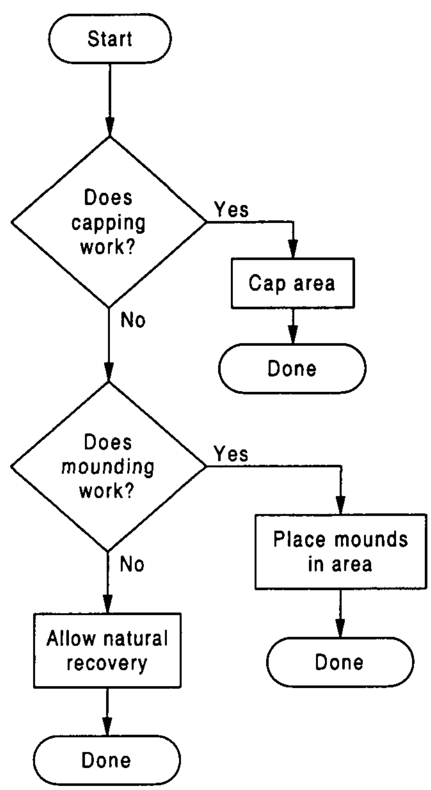

Figure 3. Decision Rule 1

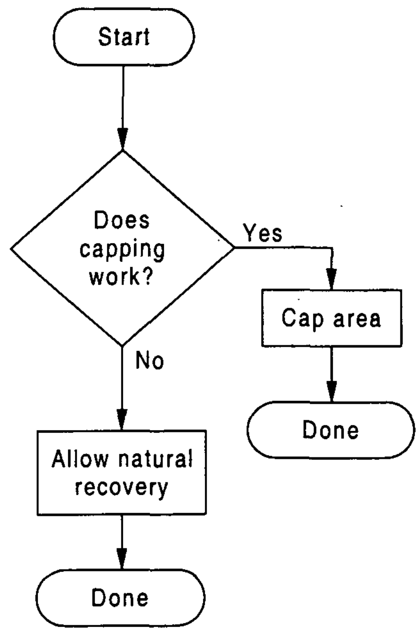

Figure 4. Decision Rule 2

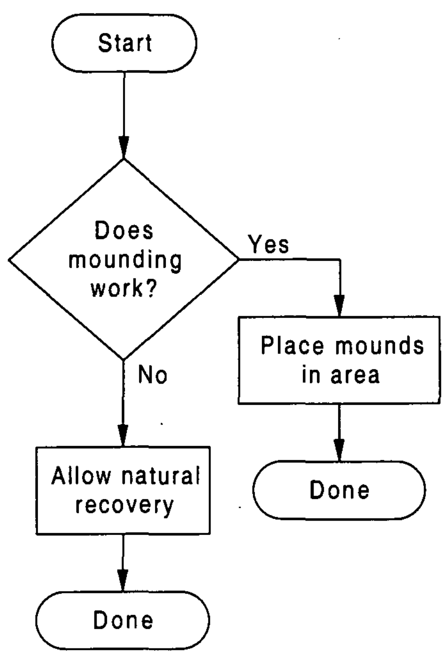

Figure 5. Decision Rule 3

Evaluation of capping success incorporates both evaluation of acceptance criteria and evaluation of method modifications. The method modifications to be considered are as follows:

- Use of alternative equipment for cap placement
- Placement of an additional amount of sand equivalent to a thickness of three inches.

This decision process is illustrated in Figure 6. In this process, achievement of the coverage criterion, and the possibility of using different equipment, should be evaluated first. If instead the substrate condition were evaluated first, without regard to the variability in coverage resulting from the equipment used, then the addition of more sand might nevertheless leave too large a fraction of the remediation area without a thin cap. If during the first design test(s) using Decision Rules 1 or 2, the contractor finds that one cap placement method is superior, then that method may be the primary one used during subsequent design tests using Decision Rules 1 and 2.

(Figure 6 shows only decisions associated with performance standards for the design tests, not those associated with method standards. For example, method standards will be applied to ensure that a volume of cap material equivalent to a 6-in. thickness is actually applied, but the evaluation of these standards is not shown in Figure 6. The CQAP describes the method standards that will be applied to remedial activities.)

Design tests will be conducted on an area of approximately one-half acre within each category of areas. The design tests will be sequenced so that after the initial phase of each test has been completed (e.g., the first placement of 6 in. of cap material), the equipment will commence either additional design tests or remedial work in an adjacent area. Surface sediment sampling will be conducted the day following completion of the first phase of the test (weather permitting). If the acceptance criteria are not met, the equipment will resume with the next phase of design testing in that area as soon as feasible. All design testing will be completed as early as possible after remedial activities commence.

After the design tests are completed, the selected remediation method will then be applied to the entire area within each category.

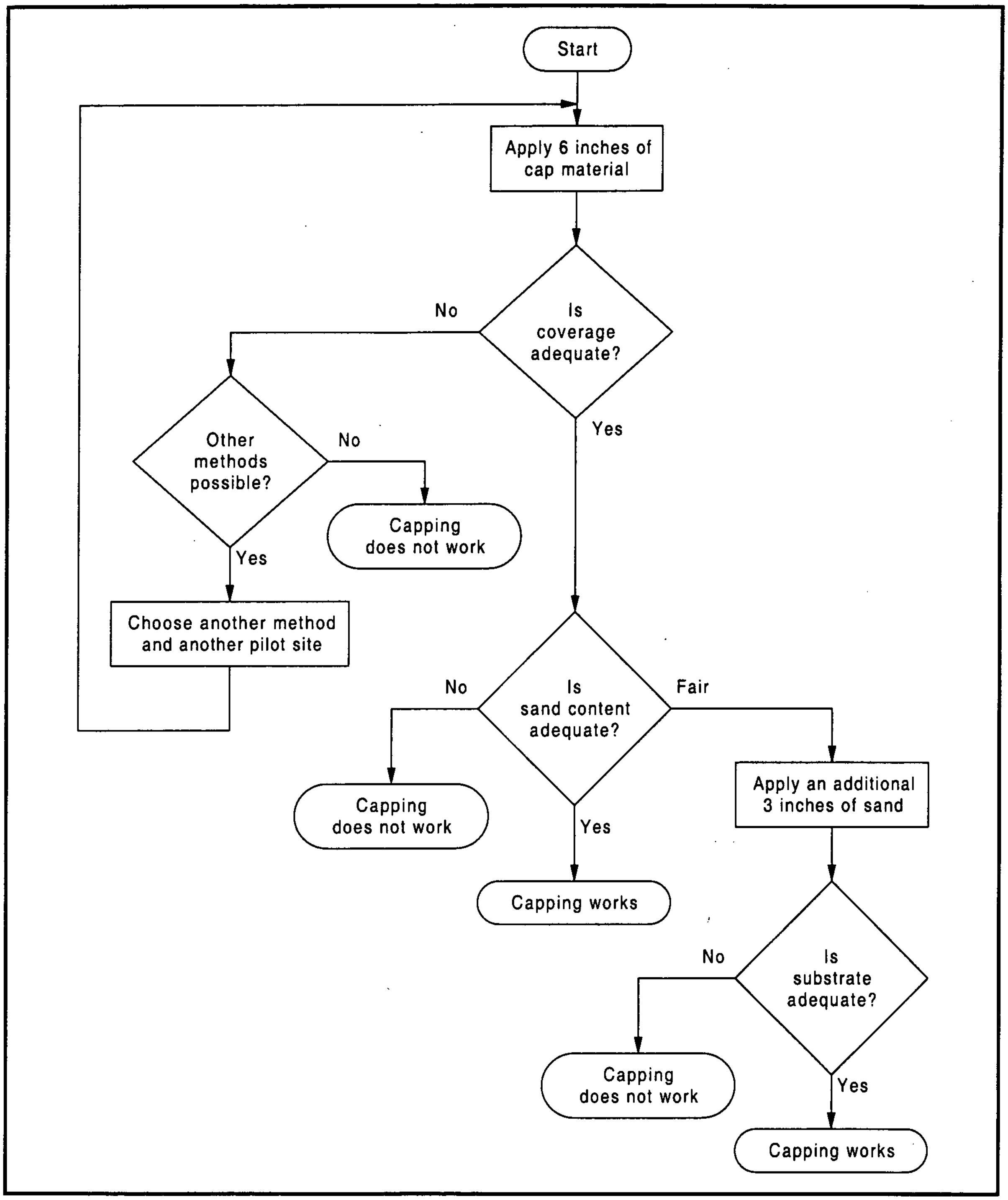

Figure 6. Evaluation of capping success

3.3 Performance Requirements for Design and Confirmation Tests

Similar methods will be used during both design and confirmation tests to determine the performance of remedial activities. Performance tests for capping will depend on the collection of sediment from the remediated area, whereas performance tests for mounding will depend on remote sensing of the sediment surface. The success of each remediation method will be assessed as described in the preceding section titled *Acceptance Criteria*.

3.3.1 Capping

Sediment samples will be collected to determine the sediment characteristics and cap coverage, both during method selection (design tests) and following method implementation (confirmation tests). Surveys will be conducted in all capping areas on the day following completion of the capping, or as soon thereafter as is feasible. Samples will be uniformly spaced on regularly spaced transects to ensure collection of representative data. A minimum of 12 samples will be collected from each of the A and B areas shown in Figure 2 (A1–A8, B1–B4), for both design and confirmation tests. For confirmation tests in areas larger than 3 acres, samples will be collected at the rate of four samples per acre (to the nearest quarter acre). Samples will be collected by divers using push tube samplers in areas with water depths of 60 ft or less. Shallow cores will be collected in areas with water depths greater than 60 ft.

The upper 10 cm of each sample, corresponding to the biologically active zone, will be used to evaluate capping effectiveness. The sand fraction of each sample will be measured in the field using a column settling test.

No diver surveys will be conducted at a distance nearer than 300 ft to operating construction equipment. No diver surveys will be conducted in water of greater than 60 ft in depth. One of the transects will be resurveyed as a quality control measure.

In locations where the transects extend into waters deeper than 60 ft, shallow gravity cores will be used to collect sediment. Transects will be laid out as for diver surveys. A DGPS reading will be taken at the winch block as each core is released.

3.3.2 Mounding

After confirmation that the method standards for placement and positioning are achieved, side-scan sonar or video cameras, and bathymetric survey data, will be used to determine the extent of mound material within each remediation area. Diver surveys will be used to verify the side-scan sonar or video camera interpretation of the extent of mound material in areas with water depths less than 60 ft (if possible). The same methods will be used for both design and confirmation tests.

Side-scan sonar observations will cover the entire remediation area to determine the spatial extent of the mound material. An SAE 350B, dual channel, side-scan sonar transceiver (or equivalent) will be used to collect bottom feature information along predetermined track lines. The parallel lines will be 100 ft apart, and scanning will be conducted with either a 100-kHz or 500-kHz sonar survey extending to 50 m (160 ft) to each side of the vessel. In the field, the two side-scan sonar surveys of different frequencies will be tested to determine which provides superior sonogram quality. Based on previous experience, the 500-kHz sonar towfish will most probably provide better resolution in shallow water (<60 ft). The proposed track-line spacing will be developed, based on the towfish elevation above the bed, to allow for a 60 percent overlap of adjacent survey lines. The towfish will be interfaced with a digital data collection system and printer (to be determined) and a DGPS. This configuration will allow for accurate representation of location and swath width during the survey (providing a sub-meter horizontal accuracy).

Alternatively, remote or diver-operated video cameras will be deployed so that they capture an image of the entire perimeter of each mound (dependent on water clarity at the time of operation). Camera depth and angle, and thus the field of view, will be held constant. A clearly marked stick or anchored line with float will be placed on the bottom and photographed at the beginning and end of the survey of each mound, using the same field of view. If the stick or line is knocked down or buried, a probing of the mound and adjacent sediment thickness will be attempted to verify mound conditions. If side-scan sonar is used as the principal method of evaluating mound coverage, a diver or video survey will used to verify the side-scan sonar results on at least one occasion, in water less than 60 ft deep.

A bathymetric survey will also be carried out in all remediation areas using an Innerspace 448 survey grade fathometer (or equivalent), which provides vertical resolution of 0.5 ft, and a DGPS, which provides sub-meter horizontal resolution. Data generated from both the fathometer and DGPS will be collected in real time using a laptop computer running HYPACK software (a hydrographic surveying, data collection, and navigation program).

Field personnel will analyze the sonar or video camera data, and bathymetric data, to determine the total area and thickness of each mound, and thus the fraction of the remediation area that is covered by mound material. This analysis will be completed immediately following the data collection and will be reported on the daily log. The boundary of the mound area will be identified on the sonagraph using both the sonar image and bathymetric data, and the area will then be measured planimetrically. A final drawing of each mound area will be developed that identifies the mound contours and extent of coverage within each acceptance area; these drawings will be included in the final report. The report will also include a photocopy of the sonagraph with the boundary of the mound identified. Drawings will be included for design tests as well as final mounding, for all acceptance areas.

3.4 Water Quality Tests

Potential impacts to water quality will be monitored in accordance with the water quality monitoring plan.

Appendix A

Acceptance Testing Methods for Thin Capping

Acceptance Testing Methods for Thin Capping

The sand content of sediment must be evaluated after capping to determine whether capping was successful. Numerical criteria for the sand content and decision rules using the sand content information are presented in the main text of the performance standard verification plan (PSVP). Because the course of remedial actions depends on the sand content achieved during design tests, rapid assessment of sand content in the field is important to prevent delays in the schedule of remedial activities. However, the presence of sand-sized wood chips in Ward Cove sediment may impair the effectiveness of a simple assessment technique such as wet sieving. A description of the development and application of alternative methods is presented in this appendix.

Development of Sand Content Testing Methods

Alternative methods for assessment of the sand content of sediment after capping will require some development work and calibration to ensure that they will be effective (i.e., rapid and sufficiently accurate for field use). This development work should be completed before capping commences. In addition to wet sieving, the methods to be evaluated (and refined as necessary) are as follows:

- Visual comparison of sediment samples to exemplars that have a known sand content. The success of this method is dependent on different reflective and textural properties of capping material versus organic sediment. Visual comparison is not expected to produce a highly accurate assessment of sand content in the range of the acceptance criterion, but is expected to allow easy identification of samples that have a sand content that is clearly well above or below the acceptance criterion.

- A column settling test for the assessment of sand content. The success of this method is dependent on different settling rates of sand particles and organic material. The column settling test is expected to provide a quantitative estimate of sand content, following appropriate calibration with sediment of a known mixture of sand and organic material. Development and calibration of this method may be unnecessary if the wet sieving method can be shown to produce accurate estimates of sand content.

If method testing indicates that neither wet sieving nor these alternative methods will work, then grain size for some (if visual comparison alone is effective) or all samples will have to be determined by sieve analysis (ASTM D 422-63 without hydrometer analysis of silt and clay fractions) after combustion. In this case, appropriate equipment, including a muffle furnace, will need to be available onsite to facilitate rapid analysis of grain size.

Testing of wet sieving and column settling methods should be conducted using sediment with a range of different sand contents—the same sediment to be used for visual exemplars. Preparation of the exemplar sediment therefore should be carried out prior to other method development tasks.

Preparation of Exemplar Sediment

Exemplar sediment samples must be prepared and the field method for sand content calibrated prior to the beginning of cap placement. The procedure for preparation of exemplar sediment samples is as follows:

1. A suitably large volume of representative organic sediment from the bottom of Ward Cove should be collected and homogenized. Excess supernatant should be removed as or after the sediment is collected, and the sediment thereafter should be maintained in an airtight

container in a cool location until preparation of exemplar samples is complete.

2. Several aliquots of the organic sediment should be weighed, dried, and reweighed to determine the mass of dry solids as a fraction of the total mass.

3. The native sand content of the organic sediment should be determined by drying an aliquot of the organic sediment, combusting it at 500°C, and performing a sieve analysis (ASTM D 422-63, sieve analysis only) to determine the quantity of sand (or coarser material) as a fraction of total dry weight.

Aliquots of the organic sediment should then be mixed with varying quantities of capping material to produce exemplars with a range of different sand contents. The target values for sand content (as a fraction of total dry weight) should be 10, 20, 30, 35, 40, 45, 50, 60, 80, and 90 percent (assuming an acceptance criterion of 40 percent sand; the actual acceptance criterion is identified in the main text of the PSVP). These target values are guidelines; a different number of exemplars or different resolution may be found to be necessary or useful (for example, the organic sediment itself may be found to have a sand content higher than 10 percent). A sufficient quantity of each different exemplar should be prepared to allow its use for all of the following purposes:

- To fill duplicate 250-mL glass jars, to be used for rapid visual screening of post-capping field samples. Color photographs of these samples, in lighting conditions equivalent to that in which they will be used, should be taken immediately after they are prepared.

- For determination of actual sand content by sieve analysis following combustion of organic matter. The exemplar sediment used for visual comparisons (in 250-mL jars) should be labeled with the measured sand content.

- To calibrate the wet sieving method
- To calibrate the column settling test method.

Different amounts of organic sediment and capping material should be mixed together to form each exemplar. The actual measured sand content and moisture content of each constituent should be used to calculate the correct proportions necessary to achieve final sand contents comparable to the target values. Exemplars should be prepared using only bulk sediment, to avoid changes in visual properties that might result from drying. After it is prepared, each batch of exemplar sediment should be stored in an airtight container, in a cool location, until method development is complete.

As described in the second bullet above, the actual sand content of each exemplar should be measured. These values will be used as a calibration standard and to establish the interpretation of visual comparisons of field samples to exemplars. Possible interference from particulate organic matter should be eliminated by combustion of organic matter prior to carrying out the grain size analysis. Two to five replicates of each exemplar should be analyzed to ensure that the precision of the calibration baseline data is well established.

Acceptability of Method Calibrations

The wet sieving and the column settling methods may both be calibrated against the true sand content of the exemplar sediments. The sand content measured by these methods is to be plotted, and regressed, against the true sand content (as determined following combustion of the exemplar sediment). Transformation of the results of either or both methods should be carried out if necessary. A calibration will considered to be acceptable if both of the following criteria are met:

- The regression is significant

- The lower prediction interval for the true sand content in a single sample is no more than 10 percent, absolute; that is, for an acceptance criterion of 40 percent, the lower prediction limit is no lower than 30 percent.

If the wet sieving method meets these calibration criteria, then the wet sieving method may be used for field measurements of sand content, and there is no need to develop the column settling method.

If the wet sieving method does not meet the calibration criteria, then the column settling method must be developed and calibrated. If the calibration of the column settling method meets the calibration criteria, it should be used for field measurements. If calibration of the column settling test does not meet the criteria, then one of the following must occur:

- Additional development of the column settling test should be carried out
- The best of the two methods (wet sieving or column settling) should be used for field measurements (and acceptance criteria for capping success may be adjusted)
- Evaluation of the sand content should be carried out solely on the basis of visual comparison to the exemplars
- Every sample of post-capping sediment must be combusted prior to grain size analysis.

Because the column settling test is expected to be refined for application to Ward Cove, it is expected that several different test procedures will be evaluated, and that the first (few) of these may not yield an acceptable calibration. Thus, two or three iterations of calibration failure, followed by method adjustment, are expected. However, if reasonable efforts to develop the method consistently fail to produce an acceptable calibration, then the best of the two methods must be chosen.

The following rules should be applied to determine the best calibration, if calibrations for wet sieving and column settling tests must be compared:

- If one method produces a significant regression and the other does not, then the first method is best; otherwise
- The method with the smallest prediction interval for a single sample at the sand content acceptance criterion (e.g., 40 percent) is best.

If a method with a prediction interval wider than 10 percent is to be used, then, depending on the size of the prediction interval, and with the agreement of Ketchikan Pulp Company and the U.S. Environmental Protection Agency, the sand content acceptance criterion (described in the main text of the PSVP) might be modified.

Development of the Column Settling Test

The column settling test is expected to be used in the following manner:

- A known mass of post-capping sediment is suspended (well-mixed) throughout a settling column or cylinder, which is then set upright and the sediment allowed to settle
- After a specified time, the volume of solid material that has settled to the bottom of the column is measured and used to compute (via a calibration curve) the sand content of the sediment.

Conditions that may be manipulated during method development to achieve an accurate measurement of sand content include the height and diameter of the column, the amount of sediment initially added, and the time at which the settled volume is measured.

Examples of the types of equipment, and mixing methods, that might be used are provided in Corps (1985). Because the goal of the test, as it is to be used in Ward Cove, is the measurement of sand content rather than of suspended solids, the height of the column and the length of time required are expected to be less than those described in Corps (1985). However, the column should be transparent and accurately marked with volumes, at least in the lower region. Determination of the optimal column size, sediment mass, and settling time is expected to require some systematic experimentation.

The column settling test will be quicker to use in the field if it is carried out using bulk sediment rather than dried sediment, but dried sediment may allow more accurate determination of sand content. The relative accuracy achieved using both bulk and dry sediment should be assessed during method development. Alternative techniques for separation of soil and liquid fractions, such as centrifugation, could also be evaluated. Depending on the settling properties of organic particulates relative to sand, centrifugation might also be an effective method of directly measuring the sand content of post-capping sediment. Other modifications or enhancements to the basic method, such as adjustments to the fluid density by addition of salt, may be carried out as necessary and appropriate.

Application of Sand Content Testing Methods

Acceptance of the in-place cap will be evaluated as part of both design tests and confirmation tests. The main text of the PSVP describes the conduct of design and confirmation tests in detail. The following sections briefly summarize the procedures to be used for sample collection and evaluation.

Sample Collection

Sample locations should be distributed uniformly over the surface of the capped area. For example, in rectangular acceptance areas, a grid of 3 by 4 or 2 by 6 points might be used. Design tests should, if feasible, be carried out in such a way that the dimensions of the half-acre area used are approximately 3 by 4, and so suited to a corresponding grid of samples (the dimensions of such a half-acre parcel would be approximately 128 by 170 ft). For sampling of irregularly shaped acceptance areas after complete capping, sampling locations should be laid out so that the distances between adjacent samples are all relatively equivalent (and approximately equal to the square root of one-twelfth of the overall area).

Samples may be collected using either diver-operated hand cores (only in water no more than 60 ft deep) or samplers such as gravity cores or grab samplers (e.g., van Veen) that are operated from a boat.

Only the upper 10 cm of the sediment should be collected for analysis of sand content. This depth corresponds to the biologically active zone, and provides the best measure of the sediment characteristics to which benthic infauna will be exposed.

Evaluation of Sand Content

Each of the 12 (or more) post-capping sediment samples collected as part of a design or confirmation test must be evaluated to determine the sand content. Initial screening of the samples is expected to be performed using visual comparison of the samples to exemplar sediments. If visual examination indicates either that all of the 12 samples are clearly above the sand content acceptance criterion, or that more than 4 samples are clearly below the sand content acceptance criterion, then a decision on cap acceptance is clear and no further measurements or comparisons are needed.

If visual evaluation does not lead directly to a conclusion regarding cap acceptance, then a quantitative estimate of sand contents must be made. In accordance with the evaluation rules described in the main text of the PSVP, the two samples with the lowest sand contents are to be eliminated; if these two samples can be identified based on visual comparison to exemplars, then quantitative estimates must only be made for 10 samples. These quantitative estimates may be made by any of the following methods:

- Subjective assessments resulting from visual comparison to the exemplars—This method may be used if visual distinctions are clear and neither the wet sieving nor column settling methods yield acceptable calibrations
- Application of either wet sieving or column settling methods—The choice between these methods should be based on calibration success, with priority given to wet sieving (as described in the section titled *Acceptability of Method Calibrations*)
- Combustion and dry sieving—This method is expected to be the most time-consuming to apply, and therefore should be used only if it is the only acceptable alternative.

Mean and variance of the estimated sand content of the 10 samples should be computed and used, as described in the main text of the PSVP, to determine cap acceptability.

References

Corps. 1985. Interim guidance for predicting quality of effluent discharged from confined dredged material disposal areas—test procedures. EEDP-04-2. U.S. Army Corps of Engineers, U.S. Army Waterways Experiment Station.