A Report to

the Portland District

Corps of Engineers

Entitled

Marsh Establishment on Dredged Materials in Oregon Estuaries

by

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Under Contract No. DACW 57-77-C-0150

December 1977

ABSTRACT

Marsh establishment on dredged materials is presented as an environmentally and economically attractive option in resolving the Corps of Engineers' dredged materials disposal problems. Marsh establishment, however, is viewed with some skepticism by various conservationists and resource and regulatory agencies. The rationales of these skeptics and rebuttals, if warranted, are provided as general background information.

It is concluded that tidal marsh establishment is feasible in the estuaries of Oregon and that the methodology of so doing is of primary importance. It is recommended that the Portland District develop a professional and sophisticated methodology through the pursuit of an applied research program that is coordinated with a variety of experimental marsh establishment projects. The orientation that this research program should take is defined by a list of recommended objectives.

Discussions of optimum locations and general designs of marsh establishment on dredged materials precedes a final discussion of possible specific sites for marsh establishment in the lower Columbia, Willamette, Yaquina, and Siuslaw Rivers.

INTRODUCTION

The identification of acceptable dredged material disposal areas for the new and recurring federal maintenance dredging projects is an increasingly difficult problem for all Districts of the Corps of Engineers. The availability of accessible upland disposal areas is on a decline as waterfront properties are becoming increasingly developed for residential use. Interest in the use of such properties for dike and fill is limited largely to owners who are developing or improving commercial, industrial, and public facilities. Ocean disposal of dredged materials is economically limited to dredging projects located near the mouths of estuaries.

Use of dredged materials for the development of new marshlands in the vicinity of dredging projects offers an alternative concept for dredged materials disposal that is economically and environmentally attractive. The value of marshes to the fisheries, to wildlife, for shoreline erosion control, and for water quality improvement is broadly recognized. Marshes are understood to be a vital component part of any productive estuarine system.

Marsh development on dredged or fill materials is not without its skeptics. One such group, the conventional conservationists, has been led to believe that the marshland natural resource is basically nonrenewable, as are our natural mineral resources, taking eons to evolve naturally. These conservationists can't accept that a fully functioning marshland can be developed by man within just several years. They offer rationales that existing marshlands are so situated and functioning to provide their many values through a design uncontrolled by man and that any man-made marshland must be short-lived or not be of functional value, for if it were to be, there would be a natural marsh in its place.

This reasoning is not altogether nonsensical and it can be abstracted to be of service in the selection of potentially acceptable sites for marsh establishment. It should be recognized, however, that both man and nature are continually altering the hydraulic and sedimentary processes in our estuaries and these processes, in turn affect the biogeography of the estuarine tidal marshes. Estuarine marshes are not all at equilibrium with the system - some are, some are eroding due to a lack of sediment supply, and others expanding or undergoing classical succession.

Another group of skeptics fears that marsh establishment may be viewed as a panacea by the Corps of Engineers in resolving its dredged materials disposal problems and by developers of wetland areas in resolving their federal and state permit acquisition problems. The fear of establishing a trade-off precedent (e.g., give up a marsh here and build one there) is a real one and those harboring this fear visualize that broad acceptance of this mitigative approach would encourage widespread development throughout our estuaries. Others visualize our estuaries filled with marshes on dredged materials with no open water for the fisheries.

These extreme visions would be understandable if it were not for existing federal and state regulatory agency processes together with the various associated resource agency reviews and recommendations. Although these agencies are not without their agency-specific near-sightedness, one must believe that rational policies will evolve in time that will allow selected use of well-designed marsh establishment as a legitimate mitigative measure for developing in wetlands and as a viable disposal alternative for dredged materials.

Yet another group of skeptics consists of the mudflat advocates. This group envisions that marsh establishment on dredged materials will lead to losses of valuable areas of intertidal mudflats in high tidal amplitude estuaries and of shallow subtidal mudflats in low tidal amplitude estuaries. These mudflats are as vital a component of productive estuaries as are marshes, for they are colonized often (1) by clams that are of commercial and recreational importance, (2) by various invertebrates that are food for avifauna, (3) by rooted submerged aquatic plants with their associated epiphytes, mollusks (e.g., scallops) and crabs that are of commercial and recreational importance as well as food for waterfowl, and (4) by benthic microflora, bacteria and algae that are of importance as food for marine and aquatic animals. Additionally, many of the chemical cyclings that occur in estuaries take place within these mudflats.

This concern of the mudflat advocate is valid, as often otherwise suitable sites for marsh establishment on dredged materials occur on and adjacent to mudflat areas. These valuable mudflats are lost when marsh establishment on dredged materials is designed to occur within areas confined by structures such as a dike, as in Figure 1A. Even if the dike is reshaped and graded after the marsh has become established (Figure 1B), the additional mudflat area to be gained is not likely to approach that lost.

However, when dredged materials are disposed offshore or alongshore in an unconfined manner, as shown in Figure 2, the opportunity exists to develop a new continuum of elevations, following the contours of the preexisting bottom, that affords no loss of mudflat area. If a dike is considered essential for containment or protection purposes, then the dike can be constructed at a location that does not infringe upon the new mudflat area (see broken line in Figure 2). Once developed, these new mudflat areas can be transplanted to invertebrates and flora or left for natural colonization.

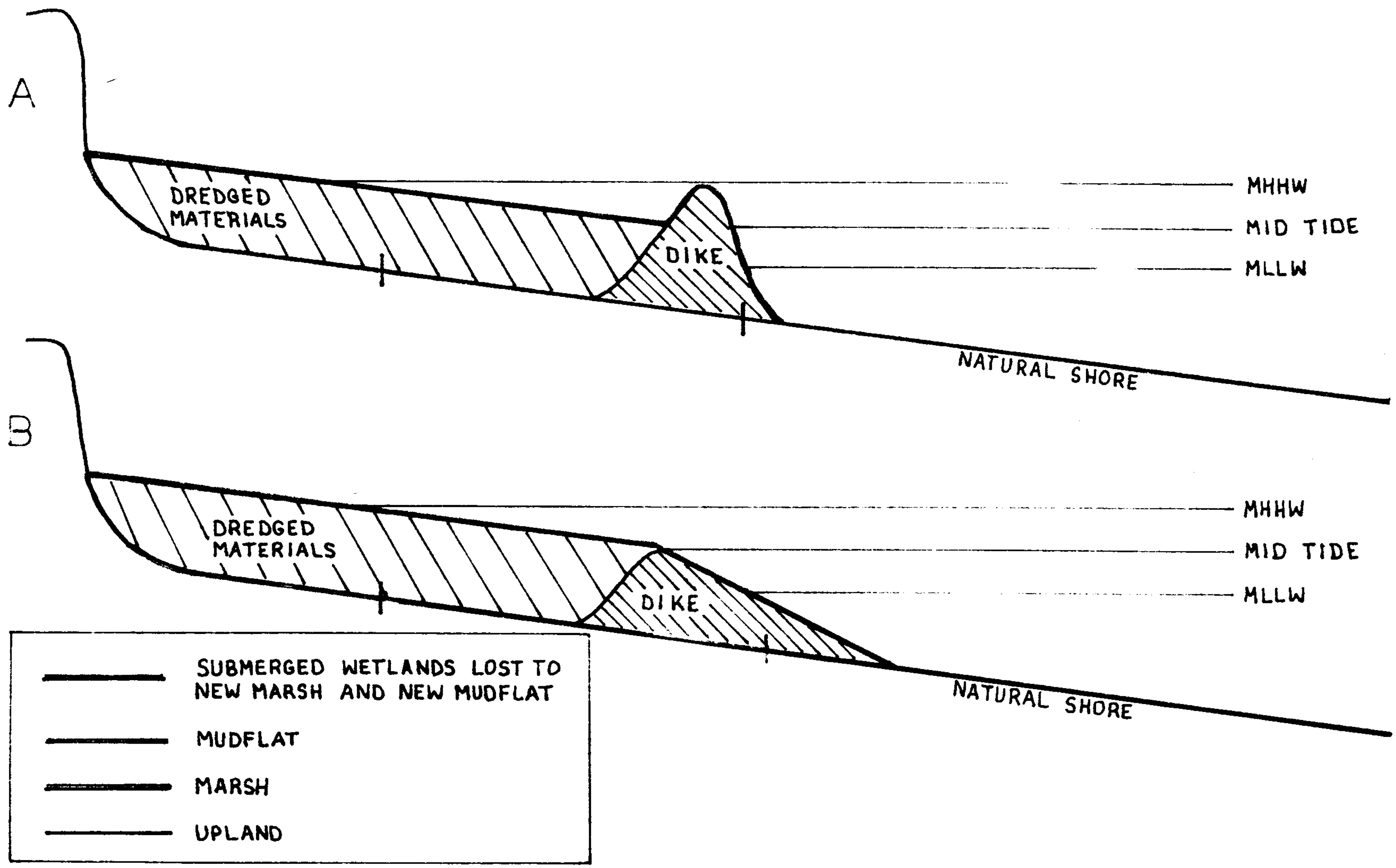

Figure 1. Marsh establishment on dredged materials confined by a dike showing (A) the nearly complete loss of valuable mudflat area and (B) the modest recovery of mudflat area after sloping the dike.

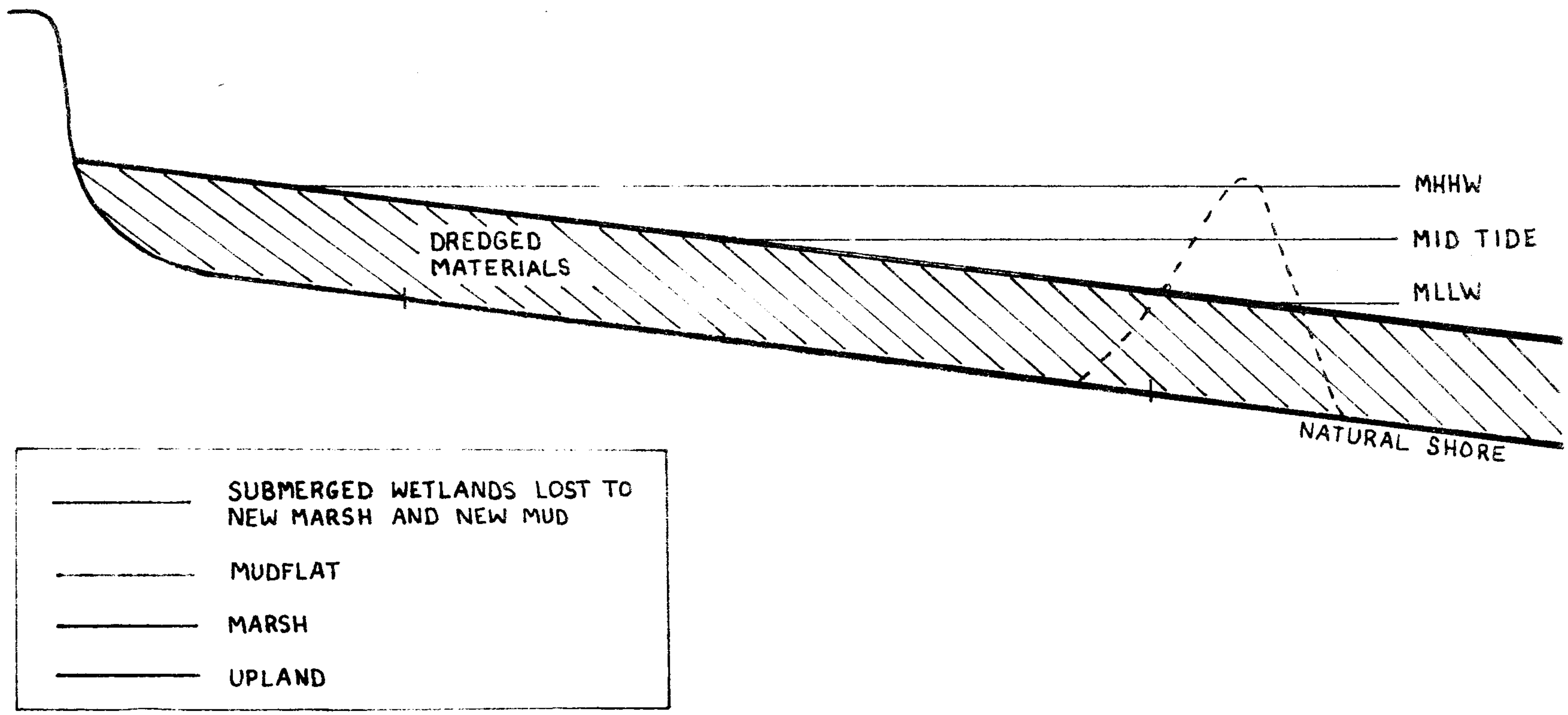

Figure 2. Marsh establishment on unconfined dredged materials leading to the recovery of the mudflat area filled.

Whatever the project design, loss of aquatic habitat is inevitable. New marsh and new mudflat establishment will lead to permanent loss of submerged wetlands. It should be decided by the authorities on a project-specific basis whether such a transfer of submerged wetlands to intertidal wetlands is beneficial, is of little consequence, or is injurious to the particular region of the estuary.

Feasibility of Marsh Establishment in Oregon Estuaries

Technically marsh establishment is agriculture on wetlands. And since agriculture is feasible with various physical limitations, anywhere in the world where there is soil and a source of water, marsh establishment on hydric soils (wetlands) is similarly feasible with no geographic limitations. The biogeography of estuarine marshes is regulated by tides whose periodicities and amplitudes are statically controlled by celestial bodies, with exceptions where winds may have a significant influence. This vastly simplifies marsh establishment in estuaries, as the zone of hydric soils on which marsh plants grow lies within the relatively constant tidal zone. Tidal estuarine marshes can be established wherever such marshes are naturally found. Marsh establishment is feasible in the estuaries of Oregon.

The important matter in marsh establishment is methodology and this should be seriously considered by the Portland District.

Methodology of Marsh Establishment

Given a person with a green thumb, the probability that this person could excavate a plug of *Carex lynbyei* (Lynbye's sedge) from a specific elevation of a saltmarsh in Oregon and successfully transplant it to the same elevation on a developed dredged material tidal flat nearby would be greater than the probability that this person could excavate a Tsuga heterophylla (Western hemlock) sapling from the forest and successfully transplant it to his back yard. This is so because the successful establishment of marsh plants does not appear to be limited to sediment type. Sediment primarily is a physical support for marsh plants. Water and nutrients are available from the tides (this is somewhat simplistic, as fertilization in many sediment types may greatly enhance marsh establishment and water stress at high elevations in highly permeable sediments may limit marsh establishment).

Consequently, if the Portland District were to adopt the general method of excavating naturally occurring marsh plant species and transplanting these excavated materials to appropriate elevations on a tidal dredged materials flat nearby, as shown in Figure 3, marsh establishment on dredged materials could begin immediately in Oregon estuaries. Refinements regarding the optimum time of year to conduct the transplanting, the need for fertilization, and the need for temporary or permanent breakwater protection could be evaluated empirically.

However, if the Oregon State Department of Transportation contracts the landscaping a highway with Western hemlock, it is unlikely that the contractor would be permitted or otherwise would rumage through the State Forest Preserves and excavate Western Hemlocks that meet the contract specifications. The contractor, most probably would obtain the specified plant materials from a qualified liscensed nursery. Similarly, should the natural marshes of Oregon be the source (other than for seeds and starter nursery stock) of plant materials for marsh establishmant in Oregon estuaries? It is not only a question of principle, for many marshes that are sparsely and otherwise

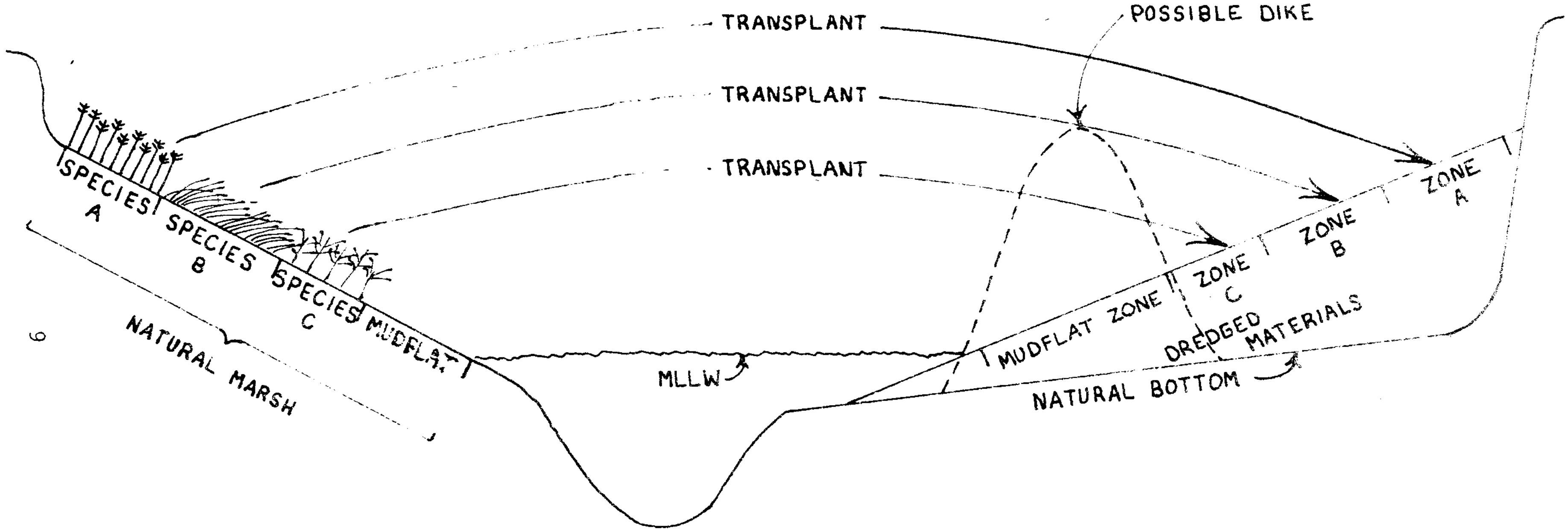

Figure 3. Schematic representátion of marsh establishment through transplanting natural marshes.

properly excavated can naturally rejuvenate. It is a question of economics. Excavating natural marsh stock is more expensive than purchasing nursery stock, provided marsh establishment is a recurring process and there is a market for such plant stock.

Should marsh establishment on dredged materials be seriously pursued in the future throughout Oregon estuaries, it is recommended that the Portland District develop, through subsidized applied research, a more professional and sophisticated methodology than outlined above. Expenditures for such applied research might be justified on the basis that in the long run maintenance dredging funds would be saved through increased efficiencies and successes and lower costs for marsh establishment.

Such an applied research program could be coordinated with a variety of experimental marsh establishment projects that would cover a range of water salinities, exposures to wave stress, and sediment types. Recommended objectives of the program are ones that would ultimately lead to the successful design and execution of marsh establishment projects. These objectives, some of which may be achieved through literature research, are:

1. To develop a working knowledge of the practical biology of selected freshwater and saltwater marsh perennial plant species that includes:

   a. To understand the range in elevations within the tidal zone that the selected species can become established.

   b. To understand the flowering sequences of the selected species, the times for harvesting their respective seed, and the afterripening characteristics and optimum storage conditions for their respective seed.

c. To understand the plant dormancy requirements of the selected species.

d. To understand the tolerance levels of the selected species to wave and salt stresses.

e. To understand the sediment stabilizing characteristics and the rates of vegetative spread of the selected species.

f. To understand any limitations in the times of year for successful seeding or transplanting various nursery stock of the selected species.

g. To identify the need for initial or maintenance fertilization that might be required to ensure rapid plant establishment and continued plant development, particularly as it might be related to high wave energy and/or high salinity areas.

2. To develop methods of nursery cultivation and propagation of the selected plant species, and to provide a variety of peat-potted nursery stock, bare root nursery stock, and seeds for field-scale experimental plantings.

3. To understand the resident and transient wildlife populations within the estuaries of Oregon and their relationship to the estuarine marshes. To

understand the risks of wildlife predation on newly planted marshes and to develop vegetative and/or physical methods to minimize the loss of a project through wildlife depredation. To understand, at least qualitatively, the relationships between marsh type - marsh size and the populations of wildlife that the marsh can accomodate before succumbing to the populations.

4. To develop specifications for the physical development of dredged material marsh establishment sites (much of this information is already available).

Recommended marsh plant species to select for initial nursery propagation and marsh establishment evaluation are given in Table 1. The plant species in Table 1 are all perennial and the number of saltwater species exceeds that of freshwater ones. As opposed to freshmarshes, saltmarshes rarely consist of significant contributions of annual plants. This may reflect the apparent difficulty of rapid natural saltmarsh establishment from seed. Pioneering of tidal saltwater flats by saltmarsh seedlings often is sparse. The marsh develops through the vegetative propagation of these individual pioneers.

The species diversity in tidal freshmarshes generally greatly exceeds that in saltmarshes, although monotypic marshes may exist in both freshwater and saltwater. Additionally, freshmarshes often may consist largely of annual plants (e.g., *Polygonum* spp.). Consequently, in freshwater marsh establishment, initial stabilization of the dredged materials is of primary importance. Species diversity can be expected to increase rapidly as the established ground cover marsh traps the

Table 1. Recommended marsh plant species for nursery propagation and marsh establishment evaluation in Oregon estuaries.

Species	Water Salinity	Tidal Range for Establishment
Triglochin maritima (seaside arrowgrass)	salt	MT - MHHW
Carex lyngbyei (Lyngbye's sedge)	salt	MT - MHHW
Deschampsia caespitosa (tufted hairgrass)	salt	MHW - MHHW
Distichlis spicata[a] (seashore saltgrass)	salt	MHW - MHHW
Agrostis alba (red top)	salt	MHHW +
Juncus balticus (Baltic rush)	salt	MHHW +
Scirpus americanus[a] (three square)	fresh	MT - MHHW +
Sagittaria latifolia[a] (wapato)	fresh	MT - MHHW
Carex obnupta (slough sedge)	fresh	MHW - MHHW +

a. Also found in East Coast tidal marshes.

generally abundant supply of seeds of annual and perennial marsh plants and renders shelter for subsequent seedling development.

Locations for Marsh Establishment on Dredged Materials in Oregon Estuaries

Estuarine tidal marshes, if they are to be physically stable systems, require a supply of sediments of sufficient particle size (i.e., silt or coarser) to be vegetatively trapped and retained. When this supply to natural marshes is lost, due to, for example, the construction of a jetty, a causeway, or a dredged channel (across which coarse sediment cannot pass), the marsh is destined to erode at a rate proportional to its exposure to wave stress. The ultimate stability of a marsh is related to the difference between the rate of loss of sediment (i.e., cu yds lost per year) from erosion and the rate of sediment supply. If the rates are comparable, the marsh will be in physical equilibrium with the system. When the rate of loss exceeds that of gain, the marsh will undergo a net annual erosion. When the rate of loss is less than that of gain, the marsh will expand horizontally and vertically.

Unprotected (e.g., undiked) marshes should be established in areas where there is evidence of a supply of sediment. For example:

1. offshore and alongshore in shoaling areas

2. contiguous to or in the immediate vicinity of stable or expanding natural marshes

3. contiguous to unvegetated eroding shores that are experiencing a supply of sediment

Unprotected marshes should not be established in areas experiencing a loss of sediment. For example:

1. offshore and alongshore in areas experiencing bottom scouring

2. contiguous to or in the immediate vicinity of eroding natural marshes

3. in areas where existing or planned structures are expected to obstruct sediment supply

Until known to be feasible, the establishment of unprotected marshes should not be attempted in areas that are so exposed to waves that natural marshes are nonexistent.

If the conditions outlined above are favorable, ideal locations for marsh establishment may be within abandoned log storage corridors. These corridors generally will have existing pilings which are obstructions to navigational use of the areas. Also, they may be biologically unproductive due to shading and to leaching of possible toxins from the logs during storage.

General Designs for Marsh Establishment on Dredged Materials in Oregon Estuaries

The physical development of a dredged material site for marsh establishment is the most critical phase of the project. Elevation is the name of the game, as tidal marsh species correlate strongly with narrow elevational ranges within the regional tidal range. In an 8-foot tidal amplitude area (MHHW relative to MLLW) the marsh zone will lie approximately in the upper 4 feet and marsh species can be expected to be elevation specific to $\pm$ 1-foot within this zone. In lower tidal amplitude regions of estuaries, the elevation tolerances become tighter.

The structural and configurational design of a marsh establishment site should be such that the sediments are stable under average prevailing conditions without vegetation. The area should be well-drained at MLLW with minimum pockets of standing water. This is particularly important at the higher elevations of saltwater sites, as toxic supersaline conditions in these pockets can develop through the evaporation of salt-water.

Marsh establishment sites can be designed for single or periodic disposal use. Provided site stability can be achieved within the disposal limits, an unconfined (undiked) design is preferred. It is also the most economical design and accomodates the maximum volume of dredged materials, As discussed earlier, an unconfined site design allows the most natural configuration to be developed. Mudflat areas inpacted can be re-developed.

Energetics within a marsh is another factor that should discourage the development of a confined design. One of the most important values of tidal marshes derives from the export of produced organic material to the surrounding estuarine waters. This export requires energy - energy to naturally harvest the standing crop of vegetation and energy to export it. Waves, currents, and tides provide this critical energy. Under a confined design, wave and current energies are largely excluded from the marsh with the result that the annual standing crop is contained on the site, often smothering live plants or otherwise limiting marsh growth the following year. Together with the loss of exported matter, confined marsh productivities can be expected to decline with time.

But too much of a good thing may be harmful, and in many areas wave energies may exceed the tolerance levels of the marsh to be established. In such instances, at least a partial dike breakwater may be essential along the exposed sides of the site. If the use of a dike is considered necessary, and the energetics at the site permit, the dike should be graded to the surface of the marsh, sloped seaward, and vegetated after the confined marsh has become established.

The two basic designs for marsh establishment on dredged materials are island development and alongshore development. These designs together with their relative merits are discussed below.

1. Island Development

Of the two basic designs, island development renders the maximum environmental benefits and offers the greatest opportunity for constructive innovation for the following reasons.

a. offers minimum access for people and maximum access for wildlife

b. offers the best potential for the export of organic marsh materials

c. offers fewer problems in functioning as a catchall for debris and logs

d. offers the best opportunity for the development of maximum habitat sites, including upland vegetated and unvegetated areas, upland freshwater ponds, and tidal lagoons.

Generally, the maximum diversity in habitat, the maximum diversity of wildlife use

e. offers the maximum design flexibility for continued use as a disposal area

f. offers generally the greatest volume per unit area for dredged materials

The seaward slopes of islands developed from dredged materials should be sufficiently gentle so that surf energies are minimum and benthic organisms and marsh plants can survive. Generally, the greater the wave energy the gentler the slope so that energies are dissipated largely through shoaling before reaching the marsh zone. Slopes of 30:1 to 60:1 may be required in high wave energy environments unless dike or breakwater protection is provided.

Two concepts for island development, (a) nearshore and (b) offshore, are illustrated in Figures 4 and 5, respectively. In the nearshore island concept, the island is developed seaward of the existing mudflat zone, thereby increasing this valuable resource upon the development of the island. Sufficient subtidal area between the island and the existing shore should be included to allow tidal currents to develop for the export of marsh matter. The island should be developed on the side of the channel where sediment accretion is occurring. Often, this may be located at or near the bends in rivers. Depending upon the size of the island, some of its area may be developed into upland habitat.

In the offshore island concept (see Fig. 5), the configuration of the island, it would appear, should coincide approximately with that of the shoaling bottom with the axis of the

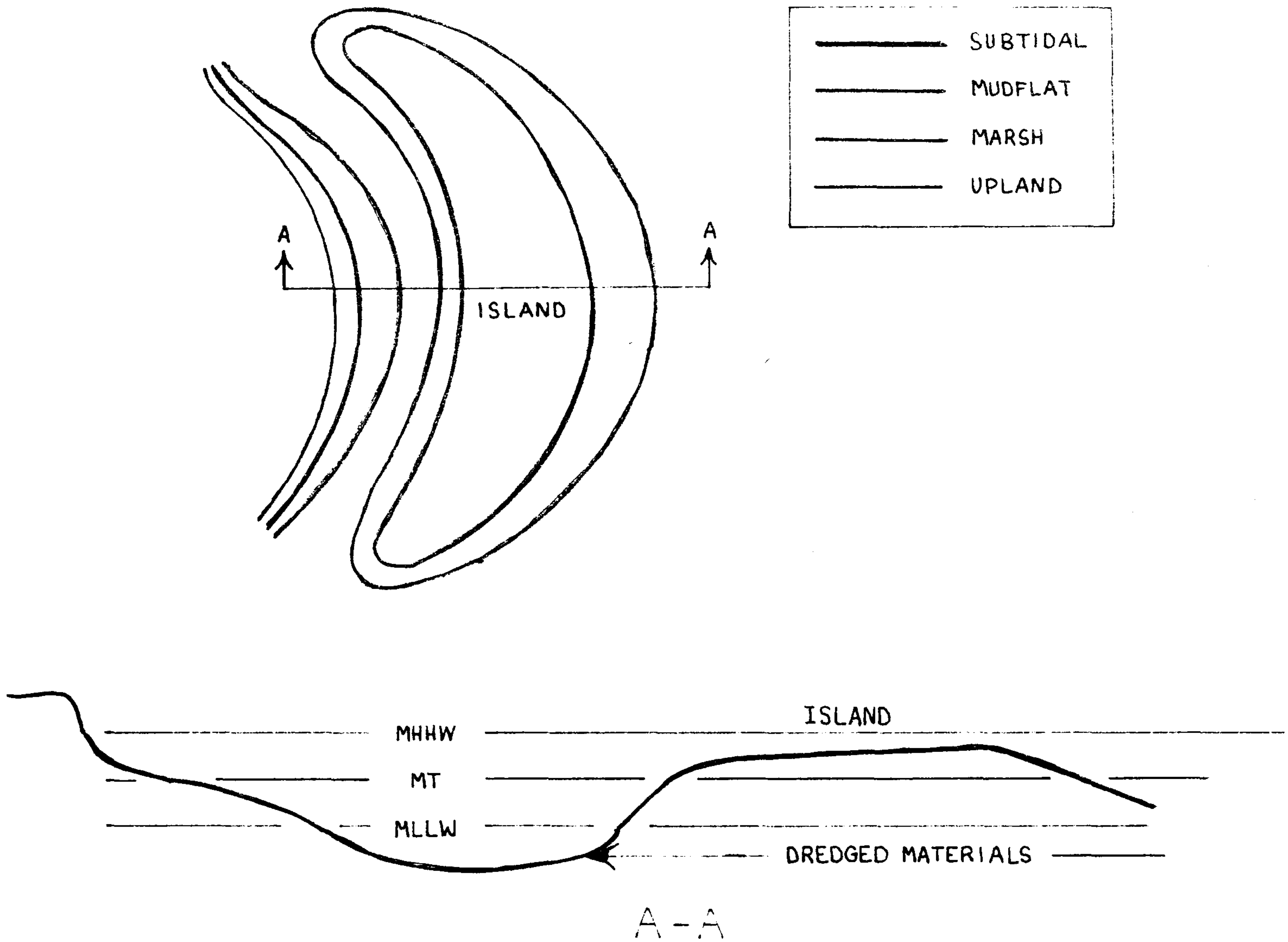

Figure 4. Schematic representation of the nearshore concept for marsh island development.

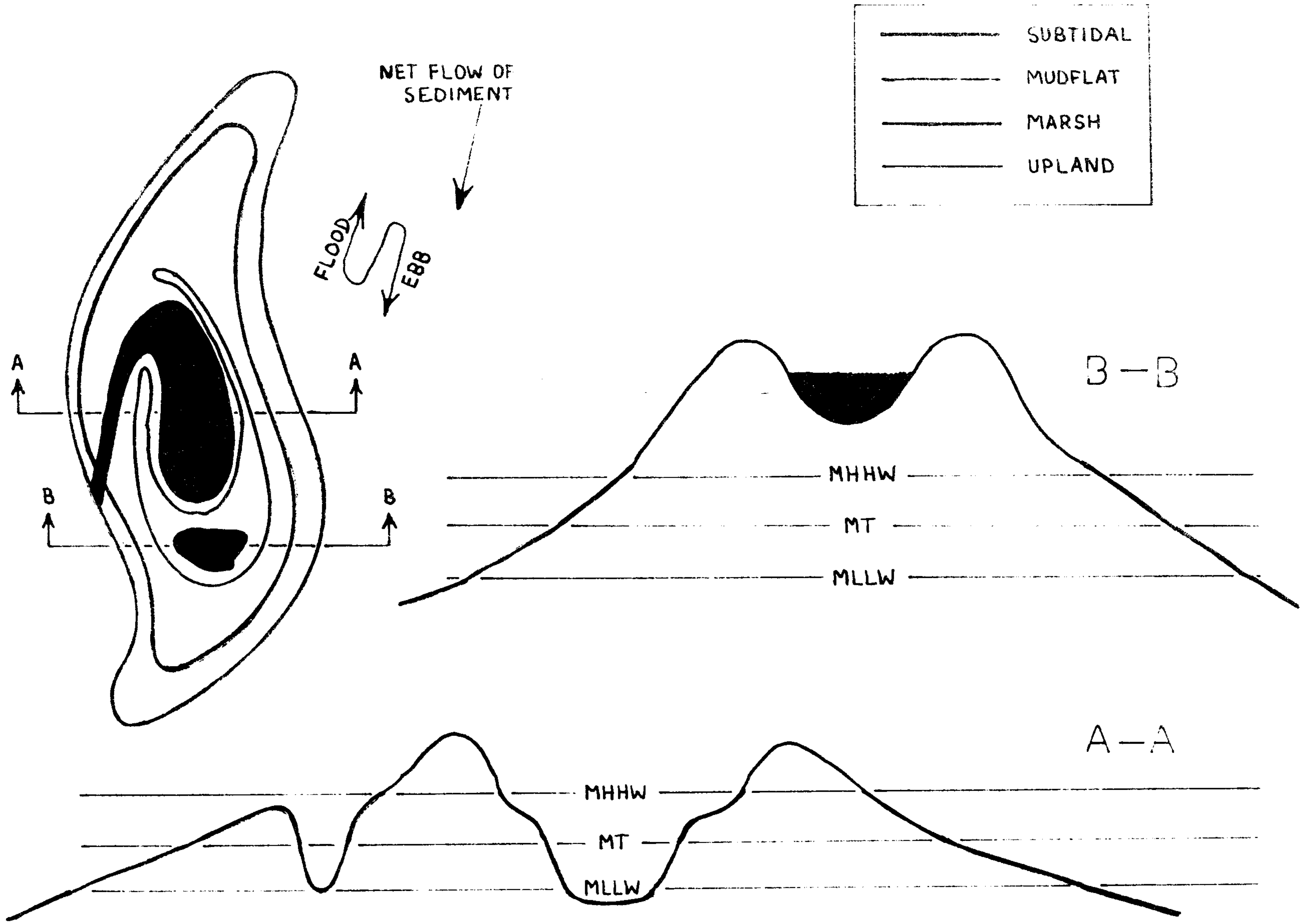

Figure 5. Schematic representation of the offshore concept for diversified habitat island development.

island paralleling the flow of the tides. Any tidal cut into the island should occur on its lee side where the rates and volumes of transported sediment are likely to be least. The mouth of the tidal cut should face the direction opposite from that of the net flow of sediment. If the island is large, one or more tidal cuts plus possibly a connected lagoon will facilitate the water flow throughout the marsh and assist in the export of marsh matter as well as deposited debris. Depending upon the elevation to which an upland area, if any, is developed, groung water may allow the development of freshwater ponds in saltwater estuarine areas. The island could be developed in stages in areas where periodic maintenance dredging is forecasted.

2. Alongshore Development

Establishment of marshes on dredged materials developed alongshore may be the only design feasible in narrow sections of estuaries. Unvegetated shores that are undergoing erosion are candidate sites, provided some supply of sediment is apparent. Also, as discussed previously, shores associated with abandoned log storage corridors may be particularly attractive sites. Marsh fringed shores should not be excluded from consideration, as the existing marsh might be expanded.

Although an occasional opportunity might become available for the development of upland together with marsh and mudflat habitats alongshore, diversifying the habitat developed will be limited largely to island development.

A problem with alongshore marsh establishment, particularly in Oregon estuaries, is that potentially extensive quantities of logs may accumulate throughout the higher elevations of the established marsh, near the transition zone to upland. The marsh underlying these log deposits will be lost. Such deposits are only transient in marsh islands, as they are eventually washed out on spring and storm tides.

Several concepts for the establishment of marshes on dredged materials developed alongshore are depicted in Figures 6 and 7.

Possible Sites for Marsh Establishment in Oregon Estuaries

During the period of 19-24 August 1977, the author together with representatives of the Portland District visited various locations in the lower Columbia and the Siuslaw Rivers where potential dredged material disposal problems exist, and toured the entire Yaquina River for which disposal needs for the next 20 years have been identified and a disposal plan presented by Wilsey & Ham of Portland, Oregon under commission by the State and Lincoln County. The purpose of these visits was to make recommendations for the locations and designs of any potential marsh establishment projects. A specific site off of the Multnomah Channel in the Willamette River at River Mile 1.5 also was inspected for its suitability as a marsh establishment site for implementing Section 150 of the Water Resources Development Act of 1976. A dredged material disposal site in the lower Columbia River, Rice Island, was very briefly viewed for possible upgrading from essentually barren sand to a marsh and upland wildlife habitat.

The time spent at these sites was too short and their inspections too superficial to develop anything but the most qualitative evaluations and recommendations. However, these should be of some value for purposes of initial planning. They also may serve as an impetus to the Portland District to decide whether to move forward with a serious marsh establishment program.

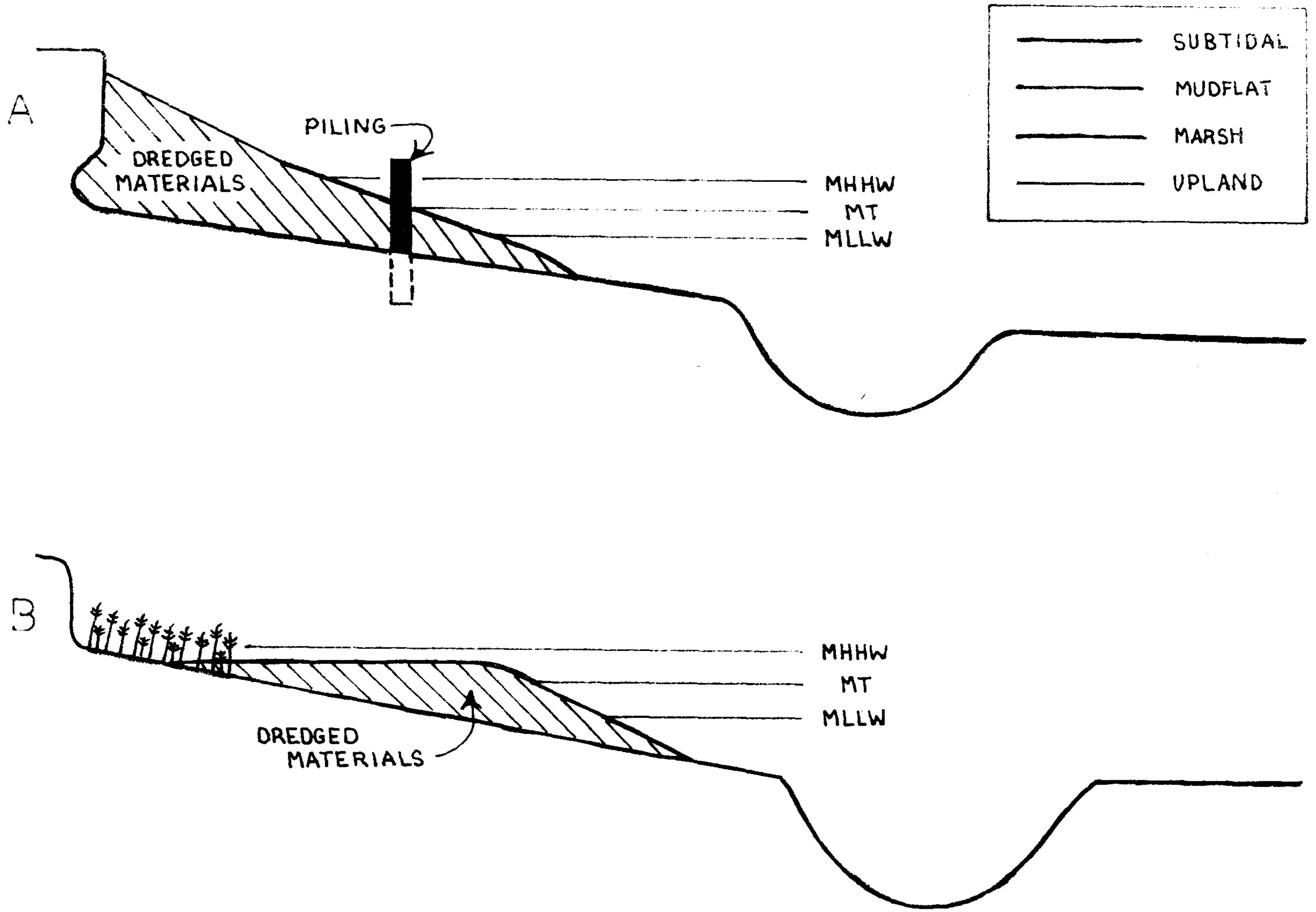

Figure 6. Marsh (and upland) habitat establishment on dredged materials developed (A) along an eroding unvegetated shore associated with an abandoned log storage corridor and (B) along a shore with an existing marsh fringe.

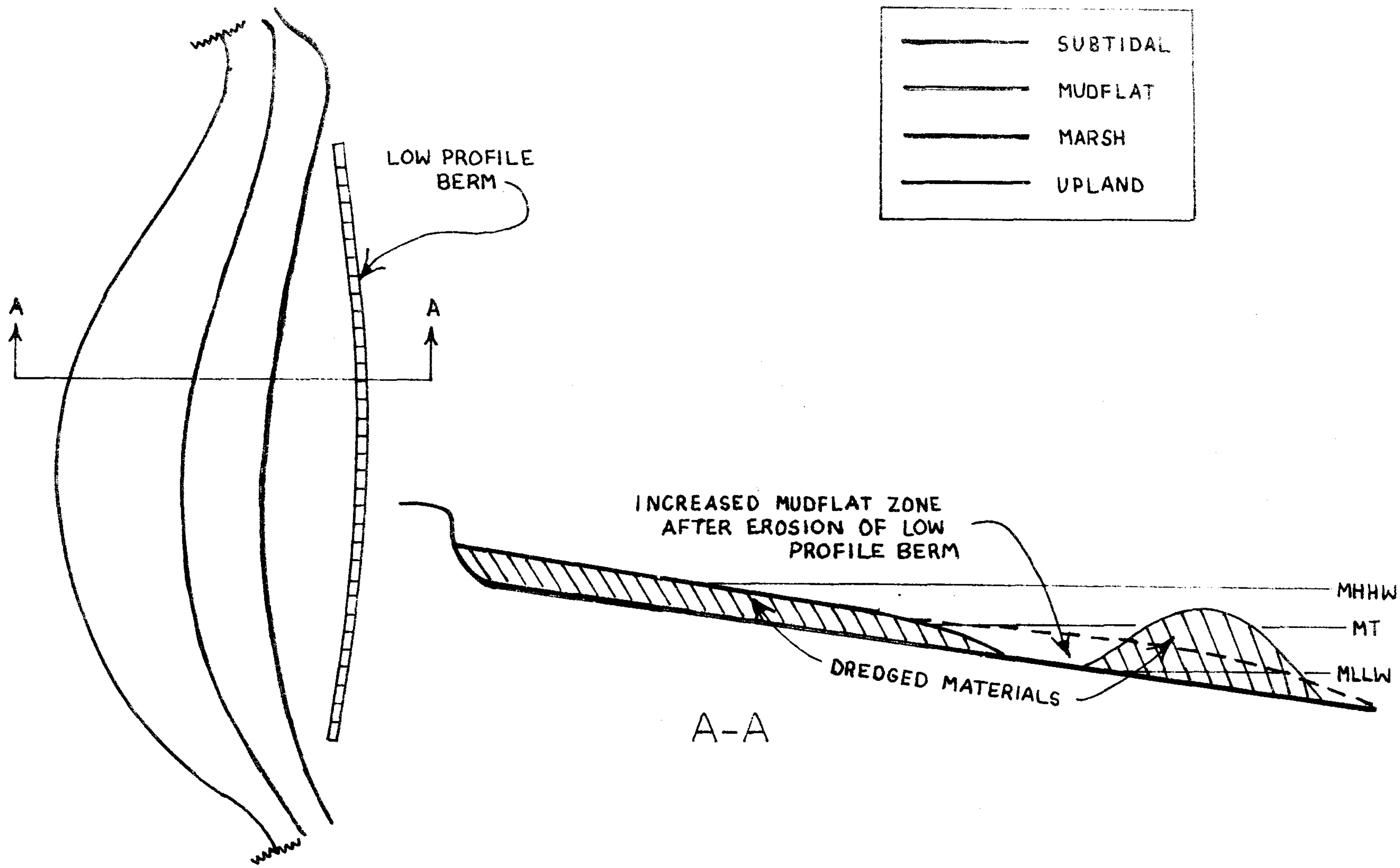

Figure 7. Schematic design of possible marsh establishment on dredged materials developed along a high energy shore. The low profile berm developed from dredged materials renders temporary protection for marsh establishment and eventually will erode to provide an extended mudflat zone.

1. Lower Columbia River

Possible sites were evaluated for marsh establishment on materials dredged from the Astoria, Oregon dock slip area and from the Chinook Channel to the boat basin at Chinook, Washington. Previously, materials dredged from the Chinook Channel were disposed in an upland dike just southeast of the boat basin and the materials dredged from Astoria have been disposed at sea. Sand Island, a site for habitat improvement, also is located in this region.

a. Astoria Sites. Possible saltmarsh island establishment sites for the sandy silt materials dredged from the Astoria dock slips are located in the areas of Desdemona Sands (Site-1), Smith Point (Site-2), and the center mouth of Youngs Bay (Site-3) as shown in Figure 8.

All sites are subject to high wave energies, with Desdemona Sands being the most exposed. Site-2 is best situated for pipeline dredging (cost ca. $2.00 per cu yd). It could accept over 400,000 cu yds of dredged materials to bring it to a marsh grade of +5 to +8 feet relative to MLLW. Site-1 may be the worst situated for pipeline dredging because its distance from the dock slips is nearly two miles (cost ca. $5.00 per cu yd). Bringing Site-1 southward would subject it to yet greater wave energies.

It is my feeling that the technology of marsh establishment in the northwest is insufficiently developed to proceed with any of the three sites described above. Information on the interrelationship between wave climates and successful marsh establishment should first be acquired through field-scale experimental marsh establishment at more promising (less wave stressed) sites. A failure at the beginning of a marsh establishment program would not only be unproductive in terms of

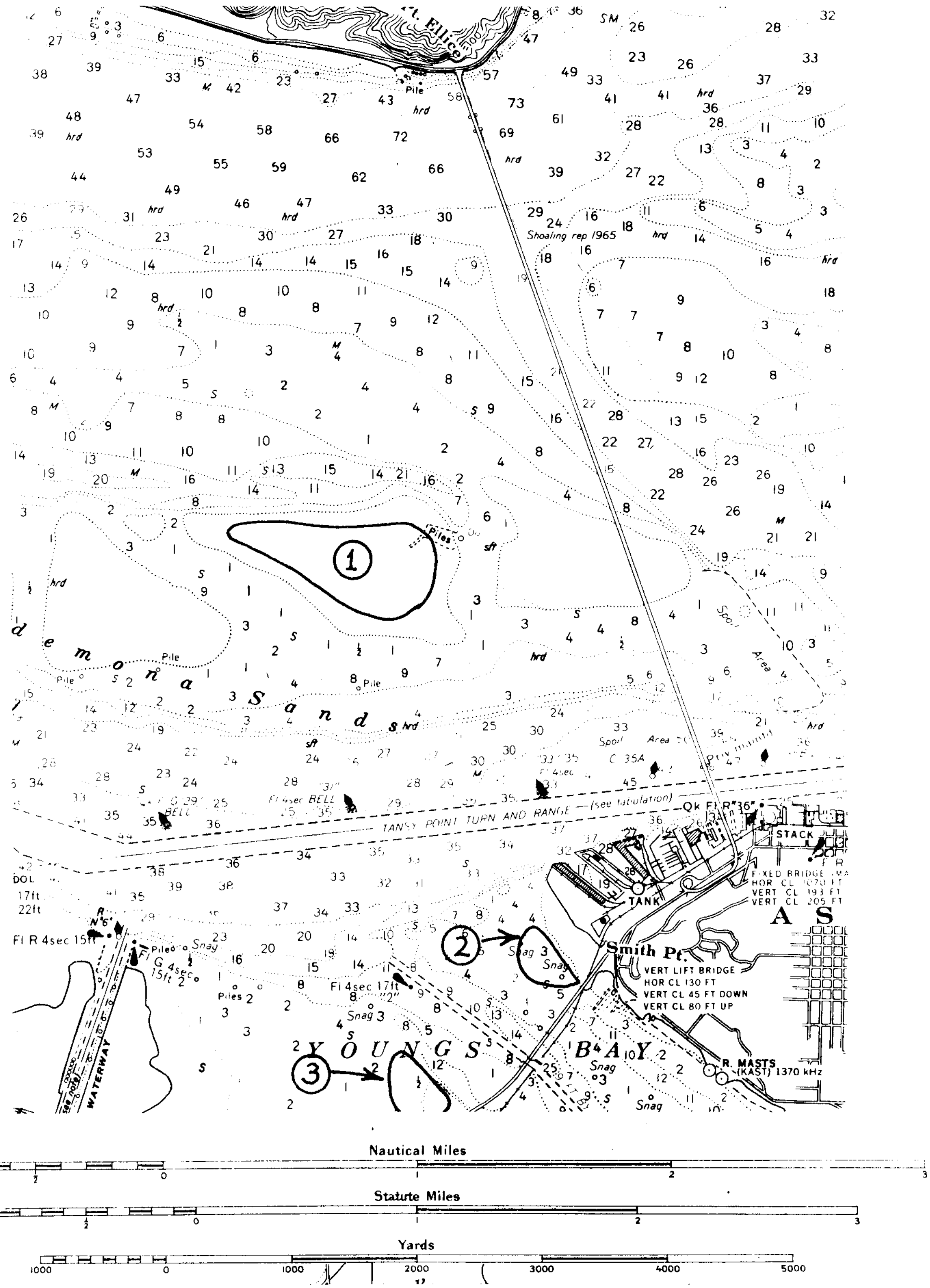

Figure 8. Possible saltmarsh establishment sites in the vicinity of dock slips at Astoria, Oregon, as shown on a section of C& GS Chart No. 18521.

information gathering, it could discourage pursuance of the program.

b. Chinook Channel Sites. Three potential sites for saltmarsh establishment on the fine-grained materials dredged from the Chinook Channel are located in Figure 9. Site-1 is located along the eastern half of the northern shore of Sand Island. Site-2 is located just west of the last flashing light No. 8 heading in Chinook Channel, and Site-3 is located just south of the Chinook boat basin. Site-3 is the most exposed site to the strong south-southwesterly storm winds and all three sites are exposed to the prevailing west-northwest winds. A fourth potential site is the sand flat just south of flashing light No.2 in Chinook Channel. The present configuration of this flat is better shown in the 21 August 1976 photograph shown in Condition Survey CL-5-172 of the Portland District. The soundings in this survey show channel shoaling particularly north to west of the sand flat suggesting that the channel may be a depository for sediments from the flat. For this reason, this site was not further considered as a viable disposal area.

All three sites lie within an economical pipeline dredging distance from the channel. Although existing bottom elevations are unknown, minimum estimates of the volume capacities (from existing grades sloped to marsh grades of +5' to +8' relative to MLLW within the boundaries shown) for Sites-1, -2, and -3 are 100,000 cu yds, 200,000 cu yds, and 200,000 cu yds, respectively.

It is recommended that the design of Site-1 be similar to that shown in Figure 7, with or without the temporary protective berm. Inclusion of the berm would increase the volume capacity of the site by about 40%, however, it may

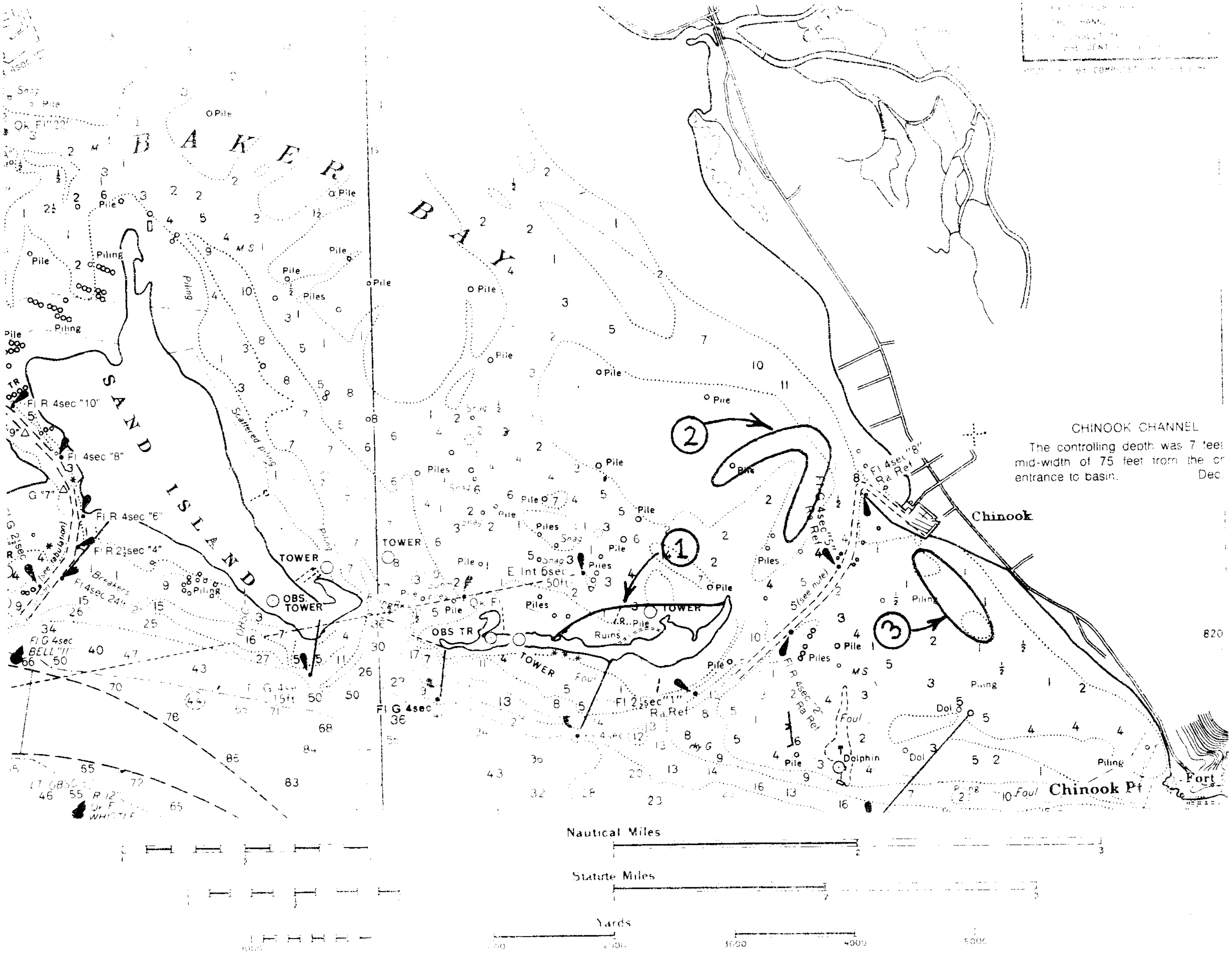

Figure 9. Possible saltmarsh establishment sites in the vicinity of Chinook Channel as shown on a section of C&GS Chart No. 18521.

not be feasible to construct a berm unless coarse-grained materials exist somewhere within the dredging limits. Both Sites -2 and -3 could be of the unconfined saltmarsh island designs similar to that shown in Figure 4.

It is uncertain to what extent the Chinook Channel and the jetty structures on the two Sand Islands and west of Chinook Point will interfere with sediment transport to the three sites. Assuming that none of the sites have a paucity of sediment supply, it is recommended that the eastern sections of Site-1 (with a protective berm, if feasible) and Site-2 be pursued as marsh establishment sites. This would allow simultaneous evaluations of protected and relatively exposed sites for saltmarsh establishment.

c. Rice Island. This dredged material island (see Fig. 10) was only viewed from the water after inspecting the marsh establishment work that is currently being conducted by the Waterways Experiment Station on Miller Sands Island. Rice Island mostly has steep-sloped shores grading to upland areas of varying elevations. Vegetation throughout appeared sparse and no vegetation was apparent on the shores.

Upgrading Rice I. to a productive wildlife habitat may be diffucult and expensive. At the high elevations to which Rice I. has been developed, the coarse-grained and low organic content sediments would not promote satisfactory development of many desirable plant species, particularly in view of the droughty summers that typically prevail in this region. Several plant species that may have some potential for establishment on Rice I. as it exists are provided in the Sauvie Island Game Management Area - Columbia River Dredged Spoils Report that is in the possession of Dr. Yvonne Weber of the Portland District.

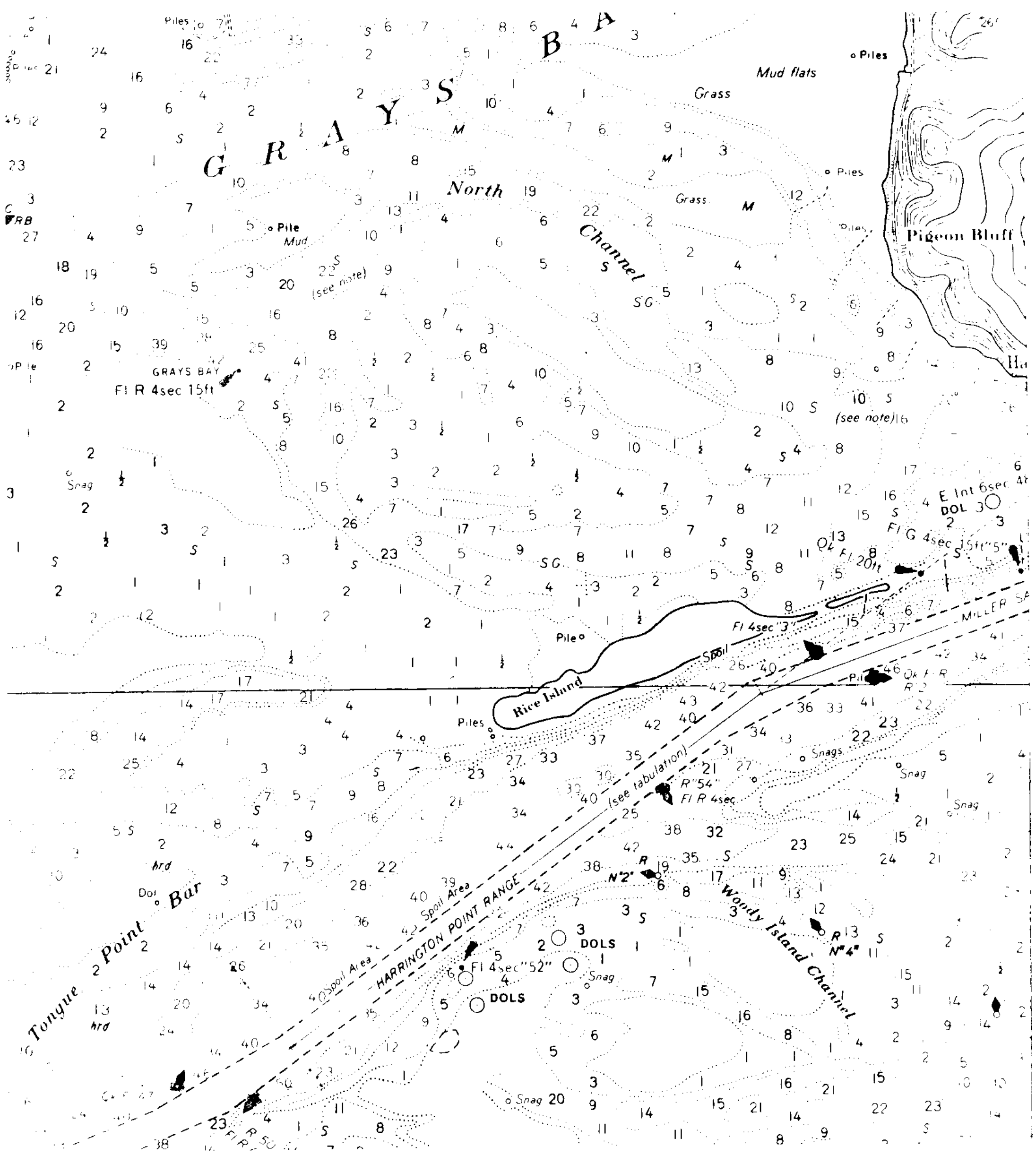

Figure 10. Section of C&GS Chart No. 18521 showing the location of Rice Island.

This report describes the relative successes of the 1972-1975 plantings of 37 species of dune and upland erosion control and wildlife habitat improvement plants on gravelly sand dredged materials disposed alongshore Sauvie Island Game Management Area. All of the plantings were above MHHW but at elevations lower than the dominant ones at Rice I.

Rice I. could best be upgraded by earthmoving - developing areas of various elevations, thereby allowing ground water stored at the higher elevations during the wet winter months to move downward supplying vegetation with moisture during the dry summer months. Developing island wetland areas as well as sloping the north shore and establishing marsh vegetation throughout would further diversify the habitat and improve the island's quality for wildlife.

It is recommended that the Portland District conduct topographic and vegetative surveys of Rice I. and determine what correlations may exist between elevations and vegetative communities. Then, a phased plan for habitat improvement might be developed in cooperation with the SCS Corvallis Plant Materials Center, the Oregon Department of Fish and Wildlife, and appropriate outside consultants.

2. Multnomah Channel Site

The Multnomah Channel Site is located on the Willamette River at River Mile 1.5. The Site, as shown in Figure 11, is bordered by woodland and a mixed freshmarsh fringe on the inside. The northwestern woodland fringe of the Site has breaches at five locations. Depths of the water bottom throughout the Site vary between 2 and 3 feet below the elevation of the fringe marsh. The volume capacity of the Site up to the existing marsh fringe grade is approximately 100,000 cu yds.

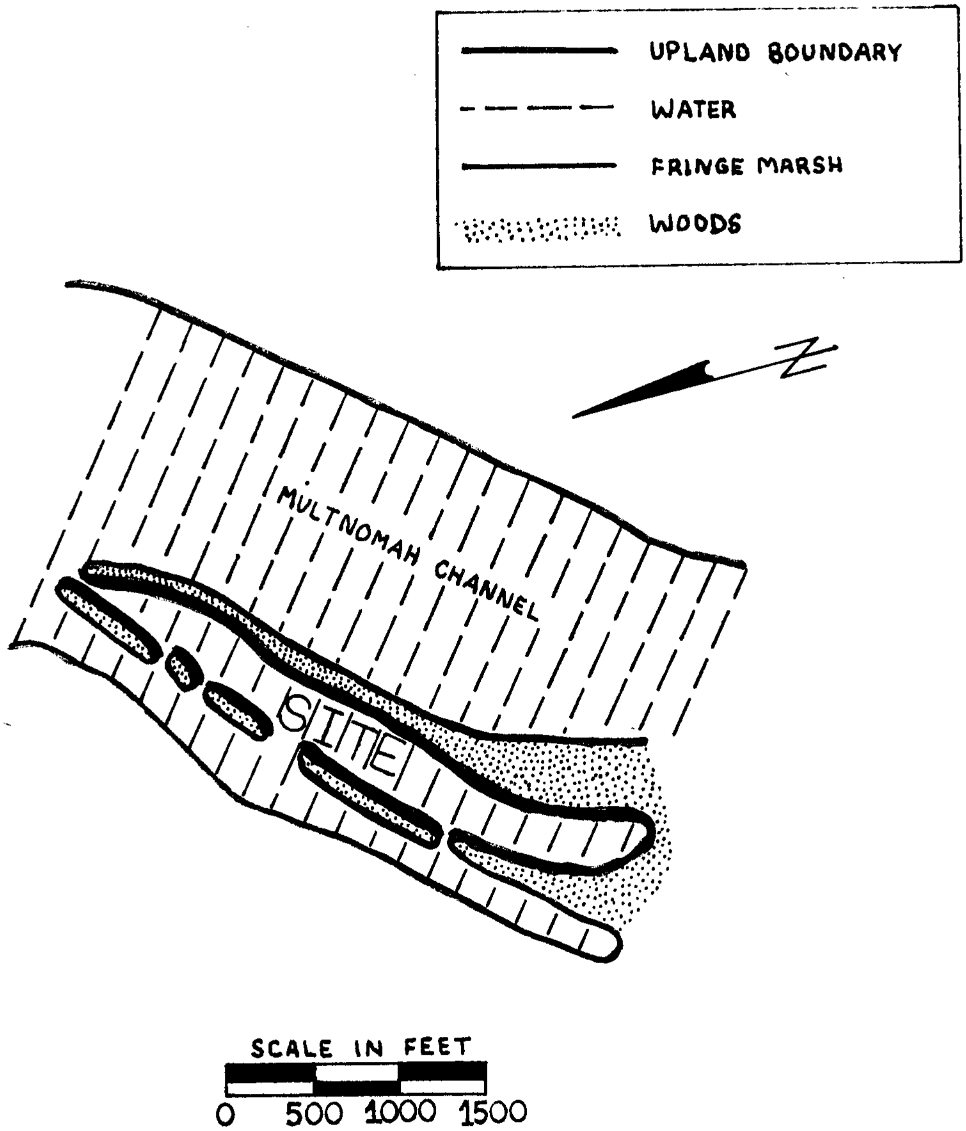

Figure 11. Multnomah Channel Site on the Willamette River at River Mile 1.5.

The Site is suitable for freshmarsh establishment on dredged materials. It is effectively confined, but should have good tidal circulation throughout due to the breaches in the woodland fringe. Its being protected from wave stress should not particuarly hinder the export of the produced organic matter, as freshwater plants appear generally to decompose at faster rates than do saltmarsh ones. Being confined with an existing marsh fringe around its interior, a freshmarsh probably would become established naturally within several years once the dredged materials were brought to the proper elevations. The process could be accelerated by transplanting or seeding plants at a modest density.

The Site could be used as an example of freshmarsh establishment on confined dredged materials. The "dike" is there, should there ever be a disposal need in this particular reach of Multnomah Channel.

3. Yaquina River Sites

Several potentially acceptable sites for marsh establishment on dredged materials exist throughout River Miles 5.7-7.9, 7.9-9.8, and 9.8-11.7 of the Yaquina River. Upriver from River Mile 11.7 log storage areas are in active use and no opportunities for marsh establishment appear feasible. The maintenance dredging requirements for these river segments over the next 20 years are reviewed in the aforementioned Dredged Material Disposal Plan (July 1977) that was prepared by Wilsey & Ham.

a. River Miles 5.7-7.9. One site in this section of the river appears promising. It is located at the western terminus of the shoaling region of the Channel and is shown in Figure 12. The recommended design is to extend the existing

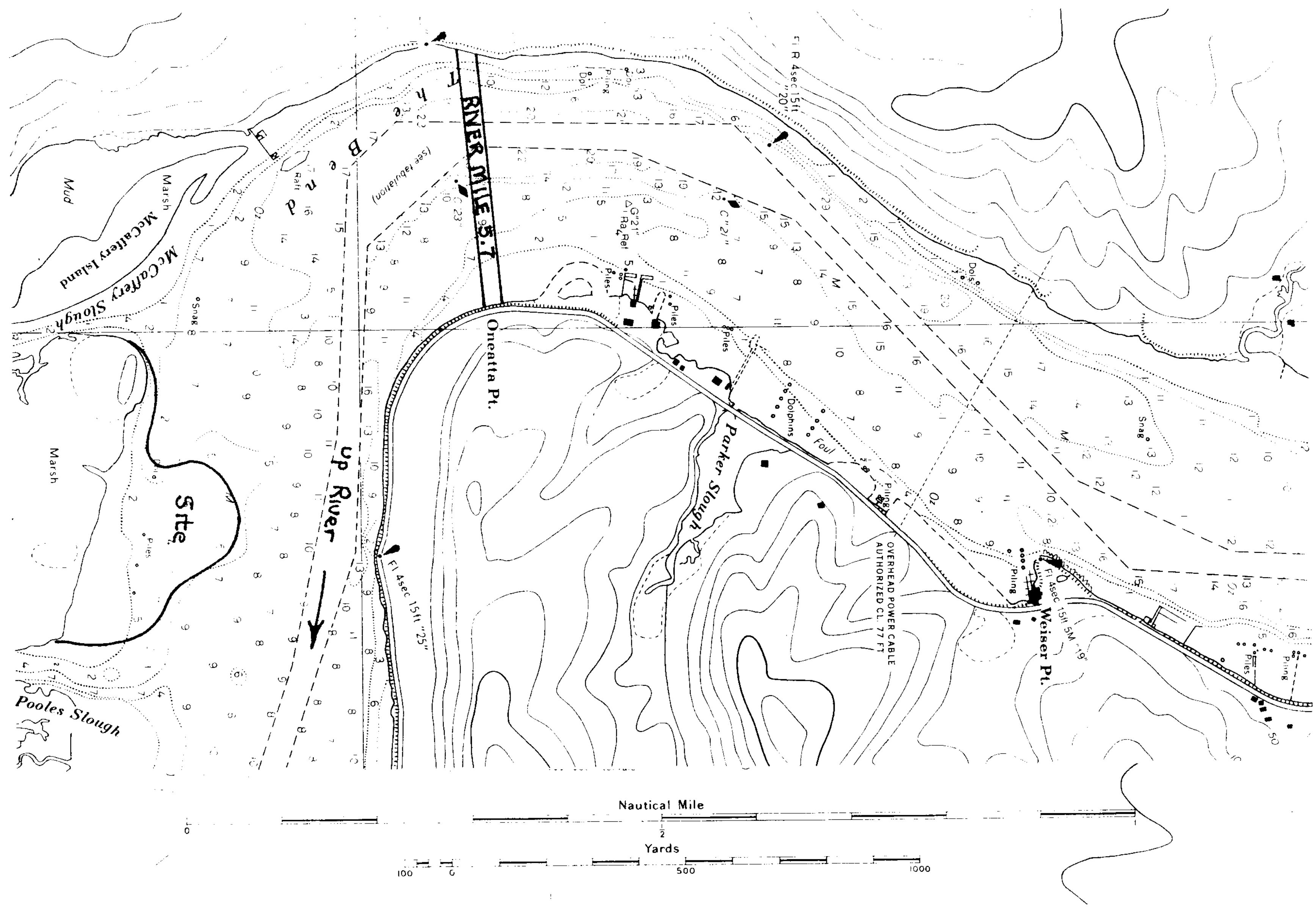

Figure 12. Section of C&GS Chart No. 18581 showing the location of a possible saltmarsh establishment site within River Miles 5.7-7.9 of the Yaquina River.

saltmarsh and mudflat channelward as depicted in Figure 6B. The existing marsh is relatively stable and there lies a steep-banked woodland at its western end.

The approximate volume capacity of the site is 50,000 cu yds, graded to existing marsh elevation. The 20-year dredged material disposal requirement for this river segment is about 75,000 cu yds. The Site is well located to accomodate the westernmost 3000 ft of the shoaling region of the Channel.

b. River Miles 7.9-9.8. Two possible marsh establishmant sites exist along this river segment. Site-1 is situated just east of RM 7.9 and Site-2 is situated just southwest of RM 9.8. Both sites are located near shoaling regions of the navigation channel (Wilsey & Ham report) and are identified in Figure 13.

It is recommended that both sites be of a marsh island design (see Fig. 4), surrounded by natural mudflats. Encroachment by the sites on existing mudflats is proposed to be minimal. The extension of Site-2 into an active log storage area may exclude it from being a viable site. Sites -1 and -2 have volume capacities, for dredged materials developed to marsh grade, of approximately 70,000 cu yds and 33,000 cu yds, respectively. Approximately 54,000 cu yds of materials are expected to be dredged from this river segment during the next 20 years (Wilsey & Ham report).

c. River Miles 9.8-11.7. Two possible marsh establishment sites exist in the lower half of this river segment. Site-3 is located in a marsh - shallow open water complex just east of River Mile 9.8 and Site-4 is located about 500 yds northeast of Site-3, as shown in Figure 13.

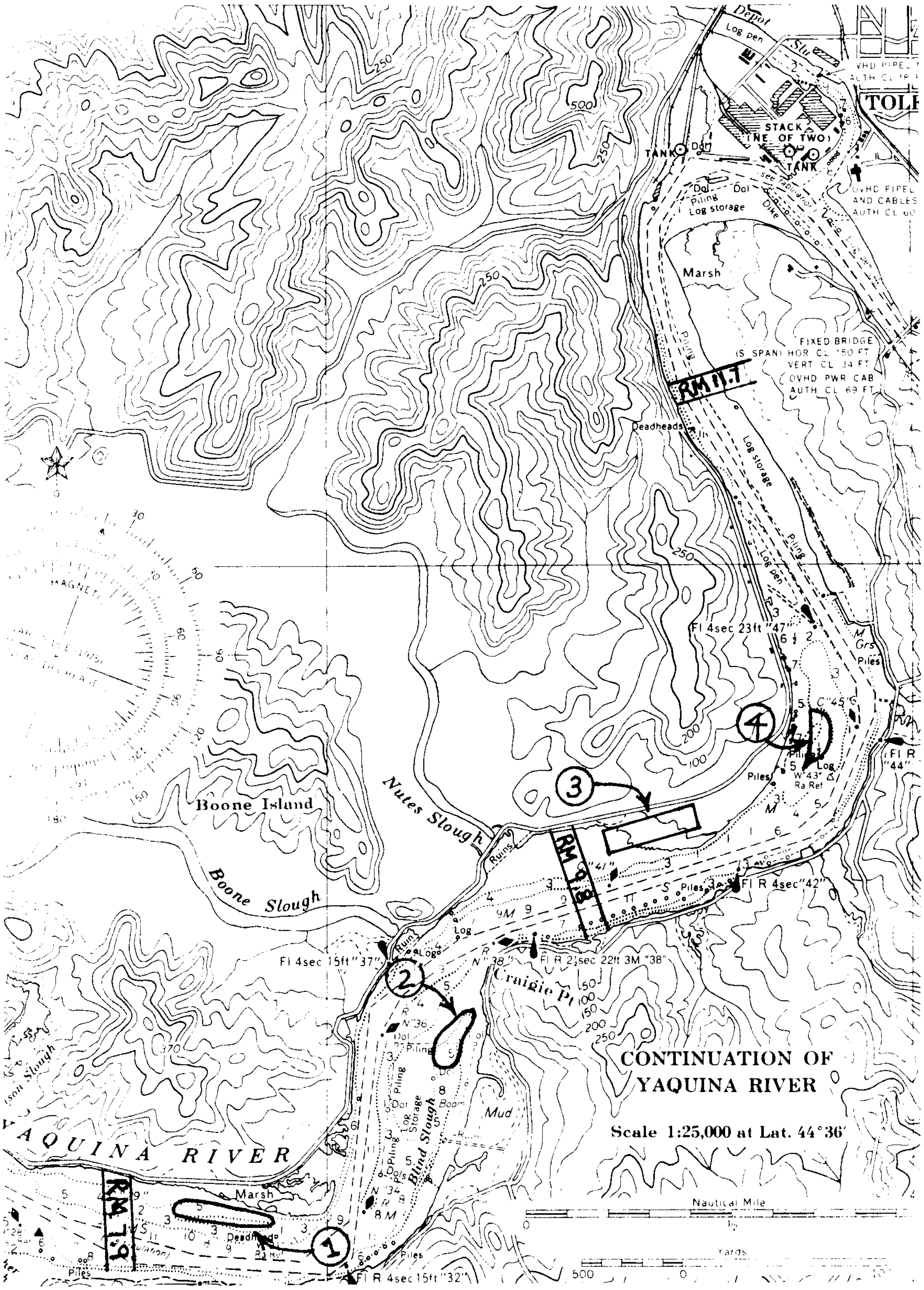

Figure 13. Possible saltmarsh establishment sites within River Miles 7.9 - 11.7 Channel of the Yaquina River as shown on a section of C&GS Chart No. 18581.

The complex of marsh and shallow open water about Site-3 is not shown in the figure. The concept here would be to fill in the shallow open water, which is surrounded except for several openings by marsh, and develop a more continuous marsh area. The design of Site-4 is of the marsh island variety (see Fig. 4), surrounded by existing and developed mudflats. The volume capacities of Sites -3 and -4, developed to marsh grade with dredged materials, are approximately 33,000 cu yds each. An approximate 88,000 cu yds of channel maintenance dredged materials are anticipated during the next 20 years (Wilsey & Ham report). Sites-3 and -4 are situated near two of the three shoaling regions of the navigation channel (Wilsey & Ham report).

4. Siuslaw River Site

Not many possibilities exist for the establishment of saltmarsh on materials dredged between Florence, Oregon and the North Fork in the Siuslaw River. The only such possibility without impacting existing mudflats is to extend the existing marsh and mudflat at the North Fork Shoal channelward as shown in Figure 14. The site area delineated in Figure 14 would accomodate approximately 125,000 cu yds of dredged materials graded from existing to marsh elevations. The design of the marsh establishment would be similar to that shown in Figure 6B.

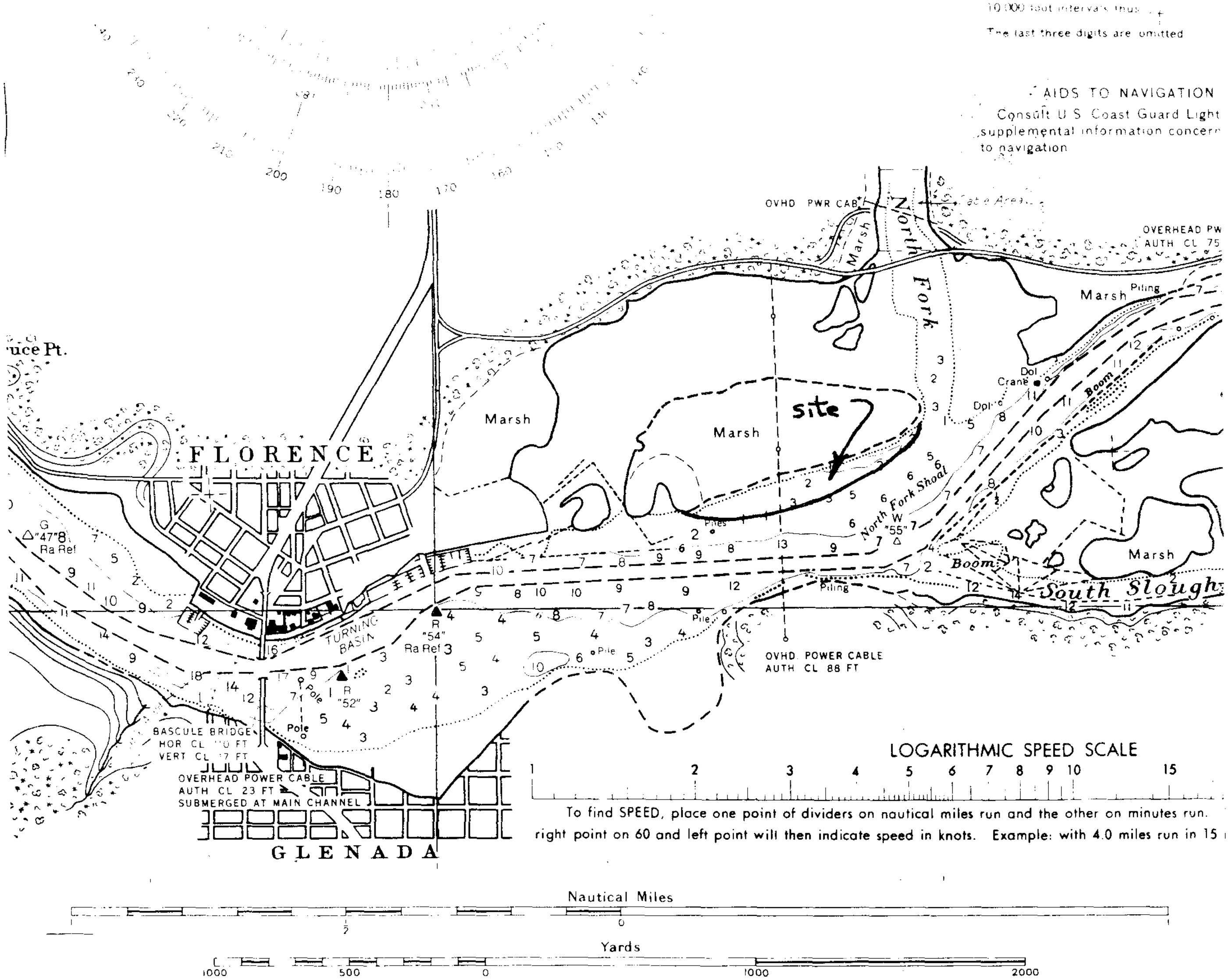

Figure 14. A possible saltmarsh establishment site between Florence, Oregon and the North Fork in the Siuslaw River.