APPENDIX A

PHYSICAL SUCCESS CRITERIA (PSC1-7)

PHYSICAL SUCCESS CRITERION 1
INTERTIDAL AREAL COVERAGE

INTERTIDAL AREAL COVERAGE: *The total restored area between an elevation of +12 ft NOS MLLW and -2 ft MLLW will be at least 90% of the target intertidal elevation.*

Monitoring Tasks:

- Using standard areal calculation techniques, such as geo-referenced aerial photography, LIDAR, GPS or other field survey techniques, estimate the total intertidal acreage (below +12 ft MLLW) of the project.

- "As-built" plan drawing(s) will be provided in the same format or appearance and on the same scale as the construction drawings. These will typically be provided by a contractor as part of project completion.

- Visual inspection(s) should be conducted following extreme episodic flood events (*e.g.*, 100-year flood conditions) to determine any erosional impacts.

Schedule:

- The "as-built" plan(s) will be prepared within two months of completion of construction. Year "0" is the year of construction; subsequent years will be the next growing season. This means Year "1" might be from 6 to15 months after completion of construction. For example, if a project is completed by September 30, 2000, Year 1 monitoring would start during September 2002.

- Areal calculations of intertidal habitat will be completed in Monitoring Years 1 and 5, and if funding is available, Years 7 and 10.

Contingency Measures:

- None, unless gross deviations -- indicated by filling or bank erosion of the intertidal area – exceed the criterion.

Discussion:

The elevation bands may be further subdivided, when needed. Certain minimum expectations for project size is a legitimate success criterion for an increase in area of intertidal habitat and in the softening or laying back of shoreline banks.

PHYSICAL SUCCESS CRITERION 2
INTERTIDAL STABILITY

INTERTIDAL STABILITY. *The as-designed contour elevations, especially for intertidal plant introductions, will be +/- 0.5 ft of the elevations specified in the construction plan. 75% of the target elevations will be maintained through Year 5.*

Monitoring Tasks:

- An "as-built" plan drawing(s) will be provided in the same format or appearance and on the same scale and contours as the construction drawings.

- Using standard areal calculation techniques, such as geo-referenced aerial photography, LIDAR, GPS or other field survey techniques, estimate any changes in surface topography of the project site. Profiles of the project can be taken from the transects employed for the Biological Monitoring criteria.

Schedule:

- The "as-built" plan(s) will be prepared within two months of completion of construction.

- Profiles on transects through the intertidal habitat will be completed in Monitoring Years 1, 2, and 5, and if funding is available, Years 7 and 10.

Contingency Measures:

- None, unless gross deviations – *e.g.*, 75% of the target elevations (+/- 0.5 ft) are not maintained through Year 5 – exceed the criterion. Project-specific elevation change will be evaluated that may modify this measure.

Discussion:

The hydrologic condition of intertidal sites are determined by measuring elevations relative to NOAA datums. Distribution of salt marsh plants often are referenced to these standard datum. High precision is necessary in elevation surveys. Salt marsh vegetation is extremely sensitive to slight differences in tidal inundation and plants that thrive at one elevation may yield to another species if the topography is six inches too high or too low.

This criterion differs from physical criterion # 4 in that physical criterion # 2 looks at the overall percentage of elevations maintained at a project site, it quantifies aerial extent of intertidal habitat. In contrast, physical criterion # 4 is designed to focus on the development of stream-channels within a project site. Criterion 4 is designed to help discern the occurences and distribution of hydrologic elements and how they change over time.

PHYSICAL SUCCESS CRITERION 3
TIDAL CIRCULATION

TIDAL CIRCULATION. *The tidal amplitude, as determined by both timing and elevation of high and low tide events, is equivalent inside and outside of the project area.*

Monitoring Tasks:

- Periodic visual inspections of the project area to see if tidal flows are unimpeded and there are no undrained basins which might strand fish during periods of low water. Tidal staffs can be placed both inside and outside the project if specific tidal heights are desired for an instantaneous reading. Recording tidal gauges (data loggers) may be used for longer-term determination, where justified.

Schedule:

- Periodic and during post-construction Years 1, 2 and 5. "Periodic" means opportunistic times other than during defined sampling events specific by the Monitoring Plan.

Contingency Measures:

- Failures at any site to show tidal circulation and tidal inundation consistent with the objectives of the individual projects will trigger discussion on the need to increase the size of the tidal connection between the project location and inundation water source (*i.e.*, Commencement Bay, the Waterways or Puyallup River).

- Attempt to drain any pools which might strand fish using low technology means (hand tools); failing this, discussions would be needed to develop more permanent solutions (*i.e.*, filling, determining current patterns).

Discussion:

The development of adequate tidal connections between the project sites and the rest of Commencement Bay and its tributaries is essential. Inadequate connection would lead to a dampened tidal hydrology which could favor invasive plant species over desired native plant communities. Other consequences could include reduction in fish access to and use of the project sites, reduced export of organic material from the site and associated food web support for the estuaries, excessive current velocities within the channels and openings that provide the connections, and associated problems with erosion. Where shallow pooling or ponding occurs within a project that traps water during periods of low tide, fish can become stranded and stressed through increased temperature, decreased oxygen, and increased bird predation. Additionally, ponding and resulting evaporation can result in hyper-saline conditions not healthy for plants or fish. Tidal circulation measurements will help to establish nutrient and organic carbon import and export.

PHYSICAL SUCCESS CRITERION 4
ELEVATION AND CHANNEL MORPHOLOGY

ELEVATION AND CHANNEL MORPHOLOGY. *No evidence of erosion that threatens restoration project goals, property, infrastructure, or is otherwise unacceptable is observed after a period of initial site stabilization.*

Monitoring Tasks:

- Periodic visual inspections of the project for signs of excessive erosion will be completed. Areas of concern may be photographed from a stable photo point periodically so the rate and severity of erosion can be judged.

- "As built" site surveys will be used to monitor and quantify changes in site geomorphology, especially where similar surveys are repeated on a periodic basis.

- Cross-section elevation data collected across permanent transects through the project will provide another way of evaluating how the project morphology is changing.

- In addition to visual inspections specific to this criterion, analysis of any available aerial photographs and elevation cross-section survey data to be obtained under PSC1 tasks will assist in quantifying the extent of erosion.

Schedule:

- Visual inspections and written comments regarding erosion should be made during all monitoring events at the project; observations will be recorded during monitoring of PSC2 (Intertidal Stability) in Years 1, 2, 5 and in Years 7 and 10 if funding is available.

Contingency Measures:

- The primary defense against excessive erosion should be non-structural, such as vegetation, fiber mats, low-tech drainage swales, or other "soft" approaches. Engineered approaches such as riprap or other shoreline "hardening" (*e.g.*, logs, root wads, post-construction) should be used as a last resort and in cases where the property owner, the NRDA Trustees, and relevant permitting authorities agree that a hazardous condition to the property exists or the need to preserve function and integrity of the project warrants corrective action.

Discussion:

Please refer to the disussion under PSC#2.

This criterion differs from physical criterion #2. Criterion # 2 looks at the overall percentage of elevations maintained at a project site, it quantifies aerial extent of intertidal habitat. In contrast physical criterion 4 is designed to focus on the development of stream-channels within a project site. Criterion 4 is designed to help discern the occurences and distribution of hydrologic elements and how they change over time.

PHYSICAL SUCCESS CRITERION 5
SEDIMENT STRUCTURE

SEDIMENT STRUCTURE. *Over time, intertidal sites may accumulate fine-grained materials and organic matter. This would be evidenced by a decrease in mean grain size and an increase in organic carbon in the surface sediments.*

Monitoring Tasks:

- Sediment grain size samples should be collected at each site in areas that will be also be sampled for benthic invertebrates (BSC8). Where appropriate, consideration will be given to stratifying the project sites into two bands: vegetated (+10 feet MLLW and above) and unvegetated (below +10 feet MLLW). Core samples in a project-defined sampling grid will be processed for grain size distribution and organic carbon by standard methods (*see*, CSC1). The results will be compared to reference sites and to comparable data from the same site in previous years.

Schedule:

- This monitoring task will be completed in all years where benthic invertebrates are sampled. The recommended schedule for sampling is post construction Years 1, 3, 5 and Years 7 and 10 if funding is available.

Contingency measures:

- Generally few modifications could be made. If the intertidal sediments do not support the biological production anticipated, analyses could be made to determine if adequate soil nutrients are present. Soil amendments could be considered if deemed appropriate by the technical staff.

Discussion:

Several intertidal habitat functions are associated with depositional environments. Specifically, the accumulation of fine grained sediment is indicative of environments that support the accumulation of organic matter and a detritus- based food web. Soft sediments and organic rich areas support benthic invertebrate prey resources, especially for juvenile fish, like salmonids, and shorebirds.

PHYSICAL SUCCESS CRITERION 6
SOIL SALINITY

SOIL SALINITY. *Suitable salinity for emergent plant propagation, colonization and growth. Soil salinity affects seed germination and plant establishment.*

Monitoring Tasks:

- Soil salinity will be determined at multiple locations on the intertidal plant surface (and potentially core) samples using standard sampling methods and analysis using an accredited soils testing laboratory. In addition, soil salinity may be discerned through observation. Monitoring staff should keep detailed notes on patchy areas of vegetation, especially those in near seeps.

Schedule:

- Periodic and as appropriate as defined by the site-specific monitoring plans.

Contingency Measures:

- If, through sampling and analysis, it is determined that soil salinity is a limiting factor to plant growth and propagation at a restoration project site additional (different, more salt tolerant), plantings and plant species should be considered.

Discussion:

Soil salinities control seed germination and seedling establishment in coastal wetlands (Zedler and Beare, 1986). Soluble salts commonly associated with soil salinity affect plant growth in two ways. Firstly, they attract water, raising the suction (osmotic potential) of water held in the soil, thereby reducing a plant's ability to attract water from the soil. This limits plant vigor and growth. Secondly, soluble salts contain ions such as sodium, chloride and borates that are often toxic to plants. These ions are often responsible for raising soil pH. Indirectly, this results in nutrients such as iron, phosphate, zinc and manganese becoming unavailable for plant growth. As soil becomes increasingly sodic it is subject to dispersion and so is unstable and easily eroded. Other associated potential impacts include (but are not limited to) water-quality deterioration, loss of native aquatic habitat and death of vegetation.

If marsh vegetation does not reach full function as defined by the project goals, this success criteria and monitoring activity will be implemented.

PHYSICAL SUCCESS CRITERION 7
LIGHT ATTENUATION

LIGHT ATTENUATION. *Suitable light as compared to reference areas. This criterion is especially important if working in the shallow subtidal areas and with eelgrass enhancement creation. For plant propagation, colonization and growth results should be comparable to reference sites within two years.*

Monitoring Tasks:

- Compare restoration project areas to reference area using readings obtained using a submersible light refractometer which may be used in combination with a data logger.

Schedule:

- Periodic and during post-construction Years 1, 2, and 5 .

Contingency Measures:

- If plant communities do not develop, sediment control measures and/or turbidity controls should be considered in project areas not directly affected by the turbidity of the Puyallup River and its load of glacial four. It is noted that the Puyallup River system carries a significant sediment load into Commencement Bay. When planning a restoration effort that could require significant control of turbidity, the location of a project in relation to the Puyallup River must be considered carefully.

Discussion:

Several factors discussed above - such as nutrient concentration, light attenuation, dissolved oxygen, salinity and temperature should be recorded to overall assess water quality. Sampling before, during, and after restoration measures take place is important to determine the changes in ecosystem condition.