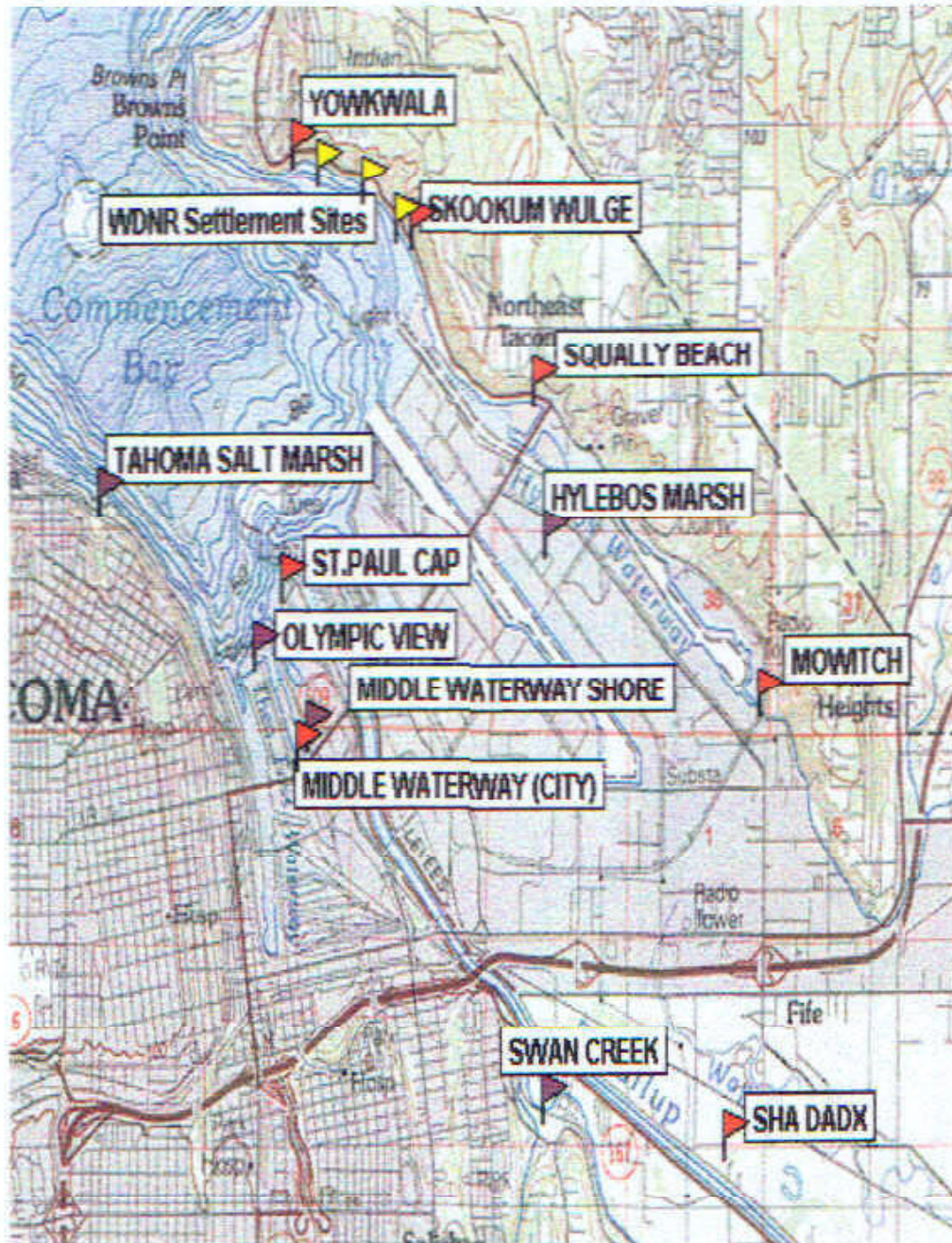


APPENDIX D

FIGURES

FIGURE 1. NRDA RESTORATION PROJECT SITES



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APPENDIX E

TABLES

Physical Monitoring Criteria	Attribute & Measure	Rationale	Success Criterion	Methodology	Sampling Schedule- Post Construction Years	Adaptive Management/Contingency Measures
1	Intertidal Areal Coverage	Surveys are necessary to document the success of plant growth and assess the site's potential for supporting animal populations.	90% of designed area +12ft to -2ft MLLW	As-Built Drawings, Topographic Surveys, Aerial Photographs, LIDAR, Visual Inspection Photopoints	1.5 (7,10)	None, Unless gross deviations which could result in some active reshaping or restructuring of the site.
2	Intertidal Stability	Influences hydrologic gradient, plant establishment, animal excess and characteristics of wetted edge.	Contours remain within +/- 0.50' of design, 75% of contours maintained through year 5	As-Built Drawings, Topographic Surveys, Transects and Profiles	1,2.5 (7,10)	None, unless gross deviations, in which case re-contouring may be considered.
3	Tidal Circulation	Influences plant establishment, substrate stability and chemistry.	Tidal amplitude equivalent inside and outside site	Data Logger/Tide Gauge or Tidal Staff and Visual Observation	1,2.5 (7,10 and/or periodic)	Drain pools to avoid fish stranding
4	Elevation & Channel Morphology	Influences hydrologic gradient, plant establishment, animal excess and characteristics of wetted edge.	Erosion does not threaten the property, infrastructure, project/permit goals	Site Survey & Aerial Photographs, LIDAR	periodic observation and examination of data gathered to monitor contour stability in years 1,2.5 (7 & 10)	Non-structural controls first (plantings, erosion control mats) followed by more engineered controls shoreline reinforcement, wave-action controls, etc.,) if necessary.
5	Sediment Structure	Influences habitat value for fish and benthic organisms. Indicator of sedimentation and/or erosion, stability indicator.	Accumulating fine grained materials to support biological production.	Grain Size Analysis Organic Carbon Content	1,3.5 (7,10)	Soil amendments will be considered.
6	Soil Salinity	Control seed germination and seedling establishment.	Comparable with reference sites.	Soil core sampling and laboratory analysis	Contingent upon adaptive management	Soil amendments will be considered.
7	Light Attenuation	Influences plant development, especially of concern if attempting to restore eelgrass beds.	Comparable with reference sites.	submersible light meter	1,2.5	Develop sediment/turbidity control measures

Biological Monitoring Criteria	Attribute & Measure	Rationale	Success Criterion	Methodology	Sampling Schedule- Post Construction Years	Adaptive Management/Contingency Measures
1	Marsh Development Areal Coverage	Plant surveys are necessary to document the success of plant growth and assess the site's potential for supporting animal populations.	Stable or increasing over time.	Aerial Photographs, Vegetation Surveys, Photo Points.	1,2,3,5 (7,10)	Soils amendments, additional plantings, consideration of a change in elevation of plant species, if warranted.
2	Marsh Development Species Composition	same as above	50% overall plant survival by year 3, <1% non-native, invasive species present.	Transect and Quadrat sampling, Photo Points	1,2,3,5 (7,10)	Physical removal of non-native/invasive plants.
3	Marsh Development Plant Vigor	same as above	Stem height and shoot density 80% of that of the reference by year 3.	Transect and Quadrat sampling, Stem height/ Shoot density measures & Photo Points.	1,2,3,5 (7,10)	Soil amendments including nutrient content will be considered.
4	Marsh Vegetation Herbivory Avoidance	Plants, especially young intertidal plants are susceptible to predation by Canada geese.	Control herbivory by Canada geese.	Installation and maintenance of Goose exclusion devices/physical barriers.	Installation no later than along with initial plantings. Devices must be maintained for the first 3 years of the project. Therefore periodic monitoring is necessary.	Repair, reinstall exclusion devices.
5	Riparian Vegetation Survival	same as above	75% survival in 3 years	Aerial Photographs, Quadrats/Transects, Point-line Intercepts	1,2,3	Replacement plantings, Soil amendments, Stewardship
6	Riparian Vegetation Areal Coverage	Plant surveys are necessary to document the success of plant growth and assess the site's potential for supporting animal populations.	70% coverage in 5 years, 90% coverage in 10 years.	Aerial Photographs, Quadrats/Transects, LIDAR Point-line Intercepts	1,2,3,5 (7,10)	Additional plantings, Soil amendments, Stewardship
7	Fish Access / Presence	Fishes are good indicators of ecosystem health. Generally, the presence of a few species (low species richness) may indicate stressful environmental conditions.	Comparable to reference areas in 10 years.	Fyke Nets, Beach Seine, Stomach Contents	1,2,3,5 (7,10)	Re-examine project design & goals - retain outside consultation.

8	Invertebrate Prey Resource Production	Benthic macroinvertebrates are good indicators of ecosystem health. Tidal wetlands can easily, and often do, support a wide variety and number of benthic invertebrate species.	Comparable to reference areas in 10 years.	Cones, Seives, Litterbags, and visual observation	1,3,5 (7,10)	Re-examine project design and goals, retain outside consultation.
9	Bird Use	Increased bird use of the restored habitat will be used as an indication of improved habitat conditions.	Use within 50 m. comparable to reference sites	Observational Surveys	1,2,3,5 (7,10)	Re-evaluation of human disturbance, installation of nest boxes and or other enhancement measures (decoys)
10	Primary Production	Influences growth rate/food chain support.	Algal mats comparable with reference sites.	Visual Inspection, Aerial Photographs	1,2,3,5 (7,10)	None
11	Insect Production	Insects are responsible for pollination, seed dispersal, aerating soils, controlling herbivorous insects and food chain support.	Comparable with reference sites.	Floating Pan Traps, Litter bags, Sweep Nets	1,2,3,5 (7,10)	None
12	Plankton Presence	Primary production indicators.	Comparable with reference sites.	Plankton Nets	1,3,5 (7,10)	None
Chemical Monitoring	Attribute & Measure	Rationale	Success Criterion	Methodology	Sampling Schedule- Post Construction Years	Adaptive Management/Contingency Measures
1	Sediment/Soil Quality	Influences habitat value for fish and benthic organisms. Influences growth rates. Indicator of sedimentation and/or erosion, stability indicator.	Comparable to reference sites.	Sediment samples, Standard methods, surficial and core samples as necessary.	As needed, as determined by physical and biological criteria above.	Soil Amendments
2	Water Quality/Quantity Temperature	Influences plant development and is an indicator for tidal circulation.	Suitable salinity for emergent plant propagation, colonization and growth. Suitable temperatures for fishery resources.	Data Logger, Salinometer or Refractometer	1,2,5 (7,10 and/or periodic)	Manipulate Freshwater flow as practicable and feasible, re-examine plant species selection.

ELEVATION

TABLE 2		LOW	HIGH
HIGH SALINITY	MARINE	<i>Salicornia virginica</i> <i>Zostera marina</i> <i>Zostera japonica</i>	<i>Elymus mollis</i> * <i>Fragaria chiloensis</i>
	ESTUARINE	<i>Atriplex patula</i> [high estuary] <i>Cuscuta salina</i> [low brackish] <i>Distichlis spicata</i> <i>Jaumea carnosa</i> <i>Lilaeopsis occidentalis</i> <i>Plantago maritima</i> [high estuary] <i>Salicornia virginica</i> <i>Triglochin maritimum</i> <i>Carex lyngbyei</i> (along channels) <i>Scirpus maritimus</i> <i>Scirpus americanus</i>	<i>Aster subspicatus</i> <i>Atriplex patula</i> <i>Carex lyngbyei</i> <i>Cuscuta salina</i> [low brackish] <i>Deschampsia caespitosa</i> <i>Distichlis spicata</i> [low estuarine] <i>Grindelia integrifolia</i> <i>Hordeum brachyantherum</i> <i>Jaumea carnosa</i> [low estuarine] <i>Juncus balticus</i> <i>Orthocarpus castillejoides</i> * <i>Plantago maritima</i> <i>Potentilla anserina</i> ssp. <i>Pacifica</i> <i>Scirpus acutus</i> [high tidal fresh] <i>Scirpus maritimus</i> [low estuarine] <i>Trifolium wormskjoldii</i>
LOW	BRACKISH	<i>Carex lyngbyei</i> <i>Lilaeopsis occidentalis</i> * <i>Scirpus americanus</i> <i>Triglochin maritimum</i> [low estuarine] <i>Cuscuta salina</i> * <i>Jaumea carnosa</i>	[<i>Agrostis alba</i>] <i>Eleocharis palustris</i> * <i>Juncus balticus</i> <i>Scirpus americanus</i> [low estuarine] <i>Trifolium wormskjoldii</i> [high estuarine] <i>Pyrus fusca</i> <i>Picea sitchensis</i> <i>Salix hookeriana</i>
	TIDAL FRESH	<i>Carex obnupta</i> <i>Typha latifolia</i> * <i>Scirpus tabernaemontanii</i>	<i>Agrostis alba</i> [high brackish] <i>Carex obnupta</i> <i>Physocarpus capitatus</i> <i>Rosa nutkana</i> <i>Scirpus acutus</i> <i>Typha latifolia</i> [low tidal fresh] <i>Pyrus fusca</i> <i>Picea sitchensis</i> <i>Salix hookeriana</i> <i>Salix lucida</i> var. <i>lasiandra</i>

*Volunteer species, should not be widely planted.

Table 2. (cont.) Latin and Common Names for Commencement Bay Plant List

Latin Name	Common Name
<i>Agrostis alba</i>	Creeping bentgrass
<i>Aster subspicatus</i>	Douglas aster
<i>Atriplex patula</i>	Saltweed, orache, fat hen
<i>Bidens cernua</i>	Nodding beggar-tick
<i>Carex lyngbyei</i>	Lyngby's sedge
<i>Carex obnupta</i>	Slough sedge
<i>Cuscuta salina</i>	Saltmarsh dodder
<i>Deschampsia caespitosa</i>	Tufted hairgrass
<i>Distichlis spicata</i>	Seashore saltgrass
<i>Eleocharis palustris</i>	Creeping spikerush
<i>Elymus mollis</i>	American beachgrass
<i>Fragaria chiloensis</i>	Beach strawberry
<i>Grindelia integrifolia</i>	Puget-Sound gumweed
<i>Hordeum brachyantherum</i>	Meadow barley
<i>Jaumea carnosa</i>	Fleshy jaumea
<i>Juncus balticus</i>	Baltic rush
<i>Lilaeopsis occidentalis</i>	Western lilaeopsis
<i>Orthocarpus castillejoides</i>	Paintbrush owl-clover
<i>Physocarpus capitatus</i>	Pacific ninebark
<i>Picea sitchensis</i>	Sitka spruce
<i>Plantago maritima</i>	Seaside plantain
<i>Potentilla pacifica</i>	Pacific silverweed
<i>Pyrus fusca</i>	Pacific crabapple
<i>Rosa nutkana</i>	Nootka rose
<i>Salicornia virginica</i>	Pickleweed
<i>Salix hookeriana</i>	Hooker's willow
<i>Salix lucida var. lasiandra</i>	Pacific willow
<i>Scirpus acutus</i>	Hardstem bulrush
<i>Scirpus americanus</i>	Three-square bulrush
<i>Trifolium wormskjoldii</i>	Springbank clover
<i>Triglochin maritima</i>	Seaside arrowgrass
<i>Typha latifolia</i>	Common cattail
<i>Zostera japonica [delete]</i>	Eelgrass, Grass-Wrack
<i>Zostera marina</i>	Dwarf Eelgrass, Narrow-Bladed Eelgrass