GRAVINA ACCESS PROJECT

Biology Report

Draft

Agreement 36893013
DOT&PF Project 67698
Federal Project ACHP-0922(5)

Prepared for
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OCTOBER 2001

1—Introduction

HDR Alaska, Inc. (HDR) and its affiliate, Pentec Environmental (Pentec), investigated the water resources and wildlife within the Gravina Access Project study area and documented the findings in the following technical memoranda:

- *Preliminary Wetlands Analysis* (HDR, February 2000)
- *Federal and State Listed Threatened and Endangered Species Technical Memorandum* (HDR, April 2000)
- *Phase I Marine Reconnaissance Technical Memorandum* (Pentec, April 2000)
- *Project Area Water Bodies and Wildlife* (HDR, August 2000)

Since the time that those memoranda were written, additional technical studies have been completed of the wetlands (by HDR) and of the marine environment (by Pentec), focusing on the areas potentially affected by the project alternatives and characterizing potential project impacts. In addition, the project team has further coordinated with resource agencies concerning the Gravina Access Project. This technical memorandum summarizes the findings of the previous studies, reports the results of the additional technical studies and agency coordination, and describes the potential impacts of the project alternatives on the biological environment.

2—Water Resources

2.1 Surface Water

2.1.1 Existing Conditions

Surface water in the project area flows into Tongass Narrows either directly from streams and runoff, or indirectly through tributaries of major streams. The major watersheds traversed by the proposed alternatives are Airport Creek, Government Creek, and Clam Cove on Gravina Island. There are no major watersheds on Revillagigedo or Pennock islands that are traversed by the proposed alternatives. In the areas on Revillagigedo and Pennock islands where the alternatives would be located, surface runoff is not channelized and is likely to flow directly into Tongass Narrows in sheetflow.

General descriptions of Tongass Narrows and other water bodies in the project area are provided in the memorandum on *Project Area Water Bodies and Wildlife* (HDR, August 2000) and the *Phase I Marine Reconnaissance Technical Memorandum* (Pentec, April 2000). These previous studies found no flow data or water quality data available for any of the streams that would be crossed by the project alternatives.

2.1.2 Potential Impacts

Tongass Narrows

All of the project alternatives would require construction in Tongass Narrows. The bridge alternatives (C3[a], C3[b], C4, D1, and F3) would require the placement of piers in Tongass Narrows, which would have localized impacts on water flow but would not alter flow rates in the Narrows. The ferry alternatives would require placement of ferry berths and dolphins in the nearshore environment and intertidal area of Tongass Narrows, which also would have localized impacts on water flow but would not alter flow rates in the Narrows. Water quality could be affected by runoff from the bridges (Alternatives C3[a], C3[b], C4, D1, and F3) or from the ferry terminals and ferry vessel emissions (Alternatives G2, G3, and G4). Pollutants from the bridges could include particulate matter, metals, and petroleum products from vehicle emissions and road maintenance activities. Pollutants from the ferry terminals and ferry vessels could include petroleum product, metals, and gaseous emissions from the ferry vessels, as well as particulate matter, petroleum product, solvents, and other maintenance materials from the ferry terminal. Impacts on water quality would be minimized through the implementation of best management practices to reduce runoff from the facilities directly into Tongass Narrows.

Revillagigedo Island

Alternatives C3(a), C3(b), C4, and D1 would be located in the Peninsula Point watershed, which encompasses an area of approximately 957 acres and has no well-defined streams or water bodies. The topography is characterized primarily by steep-sided hills. The roadway features would be designed to accommodate stormwater flow and runoff and minimize impacts on water quality from roadway runoff (i.e., vehicle emissions and roadway maintenance materials).

Alternatives F3, G2, G3, and G4 would be positioned in low-lying, nearshore areas that drain directly to Tongass Narrows. There are no streams or other water bodies within the areas that would be affected by the alternatives. The roadway features would be designed to accommodate stormwater flow and runoff and minimize impacts on water quality from roadway runoff (i.e., vehicle emissions and roadway maintenance materials). No impacts on streams or other water bodies on Revillagigedo Island are expected.

Gravina Island

All of the project alternatives include roadway development in the Airport Creek watershed and would cross Airport Creek. The Airport Creek watershed is approximately 1,835 acres. Water in this watershed flows directly into Tongass Narrows or into Airport Creek, which flows into Lewis Cove, a protected area of Tongass Narrows. The creek crossing would be designed to maintain natural streamflow. The creek crossing and other roadway features would be designed to accommodate stormwater flow and runoff and minimize impacts on water quality from roadway runoff (i.e., vehicle emissions and roadway maintenance materials).

The Government Creek watershed is approximately 1,869 acres and includes the southern end of the airport property. All of the project alternatives include roadway development in the Government Creek watershed. Only Alternatives F3 and G3 would cross Government Creek. The watershed includes Government Creek and its tributaries; the area is also characterized by a large number of unnamed lakes. Very little topographic relief exists in this watershed. The creek crossing would be designed to maintain natural streamflow. The creek crossing and other roadway features would be designed to accommodate stormwater flow and runoff and minimize impacts on water quality from roadway runoff (i.e., vehicle emissions and roadway maintenance materials).

The Clam Cove watershed is approximately 3,533 acres. This watershed is characterized by very little topographic relief, which accounts for the large number of lakes and no major streams throughout its area. Alternative F3 is the only alternative that would cross this watershed. The roadway features would be designed to accommodate stormwater flow and runoff and to minimize impacts on water quality from roadway runoff (i.e., vehicle emissions and roadway maintenance materials).

Pennock Island

There are no major watersheds on Pennock Island. Surface flow is not channelized in any stream or creek valley. Surface runoff from the island would flow directly into the East or West channels of Tongass Narrows. The roadway features would be designed to accommodate stormwater flow and runoff and to minimize impacts on water quality from roadway runoff (i.e., vehicle emissions and roadway maintenance materials). No impacts on streams or other water bodies on Pennock Island are expected.

2.2 Groundwater

2.2.1 Existing Conditions

Groundwater in the project area is very shallow or at the ground surface. Most of the overburden is saturated. All unpaved and undeveloped land areas serve as groundwater recharge areas for the surface aquifer. There are no data available on groundwater quality in the project area. Groundwater is not a source of water supply in Ketchikan.

2.2.2 Potential Impacts

None of the project facilities would have a significant effect on groundwater resources. Roadway construction would disturb the surface and potentially change the direction and rate at which groundwater flows in the immediate vicinity of the roadway. The overall effects on groundwater in the region would be minor; however, localized changes in groundwater flow could adversely affect streams that are hydrologically connected to these groundwater resources.

3—Wetlands

HDR investigated general wetland types and locations within the project area and reported the findings in a technical memorandum, *Preliminary Wetlands Analysis* (HDR, February 2000). In the spring of 2000, HDR's wetlands scientists met with the Alaska Department of Fish and Game (ADF&G), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Army Corps of Engineers (USACE) to discuss wetland functional values in southeastern Alaska, discuss ecological processes associated with wetlands in the regions, and review wetland delineation techniques. During the summer and fall of 2000, HDR conducted field studies to verify preliminary wetland delineations. The results of the field studies were mapped into the project's database in a geographical information system (GIS), using aerial photographs and maps of the project alternatives. The results of these recent wetland studies are presented in Attachment A, the *Wetlands Evaluation Technical Memorandum* (HDR, October 2001), and summarized briefly in the following paragraphs.

3.1 Existing Conditions

Field efforts confirmed that nearly all of Gravina and Pennock islands in the vicinity of the project alternatives are wetlands. Uplands on those islands are limited to disturbed areas near the airport, some beach fringes, and some steep slopes along streams and shores. Uplands were found on Revillagigedo Island in disturbed areas and on some steep slopes and high knobs. Other sloping areas are wetlands.

Four major wetland types exist in the Gravina Access Project area: forested wetlands, shrub-scrub wetlands, muskegs (which are freshwater wetlands), and intertidal marshes and meadows (which are marine wetlands). With respect to the wetland functions of providing fish habitat, wildlife habitat, and biodiversity, the forested wetlands and intertidal marshes and meadows are the most important wetlands in the area. With respect to the wetland functions of groundwater recharge, groundwater discharge, and streamflow moderation, the forested wetlands, shrub-scrub wetlands, and muskegs are the most important wetlands in the area.

3.2 Potential Impacts

Table 1 provides the acreage of each type of wetland that is within the right-of-way of each alternative.

TABLE 1. ACRES OF WETLANDS WITHIN RIGHT-OF-WAY BY ALTERNATIVE

Wetland Type	*C3(a) 200 ft Bridge*	*C3(b) 120 ft Bridge*	*C4 200ft Bridge*	*D1 120 ft Bridge*	*F3 60ft/200ft Bridges*	*Ferry Alternatives*		
						G2	*G3*	*G4*
Forested Wetlands	15.6	14.2	10.7	8.0	11.2	13.1	9.3	7.7
Shrub/Scrub Wetlands	3.0	3.0	3.1	3.0	13.2	2.9	6.5	2.9
Muskegs	25.2	25.2	25.2	25.2	61.7	25.3	29.4	24.7
Intertidal Marshes and Meadows	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
All Wetland Types	43.9	42.5	39.1	36.3	86.2	41.4	45.3	35.4

4—Fish and Wildlife

The project area has plentiful marine, freshwater, and terrestrial habitat that support a variety of fish and wildlife. Descriptions of the species commonly found in the study area and their habitat are provided in the memorandum on *Project Area Water Bodies and Wildlife* (HDR, August 2000) and the *Phase II Marine Reconnaissance Technical Memorandum* (Pentec, August 2001). Protected species and habitat are identified in the *Federal and State Listed Threatened and Endangered Species Technical Memorandum* (HDR, February 2000). This section describes the affected species and the potential impact of the Gravina Access Project alternatives.

4.1 Aquatic Species

4.1.1 Existing Conditions

Approximately eight species of marine mammals are commonly found in the Gravina Access Project area. Harbor seals *(Phoca vitulina richardsi)* and Steller sea lions *(Eumetopias jubata)* inhabit Tongass Narrows year-round. Additionally, humpback whale *(Megapters novaeangliae)*, killer whale *(Orcinus orca)*, dall porpoise *(Phocoenoides dalli)*, Pacific white-sided dolphin *(Lagenorynchus obliquidens)*, minke whale *(Balaenoptera acutorostrata)*, and harbor porpoise *(Phocoena phoecena)* travel through the area (Frietag, 2000; City of Ketchikan, 1994).

Fish species in the area include anadromous fish and marine fish. Anadromous fish in the project area (i.e., fish that spend periods of their lives in fresh water and marine water) include Chinook salmon (*Onocorhynchus tshawytscha*), chum salmon (*Onocorhynchus keta*), coho salmon (*Onocorhynchus kisutch*), pink salmon (*Onocorhynchus gorbuscha*), sockeye salmon (*Onocorhynchus nerka*), steelhead trout (*Onocorhynchus mykiss*), cutthroat trout (*Salmo clarki*), and Dolly Varden char (*Salvelinus malma*). Marine fish in the project area include Pacific halibut (*Hippoglossus stenolepis*), Pacific herring (*Clupea pallasii*), and lingcod (*Ophiodon elongatus*).

Detailed information on the marine environment in the vicinity of the project area is provided as Attachment B, the *Phase II Marine Reconnaissance Technical Memorandum* (Pentec, October 2001). Marine species found in the project area are typical of those found along semi-sheltered shorelines throughout southeastern Alaska. Eelgrass beds are an important habitat in subtidal areas, providing food and shelter for epibenthic zooplankton and important rearing habitat for juvenile salmonids as well as Dungeness crab (*Cancer magister*).

4.1.2 Potential Impacts

The bridge alternatives [C3(a), C3(b), C4, D1, and F3] would shade marine habitat, which could negatively affect eelgrass beds and intertidal areas. Bridge piers might affect juvenile fish movement in nearshore areas, particularly for alternatives C3(a), C3(b), C4, and D1 where the structure parallels the shore. Long-term use of the bridge and roadway would adversely affect marine resources as a result of runoff. The potential impacts on the marine environment resulting from the project alternatives are described in detail in the *Marine Environment Impact Assessment* (Pentec, October 2001), which is provided as Attachment C.

The ferry alternatives (G2, G3, and G4) would adversely affect intertidal areas as a result of ferry vessel emissions and maintenance activities. Terminal structures and shoreline alternation might affect juvenile fish movement in nearshore areas. Maintenance and long-term use of the roadway would adversely affect marine resources as a result of runoff.

4.2 Amphibians

4.2.1 Existing Conditions

Two species of amphibians are assumed to inhabit the project area. Rough-skinned newt salamander (*Taricha granulosa*) and the western (boreal) toad (*Bufo boreas*) have been observed on Gravina Island (Brown, 2000; Reich, 2000a). The rough-skinned newt occurs in creeks and wet areas. The western toad breeds in freshwater wetlands and moves to nonforested terrestrial areas to feed.

4.2.2 Potential Impacts

Impacts on amphibians in the project area could occur as a result of impacts on freshwater wetlands and streams. Roads associated with all of the alternatives would eliminate some habitat potentially used by the rough-skinned newt and the western toad. Specific information concerning the prevalence of these species in the alternative corridors and the likely impacts resulting from the project alternatives will be developed once a preferred alternative is selected.

4.3 Terrestrial Species

4.3.1 Existing Conditions

More than 300 bird species spend some period of time in southeastern Alaska, and 160 species nest in or near Ketchikan (O'Clair et al, 1997). Around Revillagigedo and Gravina islands and the surrounding waters, local birdwatchers and naturalists have observed approximately 225 species of birds (Heinl and Goucher, 2000). In the Gravina Access Project area, birds dwell in a variety of habitats, primarily in marine waters, freshwater wetlands, and forests.

According to the U.S. Forest Service (USFS), approximately 50 species of terrestrial mammals inhabit the Tongass National Forest and most of southeastern Alaska (USFS, 1997). Many of those species are found within the Gravina Access Project area. Ubiquitous species, including Sitka black-tailed deer, black bear, mink, beaver, and river otters contend with heavy rains, deep winter snows, geographical barriers such as mountains, larger rivers, and wide marine channels that limit the distribution of terrestrial mammals in southeastern Alaska. They feed and breed in coastal rain forests, salt and freshwater wetlands, and alpine areas. While much information exists on larger land mammals, the exact distribution and numbers of many small mammals remains unknown. The USFWS and ADF&G identify Sitka black-tailed deer, Alexander Archipelago wolf, and black bear as important common species in the area.

4.3.2 Potential Impacts

Habitat for deer, wolf, and bear on Gravina Island could be degraded where the alternatives traverse wetlands and upland areas that these animals might use for food and shelter. The alternatives could also traverse migration corridors used by deer, wolf, and bear as they travel between low and high elevations. The result would be more frequent human interaction and increased risk of mortality due to vehicular collisions. Indirect impacts to game species could result from increased hunting activity on Gravina Island as a result of improved access.

4.4 Threatened and Endangered Species

4.4.1 Existing Conditions

HDR determined that there are no listed, candidate, or proposed species under the jurisdiction of the USFWS within the Gravina Access Project area. Under the jurisdiction of the National Marine Fisheries Service (NMFS), however, there are two listed endangered species that are likely to occur within the Gravina Access Project area: the humpback whale (*Megaptera novaeangliae*) and the Steller sea lion (*Eumetopias jubatus*). Neither species has critical habitat in the project area, and no Steller sea lion haulout sites are near the project area (HDR, April 2000). There are no threatened, proposed, or candidate species under the jurisdiction of NMFS within the Gravina Access Project area.

4.4.2 Potential Impacts

In March 2001, the Federal Highway Administration (FHWA), in accordance with Section 7 of the Endangered Species Act, initiated informal consultation with the USFWS and NMFS regarding the potential effects of the project alternatives on threatened and endangered species under their jurisdictions. In response to this consultation effort, USFWS concurred that the Gravina Access Project would have no effect on listed species under its jurisdiction (personal communication between Ed Grossman, USFWS, and Tim Haugh, FHWA, June 6, 2001) and NMFS concurred that humpback whales and Steller sea lions are likely to occur within the project area and could be affected by project activities (letter from James W. Balsiger, NMFS Administrator, Alaska Region, to David C. Miller, FHWA Division Administrator, June 4, 2001; see Attachment D).

According to NMFS, construction of a bridge or additional ferry terminals would create underwater noise that could affect humpback whales. Ferry vessel traffic could displace whales traversing, resting, or feeding in Tongass Narrows. Whale populations could also be affected if any of the alternatives reduce the abundance of their prey (i.e., herring and krill). Steller sea lions could be affected by construction activities requiring underwater explosives. Construction activities and a reduction in abundance of prey resources could displace Steller sea lions from Tongass Narrows. Avoiding construction activities when both of these species are present could minimize impacts. New technology may be available to reduce underwater construction noise.

4.5 Essential Fish Habitat

4.5.1 Existing Conditions

The Magnuson-Stevens Fishery Conservation and Management Act, as amended, gives NMFS the authority to protect the habitat needed by the fish it manages. This habitat is called "essential fish habitat" (EFH) and is defined as "waters and substrate necessary for fish spawning, breeding or growth to maturity." The project alternatives cross Tongass Narrows and anadromous streams (e.g., Airport Creek and Government Creek) that provide EFH for fish species in the project area.

4.5.2 Potential Impacts

HDR calculated the acreages of EFH potentially affected by each alternative based on preliminary engineering design. The resulting acreages are shown in Table 2.

TABLE 2. ACRES OF ESSENTIAL FISH HABITAT POTENTIALLY AFFECTED BY THE ALTERNATIVES

	Type of EFH		
Alternative	Freshwater	Marine	Total EFH
C3(a) 200ft Bridge	0.10	7.13	7.23
C3(b) 120ft Bridge	0.10	7.84	7.94
C4 200ft Bridge	0.10	7.45	7.55
D1 120ft Bridge	0.10	4.66	4.76
F3 60ft and 200ft Bridges	0.22	1.00	1.22
G2 Ferry	0.09	1.00	1.09
G3 Ferry	0.15	2.45	2.60
G4 Ferry	0.09	0.40	0.49

Attachment A

Wetlands Evaluation Technical Memorandum

Wetlands Evaluation
Technical Memorandum

Draft

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1—Introduction

The Alaska Department of Transportation & Public Facilities (DOT&PF) is evaluating alternatives to improve access between Revillagigedo Island and Gravina Island in southeastern Alaska. HDR Alaska, Inc., is supporting the DOT&PF through the process mandated by the National Environmental Policy Act that entails preparation of an environmental impact statement (EIS) in which the effects of project build alternatives and the no-build option are disclosed and evaluated.

A consideration for siting and selection of Gravina Access Project build alternatives is the presence of wetlands. Federal regulations and policies require projects to minimize their impacts on wetlands, and to locate projects in wetlands only if there is no practicable alternative with lesser adverse environmental impact. Wetland identification and analysis of potential wetland-related impacts have been ongoing during development of the project alternatives.

This memorandum describes the wetland identification process, briefly describes the extent and types of wetlands found in the project area, identifies functions and values of those types of wetlands, and compares the wetland impacts (in terms of acres) of the alternatives currently under consideration.

Wetlands. Wetlands, as referenced in the this memorandum, are “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (33 Code of Federal Regulations [CFR] Part 328.3(b)).

Waters of the U.S. Note that this definition does not include unvegetated areas such as streams, ponds, and most tidal shores; these are other “waters of the U.S.”. Large, year-round open water bodies in the project area are mapped as ponds. All mapped ponds are on Gravina Island and are coded as PUBH (palustrine, unconsolidated bottom, permanently flooded bodies of water).

Uplands. Non-water and non-wetland areas are called uplands.

2—Wetland Functions Background

Wetland functions are the chemical, physical, and biological processes or attributes that contribute to the self-maintenance of a wetland and relate to the ecological significance of wetland properties without regard to subjective human values (ASTM 1999). Based on discussions with wetland and wildlife specialists from state and federal regulatory agencies, on-site wetland functional assessment techniques, and brief review of literature on the wetlands of southeastern Alaska, the impacted wetlands may have some of the following functions. Some of these functions are not exclusive to wetlands.

Not all wetlands perform all functions, nor do they perform all functions equally well. The location and size of a wetland may determine what functions it will perform. For example, the geographic location may determine its habitat functions, and the location of a wetland within a watershed may determine its hydrologic or water quality functions. The principal factors that determine how well a wetland will perform these functions are climatic conditions, quantity and quality of water entering the wetland, and disturbances or alteration within the wetland or the surrounding ecosystem (Novitzki et al., 1997).

2.1 Groundwater Recharge and Discharge

Groundwater recharge is the infiltration of groundwater from a wetland into the underlying aquifer. Groundwater discharge is the net upward vertical movement of water from an aquifer to the surface (Mitsch and Gosselink, 1993). Often under natural conditions, wetlands manifest near groundwater recharge or discharge areas (Adamus Resource Assessment, 1987). While less detail on groundwater recharge through wetlands exists, the groundwater discharge function of wetlands is well documented (USFWS, 1984).

The function of Alaskan wetlands in groundwater recharge varies. Groundwater recharge by southeastern Alaska wetlands has not been well documented. Discharge is common in muskeg peatlands, springs, and gaining streams throughout southeastern Alaska and northern Canada (Adamus Resource Assessment, 1987). In the project area, wetlands without thick peat accumulations that are at toes of slopes are presumed to discharge groundwater.

2.2 Stream Flow Moderation

In many areas of Alaska, wetlands have been documented as important in flood control. Wetlands may reduce the magnitude of peak flows and associated flood stages, delay the release of water downslope and downstream immediately after storms, sustain streamflows during dry seasons by providing a steady outflow, and reduce bank erosion and channel bed scour (Adamus Resource Assessment, 1987). This function adds to the stability of the aquatic environment and, in populated areas, may provide some social and economic value related to flood control. Wetlands with a surface outlet and wetlands along streams are presumed to moderate surface flows to varying degrees. Wetlands with varying degrees of soil saturation are presumed to perform this function more effectively. Additionally, wetlands with dense vegetation can retain more water than other wetland types (USFWS, 1984).

2.3 Shoreline, Stream Bank, and Soil Stabilization

Wetland vegetation can stabilize stream banks and lake and ocean shores against erosion in various ways. Vegetation can bind and stabilize substrates; it can dissipate wave and current action; and it can trap sediments during flood periods. The effectiveness of shoreline vegetation in controlling erosion depends on the plant species present, the width of the vegetation, the efficiency of the vegetation in trapping sediments, the soil composition of the bank or shore, the height and slope of the bank or shore, and the elevation of the toe of the bank relative to mean high water (MHW) (USFWS, 1984). In Alaskan streams, erosion and collapse of undercut banks can reduce the availability of cover, degrade water quality, and reduce the suitability of coarse sediment important for salmon spawning, at least temporarily (Adamus Resource Assessment, 1987). The vegetation in wetlands also stabilizes the wetland soils against erosion by water that may pass through the wetland by sheetflow and shallow flow through the soils.

2.4 Nutrient Cycling, Primary Production, and Carbon Export

In some regions, usually associated with urban or farming areas, the removal or retention of nitrogen and phosphorus is viewed as one of the most positive attributes of wetlands, because downstream waterways could become so enriched that algae flourish and decompose, causing deoxygenation of waters. However, because few artificial sources of nutrients and because no nutrient overenrichment are documented upstream from wetlands within the project area, removal of nutrients is not an important function of these wetlands.

Generally, wetlands support higher levels of net primary production (NPP) (i.e., plant growth) than other ecosystems. This plant tissue may be consumed directly by some vertebrates and invertebrates or chemically and physically altered through decomposition prior to use by other consumers. Therefore, decomposition and the rate at which nutrients are transformed to usable forms likely influence NPP and, ultimately, food chain dynamics. Whether decomposition and the rate at which nutrients and organic carbon are transported out of the wetland affects the wetland's role in the aquatic food chain wetlands with surface flow outlets, wetlands that flood and those used by highly mobile fish and wildlife species are presumed to export higher levels of organic matter that supports food webs outside of the wetland itself. Wetland systems that have lower levels of nutrients, lower pH, peat soils, and evergreen vegetation are presumed to have lower NPP.

2.5 Fish and Wildlife Habitat

Fish and wildlife species are likely dependent on major wetland habitat factors such as the availability of cover, freedom from disturbance, availability of food, availability of specialized habitat features, and interspersion of different vegetation forms and water. The fish and wildlife habitat function considers the effectiveness of the wetland in providing habitat for various types and populations of resident and migratory species typically associated with wetlands and the wetland edge (USACE, 1995).

Relatively few mammals are truly wetland-dependent. However, many mammal species have populations that are highly wetland-dependent in some areas at certain times of the year. Many birds depend on wetland habitats during all or parts of their life histories.

2.6 Biodiversity

Wetlands serve as an important repository of substantial biodiversity in supporting numerous species from all of the major groups of organisms. From microbes to mammals, wetland biodiversity sustains a significant reservoir of genes that has considerable economic, biological, and genetic potential. Wetland biodiversity is a term scientist's use for the variety of life and the natural processes of which living things are a part. This includes all living organisms and the genetic differences between them and the different wetland communities they live in. Functional diversity in wetlands is clearly important. For example, a wetland management plan designed to keep a certain wetland from deteriorating will almost certainly fail in the long run unless evolution processes, species diversity and richness, and ecological relationships are maintained.

2.7 Human Values

Wetland values are the benefits to humans that are derived from a wetland's features, processes, or setting. If something has "value," it is deemed worthwhile, beneficial, or desirable. Wetland characteristics may be valuable for "consumptive" uses such as subsistence harvesting (e.g., fishing, hunting, and berry-picking) and the support of commercial harvesting of natural resources, or for "nonconsumptive" uses such as aesthetics, recreational and educational uses, and flood control protection of downstream developments).

Gravina Island is considered one of the most important subsistence and recreational hunting areas in the Ketchikan Gateway Borough because of its high densities of Sitka deer and the high cost of living in Ketchikan and Saxman. In addition, many of the muskeg and shrub/scrub areas of Gravina Island are important sites for subsistence harvesting of berries. Wetland values are not easily measured. Often values are subjective and may be specific to certain groups or individuals; that is, a wetland feature valuable to one group may have little value to other groups.

2.8 Comparison of Wetland Functions

Table 1 compares the importance of the various wetland functions by type of wetlands.

Table 1
COMPARISON OF WETLAND FUNCTIONS IN PROJECT AREA

Wetland Function and Type	*Intertidal Marshes and Meadows*	*Forested Wetlands*	*Shrub/Scrub Wetlands*	*Muskegs*
Groundwater Recharge and Discharge	U	I	I	I
Stream Flow Moderation	U	I	I	I
Shoreline, Stream Bank, and Soil Stabilization	I	I	I (some)	U
Primary Production and Carbon Export	I	I	I	I
Fish Habitat	I	I (some)	I (some)	U
Wildlife Habitat	I	I	M	M
Biodiversity	I	I	M	M
Human Consumptive Values	I	I	M	M
Human Nonconsumptive Values	I	I	U	M

I=important; M=moderately important; U=unimportant.

3—Wetland Determination Methods

The wetland determination was completed in four phases: office-based premapping, discussions with regulatory agency personnel, field delineation, and office-based GIS mapping and final delineation.

3.1 Office-Based Premapping

Initially, scientists premapped wetlands in a broad project area encompassing the area of all the potential alternatives. This mapping entailed stereoscopic interpretation of color aerial photographs (with a scale of 1" = 400'). Initial wetland/upland boundaries and boundaries between wetland types were drawn on mylar overlays of the photos. Wetland areas were delineated based on vegetation characteristics (e.g., small plant size and low-density stands), hydrologic indicators (such as stream locations and ponding), and topographic clues (such as concave topography). Upland locations were based on the lack of surface water visible on aerial photographs, the presence of tall and dense forest, and steep topography that would allow good surface drainage. Several information sources were examined initially:

- Aerial photographs from AeroMap U.S. (taken 7/2/99, scale 1" = 400'; and taken 8/15/97, scale 1" = 1000'), true color.
- Detailed topographic maps.
- National Wetlands Inventory (NWI) map for quadrangles Ketchikan B-5 and B-6. The NWI maps are based largely on interpretation of aerial photographs and are presented at a coarse scale.
- The detailed preliminary wetland determination prepared by Dunn Environmental Services for the Alaska Department of Transportation & Public Facilities in July 2000. The report provides wetland mapping and a wetland function assessment specifically for the current update of the Ketchikan International Airport Master Plan.
- Existing GIS layers including streams, water bodies, NWI mapping, soil data, slope, and elevation data.

Wetland/upland boundaries drawn in the office were used to plan the field efforts and determine potential problem areas. Initial mapping showed that most of the project area on Gravina Island is wetland.

3.2 Discussions with Agency Personnel

HDR completed interviews of knowledgeable agency representatives regarding the physical and ecological processes that occur in the project area wetland types. During spring of 2000, HDR met with key ADF&G and USFWS staff members in Ketchikan to hear their views on the importance and functions of the wetlands present in the area. A literature review was completed to identify known functions of forested, muskeg, and intertidal wetlands in southeastern Alaska. In addition, HDR met with a representative of the U.S. Army Corps of Engineers in Ketchikan on site to review wetland delineation techniques and discuss wetland functions.

3.3 Field Delineation

Scientists verified wetland boundaries in the field during the summer and fall of 2000. The primary activity of these trips was to ground-truth the office-based preliminary delineation and adjust premapped boundaries to actual on-the-ground conditions. HDR and Corps of Engineers staff met in the field in May 2000 to discuss the delineation methods that would be used. The ground-truthing included identification of wetlands based on the wetland identification methodology described in the Corps of Engineers Wetland Delineation Manual (USACE, 1987). This methodology followed a three-parameter approach to wetland identification and delineation, using the criteria of hydric soils, dominant hydrophytic vegetation, and wetland hydrology. For questionable locations (as determined from office premapping) and at other selected locations throughout the project area, Corps of Engineers' data sheets and photographs of the project area wetlands were completed. These will be provided to the Corps of Engineers in a Preliminary Jurisdictional Determination report. Where wetland sites were similar to areas where a data form had previously been completed, scientists completed a detailed examination. Geographic coordinates were logged at all data collection locations. Qualitative information was also collected for identification of wetland functions and values (to be discussed in the EIS). Much of the fieldwork was done in the vicinity of alternatives that are no longer under consideration, but the findings are applicable throughout the project area.

3.4 Office-Based GIS Mapping and Final Delineation

Upon return from the field, the project team mapped sites and amended the office-delineated wetland boundaries on georeferenced aerial photographs using geographic information systems (GIS) technology. The NWI wetland types were determined based on a review of field notes, data forms, and site photographs. Boundaries were digitized into the GIS using existing spatially rectified base mapping and the project's preferred alternative alignments. The final mapping has been prepared for a ¼-mile-wide corridor along each current alternative. To aid in the final mapping, the following resources were used:

- Premapped wetland/upland boundaries
- Digital georeferenced aerial photograph mosaic taken 7/2/99 with 6'-pixel resolution
- Detailed field notes, data forms, and photographs
- GPS coordinates of field observation locations
- COE wetland data forms

4—Wetland Determination Results

Figures 1 and 2 delineate the wetland/upland boundaries and the boundaries between wetland types along the proposed project alignment of each alternative. Ponds are also mapped. On Gravina and Pennock islands, fieldwork confirmed that nearly all of the alternative areas are wetlands. Uplands on those islands are limited to disturbed areas near the airport, some beach fringes, and some steep slopes along streams and shores. On Revillagigedo Island, uplands were found in disturbed areas and on some steep slopes and high knobs; other sloping areas are wetlands.

Four major wetland types exist in the Gravina Access Project area:

Marine Areas:

Intertidal marshes and meadows

Freshwater Wetlands:

Muskegs

Shrub/scrub wetlands

Forested wetlands

Following are general descriptions of these wetland types and their associated functions in the project area.

4.1 Intertidal Marshes and Meadows

General Description. These saltwater-influenced wetlands were found on slightly sheltered shores, where substrate is not bedrock or loose rock, but is sandy. They occur along a narrow band from about the MHW mark to the high tide line. Vegetation in these areas is limited to a dense ground covering of grasses and herbs; dominant species are *Carex lyngbyei* (50-90% cover), *Deschampsia caespitosa* (5-20% cover), and *Potentilla egedii* (10%). These wetlands were found only along the shoreline areas of Gravina Island; none was found on the shores of Pennock or Revillagigedo island.

NWI Code. The NWI code for these wetlands is E2EM1N (estuarine [saltwater] intertidal areas, vegetated with erect herbs, and regularly flooded by tidal waters).

Project Area Functions. Estuarine sites are often considered unique, valuable, and scarce throughout southeastern Alaska. Estuarine beach meadows are found in protected areas along the shore of Gravina Island, generally associated with a stream. Intertidal beaches and meadows are important components in maintaining a stable shoreline. They are highly productive habitats, and much organic matter produced within them washes into the marine ecosystem, where it supports food webs. These areas provide biologically diverse sites that are important sources of faunal and floral diversity. The beach meadows are important feeding areas for many terrestrial and aquatic species of wildlife, including deer, black bear, river otter, mink, shorebirds, waterfowl, and songbirds. They provide succulent forage in spring when other habitat types may be snow-covered. They also serve as nurseries for young fish. Estuarine habitats are considered relatively scarce in southeastern Alaska. Because of the high wildlife use in these areas, they tend to be aesthetically important sites for viewing wildlife.

Impacts. Estuarine meadow areas that potentially could be affected by alternatives include shorelines at Lewis Point, the Government Creek outlet, and the site where Alternative G3 (ferry from downtown) enters Gravina Island (Table 2). No impacts on estuarine meadow areas are expected to occur along the shores of Pennock and Revillagigedo islands.

4.2 Muskegs

General Description. These wetlands are extensive on the relatively flatter ground on Gravina and Pennock islands, although the ground still often slopes substantially. Most of these muskegs include many bedrock outcrops. They support a sparse cover of shrub-form shore pine, a lesser cover of shrubby yellow and red cedar and western hemlock, and a dense ground cover dominated by sedges (*Trichophorum caespitosum*, *Carex pluriflora* and other *Carex* species, *Eriophorum* species), crowberry (*Empetrum nigrum*), Labrador tea (*Ledum groenlandicum*), and other herbs. They are saturated to the surface and include many small ponds. Muskegs include many small "islands" of scrub/shrub wetlands.

NWI Code. All of these wetlands were mapped by NWI. The NWI code for the muskeg areas is PEM1B (palustrine, saturated herbaceous meadows). The NWI code for muskeg areas with substantial amounts of shrubby vegetation is PSS4/EM1B (palustrine, evergreen needle-leaved shrub/grass-like, saturated herbaceous meadows).

*Soils and Water****.*** While organic soils were expected in these wettest sites, field scientists found that their organic surface layers were generally quite shallow (1-12"), and mineral material was often exposed on the surface of channels and ponds.

Project Area Muskegs. Little is known about the specific functions of the open, muskeg-type wetlands in the project area. Muskeg is a term used by scientists to describe extensive northern wetlands with deep peat soils and open, often evergreen, vegetation with a mossy ground cover. In the project area, the areas mapped as muskeg encompass wetlands dominated by tall sedges (grass-like plants), short sedge fens, and bogs, as described below.

Tall-Sedge Fens. Tall sedge fens[1] tend to be found at toes of slopes where groundwater discharges, as well as around the margins of muskegs and in drainage tracks. They are thought to have the highest nutrient status and be the best aerated and most productive of the muskeg wetland types. They may support a greater diversity and abundance of wildlife. Because they are productive and tend to have water flowing through them, they may export organic material that supports downstream ecosystems and help maintain natural chemistry and low flows in those creeks. These rich fens may be particularly susceptible to disturbance of hydrology by upslope activities. They are considered relatively scarce in southeastern Alaska. The agency representatives interviewed for this project generally believed that, because fens are more productive than bogs, they should be more highly valued. Further discussion with them indicated that, more specifically, it is the fens dominated by tall sedges that are most productive and important.

Short-Sedge Fens. Short sedge fens dominate the open wetlands in the project area. These areas have less water flowing through them and are not as nutrient-rich as are the tall sedge fens. The muskeg areas nearest creeks are considered important for maintaining base flows to those creeks. Organic material produced in these wetlands, particularly in the more sloped wetlands and those nearest streams, washes into creeks and supports the food webs of the aquatic system. The less-sloped fens would be effective at retaining sediments in the event of ground disturbance. They are probably not highly effective at moderating high stream flows for most of the year because their soils are already saturated and cannot hold more water. Fens will act to filter and buffer water conveyed through them. Little is known about wildlife use of these extensive habitats. Deer and black bear are thought to feed in them seasonally, and some shorebirds and passerine species and blue grouse are known to use these areas. Waterfowl often use intermixed open freshwater ponds as resting and nesting habitat. Humans use these areas for subsistence, as they are important berry-harvesting locations.

[1] Fens are wetlands with peat soils and contact with relatively mineral-rich water. The "fens" in the project area generally do not meet the technical definition because the organic soil accumulation (peat) is too shallow, but no term describes them better.

Bogs. True bogs[2] are also present, but not common, in the project area. These areas have deep peats, are highly acidic, and support plants that can tolerate acidic, nutrient-poor conditions. They are relatively scarce in southeastern Alaska and therefore contribute to biodiversity. The deep peats in these wetlands are usually water-saturated. During periods of little precipitation, they may continue to release water slowly to creeks downstream, thus maintaining low flows. These are not thought to be highly productive wetlands, although they may support certain species of shorebirds and songbirds, as well as deer and black bear. Both bogs and fens can function as water discharge and recharge areas (Siegel, 1988).

Impacts. The most prominent muskeg impacts will occur if areas south of the Ketchikan International Airport on Gravina Island are crossed. Depending upon muskeg depth and slope, a road across muskeg wetlands could alter both surface and subsurface flows.

4.3 Shrub/Scrub Wetlands

General Description. This wetland type dominates areas adjacent to muskeg wetlands and other areas where tree growth is limited by soil saturation. The tree canopy is sparse enough to allow light to penetrate, promoting a dense shrub and scrub tree understory. Scrub/shrub wetlands often form slightly drier “islands” within the muskegs. They also tend to occur on the slightly better-drained (sloping) ground along the streams that run through muskegs. This wetland type has an open canopy (about 15-50%) of western or mountain hemlock (*Tsuga heterophylla, Tsuga mertensiana*). Shore pine (*Pinus contorta*), small Sitka spruce, and red and yellow cedar may also be present. Tall blueberry and rusty menziesia form a dense shrub layer. Prominent herbs are bunchberry, deer cabbage (*Fauria crista-galli*), skunk cabbage, and fernleaf goldthread (*Coptis aspleniifolia*), in addition to a dense ground covering of sphagnum moss (60-70%).

NWI Code. These sites were mapped as wetland by NWI. The NWI code for these wetlands is PSS4B (palustrine, evergreen needle-leaved shrub/scrub dominated areas that are saturated).

Soils and Water. Scientists in the field noted that soils in the scrub/shrub wetlands were generally saturated near the surface and often exhibited a sulfidic odor within 10” of the surface. There was little surface water on these sites.

Functions. Many of these wetlands share the same functions as forested wetlands, described above. As with forested wetlands, shrub/scrub wetlands function as streamflow moderators and stream bank stabilizers, and provide important foraging habitat for Sitka deer, black bear, and mink. Humans will often enter these areas for subsistence purposes, collecting berries for a source of food.

4.4 Forested Wetlands

General Description. On Gravina and Pennock islands, most of the forested areas visited are forested wetlands; on Revillagigedo Island, the flatter forested areas are generally wetlands. This wetland type generally has a closed canopy (about 45-85%) of western hemlock and red and yellow cedar (*Tsuga heterophylla, Thuja plicata, Chamaecyparis nootkatensis*). Sitka spruce (*Picea sitchensis*) and Pacific crab apple (*Malus fusca)* are also present in several areas. Tall blueberry, red huckleberry, and rusty menziesia (*Vaccinium ovalifolium* or *V. alaskaense, Vaccinium parvifolium, Menziesia ferruginea*) form the shrub layer (30-50% cover). Prominent herbs are bunchberry (*Cornus canadensis*), deer fern (*Blechnum spicant*), *Maianthemum dilitatum*, and sometimes skunk cabbage (*Lysichiton americanum*). Except for skunk cabbage, the understory plants are not particularly indicative of wet conditions. However, the smaller growth form of the trees indicates that water may limit growth.

[2] Bogs are wetlands with deep peat soils in which most of the water is derived from precipitation.

NWI Code. The forested wetlands mapped by HDR were generally also mapped as wetland by NWI. The NWI code for the more open forested wetlands is PFO4/SS1B (palustrine, open forested wetlands with deciduous shrub understory, saturated) and PFO4/SS4B (palustrine, open forested wetlands with evergreen shrub understory, saturated). The NWI code for the closed-canopy forested wetlands is PFO4B (palustrine, needle-leaved evergreen forest, saturated).

Soils and Water. Forested wetlands are generally the best-drained of the wetlands. They often occur on the beach fringe, on steep slopes, and along streams, where topographic relief allows the soils to drain somewhat. Soils in the project area include moderately deep organic deposits (10") with depth to saturated soils ranging from 4" to about 12" below the surface. Scientists in the field noticed a sulfidic odor at most sites within a foot of the surface. They saw little surface water, although they sometimes observed water ponded below exposed tree roots or in other depressions.

Functions in Near-Shore Areas. Forested areas form a fringe just inland from the high-tide line on Gravina and Pennock islands. On Gravina Island, the trees in these forests are generally larger than in adjacent areas farther inland, the result of slightly better drainage. Forested beach fringes—whether wetland or upland—are highly valued throughout southeastern Alaska, primarily for the important habitat they provide. They serve as cover for animals feeding along the beaches, and as den sites for terrestrial species like river otter and mink that feed in the marine environment. Bald eagles typically nest in trees in this fringe. If these forested fringes were located downslope from human developments, they would provide a buffer to improve runoff water quality before its discharge into the sea, as well as a visual buffer between that development and the sea.

Functions South of Airport. Other forested wetland areas, not within the beach fringe or a riparian corridor, are prominent south of the airport. Important functions of these wetlands are less well known. These wetlands may be groundwater recharge areas and may help regulate stream flows, particularly those forests that have deeper peat accumulations. They likely export dissolved organic matter that supports downstream aquatic ecosystems. They provide habitat for forest-dwelling wildlife like Sitka deer, black bear, and breeding Vancouver Canada geese. The forest edges are used by other species, such as certain songbirds. Forested habitat is relatively rare on the lowlands on the eastern side of Gravina Island, but wetland forests are not scarce in southeastern Alaska.

Functions in Ravines and Riparian Areas. Steep-sided ravines with streams are often buffered with forested wetlands on both Gravina and Revillagigedo islands. South of the airport on Gravina Island, the forested strips are narrower and open wetlands may abut the streams. Most of the functions of these areas relate more to their position next to streams than to their status as very wet sites. Many riparian forests, particularly north of the airport, may not be wetlands but serve the same function as wetland forests. Groundwater may be discharged in some of these streamside areas, which is important for maintenance of base flows in the streams. These riparian corridors shade the creeks, provide woody debris that maintains the streams' structure and provides substrate for invertebrates, bind creek banks, and produce other organic matter that washes into the creek to support the aquatic food webs. Riparian areas serve as travel corridors and as feeding and resting habitat for many species, such as mink and black bear. Riparian areas along streams that support anadromous fish receive rich nutrient input each year when animals feed upon the fish and scatter their carcasses over the forest floor. The trees in these corridors are among the largest in the area. If ground-disturbing activities were to occur nearby, the riparian areas could serve as important filters of sediments and other pollutants that might otherwise be discharged into streams.

Human Values. Forested wetlands have both consumptive and nonconsumptive human use values (see Table 1). For many people, forested wetlands serve as a buffer zone between developed, commercially used areas of the islands and undeveloped, recreational use areas. Commercially, the large trees found in these wetlands have been historically used for the timber harvest in southeastern Alaska.

Impacts. Forested wetland impacts would be potentially greatest on Revillagigedo Island approximately ½-mile northwest of the airport ferry terminal and on Gravina Island near Lewis Point.

5—Comparison of Alternatives

Footprint Acreages. Table 2 quantifies (in terms of footprint acres) the anticipated impacts of each alternative on the different wetland types. These calculations were obtained by overlaying the footprint of each alternative on the wetland mapping using GIS analysis functions. The values are shown as acreage comparisons only.

Fill Volumes. Table 3 summarizes the volume of fill that would be used to construct each alternative. The fill acreages and volumes vary by alternative (from approximately 180,000 cubic meters [m^3] to almost ten times that amount) because of the different requirements for bridge and ferry facilities, as well as the varying bridge lengths and heights among the bridge alternatives .

Table 2
IMPACTS ON WETLANDS, UPLANDS, AND WATER BODIES (BY PROJECT ALTERNATIVE)

	Acres Within Footprint							
	Bridge Alternatives[1]					*Ferry Alternatives*[2]		
Wetland Type (NWI Code)	*C3(a)*	*C3(b)*	*C4*	*D1*	*F3-200*	*G2*	*G3*	*G4*
Intertidal Marshes and Meadows	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Muskegs	25.2	25.2	25.2	25.2	61.7	25.3	29.4	24.7
Shrub/Scrub Wetlands	3.0	3.0	3.1	3.0	13.2	2.9	6.5	2.9
Forested Wetlands	15.6	14.2	10.7	8.0	11.2	13.1	9.3	7.7
Ponds	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Uplands (Non-wetlands)	*5.0*	*9.1*	*10.3*	*8.5*	*4.8*	*5.1*	*4.7*	4.7
Total Wetland Impacts	43.9	42.5	39.1	36.3	86.2	41.4	45.3	35.4

1. Bridge Alternatives:
Alternative C3(a) = 200-ft Bridge from Signal Road to Airport
Alternative C3(b) = 120-ft Bridge from Signal Road to Airport
Alternative C4 = 200-ft Bridge from Cambria Drive Area to Airport
Alternative D1 =120-ft Bridge from Airport Ferry Terminal to Airport
Alternative F3 = Bridges Across Pennock Island

2. Ferry Alternatives:
Alternative G2 = Ferry from Peninsula Point
Alternative G3 = Ferry from Downtown
Alternative G4 = Expanded Existing Ferry

[3] Fens are wetlands with peat soils and contact with relatively mineral-rich water. The “fens” in the project area generally do not meet the technical definition because the organic soil accumulation (peat) is too shallow, but no term describes them better.

[4] Bogs are wetlands with deep peat soils in which most of the water is derived from precipitation.

Table 3
ESTIMATED FILL VOLUME (BY PROJECT ALTERNATIVE)

Fill Volume (Cubic Meters)							
*Bridge Alternatives**					*Ferry Alternatives**		
C3(a)	*C3(b)*	*C4*	*D1-120*	*F3-200*	*G2*	*G3*	*G4*
1,775,400	1,231,800	1,655,500	923,200	1,734,800	1,943,900	201,300	179,400

** See Table 2 for descriptions of alternatives.*

6—Wetland Impact Mitigation

Federal regulations and guidelines associated with Section 404 of the Clean Water Act require that project proponents eliminate or reduce adverse impacts on wetlands by taking certain specific steps during project planning. These steps are as follows (emphasis added):

1. Design the project to *avoid adverse impacts*.
2. Incorporate measures to *minimize adverse impacts*.
3. Plan to *restore sites* that must be temporarily adversely affected by the project.
4. *Compensate for unavoidable adverse impacts* through preservation, restoration, or creation of wetlands.

Each of the steps listed above is to be implemented to the extent feasible before moving on to the next step. Together, these steps mitigate (i.e., lessen) the overall adverse effects of a project.

6.1 Impact Avoidance

Suitable non-wetland (upland) alternatives cannot be defined because of the extremely wet climate of southeastern Alaska; Ketchikan on average receives approximately 169” of precipitation annually. Nearly all lands in the general vicinity of the Ketchikan International Airport on Gravina Island are wetlands. Similar to Gravina Island, all alternative locations on Pennock Island would impact wetlands extensively. Few areas with substantial uplands exist within the entire Tongass Narrows vicinity; therefore, substantial impacts on wetlands are nearly unavoidable by any alternative that includes much new road on land. Several upland areas do occur on Revillagigedo Island, but these areas tend to be steep slopes, where sufficient drainage occurs so wetlands have not developed. These areas are not practicable road locations. Total avoidance of wetlands with this project is unachievable.

6.2 Impact Minimization

The following minimization measures are suggested for consideration.

Bridges

Bridges should be located to avoid direct disturbance of the estuarine beach meadows and adjacent shorelines and river mouths.

Ferry

- Ferry parking areas should be constructed on existing filled or disturbed sites, if available.

Construction Methods

- Erosion and sedimentation control measures should be employed during construction and permanent measures should be employed as early in construction as possible.
- Only clean fill material should be used for the roadway embankment.
- Staking should be done at the planned outside limits of disturbance prior to construction to ensure that impacts are limited to that area.

- The roadway should be constructed using the minimum-width fill footprint necessary to provide a stable road base.
- The roadway should be constructed with a low-profile embankment to limit the fill footprint.
- Rock should be used to stabilize toes of slopes at ponds and stream crossings.
- Grass seed should be placed on road slopes. Topsoil should be applied to the surface of road slopes to aid in the reseeding process. To protect the integrity of the natural plant communities, plant species indigenous to the area should be used for vegetating road slopes, except that nonnative annual grasses may be used to provide initial soil cover.
- No clearing or grubbing should be done outside of fill footprint.
- Silt fences should be used adjacent to waterways just beyond the estimated toe of fill.
- Ditch checks should be used to reduce bank erosion during construction.
- Sedimentation basins should be used, as necessary, during construction.
- Roadside swales should be designed to keep surface water within the natural drainage basins.
- Culverts should be installed through fill slopes in appropriate locations to maintain natural flow patterns for surface water.

7—Sources

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7.2 Interviews of Agency Personnel

Alaska Department of Fish and Game

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U.S. Army Corps of Engineers

<u>*Anchorage*</u>

Steve Duncan

<u>*Juneau*</u>

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U.S. Fish and Wildlife Service

Steve Brockman

U.S. Forest Service

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Regional Office
Terry Brock
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Supervisor's Office, Ketchikan
Patricia Krosse
Dennis Landwehr

A Gateway to the Future
Gravina Access Project

MAP NOTES:

1. Aerial photograph taken 07/07/99, by Aeromap U.S.
2. Aerial photograph is not orthorectified. The photograph has been georeferenced to match existing mapping in Alaska Stateplane zone 4, NAD27.
3. Gravina Access Alternatives shown are based upon current alternative options as of 06/07/01.

0 500 1000 1500 2000 Feet

N

WETLAND DELINEATION ALONG ALTERNATIVES C3(a), C3(b), C4, D1, G2, and G4

GRAVINA ACCESS PROJECT

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

MAPPING CODES

E2EM1N	-Intertidal marshes and meadows
PEM1B	-Muskeg
PSS4/EM1B	-Evergreen scrub tree/muskeg
PSS4B	-Shrub/scrub wetlands
PFO4/SS1B	-Open evergreen forest with deciduous shrub understory
PFO4/SS4B	-Open evergreen forest with evergreen scrub understory
PFO4B	-Closed canopy forested wetlands
PUBH	-Ponds
U	-Upland (non-wetlands)

LEGEND

Wetland/Upland or Wetland Type Boundaries
Alternative Road Routes
Estimated Fill Limit
Ferry Alternatives

DATE: August 2001

FIGURE 1

HDR Alaska

A Gateway to the Future
Gravina Access Project

MAP NOTES:

1. Aerial photograph taken 07/07/99, by Aeromap U.S.
2. Aerial photograph is not orthorectified. The photograph has been georeferenced to match existing mapping in Alaska Stateplane zone 4, NAD27.
3. Gravina Access Alternatives shown are based upon current alternative options as of 06/07/01.

0 500 1000 1500 2000 Feet

WETLAND DELINEATION ALONG ALTERNATIVES F3 and G3

GRAVINA ACCESS PROJECT

STATE OF ALASKA
DEPARTMENT OF TRANSPORTATION
AND
PUBLIC FACILITIES

MAPPING CODES

E2EM1N	-Intertidal marshes and meadows
PEM1B	-Muskeg
PSS4/EM1B	-Evergreen scrub tree/muskeg
PSS4B	-Shrub/scrub wetlands
PFO4/SS1B	-Open evergreen forest with deciduous shrub understory
PFO4/SS4B	-Open evergreen forest with evergreen scrub understory
PFO4B	-Closed canopy forested wetlands
PUBH	-Ponds
U	-Upland (non-wetlands)

LEGEND

Wetland/Upland or Wetland Type Boundaries
Alternative Road Routes
Estimated Fill Limit
Ferry Alternatives

DATE: August 2001

FIGURE 2

Attachment B

Phase II Marine Reconnaissance Technical Memorandum

Phase II Marine Reconnaissance
Technical Memorandum

Draft

Agreement 36893013
DOT&PF Project 67698
Federal Project ACHP-0922(5)

Prepared for
STATE OF ALASKA
Department of Transportation
and Public Facilities
6860 Glacier Highway
Juneau, Alaska 99801

Prepared by
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120 Third Avenue S, Suite 110
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Under Contract to
HDR ALASKA, INC.
712 West 12th Street
Juneau, AK 99801

OCTOBER 2001

Contents

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Appendix

1—Introduction

The Alaska Department of Transportation and Public Facilities (DOT&PF) is evaluating the engineering, economic, and environmental feasibility of various options for providing improved access between Gravina Island and Revillagigedo Island. As a part of this project, Pentec Environmental (Pentec, a Division of Hart Crowser, Inc.) conducted preliminary marine resource and habitat surveys under contract to HDR Alaska, Inc. (HDR). The overall objective of Phase I of these surveys, conducted in January 2000 (Houghton et al., 2000), was to identify and qualitatively describe habitat types and associated marine resources of ecological or economic concern along the shorelines of Tongass Narrows, including Pennock Island, the western side of Revillagigedo Island from Refuge Cove to just north of the community of Saxman, and the eastern side of Gravina Island from Rock Point to Gravina Point. Phase II surveys were conducted in late June and early July of 2000, and focused on areas south of Ward Cove that were potential locations for crossing route options (see Figure 1, Site Plan and Survey Locations).

In Phase I, 22 intertidal stations were investigated that are believed to represent shoreline conditions along the Tongass Narrows, and 25 subtidal transects in adjacent offshore areas were surveyed as well. The intertidal stations were selected based on the various crossing options under consideration at that time, and the subtidal transects cross the areas seaward from the intertidal sites.

This Phase II survey investigated 25 intertidal stations, of which 14 were resurveys of Phase I stations and 11 were new stations, based on new information about crossing locations, . (Five of the 25 station sites have since been eliminated as potential project crossing locations, so data from these sites are not reported in this document.) For subtidal sites, Phase II surveyed 22 transects, of which 13 were resurveys of Phase I transects and 9 were new transects.

Since the Phase II surveys were conducted, DOT&PF, with input from local, state, and federal agencies, has identified five bridge and three ferry alternatives for further analysis. Each alternative requires two or more landfalls involving construction in or across potentially productive littoral (intertidal and shallow subtidal) areas. This document reports on the range of littoral and subtidal conditions present in the vicinity of these potential landfalls. Phase I survey information for areas potentially affected by the eight build alternatives are included in this report to facilitate comparison of seasonal data.

2—Methods

See Figure 1 (Site Plan and Survey Locations) for the locations of the intertidal stations and subtidal transects that were surveyed in Phase II and are discussed in this report.

2.1 Intertidal Surveys

2.1.1 General

The general approach to intertidal surveys was similar in Phase I and Phase II. A Pentec intertidal ecologist and a phycologist, both highly experienced in Alaskan intertidal flora and fauna, conducted the Phase II intertidal field program from June 29 through July 3, 2000. The reconnaissance survey comprised detailed examinations of intertidal assemblages in characteristic habitat types within the study area, based on alternatives under consideration for the Gravina Access Project at the time. The survey stations documented in this Phase II report represent typical shorelines that could be crossed by Gravina Access Project alternatives.

This report describes changes in habitats through the intertidal range (i.e., the pattern of intertidal zonation), characterizes dominant biota in each habitat type, and, where appropriate, compares and contrasts summer and winter conditions.

2.1.2 Specific Approach

In the field, investigators typically ranged laterally 30 to 50 meters (m) (98 to 164 feet [ft]) along the beach to document the range of substrata present at each site and took photographs to document assemblages and habitats encountered. Species were noted as rare, present, common, or abundant in each habitat or elevation zone (see Appendix A, Intertidal Species List). In a limited number of habitats, primarily on bedrock, large boulders, or riprap, the relative abundance of dominants was characterized based on one to five haphazardly placed 0.25-m^2 (0.82-ft^2) quadrats. Quadrat data are reported as mean density (number/0.25 m^2 [0.82 ft^2]) or mean cover (percentage) for the number of quadrats enumerated. These data, however, are not the result of a truly quantitative sampling procedure, because the sampling locations were not systematically stratified or randomized. For soft habitats (mixed-soft, sand, and mudflat), the nature of the infauna was characterized by excavations, with particular emphasis on the presence and relative abundance of harvestable bivalves.

This report describes the pattern of intertidal habitats by zones, based on the dominant substrata and organisms, and approximates tidal elevations based on visual estimates of height above known water surface elevations. Benthic assemblages in each distinct habitat zone (e.g., low, mid, and upper intertidal) are described along with the nature of the habitat, dominant macrovegetation, and sessile and motile invertebrates.

Identifications of and nomenclature for invertebrates follow O'Clair and O'Clair (1998); those for algae follow O'Clair et al. (1996), O'Clair and Lindstrom (2000), Gabrielson et al. (2000), and Scagel et al. (1989). Vascular plant identifications and nomenclature follow Pojar and MacKinnon (1994).

2.2 Subtidal Surveys

2.2.1 General

A Pentec field crew conducted a preliminary subtidal habitat survey from June 24 through June 28, 2000, using Pentec's *Sea-All™* video mapping system. The system includes a high-resolution underwater color camera that was lowered on a weighted mount to view the bottom habitat while a chartered vessel towed the camera slowly along transects. A differential global positioning system (DGPS) provided the geographical coordinates of the camera during the survey. The system superimposed this position and the date and time on the videotape image and recorded these data on Hi-8 videotape. The system also recorded these data (approximately once per second) onto the hard drive of the system's navigation computer.

2.2.2 Specific Approach

The investigators ran transects parallel to shore along depth contours (Figure 1). However, small changes in distance from shore often resulted in large changes in depth due to steep and irregular slopes. When these slopes were compounded by strong wind and currents, the boat operator sometimes could not follow a precise depth contour. As a result, the camera lost sight of the bottom on numerous occasions when the depth under the survey vessel increased more rapidly than adjustments could be made to the camera depth. Approximately three transects were made at different depths at each site, with the shallowest located as close to the beach as was safe and the deepest at approximately 40 ft below mean lower low water (MLLW). Onboard scientists made audio notations on the videotape of water depth as indicated by the boat's depth finder. The depths were later converted into elevations below MLLW using predicted tidal height.

Copies of the original Hi-8 videotape were made on VHS-format videotape for viewing convenience. The VHS copies do not provide resolution as high as that provided by the original videotapes.

After completing the field survey, the computer file was imported into a spreadsheet. A biologist reviewed the Hi-8 videotapes and visually described the substratum type, noting eelgrass and algal coverage, and the presence of bull kelp and sea cucumber. Data logged during times when the camera was too far from the bottom to view bottom conditions were deleted from the computer file.

2.2.3 Navigation

The field investigators set the *Sea-All™* DGPS for the Universal Transverse Mercator (UTM) coordinate system, North American Datum 1983 (NAD 83) during the January survey to document the location of the videotape data. After the surveys were completed, data were imported from the *Sea-All™* system onto the project base map provided by HDR. At that time, a discrepancy of approximately 200 m (656 feet) was recognized and attributed to the fact that the base map was in UTM, NAD 27. Because the system had imprinted coordinate data in NAD 83 onto the videotapes during the survey, the base map was corrected into the NAD 83 datum for use in this report (both surveys). The correction factor used was +180.05135 m (590.71247 ft) northing and -101.99061 m (-334.61079 ft) easting for the entire mapped area.

2.3 Sites Surveyed

Table 1 lists all sites surveyed during both Phase I and Phase II of the marine reconnaissance. On this table, the 22 intertidal stations for which survey data are reported in Appendix A are shown in boldface type.

Table 1
STATIONS/TRANSECTS SURVEYED (PHASES I AND II[1])

Site[2]		*Subtidal[3] Surveys*		*Intertidal Surveys*		
Name (Station or Transect)	*Description*	*Phase I*	*Phase II*	*Phase I*	*Ph. II (re-ported)*	*Ph. II (not re-ported)*
Channel Island		X				
Danger Island		X				
Refuge Cove Reef		X				
E Deep			X			
W Deep			X			
GRV-1	Ohio Point	X		X		X
GRV-1A	Ohio Point South					X
GRV-2	1-Mile Range	X		X		X
GRV-3	Lewis Cove North	X		X		
GRV-3A	**Lewis Point**		**X**		**X**	
GRV-4	Lewis Cove South		X	X[4]		
GRV-4A	**Lewis Estuary**				**X**	
GRV-5	**Barge Dock**	**X**	**X**	**X**	**X**	
GRV-5A	**Barge Dock Beach**	**X**	**X**		**X**	
GRV-5B	**Airport North**	**X**	**X**		**X**	
GRV-6[5]	**Airport South**		**X**	**X**		
GRV-6A	**Ferry West**		**X**		**X**	
GRV-7	**East Clump Island**	**X**	**X**	**X**	**X**	
GRV-7A	**Government Creek Estuary**				**X**	
GRV-8	**Tugboat**	**X**	**X**	**X**	**X**	
GRV-8A	**Tugboat North**				**X**	
GRV-9[5]	**West Channel Southwest**	**X**	**X**	**X**		
REV-1	Refuge Beach	X		X		X
REV-2	Floatplane Dock	X		X		X
REV-3	Propane Dock	X		X		
REV-3A	**Peninsula Point**		**X**		**X**	
REV-4	**North Dump**	**X**	**X**	**X**	**X**	
REV-5	**Riprap Cove**	**X**	**X**	**X**	**X**	
REV-5A	**Ferry East**		**X**		**X**	
REV-6	**Bar Point**	**X**	**X**	**X**	**X**	
REV-7	Thomas Basin	X		X		
REV-8	**South Dump**	**X**	**X**	**X**	**X**	
PEN-1	Radenbough Cove	X		X		
PEN-2	**East Channel Northwest**	**X**	**X**	**X**	**X**	
PEN-2A	**East Channel Southwest**		**X**	**X**	**X**	
PEN-3	West Channel North	X		X		
PEN-4	**West Channel Northeast**	**X**	**X**	**X**	**X**	
PEN-4A	**West Channel South**	**X**	**X**		**X**	
	Totals:[6]	25	22	22	20	5

1. Phase 1 Surveys, January 2000; Phase II Subtidal Survey, June 2000; Phase II Intertidal Survey, June and July 2000.
2. Boldface indicates the intertidal sites for which data are reported in Appendix A of report.
3. Each subtidal transect crossed the area seaward from the named intertidal station.
4. Limited qualitative observations.
5. Although Sites GRV-6 and GRV-9 were not resurveyed intertidally in Phase II, they are still associated with one of the current project build alternatives and so are reported herein, based on Phase I data.
6. The number of sites investigated in Phases I and II totaled 38. Five sites were investigated subtidally only; four sites, intertidally only; and 29 sites, both subtidally and intertidally.

3—Results

3.1 General Habitat Type

Tongass Narrows is generally characterized by strong tidal currents and by steep bedrock or coarse gravel-cobble-boulder shorelines. Lower intertidal and shallow subtidal areas are often sandy or mixed gravel, sand, and shell, with varied amounts of silt (termed "mixed-fine"). At other areas, however, such as at rocky points and along the northwestern shore of Pennock Island, bedrock slopes steeply to subtidal depths. Subtidal habitats, like those in the intertidal zone, are a mix of bedrock outcrops or ledges, boulder-cobble slopes, and, where lower slopes permit, sandy gravel bottoms, often mixed with significant amounts of shell debris.

Several small natural coves and areas protected by constructed breakwaters provide wave and current protection for anchorages and/or marine habitats with predominantly sand or gravel bottoms. Extensive areas of riprap bank protection and filling occur along the northeastern shoreline of and north of the City of Ketchikan. Construction of numerous buildings on pilings over the intertidal and shallow subtidal zone has significantly modified shorelines in these areas. Construction and shoreline protection have similarly modified about a mile of the shoreline of Gravina Island in the vicinity of the airport and airport ferry.

3.2 Intertidal Habitats and Assemblages

3.2.1 General

Pentec surveyed a total of 33 potential landfalls during the January and June/July 2000 intertidal surveys (Phases I and II, respectively). (Of these 33 sites, 8 were surveyed in Phase I only, 14 were surveyed in both phases, and 11 were surveyed in Phase II only.) A total of 56 plant and 137 animal taxa were identified in Phase I sampling (Houghton et al., 2000). Phase II sampling added 80 new algal taxa and 14 new animal taxa, for totals of 136 plant taxa and 151 animal taxa from the two surveys combined. Appendix A provides Tables 1 through 13, which list taxa documented in either the winter (Phase I) or summer (Phase II) survey at the sites still under consideration at the time of this report.

In the sections that follow, we summarize the typical assemblages consistently found on each habitat type and elevation. Note that these are generalizations, and that many exceptions exist that reflect microhabitats present within each zone. For example, small tidepools in mid or upper rocks typically support plants and animals found only at lower elevations on well-drained rock. These descriptions are followed by more detailed descriptions of specific sites and any unusual physical or biological conditions.

3.2.2 Typical Assemblages – Rock, Riprap, and Large Boulders

Upper Zone (>+8 ft MLLW)

At most rocky sites, including those where the rock consists of riprap or large boulders, the organisms found at the highest elevations were limpets, usually *Tectura persona* or *Lottia digitalis*, which sometimes occurred as much as a half-meter higher on the beach than the highest attached animal, usually the acorn barnacle (*Balanus glandula).* This barnacle dominated the upper zone at virtually all rocky sites and was typically accompanied by lesser densities of the smaller barnacles *Semibalanus balanoides* and, especially at lower elevations, *Chthamalus dalli.* Just below the uppermost barnacles, the substratum and the attached fauna were typically covered with rockweed (*Fucus gardneri).* Rockweed often achieved 50- to nearly 100-percent cover in some portion of the upper zone. Tufts of the red algae *Gloiopeltis furcata* and *Endocladia muricata* were often present on the exposed tops of rocks and riprap, while other red algae such as *Halosaccion glandiforme* and *Neorhodomela oregona* were sometimes present in the more moist cracks in the rock in this zone. Other animals often found in the upper zone were other limpets (Lottiidae) and the littorine snails *Littorina sitkana* and *L. scutulata. L. sitkana* was most often dominant on natural rock outcrops in association with rockweed, while *L. scutulata* was most often dominant (to several hundred/0.25 m^2 [0.82 ft^2]) on rock or riprap faces lacking significant rockweed cover.

Middle Zone (+8 to +4 ft MLLW)

The assemblage on rocky substrates at mid-tide elevations generally included most of the species found at higher elevations, with the addition of several other common taxa. Rockweed and barnacles covered much of the rock surface, and littorines were often common. The two limpets most characteristic of the highest zones (*T. persona* and *Lottia digitalis*) were seldom seen in the middle zone, but were replaced by *T. scutum* and Lottia pelta and numerous unidentified smaller lottiids. The large, but cryptically colored, isopod *Idothea wosnesenskii* was often found in association with the rockweed. During the Phase II (summer) survey, green algae, especially *Ulva fenestrata*, were often abundant over restricted elevation ranges, and created a distinct green horizontal band across the beach below the upper middle rockweed zone.

Biological controls on algal cover and animal cover become increasingly important in the middle zone. For example, the cover of rockweed was typically reduced by grazers, and, especially during the Phase I (January) surveys, rockweed at lower elevations (i.e., in the lower portion of the middle zone) was often reduced to stipes with a few highly grazed fronds. Also, some areas of the middle zone supported a dense cover of mussels (*Mytilus trossulus*), while at slightly lower levels, this species was eliminated by predation by sea stars (e.g., *Leptasterias epichlora, Dermasterias imbricata*) or drills (*Nucella lamellosa, N. lima, N. emarginata*). Other species found more commonly in the middle zone were the thatched barnacle *S. cariosus* and red algae such as *H. glandiforme, Mastocarpus papillatus, Neorhodomela larix*, and *N. oregona*. Encrusting red algae such as *Hildenbrandia rubra* and *Gloiopeltis base* or "*Petrocelis*" were often abundant, especially in the winter survey.

Areas around tidepools or under overhanging ledges in this zone included many species common in the lower rocky zone, while the pools themselves often supported sharpnose sculpin (*Clinocottus acuticeps*), heptacarpid shrimp, and hermit crabs (mostly *Pagurus hirsutiusculus*).

Lower Zone (+4 to -4 ft MLLW)

The lower rocky intertidal zone along Tongass Narrows is substantially more diverse than other habitats surveyed, except for the low boulder fields that include most of the species characteristic of lower rocky habitats and species present in the surrounding mixed-fine substrata (see Section 3.2.4). This diversity is heightened in areas below about MLLW, where many species that are essentially subtidal in habitat preference were found. Few riprapped areas were examined below MLLW, but riprap near MLLW and above generally supported a less diverse biota than did natural rocky areas at similar elevations.

In the lower intertidal areas, algae present during the winter were highly diverse, primarily small individuals representing the next year's recruits or tattered senescent individuals from the previous year's growing season. Some typical new recruits included the sea lettuce *Ulva fenestrata* and the red algae *Neodilsea borealis, M. papillatus, N. oregona,* and *Cryptosiphonia woodii*. Remnants of last year's kelp *Laminaria* and *Cymathere triplicata* were often encountered along with the red algae *Constantinea subulifera* and *Palmaria* spp. Encrusting and articulated coralline algae (e.g., *Corallina frondescens*) often occupied a large percentage of the rock surface, and grazers on these forms, especially the chiton *Tonicella* spp., were common.

Algae were more diverse in summer than in winter (twice as many taxa found), although the species occupying the area in the winter remained dominant. Most of these algae were found on lower intertidal rocks and boulders. Sizes of some taxa, especially laminarians and ulvoids, were substantially greater, and algae were generally more robust in the summer. The green horizontal band found in the lower middle rocky zone extended into the lower intertidal at many locations, with the *Ulva* forming a canopy over the diverse assemblage of red algae.

Intense predation by a variety of sea stars (*Leptasterias*, *Pycnopodia helianthoides*, *Dermasterias*, *Henricia leviuscula*, *Evasterias troschelli*, *Mediaster aequalis*, *Orthasterias kohleri*) and gastropods (*Nucella* spp., *Searlesia dira*, *Ceratostoma foliatum*, *Trichotropis insignis*) limited the number of attached barnacles or bivalves in the lower intertidal zone. The rock surface was typically occupied by encrusting coralline algae or other encrusting forms such as bryozoans, serpulid polychaetes (*Serpula vermicularis*, *Pseudochitinopoma occidentalis*), spirorbid polychaetes, sponges (e.g., *Halichondria panacea*), and tunicates (e.g., *Cnemidocarpa finmarkiensis*, *Aplidium californicum*). Rock jingles *Pododesmus macroschisma* and anemones (*Metridium* spp.) were often present on sheltered undersides of ledges. We found the large black chiton *Katharina tunicata* in shallow depressions or crevices in the rock at lower and lower-middle elevations. Several other taxa of tunicates, nudibranchs, gastropods, and other groups were present, although their numbers were seldom high.

3.2.3 Typical Assemblages – Cobble and Gravel

Upper Zone (>+8 ft MLLW)

Upper intertidal cobble and gravel beaches in Tongass Narrows tend to have a limited biota except on larger cobbles, which often have low densities of barnacles or littorines in the summer and winter. Moist areas under cobbles typically collect bits of organic matter, and these areas harbored gammarid amphipods and shore crabs (*Hemigrapsus nudus*).

Middle Zone (+8 to + 4 ft MLLW)

Middle intertidal cobble and gravel beaches supported an increased epibiota and flora compared to higher elevations. Rockweed and *Mastocarpus* were typical algae on cobbles in this assemblage; barnacles were likely to be more abundant than at upper elevations. Under-rock animals were often very abundant and were joined by hermit crabs and, occasionally, *Leptasterias* and fish of the families Pholidae or Stichaeidae. Mussels and barnacles were often more abundant on cobbles or boulders at lower elevations than on steeper rocky shores, because the lower slope of these beaches provides some refuge from predation by sea stars. Areas with higher concentrations of silt and organic matter in the sediment supported an infauna, including a few littleneck clams (*Protothaca staminea*) and a limited number of polychaetes.

Lower Zone (>+ 4 to -3 ft MLLW

Lower cobble gravel beaches comprise a wide variety of microhabitats that contribute to a diverse biota. The diversity of substrata allows for attachment of a diversity of algae, which in our survey included several laminarians and a number of foliose and filamentous red algae. Larger rocks (cobbles or boulders) supported most of the diverse epibiota described in lower rocky habitats, along with a more diverse under-rock fauna that included gammarids; the crabs *Petrolisthes eriomerus*, *Lophopanopeus belli*, and *Cancer oregonensis;* jingles; the cucumber *Cucumaria miniata*; and the hermit crabs *Pagurus beringanus* and *P. granosimanus*. Pholid or stichaeid fish were more abundant at lower elevations, and the dorid nudibranch *Onchidoris bilamellata* was usually present; in the winter survey, this species was often found in spawning aggregations. We usually found two or more species of chitons (*Mopalia* spp., *Tonicella* spp.).

3.2.4 Typical Assemblages – Sand, Mud, and Mixed-Fine

Supralittoral (+ 14 to +18 ft MLLW)

At the highest intertidal elevations in Tongass Narrows, near or above mean higher high water (MHHW), which is +15.4 ft MLLW), areas of sandy or gravel and sand substrata typically supported a fringe of salt-tolerant vascular plants typical of saltmarshes in the northeastern Pacific. Dominant species where freshwater influence is present in the lower part of this zone was Lyngby's sedge (*Carex lyngbyei*). Other species common in various areas with and without substantial freshwater influence are tufted hairgrass (*Deschampsia elongata* [*caespitosa*]), Pacific silverweed (*Potentilla pacifica*), seaside plantain (*Plantago maritima*), pickleweed (*Salicornia virginica*), and saltgrass (*Puccinellia nutkaensis*). Although most of these plants are perennials, most die back to roots in the winter; thus, they were recognized as present during the summer (Phase II) survey only. Exceptions were *Carex, Deschampsia*, and dune grass (*Elymus mollis*), whose dead leaves were identifiable in the winter (Phase I) survey.

Upper Zone (>+8 ft MLLW)

Upper intertidal sand or mud beaches are not widely distributed in Tongass Narrows. Where seen, sandy gravel at higher elevations reflects wave energies that preclude the establishment of a significant biota. We found exceptions where sand or mud pockets exist above rocky ledges that tend to retain water and protect the finer-grained substratum from wave action. In these areas, we saw a few infaunal species, most notably the softshell clam *Mya arenaria.*

Middle Zone (+8 to + 4 ft MLLW)

Where the beach is sufficiently sheltered to maintain its stability against wave action and where fines and organic matter can accumulate within the coarser gravel-sand sediment matrix (defined as mixed-fine), we found an increasing number of animals living within the sediment. The dominant infaunal species in the middle intertidal zone in areas of mixed gravel and silt was the littleneck clam *P. staminea*. Polychaetes such as nereids and glycerids also became increasingly abundant at lower elevations.

Mussels were often well-established in the gravel surface of mixed-fine beaches, with their byssus threads serving to stabilize the surface gravels, thus allowing the attachment of rockweed and barnacles with their associated gammarid amphipods, isopods, limpets, littorine snails, and hermit crabs (*P. hirsutiusculus*).

Lower Zone (+4 to -3 ft MLLW)

Lower-elevation mixed-fine beaches along Tongass Narrows often occur below mid-intertidal rock or boulder-cobble beaches and often have scattered boulders supporting the typical lower-elevation biota described in the middle intertidal zone. Depending on the degree of predation by sea stars and naticid snails (*Cryptonatica affinis, Polinices lewisii*), these areas often have very high densities of littleneck and butter (*Saxidomus giganteus*) clams. We estimated that densities of these hardshell clams exceeded 40/0.25 m^2 (0.82 ft^2) in several areas. Mixed-fine beaches supported a diverse and abundant infauna as well. Several families of polychaetes were well-represented (e.g., Glyceridae, Capitellidae, Opheliidae, Nereidae, Chaetopteridae, Oweniidae) along with the burrowing cucumber *Chiridota discolor* and the peanut worm *Phascolosoma agassizii*.

At locations where the lower mixed-fine or sand bottom extends subtidally, beds of eelgrass *Zostera marina* were present. Eelgrass was found as high as about +1 ft MLLW in one area.

3.2.5 Site-Specific Intertidal Habitat Conditions

GRV-3, GRV-3A, GRV-4, and GRV-4A – Lewis Cove North, Lewis Point, Lewis Cove South, and Lewis Estuary

These sites lie on the northeastern shore of Gravina Island, north of the Ketchikan International Airport (Airport) runway. Lewis Cove lies in an embayment partially protected on the northwest by Lewis Point, on the south by the shoreline configuration, and on the east (at low tide) by a rock reef. A small stream (No. 10450) flows into the head of the cove through an area of brackish marsh and saltmarsh.

The northern end of the area surveyed as GRV-3 in January 2000 has a silty-sand lower beach (near MLLW) with abundant eelgrass that extends for some distance subtidally. Probably because of its protection from wave action, this site had among the richest infaunas of any site surveyed. When sampled, a large variety of polychaetes and bivalves (littleneck clams, butter clams, cockles [*Clinocardium nuttalli*]) were present. A high degree of patchiness in infaunal abundance was evident, with a less rich fauna in less organic and fine-grained sediments higher on the beach and very high densities of littleneck clams (to about 50/0.25 m^2 [0.82 ft^2]) in siltier areas to the south. Higher on the beach, the substratum had increasing numbers of cobbles on the surface and had the typical rockweed, barnacle, limpet, and littorine assemblage with the typical under-cobble species. Mussels were embedded in the mid-tide range beach sediments over much of the area.

At the southern end of the cove (GRV-4), the lower beach in January supported fair numbers of littleneck clams, but densities varied greatly as a result of dynamically moving gravel-sand berms. As these phenomena migrate up the beach, driven by waves, they progressively bury existing infauna (including clams and polychaetes) and provide new sediment for colonization by a new infauna. Mid-tide elevations on this beach were similar to those described above.

The meandering creek enters salt water along the eastern side of the mid-tide beach; a high-elevation spit and storm berm at the head of the cove protect the creek mouth and support a fringe of saltmarsh and dune vegetation. The creek mouth itself was covered by a broad ice shelf that rested on the intertidal area in January. When visited in June, the upper intertidal area around the creek mouth (GRV-4A) consisted of a relatively flat bench dominated at lower elevations by *Salicornia* and *Puccinellia*, with an understory of *Potentilla* and *Draba hyperborea* (Appendix A, Table 1). At somewhat higher elevations, taller species such as the sedge *Carex*, velvet grass *Holcus lanata*, and tufted hairgrass *Deschampsia* dominated. Gravelly areas adjacent to the stream channel supported patches of *Honkenya peploides*, and higher-elevation sand and gravel had a dense growth of dune grass. Muddy areas at about +11 ft MLLW supported dense patches of the diminutive fucoid *Fucus cottonii* as well as scattered *Chaetomorpha linum*, *Percursaria percursa*, and *Rhodomela tenuissima*. This was the only site at which these species were found. (*R. tenuissima* also occurred at station GRV-1 in July, but this station is not included in this report.) Bird life seen in the estuary area include bald eagles, greater yellow legs, peep sand pipers, and winnowing snipe.

Lewis Point (GRV-3A) was sampled on June 30, 2000. The site includes multilobed rocky outcrops separated by sheltered, low-elevation areas of mixed-fine and sandy substrata, often supporting eelgrass patches to elevations as high as +1.5 ft MLLW. Scattered *Laminaria* and *Alaria* were also present, along with the red alga *Sarcidotheca gaudichaudii*. These mixed-fine patches had high densities of butter clams, lesser numbers of horse clams (*Tresus* sp.), and a species of *Mya* that was being preyed upon by three species of sea stars (*Pisaster ochraceous, Dermasterias imbricata,* and *Pycnopodia helianthoides*), as well as the moon snail *Polinices lewisii*.

The highest elevations of the rock substratum at Lewis Point were dominated by rockweed (90 to 100 percent cover; Appendix A; Table 1). Associated biota were typical for the elevation, except that *Semibalanus cariosus* was the dominant barnacle on the more exposed rock faces, while *Balanus glandula* was dominant on the more sheltered faces. The lower mid-tide and lowest elevations on the rock had a distinctly green appearance, as rockweed and other epibiota were covered by an overstory of green algae, dominated by *Ulva fenestrata* and *Enteromorpha linza* along with the red alga *Cryptosiphonia woodii*, which was bleached to a greenish hue. As is typical of lower rocky areas, the flora was diverse and robust, while the fauna was depauperate and cryptic. At about -1.5 ft MLLW and deeper, *Laminaria groenlandica* formed a low-tide fringe around the rocky areas.

GRV-5, GRV-5A, and GRV-5B – Barge Dock, Barge Dock Beach, and Airport North

The Barge Dock site (GRV-5) was surveyed at the end of a riprapped fill north of the floatplane dock and boat ramp in the cove just north of the airport terminal area. Riprap extended down to below the water surface at the time of the surveys; a coarse mixed gravel-and-cobble bottom appeared to begin at about -1 ft MLLW. The larger riprap around the site contained biota typical for the habitat and elevations, with rockweed cover of 40 to 50 percent (Appendix A, Table 2). Smaller riprap on the eastern face of the fill (apparently placed to allow barges to approach the beach) had a less rich biota than is typical on larger riprap.

The beach between the barge dock and the boat ramp (GRV-5A) was surveyed in some detail in July. The upper beach had a substantial amount of log and woody debris, with patches of saltgrass *Puccinellia*. The mid-tide range on this beach is composed of cobble over a sand-and-gravel matrix. The cobbles supported a relatively dense cover of rockweed, along with the typical fauna of barnacles, littorine snails, limpets, and mussels (Appendix A, Table 2). The lower mixed-fine beach was found to support a rich infauna of polychaetes and hardshell clams (littleneck and butter) at about +2 to +5 ft MLLW. Densities of littleneck clams and butter clams were 34/0.25 m^2 (0.82 ft^2) and 14/0.25 m^2 (0.82 ft^2), respectively (n = 2).

The beach adjacent to the northern end of the runway (GRV-5B – north of the last building and past the end of a riprapped section of shoreline) consists of a series of bedrock benches that terminate in a rocky point that separates Lewis Cove (GRV-4A) from Tongass Narrows. A narrow band of trees occupies the top of this point and the upper beach on the Tongass Narrows side is sandy gravel with a fringe of *Carex* and other saltmarsh vegetation (Appendix A, Table 2). The bedrock benches supported epibiota typical for their elevations. The benches were separated by bands of sandy gravel and cobble that support clumps of mussels. Detailed surveys were not conducted at this area because of poor tides at the time of the visit.

GRV-6 and GRV-6A – Airport South and Ferry West

The Airport South site (GRV-6) consists of large riprap just south of the ramp to the new airport floatplane dock. Biota on the riprap was typical for the substratum and elevation, except that pandalid shrimp (*Pandalus* sp.) were common in the water among the lowest riprap in January 2000 (Appendix A, Table 3).

The Ferry West site (GRV-6A) includes newly placed and older riprap immediately south of the airport ferry terminal on Gravina Island. The newly placed riprap was only sparsely colonized with barnacles (*Semibalanus balanoides*, *Chthamalus dalli* set) and a few scattered rockweed. The older riprap, in contrast, was densely vegetated with rockweed and other typical epibiota (Appendix A, Table 3).

GRV-7 and GRV-7A – East Clump Island and Government Creek Estuary

East Clump Island (GRV-7) is a rocky promontory along the northwestern shore of Tongass Narrows south of the mouth of Government Creek and south of the southern end of the airport. The wooded rocky upland is separated from the mainland of Gravina Island by a mixed gravel-cobble tombolo that supports saltmarsh vegetation in the vicinity of ordinary high water. The bedrock of the island is flanked on the northern and southern sides by mixed gravel-cobble beaches that grade into a siltier mixed-fine substratum at lower elevations. In late June 2000, the uppermost vegetated zone on the bedrock and the gravel-cobble beaches was dominated by rockweed (90- to 100-percent cover) with the typical associated biota (Appendix A, Table 4). Below this obvious rockweed zone, the appearance of the rock was green, the result of a dense cover of

Enteromorpha linza with some *Ulva fenestrata* (especially in the lower portion). A dense set of the barnacles, *S. cariosus*, and *B. glandula* was present throughout the zone and was being grazed by sea stars (*Pisaster ochraceous* and *Dermasterias imbricata*; Appendix A, Table 4).

Lower bedrock elevations (near and below MLLW) also had the green appearance due to the dominance of *E. linza*, on bedrock as well as on cobble, but supported a rich assemblage of red and brown algae with relatively few animals (Appendix A, Table 4).

The mixed-fine beach areas around East Clump Island were visually dominated by the rockweed and *E. linza* seen on the bedrock (Appendix A, Table 4). Beach elevations between about +2 and -1 ft MLLW supported very high densities of butter and littleneck clams (estimated at 64 and 44 per 0.25 m^2 (0.82 ft^2), respectively; Appendix A, Table 4).

General conditions in the area in front of the Government Creek Estuary (GRV-7A) were surveyed on January 27 during a +3.3-ft-MLLW tide. The site has generally moderate slopes, and the dominant substratum is boulder-cobble with patches of coarse sand and shell. A flat sandy gravel bench at about +2 to +3 ft was visited on July 2, 2000. The beach at this elevation continued the dense cover of green algae seen on East Clump Island and was found to have high densities of both butter and littleneck clams. A slowly moving sand-gravel berm driven by storm waves from the north was moving across the bench. The mid-tide boulder-cobble beach supported dominant biota typical for the substratum and elevation, with increasing coverage of rockweed and barnacles at higher elevations (Appendix A, Table 4). More sandy gravel, supporting fewer epibiotal species, was present at higher elevations and nearer the mouth of Government Creek.

Government Creek enters the marine environment through a shallow gravel-cobble-bottomed stream channel in a small V-shaped embayment. The stream channel bottom was covered with a dense growth of the filamentous brown alga *Pilayella littoralis*. Lower streambanks supported a band of dense rockweed; in muddy pockets adjacent to the stream, softshell clams (*Mya arenaria*) were abundant. Finer sediments at higher elevations (>+13 ft MLLW) had a well-developed saltmarsh assemblage. Dominant plants in the lower saltmarsh were *Carex*, *Glaux*, and *Plantago*; higher elevations had *Potentilla*, *Deschampsia*, and *Juncus* sp. (Appendix A, Table 4). Higher, coarser sand and gravel, especially to the south toward East Clump Island, supported patches of *Salicornia* and a broad dunegrass-dominated backshore assemblage with a mix of salt-tolerant grasses and herbs.

GRV-8 and GRV-8A – Tugboat and Tugboat North

The Tugboat intertidal site (GRV-8) is located just shoreward and south of the beached tugboat in the West Channel around Pennock Island. The site has a diversity of habitats that range from relatively clean sand, mixed-fine, and boulder fields at the lower elevations (below MLLW) to clean gravel-cobble and bedrock outcroppings at mid-tide and upper elevations. The lower habitats were uniformly rich in epibiota (Appendix A, Table 5). Moderately high densities of hardshell clams (littleneck and butter) were present in the lower mixed-soft substrata, especially in more sheltered pockets. Patches of eelgrass occupied these substrata, with several kelps (Laminaria, Cymathere, Nereocystis) present and attached to cobbles and boulders below MLLW (Appendix A, Table 5).

Mid-tide bedrock outcroppings and boulders supported dense rockweed and green algal cover, along with the typical associated biota. The highest vegetated rock had nearly 100 percent rockweed cover (Appendix A, Table 5).

North of the tugboat (GRV-8A), rock benches were more extensive than at GRV-8, but supported a similar biota. Several gumboot chitons (*Cryptochiton stelleri*) were notable additions to this fauna.

GRV-9 – West Channel Southwest

This site encompasses a broad intertidal boulder-cobble bench with large areas of sand and gravel (mixed-soft) and limited areas of bedrock outcrop. Like GRV-8, the lower elevations were extremely rich in species. Large (1- to 2-meter-high) boulders added to the habitat diversity and created a variety of microniches supporting the greatest diversity of taxa found at lower elevations anywhere in the narrows (Appendix A, Table 6). Mid- and upper-elevation cobble and rock outcroppings supported biota similar to those found elsewhere on similar substrata.

REV-3A – Peninsula Point

Peninsula Point (REV-3A) is a natural rock outcrop into the eastern shore of Tongass Narrows, about 1.5 miles northwest of the airport ferry dock on Revillagigedo Island. Temsco Helicopters occupies fill that has been placed around and over the underlying rock; the site surveyed is about midway along the channel face of the peninsula, behind a large hangar. Above approximately MHHW, the site surveyed consists of steep riprap overlying steep horizontal ledges of a dark gray shale with a sharp dip to the southeast, away from the channel. This rock formation creates conditions that favor water retention in numerous longitudinal tide pools and has led to the development of an unusually rich and diverse biota. At about -2 to -3 ft MLLW, the toe of the rock slope meets a sandy bottom that supported the brown algae *Laminaria* and *Desmarestia viridis*; the sea star *Dermasterias* was visible on the sand.

The lowest rock ridges were dominated by the species in the middle elevations and several other kelps (*Costaria, Cymathere*) and numerous other species of smaller algae (Appendix A, Table 7). Because of its high rugosity (roughness) and the presence of numerous small tide pools, this site supported a more diverse fauna than is typical of rock or riprap at similar elevations. Middle and upper elevations on the rock were dominated by rockweed (>70 percent cover; Appendix A, Table 7). However, again because of the rock characteristics, the associated biota was uncharacteristically diverse.

REV-4 – North Dump

This site is at the base of riprap encasing a former dump, and the beach along its entire face was littered with iron, wire, glass, and other debris. At a -1.5-ft tide, riprap and rock extended into the water, but a small pocket beach of gravel, sand, and debris remained to the north. Biota was typical for the substratum and elevation, except that excavations in the limited beach area in January did not reveal any significant infauna (Appendix A, Table 8). The diversity of both algae and animals on the low- to mid-elevation riprap was somewhat greater in June-July than in January. A narrow band of bull kelp lay just offshore.

REV-5 and REV-5A – Riprap Cove and Ferry East

Riprap Cove (REV-5) lies at the southern end of the dump and is the most recently disturbed of any site surveyed. The substratum is largely riprap or quarry spalls, and much of the area appeared to have been recently disturbed by activity at an adjacent work area. A high-elevation constructed bench of quarry spalls appeared to be recently placed and was barren during both surveys. As a result of recent instability, the middle and upper intertidal areas were relatively impoverished, but rockweed reached 40-percent cover in some areas (Appendix A, Table 9). Lower elevations were not accessible in January because of the tide during the survey. In late June, the lower riprap was dominated by the small barnacle *Chthamalus dalli*, with scattered rockweed and a few other algal species, including *Blidingia* and *Porphyra*, forms that favor disturbed sites. Some limited areas had a dense cover of the green algae *Enteromorpha intestinalis* and *E. linza.*

The Ferry East site (REV-5A) is a riprapped area that includes some boulders, cobbles and asphalt. The site lies inshore of the eastern dock for the airport ferry. The riprap is smaller and placed at a lower angle than that along the dump to the north (REV-3 to REV-4). Middle and upper elevations were dominated by rockweed that averaged over 75-percent cover at both elevations (Appendix A, Table 9). Dominant barnacles were *C. dalli* at the lowest elevations and *B. glandula* at the middle and upper elevations. Freshwater from a stormwater culvert had stimulated a dense growth of green alga *Enteromorpha intestinalis* and *Blidingia minima* in a narrow vertical band at the northern end of the site. The presence of large barnacles and mussels below the culvert at elevations where they are not typically found on riprap suggests that the freshwater has limited predation by sea stars and other species that would normally remove these species.

REV-6 – Bar Point

The intertidal site surveyed at Bar Point (REV-6) includes the upper portion of a rocky reef flat that extends out beyond the riprap fill, forming a large commercial development southeast of the Bar Point Marina breakwater. Lowest tide during the surveys was +2.5 ft MLLW, so that only the middle and upper intertidal zones were surveyed. The biota on the rock bench and lower riprap was typical of rocky habitats at the same elevations (Appendix A, Table 10). The outer and lower portions of the rock bench had relatively sparse growths of highly grazed rockweed during both surveys; at higher elevations on the bench, the rockweed was much more robust, covering up to 80 percent of the surface in some areas in January and averaging over 90-percent cover in June 2000 (Appendix A, Table 10). Overall, the rocky bench was relatively rich, given the disturbed nature of surrounding areas.

The infauna in the limited areas of mixed-fine habitat around the upper base of the rocky bench and along the adjacent riprap included burrowing cucumbers (*Chirodota*) and high densities of hardshell clams (*P. staminea*). Fauna under rocks in the mixed-fine area in June included a rich assortment of gunnels, cottids, shore crabs, polychaetes, sea stars, urchins, and snails. Many butter clam siphons were also present. Small patches of eelgrass were present in June. Biota on the riprap was typical for the area and elevation.

REV-8 – South Dump

The South Dump site (REV-8) was remarkable in that the mixed gravel-sand beaches interspersed between and below the rock benches occupying much of the site were covered with debris, predominantly broken glass and metal. Some areas of rocky bench had accretions of 1 to 2 ft of fused metal waste that elevated the substratum and were themselves colonized by typical rock-dwelling biota (Appendix A, Table 11). In January, the site was similar to REV-6 in having heavily grazed rockweed at the lower elevations (+2 to +3 ft MLLW) and healthy rockweed covering up to 100 percent of the rock surface at higher elevations. In July, the lower rock was more densely covered with algae, dominated by rockweed (35.7-percent cover), several red algae, and the green alga *Ulva fenestrata*. Attached animals were rare on the lowest rocks, dominated by *Semibalanus cariosus* on middle-elevation rocks and by *Balanus glandula* and blue mussels at higher elevations (Appendix A, Table 11). Predators (*Nucella, Searlesia, Evasterias, Pisaster, Pagurus, Leptasterias*) and grazers (lottiids, *Katharina, Tonicella*, littorines) were relatively diverse at this site, although the tide was not particularly low during the survey.

PEN-2 and PEN-2A – East Channel Northwest and East Channel Southwest

These sites lie on the eastern shoreline of Pennock Island, just south of Whiskey Cove. Relatively steep bedrock ledges form a point that breaks to the south into boulder fields (PEN-2A). PEN-2 is north of the point with upper elevations in rock ledges and the lower elevations in boulders set in silty sand and gravel. Offshore boulders below about -2 ft MLLW supported beds of kelp (*Nereocystis, Laminaria groenlandica, Cymathere*) during the summer survey. The epibiota on the rock and boulder substrata was typical for the elevation, with high densities of the sea star *D. imbricata* and the drill *S. dira* noted on the lower rock ledges at PEN-2 in January (Appendix A, Table 12). Possibly as a result of heavy predation by these carnivores and by the grazing of abundant limpets, the mid- and lower-elevation rock was relatively barren in July. The lowest rock and boulder elevations at both stations in July had a green appearance due to high cover of green algae (*Ulva, Cladophora, Enteromorpha*) and bleached red algae (*Cryptosiphonia, Halosaccion*).

Littleneck clams were abundant in pockets of sand and gravel (mixed-fine) at low elevations among the boulders (Appendix A, Table 12). Sandy areas above the highest intertidal boulders supported a fringe of saltmarsh vegetation dominated by dune grass, *Carex*, and *Deschampsia*, but included several other species (Appendix A, Table 12).

PEN-4 and PEN-4A – West Channel Northeast and West Channel South

PEN-4 is located on the northwestern shore of Pennock Island opposite the channel marker buoy. The substratum at this survey site consists of steep bedrock and large rock slabs that slope into deep water. Because of the shading of overhanging trees and the western exposure of this site, it has limited algae at the upper elevations and was, uncharacteristically, nearly devoid of rockweed in both surveys (Appendix A, Table 13). As a result, the upper rocks were dominated by barnacles, primarily *C. dalli*, except that *B. glandula* was present at the very highest intertidal elevations, along with the limpet *T. persona* and the predatory snail *Nucella lamellosa*. PEN-4A was located approximately 100 m (328 ft) north of the onshore fixed channel marker. This site is similar to PEN-4, except that the boulders are somewhat smaller. Again, the upper rock surfaces were dominated by barnacles, with only sparse rockweed.

At lower tide levels, a rich epibiota was present at both sites. Rock slabs extending subtidally and crevices under large overhanging rock slabs supported a number of taxa that are not found, or rare, elsewhere in the narrows (e.g., the coral *Balanophyllia elegans*, the erect bryozoan *Dendrobenia lichenoides*, the scallop *Chalmys hastata*, the gastropods *Scabrotrophon maltzani* and *Trichotropus cancellata*, the white limpet *Acmaea mitra*, the sea peach *Halocynthia auranthium*, and several hydroids and bryozoans). The red algae *Antithamnion defectum* and *Saundersella simplex* were found only at this site. In July 2000, large *Laminaria groenlandica* formed a dense bed from about MLLW down and a narrow band of bull kelp lay just offshore.

3.3 Subtidal Habitats and Assemblages

3.3.1 General

Pentec surveyed a total of 34 subtidal transects during the January and June 2000 surveys (Phases I and II, respectively). Of these 34 sites, 14 were surveyed in Phase I only, 11 were surveyed in both phases, and 9 were surveyed in Phase II only. Five of these transects were at different sites than the intertidal stations, and 29 of them were offshore of intertidal stations (and have the same site names). The transects discussed here are the 20 surveyed in Phase II.

Subtidal margins of Tongass Narrows are characterized by a narrow gravel-sand shelf with steeply sloping bedrock or coarse gravel-cobble bottoms extending from the lower intertidal zone to the deeper, flatter center of the channel at depths of -80 to -150 ft MLLW (Figures 2A-2F). For the most part, these subtidal slopes are swept by strong tidal currents and support a number of kelp and other algal species down to about -40 ft MLLW (Figures 3A-3F). The primary algal taxon observed in the January surveys was *Laminaria*, which covered much of the bottom surveyed. In spring and summer, many of these rocky areas also supported a canopy of bull kelp (to a maximum depth of about -30 ft MLLW, but mostly shallower). At depths below -40 ft MLLW, the bottom became nearly barren sand and gravel.

Shallow subtidal areas that are protected from direct impact of the currents in small coves or behind breakwaters had more gradually sloping sandy bottoms that often supported healthy eelgrass and *Laminaria* beds (Figures 2A-2F and 3A-3F). Sea cucumbers (*Parastichopus californicus*) were seen at all locations (Figures 4A-4F). Otherwise, very few vertebrate or invertebrate organisms, such as fish or crab, were observed during either the winter or summer surveys.

The substratum types are shown in Figures 2A-2F.

3.3.2 Site-Specific Subtidal Habitat Conditions

GRV-3A – Lewis Point

The bottom substrate in the area surveyed is bedrock with trace amounts of sand (Figure 2A). Depths ranged to -70 ft MLLW. A large algal bed with patchy *Laminaria* extended along the shoreline in a nearly continuous band (Figure 3A). Many sea cucumbers were present throughout the surveyed area (Figure 4A).

GRV-4 – Lewis Cove South

Shallow depths and a rock reef protecting this cove prevented the survey vessel from entering. Offshore, the bottom is a mixture of gravel and sand (Figure 2B). Depths ranged to -20 ft MLLW. As observed in the January survey, this area supported part of a large eelgrass bed seen along northern Gravina Island, between GRV-3 and GRV-5 at -7 to -16 ft MLLW. *Laminaria* and other algae also dominated the bottom habitat (Figure 3B). Unlike GRV-3A, relatively few sea cucumbers were observed in this area (Figure 4B).

GRV-5, GRV-5A, and GRV-5B – Barge Dock, Barge Dock Beach, and Airport North

Just offshore of the riprapped beach, the bottom is a mixture of sand, shell, and gravel. The continuation of the band of eelgrass beginning at GRV-3 was present just offshore of the riprapped beach along the Airport at GRV-5. A band of *Nereocystis* that was observed in January paralleling the beach inside of the eelgrass bed was not observed during the June survey, possibly because the survey did not include a transect at the shallower depths occupied by this species. Depths ranged to -25 ft MLLW. Offshore, a nearly continuous mat of *Laminaria* and other algae was present. As at GRV-4, few sea cucumbers were observed along this shoreline.

GRV-6 and GRV-6A – Airport South and Ferry West

The substratum offshore of the riprapped shoreline along the airport terminal area is primarily gravel and sand (Figure 2C). Depths ranged to -45 ft MLLW. The band of eelgrass along the southwestern shore of Tongass Narrows observed in January was not observed in June. Near the shoreline, there was a band of *Nereocystis*, which was probably attached to the lower portions of the riprap. *Laminaria* and other algae were also common. Sea cucumbers were observed at GRV-6, but not at GRV-6A.

GRV-7 – East Clump Island

The area to the north of East Clump Island was surveyed in January. This area is a “boat graveyard,” with numerous sunken vessels. The sand, gravel, and shell bottom was littered with debris. We observed small amounts of eelgrass at depths of -11 ft MLLW; however, for safety reasons, the survey vessel could not investigate close to shore. It is likely that the eelgrass bed was somewhat larger than indicated by the videotape survey, especially shoreward from the videotape trackline. Small patches of *Laminaria* also were present.

The area to the south of East Clump Island was surveyed in June. The substratum in this area is primarily gravel, sand, and shell (Figure 2D). Depths ranged to -67 ft MLLW. *Laminaria* and other algae were observed in the shallower transects, but were absent in the deepest transect (Figure 3D). A large population of sea cucumbers was observed in these areas as well (Figure 4D).

GRV-8 – Tugboat

A large sunken tugboat served as a landmark at this site at low tide and is a significant navigation hazard at high tide. The bottom is sand and gravel with occasional rocky outcroppings (Figure 2E). The depths ranged to -35 ft MLLW. An eelgrass bed observed in this area in June was not detected in January. Large beds of *Laminaria* were also observed (Figure 3E). We observed considerable numbers of sea cucumbers, especially near the middle of the channel (Figure 4E).

GRV-9 – West Channel Southwest

Bathymetric contours are uncharacteristically gentle at this location. The bottom is sand or gravel and shell, with outcroppings of bedrock. We observed occasional remnants of *Nereocystis* in the vicinity, probably attached to the rocky outcroppings. Small numbers of sea cucumbers were present and *Laminaria* was common.

REV-3A – Peninsula Point

The substratum offshore of Peninsula Point is predominantly sand, with considerable coverage of *Laminaria* and other algae (Figures 2A and 3A). Depths ranged to -63 ft MLLW. A small patch of eelgrass was observed in the sheltered shallow water north of the point at depths to -8 ft MLLW (Figure 3A). Sea cucumbers were also observed in this area (Figure 4A).

REV-4 – North Dump

This site is just north of the riprapped face of a former garbage dump, and large amounts of scrap steel litter the beach and bottom. The beach drops very quickly to -78 ft MLLW. The substratum in shallow water consists of gravel and sand (Figure 2B). As the beach dropped into deeper water, bedrock outcroppings and patches of cobble were observed to support large patches of *Laminaria* (Figure 3B). Few sea cucumbers were observed in this area (Figure 4B).

REV-5 and REV-5A – Riprap Cove and Ferry East

The subtidal bottom from the southern end of the former dump site to just north of the Airport ferry terminal is similar to that at REV-4, with large amounts of debris and patches of *Laminaria* on a steeply sloping rock and cobble bottom (Figures 2B and 3B). Depths ranged to -78 ft MLLW. Additionally, a small bed of bull kelp was observed along the northern section of GRV-5 at approximately -24 ft MLLW (Figure 3B). This bed is a continuation of the narrow band of bull kelp noted along the shore in the intertidal surveys (Section 3.2.5). Few sea cucumbers were observed in this area (Figure 4B).

REV-6 – Bar Point

The Bar Point site covers a large, shallow reef east of the breakwater that protects the Bar Point Basin marina. Depths ranged to -30 ft MLLW. The bottom is primarily sand or a mixture of sand, sand and gravel, and patches of cobble (Figure 2D). During the January survey, patchy eelgrass was growing at this site and *Laminaria* covered a large portion of the bottom area. During the June survey, the eelgrass bed was more extensive and a bull kelp bed had formed (Figure 3D). Very few sea cucumbers were observed in this area (Figure 4D).

REV-8 – South Dump

Similar to the North Dump site, the South Dump site lies offshore of a former garage dump. The substratum is sand or gravel and shell debris (Figure 2F). Depths ranged to -50 ft MLLW. The bottom supported a nearly continuous mat of *Laminaria*. In June, this area supported a patchy eelgrass bed at depths to -9 ft MLLW, which was not observed in January (Figure 3F). Sea cucumbers were abundant in this area as well (Figure 4F).

PEN-2 and PEN-2A – East Channel Northwest and East Channel Southwest

This site on the eastern side of Pennock Island has a bottom of gravel and sand, or sand and shell, that appeared to be heavily scoured by strong currents (Figure 2F). Depths ranged to -76 ft MLLW. *Laminaria* beds were the primary biological features, although scattered, isolated areas of eelgrass were observed as well (Figure 3F). This area was heavily populated by sea cucumbers (Figure 4F).

PEN-4 and PEN-4A – West Channel Northeast and West Channel South

The bottom of the channel between Pennock and Gravina islands is gravel and sand, with occasional boulders (Figure 2E). Depths ranged to -60 ft MLLW. Small areas of *Nereocystis* were observed near shore at the surface of the water. The *Laminaria* bed had expanded since the January survey and was abundant in June (Figure 3E). Sea cucumbers were also observed in this area (Figure 4E).

W Deep

An attempt was made to videotape the deeper parts of Tongass Narrows between REV-5 and GRV-6. Depths in the channel along the transect ranged to -115 ft MLLW. We found that the weight on the camera was too light to effectively perform this task, and we encountered considerable difficulty in keeping the camera within sight of the bottom. The limited views of the bottom indicated that the bottom is nearly barren, with a gravel-sand substratum and numerous sea cucumbers (Figure 4B).

E Deep

An attempt was also made to videotape the deeper parts of Tongass Narrows between REV-6 and GRV-7. Similar problems were encountered as during the W Deep survey. Depths in the channel along the transect ranged to -123 ft MLLW. The limited views of the bottom indicated that the bottom is nearly barren, with a gravel-sand substrate and numerous sea cucumbers (Figure 4D).

4—Discussion

4.1 General Habitat Types

Littoral (intertidal and shallow subtidal) areas along the Tongass Narrows represent a range of habitat types, from sand and gravel to bedrock. Because of the geology and the strong currents in the narrows, mud habitat is very limited in the area surveyed. Most natural beaches surveyed have bedrock outcrops in some portion of the intertidal zone; often an area of fractured bedrock or boulders also is present. When present, sediment is largely coarse gravel or sand; only in the most sheltered areas or in the lowest intertidal zone was there a significant percentage of fines present. A substantial portion of the northeastern shoreline of Tongass Narrows between stations REV-8 (South Dump) and REV-3A (Lewis Point) has been modified by riprap, bulkheading, and/or construction of overwater structures. Anthropogenic debris is common, especially at former dump sites.

4.2 Characteristic Biological Conditions

The biota found in each of these diverse habitat types was generally typical of biota found over a larger ecoregion (e.g., Ricketts and Calvin 1962). More specifically, the biota was typical of that expected for this area of southeastern Alaska. Quast (1968) characterized the inside waters of southern southeastern Alaska as being warmer than northern inside waters, but with lower salinity than outside waters of the Panhandle; Quast recognized each region to harbor a distinctive association of fishes. Lindstrom and Foreman (1978), Lindstrom et al. (1997), and Lindstrom (unpublished data) noted the similarity of the seaweed flora of the Ketchikan area to that of the Strait of Georgia in southern British Columbia, which is another area of relatively warm, low-salinity water.

Several taxa identified in this survey may not have been previously reported in the Ketchikan area. In the winter, the highest standing crop of algae, primarily rockweed, was found in the middle to upper intertidal zones that have stable boulders or bedrock. Coverage of rockweed often approached 100 percent, even in the mid-winter survey. At lower intertidal elevations, grazing, probably by limpets and snails (*Littorina* and/or *Lacuna*), had greatly reduced the standing stock and health of rockweed, especially in the winter survey. Lowest intertidal and shallow subtidal rocky and boulder habitats in areas of high current had the richest epibiota found in the study area. In these areas, biological controls, primarily sea star and gastropod grazing, maintain the assemblage composition (e.g., Paine, 1966). Prime examples are the lowest rocks and boulders sampled along the West Channel around Pennock Island.

On the Ketchikan side of the narrows and near the Airport, riprap placed to build additional usable uplands or to protect existing shorelines from erosion provides an artificial rocky shoreline. Riprapped areas display an epibiota generally similar to, but usually less diverse than, that on natural rocky shores. Because riprap consists of angular boulders stacked on top of one another (rather than boulders set in a gravel matrix, as is often the case in nature), individual boulders lack continuity with the adjacent substratum. Also, riprap rock typically lacks consistent patterns of cracks and crevices that retain water or sediment in miniature tidepools and tends to retain little moisture between tides. For example, rockweed tends to be abundant on the tops and northern or eastern faces of riprap boulders, and absent or scarce on sloping southern or western faces, which dry out between tides during the summer.

On gravel and sand substrates, the presence and abundance of epibiota depend on the elevation, size, and stability of beach materials. In more energetic intertidal and subtidal gravel and sand bottoms, little epibiota is present. However, during periods of relatively low wave energy and high light levels, these areas may develop a substantial microflora that can support productive epibenthic zooplankton populations, especially at lower intertidal elevations. These zooplankton, primarily amphipods and harpacticoid copepods, are important prey for juvenile salmonids during their early marine life history (e.g., Simenstad et al., 1982). Cobbles resting on a gravel beach support some of the more interesting animals and plants in the middle to lower intertidal range, including mobile scavengers that leave the protection of the cobble during high tide to forage over adjacent beach areas. This under-rock biota includes several species of amphipods, crabs, and fish. Another important function of sand and gravel beaches is as a spawning site for forage fish species such as surf smelt (*Hypomesus pretiosus*) and sand lance (*Ammodytes hexapterus*), which occur at middle to upper intertidal zones.

In protected or semiprotected areas, varying amounts of finely divided organic matter or silt-sized inorganic particles can accumulate in the gravel-sand matrix. Such areas support a diverse infauna, typically dominated by polychaetes and bivalves. In study sites surveyed in Tongass Narrows, areas with higher proportions of fines in the gravel-sand matrix often had moderate to very high densities of edible hardshell clams, including butter clams and littlenecks.

In subtidal habitats, the study design placed emphasis on mapping key habitat types, biota, and substrata. The most important resource mapped was eelgrass. Small patches or larger beds of eelgrass were present in most areas surveyed that had appropriate substrata (small gravel, sand, and silty sand bottoms) from near or just above MLLW to maximum subtidal depths of -16 ft MLLW. The largest beds began along the shoreline near the airport floatplane dock and extended northeast at least to Lewis Cove (Figure 3B). Some algal species, including laminarians, red algae, and green algae often occurred within eelgrass beds, adding to the species diversity and habitat structure within the beds. Eelgrass beds expanded between the winter and summer surveys at REV-6. Additionally, eelgrass beds observed in the summer survey were not detected during the winter survey at GRV-8 and REV-8.

Eelgrass beds and adjacent gravel, sand, and mud mixed-soft beaches provide habitat for epibenthic zooplankton in spring and summer and are highly important rearing areas for juvenile salmonids during their early marine life history (Simenstad et al., 1982). A wide range of research (e.g., McRoy, 1970; Phillips, 1984; and Fonseca, 1992) has shown that eelgrass beds also provide important rearing areas for numerous other species, including Dungeness crab (*Cancer magister*), and a substratum for spawning by Pacific herring (*Clupea pallasii*).

Because of a requirement for attachment to larger substrata, dense kelp beds typically existed in areas not occupied by eelgrass beds. The January surveys were not considered definitive in terms of the location or importance of eelgrass or kelp because one of the primary kelp-bed-forming species, bull kelp, is an annual, and eelgrass dies back considerably in the winter. Bull kelp displayed highly reduced coverage and abundance in the winter survey, but the survey conducted in summer found much-expanded bull kelp beds and a more diverse and healthy flora of associated algae. For example, two annual brown algae that were common along the low-tide rocky and cobble shorelines in the summer were either absent (*Alaria tenuifolia*) or present only as senescent and degrading plants (*Cymathere triplicata*) in January. Bull kelp and *Laminaria* beds are present throughout the project area on gravel and sandy bottoms from MLLW to a maximum subtidal depth of -30 ft MLLW. A bull kelp bed observed at REV-6 in June was not detected in January. Most *Laminaria* beds expanded substantially from surveys in January. *Laminaria* is a perennial that begins producing new growth in January, reaching its maximum length in late spring, at which time the blade begins to thicken in preparation for reproduction (Calvin and Ellis, 1976).

Sea cucumbers, a commercially harvested species, were also present primarily in silty sand and gravel areas, sometimes within eelgrass beds. However, we also found sea cucumbers in deeper and more cobble-dominated habitats (Figures 4A-4F). More sea cucumbers were observed during the June survey than the January survey.

In summary, the littoral resources of Tongass Narrows are typical of those found along semisheltered shorelines throughout southeastern Alaska and in adjacent areas to the north and south with specific features like those of other relatively warm euryhaline environments in the northeastern Pacific region (Quast 1968; Lindstrom and Foreman 1978). Some areas of the shoreline support harvestable quantities of hardshell clams, and littoral areas include habitats of substantial ecological importance for a variety of marine resources. Healthy littoral areas with a mosaic of eelgrass and kelp beds are important to the early life history stages of commercially harvested crab and shrimp and to the early marine life history of anadromous salmonids. A variety of other species (e.g., sea ducks, marine mammals, terrestrial birds, and mammals) also rely on these shorelines for a portion of their diets.

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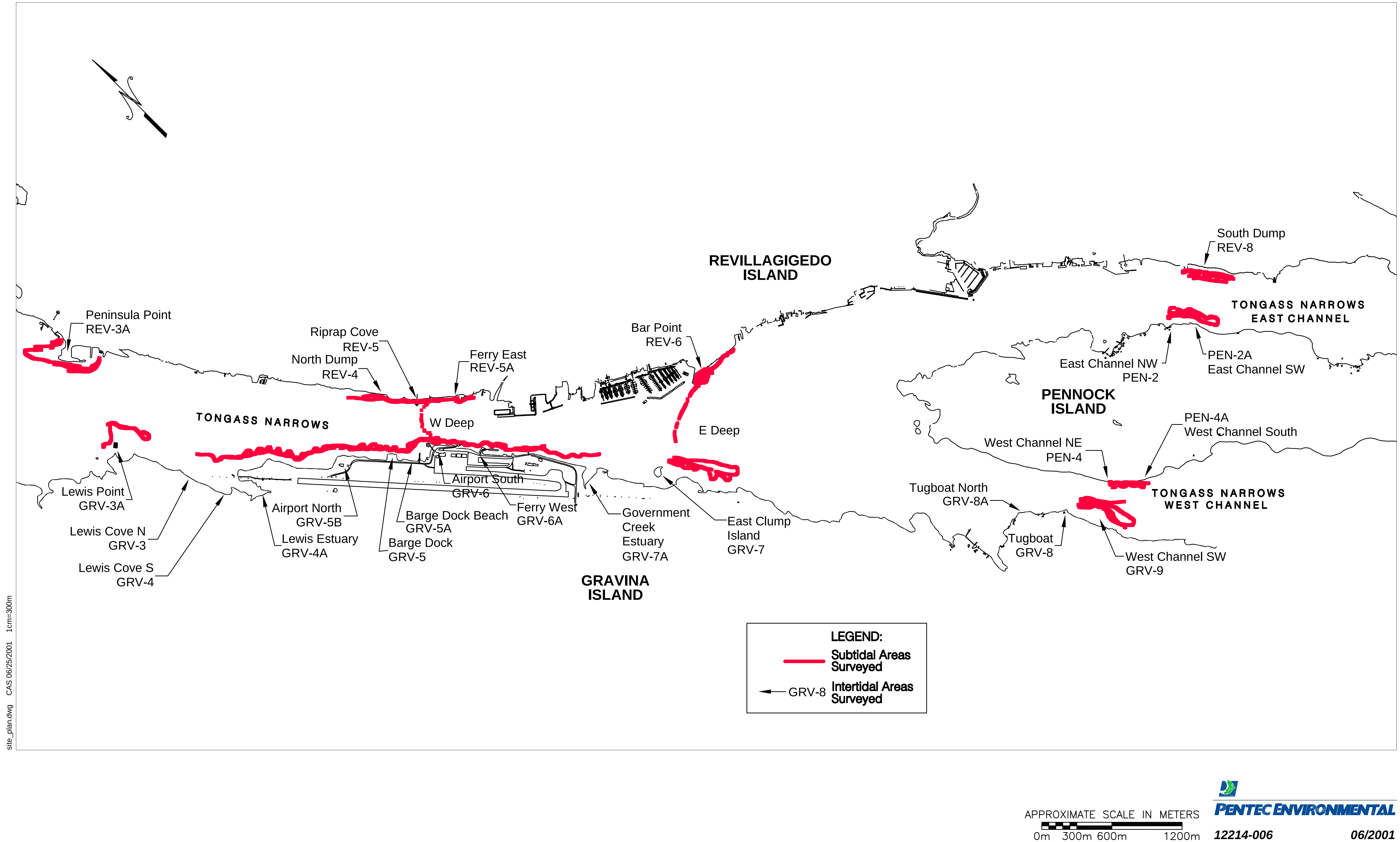
Figures

Gravina Access Project
Site Plan and Survey Locations

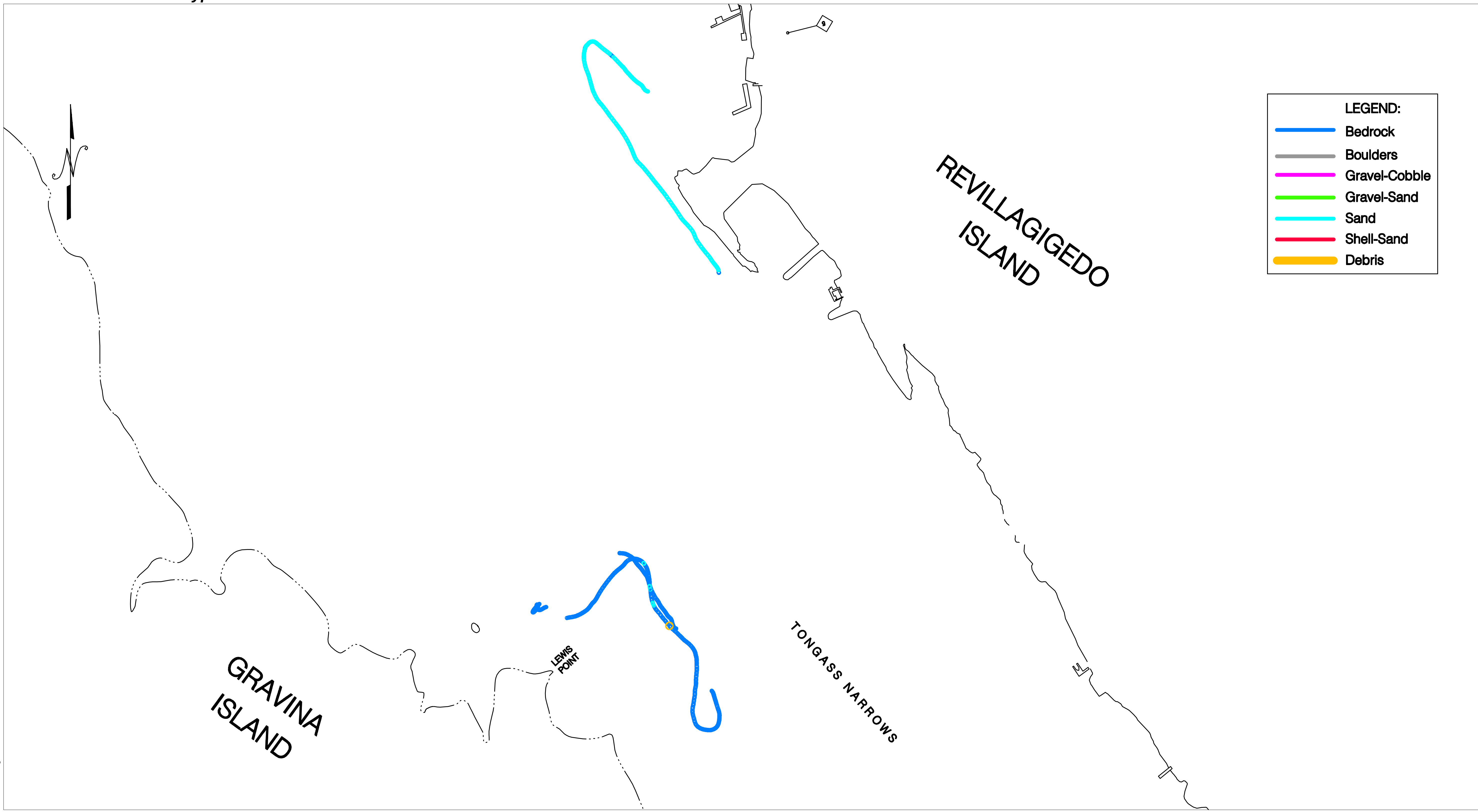


PENTEC ENVIRONMENTAL

12214-006 *06/2001*

Figure 1

Gravina Access Project
Subtidal Video Survey Trackline and Subtidal Substrate Types

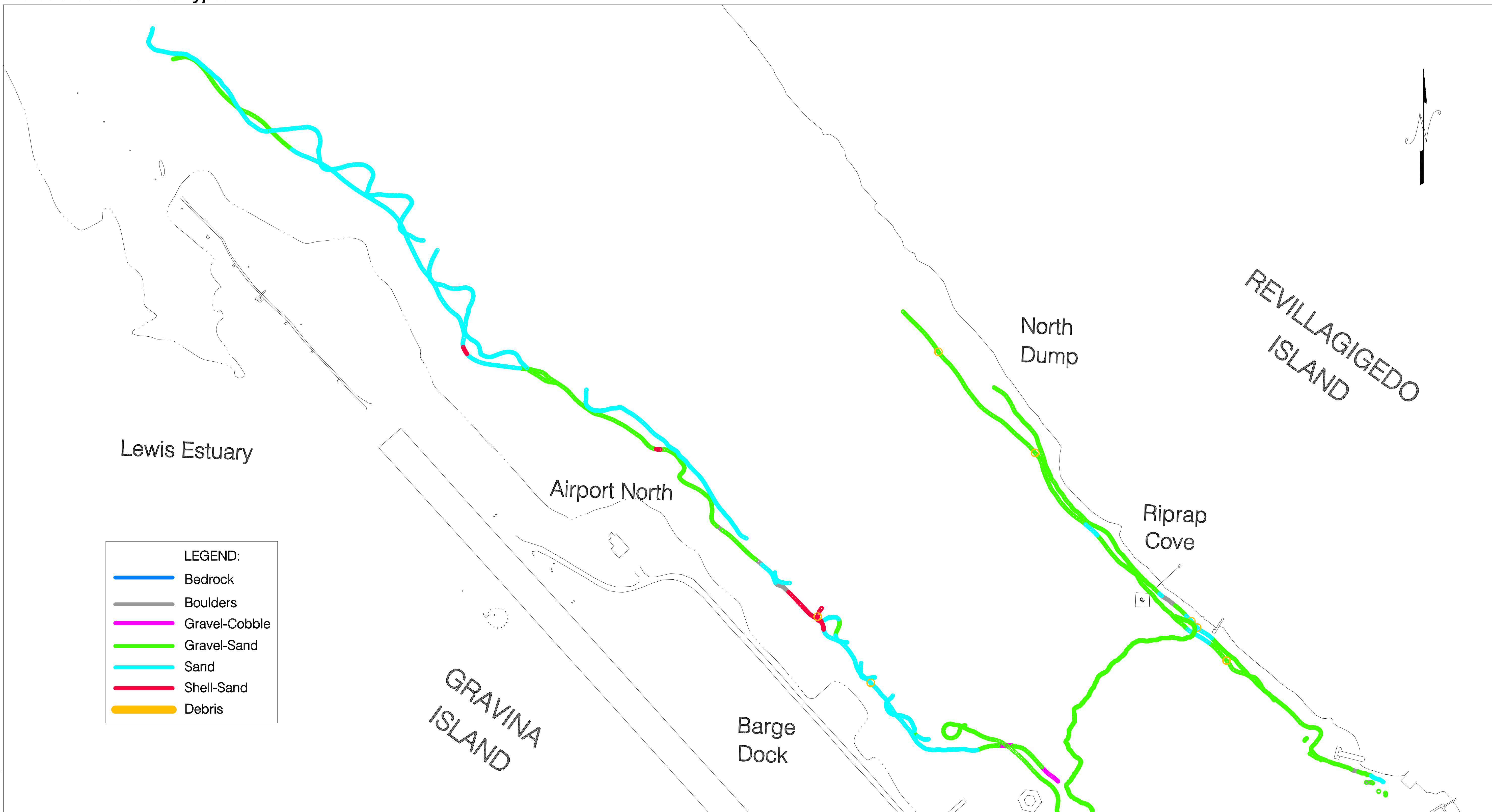


substrate.dwg CAS 1cm=70mN/A

APPROXIMATE SCALE IN METERS
0m 70m 140m 280m

PENTEC ENVIRONMENTAL
12214-006 06/20/2001
Figure 2A

Gravina Access Project
Subtidal Video Survey Trackline and Subtidal Substrate Types



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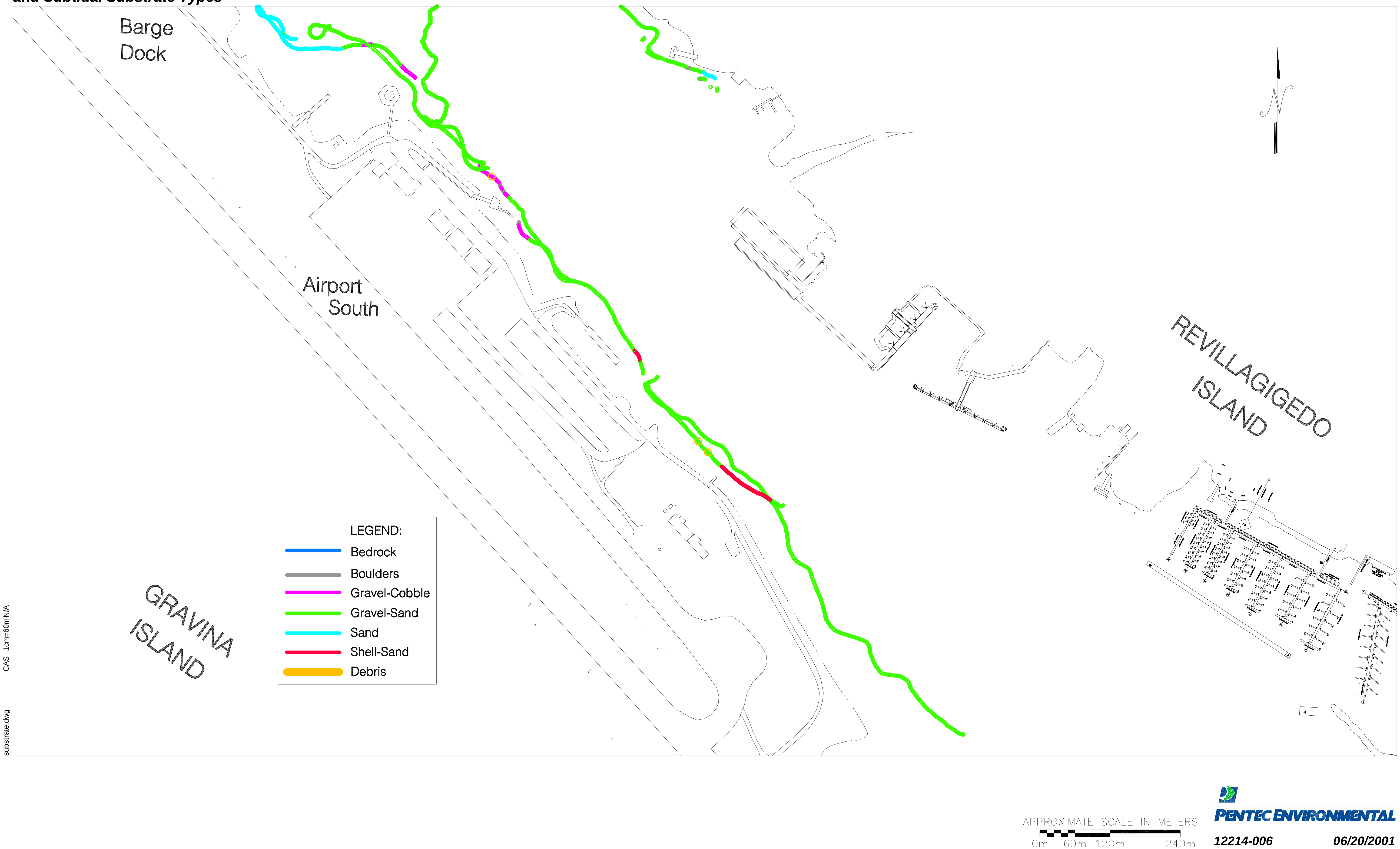
substrate.dwg

PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 2B

Gravina Access Project
Subtidal Video Survey Trackline and Subtidal Substrate Types



PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 2C

Gravina Access Project
Subtidal Video Survey Trackline and Subtidal Substrate Types

substrate.dwg CAS 1cm=50m N/A

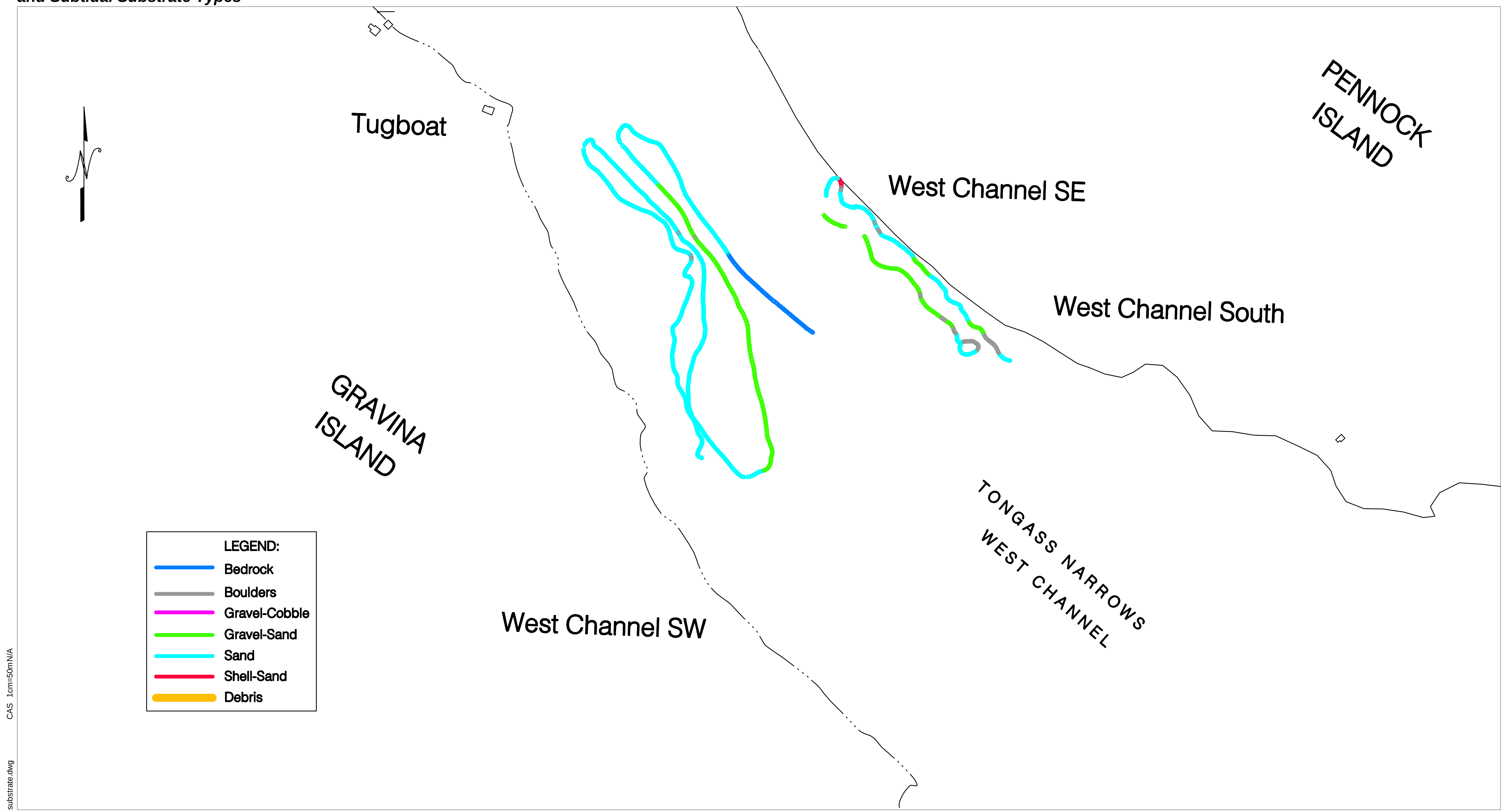
APPROXIMATE SCALE IN METERS
0m 50m 100m 200m

PENTEC ENVIRONMENTAL

12214-006 *06/20/2001*

Figure 2D

Gravina Access Project
Subtidal Video Survey Trackline and Subtidal Substrate Types

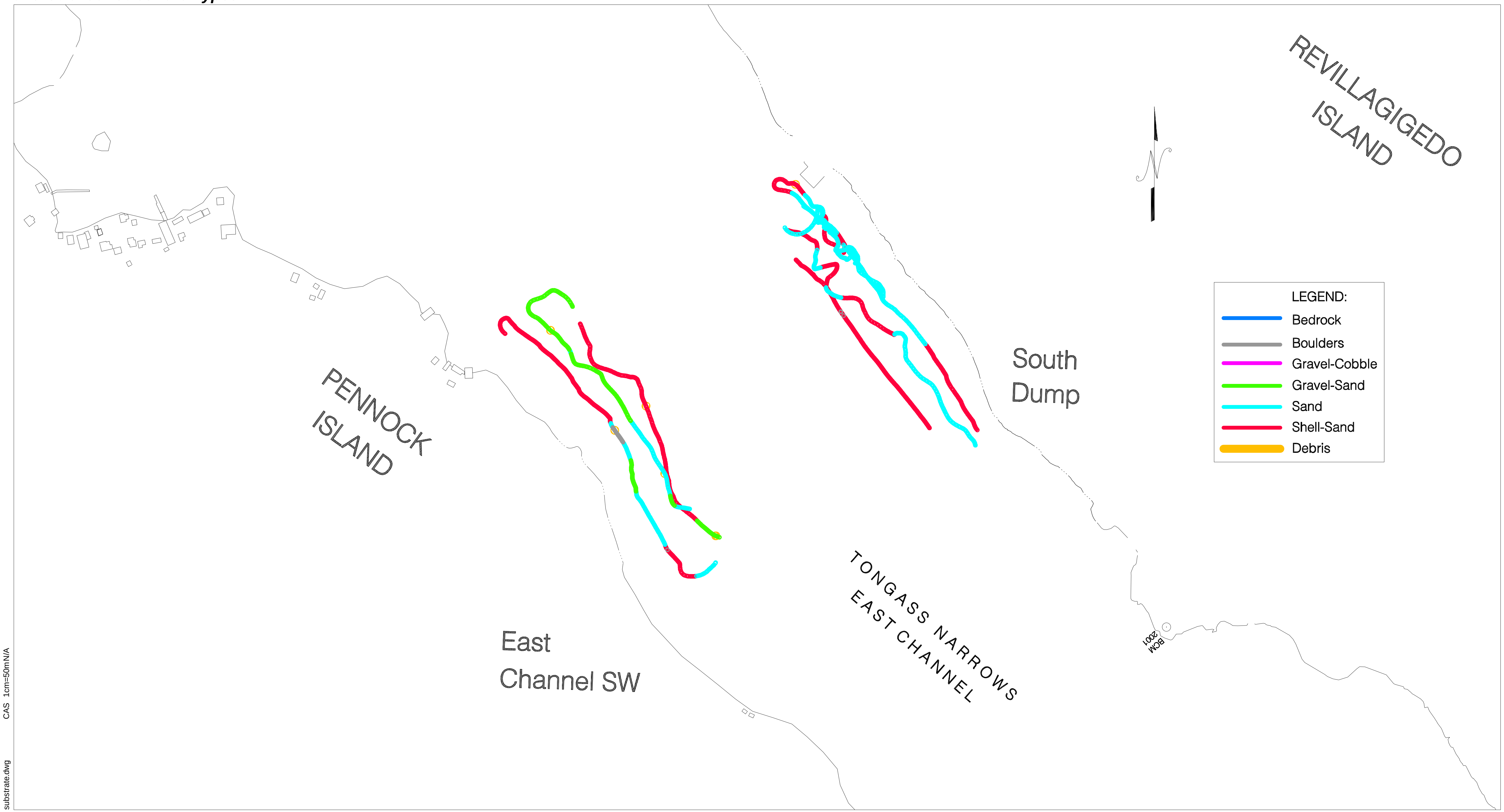


PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 2E

Gravina Access Project
Subtidal Video Survey Trackline
and Subtidal Substrate Types

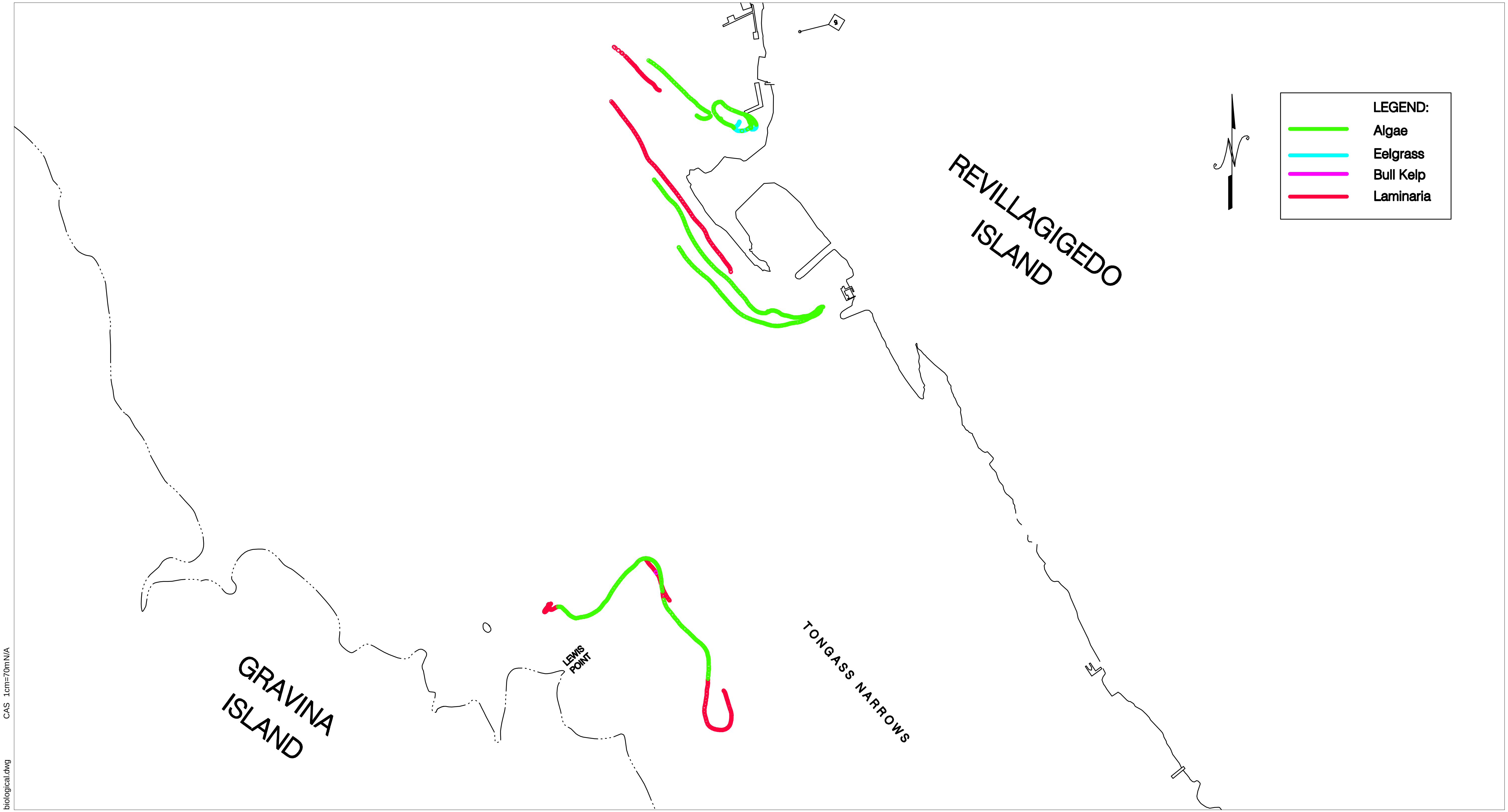


substrate.dwg CAS 1cm=50m N/A

PENTEC ENVIRONMENTAL

12214-006 **06/20/2001**
Figure 2F

Gravina Access Project
Subtidal Algae, Eelgrass, Bull Kelp, and Laminaria Beds



APPROXIMATE SCALE IN METERS
0m 70m 140m 280m

PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 3A

Gravina Access Project
Subtidal Algae, Eelgrass, Bull Kelp, and Laminaria Beds

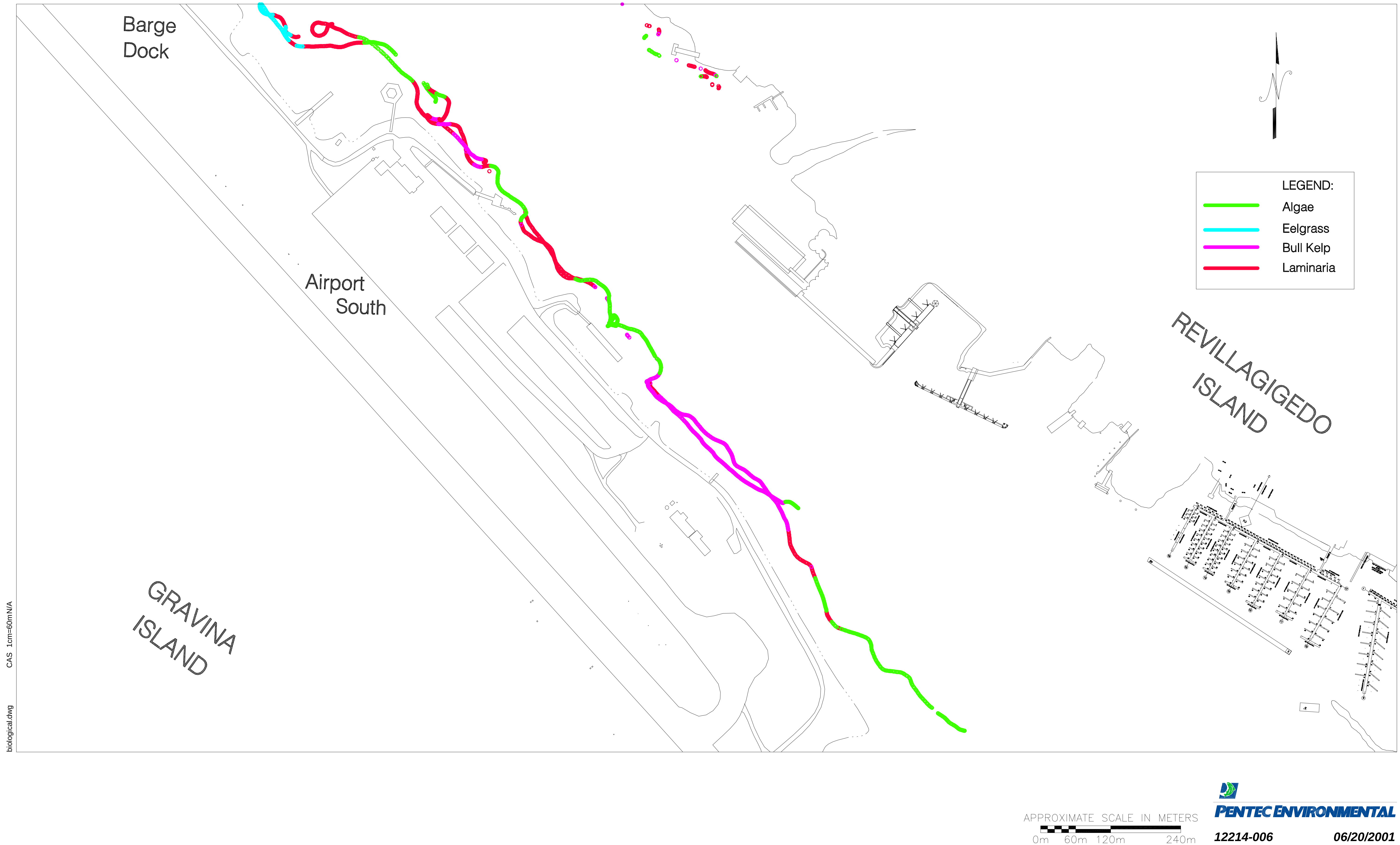
biological.dwg CAS 1cm=60m N/A

PENTEC ENVIRONMENTAL

12214-006 *06/20/2001*

Figure 3B

Gravina Access Project
Subtidal Algae, Eelgrass, Bull Kelp, and Laminaria Beds



PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 3C

Gravina Access Project
Subtidal Algae, Eelgrass, Bull Kelp, and Laminaria Beds

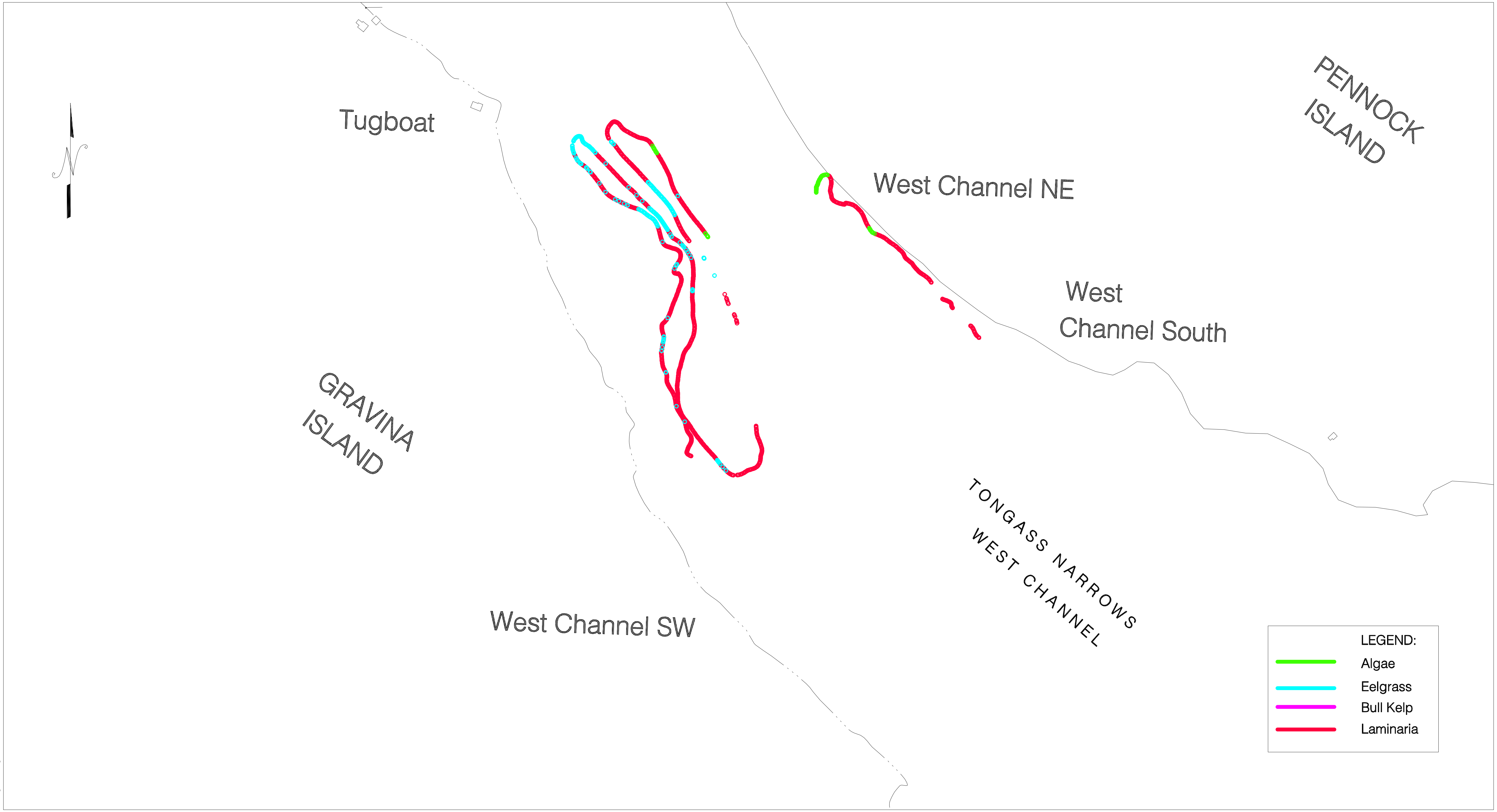
APPROXIMATE SCALE IN METERS
0m 50m 100m 200m

PENTEC ENVIRONMENTAL

12214-006 *06/20/2001*

Figure 3D

Gravina Access Project
Subtidal Algae, Eelgrass, Bull Kelp, and Laminaria Beds



biological.dwg CAS 1cm=50m N/A

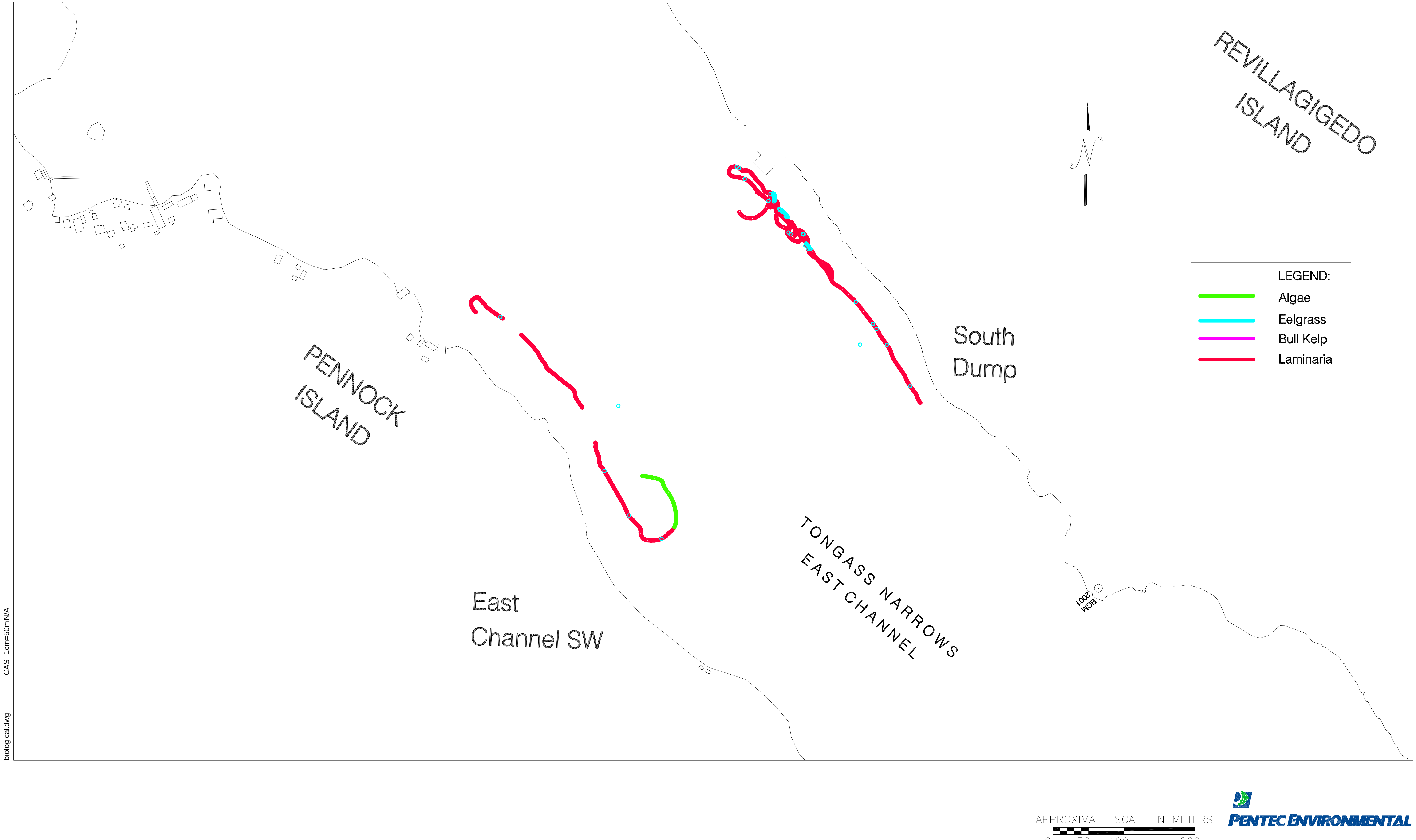
APPROXIMATE SCALE IN METERS
0m 50m 100m 200m

PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 3E

Gravina Access Project
Subtidal Algae, Eelgrass, Bull Kelp, and Laminaria Beds

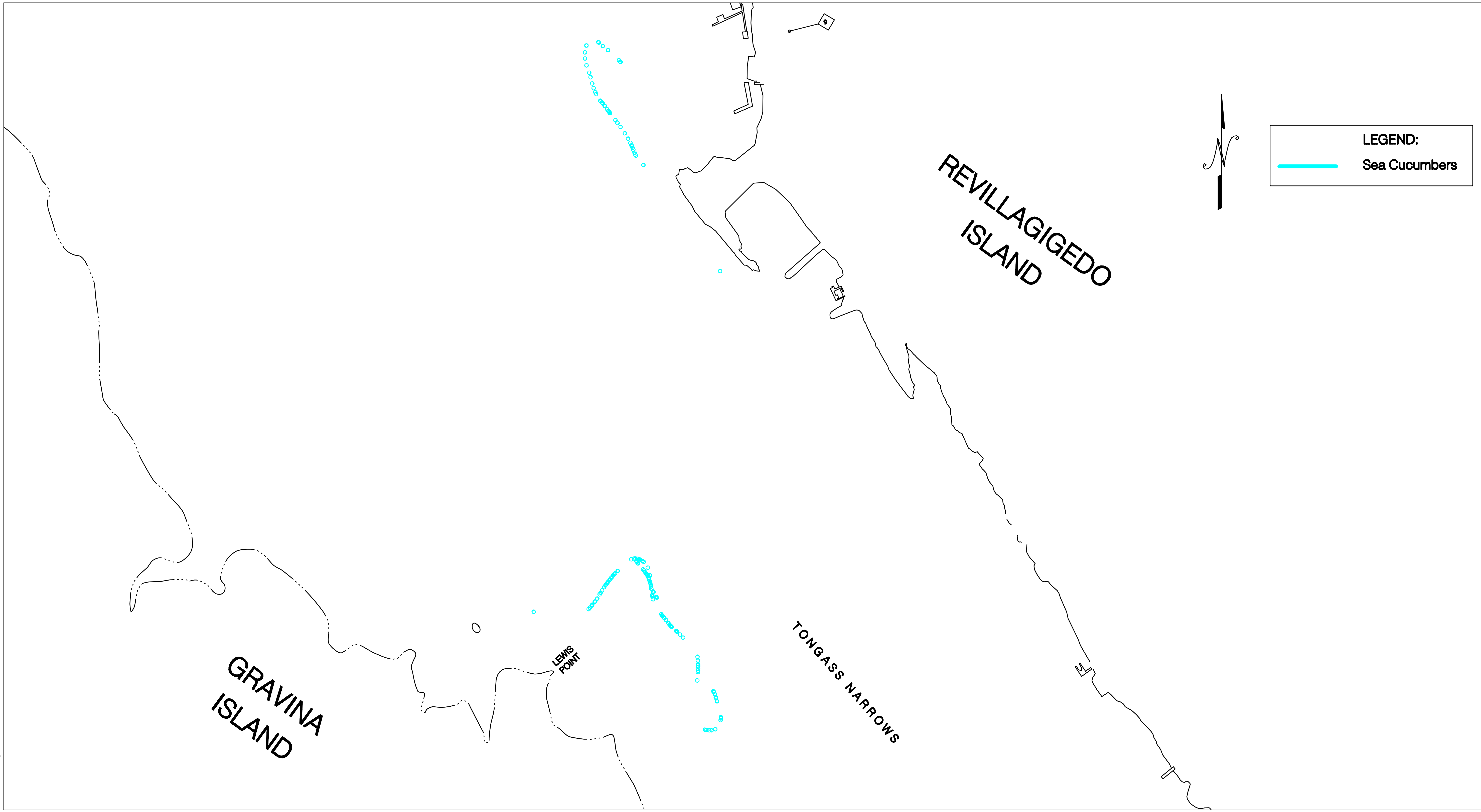


PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 3F

Gravina Access Project
Subtidal Locations of Sea Cucumber



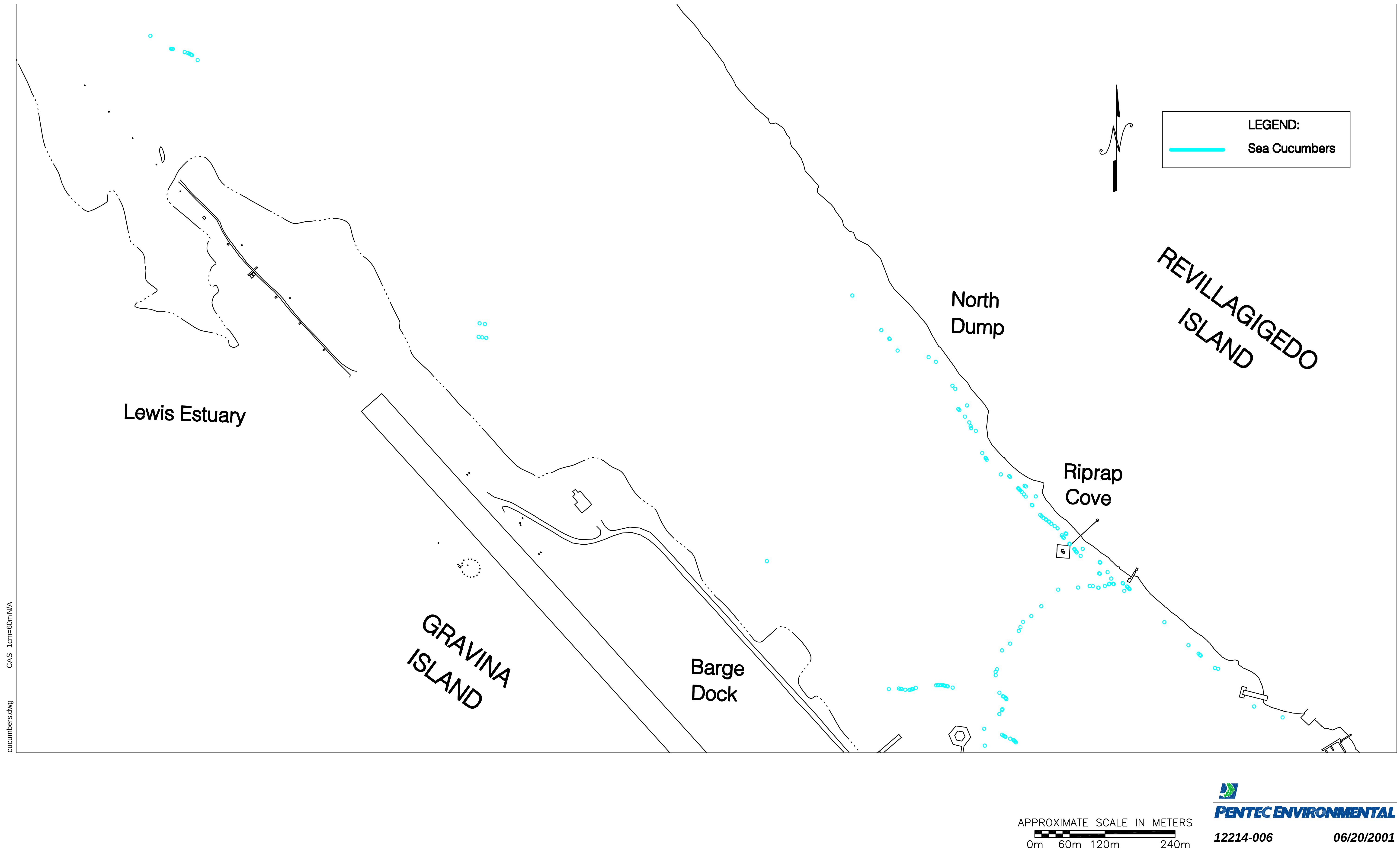
cucumbers.dwg CAS 1cm=70m N/A

PENTEC ENVIRONMENTAL

12214-006 *06/20/2001*

Figure 4A

Gravina Access Project
Subtidal Locations of Sea Cucumber

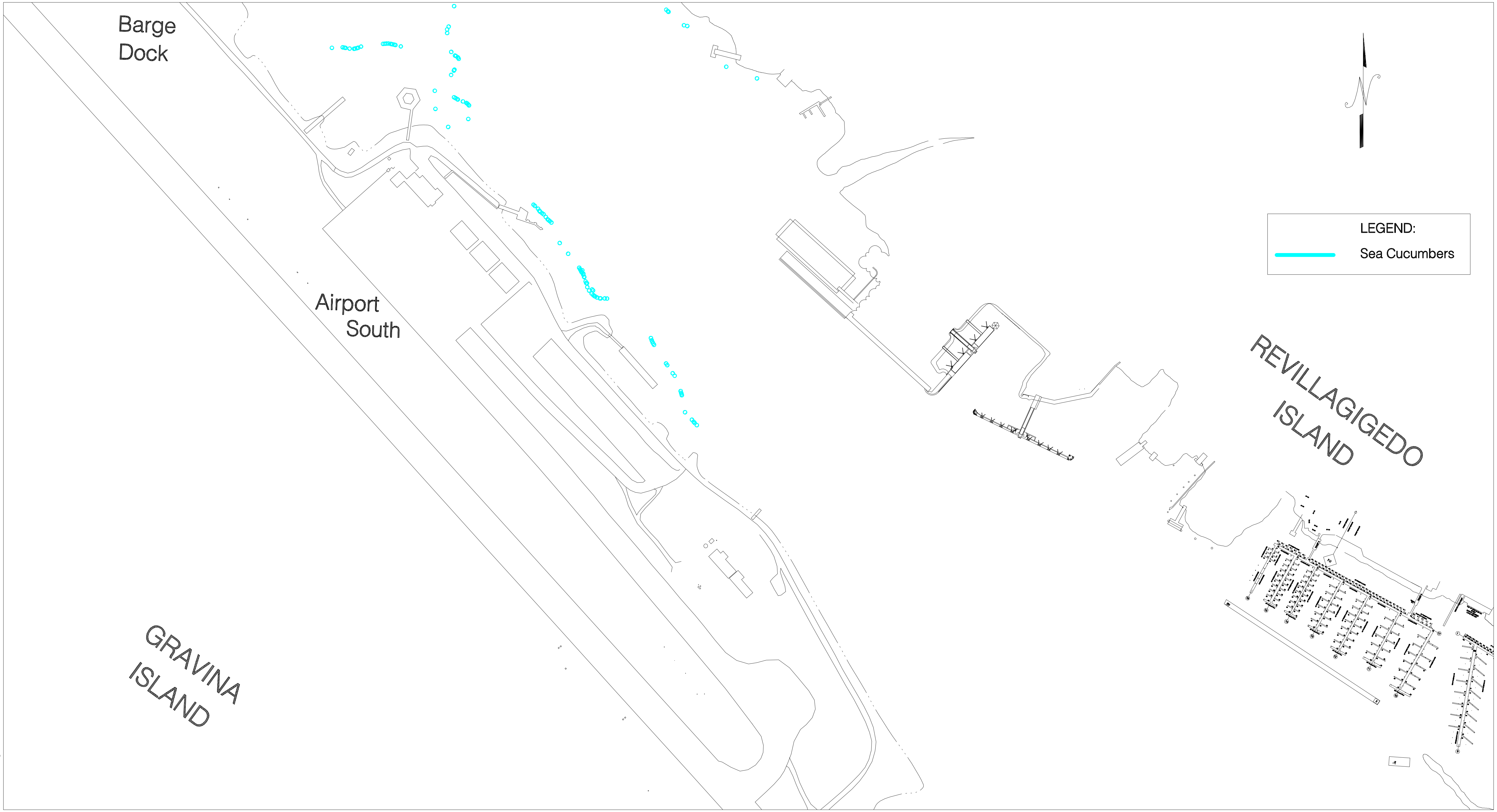


PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 4B

Gravina Access Project
Subtidal Locations of Sea Cucumber



cucumbers.dwg CAS 1cm=60m N/A

APPROXIMATE SCALE IN METERS
0m 60m 120m 240m

PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 4C

Gravina Access Project
Subtidal Locations of Sea Cucumber

CAS 1cm=50m N/A
cucumbers.dwg

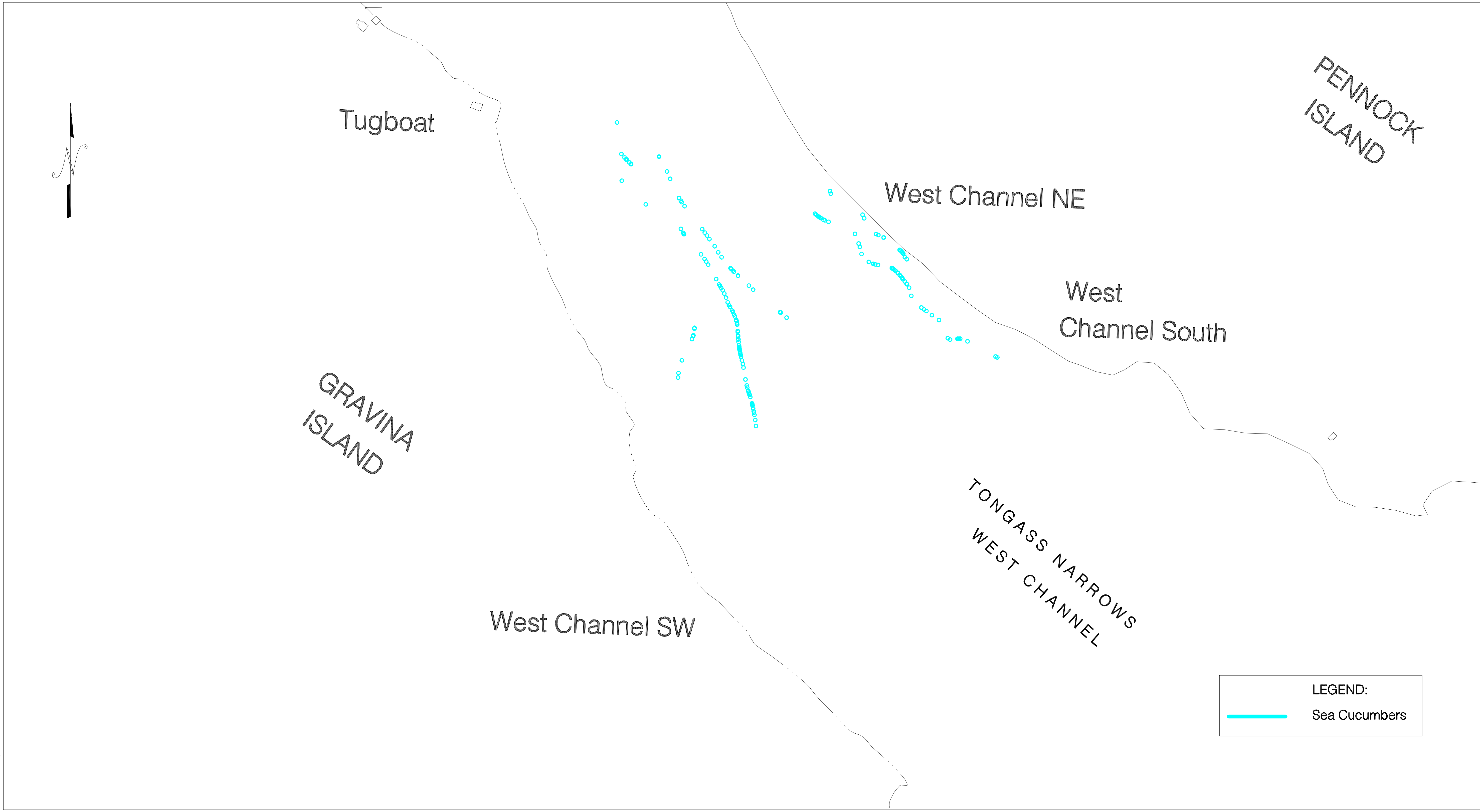
APPROXIMATE SCALE IN METERS
0m 50m 100m 200m

PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 4D

Gravina Access Project
Subtidal Locations of Sea Cucumber



cucumbers.dwg CAS 1cm=50m N/A

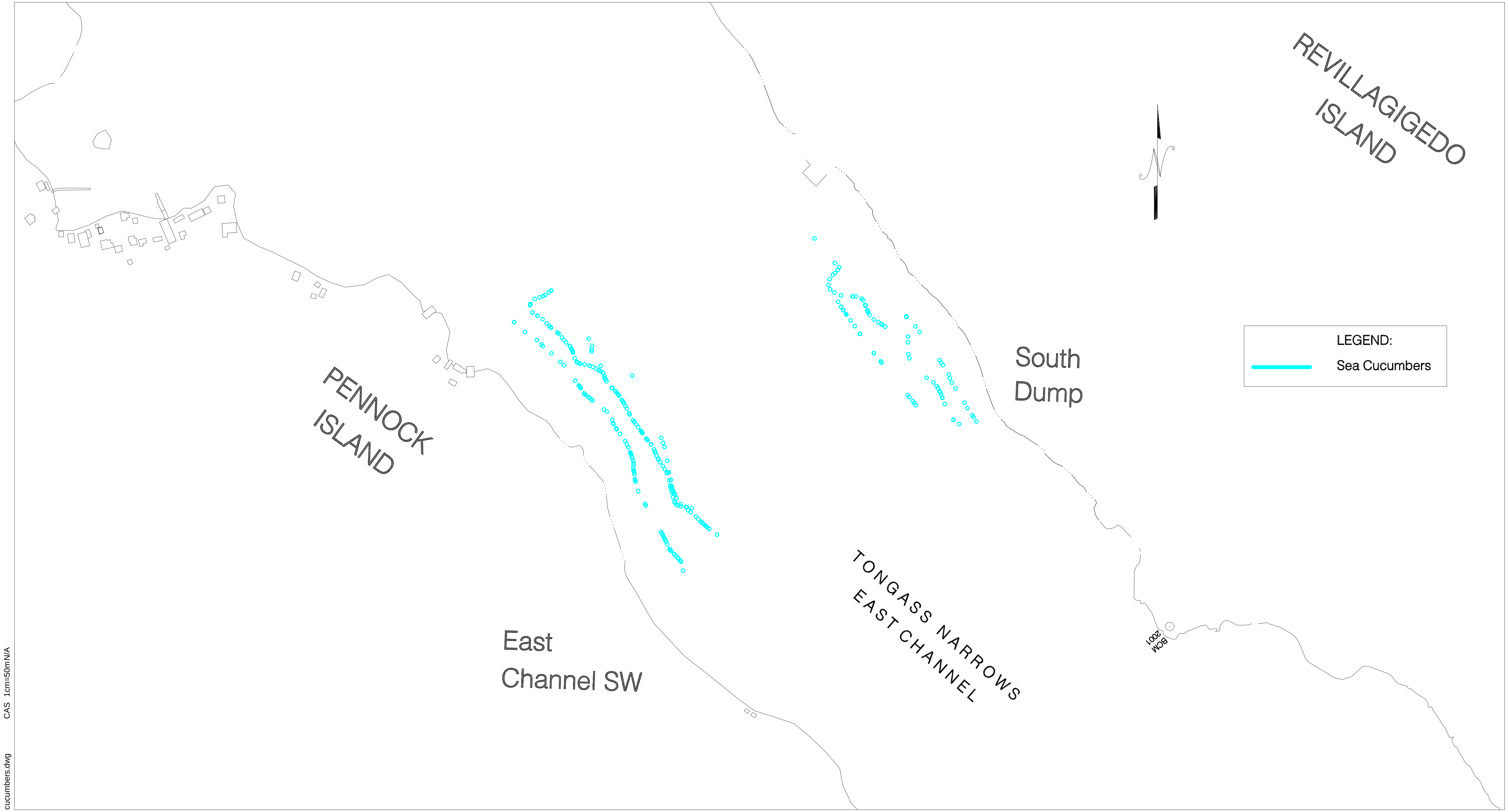
APPROXIMATE SCALE IN METERS
0m 50m 100m 200m

PENTEC ENVIRONMENTAL

12214-006 *06/20/2001*

Figure 4E

Gravina Access Project
Subtidal Locations of Sea Cucumber



PENTEC ENVIRONMENTAL

12214-006 06/20/2001

Figure 4F

Appendix A
Intertidal Species Lists

In the following tables, the relative abundance of each taxon of intertidal flora and fauna observed at the Gravina Access Project site is indicated with either a letter code or a number. Letter codes are as follows:

- A = Abundant–typically more than about 20-percent cover (20/0.25 m^2)
- C = Common–typically between about 5- to 20-percent cover (5 to 20/0.25 m^2)
- P = Present–typically between about 1- to 5-percent cover (1 to 5/0.25 m^2)
- R = Rare–typically less than 1-percent cover (1/0.25 m^2)

If a specific number is given for a species, an actual quadrat was used to estimate the abundance.

Note that larger animals (such as sea stars), because of their greater influence on the community, were considered to be abundant or common at densities below those listed above. Algae and plants were typically not categorized as "rare" because the surveys were in winter, when most plants are expected to be found at abundances well below the levels present at other times of the year.

There are 13 tables covering the 22 reconnaissance sites reported on in this document, as follows:

- 1: GRV-3A (Lewis Point) and GRV-4A (Lewis Estuary)
- 2: GRV-5 (Barge Dock), GRV-5A (Barge Dock Beach), and GRV-5B (Airport North)
- 3: GRV-6 (Airport South)* and GRV-6A (Ferry West)
- 4: GRV-7 (East Clump Island) and GRV-7A (Government Creek Estuary)
- 5: GRV-8 (Tugboat) and GRV-8A (Tugboat North)
- 6: GRV-9 (West Channel Southwest)*
- 7: REV-3A (Peninsula Point)
- 8: REV-4 (North Dump)
- 9: REV-5 (Riprap Cove) and REV-5A (Ferry East)
- 10: REV-6 (Bar Point)
- 11: REV-8 (South Dump)
- 12: PEN-2 (East Channel Northwest) and PEN-2A (East Channel Southwest)
- 13: PEN-4 (West Channel Northeast) and PEN-4A (West Channel South)

** Although Sites GRV-6 and GRV-9 were not surveyed intertidally in Phase II, they are still associated with current project alternatives and so are reported herein, based on data from the Phase I survey.*

Table 1 Intertidal flora and fauna identified at Stations GRV-3A and GRV-4A, June/July 2000.

Site:	GRV-3A (Lewis Point)				GRV-4A (Lewis Estuary)
Habitat	Rock			Mixed-Fine	Mixed-Fine
Zone	High	Mid	Low	Low	High
Approximate elevation (ft MLLW)	> +8	+6 to +4	+1 to -2.5	+1 to -2.5	>MHHW
Survey	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Plants (% cover)					
Acrosiphonia sp. (cf. *arcta*)		0.5	P		
Alaria tenuifolia		P	4	P	
Analipus japonicus			P		
Blidingia minima				P	
**Carex ?lyngbyei*					C
Ceramium pacificum/washingtoniense			P		
Chaetomorpha linum					P
Chaetomorpha sp.		1			
Corallina frondescens			30		
Cryptosiphonia woodii		2	22	P	
Delesseria decipiens			P		
**Deschampsia elongata [caespitosa]*					C
Desmarestia aculeata				P	
Dilsea californica		P	P		
**Draba hyperborea*					C
Elachista fucicola	P	P			
**Elymus mollis*					C
Encrusting coralline algae		P	C		
Endocladia muricata		1.6	P		
Enteromorpha intestinalis					P
Enteromorpha linza		P	A	P	
Enteromorpha prolifera			P	A	
Fucus cottonii					P
Fucus gardneri	99	92	P	P	P
Fucus gardneri germlings	2				
Halosaccion glandiforme		P	20		
**Holcus lanata*					P
**Honkenya peploides*					C
Laminaria groenlandica			C		
Laminaria saccharina				P	
Leathesia difformis		P	1	P	
Mastocarpus papillatus	4	0.8	P		
Mazzaella heterocarpa		1.0	P		
Melanosiphon intestinalis			P		P
Microcladia borealis		P	P		
Monostroma grevillei		P	P		
Neodilsea borealis			P		
Neorhodomela oregona	P	13.9			
Neorhodomela larix [may include *N. aculeata*]		P	A		
Neorhodomela oregona and/or *Cryptosiphonia woodii*					
Odonthalia floccosa		1	P		
Odonthalia floccosa f. *comosa*		P	5		

continued

Table 1 (continued).

Site:	GRV-3A (Lewis Point)				GRV-4A (Lewis Estuary)
Habitat	Rock			Mixed-Fine	Mixed-Fine
Zone	High	Mid	Low	Low	High
Approximate elevation (ft MLLW)	> +8	+6 to +4	+1 to -2.5	+1 to -2.5	>MHHW
Survey	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Palmaria hecatensis			P		
Palmaria mollis			10		
Percursaria percursa					P
Petalonia fascia		P			
Petrocelis phase (of *Mastocarpus*)	6	10	P		
Petrocelis and/or *Gloiopeltis* base					
Pilayella littoralis		8.8			P
**Plantago maritima*					C
Plocamium tenue		P	P		
Polyneura latissima		P	C		
Polysiphonia hendryi var. *gardneri*		P			
Porphyra cf. *fucicola*		P			
**Potentilla anserina* var. *pacifica*					C
Pterocladia caloglossoides			P		
Pterosiphonia bipinnata		P	P		
Ptilota filicina/tenuis		P	C		
**Puccinellia nutkaensis*					P
Punctaria cf. *lobata*				P	
Ralfsia fungiformis			P		
cf. *Rhizoclonium riparium*					P
Rhodomela tenuissima					P
**Salicornia virginica*					C
Sarcodiotheca gaudichaudii			P	P	
Scytosiphon lomentaria				P	
Soranthera ulvoidea		P	C		
Sphacelaria cf. *rigidula*		P			
Ulva fenestrata	P	P	C	P	
Ulva sp.			20	P (mid)	
Ulvaria obscura var. *blytii*				P	
Vaucheria cf. litorea					P
**Zostera marina*				A	
Animals (% cover)					
Balanus crenatus		P	P		
Balanus glandula (set)	20	1.8			
Balanus glandula	1	12			
Chthamalus dalli (set)	0.5	0.3			
Chthamalus dalli	17.5	2.8	P		
Halichondria panicea		P			
Mytilus edulis (spat)		3.1			
Mytilus edulis	0.5	2		C	
Nucella spp. (eggs)	P	P			
Rhynchozoon bispinosum			P		
Semibalanus balanoides (set)	0.5	0.5			
Semibalanus balanoides	0.5				

continued

Table 1 (continued).

Site:	GRV-3A (Lewis Point)				GRV-4A (Lewis Estuary)
Habitat	Rock			Mixed-Fine	Mixed-Fine
Zone	High	Mid	Low	Low	High
Approximate elevation (ft MLLW)	> +8	+6 to +4	+1 to -2.5	+1 to -2.5	>MHHW
Survey	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Semibalanus cariosus (set)	P	0.5			
Semibalanus cariosus	25	0.5	P		
Spirorbidae, unid.			P		
Animals (number/0.25 m²)					
Amphissa spp.			R		
Anthopleura elegantissima		1			
Armandia ?					
Bittium sp.		P	A		
Buccinum baeri	1				
Cadlina leutomarginata					
Carinella ?sexlineata				R	
Ceratostoma foliata		C			
Chaetopteridae				A	
Clinocardium nuttalli					
Cnemidocarpa finmarkiensis			R?		
Cryptonatica affinis					
Dermasterias imbricata		P		P	
Gammaridea, unid.					
Glyceridae, unid.				P	
Hemigrapsus nudus	3	C			
Hemigrapsus oregonensis		P			
Idothea wosnesenskii	2				
Katharina tunicata		P			
Lacuna spp. (probably *L. variegata*)					
Leptasterias epichlora		0.5			
Littorina scutulata	51	6			
Littorina sitkana	82	1.3			
Lottia pelta	10	1.8			
Lottiidae, unid. (incl. juv.)	P	A			
Mopalia lignosa		R			
Mya arenaria				P	
Mya truncata				P	
Nereidae, unid.					
Nucella lamellosa	13	C	P		
Onchidoris bilamellata					
Oweniidae					
Pagurus hirsutiusculus	16	17.5	C		
Pectinaria granulata					
Pentidotea wosnesenskii		1			
Pholidae/Stichaeidae		C			
Pisaster ochraceus		A	C	P	
Polinices lewisii				A	
Protothaca staminea					
Pseudochitinopoma occidentalis			P		

continued

Table 1 (continued).

Site:	GRV-3A (Lewis Point)				GRV-4A (Lewis Estuary)
Habitat	Rock			Mixed-Fine	Mixed-Fine
Zone	High	Mid	Low	Low	High
Approximate elevation (ft MLLW)	> +8	+6 to +4	+1 to -2.5	+1 to -2.5	>MHHW
Survey	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Pugettia producta		P			
Pycnopodia helianthoides			P		
Pycnopodia helianthoides (juv.)				C	
Saxidomus giganteus				C	
Serpula vermicularis		C	P		
Tectura scutum		P			
Telmessus cheiragonus			P	P	
Tresus				P	

00214\006\phaseii\ph2gravinaspecieslist.xls

Table 2 Intertidal flora and fauna identified at Stations GRV-5, GRV-5A, and GRV-5B, January and June/July 2000.

Site:	GRV-5 (Barge Dock)				GRV-5A (Barge Dock Beach)		GRV-5B (Airport North)	
Habitat	Riprap				Mixed-Fine	Cobble	Mixed-Fine	Bedrock
Zone	Upper/Mid		Low/Mid		Lower	Mid	High	Mid
Approximate elevation (ft MLLW)	> +6		+4.5 to +1		+3 to +5	+6 to +8	>MHHW	+4 to +6
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Plants (% cover)								
Acrosiphonia sp. *(* cf. *arcta*)					P			
Bangia sp.		P						
Blidingia minima		0.75		8	P			
**Carex ?lyngbyei*							C	
Cryptosiphonia woodii				0.5				
**Deschampsia elongata [caespitosa]*							C	
Elachista fucicola		1.5		6				
Encrusting red algae		0.5		14				
Endocladia muricata	R							
Enteromorpha linza		1.5		4	P			
Fucus gardneri	57	50.5		42	P	62.5		A
Glaux maritima							C	
Gloiopeltis furcata	R	P						
Halosaccion glandiforme				P	P			
Hildenbrandia rubra	R			P				
**Juncus balticus*							C	
Mastocarpus papillatus	2	4		0.5	P	1.5		
Mazzaella heterocarpa				P	P			
Neorhodomela oregona				P				
Petrocelis phase (of *Mastocarpus*)				P				
Petrocelis and/or *Gloiopeltis* base	18.5							
**Plantago maritima*							P	
Porphyra cuneiformis				P				
Porphyra cf. *fucicola*				0.5				
**Potentilla anserina* var. *pacifica*							P	
**Spergularia canadensis*							C	
Ulva fenestrata				0.5	P			

continued

Table 2 (continued).

Site:	GRV-5 (Barge Dock)				GRV-5A (Barge Dock Beach)		GRV-5B (Airport North)	
Habitat	Riprap				Mixed-Fine	Cobble	Mixed-Fine	Bedrock
Zone	Upper/Mid		Low/Mid		Lower	Mid	High	Mid
Approximate elevation (ft MLLW)	> +6		+4.5 to +1		+3 to +5	+6 to +8	>MHHW	+4 to +6
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Animals (% cover)								
Balanus crenatus				P	P			
Balanus glandula (set)								
Balanus glandula	C	4.5	P			11		A
Chthamalus dalli	A	0.5						
Mytilus edulis	C	P				3.5		A
Semibalanus balanoides (set)		2		1	A			
Semibalanus balanoides	C	7		0.5				
Semibalanus cariosus (set)				P				
Spirorbidae, unid.				P				
Animals (number/0.25 m²)								
Ceratostoma foliata				P				
Chiridota spp.					P			
Clinocardium nuttalli					2			
Cucumaria miniata				P				
Evasterias troschelii				1				
Gammaridea, unid.	P							
Hemigrapsus nudus			A	3	P			
Hemigrapsus oregonensis				P	P	2.5		
Idothea wosnesenskii			P					
Katharina tunicata				P				
Lacuna spp. (probably *L. variegata*)	R							
Leptasterias epichlora			C	C		0.5		
Littorina scutulata	P	133				34.5		
Littorina sitkana		13				21		A
Lottia digitalis	C	1						
Lottia pelta	P	P				0.5		
Lottiidae, unid. (incl. juv.)	A	5.5	A			64		

continued

Table 2 (continued).

Site:	GRV-5 (Barge Dock)				GRV-5A (Barge Dock Beach)		GRV-5B (Airport North)	
Habitat	Riprap				Mixed-Fine	Cobble	Mixed-Fine	Bedrock
Zone	Upper/Mid		Low/Mid		Lower	Mid	High	Mid
Approximate elevation (ft MLLW)	> +6		+4.5 to +1		+3 to +5	+6 to +8	>MHHW	+4 to +6
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Macoma inquinata					2			
Mopalia spp.				1				
Notoplana sp.			P					
Onchidoris bilamellata			P					
Pagurus hirsutiusculus			A	P		8.5		
Pagurus sp.				2				
Phascolosoma agassizii				P				
Pholidae/Stichaeidae			P	P				
Pisaster ochraceus				P	P			
Protothaca staminea				A	34			
Saxidomus giganteus					14			
Tectura persona		P						
Tectura scutum	P	1	P	2	P			
Tresus					P			

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Table 3 Intertidal flora and fauna identified at Station GRV-6, January, and GRV-6A, June/July 2000.

Site:	GRV-6 (Airport South)		GRV-6A (Ferry West)	
Habitat	Riprap		Riprap	
Zone	Upper/Mid	Low/Mid	High/Mid	Low/Mid
Approximate elevation (ft MLLW)	> +6	+4 to +1	> +6	+4 to +1
Survey	Jan	Jan	Jun/Jul	Jun/Jul
Plants (% cover)				
Acrosiphonia sp. (cf. *arcta*)				A
Blidingia minima			P	P
Cladophora sericea		P		P
Cryptosiphonia woodii				P
Endocladia muricata			P	
Enteromorpha linza				P
Fucus gardneri	52.5	32.5	P	A
Gloiopeltis furcata	P		P	
Halosaccion glandiforme		15		
Hildenbrandia rubra	P	15		
Mastocarpus papillatus	1.8	2.5		P
Mazzaella heterocarpa				P
Melanosiphon intestinalis				P
Neorhodomela oregona				P
Neorhodomela oregona and/or *Cryptosiphonia woodii*		P		
Odonthalia floccosa				P
Palmaria hecatensis		P		P
Palmaria mollis		P		
Petrocelis phase (of *Mastocarpus*)				P
Petrocelis and/or *Gloiopeltis* base		P		
Pilayella littoralis			P	P
Pleonosporium vancouverianum		P		
Porphyra cf. *fucicola*			P	
'Ralfsia'				P
Ulva fenestrata		P		P
Ulva sp.	R	R		
Animals (% cover)				
Balanus/Semibalanus sp. (flat)		P		
Balanus glandula	C		P	
Chthamalus dalli (set)		P		
Chthamalus dalli	A			P
Encrusting bryozoan		P		
Semibalanus balanoides	P		P	
Semibalanus cariosus (set)				P
Semibalanus cariosus				P
Spirorbidae, unid.		A		

continued

Table 3 (continued).

Site:	GRV-6 (Airport South)		GRV-6A (Ferry West)	
Habitat	Riprap		Riprap	
Zone	Upper/Mid	Low/Mid	High/Mid	Low/Mid
Approximate elevation (ft MLLW)	> +6	+4 to +1	> +6	+4 to +1
Survey	Jan	Jan	Jun/Jul	Jun/Jul
Animals (number/0.25 m²)				
Ceratostoma foliata				P
Dermasterias imbricata		P		
Evasterias troschelii				R
Leptasterias epichlora		C		
Littorina scutulata	C			
Littorina sitkana	P			
Lottia pelta	P			
Lottiidae, unid. (incl. juv.)	C			P
Nucella lamellosa			P	
Pagurus hirsutiusculus		C		P
Pisaster ochraceus				P
Pseudochitinopoma occidentalis		C		
Serpula vermicularis		C		C
Tectura persona			P	
Tectura scutum			P	
Trichotropus cancellata		P		

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Table 4 Intertidal flora and fauna identified at Stations GRV-7 and GRV-7A, January and June/July 2000.

Site:	GRV-7 (East Clump Island)							GRV-7A (Gov. Cr. Estuary)
Habitat	Bedrock/Boulder/Cobble/Gravel						Mixed-Fine	Mixed-Fine
Zone	High		Mid		Low/Mid		Low	High
Approximate elevation (ft MLLW)					+5 to +3	+2 to -1	+2 to -1	
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul
Plants (% cover)								
Acrosiphonia sp. *(* cf. *arcta*)						1.5		
Alaria tenuifolia						C		
Blidingia subsalsa								P
Bossiella cretacea						P		
Callithamnion pikeanum						P		
**Carex ?lyngbyei*								P
Ceramium pacificum/washingtoniense						P		
Colpomenia peregrina						0.2		
Constantinea subulifera						P		
Corallina frondescens						10		
Costaria costata						P		
Cryptosiphonia woodii						5		
Cymathere triplicata						P		
Delesseria decipiens						P		
**Deschampsia elongata [caespitosa]*								P
Dictyosiphon foeniculaceus						0.2		P
Dilsea californica						0.2		
**Elymus mollis*								P
Encrusting coralline algae						45		
Endocladia muricata	?		?	P		P		
Enteromorpha intestinalis								P
Enteromorpha linza						29	A	
Fucus gardneri	A		A	P	40	1	P	P
**Glaux maritima*								P
Halosaccion glandiforme			P		P	8.7		
Hedophyllum sessile						R		
**Juncus balticus*								P
Laminaria groenlandica						0.5		
Leathesia difformis						1.8		

continued

Table 4 (continued).

Site:	GRV-7 (East Clump Island)							GRV-7A (Gov. Cr. Estuary)
Habitat	Bedrock/Boulder/Cobble/Gravel						Mixed-Fine	Mixed-Fine
Zone	High		Mid		Low/Mid		Low	High
Approximate elevation (ft MLLW)					+5 to +3	+2 to -1	+2 to -1	
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul
Mastocarpus papillatus		C				3.5		P
Mazzaella heterocarpa						1		
Microcladia borealis						0.3		
Monostroma grevillei						0.2		
Neorhodomela oregona						0.3		
Neorhodomela larix [may include *N. aculeata*]						P		
Odonthalia floccosa						0.3		
Palmaria hecatensis						P		
Palmaria mollis						P		
Palmaria spp.						P		
Petalonia fascia						0.2		
Petrocelis phase (of *Mastocarpus*)						3.7		
Pilayella littoralis								C
**Plantago maritima*								P
Polyneura latissima						P		
**Potentilla anserina* var. *pacifica*								P
Prasiola cf. *crispa*								P
Ptilota filicina/tenuis						P		
**Puccinellia nutkaensis*								P
'Ralfsia'		C				0.3		
Ralfsia fungiformis						P		
cf. *Rhizoclonium riparium*								?
**Salicornia virginica*								P
Scytosiphon lomentaria						0.3		P
Soranthera ulvoidea						P		
Sphacelaria cf. *rigidula*						0.2		
turf (usually *Polysiphonia* /*Pterosiphonia*)						0.8		
Ulva fenestrata	P					1.7	A	
Ulva sp.								P

continued

Table 4 (continued).

Site:	GRV-7 (East Clump Island)							GRV-7A (Gov. Cr. Estuary)
Habitat	**Bedrock/Boulder/Cobble/Gravel**						**Mixed-Fine**	**Mixed-Fine**
Zone	**High**		**Mid**		**Low/Mid**		**Low**	**High**
Approximate elevation (ft MLLW)					**+5 to +3**	**+2 to -1**	**+2 to -1**	
Survey	**Jan**	**Jun/Jul**	**Jan**	**Jun/Jul**	**Jan**	**Jun/Jul**	**Jun/Jul**	**Jun/Jul**
Vaucheria cf. litorea								P
**Zostera marina*							C	
Animals (% cover)								
Balanus crenatus						C		
Balanus glandula (set)						A		
Balanus glandula	A	A	C		C			P
Chthamalus dalli								P
Mytilus edulis	P	C	P		C		P	P
Rhynchozoon bispinosum						P		
Semibalanus balanoides			?		P			P
Semibalanus cariosus (set)				P		A		P
Semibalanus cariosus			P	C				
Animals (number/0.25 m²)								
Anthopleura elegantissima		C						
Bittium sp.						1		
Ceratostoma foliata						P		
Dermasterias imbricata						P		
Emplectonema						1		
Evasterias troschelii						P	P	
Hemigrapsus nudus								P
Hemigrapsus oregonensis								P
Lacuna spp. (probably *L. variegata*)						0.3		
Leptasterias epichlora				P				
Littorina scutulata								P
Littorina sitkana		A						P
Littorina spp. (juv.)	A		P		C			
Lottia pelta		A						P

continued

Table 4 (continued).

Site:	GRV-7 (East Clump Island)							GRV-7A (Gov. Cr. Estuary)
Habitat	Bedrock/Boulder/Cobble/Gravel						Mixed-Fine	Mixed-Fine
Zone	High		Mid		Low/Mid		Low	High
Approximate elevation (ft MLLW)					+5 to +3	+2 to -1	+2 to -1	
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul
Lottiidae, unid. (incl. juv.)	R		P					
Margarites pupillus						P	8	
Mya arenaria								A
Nucella lamellosa		A						
Pagurus hirsutiusculus					P	C	C	
Pagurus sp.			P			0.3		
Pholidae/Stichaeidae							C	
Pisaster ochraceus						P		
Protothaca staminea							44	
Pugettia gracilis						R	C	
Pycnopodia helianthoides							C	
Saxidomus giganteus							64	
Searlesia dira						P		
Strongylocentrotus droebachiensis							16	
Tectura persona								P
Tonicella lineata						P		
Tonicella spp.						0.3		

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Table 5 Intertidal flora and fauna identified at Stations GRV-8 and GRV-8A, January and June/July 2000.

Site:	GRV-8 (Tugboat)								GRV-8A (Tugboat North)		
Habitat	Cobbles		Bedrock/Boulders				Mixed-Fine		Cobbles	Bedrock	
Zone	Upper		Low/Mid		Low		Low/Mid		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+7 to +4		0 to -3		+4 to +3	0 to -4	> +8	+7 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Plants (% cover)											
Acrosiphonia sp. *(* cf. *arcta*)				0.5		2					
Alaria tenuifolia						P					
Ceramium pacificum/washingtoniense						0.5					
Chondracanthus exasperatus						P					
Colpomenia bullosa						0.5					
Constantinea subulifera						P					P
Corallina sp.											P
Corallina frondescens						12	P				
Costaria costata						P					
Cryptosiphonia woodii						4				P	
Cymathere triplicata						P		P			
Desmarestia aculeata					P	P		P			
Desmarestia viridis						P		P			
Dilsea californica						P					
Elachista fucicola				2.5							
Encrusting coralline algae						8	P	P			
Encrusting red algae						0.5					
Endocladia muricata				0.25						0.5	
Enteromorpha linza				45.3							
Fucus gardneri	15	98.5	70	75					67.5	67.5	
cf. *Gayralia oxysperma*								P			
Gloiopeltis furcata		0.5							1	P	
Halosaccion glandiforme				1.3		9	P	P		0.5	
Hedophyllum sessile						P					
Hildenbrandia rubra	P	14	R	3.5			P		9.5	6	
Laminaria groenlandica						3	P	P			P
Laminaria saccharina								P			
Leathesia difformis				0.5		0.5				0.3	
Mastocarpus papillatus		0.5		0.5		P	P	P	1	1.3	
Mazzaella spp.										P	

continued

Table 5 (continued).

Site:	GRV-8 (Tugboat)								GRV-8A (Tugboat North)		
Habitat	Cobbles		Bedrock/Boulders				Mixed-Fine		Cobbles	Bedrock	
Zone	Upper		Low/Mid		Low		Low/Mid		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+7 to +4		0 to -3		+4 to +3	0 to -4	> +8	+7 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Mazzaella heterocarpa				0.3		2					
Microcladia borealis				P							
Neodilsea borealis						P	P	P			
Neorhodomela oregona				4		P	P		0.5	20.3	P
Neorhodomela larix											
[may include *N. aculeata*]						0.5	P	P		P	
Neorhodomela oregona and/or											
Cryptosiphonia woodii							P				
Nereocystis luetkeana						P		P			
Odonthalia floccosa						P	P	P			
Opuntiella californica						P		P			
Palmaria hecatensis							C	P			
Palmaria mollis						P		P		0.5	P
Petrocelis phase (of *Mastocarpus*)		2.8		2.2		5			1	P	
Petrocelis and/or *Gloiopeltis* base			R				P				
Pleonosporium vancouverianum							P				
Polyneura latissima							P				
Porphyra cuneiformis								P			
Pterosiphonia bipinnata				0.1						0.5	
'Ralfsia'						P					
Ralfsia fungiformis							P				
Rhodomela tenuissima						P					
Sarcodiotheca gaudichaudii								P			
Soranthera ulvoidea										0.5	
Sparlingia pertusa						P					
turf (usually *Polysiphonia* /*Pterosiphonia*)										P	
Ulva fenestrata				1.5		34	P	P		2	P
Ulvaria obscura var. *blytii*						P					
**Zostera marina*								P			

continued

Table 5 (continued).

Site:	GRV-8 (Tugboat)								GRV-8A (Tugboat North)		
Habitat	Cobbles		Bedrock/Boulders				Mixed-Fine		Cobbles	Bedrock	
Zone	Upper		Low/Mid		Low		Low/Mid		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+7 to +4		0 to -3		+4 to +3	0 to -4	> +8	+7 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Animals (% cover)											
Balanus crenatus					P						P
Balanus glandula (set)									0.5		
Balanus glandula	P	2	C						0.5	9.5	
Chthamalus dalli		3							0.5	0.5	
Mytilus edulis (spat)		0.5	P								
Nucella spp. (eggs)				0.3							
Rhynchozoon bispinosum											P
Semibalanus balanoides (set)						P			0.5	2.8	
Semibalanus balanoides	C	15.3							24	0.5	
Semibalanus cariosus (set)				4		P					
Semibalanus cariosus			45	30						1	
Spirorbidae, unid.					P						
Animals (number/0.25 m²)											
Acanthodoris ?nanaimoensis					P						
Boltenia villosa					P						
Boreotrophon multicostatus					R						
Cancer oregonensis					P			P			
Chiridota spp.							P				
Clinocardium nuttalli								P			
Clinocottus acuticeps										0.5	
Cnemidocarpa finmarkiensis					P						P
Cryptochiton stelleri											P
Cucumaria miniata											P
Dermasterias imbricata					P	P		P			P
Evasterias troschelii					C			P			P
Gammaridea, unid.				P	C						
Gnorimosphaeroma oregonensis				P							
Hemigrapsus nudus		1							2		

continued

Table 5 (continued).

Site:	GRV-8 (Tugboat)								GRV-8A (Tugboat North)		
Habitat	Cobbles		Bedrock/Boulders				Mixed-Fine		Cobbles	Bedrock	
Zone	Upper		Low/Mid		Low		Low/Mid		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+7 to +4		0 to -3		+4 to +3	0 to -4	> +8	+7 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Hiatella arctica			P								
Idothea wosnesenskii			P								
Lacuna spp. (probably *L. variegata*)					C						
Leptasterias epichlora				0.5						0.5	
Littorina scutulata		48	48						181	10.5	
Littorina sitkana	A	201.5	P						159	4	
Lottia digitalis		4									
Lottia pelta		1	C	2.3						0.5	
Lottiidae, unid. (incl. juv.)		12.5	52	5	C				6.5	58.5	
Margarites pupillus					P		P	P			
Margarites helcinus					C						P
Mopalia spp.				0.7							
Nucella lamellosa		1.5			R				2.5	1	
Nucella lamellosa (juv.)				1.3							
Nucella lima		4.5							1.5		
Nucella emarginata	P										
Onchidella borealis				0.3							
Onchidoris bilamellata					C						
Oregonia gracilis					P						
Pagurus hirsutiusculus		3.5	P	34.7	P			P	7.5	24.5	
Pagurus sp.										4	
Pentidotea wosnesenskii				0.3							
Pholidae/Stichaeidae					C						P
Pisaster ochraceus					C	P					
Pododesmus macroschismata					C	P					
Protothaca staminea							A	P			
Pseudochitinopoma occidentalis					C						P
Pugettia gracilis					P	P					
Pycnopodia helianthoides					P			P			
Saxidomus giganteus							C	C			
Searlesia dira										0.5	

continued

Table 5 (continued).

Site:	GRV-8 (Tugboat)								GRV-8A (Tugboat North)		
Habitat	Cobbles		Bedrock/Boulders				Mixed-Fine		Cobbles	Bedrock	
Zone	Upper		Low/Mid		Low		Low/Mid		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+7 to +4		0 to -3		+4 to +3	0 to -4	> +8	+7 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Serpula vermicularis					C						P
Solaster (small, orange)						P		P			
Tectura persona	P	1							6		
Tectura scutum				0.3							
Telmessus cheiragonus											P
Tonicella lineata					P	P					
Tresus							C	P			

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Table 6 Intertidal flora and fauna identified at Station GRV-9, January 2000.

Site:	**GRV-9 (West Channel Southwest)**			
Habitat	**Bedrock/Boulders**			**Mixed-Fine**
Zone	**Upper**	**Low/Mid**	**Low**	**Low**
Approximate elevation (ft MLLW)	**> +8**	**+6 to +4**	**0 to -4**	**0 to -4**
Plants (% cover)				
Agarum cf. *clathratum*				P
Bossiella cretacea			P	
Constantinea subulifera				P
Cymathere triplicata			P	
Desmarestia aculeata			P	
Encrusting coralline algae		R		P
Fucus gardneri	55	16		
Gloiopeltis furcata	P	R		
Halosaccion glandiforme		P		
Hildenbrandia rubra	P	P		
Laminaria groenlandica				P
Mastocarpus papillatus		1.5	P	
Neodilsea borealis			P	
Neorhodomela oregona	P			
Neorhodomela larix [may include *N. aculeata*]			P	
Odonthalia floccosa				P
Petrocelis and/or *Gloiopeltis* base		P		
Pleonosporium vancouverianum			P	
'Ralfsia'				P
Sparlingia pertusa				P
Ulva fenestrata				P
Animals (% cover)				
Balanus crenatus			P	
Balanus glandula (set)	C			
Balanus glandula		P		
Chthamalus dalli	P		P	
Semibalanus balanoides	P			
Semibalanus cariosus (set)		18		
Spirorbidae, unid.			C	C
Animals (number/0.25 m²)				
Acmaea mitra			C	
Boltenia villosa			P	
Ceratostoma foliata			R	
Cerebratulus (pink)			R	
Clinocottus acuticeps		P		
Cnemidocarpa finmarkiensis			P	C
Crassadoma gigantea			R	
Cryptochiton stelleri			R	
Cucumaria miniata				C
Dendrobenia lichenoides				P
Dermasterias imbricata			C	C
Doridacea, unid. White				P
Elassochirus tenuimanus				R

continued

Table 6 (continued).

Site:	GRV-9 (West Channel Southwest)			
Habitat	Bedrock/Boulders			Mixed-Fine
Zone	Upper	Low/Mid	Low	Low
Approximate elevation (ft MLLW)	> +8	+6 to +4	0 to -4	0 to -4
Evasterias troschelii			P	
Gammaridea, unid.		C	C	C
Henricia leviuscula			P	
Hydroidea			P	C
Idothea wosnesenskii		P		
Lacuna spp. (probably *L. variegata*)			C	
?Lepidochitona sp.			R	
Littorina sitkana	C	C		
Lophopanopeus bellus				P
Lottiidae, unid. (incl. juv.)			P	
Margarites pupillus			P	
Mediaster aequalis			R	
Micrura verrilli			R	
Nucella lima		P		
Onchidella borealis		R		
Onchidoris bilamellata			C	
Ophiuroidea				P
Oregonia gracilis				P
Pagurus hirsutiusculus		P		
Parastichopus californica				R
Petrolisthes				C
Pholidae/Stichaeidae				A
Pisaster ochraceus			P	
Pododesmus macroschismata			C	C
Protothaca staminea			P	
Pseudochitinopoma occidentalis			C	C
Pycnopodia helianthoides			C	A
Saxidomus giganteus			P	
Serpula vermicularis			C	P
Strongylocentrotus droebachiensis				R
Tectura persona	6			
Tonicella spp.			P	
Trichotropus cancellata			P	

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Table 7 Intertidal flora and fauna identified at Station REV-3A, June/July 2000.

Site:	**REV-3A (Peninsula Point)**		
Habitat	**Riprap/Bedrock**	**Bedrock**	
Zone	**High**	**Mid**	**Low**
Approximate elevation (ft MLLW)			**+3 to -2**
Survey	**Jun/Jul**	**Jun/Jul**	**Jun/Jul**
Plants (% cover)			
Acrosiphonia sp. *(* cf. *arcta*)	0.5	3	P
Blidingia minima			P
Bossiella cretacea			P
Callithamnion pikeanum			0.5
Chaetomorpha brachygona		P	
Chaetomorpha sp.			P
Cladophora sericea		3.5	4
Constantinea subulifera			P
Corallina frondescens			4
Costaria costata			P
Cryptosiphonia woodii		4	8
Cymathere triplicata			P
Delesseria decipiens			P
Desmarestia viridis			P
Dilsea californica			P
Elachista fucicola		5.5	
Encrusting coralline algae		4.5	6
Encrusting red algae		6	
Endocladia muricata		1.5	
Enteromorpha linza		1.8	4
Farlowia mollis			P
Fucus gardneri	82	70	0.5
Fucus spiralis	P		
Halosaccion glandiforme		4	2
Hildenbrandia rubra	3	0.5	0.5
Laminaria groenlandica			P
Leathesia difformis		P	0.5
Mastocarpus cf. *jardinii*			P
Mastocarpus papillatus	3	1	3
Mazzaella heterocarpa		1.5	9
Melanosiphon intestinalis		0.5	
Microcladia borealis		0.5	2
Monostroma grevillei			0.5
Neodilsea borealis			P
Neorhodomela oregona		2.5	
Neorhodomela larix [may include *N. aculeata*]		12.8	5
Neorhodomela oregona and/or *Cryptosiphonia woodii*			
Odonthalia floccosa			0.5
Palmaria hecatensis			P
Palmaria mollis			0.5
Palmaria spp.			
Petrocelis phase (of *Mastocarpus*)	3		6
Petrocelis and/or *Gloiopeltis* base			

continued

Table 7 (continued).

Site:	REV-3A (Peninsula Point)		
Habitat	Riprap/Bedrock	Bedrock	
Zone	High	Mid	Low
Approximate elevation (ft MLLW)			+3 to -2
Survey	Jun/Jul	Jun/Jul	Jun/Jul
Pilayella littoralis		1.5	0.5
Polyneura latissima			P
Pterocladia caloglossoides			P
Pterosiphonia bipinnata		1	10
Ptilota filicina/tenuis			6
'Ralfsia'			
Sarcodiotheca gaudichaudii			P
Soranthera ulvoidea			P
Sparlingia pertusa			P
Ulva fenestrata		1.5	3
Animals (% cover)			
Aplidium californicum			
Balanus crenatus			0.5
Balanus glandula (set)	0.5		
Balanus glandula	8		
Chthamalus dalli (set)			
Chthamalus dalli	1	3.5	P
Encrusting bryozoan			0.5
Encrusting sponge			
Halichondria panicea		0.5	P
Mytilus edulis			
Rhynchozoon bispinosum			P
Semibalanus balanoides (set)	0.5		
Semibalanus balanoides	2		
Semibalanus cariosus (set)		3.5	
Spirorbidae, unid.			P
Animals (number/0.25 m²)			
Amphiporus spp. (Nemertea, white)			P
Anthopleura elegantissima		P	
Cancer oregonensis			P
Cancer productus			P
Cnemidocarpa finmarkiensis			P
Cryptochiton stelleri			R
Cucumaria miniata			P
Dermasterias imbricata			P
Evasterias troschelii		P	
Gammaridea, unid.			P
Gastropoda, unid.			C
Hemigrapsus nudus	2	P	
Katharina tunicata		0.5	
Leptasterias epichlora			P
Ligia sp.			
Littorina scutulata	55		
Littorina sitkana	35		

continued

Table 7 (continued).

Site:	REV-3A (Peninsula Point)		
Habitat	Riprap/Bedrock	Bedrock	
Zone	High	Mid	Low
Approximate elevation (ft MLLW)			+3 to -2
Survey	Jun/Jul	Jun/Jul	Jun/Jul
Lottia digitalis			
Lottia pelta	2		
Lottiidae, unid. (incl. juv.)	20	0.5	P
Mopalia spp.		1.5	P
Onchidoris bilamellata			
Orthasterias koehleri			
Pagurus hirsutiusculus	2	4.5	P
Pholidae/Stichaeidae			P
Pisaster ochraceus		3	P
Polycladia, unid.			P
Pseudochitinopoma occidentalis			P
Pugettia gracilis			P
Pugettia producta			P
Searlesia dira		1.5	
Serpula vermicularis			P
Strongylocentrotus droebachiensis			P
Tectura persona	P		
Tectura scutum		0.5	
Telmessus cheiragonus			P
Tonicella lineata		0.5	P
Tonicella spp.			2

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Table 8 Intertidal flora and fauna identified at Station REV-4, January and June/July 2000.

Site	REV-4 (North Dump)					
Habitat	Riprap					Mixed-Fine
Zone	High		Low/Mid		Low	Low
Approximate elevation (ft MLLW)	> +6		0 to +4		0 to -2 ft	0 to -2
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jan
Plants (% cover)						
Acrosiphonia sp. (cf. *arcta*)				4		
Blidingia minima				0.3		
Chaetomorpha sp.				P		
Corallina frondescens					P	
Cryptosiphonia woodii				0.1		
Elachista fucicola				0.1		
Encrusting coralline algae					P	
Endocladia muricata			R	1.3		
Enteromorpha intestinalis				P		
Enteromorpha linza				0.1		
Fucus gardneri	30	39	20	10	P	
Fucus gardneri germlings		R				
Gloiopeltis furcata	R			1.3		
Halosaccion glandiforme			P	0.2	P	
Hildenbrandia rubra					P	
Leathesia difformis				0.1		
Mastocarpus papillatus	1	3	0.5	0.4	P	
Mazzaella heterocarpa				0.1		
Microcladia borealis				0.1		
Neorhodomela oregona				7.5		
Neorhodomela larix [may include *N. aculeata*]					P	
Neorhodomela oregona and/or *Cryptosiphonia woodii*					P	
Palmaria hecatensis					P	
Palmaria mollis					P	
Petrocelis phase (of *Mastocarpus*)				0.1		
Petrocelis and/or *Gloiopeltis* base			P		P	
Pilayella littoralis		R		0.4		
Pleonosporium vancouverianum					P	
Polysiphonia pacifica					P	
Porphyra cf. *fucicola*				0.1		
Pterosiphonia bipinnata				P	P	
'Ralfsia'					P	
Rhizoclonium cf. *tortuosum*				1		
Soranthera ulvoidea				P		
Ulva fenestrata					P	
Ulva sp.				0.4		
Animals (% cover)						
Balanus crenatus						P
Balanus glandula	1	30		0.4		
Chthamalus dalli (set)				1.1	C	
Chthamalus dalli	P	6.5	20	18		
Encrusting bryozoan					P	

continued

Table 8 (continued).

Site	REV-4 (North Dump)					
Habitat	Riprap					Mixed-Fine
Zone	High		Low/Mid		Low	Low
Approximate elevation (ft MLLW)	> +6		0 to +4		0 to -2 ft	0 to -2
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jan
Halichondria panicea					P	
Mytilus edulis (spat)		P		0.3		
Semibalanus balanoides (set)		2.3		0.8		
Semibalanus balanoides	5	C				
Semibalanus cariosus (set)			P	0.6		
Spirorbidae, unid.					C	P
calcareous tube worm						
Animals (number/0.25m²)						
Evasterias troschelii				R	C	
Gammaridea, unid.				P		P
Gnorimosphaeroma oregonensis						P
Hemigrapsus nudus		1		C		
Henricia leviuscula						R
Idothea wosnesenskii			P			
Lacuna spp. (probably *L. variegata*)					P	
Leptasterias epichlora				P		
Littorina scutulata	P	281.5		10	R	
Littorina sitkana	C	14		1		
Lottia digitalis		4				
Lottia pelta	C	7	C			
Lottiidae, unid. (incl. juv.)	C	78.5	P	87.5		P
Metridium sp.					P	
Mopalia lignosa					R	
Nucella lamellosa				P		
Nucella lamellosa (juv.)			P			
Pagurus hirsutiusculus				P	C	
Pagurus sp.				0.3		
Pholidae/Stichaeidae					P	
Pisaster ochraceus				P		
Protothaca staminea				P		
Pseudochitinopoma occidentalis					C	
Serpula vermicularis					C	
Tectura persona		P				
Tectura scutum			P	P		
Tonicella spp.					P	

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Table 9 Intertidal flora and fauna identified at Stations REV-5 and REV-5A, January and June/July 2000.

Site	**REV-5 (Riprap Cove)**						**REV-5A (Ferry East)**	
Habitat	**Small Riprap**		**Riprap**				**Riprap**	
Zone	**High**		**Low/Mid**		**Low**		**High**	**Low/Mid**
Approximate elevation (ft MLLW)	**> +8**		**+3 to +6**	**+4 to +6**	**+3 to +1**	**+4 to +2.5**	**> +7**	**+3.7 to +6.9**
Survey	**Jan**	**Jun/Jul**	**Jan**	**Jun/Jul**	**Jan**	**Jun/Jul**	**Jun/Jul**	**Jun/Jul**
Plants (% cover)								
Acrosiphonia sp. (cf. *arcta*)						P		P
Bangia sp.			P	0.5				
Blidingia minima				0.5				C
Cryptosiphonia woodii						P		
Elachista fucicola				3		P		
Endocladia muricata								P
Enteromorpha intestinalis			A	C		P		C
Enteromorpha linza				0.5		P		
Enteromorpha prolifera						P		
Fucus gardneri			P	40		C	75.1	77.5
Fucus gardneri germlings						P		
Gloiopeltis furcata						P	1.0	P
Mastocarpus papillatus				P	P	P	2.6	1
Mazzaella heterocarpa						P		P
Melanosiphon intestinalis								P
Neorhodomela larix [may include *N. aculeata*]					P			
Neorhodomela oregona and/or *Cryptosiphonia woodii*					A	P		
Petrocelis phase (of *Mastocarpus*)				0.5				
Pilayella littoralis				2			0.5	0.25
Porphyra cf. *fucicola*			P	P				
Porphyra perforata				P		P		
Pterosiphonia bipinnata								P
Ulva fenestrata			A					P
Animals (% cover)								
Balanus glandula			A		C		6.8	C
Chthamalus dalli (set)					A			
Chthamalus dalli			A	5	C	C	5.2	A

continued

Table 9 (continued).

Site	REV-5 (Riprap Cove)						REV-5A (Ferry East)	
Habitat	Small Riprap		Riprap				Riprap	
Zone	High		Low/Mid		Low		High	Low/Mid
Approximate elevation (ft MLLW)	> +8		+3 to +6	+4 to +6	+3 to +1	+4 to +2.5	> +7	+3.7 to +6.9
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul
Mytilus edulis			P		R		0.5	C
Semibalanus balanoides (set)							0.8	
Semibalanus balanoides				C			P	
Semibalanus cariosus (set)								P
Semibalanus cariosus						P		
Animals (number/0.25m²)								
Acarina							P	
Capitellidae, unid					C			
Chaetopteridae					C			
Dermasterias imbricata					P			
Evasterias troschelii				R				R?
Gammaridea, unid.						A		P
Hemigrapsus nudus							2	P
Littorina scutulata				C			171.7	A
Littorina scutulata (juv.)						A		
Littorina sitkana	P						6	
Lottia digitalis			P					
Lottia pelta			C					
Lottiidae, unid. (incl. juv.)				P	C	A	27.3	P
Margarites helcinus					P			
Onchidoris bilamellata					C			
Pagurus hirsutiusculus								P
Pagurus sp.							1	
Pisaster ochraceus				1		P		0.5
Tectura scutum								P

Table 10 Intertidal flora and fauna identified at Station REV-6, January and June/July 2000.

Site:	REV-6 (Bar Point)					
Habitat	Riprap		Bedrock		Mixed-Fine	
Zone	Upper/Mid		Low/Mid		Low/Mid	
Approximate elevation (ft MLLW)	> +6		+4 to +2		+4 to +2	
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul
Plants (% cover)						
Acrosiphonia sp. (cf. *arcta*)				P		
Bangia sp.		P				
Black crust				0.6		
Blidingia minima		P		P		
Ceramium pacificum/washingtoniense				P		
Cladophora sericea			P	3.8		
Codium fragile				R		
Cryptosiphonia woodii			12	4.2		
Desmarestia aculeata				0.1		
Elachista fucicola		6		2		
Encrusting coralline algae			R	2.2		
Endocladia muricata	14.3	2.5		2		
Enteromorpha linza				0.3		
Fucus gardneri	50	38	36.3	90.8		
Gloiopeltis furcata		0.3				
Halosaccion glandiforme			P	4.0		
Hildenbrandia rubra			P	1.1		
Leathesia difformis				C		
Mastocarpus papillatus	0.4	2.5	4	6.6		
Mazzaella heterocarpa				1.8		
Melanosiphon intestinalis				P		
Neorhodomela oregona			P	4.8		
Palmaria mollis			R	0.7		
Petrocelis phase (of *Mastocarpus*)		3		8		
Petrocelis and/or *Gloiopeltis* base	R		C			
Pilayella littoralis			P			
Pterosiphonia bipinnata			P			
'Ralfsia'				0.3		
Soranthera ulvoidea				0.6		

continued

Table 10 (continued).

Site:	REV-6 (Bar Point)					
Habitat	Riprap		Bedrock		Mixed-Fine	
Zone	Upper/Mid		Low/Mid		Low/Mid	
Approximate elevation (ft MLLW)	> +6		+4 to +2		+4 to +2	
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul
Ulva fenestrata	R	0.5	P	3.2		
**Zostera marina*						P
Animals (% cover)						
Aplidium californicum			P			
Balanus crenatus			P	0.3		
Balanus glandula	A	6.8	C	P		
Chthamalus dalli	P	1	A	A		
Encrusting bryozoan			R			
Encrusting sponge				P		
Mytilus edulis (spat)		1		C		
Mytilus edulis	C	4.6		0.3	P	
Nucella spp. (eggs)			R			
Rhynchozoon bispinosum				0.5		
Semibalanus balanoides (set)		2.5				
Semibalanus balanoides	P	18.3		P		
Semibalanus cariosus (set)		9	P	0.3		
Semibalanus cariosus		1	A	10.8		
Spirorbidae, unid.			P			C
Animals (number/0.25 m²)						
Anthopleura				3.5		
Anthopleura elegantissima				P		
Bittium sp.			P	0.3		
Ceratostoma foliata				P		
Chiridota spp.					C	
Clinocottus acuticeps			P	P		C
Doridacea, unid. White			R			
Evasterias troschelii				P		
Gammaridea, unid.		P		P		
Gastropoda, unid.				R		

continued

Table 10 (continued).

Site:	REV-6 (Bar Point)					
Habitat	**Riprap**		**Bedrock**		**Mixed-Fine**	
Zone	**Upper/Mid**		**Low/Mid**		**Low/Mid**	
Approximate elevation (ft MLLW)	**> +6**		**+4 to +2**		**+4 to +2**	
Survey	**Jan**	**Jun/Jul**	**Jan**	**Jun/Jul**	**Jan**	**Jun/Jul**
Halichondria panicea			P			
Hemigrapsus nudus			C			A
Hydroidea				P		
Lacuna spp. (probably *L. variegata*)			C	1		
Leptasterias epichlora		3	C	2.8		C
Littorina scutulata	C	461.3	P			
Littorina spp. (juv.)	C					
Lottia digitalis	C					
Lottia pelta	C	18		0.5		
Lottiidae, unid. (incl. juv.)		29.3	A	A		
Margarites pupillus			P	0.7		
Metridium sp.			R			
Mopalia lignosa				R		
Nucella lamellosa			P	P		
Onchidella borealis				0.3		
Onchidoris bilamellata			P			
Pagurus granosimanus				P		
Pagurus hirsutiusculus		1	C	6		
Paranemertes peregrina						R
Parastichopus californica						R?
Pholidae/Stichaeidae			P			A
Pisaster ochraceus			P	P		
Polycladia, unid.						P
Protothaca staminea					50	A
Saxidomus giganteus						A
Searlesia dira		P		2.3		A
Serpula vermicularis				P		
Strongylocentrotus droebachiensis						A
Tectura scutum		4.7	P	1.3		A
Tonicella lineata				P		

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Table 11 Intertidal flora and fauna identified at Station REV-8, January and June/July 2000.

Site	REV-8 (South Dump)					
Habitat	Bedrock					Gravel/Glass
Zone	High	Mid		Low/Mid		Low/Mid
Approximate elevation (ft MLLW)	>+10	+6 to +10		+4 to +1		+3 to +1
Survey	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jan
Plants (% cover)						
Acrosiphonia sp. (cf. *arcta*)				R	1.2	
Blidingia minima			P			
Blidingia subsalsa		P				
Ceramium pacificum/washingtoniense					P	
Cryptosiphonia woodii					9.0	
Elachista fucicola			5.0		2.0	
Encrusting coralline algae		R		55.0	7.0	P
Endocladia muricata		R				
Enteromorpha intestinalis		P				
Enteromorpha linza					3.3	
Farlowia mollis					P	
Fucus gardneri	92.7	84.0	100.0	P	35.7	P
Fucus spiralis	P					
Gloiopeltis furcata			P			
Halosaccion glandiforme				P	8.0	P
Hildenbrandia rubra	3.0	P	60.0		0.3	
Laminaria groenlandica					P	P
Leathesia difformis					1.8	
Mastocarpus papillatus	1.3	4.0	7.8	4.0	4.3	P
Mazzaella spp.				R		
Mazzaella heterocarpa					4.0	
Neorhodomela oregona	0.3				3.7	P
Neorhodomela larix [may include *N. aculeata*]				7.5	0.3	P
Neorhodomela oregona and/or *Cryptosiphonia woodii*		P		7.5		P
Odonthalia floccosa					1.0	
Palmaria mollis				R	0.5	P
Petrocelis phase (of *Mastocarpus*)					18.0	
Petrocelis and/or *Gloiopeltis* base		P		12.0		P
Pseudolithophyllum neofarlowii					P	
Pterosiphonia bipinnata				6.0	5.0	P
Ralfsia fungiformis				P	0.3	P
cf. *Rhizoclonium riparium*		P				
Scytosiphon lomentaria			P			
Soranthera ulvoidea					0.8	
Ulva fenestrata				R	6.3	P
Animals (% cover)						
Balanus glandula (set)	P		P			
Balanus glandula	19.7	A				A
Chthamalus dalli (set)			0.5			
Chthamalus dalli	4.5			P		
Encrusting bryozoan						P
Mytilus edulis	5.7	A				

continued

Table 11 (continued).

Site	REV-8 (South Dump)					
Habitat	Bedrock					Gravel/Glass
Zone	High	Mid		Low/Mid		Low/Mid
Approximate elevation (ft MLLW)	>+10	+6 to +10		+4 to +1		+3 to +1
Survey	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jan
Semibalanus balanoides (set)	0.5					
Semibalanus balanoides	3.0					
Semibalanus cariosus (set)		30.0	0.5			
Semibalanus cariosus			6.0			
Spirorbidae, unid.				C	C	P
Animals (number/0.25m²)						
Anthopleura elegantissima			1.0			
Cancer productus					P	
Cerebratulus (pink)						R
Chiridota spp.						P
Clinocottus acuticeps					P	
Cnemidocarpa finmarkiensis					R	
Dermasterias imbricata				P		P
Evasterias troschelii			1.0		P	P
?Flustrellidra corniculata						P
Gammaridea, unid.					P	P
Gnorimosphaeroma oregonensis					P	
Hemigrapsus nudus	0.7				P	C
Hemigrapsus oregonensis					P	
Henricia leviuscula				P		
Hermissenda crassicornis					P	
Hiatella arctica				P		
Katharina tunicata				P	0.3	
Lacuna spp. (probably *L. variegata*)		P		P	0.3	
?Lepidochitona sp.					P	
Leptasterias epichlora			3.5	C	0.3	A
Littorina scutulata	114.0	C	1.0			
Littorina sitkana	221.3	A	1.0			
Lottia pelta		C				
Lottiidae, unid. (incl. juv.)	3.7	A	1.0		3.7	A
Mediaster aequalis						R
Metridium sp.				P		
Mopalia lignosa					P	
Mopalia spp.					R	
Nereidae, unid.						R
Nucella lamellosa	0.7	P	1.5	A	P	
Nucella lima		C				
Onchidella borealis					P	
Onchidoris bilamellata						C
Pagurus granosimanus				P	1.0	
Pagurus hirsutiusculus	9.7	P		C	7.0	
Pagurus sp.			10.0		13.0	
Pentidotea wosnesenskii			2.0			
Pholidae/Stichaeidae					P	C
Pisaster ochraceus				P	P	

continued

Table 11 (continued).

Site	REV-8 (South Dump)					
Habitat	Bedrock					Gravel/Glass
Zone	High	Mid		Low/Mid		Low/Mid
Approximate elevation (ft MLLW)	>+10	+6 to +10		+4 to +1		+3 to +1
Survey	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jan
Protothaca staminea						P
Searlesia dira		P	16.5	C	2.7	
Serpula vermicularis				C	P	
Strongylocentrotus droebachiensis					P	P
Tectura persona	5.0					
Tectura scutum		P	3.0	P	P	
Tonicella lineata				P	0.7	
Tonicella spp.			2.0			
Trichotropus cancellata					P	

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Table 12 Intertidal flora and fauna identified at Stations PEN-2 and PEN-2A, January June/July 2000.

Site:	PEN-2 (East Channel NW)							PEN-2A (East Channel SW)		
Habitat	Boulders				Bedrock		Mixed-Fine	Boulders		
Zone	High/Mid		Low		Low/Mid		Low	High	High/Mid	Low
Approximate elevation (ft MLLW)	+15 to +5		+3 to -1	0 to -3	+5 to +3		0 to -3			0 to -2.5
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Plants (% cover)										
Acrosiphonia sp. (cf. *arcta*)							4			P
Alaria tenuifolia							P			
Black crust										P
Blidingia minima									P	
Ceramium pacificum/washingtoniense										P
Cladophora sericea							5			C
Codium fragile			R							
Constantinea subulifera							P			
Costaria costata							P			
Cryptosiphonia woodii							8			A
Cymathere triplicata							P			
**Deschampsia elongata [caespitosa]*		P								
**Draba hyperborea*		P								
**Elymus mollis*		P								
Encrusting coralline algae			P				P			P
Encrusting red algae							P			P
Enteromorpha intestinalis										P
Enteromorpha linza									P	P
Fucus gardneri	65	30		1	30	C		P	P	
Gloiopeltis furcata	P	8		1					P	
Halosaccion glandiforme			P				1			C
Hildenbrandia rubra	10				74			P	P	
**Honkenya peploides*		P								
Laminaria groenlandica										P
Laminaria saccharina							6			
Leathesia difformis							P			
Mastocarpus papillatus	2	1		4	0.5		0.5		P	A
Mazzaella heterocarpa							3			A

continued

Table 12 (continued).

Site:	PEN-2 (East Channel NW)							PEN-2A (East Channel SW)		
Habitat	Boulders				Bedrock		Mixed-Fine	Boulders		
Zone	High/Mid		Low		Low/Mid		Low	High	High/Mid	Low
Approximate elevation (ft MLLW)	+15 to +5		+3 to -1	0 to -3	+5 to +3		0 to -3			0 to -2.5
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Neodilsea borealis							P			
Neorhodomela oregona										C
Neorhodomela larix [may include *N. aculeata*]							C			P
Neorhodomela oregona and/or *Cryptosiphonia woodii*	P									
Nereocystis luetkeana							P			P
Palmaria hecatensis							2			
Palmaria mollis							2			C
Petrocelis phase (of *Mastocarpus*)	P			0.5					P	
Plantago maritima		P								
Pterosiphonia bipinnata			P				2			A
'Ralfsia'									P	
Ralfsia fungiformis							P			
Rhodoptilum plumosum										P
Scinaia confusa							P			
Sparlingia pertusa										P
Triglochin maritima	P									
Ulva fenestrata							32			A
Animals (% cover)										
Aplidium californicum										P
Balanus glandula (set)	R									
Balanus glandula			C					C		
Chthamalus dalli (set)	R								C	
Chthamalus dalli	P		C	1	P		P	P		P
Rhynchozoon bispinosum							P			C
Semibalanus balanoides (set)									P	
Semibalanus balanoides	13	1				P		A		
Semibalanus cariosus (set)	R									

continued

Table 12 (continued).

Site:	PEN-2 (East Channel NW)							PEN-2A (East Channel SW)		
Habitat	**Boulders**				**Bedrock**		**Mixed-Fine**	**Boulders**		
Zone	**High/Mid**		**Low**		**Low/Mid**		**Low**	**High**	**High/Mid**	**Low**
Approximate elevation (ft MLLW)	**+15 to +5**		**+3 to -1**	**0 to -3**	**+5 to +3**		**0 to -3**			**0 to -2.5**
Survey	**Jan**	**Jun/Jul**	**Jan**	**Jun/Jul**	**Jan**	**Jun/Jul**	**Jun/Jul**	**Jun/Jul**	**Jun/Jul**	**Jun/Jul**
Semibalanus cariosus	4				C					
Spirorbidae, unid.										A
Animals (number/0.25 m²)										
Acmaea mitra										P
Bittium sp.			A							
Ceratostoma foliata							P			P
Cnemidocarpa finmarkiensis							A			
Cucumaria miniata			P							
Dermasterias imbricata			A				P			
Evasterias troschelii			P							
Gammaridea, unid.		C	C							P
Hemigrapsus nudus		C	C		P				A	
Hemigrapsus oregonensis			P							
Lacuna spp. (probably *L. variegata*)					R					
Leptasterias epichlora		P	A			P				
Littorina scutulata	9	30				C				
Littorina sitkana	A	10				A				
Lottiidae, unid. (incl. juv.)	12	P			P		P	C		P
Margarites pupillus							P			
Margarites helcinus			P							
Nereis vexillosa			P							
Nucella lamellosa		2	C						P	
Nucella lamellosa (juv.)		1								
Nucella lima						A				
Onchidoris bilamellata			C							
Pagurus hirsutiusculus	A		C		P		P			C
Parastichopus californica							P			
Pisaster ochraceus							P			C
Protothaca staminea				P			P			P
Pugettia gracilis										P

continued

Table 12 (continued).

Site:	PEN-2 (East Channel NW)							PEN-2A (East Channel SW)		
Habitat	Boulders				Bedrock		Mixed-Fine	Boulders		
Zone	High/Mid		Low		Low/Mid		Low	High	High/Mid	Low
Approximate elevation (ft MLLW)	+15 to +5		+3 to -1	0 to -3	+5 to +3		0 to -3			0 to -2.5
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Searlesia dira		P	A	1						P
Serpula vermicularis							P			P
Tectura persona								A		
Tectura scutum			A	6	P				A	
Trichotropus cancellata							P			

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Table 13 Intertidal flora and fauna identified at Stations PEN-4 and PEN-4A, January and June/July 2000.

Site:	PEN-4 (West Channel NE)						PEN-4A (West Channel South)		
Habitat	Bedrock						Bedrock/Boulders		
Zone	Upper		Low/Mid		Low		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+6 to +4		0 to -3		> +8	+6 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Plants (% cover)									
Acrosiphonia sp. *(* cf. *arcta*)						P		P	P
Analipus japonicus									P
Antithamnion defectum									P
Bangia sp.	P	P						P	
Blidingia minima		P						P	P
Callophyllis firma									P
Ceramium pacificum/washingtoniense						P			P
Cladophora sericea									P
Codium fragile						P			P
Constantinea subulifera					P	P			
Corallina frondescens					P	P			P
Corallina vancouveriensis						P			
Costaria costata						P			
Cryptosiphonia woodii									P
Delesseria decipiens									P
Encrusting coralline algae					P	P			P
Enteromorpha linza								P	P
Farlowia mollis									P
Fauchea laciniata									P
Fucus gardneri		P	0.5	P				P	P
Gloiopeltis furcata		P						P	
Halosaccion glandiforme			P		P			P	P
Herposiphonia plumula									P
Hildenbrandia rubra	P	P		P			P	P	P
Laminaria groenlandica					P	P			A
Leathesia difformis									P
Mastocarpus papillatus			0.5	P				P	
Mazzaella heterocarpa						P		A	P
Microcladia borealis									A
Monostroma grevillei									P

continued

Table 13 (continued).

Site:	PEN-4 (West Channel NE)						PEN-4A (West Channel South)		
Habitat	Bedrock						Bedrock/Boulders		
Zone	Upper		Low/Mid		Low		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+6 to +4		0 to -3		> +8	+6 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Neorhodomela oregona				P					P
Neorhodomela larix [may include *N. aculeata*]					P	P			P
Neorhodomela oregona and/or *Cryptosiphonia woodii*					P			P	
Nereocystis luetkeana						P			P
Odonthalia floccosa				P		P			P
Palmaria hecatensis					P	P			P
Palmaria mollis						P			P
Petalonia fascia									P
Petrocelis phase (of *Mastocarpus*)				C				P	P
Petrocelis and/or *Gloiopeltis* base			P		P				
Polysiphonia hendryi var. *gardneri*									P
Porphyra perforata								P	
Pseudolithophyllum neofarlowii				P					P
Pterosiphonia bipinnata				P		P		P	P
'Ralfsia'					P				
Ralfsia fungiformis									P
Saundersella simplex									P
Scytosiphon lomentaria						P			P
Soranthera ulvoidea						P			P
Sphacelaria cf. *rigidula*									P
Ulva fenestrata				P	P	P		P	P
Animals (% cover)									
Aplidium californicum									P
Balanus glandula (set)		P						P	
Balanus glandula		C					P		
Bryozoa, unid.									P
Chthamalus dalli	A	A	85	A			P	P	
Encrusting bryozoan						P			P

continued

Table 13 (continued).

Site:	PEN-4 (West Channel NE)						PEN-4A (West Channel South)		
Habitat	Bedrock						Bedrock/Boulders		
Zone	Upper		Low/Mid		Low		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+6 to +4		0 to -3		> +8	+6 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Mytilus edulis							P		
Semibalanus balanoides (set)	P	P		P				P	P
Semibalanus balanoides							P		
Semibalanus cariosus (set)								P	
Spirorbidae, unid.					C				
calcareous tube worm						C			P
Animals (number/0.25 m²)									
Acmaea mitra					P	C			P
Amphissa spp.									R
Anthopleura elegantissima							P		
Ballanophyllia elegans					P				
Boltenia villosa					P	P			P
Cancer oregonensis						P			P
Ceratostoma foliata						P			
Chlamys hastata					R	P			
Chelyosoma productum									R
Cnemidocarpa finmarkiensis					C	P			P
Cucumaria miniata					P	C			P
Dermasterias imbricata				P	C	P			P
?Eudistoma ritteri					R				
Evasterias troschelii							P		
?Flustrellidra corniculata			R						P
Gastropoda, unid.						P			
Halichondria panicea						P			
Halocynthia aurantium					R				
Haplogaster mertensii									P
Hermissenda crassicornis				P		P			
Heteropora alaskensis					P				
Hydroidea					C	C			
Lacuna spp. (probably *L. variegata*)					P				

continued

Table 13 (continued).

Site:	PEN-4 (West Channel NE)						PEN-4A (West Channel South)		
Habitat	Bedrock						Bedrock/Boulders		
Zone	Upper		Low/Mid		Low		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+6 to +4		0 to -3		> +8	+6 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Littorina scutulata		A	P				P		
Littorina scutulata (juv.)		P							
Lophopanopeus bellus						P			P
Lottia digitalis							P		
Lottia pelta							P		
Lottiidae, unid. (incl. juv.)	C	C	320		R			P	A
Margarites pupillus			R		P				
Margarites helcinus									P
Metridium sp.						P			
Nucella lamellosa		P	P				P	P	P
Ophiuroidea									P
Pagurus beringanus						P			P
Pagurus granosimanus					P				
Pagurus hirsutiusculus									P
Parastichopus californica					R				
Petrolisthes					C				
Pholidae/Stichaeidae									P
Pisaster ochraceus					P	P		P	P
Pododesmus macroschismata					C	P			
Polycladia, unid.									P
Porifera, orange						C			P
Protothaca staminea									P
Pseudochitinopoma occidentalis					C				P
Pugettia gracilis						P			P
Pycnopodia helianthoides			P		P	P			P
?Scabrotrophon maltzani					P				
Scyra acutifrons					R				
Searlesia dira		P							
Serpula vermicularis					A	A			A
Strongylocentrotus droebachiensis									P
Tectura persona		P					P		

continued

Table 13 (continued).

Site:	PEN-4 (West Channel NE)						PEN-4A (West Channel South)		
Habitat	Bedrock						Bedrock/Boulders		
Zone	Upper		Low/Mid		Low		High	Low/Mid	Low
Approximate elevation (ft MLLW)	> +8		+6 to +4		0 to -3		> +8	+6 to +4	0 to -4
Survey	Jan	Jun/Jul	Jan	Jun/Jul	Jan	Jun/Jul	Jun/Jul	Jun/Jul	Jun/Jul
Tectura scutum		P					P		
Tonicella lineata									C
Tonicella spp.					P				
Trichotropus cancellata						P			P

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Attachment C

Marine Environment Preliminary Impact Assessment Technical Memorandum (Draft)

Marine Environment Impact Assessment

Technical Memorandum

Draft

Agreement 36893013
DOT&PF Project 67698
Federal Project ACHP-0922(5)

Prepared for
STATE OF ALASKA
Department of Transportation and Public Facilities
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OCTOBER 2001

Contents

1—Introduction

This technical memorandum describes general impacts that could result from the Gravina Access Project alternatives based on a set of assumptions concerning the alternative designs and engineering requirements, as described in Section 2; the nature of habitats in the vicinity of project landfalls, as described in the *Phase II Marine Reconnaissance Technical Memorandum* (Pentec, 2001); and the considerable literature on the effects of various perturbations on freshwater and marine resources.

Along the Revillagigedo Island shoreline, resource values in general are limited by previous alterations in the form of riprap—as at the shoreline affected by four bridge alternatives (C3[a], C3[b], C4, and D1) and by two ferry alternatives (G2, from Peninsula Point, and G3, from downtown Ketchikan)—or by previous use of the site as a dump (Alternative F3, Bridges Across Pennock Island). The Gravina Island shoreline in the vicinity of the Ketchikan International Airport—as at the locations of Alternatives C3(a), C3(b), C4, and D1—is currently riprapped, but some subtidal areas support eelgrass. The most natural littoral habitats potentially affected by the alternatives are at Lewis Point near the location of Alternative G2, southeast of East Clump Island near the location of Alternative G3, and on Pennock and Gravina islands near the landfalls of Alternative F3.

Section 3 describes both the effects on the marine environment that could result during project construction (short-term), and those that could be expected during project operation (long-term), i.e., continuing as long as the project remains in place. Section 4 briefly indicates the types of impacts associated with each alternative.

2—Project Assumptions

For the purposes of conducting a preliminary assessment of the potential environmental impacts resulting from construction and operation of improved access across Tongass Narrows to Gravina Island, we have made the following assumptions about the alternatives under consideration:

- All bridge alternatives would require placement of piers in shallower waters (e.g., shallower than -50 feet mean lower low water [MLLW]) near the shoreline.
- All build alternatives would increase access to and development on Gravina Island.
- All build alternatives would require filling of nearshore areas adjacent to the southern portion of the airport runway on Gravina Island.
- All build alternatives would encroach, to varying degrees, on the Government Creek Estuary or its riparian zone on Gravina Island.
- Regardless of the alternative selected, final design will seek to avoid or minimize effects on sensitive resources and habitats.

3—Nature of Potential Impacts

3.1 Construction Effects

3.1.1 Erosion and Turbidity

Construction of alternatives that involve movement of significant amounts of soil and rock would have a high potential for generation of sediment-laden runoff in the vicinity of Ketchikan. Dredging that might be required to provide necessary navigation depths for ferry alternatives (G2, G3, and G4) and filling along the shoreline of the airport for the bridge alternatives there (C3[a], C3[b], C4, and D1) would generate turbidity plumes. Activities associated with installation of inwater piers also have the potential to release turbidity.

Juvenile salmon have been shown to avoid areas of unacceptably high turbidities (e.g., Servizi, 1988), although they might seek out areas of moderate turbidity (10 to 80 nephelometric turbidity units [NTU]), presumably as cover against predation (Cyrus and Blaber, 1987a,b). Feeding efficiency of juveniles is also impaired by turbidities in excess of 70 NTU, well below sublethal stress levels (Bisson and Bilby, 1982). Reduced preference by adult salmon homing to spawning areas has been demonstrated where turbidities exceed 30 NTU (20 milligrams [mg] of suspended sediments per liter [L]). However, Chinook salmon exposed to 650 mg/L of suspended volcanic ash were still able to find their natal water (Whitman et al., 1982). Any adult salmon present near the project area during inwater work might avoid areas of increased turbidity or reduced oxygen, but are not expected to interrupt their upstream migrations (e.g., Whitman et al., 1982). Based on these data, it is unlikely that the locally elevated turbidities generated by constructing these proposed alternatives would significantly affect juvenile or adult salmonids that might be present.

Excessive sedimentation rates in marine areas with benthic communities adapted to relatively clean water conditions can alter community composition and productivity in unexpected ways. An example of the level of effect caused by turbid water runoff is provided by the stormwater outfall at one of the marine reconnaissance survey sites, Station REV-5A (see Figure 3-1, *Phase II Marine Reconnaissance Survey*, Pentec, 2001). Over the past 5 years, this outfall has frequently delivered turbid (sometimes highly turbid) water from a rock quarry to Tongass Narrows. The intertidal biota in the immediate vicinity of the outfall is very different in nature from that on adjacent riprap, but this condition is attributed to the exclusion of predators from the area by the freshwater, rather than to the effects of turbidity. Bull kelp beds immediately offshore of the outfall did not appear to differ from those up and down the shoreline. Because of the strong currents in the area, intermittent discharges of waterborne sediments, especially when released in deeper waters offshore, are likely quickly dissipated with minimal effect on biota.

3.1.2 Upland Noise

Blasting in upland areas near Tongass Narrows might be required to construct bridge approaches. Upland blasting could affect marine resources such as bald eagles and marine mammals, but would not affect inwater resources.

Increased noise levels might temporarily disrupt foraging behavior of bald eagles in the vicinity of the project area. The Washington State Department of Transportation (WSDOT) conducted monitoring to determine the potential impacts on wintering eagles associated with pile-driving activities at Orcas and Shaw islands in San Juan County, Washington, from December 15, 1986, through March 15, 1987 (Bottorff et al., 1987). Each of the monitoring areas was associated with a Washington State ferry terminal. Background noise sources included ferry whistles, boat motors, chain saws, aircraft, front-end loaders, cranes, generators, diesel trucks, hammers, and other general noise sources associated with construction. Noise readings were taken at the construction sites and various intermediate points out to about 6,000 feet from the construction sites.

Driving of wood piles did not visibly disturb the eagles observed during the course of the study. A steel pile, which produces some of the loudest noises during pile-driving, might have disturbed a bald eagle pair at a distance of 4,000 feet. However, this same pair of eagles had been in the same location during the driving of two steel piles earlier in the day and exhibited no visible disturbance reaction. The eagles returned to their preferred perch and no further adverse reactions were observed, even after over 100 wood piles were driven (Bottorff et al., 1987).

Environmental factors such as wind and wave action, movement of tree branches and forest litter, barking dogs, bird noises, automobiles, airplanes, human voices, woodcutting, light construction activities, boats, and other unidentified noise sources create ambient noise levels that are similar to those produced by pile driving at distances of 0.25 to 0.5 mile away from the point source (Bottorff et al., 1987).

WSDOT also monitored noise levels during pile-driving activities at its Anacortes, Washington, facility (Visconty, S., Washington State Ferries, pers. comm., March 9, 2000). For comparison purposes, background noise levels were monitored at the Friday Harbor, Washington, terminal. At Friday Harbor, ambient noise levels around the closest bald eagle nest (located near the terminal) ranged between 45 and 72 decibels (dB); 40 to 51 dB were recorded for local harbor traffic background noise, and 69 to 74 dB were recorded from use of a 100-ton crane at the terminal. Pile-driving noise at the Anacortes facility ranged from 105 to 115 dB at 50 feet from the noise source. Noise levels were highest when a pile was first driven and decreased near completion because of a reduction of the exposed surface area and increased stiffness as the pile became more embedded (Visconty, S., Washington State Ferries, pers. comm., March 9, 2000). Simultaneous readings taken at several distances to determine propagation loss at Anacortes indicated a 6-dB decrease in sound pressure for every doubling of distance. Given this information, at 1,850 feet from the noise source at Anacortes, the sound was 70 dB, well within measured background ambient noise levels recorded at the Friday Harbor terminal (Visconty, S., Washington State Ferries, pers. comm., March 3, 2000).

Based on this information, and the fact that bald eagles in the Ketchikan area are well-acclimated to high levels of human activity (e.g., operation of large vessels and heavy equipment, and floatplane noise), short-term direct effects on eagles and other marine wildlife due to construction disturbances are anticipated to be minimal and localized.

3.1.3 Inwater Noise

Inwater noise from construction can result from dredging, fill placement, pile driving, and waterborne vessel movements. Construction noise generated in assembly of bridge or ferry landing structures above the water can be transmitted into the water through steel or concrete structures. Inwater blasting might be necessary to prepare the foundations for inwater piers. Noise levels associated with pile removal, driving, and predrilling, as well as with other aspects of the proposed action, might temporarily be elevated above existing background noise levels.

Feist et al. (1996) investigated the impacts of pile driving on juvenile pink and chum salmon behavior and distribution in Everett Harbor, Washington. The authors reported that there might be changes in general behavior and school size, and that fish appeared to be driven toward the acoustically isolated side of the site during pile driving. However, the prevalence of fish schools did not change significantly with or without pile driving, and schools were often observed about the pile-driving rigs themselves. No impacts on feeding were reported. The study concluded that any effects of pile-driving noise on juvenile salmonid fitness would be very difficult to measure quantitatively. Noise generated by dredging is expected to be of lower peak intensity than that resulting from pile driving.

Based on this information, the effects of project construction on marine and anadromous fish are expected to be minimal and localized. Marine mammals (e.g., seals) might be the most affected by project construction noise, although the level of effect is expected to be limited to movement of mammals away from areas of noise in excess of their tolerances.

3.1.4 Direct Displacement

Construction would require placement of concrete, rock, and other fill materials in habitats that currently support important resources. Bridge piers or fill placed in the littoral zone (the area between mean higher high water [MHHW] and about -20 ft MLLW) would cover and destroy existing sedentary biota that includes commercially or recreationally harvestable clams and mussels. The relative significance of this impact would depend on the nature of the substrata and habitats present, and the depth of the affected substratum.

The most significant resource loss would occur where areas of eelgrass or saltmarsh and associated riparian vegetation are lost. Eelgrass beds have been located at or near several of the proposed landfall areas. Eelgrass beds are important areas of feeding and refuge for several species of fish, especially juvenile salmonids (e.g., Simenstad et al., 1997) and shellfish (e.g., Dungeness crab). Eelgrass also provides a substratum (along with kelp beds and other intertidal species of algae) for spawning by Pacific herring. Herring are known to migrate and spawn in Tongass Narrows from late March through April (House, D., Alaska Department of Fish and Game [ADF&G], pers. comm., July 31, 2001). Along the western of Tongass Narrows, herring spawn from Rosa Reef west to Vallenar Point. Along the eastern banks, herring spawn from Refuge Cove west to Point Hagen and south of Pennock Island. Additionally, intermittent and sporadic spawning has occurred over the past 5 years on the eastern banks from near the U.S. Coast Guard station east to the town of Saxman (House, D., ADF&G, pers. comm., July 31, 2001).

Areas of saltmarsh exist along the upper intertidal zone south of the airport and especially in the estuary of Government Creek. This latter habitat is particularly productive; pink and chum salmon are known to spawn in Government Creek (House, D., ADF&G, pers. comm., July 31, 2001).

The least-significant impacts on resources would result from pier placement on dynamic sand or gravel beaches, which tend to have minimal resource values except in areas that support spawning by forage fish. Surf smelt and sand lance spawn in upper intertidal sand or mixtures of sand, small gravel, and shell. The locations of forage fish spawning areas in Tongass Narrows have not been documented (House, D., ADF&G, pers. comm., July 31, 2001).

Although rocky littoral habitats are highly productive, they support few resources currently harvested in the Ketchikan area. Bridge or ferry structures that destroy rocky habitat would themselves provide a substratum for development of a biota that could be expected, over time, to resemble the lost biota.

3.1.5 Spills

Moderate spills (e.g., more than a few gallons) of diesel oil could occur during construction from an accidental release from a work vessel or tank truck near the water.

Spilled diesel oil that grounded in the small saltmarshes at the mouths of Lewis Cove Creek or Government Creek, or in the marsh fringes along substantial portions of the Gravina shoreline, would have significant and lasting impacts on saltmarsh plants and animals contacted. Because both marshes are relatively close to (within

1 to 2 miles of) construction areas where spills would be initiated, oil contacting them would be relatively fresh and there would be little opportunity for weathering of toxic lighter fractions.

Diesel and hydraulic oils grounding in a soft bottom marsh are more likely to penetrate into the marsh substratum than are heavier bunker or crude oils (Baker, 1970). On the other hand, subsequent weathering of the lighter oils would proceed more rapidly than for heavier oils. Oiling of saltmarsh plants can be expected, at a minimum, to cause some reduction of primary production in the plants for at least a year. Time of year and type of oil are extremely important in the degree of impact experienced; oiling of a marsh during the winter months can often be cleaned up mechanically or by natural processes with little residual reduction in productivity (e.g., Hoff et al., 1993). Several species of saltmarsh plants in Prince William Sound were routinely seen pushing new shoots up through several millimeters of weathered crude oil from the *Exxon Valdez* (Houghton, J., Pentec Environmental, pers. obs., July, 1991).

Diesel oil contacting aboveground saltmarsh vegetation during the active growing period (spring and summer) can be expected to cause "burning," browning, reduced growth, and even death. Perennial plants with extensive belowground root/rhizome systems appear to be more resistant than annuals and regenerate readily following even severe damage to aboveground parts (e.g., Baker, 1970). The greatest damage in saltmarshes often results from inappropriately applied cleanup approaches that can severely damage root/rhizome systems and alter the physical structure and stability of the marsh.

A worst-case scenario in Tongass Narrows would result from a spill occurring late in a flooding peak spring tide with a strong wind, during the springtime. These circumstances could push relatively fresh oil high into the marshes and channels of one or both of the estuaries. This circumstance during a peak spring tide would result in a maximum amount of oil deposition well into the marsh, and timing relative to the tidal cycle would ensure a maximum interval before the next inundation. Contact with actively growing shoots of saltmarsh plants would maximize the damage. A high sun angle would also dry out the stranded oil and greatly reduce the rate at which the residues would be washed from the marsh.

Recovery of aboveground vegetation could be expected in 1 to 2 years for most species. Hoff et al. (1993) documented nearly full recovery of aboveground biomass of *Salicornia* and *Distichlis* (species present in both marshes) within 1 year following a crude oil spill in Fidalgo Bay, Washington, marsh. They noted, however, a possible trend of reduced belowground biomass in the second year following the spill.

Heavy initial mortalities of invertebrates would be expected on intertidal shorelines oiled with fresh diesel oil, and sublethal effects on plants and invertebrates might affect physiology, growth, reproduction and development, and behavior of invertebrates. Sublethal effects might actually become lethal if there were a loss in ability to avoid predators resulting from the response to oils. For instance, No. 2 diesel fuel has a narcotic effect on invertebrates; for example, large percentages of the limpet *Tectura scutum* exposed to diesel fuel became detached from aquarium walls (Ehrsam et al., 1972). Many bivalves exposed to *Exxon Valdez* crude oil were either killed *in situ* or found on the beach surface where they were vulnerable to predators (Houghton, J., Pentec Environmental, pers. obs., 1989; Shigenaka et al., 1997). Cardwell (1973) found that low levels of No. 2 diesel oil also inhibit the byssal attachment of the young mussels *Mytilus edulis*. However, Cardwell also found complete recovery (reattachment) within 24 hours after the mussels were placed in clean running seawater.

In general, fish are less vulnerable to effects of oil spills than are most other types of marine organisms. They are mobile, can usually avoid adverse conditions, and rapidly metabolize hydrocarbons (e.g., Craddock, 1977; Patton, 1977). However, more recent work has shown high sensitivities of fish to levels of sediment hydrocarbon concentrations in the parts per million or even parts per billion range (Horness et al., 1998). Other work has shown a very high sensitivity of salmon eggs to residual hydrocarbons from the *Exxon Valdez* spill (e.g., Bue et al, 1998). Salmon use of Government Creek is noted previously, and pink, coho, and chum salmon are known to spawn in the small creek entering Lewis Cove (House, D., ADF&G, pers. comm., July 31, 2001). If a portion of this spawning occurs in tidal areas, a spill could affect egg survival in either of these estuaries. Smolt outmigration from these and other streams in the area occurs from early April through late June. Fry would probably not be vulnerable to acute effects unless a few fish became isolated in a small embayment that received heavy oiling (Brannon et al., 1195).

Birds associated with the water or sediment surface (dabbling ducks, shorebirds) would potentially become oiled and suffer from hypothermia or might bring oil back to their nests, injuring or killing eggs or young. The effects of oil on birds have been reviewed by many authors, including the National Research Council (NRC) (1985) and Leighton (1991). These effects include:

- Effects on plumage, buoyancy, and thermoregulation
- Effects from ingestion of oil
- Effects on the alimentary tract
- Effects on blood
- Effects on salt glands and osmoregulation
- Effects on adrenal glands and corticosteroid hormones
- Effects on kidneys and liver
- Effects on reproductive system
- Suppressed immunity
- Mutagenic effects

High mortalities of bird species are often seen in the vicinity of a spill. Estimates of bird mortalities following major spills of heavy fuel oil or bunker C fuel oil from 1937 to 1991 have ranged from about 6,000 birds following the *Seagate Washington* spill (Vermeer and Vermeer, 1975) and the *Hamilton Trader* spill of 1969 (Hope Jones et al., 1970), to greater than 50,000 birds following the January 1970 spill of fuel oil off northeast Britain (Greenwood et al., 1971) and the *Nestucca* barge spill of bunker oil off Grays Harbor Washington in 1988 (Ford et al., 1991).

Water-associated mammals (e.g., harbor seals, mink, river otter) could suffer a similar fate. Geraci and Smith (1977) showed that harbor seals are relatively tolerant of ingested oil, but suffer considerably from surface contact, especially to the eyes. Because harbor seals depend on fat layers rather than fur or hair for insulation, they are less vulnerable to surface contact than are sea otters or river otters. Several hundred harbor seals were killed in the *Exxon Valdez* spill (Loughlin, 1996). Deaths occurred over a period of several months following the spill; autopsied animals displayed liver damage, skin lesions, and elevated tissue concentrations that were attributed to oil exposure.

In summary, the probability of an oil spill resulting from the project is low and the volume of oil that might be spilled in any given event associated with the proposed project is relatively limited (a few thousands of gallons). Local impacts could be severe, however, especially if large quantities of this oil were to be stranded in marshes or stream mouths. Recovery of most species of vegetation and invertebrates would be expected within 1 to 2 years, but recovery of birds and mammals could take longer.

Several measures are available that could be employed to reduce the impacts of a spill if a stream mouth or saltmarsh were impacted. Booms could be deployed to limit oil movement into tidal channels; sorbent booms could be deployed to pick up oil in those channels; and low-pressure ambient water could be used to flush oil from the marsh into areas where it could be sorbed or vacuumed from the water surface. This latter approach appears to have been successful at enhancing recovery of the *Salicornia* marsh oiled in Fidalgo Bay (Hoff et al., 1993). In all cases, care must be taken to avoid techniques that physically damage the marsh (e.g., high-pressure washes, manual cutting of vegetation, or anything that requires much foot traffic in the marsh).

3.2 Operation Effects

3.2.1 Shading

Bridges or ferry ramps would partially shade littoral areas, reducing primary productivity and possibly limiting the distribution of some algae, while extending the distribution of other taxa. Examples of the effects of partial shading on steeply sloped rocky intertidal areas were reported at Stations PEN-4 and PEN-4A (see *Phase II Marine Reconnaissance Survey*; Pentec, 2001), where the middle and upper intertidal elevations were relatively devoid of macroalgae. However, below MLLW (and out from under the influence of overhanging trees), a typically lush kelp-dominated flora was found.

The presence of overwater structures (bridges, causeways, and ferry docks) might partially shade portions of the adjacent beach and subtidal bottom areas. The area under a dock or causeway would likely receive full-time shade, whereas the area under a bridge would not, because the shadow cast by structures high above the water would move across the beach as the sun traverses the sky. Because the upper limits of many intertidal species, including eelgrass, are set by the degree of desiccation experienced and shading would reduce desiccation, shading by project structures would allow some species to extend their range upslope.

However, net loss of eelgrass productivity could result from the project if shading of deeper portions of a bed reduces production by more than shading of shallower portions of the bed allows increased production. If this occurs, it would constitute an incremental reduction in the area of eelgrass habitat available for juvenile salmons during their migration and for support of many other species, including Dungeness crab. Reduced eelgrass productivity would decrease the eelgrass blade area available to support epiphytic crustaceans, an important food source for juvenile salmon, and could reduce the area of refuge for salmon and other small fish.

3.2.2 Inwater Structures

Pilings and piers necessary to support bridges or nearshore components of the alternatives could alter the nearshore migration pathways of smaller juvenile salmonids (e.g., pink and chum salmon) or other marine species in Tongass Narrows. Impacts could be reduced by locating nearshore components in a manner that leaves a nearshore migration corridor (e.g., down to at least -5 feet MLLW) near the extreme low-water line, clear of obstruction. Deeper piers or pilings would allow free passage of marine species migrating along shorelines and would develop an epifauna typical of natural deeper hard-bottom areas.

3.2.3 Overwater Structures

In addition to shading, overwater structures that create areas of darkened water can impede or delay long-shore migrations of juvenile salmonids. Studies in Washington State have shown that schools of juvenile Chinook and chum salmon might pause in their migration when they encounter an overwater structure that creates a darkened area of water, such as a marginal wharf or wide pier that is constructed close to the water and of dark materials such as treated wood (e.g., Pentec, 1997). In the Gravina Access Project, there is little expectation that an elevated bridge constructed of concrete would create light conditions that would impede salmon migrations.

3.2.4 Runoff

The increase in impervious surface area would increase the current volume of runoff from the area. Runoff from new roads, if not collected and treated, would create temporary, localized increases in turbidity in drainage pathways and in Tongass Narrows (see the discussion of turbidity effects in Section 3.1.1). In addition, some contaminants, such as oil and metals from vehicle brake dust, are also likely to reach the drainage pathways and Tongass Narrows. In the climate of Ketchikan, frequent rainfall would limit accumulation of these materials on roadways. Thus, it is unlikely that these materials would run off the bridge or roadways in concentrations that would create conditions harmful to biota; again, the high circulation rates in Tongass Narrows would quickly dilute and dissipate any releases.

3.2.5 Noise

Existing sources of noise in the project area include commercial jets, floatplanes, vehicular traffic, construction machinery, industrial plants, and watercraft. Eagles, waterfowl, and mammals in the vicinity of Ketchikan are exposed daily to noises associated with the City and the airport, and have long been adapted to the increased noise levels. The primary sources of noise associated with the proposed project would be vehicular traffic. The degree of noise impact from the project would relate to the level of traffic increase. Studies conducted near Aberdeen, Washington, a town similar in size to Ketchikan, concluded that a doubling of roadway traffic would result in a noise increase of approximately 3 dB (DOC, 1994). An increase of 0 to 5 dB is classified as insignificant by the U.S. Environmental Protection Agency (EPA) (DOC, 1994). Based on the EPA criteria, the additional noise generated by traffic would not have a significant impact.

3.2.6 Spills

The most probable oil spill that could occur during project operation would result from a tank truck accident that spills gasoline or diesel from the bridge into the marine environment. Possible effects of marine oil spills are described in Section 3.1.

3.2.7 Increased Access

The effects of watershed suburbanization on streams are well documented (Leopold, 1968; Hammer, 1972; Hollis, 1975; Booth, 1991) and would be of concern for crossing alternatives and road systems that would increase development in the Government Creek and Lewis Creek drainages. Suburbanization is often measured by the proportion of basin area covered by impervious surfaces. Although impervious surfaces themselves do not generate pollution, they are the major contributor to changes in the hydrologic regime that drive many of the physical changes affecting urban streams (May, 1998). In addition to increasing area of impervious surface in the basin and the resulting stormwater runoff, development of watershed areas can also affect watershed drainage density (mile of stream length per square mile of basin area) when grading, landscaping, and associated infrastructure development result in straightening of stream channels. Chemical water quality of urban streams is generally not significantly degraded at low impervious levels, but it might become a more important factor in streams draining highly urbanized watersheds (May, 1998; Pitt et al., 1995; and Bannerman et al., 1993).

Streambed quality can be degraded by the deposition of fine sediment and by the streambed instability due to high flows. Basin development has the potential to cause both of these (May, 1998). Increases in fine sediments decrease the intragravel dissolved oxygen (IGDO) levels. Low IGDO is disastrous to salmonid incubation habitat (Koski, 1972, 1975).

In addition, urbanization contributes to the degradation of the riparian zone. Degraded riparian conditions influence streambank stability and large woody debris recruitment. Without riparian-zone protection, urbanization degrades the condition of riparian zones, and therefore contributes to streambank instability and loss of large woody debris in the stream (May, 1998). Instream habitat conditions have a significant influence on instream biota. Changes in riparian-zone condition and streambed quality, including fine-sediment content and streambed stability, affect the benthic macroinvertebrate community (May, 1998). As urbanization increases and riparian-zone integrity decreases, the biotic integrity of the stream decreases as well (May, 1998). Additionally, the construction of roads, bridges, and ferry docks would increase public access to nearby streams and estuaries that had not been as accessible before construction. Increased public access might also increase risk of harassment of spawning salmon.

4—Potential Impacts of Each Alternative

This section describes the potential impacts that each Gravina Access Project alternative would have on marine resources. The potentially affected resources were identified during the investigation for the *Phase II Marine Reconnaissance Technical Memorandum* (Pentec, 2001) and are characterized in this report by the survey station number used in the Phase II marine reconnaissance.

4.1 Alternative C3(a)

This bridge alternative would require a pier in nearshore waters on the eastern side of Tongass Narrows that could impact bull kelp beds near intertidal Station REV-4. These beds would be expected to reestablish on the lower intertidal rock or concrete structure of the pier. Deepwater piers in mid-channel would develop a rich epifauna.

On the western side of Tongass Narrows off the Barge Dock (Station GRV-5), the required piers might be located in an area that currently supports part of the near-continuous eelgrass bed that is interspersed with beds of *Laminaria* and an area of bull kelp. The offshore causeway that leads south parallel to the airport runway would also shade or require fill in an area with near-continuous eelgrass or kelp beds. Where the route makes landfall and curves around the southern end of the runway, care should be taken to minimize the encroachment into upper intertidal saltmarsh and adjacent riparian vegetation, especially along the Government Creek Estuary (GRV-7A).

4.2 Alternative C3(b)

This bridge alternative would have impacts similar to those of Alternative C3(a), except that it would avoid some impacts on kelp, eelgrass, and shallow-water biota off the Barge Dock and Barge Dock Beach (Station GRV-5A), north of the floatplane dock, by crossing over deeper water.

4.3 Alternative C4

This bridge alternative would have impacts nearly identical to those of Alternative C3(a), except that the pier in nearshore waters on the eastern side of the narrows would be in a slightly different location. Resources affected would not differ materially.

4.4 Alternative D1

This bridge alternative would affect fewer marine resources than the other bridge alternatives in the vicinity of the airport (i.e., C3[a], C3[b], and C4) because no pier would be required in nearshore waters on the eastern side of Tongass Narrows, and because the length of shoreline affected by the pile- and fill-supported causeway along the southern half of the airport shoreline would be shorter. Impacts on a portion of the northern shoreline of Government Creek Estuary would be difficult to avoid.

4.5 Alternative F3

Alternative F3 would cross Pennock Island and require bridges across both the East and West channels of Tongass Narrows. The eastern landfall leaving Revillagigedo Island would require an abutment along the shoreline in the vicinity of the South Dump (Station REV-8). This shoreline is relatively rich, given the extent of debris remaining on the beach from the former dump. The East Channel span would cross kelp beds on both the eastern and western shores at an elevation of approximately 60 feet above the water. This bridge elevation would likely result in some shading impacts in the form of reduced productivity of those kelp beds. Piers on both sides would avoid productive shallower nearshore waters.

The span of the West Channel would leave Pennock Island from a high rock bluff, but would require three piers. Two of these would be placed in deeper waters, likely avoiding direct impacts on marine vegetation, but the western pier might be in shallower waters that support kelp and/or eelgrass beds. The west span would be relatively high (200 feet) above the water surface over these beds and over the mid- and upper intertidal vegetation (a diversity of algae) seen at Station GRV-9. Because of this elevation, it appears unlikely that a significant reduction in productivity would result. Shading would have minimal effect on the Pennock Island shore intertidal community (Station PEN-4), which is already shaded by overhanging trees.

This alternative would approach the airport along the northern shore of the Government Creek Estuary and would cause some disruption of shallow subtidal biota. Alternative F3 would likely have few impacts on eelgrass and kelp beds.

4.6 Alternative G2

Under this alternative, a ferry would run between Peninsula Point (Station REV-3A) and Lewis Point (Station GRV-3A). It is assumed that construction of a ferry terminal at Peninsula Point would disrupt a portion of the rich rocky intertidal face of the point. However, because of the steepness of this face, the net area affected would be relatively minor, and displaced organisms would be replaced with similar species on the new hard structures placed for the terminal. No eelgrass was found in the sandy area west of the point that would require dredging for the ferry berth, but kelp (*Laminaria*) and other algae were abundant.

Construction of the ferry terminal at Lewis Point on the western side of Tongass Narrows would likely affect areas of kelp and eelgrass that lie offshore of the rocky point and in silty-sand pocket beaches at the base of the rocky intertidal outcrops. These same pocket beaches have very high densities of butter and littleneck clams. The highest intertidal areas around the several rocky outcrops of Lewis Point support a fringe of typical saltmarsh vegetation that may be eliminated, in part, by ferry access construction.

This alternative would approach the airport along the northern shore of the Government Creek Estuary and would result in some disruption of shallow subtidal biota. Alternative G2 would likely have few impacts on eelgrass and kelp beds in this area .

4.7 Alternative G3

Under this alternative, a ferry would run between Bar Point (Station REV-6) and an area south of East Clump Island (Station GRV-7). It is assumed that construction of a ferry terminal at Bar Point could disrupt a portion of the rich rocky intertidal bench at this site, although it might be possible to avoid this feature completely. Beds of eelgrass, kelp, and other algae offshore of Bar Point would be disrupted by dredging.

A band of kelp and other algae is also present and would likely be disrupted by dredging at the western ferry terminal near East Clump Island. Ferry access would also cross a relatively broad intertidal bench that has a mix of habitat types, with bedrock outcrops in a mixed-soft (cobble/ gravel/ silt) lower beach and a mixed gravel/ cobble upper beach. This mix of habitat types supports a diverse biota, and hardshell clams are abundant in the lower beach. The highest intertidal areas around the several rocky outcrops and along the shore of Gravina Island itself support a fringe of typical saltmarsh vegetation that may be eliminated, in part, by ferry access construction..

Alternative G3 would approach the airport along the northern shore of the Government Creek Estuary and would cause some disruption of shallow subtidal biota. This alternative would likely have few impacts on eelgrass and kelp beds .

4.8 Alternative G4

This alternative would require construction of new ferry terminals (near the existing terminals) on each side of Tongass Narrows. Both terminals would be close to deep water and would require little, if any dredging. Also, both would be constructed in areas that are already riprapped and thus would avoid impacts on natural intertidal areas. Narrow bands of bull kelp lie offshore of the eastern landfall and might be affected by construction.

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Attachment D

Letter from James W. Balsiger, NMFS Administrator, Alaska Region, to David C. Miller, FHWA Division Administrator, June 4, 2001

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

Tamas RD

June 4, 2001

David C. Miller, Division Administrator
U.S Dept. of Transportation
Federal Highway Administration
709 West Ninth Street
Room 851
P.O. Box 21648
Juneau, Alaska 99802

RE: Gravina Access Project - Informal Consultation in Accordance with Section 7 of the Endangered Species Act

Dear Mr. Miller:

Thank you for your letter requesting the concurrence of the National Marine Fisheries Service (NMFS) that endangered humpback whales (*Megaptera novaeangliae*) and threatened eastern population Steller sea lions (*Eumetopias jubatus*) are likely to occur in the area of the referenced project. Your determination of these species occurrence was based, in part, on previous consultation with NMFS staff, as well as with Mr. Gary Freitag, NMFS's marine mammal stranding network representative in Ketchikan. NMFS concurs with your determination. You also requested input concerning how humpback whales and Steller sea lions might be affected by the proposed action, and how to avoid and/or minimize impacts to these species.

Humpback whales may be affected directly by underwater noise associated with construction of bridges and ferry terminals. These affects may be avoided by the use of seasonal work windows and observers to monitor for the presence of whales and suspend action until whales have cleared the area. Indirect effects may also include underwater noise disturbance from ferry vessel traffic that displaces whales from traversing, resting or feeding in Tongass Narrows. These effects should be analyzed. Current available technology that may reduce underwater noise should be considered in your analysis. Finally, indirect effects may occur if any of the alternatives reduces prey abundance of humpback whales. Prey of humpback whales in southeast Alaska includes herring (*Clupea harengus pallasi*) and krill (*Euphausia pacifica, Thysanoessa spinifera, T. raschii* and perhaps occasionally *T. longipes*) (Bryant et al. 1981; Krieger and Wing 1984, 1986; Baker et al. 1985; Perry et al. 1985; Dolphin 1987b). For more information on the effects of underwater noise and vessel traffic on whales, please see page 73 of the Biological Opinion for authorization of the Bering Sea/Aleutian Islands and Gulf of Alaska groundfish fisheries issued on November 30, 2000 (BiOp) and which may be accessed from the following website url http://www.fakr.noaa.gov/protected resources/stellers/plb/dfault.htm.

Steller sea lions are unlikely to be affected by underwater noise associated with project construction activities because they have higher thresholds for noise disturbance and are able to raise their heads out of the water to avoid noise transmission (Richardson, 1995). However, any construction activity that uses underwater explosives would need to be considered for its potential effects to Steller sea lions. An observer could be used to avoid blasting when sea lions are in the area. Indirect effects to Steller sea lions by displacement from Tongass Narrows due to disturbance from construction or ferries and/or diminishment of their prey resources should be evaluated. Steller sea lions feed on a wide range of prey including invertebrates, fish and other marine mammals, although demersal and off-bottom schooling fishes predominate (Jones, 1981; Pitcher, 1981; Gentry and Johnson, 1981; Pitcher and Fay, 1982; D. Calkins, unpublished data). For more information on Steller sea lion foraging, please see pages 84-99 of the BiOp mentioned above.

Thank you for your continued coordination with NMFS for this project. If you have any further questions please contact Linda Shaw of my staff at (907) 586-7510.

Sincerely,

Ronald J. Berg

For James W. Balsiger
Administrator, Alaska Region

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