MIDDLE WATERWAY SHORE RESTORATION PROJECT MONITORING AND ADAPTIVE MANAGEMENT PLAN DATA REPORT

POST-CONSTRUCTION (YEAR 2)

Prepared for

SIMPSON TACOMA KRAFT COMPANY
P.O. Box 2133
Tacoma, Washington 98421

and

CHAMPION INTERNATIONAL
One Champion Plaza
Stamford, Connecticut 06921

Prepared by

PARAMETRIX, INC.
5808 Lake Washington Blvd. N.E.
Kirkland, Washington 98033

December 1997

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

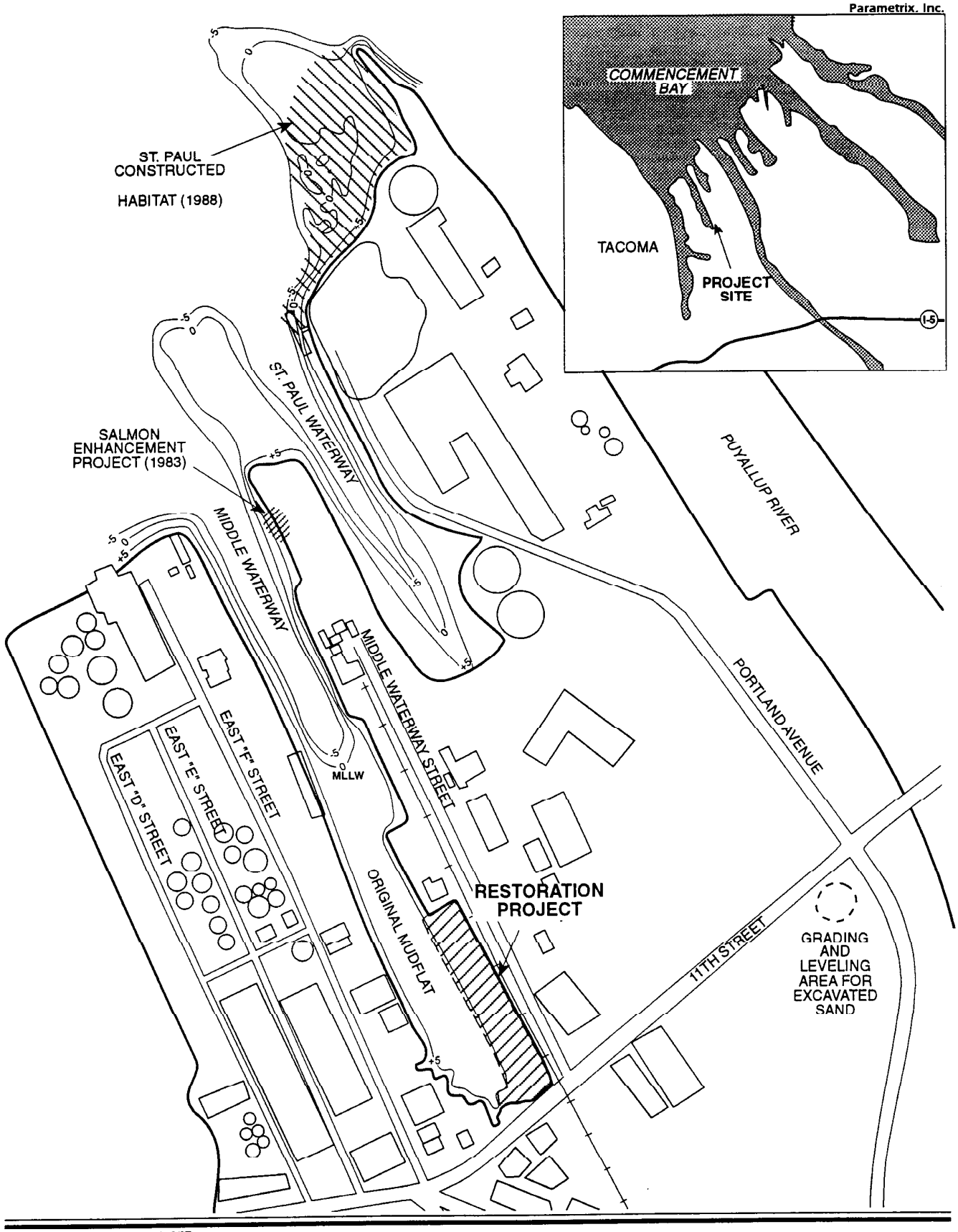
PROJECT DESCRIPTION

Under the St. Paul Waterway Natural Resource Damage (NRD) settlement agreement, Simpson Tacoma Kraft Company (Simpson) and Champion International Corporation (Champion) funded the completion of an additional restoration project to provide habitat value in Commencement Bay. The Middle Waterway Shore Restoration Project (the Project) is located on property owned by Simpson along the southeastern shore of the Middle Waterway in Commencement Bay. The project is in close proximity, and functionally related to, the intertidal habitat constructed in 1988 as part of the St. Paul Waterway Area Remedial Action and Habitat Restoration Project by Simpson and Champion at the north end of the Tacoma Kraft mill, as well as other intertidal and subtidal areas near the Puyallup River delta (Parametrix 1993) (Figure 1).

The Project was developed in cooperation with Champion and the Natural Resource Trustees for Commencement Bay (the Trustees), and other cooperating agencies. The Trustees include the National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish & Wildlife Service (USFWS), the Washington Department of Ecology (Ecology), the Muckleshoot Indian Tribe, and the Puyallup Tribe of Indians. Cooperating agencies include the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (the Corps), the Washington Department of Natural Resources (DNR), and the Washington Department of Fish and Wildlife (WDFW). Together, these organizations and agencies comprise the Restoration Project Planning Group.

The project has twin goals of long-term environmental restoration and study value. Its main objective is to provide valuable estuarine habitat, in perpetuity, that is adjacent to one of the largest remaining areas of original Commencement Bay intertidal mud flat (nearly 20 acres) and functionally related to the intertidal habitat constructed at the north shore of the Tacoma Kraft Mill in 1988, the Puyallup delta, and other nearby intertidal and shallow subtidal habitats. Other environmental restoration objectives of the project include the following:

- Convert approximately 1.5 acres of upland from existing industrial use to estuarine intertidal wetland;
- Increase the length of natural shoreline edge along the +9 to +13 foot contour from 840 to 960 feet;
- Establish approximately 1.2 acres of habitat at known high and low salt marsh elevations;
- Provide a riparian buffer and transition zone from tide flat to upland to screen, protect, and support the integrity of the remaining original Middle Waterway mud flat and the



Middle Waterway/55-1919-09 (1) 9/97

SCALE IN FEET

0 300 600

N

Figure 1.
Vicinity Map,
Middle Waterway Shore Restoration,
Commencement Bay

diverse species that use this biologically productive area of the estuary; and

- Restore a minimum of 0.23 acres of estuarine intertidal mud/sand habitat as mitigation for placing fill on a like acreage of intertidal mud/sand habitat at similar elevations.

Restoration at the Project site enhances and supports the continued existence of the remnant tide flats at the head of the Middle Waterway. The Natural Resource Trustees for Commencement Bay, together with Simpson and Champion, identified no other location that would meet the project environmental restoration objective as well or provide the additional benefit of protecting those tide flats.

A detailed description of the project and its objectives may be found in *Project Analysis: Middle Waterway Shore Restoration Project* (Parametrix 1993) and *Project Supplemental Information Summary: Middle Waterway Shore Restoration Project* (Parametrix 1994a).

PROJECT MONITORING

The Middle Waterway Shore Restoration Project consists of an approximately 3.3-acre nearshore site in Commencement Bay that is being restored to functional estuarine habitat. In early 1995, approximately 1.5 acres of industrial fill was converted into estuarine wetland, and the adjacent lower intertidal area was regraded into a more structurally diverse intertidal area. The site presently comprises a low-elevation mud flat, low salt marsh, high salt marsh, and upland riparian buffer. On October 21, 1995, the riparian buffer was planted with upland vegetation and a small area of low salt marsh was planted with "sods"[1] of saltgrass (*Distichlis spicata*). On October 16 and 23, 1995, groundcover and trees were planted. On May 22, 1996, additional areas were planted with a variety of high and low salt marsh vegetation. Post-construction site monitoring began in April 1996.

Several descriptive and experimental studies were proposed as elements of the monitoring plan, to collect data that would help determine the success and health of the restoration site over time and assist in future restoration projects in Commencement Bay. The Project monitoring program includes the following descriptive studies:

- Document the general development of estuarine habitat on the project site [through aerial photographs (through Year 5) and photogrammetric elevation mapping (when necessary)];

- Document the general development of new intertidal and salt marsh substrates [through grain size analyses (through Year 5)];

[1] Sods refer to clumps of vegetation with the root mass surrounded by attached soil.

- Document trends in sediment chemistry, including potential transportation of contaminants from adjacent mud flats [through sediment chemistry analyses (Years 0, 1, 3, and 5)];

- Document trends in benthic infauna that correspond to changes in sediment grain size and chemistry [through sediment analyses (Years 1, 3, and 5; trend analysis in Year 5)];

- Evaluate predictions about elevations and salt marsh establishment, using vegetation established on-site [through vegetation analyses (Years 0, 1, 2, and 3) and periodic measurement of elevations (when necessary)]; and

- Document the general use of intertidal, salt marsh, and riparian habitats by wildlife [through general qualitative observations (periodically, through volunteer effort)].

A schedule of annual monitoring activities is provided in Table 1. As originally envisioned in the *Middle Waterway Shore Restoration Project Monitoring and Adaptive Management Plan* (the Monitoring Plan) (Parametrix 1994b), site construction and vegetation planting were to have been completed in early 1995, followed immediately by Year 0 monitoring for physical and soil characteristics. Vegetation and sediment chemistry monitoring was to begin the second year after construction. Because nearly a year elapsed between the 1995 site construction and the final vegetation planting in 1996, the first year of post-construction monitoring combined some Year 0 and Year 1 activities. That report was referred to as Year 0-1, in the *Middle Waterway Shore Restoration Project Monitoring and Adaptive Management Plan Data Report—Post-Construction (Year 0-1)* (the 1996 Data Report) (Parametrix 1996). This report summarizes findings from the second full year of monitoring in 1997. This report is referred to as Year 2.

The monitoring program included the collection of vegetation data that could be used to support the following experimental studies:

- Evaluation of the effectiveness of hand-planting to establish intertidal high and low salt marsh vegetation;

- Evaluation of the effectiveness of natural vegetation to establish intertidal emergent low and high salt marsh vegetation;

- Evaluation of the natural revegetation of estuarine intertidal emergent vegetation on pumped Puyallup River sands; and

- Evaluation of the natural revegetation of estuarine intertidal emergent vegetation on pumped Puyallup River sands top-dressed with salvaged mud flat soils.

Evaluations will be conducted by the Trustees, based on data provided in the annual data reports.

Table 1. Middle Waterway Shore Restoration post-construction monitoring schedule.

Activity	Frequency	Activities Conducted	
		1996	1997
Physical Surveys			
Transects	annually (year 0-1 and 2)		X
Topographic Mapping	year 0-1 and 2 (only if necessary thereafter)	X	X
Sediment Surveys			
Grain Size	annually (year 0-1, 3, and 5)	X	
Biological	annually (year 5)		
Chemical	annually (year 0-1, 3, and 5)	X	
Vegetation Surveys			
Transplant/Colonization	semi-annually (year 0-1), annually (year 2 and 3)	X	X
Plant Protection	semi-annually (year 0-1); as needed thereafter	X	X
Soil Salinity	annually (year 0-1, 3, and 5)	X	
Wildlife Surveys	periodically per volunteer effort	X	X
Aerial Photo	annually (year 0-1, 2, 3, 4, 5)	X	X

year 0-1 = period of construction, planting, and first annual surveys

This data report contains the sampling methods, data, analytical results, and other related information collected during the second year of post-construction monitoring. In keeping with the Project understanding between Simpson, Champion, and the Trustees, no data interpretation was provided, other than discussions of how sampling methods may have affected or influenced the data. Copies of field survey data forms can be found in the Data Appendix. Monitoring Plan revisions that have been discussed and approved by representatives from Champion, Simpson, and the Trustees were specified in a memorandum that can be found in the Data Appendix.

Two general survey elements comprised the second year of monitoring:

- physical surveys of site and transect elevations, and
- vegetation surveys of species and substrates present in planted and unplanted areas.

Wildlife observations were reported separately by an independent observer.

METHODS AND RESULTS

PHYSICAL MONITORING

Physical monitoring is intended to record the post-construction elevations at the Project site and document elevation changes over time. The initial reconstructed elevations ranged between 9 ft mean lower low water (MLLW) and 14 ft MLLW. The monitoring plan specified that several reference locations be permanently established and their locations recorded. Physical monitoring reference locations included:

- two permanent benchmarks on-site,
- five permanent transects for elevation monitoring, and
- three photo reference points.

Two permanent benchmarks, one on each end of the site, were established by the National Ocean Service in 1995. Each benchmark consists of a 12-in-square concrete base with a 3-in-diameter domed brass cap. The benchmark locations were surveyed using Project horizontal datum (NAD 1927) and City of Tacoma MLLW elevation datum. Post-construction measurement and mapping of constructed elevations were completed by Parametrix surveyors in July 1995.

On September 10, 1997, the Project site was surveyed on 1-ft contour intervals, following the "break lines" or elevation changes that were apparent at the site (Figure 2). This method results in a contour accuracy of one-half the elevation between contours (i.e., $\pm$ 0.5 ft accuracy for 1-ft contour intervals). Contour elevations were compared between the 1995 and 1997 topographic maps. Elevation changes of one foot or more were noted on a map (Figure 3). Between surveys, no changes greater than one foot were observed; changes of one foot or less are within the accuracy limits of the survey method. Elevation differences shown in Figure 3 reflect the apparent differences in survey point locations and contour interpolations between points; they do not necessarily indicate actual areas of erosion or deposition.

Visual comparisons between 1995 and 1997 contours made during vegetation surveys revealed little noticeable change in Project topography. Only one area along vegetation transect 12 appeared to have changed: a small depression at 10 ft MLLW in 1995 had filled with fine material to a depth of about 10.5 ft MLLW in 1997. The remainder of the Project site elevations appeared relatively unchanged from 1995.

Five permanent transects (A, B, C, D and E) were re-established in September 1997 for annual elevation monitoring to detect areas of erosion or deposition along the restoration site. The transects' endpoints were marked with concrete reinforcing bar (rebar) stakes labeled T-A (extending to stake T-A'), T-B (to stake T-B'), T-C (to stake T-C'), T-D (to stake T-D'), and T-E (to stake T-E'). Transect elevations were recorded to the nearest one-tenth ft along each transect at five-ft intervals, as specified in the Monitoring Plan (Table 2).

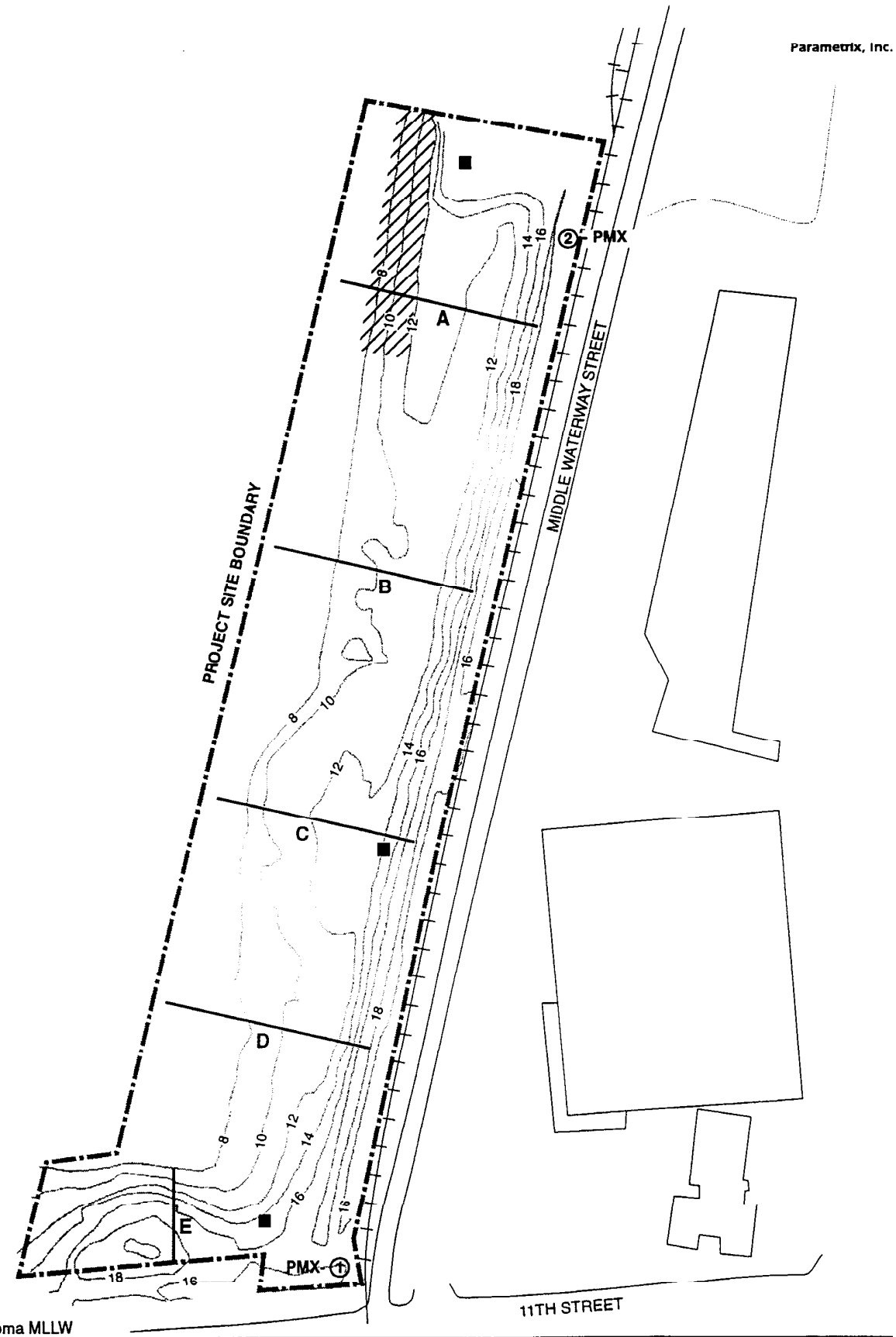


Figure 2.
Physical Monitoring Reference Locations

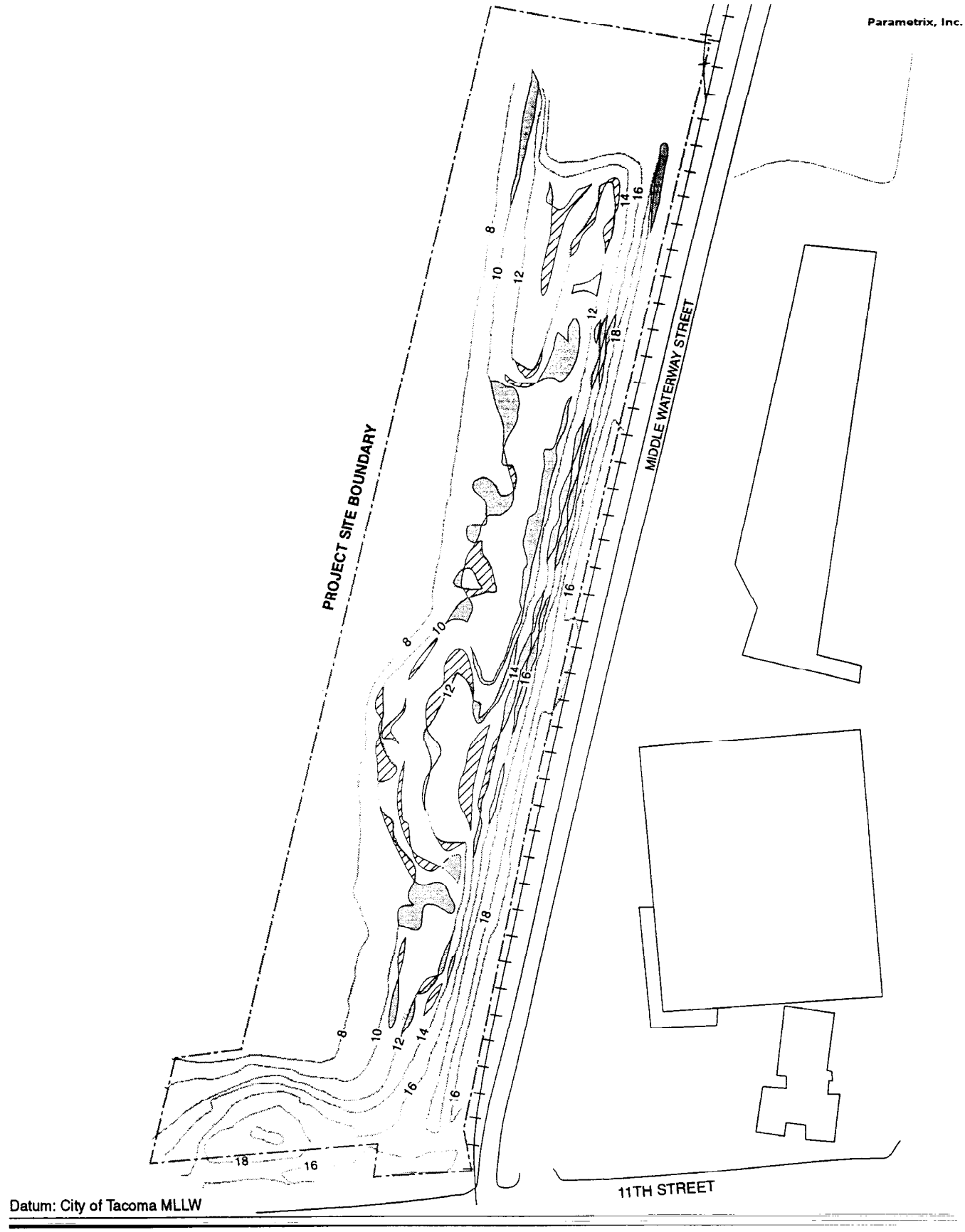


Figure 3.
Apparent Elevation Change (All Less than One Foot), 1995-1997

Table 2. Transect elevations (ft) for the 1997 physical survey.

	Transect				
Station (ft)	A	B	C	D	E
STA 0+00	18.9	18.9	19.4	19.0	15.6
0+05	18.1	17.4	18.6	18.4	15.5
0+10	16.7	15.8	17.1	16.9	15.8
0+15	15.2	14.6	15.7	14.7	16.4
0+20	14.3	13.5	14.8	13.0	17.3
0+25	13.5	12.6	14.2	12.1	18.5
0+30	12.6	11.4	13.7	11.0	19.0
0+35	11.5	11.2	13.2	10.4	19.3
0+40	10.6	11.1	12.9	10.2	19.2
0+45	10.9	10.9	12.8	10.2	19.0
STA 0+50	11.2	10.8	12.7	10.2	18.7
0+55	11.4	10.7	12.6	10.6	18.5
0+60	11.7	10.6	12.6	10.8	18.2
0+65	11.7	10.5	12.5	10.7	17.5
0+70	12.0	10.4	12.5	10.7	16.6
0+75	12.2	10.3	12.4	10.3	16.2
0+80	12.5	10.2	12.3	9.7	16.1
0+85	12.6	10.1	12.2	9.4	15.7
0+90	12.6	10.0	12.1	9.0	14.2
0+95	12.7	9.9	12.0	8.7	12.9
STA 1+00	12.7	9.8	11.9	8.5	11.1
1+05	12.4	9.7	11.7	8.3	10.1
1+10	12.0	9.4	11.5	7.9	9.4
1+15	11.6	8.9	11.3	7.8	8.8
1+20	11.2	8.4	11.2	7.7	8.6
1+25	10.8	7.9	11.0	7.6	8.5
1+30	10.2	7.6	10.7	7.5	8.4
1+35	9.6	7.3	10.4	7.5	
1+40	8.9	7.1	9.7	7.4	
1+45	8.3	6.9	8.8	7.4	
STA 1+50	7.9	6.8	8.4	7.3	
1+55	7.6	6.6	8.1	7.3	
1+60	7.4	6.4	7.7		
1+65	7.2		7.4		
1+70	7.0		7.2		
1+75	6.8		7.2		
1+80	6.7		7.2		
1+85	6.6		7.1		
1+90	6.5		7.1		
1+95	6.5		7.0		
STA 2+00	6.4				
2+05	6.3				
2+10	6.0				
2+15	5.8				
2+20	5.5				
STA 2+25	5.3				

State plane coordinates for benchmarks and transect endpoints are listed in Table 3. Three photo reference points were established in September 1996, but not surveyed. Survey coordinates can be obtained for those points when necessary. Approximate locations of all other physical monitoring reference locations were listed and mapped in the 1996 Data Report.

An aerial photo was taken of the Middle Waterway on July 22, 1997, during a low tide of -1.8 ft MLLW. Photographic conditions were good, so the aerial photo provided clear images of the re-constructed shore, intertidal zone, newly planted vegetation, transplant enclosures, bare substrate, logs, and the benchmark monuments in the project area. Photogrammetric pre-marks may be placed at the benchmarks for elevation monitoring (if needed) in subsequent years.

Table 3. State plane coordinates and elevations (ft MLLW) for 1997 Middle Waterway Shore Restoration stations.

Station	North	East	Elevation[a]	Descriptor
T-A	707790.0	1521689.0	18.9	Survey Elevation Endpoint
T-A'	707704.0	1521481.1	5.3	Survey Elevation Endpoint
T-B	707566.0	1521780.0	18.9	Survey Elevation Endpoint
T-B'	707504.9	1521632.2	6.4	Survey Elevation Endpoint
T-C	707353.5	1521867.4	19.4	Survey Elevation Endpoint
T-C'	707279.0	1521687.2	7.0	Survey Elevation Endpoint
T-D	707180.0	1521939.0	19.0	Survey Elevation Endpoint
T-D'	707120.8	1521795.8	7.3	Survey Elevation Endpoint
T-E	706896.0	1521931.0	15.6	Survey Elevation Endpoint
T-E'	706004.5	1521859.4	8.4	Survey Elevation Endpoint
PMX-1	707007.6	1522034.2	15.9	Benchmark (project datum)
PMX-2	707868.7	1521666.8	16.7	Benchmark (project datum)

a = City of Tacoma datum

SEDIMENT MONITORING

Surface sediments were not scheduled to be monitored in 1997. Grain size and total organic carbon data are collected only during years of other sediment monitoring, according to a change in the Monitoring Plan approved by the Trustees, Champion, and Simpson (McEntee 1997).

VEGETATION SAMPLING

The Middle Waterway Shore Restoration site was planted with high and low salt marsh vegetation on May 22, 1996. Vegetation monitoring was designed to assess the post-construction presence, species composition, and distribution of planted and colonizing vegetation. Both vascular (e.g., salt marsh plants) and non-vascular (e.g., seaweeds) macrophytes were surveyed. An aerial photograph was used to delineate plants on a site-wide basis for mapping. Interstitial water salinity measurements were also collected.

Aerial Photo Mapping

An aerial photo of the Middle Waterway was taken July 22, 1997. Photographic conditions were good, so the aerial photo provided clear images of the re-constructed shore, various elevations within the intertidal zone, newly planted vegetation, transplant enclosures, bare substrate, logs, and debris within the project area. The aerial photo was used to show the extent of site intertidal vegetation (Figure 4).

Vegetation Sampling

A botanist and two biologists monitored Project intertidal vegetation on August 28, 1997, using the same methods and design as 1996. The aerial photo was examined for further evidence of planted or volunteer vegetation, including macroalgae (i.e., large seaweeds).

Four general types of vegetation zones were identified in the monitoring plan: low salt marsh, high salt marsh, mud flat and marsh top-dressed with salvaged soils (Figure 5). Only limited areas of the high and low salt marsh areas were planted. Most planted areas were enclosed with string and flagging to exclude geese. Only one area, a north-end low salt marsh bed, was planted without an enclosure.

In the 1996 Data Report, the Project area was divided into nine existing and potential macrophyte beds (based on elevation, plant species, substrate, and protective enclosure) (Parametrix 1996). For data analysis comparisons, each planted bed (or "treatment" area) was associated with a control bed ("untreated") with similar physical conditions. The treatment and control macrophyte beds were listed and illustrated in the 1996 Data Report.

Vegetation was monitored by estimating percent cover by species along transects in the high marsh, low marsh, and mud flat zones (Figure 6). Percent cover by species was visually estimated within eighty 1-m^2 quadrats established along 14 transects. Transect numbers, percent cover by species, and dominant substrate type are summarized in Table 4.

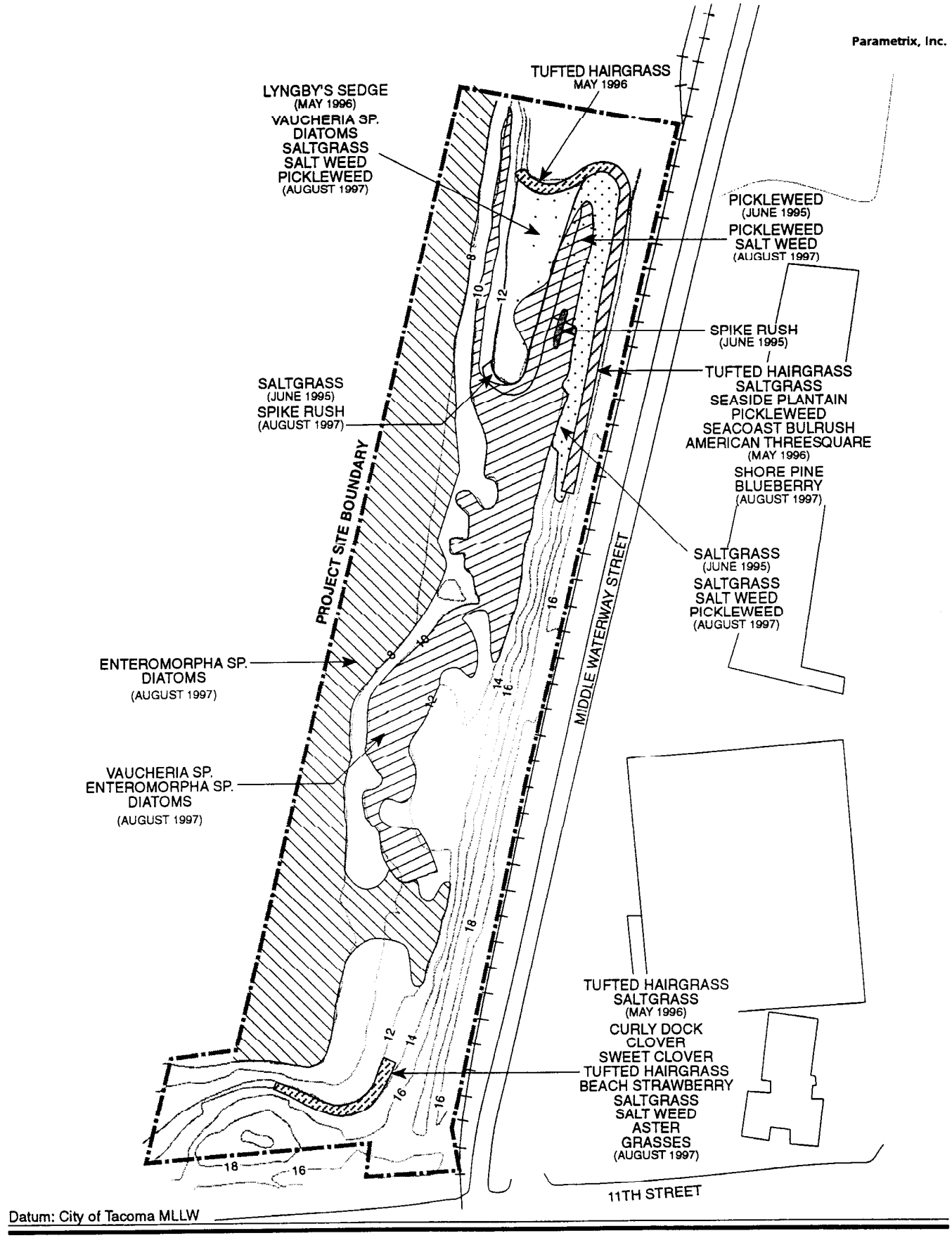


Figure 4.
Extent of Salt Marsh Vegetation 1997

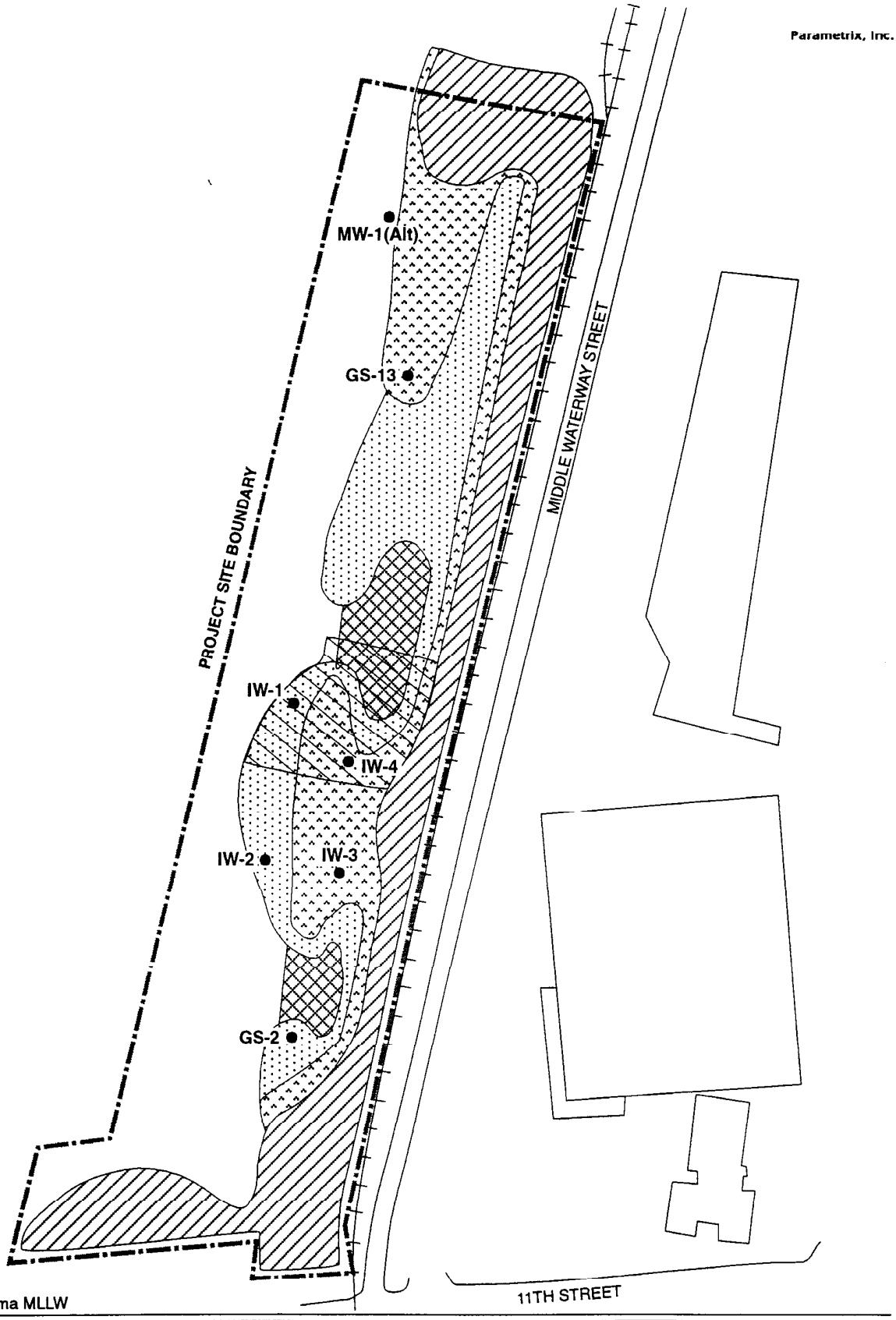


Figure 5.
Salt Marsh Zones, Upland Buffer, and Interstitial Water Sampling Stations

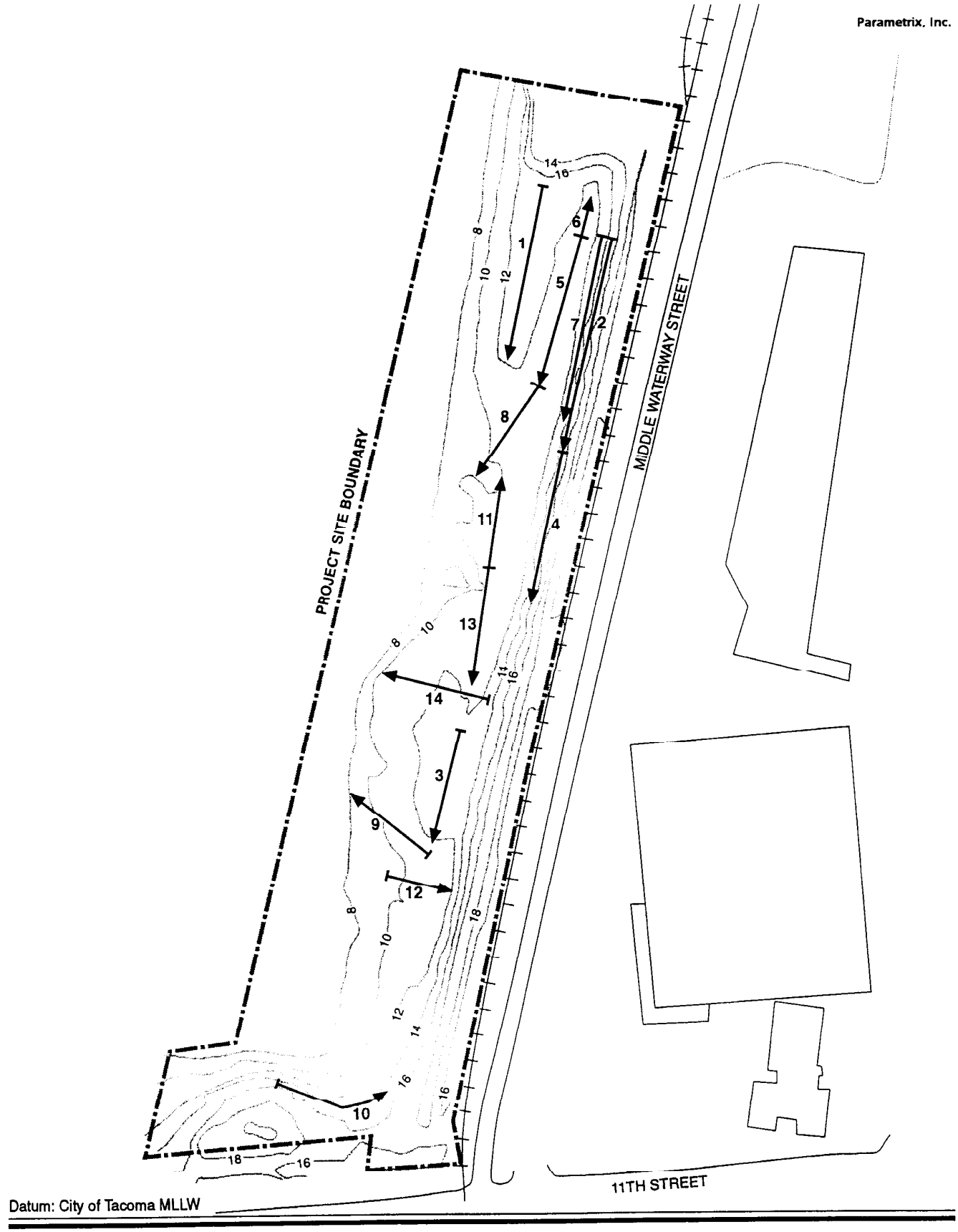


Figure 6.
Vegetation Monitoring Transects and Directions

Table 4. Vegetation species, percent cover, and dominant substrate characteristics by transect, 1997.

Transect #	Endpoints	Species	% Cover (Range)[1]	Dominant Substrate (>50%)[2]
1	A, A1	*Vaucheria* sp./Diatoms	0-99	sand, mud
		Salicornia virginica	<1	
2	B, B1	See note in Appendix field data sheet		sand
3	C, C1	Diatoms	trace	sand, cobble, wood chips
4	D, D1	No vegetation	–	sand
5	E, E1	Diatoms	0-99	mud, litter
		Vaucheria sp.	0-75	
		Eleocharis parvula	0-2	
		Enteromorpha flexuosa	trace	
6	F, F1	*Enteromorpha flexuosa*	0-75	mud
		Vaucheria sp.	0-1	
		Salicornia virginica	0-1	
		Atriplex patula	0-1	
7	G, G1	*Distichlis spicata*	1-5	sand
		Atriplex patula	0-15	
		Salicornia virginica	0-5	
8	H, H1	*Vaucheria* sp.	0-10	mud, litter, sand
9	I, I1	Diatoms	0-90	sand
		Vaucheria sp.	0-50	
10	J, J1	*Deschampsia cespitosa*	5-20	sand
		Melilotus alba	0-90	
		Grass 3	0-30	
		Fragaria chiloensis	0-20	
		Distichlis spicata	0-20	
		Rumex crispus	0-10	
		Aster subspicatus	0-5	
		Trifolium wormskjoldii	0-2	
		Agrostis sp.	0-1	
		Aster sp.	0-1	
		Agropyron repens	trace	
		Atriplex patula	trace	
		Bromus sp.	trace	
		Grass 2	trace	
		Grass 4	trace	
11	K, K1	*Vaucheria sp.*	1-50	mud
		Enteromorpha flexuosa	0-40	
		Diatoms	0-20	
12	L, L1	*Vaucheria* sp.	0-40	mud
		Enteromorpha flexuosa	trace	
13	M, M1	*Eleocharis parvula*	0-55	mud
		Enteromorpha flexuosa	0-29	
14	N, N1	*Vaucheria* sp.	0-95	sand, cobble
		Enteromorpha flexuosa	0-20	

[1] Cover estimates comprise live plants; dead plants were included as litter under the substrate heading.
[2] Underlined substrate is dominant; other substrates were present.

Sampling methods in 1997 adhered closely to 1996 methods. In 1996, transect endpoints were semi-permanently marked with rebar. In 1997, transect stations marked in 1996 were relocated and sampled. At each sampling station, percent cover by individual species was visually estimated and recorded on data sheets. In unsampled areas where new vegetation had recruited into the bed, the colonizing species were noted on the data sheets. Plants that appeared dead, without any tissue color, were recorded as litter. Copies of vegetation monitoring data sheets are in the Data Appendix.

Similar to 1996 monitoring, much of the low salt marsh and high salt marsh communities lacked vegetation or had low vegetation cover. Vegetation cover was greatest in planted areas where plants were protected from grazing by geese. However, even with enclosures, most plants exhibited some evidence of herbivory by geese.

In the planted area, new colonization by *Atriplex patula* (salt weed), *Salicornia virginica* (pickleweed), and *Distichlis spicata* (saltgrass) was common, although cover by these species was not high. Low salt marsh recruiting species (e.g., *S. virginica* and *A. patula* outside of the string enclosures appeared ungrazed. Plantings of *Carex lyngbei* (Lyngby's sedge) were not successful; few of several hundred plants survived. All surviving plants were heavily grazed.

The high and low marsh elevations were devoid of vegetation throughout much of the southern two-thirds of the site. An area near the southeast shoreline was an exception, where dense cover by *A. patula* occurred. *S. virginica*, *D. spicata*, and *Plantago maritima* (seaside plantain) were also present in this area. Both *S. virginica* and *D. spicata* showed significant evidence of herbivory by geese.

A large percentage of the mudflat was colonized by *Eleocharis parvula* (spike rush), *Enteromorpha flexuosa* (a green alga), *Vaucheria* sp. (a yellow-green alga), and diatoms. *Vaucheria* is commonly associated with freshwater seeps (Kozloff 1983), which are prevalent along the Project site. The extent of algae and *E. parvula* coverage on the mudflat appeared similar to other mudflats in the Commencement Bay area.

Enteromorpha, *Vaucheria*, and diatoms typify protected coastal salt marshes with muddy sand and provide an important food source for invertebrates that inhabit sheltered bays (Kozloff 1983). Dense mats of algae provide the primary (i.e., photosynthetic plant) productivity for secondary consumers (e.g., harpacticoid copepods) that, in turn, are consumed by tertiary consumers (e.g., juvenile salmon). Algal biomass is more readily assimilated by animals and more nutritious than marsh grass (Mitsch and Gosselink 1993); thus the algae that has colonized the Project site is an important contribution to the area's productivity. About 90,000 ft² of productive low-intertidal habitat was created from the excavation of the Middle Waterway Shore Restoration site.

Plants in the upland buffer generally exhibited good growth rates and appeared healthy. In some instances, leaf color or size indicated stress. Vine maple leaves, for example, were small in size

and undergoing early color change. This is a common occurrence for this species when planted in areas lacking shade.

Most buffer areas lacked a substantial herbaceous ground cover. An exception was found in the southern portion of the site, where *Melilotus alba* (sweet clover), growing to 6 ft in height, dominated the area. The shading created by the clover did not appear to prevent establishment of other understory species, nor did it appear detrimental to the trees and shrubs planted in the buffer.

Interstitial Water Salinity Sampling

Although salinity data collection was not scheduled in 1997, a sampling opportunity arose in October. Interstitial water was sampled for salinity and temperature on October 10, 1997 at seven stations (see Figure 5). Sampling was conducted on an ebb tide, on a day without rainfall. Four stations were co-located with interstitial water stations used the previous year (IW-1, IW-2, IW-3, and IW-4). Additional stations were co-located with one sediment chemistry station (MW-1 Alt) and two grain size stations (GS-13 and GS-2). Stations were selected to characterize salinity near the north, central, and south areas of the site. Temperature and salinity were measured *in situ* with a refractometer and mercury thermometer (Table 5). To collect interstitial water, a small hole was dug to a depth of about 30 cm and interstitial water was allowed to seep in. A clean pipette was used to transfer the water to the refractometer; the thermometer was placed directly into the water in the hole. All equipment was rinsed with deionized water between stations.

Table 5. Interstitial water salinity results.

	Time (PST)		Temp. (°C)		Salinity (ppt)	
Station	1997	1996	1997	1996	1997	1996
IW-1	1650	1810	11.5	14.4	19	28
IW-2	1655	1830	11.5	14.9	29	30
IW-3	1427	1710	12.5	15.3	13	20
IW-4	1420	1720	12.5	15.7	9	19
MW-1(Alt)	1354	--	12.5	--	8	--
GS-13	1410	--	14.0	--	24	--
GS-2	1702	--	11.3	--	21	--

-- not sampled in 1996

WILDLIFE OBSERVATIONS

Wildlife observations on the Project site were recorded by a local volunteer. Observations focused primarily on birds and small mammals.

Beach seining was conducted in Middle Waterway near the Project site for a separate study (Parametrix 1997). Beach seine results from sets collected specifically at the Project site (see Figure 2) were tabulated in the Data Appendix. Several species of commercially and/or recreationally valuable fish were found in nearshore Project habitat, including juvenile chinook, chum, and pink salmon, Pacific herring, and juvenile and adult surf smelt. A commonly occurring green alga, *Enteromorpha flexuosa*, was prevalent throughout the Project site at lower intertidal elevations in 1996 and 1997. The alga's hollow filaments are known to harbor harpactacoid copepods (Parametrix 1996), which constitute an important food resource for juvenile salmon.

REFERENCES

Kozloff, E.N. 1983. Seashore life of the northern Pacific coast. University of Washington Press, Seattle, Washington. 370 pp.

McEntee, D. 1997. Middle Waterway Shore Restoration Project (Project) grain size/TOC monitoring. Unpublished letter by Simpson-Tacoma Kraft Company to Robert Clark, NOAA Restoration Center Northwest, National Marine Fisheries Service, Seattle, Washington. July 29, 1997. 2 pp. + Attachment.

Mitsch, W.J., and J.G. Gosselink. 1993. Wetlands. 2nd ed. Published by Van Nostrand Reinhold, New York, New York. 722 pp.

Parametrix, Inc. 1993. Project analysis: Middle Waterway shore restoration project. Prepared for Simpson Tacoma Kraft Company, Tacoma, Washington.

Parametrix, Inc. 1994a. Project Supplemental Information Summary: Middle Waterway Shore Restoration Project. Prepared for Simpson Tacoma Kraft Company, Tacoma, Washington.

Parametrix, Inc. 1994b. Middle Waterway shore restoration monitoring and adaptive management plan. Prepared by the Restoration Project Planning Group for Simpson Tacoma Kraft Company, Tacoma, Washington. 23 pp.+ Appendices.

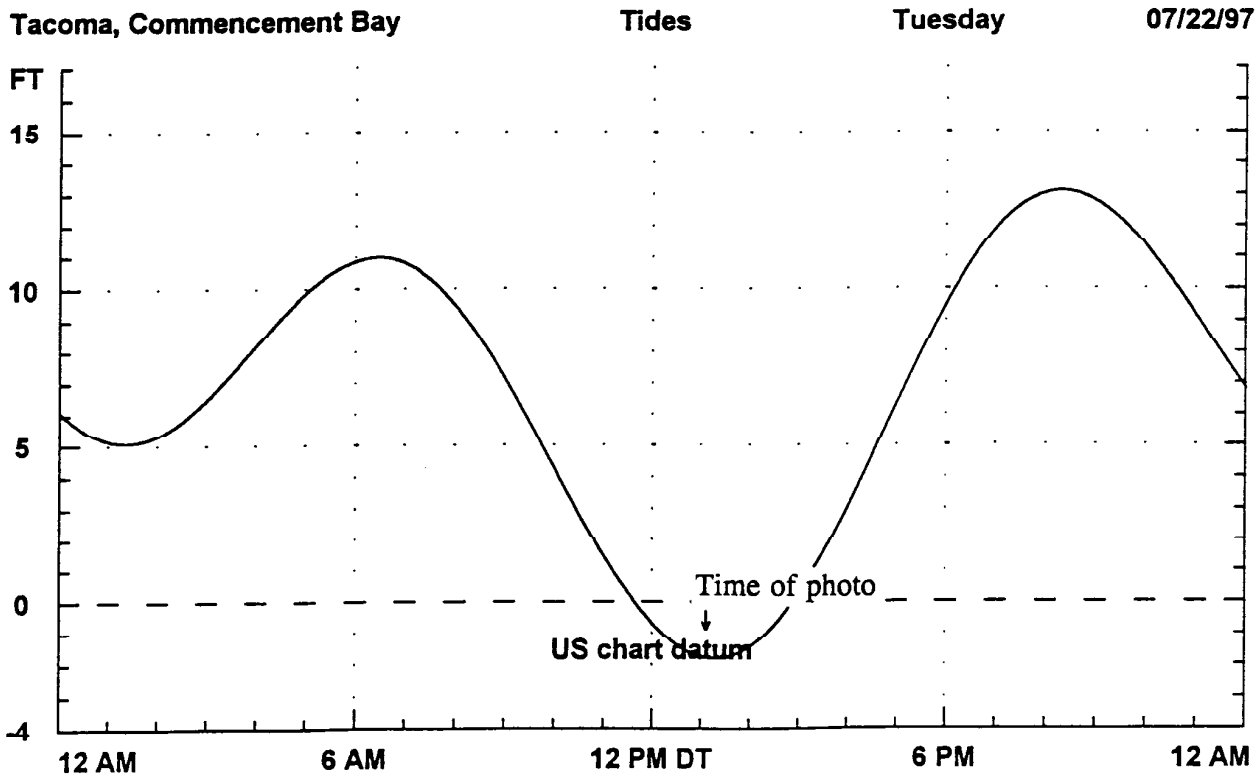
Parametrix, Inc. 1994c. Middle Waterway Shore Restoration Project preconstruction sampling report. Prepared for Simpson Tacoma Kraft Company, Tacoma, Washington. 18 pp. + Appendices.

Parametrix, Inc. 1994d. Preliminary draft sampling report Puget Sound dredged disposal analysis for sediment characterization at Middle Waterway shore restoration project. Prepared for Simpson Tacoma Kraft Company, Tacoma, Washington. 47 pp.+ Appendices.

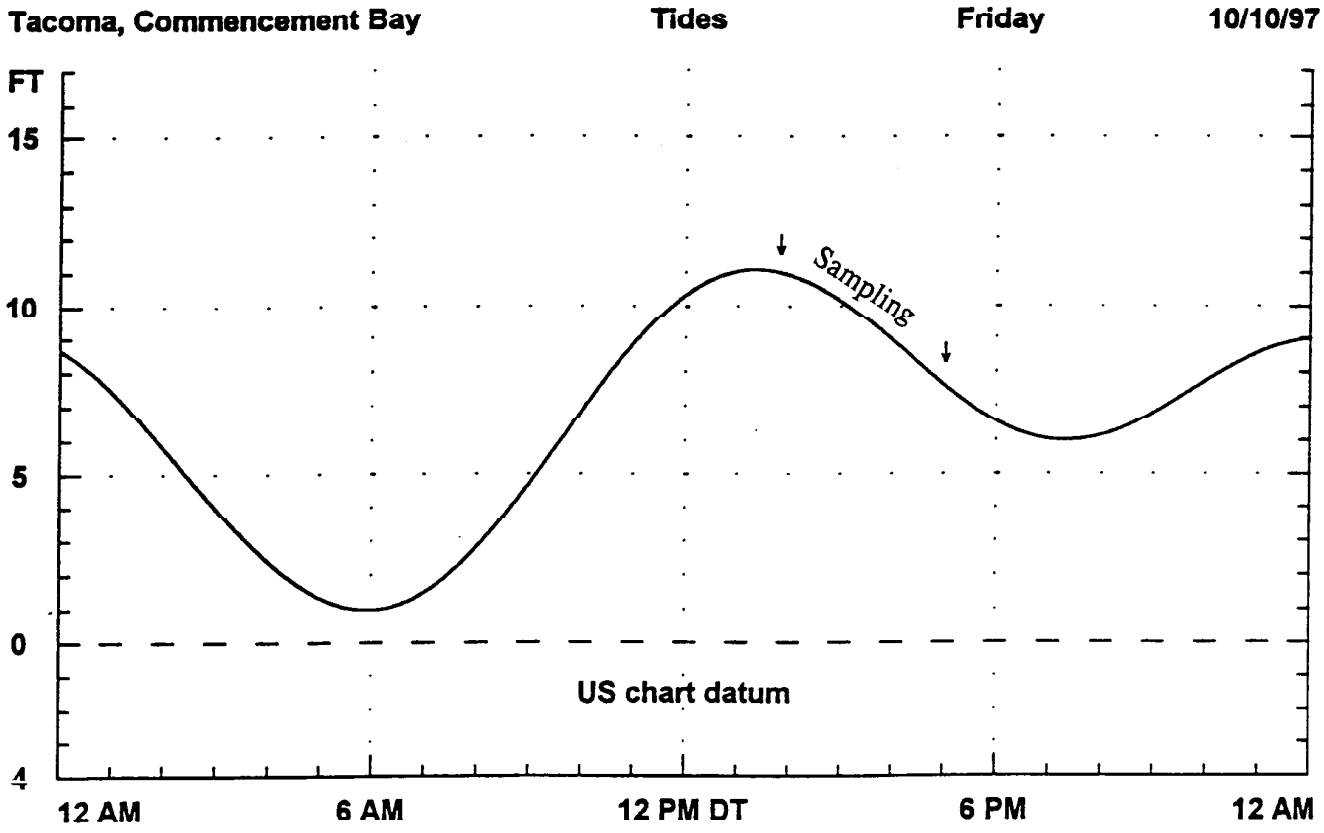
Parametrix, Inc. 1996. Middle Waterway Shore Restoration Project monitoring and adaptive management plan data report, post-construction (Year 0-1). Prepared for Simpson Tacoma Kraft Company, Tacoma, Washington and Champion International, Stamford, Connecticut. 26 pp. + Appendices.

U.S. EPA. 1988. Data validation functional guidelines for evaluating inorganic analysis. United States Environmental Protection Agency. Superintendent of Documents, United States Printing Office, Washington D.C.

TIDAL RANGE SAMPLING INFORMATION



Aerial Photograph
Tidal Range



55-1616-09

Interstitial Water Salinity Sampling Tidal Range

VEGETATION PLOT DATA

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 1 **Observer:** L. Tear, A. Reak

Macrophyte Bed: High salt marsh, enclosure **Starting Point:** North

Plot #	Distance (m)			Species	% Cover	Remarks
1	0.8	E	1.0		0	
2	2.9	W	3.9		0	
3	8.1	E	0.0		0	
4	11.3	E	4.7		0	
5	16.3	E	2.2		0	
6	22.4	W	4.8		0	(*Atriplex patula* at outer southwest corner)
7	29.1	W	3.0		0	
8	33.6	E	4.5	*Salicornia virginica*	<1	
				Diatoms/*Vaucheria* sp.	99	thin layer
9	41.6	W	3.0		0	nearby sods of *Distichlis spicata* are eroded on edges, so below-ground biomass exposed. *Atriplex patula* colonizing one of the sods where *Distichlis spicata* not doing well
10	46.7	E	1.4		0	

Note: 1997: *Distichlis spicata*, *Salcornia virginica*, *Atriplex patula* growing @ 40.3-42.5m west 1 to 3m.
several *Distichlis spicata* sods (e.g. 4.18 east edge of exclosure) roots exposed.
Small patches of *Salicornia virginica*, *Atriplex patula* here and there

Note: Other plants seen in enclosure were *Atriplex patula*, 16; *Distichlis spicata*, 2; *Salicornia virginica*, 11; *Scirpus maritimus* (all grazed), 4.

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 2 **Observer:** L. Tear, A. Reak

Macrophyte Bed: High salt marsh, planted, enclosure **Starting Point:** North

Plot #	Distance (m)			Species	% Cover	Remarks
1	10.5	E	1.2		0	
2	19.7	E	0.5		0	Note: Data probably collected from outside (east) of enclosure; may not be comparable to 1996 data.
3	23.5	E	0.4		0	
4	33.8	E	0.3		0	
5	49.0	E	1.3	*Pinus contorta*	25	
6	64.9	E	1.5	*Vaccinium* sp.	3	
7	79.7	E	1.9		0	

Notes: transect 2.5 m x 80 m
(Dog-leg) hook tape on stake @ 67.7 m from north end, run tape along east/outer edge; sample to one side in enclosure

should have been West.

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 5 **Observers:** L. Tear, A. Reak

Macrophyte Bed: Low salt marsh, planted **Starting Point:** North

Plot #	Distance (m)			Species	% Cover	Remarks
1	0.87	W	1.62	*Vaucheria* sp.	50	very thin
2	3.00	W	1.81	*Vaucheria* sp.	30	thin
3	6.24	W	0.05	*Vaucheria* sp.	2	
				Diatoms	99	
				Eleocharis parvula	trace	
4	9.53	W	0.433	Diatoms	90	
				Vaucheria sp.	trace	
5	14.09	W	2.56	*Vaucheria* sp.	45	
6	16.42	E	2.02	Diatoms	50	
				Eleocharis parvula	1	
7	19.09	W	1.09	*Vaucheria* sp.	75	thick
				Diatoms	25	
				Enteromorpha flexuosa	trace	
8	24.02	E	1.5	*Eleocharis parvula*	2	
				Diatoms	95	
9	25.1	E	3.68	*Vaucheria* sp.	50	
10	30.90	E	2.85	*Eleocharis parvula*	1	
				Diatoms	95	

Notes: transect length - 50 m (165 ft)

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 6 **Observer:** L. Tear, A. Reak

Macrophyte Bed: Low salt marsh, planted, enclosure **Starting Point:** South

Plot #	Distance (m)			Species	% Cover	Remarks
1	1.8	E	2.2	*Salicornia virginica*	trace	channel
				Vaucheria sp.	1	only *Distichlis spicata* in area (1 patch) dying
2	4.4	E	0.1	*Atriplex patula*	1	
				Salicornia virginica	trace	
3	11.1	W	2.0	*Salicornia virginica*	trace	goes into other area
				Enteromorpha flexuosa	75	

Notes: [1996: Heavy erosion around the planted clumps with an eroded channel to the east.]
transect = 8 m x 14 m

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 7 **Observer:** L. Tear, A. Reak

Macrophyte Bed: Low salt marsh, planted, enclosure **Starting Point:** North

Plot #	Distance (m)			Species	% Cover	Remarks
1	0.7	W	0.2	*Distichlis spicata*	trace	
2	4.7	W	0.9		0	
3	17.4	W	0.6	*Salicornia virginica*	5	
				Distichlis spicata	1	
4	21.7	W	0.25	*Atriplex patula*	15	
				Distichlis spicata	trace	
5	25.8	W	0.7	*Distichlis spicata*	3	
6	31.9	W	0.15	*Distichlis spicata*	trace	
7	42.8	W	0.55	*Distichlis spicata*	5	
				Salicornia virginica	2	

Notes: (narrow strip on east side of site)
All samples taken on west side of transect
transect = 1 m x 50 m
starting pin is ~5 m north of low marsh headpin, up the bank

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 8 **Observer:** L. Tear, A. Reak

Macrophyte Bed: Low salt marsh control, unplanted, mud base **Starting Point:** North

Plot #	Distance (m)			Species	% Cover	Remarks
1	0.2	E	3.5		0	some wood litter
2	7.3	W	8.6		0	wood litter, near new channel
3	14.2	E	3.7	*Vaucheria* sp.	10	small depressions with standing water
4	17.3	E	0.7	*Vaucheria* sp.	1	
5	23.5	E	1.4		0	small depression, sandier bottom

Notes: transect = 18 m x 30 m

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 3 **Observer:** L. Tear, A. Reak

Macrophyte Bed: High salt marsh, control (unplanted, with geese) **Starting Point:** North

Plot #	Distance (m)			Species	% Cover	Remarks
1	1.0	W	5.7		0	sandy with cobbles
2	2.7	W	2.5		0	sandy with cobbles
3	4.5	E	7.3		0	old wrack line, wood chips
4	11.8	E	1.3		0	
5	15.6	W	0.4		0	a few twigs
6	21.8	W	1.8		0	
7	23.7	E	5.5	Diatoms	trace	very thin layer

Notes: transect = 30 m x 15 m

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 4 **Observer:** L. Tear, A. Reak

Macrophyte Bed: High salt marsh control **Starting Point:** North

Plot #	Distance (m)			Species	% Cover	Remarks
1	3.1	W	1.7		0	
2	10.4	W	2.4		0	
3	20.2	W	0.0		0	
4	30.6	W	2.2		0	
5	34.6	W	0.3		0	

Notes: extends slightly up into buffer and slightly down slope into low marsh
transect = 2.5 m x 50 m

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 9 **Observer:** L. Tear, A. Reak

Macrophyte Bed: Low salt marsh control, unplanted, somewhat sandy **Starting Point:** South

Plot #	Distance (m)			Species	% Cover	Remarks
1	0.4	E	4.3	*Vaucheria* sp.	15	thin
2	3.9	E	2.7		0	
3	10.6	W	0.19	Diatoms	90	
4	16.7	E	3.2	*Vaucheria* sp.	50	thin
5	23.2	W	4.2	*Vaucheria* sp.	50	thicker in places

Notes: transect = 10 m x 25 m

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 10 **Observer:** L. Tear, A. Reak

Macrophyte Bed: High salt marsh, planted, enclosed, south end of site **Starting Point:** West

Plot #	Distance (m)			Species	% Cover	Remarks
1	11.5	N	0.6	*Distichlis spicata*	20	
				Fragaria chiloensis	20	
				Deschampsia cespitosa	5	
				Agropyron repens	trace	
				Agrostis sp.	1	
				Bromus sp.	trace	
2	19.0	N	0.5	*Melilotus alba*	1	
				Deschampsia cespitosa	20	
				Trifolium wormskjoldii	2	
				Fragaria chiloensis	1	
				Distichlis spicata	trace	
				Atriplex patula	trace	
				Grass 2	trace	
				Aster sp.	1	
3	28.5	N	0.5	*Melilotus alba*	90	
				Deschampsia cespitosa	20	
				Rumex crispus	10	
				Aster subspicatus	5	
				Grass 3	30	
				Herb 1	trace	Several small emergent seedlings
				Grass 4	trace	lawn grass

Notes: (run transect along outer edge; sample on one side in enclosure)
Melilotus alba dense and large in areas, some *Rubus discolor* moving in
transect = 3 m x 2.4 m
It was not possible to identify grasses 2, 3, and 4

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 13 **Observer:** L. Tear, A. Reak

Macrophyte Bed: Mud Cap #1 **Starting Point:** North

Plot #	Distance (m)			Species	% Cover	Remarks
1	5.69	E	2.94	*Enteromorpha flexuosa*	29	lots of seep
2	16.15	E	2.95	*Eleocharis parvula*	8	seep area
3	24.29	E	1.63	*Eleocharis parvula*	55	wood litter

Notes: Plot #3 is ~ ¼ in the NOAA plot (6 x 6 ft enclosure).
Transect length = 25 m (82.5 ft)

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 9/28/1997 **Transect:** 14 **Observer:** L. Tear, A. Reak

Macrophyte Bed: High to low salt marsh, topdressed (Mud Cap #2) **Starting Point:** East

Plot #	Distance (m)			Species	% Cover	Remarks
1	9.4	N	0.8		0	sand with cobbles in matrix
2	12.7	N	0.6		0	
3	16.7	S	1.4	*Enteromorpha flexuosa*	20	very thin
4	19.9	S	0.6	*Vaucheria* sp.	85	some "peeled off" and broken away
5	22.0	N	2.2	*Vaucheria* sp.	80	
6	23.7	N	0.3	*Vaucheria* sp.	95	
7	27.8	S	1.7	*Vaucheria* sp.	50	

Notes: (First 2 plots are high salt marsh, subsequent plots are low salt marsh)
transect = 10 m x 30 m

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 12 **Observer:** L. Tear, A. Reak

Macrophyte Bed: Mud #2 **Starting Point:** West @ GS-4

Plot #	Distance (m)			Species	% Cover	Remarks
1	1.1	S	0.61	*Enteromorpha flexuosa*	trace	
2	5.07	N	2.61	*Vaucheria* sp.	20	mud
3	8.93	N	1.10	*Vaucheria* sp.	40	
4	13.22	S	2.48		0	

Notes: transect length = 45 ft (14.0 m)

HERBACEOUS VEGETATION COVER DATA
MIDDLE WATERWAY SHORE RESTORATION
WETLAND MITIGATION MONITORING

Date: 8/28/1997 **Transect:** 11 **Observer:** L. Tear, A. Reak

Macrophyte Bed: Mud #1 **Starting Point:** South

Plot #	Distance (m)			Species	% Cover	Remarks
1	0.16	E	3.78	*Vaucheria* sp.	50	medium thick
2	1.94	W	1.55	*Vaucheria* sp.	30	thin
3	7.09	E	4.78	*Vaucheria* sp.	35	thick
4	10.75	W	0.89	*Enteromorpha flexuosa*	40	
				Diatoms	20	
5	16.46	E	3.78	*Enteromorpha flexuosa*	trace	
6	22.27	W	0.21	*Enteromorpha flexuosa*	5	
				Vaucheria sp.	10	very thin

Notes: transect length = 100 ft (31 m)

10/10/97 Middle Waterway Shore Restoration
55-1616-89 A. Rook, A. Ackerman

Time	Station	Salinity ‰	T °C
1354	MW-1(AH)	8	12.5 °C
1410	GS-13	24	11.0
1420	GS-8	9	12.5
1427	GS-6	13	12.5
1650	GS-9(F)	19	11.5
1655	GS-5	29	11.5
1702	GS-2	21	11.3

No rain in 24 hr.

BEACH SEINE DATA

Numbers of marine fish and invertebrates caught in 1997 by beach seine at Middle Waterway Shore Restoration site (Parametrix 1997).

Common name	Scientific name	May 28	May 30	June 3	June 12	June 20	Total
Pacific herring	*Clupea harengus pallasi*	0	5	0	0	0	5
Pacific staghorn sculpin	*Leptocottus armatus*	75	37	19	>81	93	>305
salmon (unidentified)	*Oncorhynchus* sp.	0	0	1	0	0	1
salmon, chinook	*Oncorhynchus tshawytscha*	8	6	25	8	5	52
salmon, chum	*Oncorhynchus keta*	1	5	0	0	0	6
salmon, pink	*Oncorhynchus gorbuscha*	0	1	0	0	0	1
shiner perch	*Cymatogaster aggregata*	800	154	106	>521	75	>1656
snake prickleback	*Lumpenus sagitta*	1	45	34	0	4	84
starry flounder	*Platichthys stellatus*	0	2	3	4	4	13
striped seaperch	*Embiotoca lateralis*	0	0	0	1	0	1
surf smelt	*Hypomesus pretiosus pretiosus*	14	0	2	0	21	37
surf smelt (juvenile)	*Hypomesus pretiosus pretiosus*	0	1	0	>120	0	>121
threespine stickleback	*Gasterosteus aculeatus*	0	0	0	0	1	1
tropical fish (unidentified)	aquarium escapee (?)	0	0	0	1	0	1
ctenophore	*Pleurobrachia bachei*	0	~50	~500	0	~50	~600
medusa	*Mitrocoma cellularia*	0	0	1	0	0	1
shore crab	*Hemigrapsis* sp.	0	0	1	0	0	1
shrimp	*Crangon* sp.	11	0	0	3	2	16

Notes:

">" represents the minimum number counted; a few more uncounted animals were present.

"~" represents estimates of animals too small and/or too numerous to count.

Beach seining was conducted at various locations in Middle Waterway; data reported here were collected specifically at the Shore Restoration site.

MONITORING PLAN REVISIONS

Parametrix, Inc. Consultants in Engineering and Environmental Sciences

5808 Lake Washington Blvd. N.E. Kirkland, WA 98033-7350
425-822-8880 • Fax: 425-889-8608

MEMORANDUM

to: Dave McEntee, Simpson Tacoma Kraft Company November 3, 1997

from: Allison Reak (AR) 55-1616-09

re: Changes to the *Middle Waterway Shore Restoration Monitoring and Adaptive Management Plan* (Monitoring Plan)

As part of the 1997 scope of activities for the Middle Waterway Shore Restoration Project, per Ken Weiner's recommendation, here is a list of changes in monitoring methods and procedures adapted from the original (April 1994) Monitoring Plan. The changes are proposed to clarify and reconcile the activities and schedule described in the Monitoring Plan. Most changes were proposed and approved during a December 13, 1996 meeting with representatives from Simpson, Champion International, and the Trustees. Other changes were proposed and approved at a later date[2]. The changes are listed in order of their appearance in the Monitoring Plan.

Physical Monitoring

p. 5, ¶4 Pre-marks will be placed at the two benchmark locations prior to the [annual aerial] photograph to provide reference points for photogrammetric interpretation of elevations during years when no other physical surveys are conducted (i.e., post-1997).

Chemical Monitoring

p. 8, ¶ 2 Samples will be collected at each of the 15 stations (plus one duplicate) identified in Figure 4. Grain size samples of 100 g (or volume specified by analytical laboratory, e.g., 200 ml) or more will be collected by a hand-operated 5-cm core, spatula, spoon, or equivalent device. Sample material will be collected from the upper 5 cm of sediment, except in Year 5 when the upper 15 cm of sediment will be evaluated for comparison to benthic biological data.

[2] Simpson Tacoma Kraft Co. 1997. Middle Waterway Shore Restoration Project grain size/TOC monitoring. Letter from Dave McEntee, Simpson Tacoma Kraft Company to Bob Clark, NOAA Restoration Center/Northwest. July 29, 1997. 3 pp.

p. 8, ¶ 6 Using data from these analyses, sediment granulometric parameters will be calculated in Year 5, in conjunction with benthic biological analyses.

p. 15, ¶ 5 [Add to list:]
Total solids
Total sulfides

Vegetation Monitoring

p. 17, ¶ 2 To assess the relative abundance, diversity, and composition of macrophytes that have been transplanted or colonized the site, the intertidal areas will be examined by a biologist during a low tide in June through ~~July~~ August.

p. 17, ¶ 5 A low altitude color aerial photograph of the site taken during a low tide (+5 ft MLLW) in August or in conjunction with the St. Paul Waterway annual aerial survey will be used to aid vegetation mapping.

p. 17, ¶ 6 ~~Soil nutrient status, pH, and redox potential~~ Temperature and salinity will be monitored *in situ* at sampling stations in the low marsh and high marsh zones at the same frequency as other chemical sampling ~~(Figure 7)~~. Salinity and temperature will be sampled at four interstitial water sampling stations (IW-1, IW-2, IW-3, and IW-4) (Figure 7). Station IW-1 corresponds to sediment chemistry station F; IW-2, IW-3, and IW-4 correspond to grain size stations GS-5, GS-6, and GS-8, respectively. Soil water will be collected ~~using vacuum soil water samples (made with porus ceramic cups)~~ by digging a shallow hole in the substrate and allowing interstitial water to seep into the hole. ~~These soil water samples will be analyzed for total nitrogen, total phosphorus, potassium, and pH.~~ At each sampling site, ~~redox potential~~ temperature and salinity will be measured using an electronic ~~pH~~ meter or thermometer and refractometer~~and platinum electrode~~.

Post-construction Monitoring Schedule

p. 21

Activity	Frequency
PHYSICAL	
Survey Transects	annually (year 0~~-1~~ and 2)
Topographic Mapping	year 0~~-1 and 2~~ (only if necessary thereafter)
SEDIMENT	
Grain Size	annually (year 0~~-1~~, ~~2,~~ 3, ~~4,~~ 5)
Biological	annually (year 5)
Chemical	annually (year 0 1, 3, and 5)
VEGETATION	
Transplant/Colonization	semi-annually (year 0~~-1~~) annually (year 2 and 3)
Plant Protection	semi-annually (year 0~~-1~~); as needed thereafter
Soil Salinity	annually (year 0~~-1~~, 3, and 5)
WILDLIFE	periodically per volunteer effort
AERIAL PHOTO	annually (year 0~~-1~~, 2, 3, 4, 5)

year 0~~-1~~ = ~~year~~ period of construction, planting, and first annual surveys

Information and data will be organized into a draft annual data report in late September for presentation to the Trustees at an annual meeting. ~~in late September.~~ Comments on the draft annual data report from the annual meeting participants will be incorporated into a revised report, to be issued as final within 30 days of the annual meeting.