King County

Brightwater

TREATMENT SYSTEM

Eelgrass Restoration and Biological Resources Implementation Workplan

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Executive Summary

This implementation workplan provides additional detail and refinement of the restoration and biological resource mitigation plans for the Brightwater marine outfall, beyond those contained in the *Draft Eelgrass Restoration and Monitoring Plan* (King County, 2004a). The Brightwater marine outfall was sited to minimize impacts to biological resources. The outfall will be buried to a depth of –80 feet (ft) mean lower low water (MLLW), with trenching impacts minimized by utilizing sheeted trench construction to a depth of –30 ft MLLW. The outfall alignment crosses through the intertidal zone containing sandy substrate before continuing through a relatively narrow and patchy eelgrass bed until the outfall daylights at –80 ft MLLW. From –80 ft MLLW out to the end of the diffuser at about –605 ft MLLW, the outfall pipe will lay on bottom sediments.

The goal of this implementation workplan is to describe restoration activities that will return intertidal and shallow subtidal eelgrass habitats to their pre-construction conditions. In addition, mitigative measures are proposed for resources that will be affected by temporal or permanent impacts. The primary impact of outfall construction activities will be the disturbance to eelgrass habitat. This workplan describes an extensive monitoring and transplanting plan designed to restore eelgrass habitat to pre-construction conditions. Monetary compensation is proposed for Dungeness crab and geoduck mortality during construction. Removal of derelict fishing gear, including both fishing nets and crab pots, through an existing program is proposed to mitigate for the temporal loss of habitat during outfall construction. Outfall construction was initially expected to occur in late summer of 2009 as was noted in earlier versions of this plan; however, it is now anticipated that construction will begin in spring of 2008.

This workplan includes several innovative approaches to eelgrass restoration. Preceding construction activities by five years, eelgrass monitoring will commence in the area that could potentially be impacted by construction activities (“Study Area”) as well as in a separate area to assess the natural variability of eelgrass growth patterns (“Reference Area”). Monitoring will be conducted using a combination of three methods: side-scan sonar, underwater video, and diver surveys. This approach allows the areal imaging and mapping capability of sonar to be combined with the visual classification and verification of the video. In addition, this approach provides quantitative eelgrass shoot counts from the diver surveys. Pre-construction monitoring will be repeated twice prior to construction for diver surveys and once for sonar and video surveys. Information from multiple years utilizing these methods will provide a robust baseline dataset.

Immediately following the first year of monitoring in 2004, a small portion of eelgrass shoots from the alignment (“Marine Outfall Corridor”) were harvested and transported off-site to be stockpiled and propagated in flow-through seawater tanks. Additional shoots were harvested in 2006 and 2007. Additional stock was to be obtained by harvesting flowering eelgrass shoots during this same time period, however, shoots were not flowering at the time of eelgrass collection. Prior to construction in 2008, all eelgrass shoots within the Marine Outfall Corridor will be salvaged and stockpiled in the off-site seawater tanks. This plant salvage is expected to provide sufficient eelgrass to restore the site following construction. However, an area containing ample plants for harvest (“Donor Site”) will be retained as a contingency in the event eelgrass propagation efforts fail or do not provide the required amount of plants necessary for transplanting. Several plots were established in the harvested eelgrass beds within the Marine Outfall Corridor and monitored to provide short-term recovery rates of donor beds, information which is currently lacking.

Following completion of construction activities, a sonar survey will map the area of eelgrass loss in the Study Area, confirmed by the video data. Areas with eelgrass loss due to construction

activities will be replanted the following spring in 2009 (Year 0) to allow for maximum development during optimal growing conditions. Monitoring of transplant areas will continue over a six year period (to 2014) following the transplant, with early monitoring results evaluated for transplant success and any obvious disturbances which can be corrected in a timely manner. If transplanted areas have failed to establish, attempts will be made to identify and rectify causes of failure, and an additional replanting will occur. If transplanted areas fail to meet long-term performance standards by the end of Year 5 (2014), additional monitoring will occur in 2019. If transplants fail twice, then contingency plans will be evaluated with state agencies.

Eelgrass performance standards were developed to assess the restoration efforts over time using a set of measurable criteria that are indicative of eelgrass habitat. Evaluation of transplanting success after six years will be measured against the following; long-term (i.e., 2014) survival of transplanted eelgrass within the Marine Outfall Corridor such that the total number of transplanted shoots is statistically equivalent to pre-construction eelgrass shoot counts, and long-term survival of transplanted eelgrass within the Eelgrass Study Area such that no statistically significant loss in eelgrass coverage is attributed to construction activities

The Brightwater Treatment System marine outfall restoration and monitoring plan will be conducted within a contingency framework. Under this framework, three basic actions can be taken: no action (make no changes, and monitor the outcome), make changes of some sort (e.g., modify site conditions or replant) to enhance the chances of meeting the goal, or change the goal (admit that the goal was incorrect for the project and develop a new, more realistic goal). If the underlying cause can be identified, but not rectified, consultation with state agencies will be initiated to determine appropriate adaptive strategies. Likewise, if eelgrass fails in two successive transplant attempts, alternative strategies will be considered.

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1.0. INTRODUCTION

1.1 Purpose of the Plan

The purpose of this document is to provide the implementation details regarding intent, methods, analysis, and contingencies for eelgrass transplanting at the Brightwater marine outfall. King County has distributed the *Draft Eelgrass Restoration and Monitoring Plan* (King County, 2004a) to provide a conceptual framework for federal and state agencies with jurisdiction over eelgrass and/or species that are associated with eelgrass. This conceptual framework, referred herein as the "Framework Document", allowed the agencies to come to agreement on the general approach to eelgrass restoration. The framework document was intended to support Endangered Species Act (ESA) consultation with National Oceanic and Atmospheric Administration (NOAA) Fisheries and U.S. Fish and Wildlife Service (USFWS), and to supplement the discussion of eelgrass restoration described in the *Wetland Impact and Conceptual Mitigation Plan* (King County, 2004b). This document, referred herein as the "Implementation Workplan," describes the details necessary to implement the framework document successfully. It includes methods, data analysis, and contingencies required by state agencies for permitting. This implementation workplan will be used by King County and state agencies as part of the permit application determining the type and extent of restoration and mitigation activities for the Brightwater marine outfall. The plan was initially prepared in 2004 and has since been revised several times following numerous discussions and negotiations with the applicable state agencies. It is expected that more revisions may be necessary based upon changes in the construction schedule of the outfall, monitoring results, and refinements of monitoring methods, therefore, this document will become a "living document."

The framework document combined with this workplan comprise the eelgrass restoration and mitigation approach for the Brightwater marine outfall and, when implemented, will meet permitting requirements for federal and state agencies.

1.2 Project Description

King County is committed to constructing and operating the Brightwater System to minimize environmental impacts. A comprehensive marine outfall siting process began in 1998 to identify environmental constraints and to locate the outfall in an area with as little disturbance as possible to biological resources. Biological factors, such as the presence of forage fish spawning locations, geoducks, marine mammal haul-out and rearing areas, and eelgrass beds were included in the siting process. To narrow the location of the outfall, five major scientific investigations were conducted; a geophysical study to determine slope, bathymetry, and sediment stability, a large-scale oceanographic study to determine water circulation patterns, a multi-year water quality study of both nearshore and offshore areas, a geoduck distribution and abundance survey, and a large-scale nearshore habitat mapping study which included mapping the location of eelgrass, kelp, and several other macroalgae species. Eelgrass results from the 1999 mapping effort indicated the presence of eelgrass along most of the shoreline where the outfall could be located given other constraints, such as slope stability. As it was not possible to site the outfall in a location totally devoid of eelgrass, the final outfall zone and subsequent outfall alignment were chosen in an area with as little eelgrass as possible to minimize impacts. Since the outfall construction will disturb intertidal and subtidal habitat, including eelgrass habitat, this implementation workplan was devised to determine first the extent of existing eelgrass, then the

extent of construction impacts. In addition, transplanting plans were developed and a monitoring program to assess recovery was designed. The monitoring and restoration efforts described within exceed standard eelgrass restoration and monitoring projects conducted elsewhere in Puget Sound in terms of the overall approach.

All of the pre-construction monitoring, transplanting, and post-construction monitoring will focus on sites described in this document as the Eelgrass Study Area, the Marine Outfall Corridor, the Eelgrass Reference Area, and the Donor Site. Descriptions of these areas are in Section 1.3. The areas are depicted in Figures 1 and 2. Outfall construction will displace all of the eelgrass within the Marine Outfall Corridor. The Eelgrass Study Area was delineated to capture a larger area in which any effects of construction activities would occur. The Eelgrass Reference Area was selected to measure changes and trends in adjacent eelgrass habitat for the duration of the monitoring program, rather than for direct comparison to project sites. The Donor Site was selected as a contingency in the event it becomes necessary to supplement the advance eelgrass collection and storage from the Marine Outfall Corridor, prescribed by this implementation workplan.

Pre-construction monitoring will be used to develop baseline information about eelgrass spatial distribution areal coverage in the area, eelgrass shoot density, and substrate characteristics. Using the results of pre-construction monitoring, King County will develop replacement values for site restoration. Pre-construction monitoring will consist of sonar and underwater video imagery for spatial information and diver-collected density information. These methods will be used in concert to assess conditions using the strengths of each method. Monitoring methods are described in Section 3.2. Because the effects of construction and the intent of each site varies, pre-construction monitoring is tailored for each area. The Marine Outfall Corridor will be intensively surveyed to accurately derive replacement requirements to accomplish eelgrass restoration. The Reference Area will have a similar level of monitoring in order to maintain a valid study design. The Study Area will be surveyed using sonar and underwater video to verify information within this large area. This is because King County cannot predict what, if any, effects of construction activities will have on eelgrass outside the Marine Outfall Corridor. Monitoring descriptions for each section are detailed in Sections 3.2.1 through 3.2.5.

As part of this approach, King County will cultivate eelgrass for transplanting by harvesting and propagating shoots from the Marine Outfall Corridor population that is slated for displacement. This eliminates the need to disturb other eelgrass beds to obtain transplant stock. This approach was developed following distribution of the Framework Document and constitutes a change in strategy. Salvaged eelgrass will be grown off-site at Battelle Marine Sciences Laboratory (BMSL) for propagation and reproduction over five years to develop a larger population that can be used to restore the Marine Outfall Corridor and to replace eelgrass damaged from construction activities in the broader Study Area, if necessary. As part of this design, King County is also planning a “donor meadow” recovery investigation to document the recovery of harvested beds within the Marine Outfall Corridor prior to construction. Descriptions of the harvest methods and propagation are in Section 4.0.

Eelgrass transplanting will be conducted as soon as practical after construction has ceased, likely early the following spring. Eelgrass will be transplanted by hand using methods described in Section 4.1.2. Outfall construction is now expected to begin in spring of 2008 and this year is referred to as Year -1. As eelgrass transplanting will likely occur the following spring, transplanting will occur in 2009, referred to as Year 0.

Eelgrass transplanted into the Marine Outfall Corridor and Study Area (if any) will be monitored for transplant success and habitat recovery over a 6-year period from 2009 to 2014, potentially over an 11-year period (2019) dependent upon recovery success. This post-construction

monitoring will use methods similar to the pre-construction monitoring methods. The post-construction methods are described in Section 5.0. Post-construction monitoring design includes performance standards, or benchmarks, that can be used to verify site success or guide contingency actions. The performance standards, described in Section 5.0, include site recovery indicators for eelgrass populations in both the Marine Outfall Corridor and the Study Area. The post-construction analyses used to measure performance standards are included in Section 5.3.5. The complete monitoring and transplanting schedule can be found in Section 6.0. If post-construction monitoring detects adverse developments or transplant failure, then contingency actions will be taken to address the problem. Contingency planning is addressed in Section 7.0. Mitigation for other biological resources is provided in Section 8.0.

1.3 Eelgrass Restoration Site Descriptions

1.3.1 Eelgrass Study Area

The Eelgrass Study Area surrounds the Marine Outfall Corridor and is bounded from east to west by the upper and lower range of potential eelgrass habitat and from north to south by the area in which anticipated impacts from construction, boats, and barges will be confined. In 2003, eelgrass distribution was documented in part of this area, between –2 feet (ft) mean lower low water (MLLW) and approximately –22 ft MLLW (King County, 2003).

A large study area was chosen to include potential eelgrass habitat along the marine outfall corridor and the surrounding area that could be affected by construction and barging activity, including turbidity, shading, propeller scour, and spilled construction material. The Eelgrass Study Area comprises about 2.5 acres (~10,300 m²), between 0 ft MLLW and –25 ft MLLW, and extends 210 feet to the north and 210 feet to the south from the outfall centerline (see Figure 1). This width was selected based on likely placement of barges over the study area during construction. Barges used in marine construction are typically between 100 ft and 200 ft long and up to 50 ft wide. Barges generally will work perpendicular to shore along the outfall corridor. The Study Area includes the region that could be impacted should a barge become rotated parallel to shore (perpendicular to the outfall pipeline alignment) or from prop wash created by maneuvering barges into location.

A work platform will be constructed adjacent to the north side of the Marine Outfall Corridor landward to approximately -1 ft MLLW. The platform pilings will be spaced 13 ft apart vertically and the deck will be about 22 ft wide. The platform will used to facilitate construction of the onshore and nearshore sections of the outfall pipe. Only approximately 20 ft of the western end of the platform (from 0 to -1 ft MLLW) is included in the Study Area.

1.3.2 Marine Outfall Corridor

The Marine Outfall Corridor is within the Eelgrass Study Area and comprises a 23 ft wide area centered along the outfall pipeline alignment that includes a 20 ft wide sheeted trench area and an additional 1.5 ft wide area on either side of the sheeted trench to account for potential localized effects of construction (i.e.; driving sheet pile walls, excavating material with a clamshell dredge, backfilling, etc). Prior to site selection of the pipeline alignment, an extensive eelgrass survey was conducted in order to locate the pipeline in an area with the least impact to eelgrass as possible (Woodruff et. al., 2001). Following selection of the outfall alignment, eelgrass distribution was documented in 2003 in this area, between –2 ft MLLW and approximately –10.5 ft MLLW (King County, 2003).

1.3.3 Donor Site

This implantation workplan calls for eelgrass harvest from within the Marine Outfall Corridor for replacement of eelgrass in disturbed areas (Section 4.0 provides more information regarding the eelgrass harvest) which precludes the need for a separate donor site. However, as a contingency against failure to harvest and propagate sufficient eelgrass for transplanting, a contingency Donor Site has been identified. A previous eelgrass side-scan sonar survey shows meadows of moderately dense eelgrass extending over a mile south of the site from the proposed alignment (Woodruff et al., 2001). Within these meadows are several areas of dense eelgrass. If the pre-harvest and propagation scenario does not provide sufficient eelgrass stock, eelgrass will be harvested from these beds for post-construction transplanting.

An area south of the Marine Outfall Corridor has been designated as the contingency Donor Site (Figure 2). The Donor Site has sufficient size and density of eelgrass to ensure a transplant harvest below 10 percent of the total amount of eelgrass present, even if final pre-construction surveys indicate a need for a greater number of transplant shoots.

1.3.4 Eelgrass Reference Area

A reference area near the Eelgrass Study Area will be established to identify unexpected changes in eelgrass growth and survival that are due to large-scale environmental conditions (e.g., winter storms, El Niño events, etc.). Eelgrass abundance within the Reference Area will be quantitatively assessed. The Reference Area will serve as an indicator of overall trends in eelgrass abundance. Eelgrass abundance within the Reference Area will be quantitatively surveyed for inter-annual trends in overall abundance, which can then be used to help evaluate eelgrass recovery in the Study Area. The Eelgrass Reference Area will be located immediately south of the Study Area and encompasses the same elevation range (0 ft MLLW to –25 ft MLLW) as the Study Area (see Figure 1).

Based on previous surveys (e.g., Woodruff et al., 2001; King County, 2003), the Reference Area contains less-patchy and higher-density eelgrass, similar to the southern half of the Eelgrass Study Area. This may be explained by more favorable sediment and slope conditions in the Reference Area.

1.4 Definition of Terms

Restoration: The replacement of habitat, including eelgrass and substrate, at on-site locations where construction disturbs or removes these features.

Alignment: The proposed path of the outfall pipeline and diffuser from Portal 19 to about –605 ft MLLW.

Eelgrass Study Area: The area surrounding the outfall pipeline alignment within which eelgrass and associated macroalgae grow. The Eelgrass Study Area includes the area within 210 feet both north and south of the outfall pipeline alignment centerline, between 0 MLLW and –25 ft MLLW.

Marine Outfall Corridor: A 23 ft wide area centered along the outfall pipeline alignment that includes the 20 ft wide sheeted trench area and an additional 1.5 ft wide area on either side of the sheeted trench to account for potential additional effects of construction (i.e.; driving sheet pile walls, collapse of sediments near the sheet piles, spillage of excavated material with a clamshell dredge, backfilling, etc). The Marine Outfall Corridor is within the Eelgrass Study Area.

Reference Area: An area directly south of the Study Area containing eelgrass densities similar to the southern portion of the Study Area. This area will be used to assess overall eelgrass trends and interannual variability.

Donor Site: An approximately one-acre area of moderate to dense beds that will provide the stock for transplanting as a contingency for failure of the pre-harvest and propagate strategy proposed in this workplan. The Donor Site is located south of the outfall pipeline alignment and extends from the King - Snohomish County line south.

Planting Unit: One landscape staple with four eelgrass shoots connected, ready to be planted.

2.0. RESTORATION & MONITORING GOALS

The ***primary goal of this restoration and monitoring plan is to return intertidal and shallow subtidal habitat and eelgrass to pre-construction conditions***. Habitat affected by construction activities will be restored, including spatial coverage of eelgrass (to ensure a similar ratio of vegetated and non-vegetated substrate).

To achieve the restoration goal, the following objectives were developed to address various aspects of the restoration process:

- Substrate restoration to pre-disturbance conditions by replacing excavated surface substrate with native material, removing any detectable spilled material, and restoring eelgrass in the Marine Outfall Corridor and any additional disturbed areas,
- Minimize the temporal loss of habitat function in the study area by transplanting eelgrass as soon as practicable after marine construction activities have ceased, and
- Maximize the probability of transplanting success by planting when the plants are healthiest, with adequate time to become established during the growing season.

The ***secondary goal of this plan is to provide in-kind replacement of functioning habitat; however, it is difficult to quantify function within eelgrass communities***. Studies that focus on various physical (e.g., shoot elongation, flower/seed production) or habitat (e.g., invertebrate assemblages, productivity) aspects of eelgrass do not quantify the functions provided by them in terms that can be used to calculate functional replacement value. Therefore, the focus of this restoration action will be to replace lost eelgrass "in-kind." The assumption supported by published information is that eelgrass functions relevant to foraging juvenile salmon and prey species will develop concurrently with the structure and productivity inherent to the eelgrass itself (Webb, 1991; Simenstad et al, 1988).

Some impacts resulting from outfall construction will be temporal in nature and difficult to mitigate "in-kind" regardless of any ability to quantify the loss of function. Many of these potential impacts (e.g., shading resulting in a reduction in eelgrass density) cannot be measured in terms of their subsequent affects on function. Efforts to mitigate temporary impacts on-site may further alter or degrade existing habitat function. Therefore, ***a third goal of the habitat restoration and monitoring is to:***

- ***Monitor for eelgrass recovery, and***
- ***Provide off-site mitigation for temporal impacts to fish and shellfish habitat through the removal of derelict fishing gear.***

Analytical and physical methods detailed in the following sections are intended to provide concise information explaining how the goals of the plan will be fulfilled.

3.0. PRE-CONSTRUCTION MONITORING

3.1 Pre-Construction Monitoring Goals

The pre-construction monitoring goals are to (1) document eelgrass areal coverage and mean densities indicative of eelgrass conditions before construction and (2) detect changes in project area habitat characteristics in order to better understand eelgrass dynamics in the area over time by quantifying eelgrass within the Marine Outfall Corridor and Reference Areas and determining a range of fluctuations in eelgrass area and abundance. This information will be used to develop post-construction expectations for long-term eelgrass survival and establish parameters for contingency planning.

The pre-construction monitoring plan includes patch delineation and density measurements within the Marine Outfall Corridor and Reference Areas and patch delineation within the Study Area to capture baseline conditions. These will be used to develop the transplant planning and establish parameters within the Study Area for restoration where necessary. This information can be used, if needed, to distinguish between habitat impacts attributable to construction activities versus broader habitat fluctuations. Detailed monitoring methodology is provided in Section 3.3.

3.2 Pre-Construction Monitoring Areas

3.2.1 Eelgrass Study Area

The Marine Outfall Corridor is contained within the Eelgrass Study Area but is discussed separately below. Thus, the following discussion of the Study Area excludes the Marine Outfall Corridor. The Eelgrass Study Area will be monitored before construction two times, in 2004 and 2008, to determine the areal extent and pattern of eelgrass distribution and to document natural variability. Eelgrass Study Area data will be used to (1) determine pre-construction eelgrass location and distribution, (2) determine post-construction transplanting design (i.e., the distribution and number of replacement shoots) and long-term recovery metrics, (3) determine interannual variability that can be attributed to natural and non-construction related causes, and (4) provide a baseline for measuring post-construction eelgrass areal extent and distribution for recovery assessment.

Pre-construction monitoring of the Eelgrass Study Area will use sonar and video components. For each of the pre-construction monitoring surveys, the entire Study Area will be surveyed using the sonar imaging and georeferenced underwater video techniques described in Section 3.3 during late spring or early summer. Surveying in early summer is preferred as epiphytic growth during the mid to late-summer months can make data post-processing more time-consuming. The sonar and video surveys are measuring overall eelgrass coverage which would be consistent between early summer and late (July through September) summer months. Although biomass (i.e., length of shoots) increases during the summer, this is not a metric that is being measured in this study. Data from the sonar imaging will be analyzed to determine the overall distribution in the Study Area . A side-scan sonar survey used in conjunction with underwater video was selected as the monitoring tool for the Eelgrass Study Area because it is an efficient way to monitor the larger area for changes in eelgrass coverage. Georeferenced underwater video will provide a permanent record of eelgrass and aid in interpreting sonar images. The combination of these techniques will

provide a good baseline of pre-project eelgrass coverage and relative abundance without extensive, diver-reliant sampling and delineation. Use of the same method post-construction will allow identification of disturbance to the Study Area in the same efficient manner. It also will provide some indication of interannual variability of coverage within the Study Area.

3.2.2 Marine Outfall Corridor

The Marine Outfall Corridor is centered within the Eelgrass Study Area and will be surveyed with the same side-scan sonar and video techniques during monitoring of the Eelgrass Study Area in 2004 and 2008. In addition, divers will determine eelgrass densities within 10 ft of either side of the outfall alignment centerline, from 0 to -25 ft MLLW in 2004, 2006, and 2008. A previous diver survey conducted in the Marine Outfall Corridor and Study Areas in 2003 determined eelgrass was not present below -25 ft MLLW (King County, 2003b). In summer of 2005, divers monitoring the harvest plots established in 2004 in the corridor reconfirmed that rooted eelgrass was not present below -25 ft MLLW. Five permanent transects (approximately 190 ft long) will be established at 5 ft intervals parallel to the alignment centerline; the first, third, and fifth transects will be in the same location as the three centermost transects surveyed in 2003 (Figure 1, King County, 2003b). Transects surveyed in 2003 were spaced further apart (at 10 ft intervals), therefore, only three of the five transects are in the same location. The standard Washington Department of Fish and Wildlife (WDFW) triplicate method (see Section 3.3.1) will be used to determine shoot densities every 10 ft along each of the five transects (approximately 100 total sample locations, 300 total shoot counts). Divers will also note the horizontal distances along the transect where the eelgrass edge begins or ends to compare with the sonar survey data. To ensure consistent sampling between years, transect start and end points, in addition to quadrat pivot points, will be marked with permanent markers, as will every fifth sampling point (50 ft intervals). In addition to video transects that will be conducted parallel to shore, video data will also be collected along the diver transects described above that are perpendicular to shore.

3.2.3 Eelgrass Reference Area

An Eelgrass Reference Area to the south of the Eelgrass Study Area will be monitored in conjunction with other pre-construction monitoring, to establish baseline eelgrass distribution and abundance outside the areas of potential project impacts. This will occur during the same period as the Marine Outfall Corridor monitoring, three years pre-construction in 2004, 2006, and 2008. The intent of the Eelgrass Reference Area is to evaluate local population fluctuations for post-construction evaluation. The same sonar and video monitoring methods used for the Study Area will be employed.

Five diver transects will be established in the Reference Area to obtain density data comparable to that collected in the Marine Outfall Corridor. As with the Marine Outfall Corridor, transects will be spaced parallel to each other 5 ft apart from 0 to -25 ft MLLW. Divers will determine eelgrass density along each transect using the WDFW triplicate method. However, due to the shallow shelf and length of each transect in the Reference Area, density measurements will be collected every 20 ft along each transect, rather than every 10 ft as in the Marine Outfall Corridor. Approximately 22 stations will be established along each transect for a total of 110 sample locations and 330 shoot counts in the Reference Area. Divers will also record locations of bed edges. Transect end-points and every other sampling point (40 ft intervals) will be marked with permanent markers. Diver surveys will occur during the same period as the Marine Outfall Corridor surveys.

It is anticipated that the diver surveys in the Marine Outfall Corridor and the Eelgrass Reference Areas will encompass a wide range of eelgrass densities that will then be used as further ground truthing to support interpretation of the side-scan sonar surveys.

3.2.4 Donor Site

Eelgrass distribution and relative abundance at the Donor Site will be assessed in 2004 using side-scan sonar in conjunction with georeferenced underwater video during the same period as the Eelgrass Study and Reference Areas monitoring. Pre-construction monitoring data will be used to assess if sufficient eelgrass is present at the Donor Site should it be necessary to harvest donor eelgrass if the salvage and propagation effort fails to meet transplant shoot count requirements.

3.3 Monitoring Methods

To meet the overall monitoring goals, both pre- and post-construction monitoring will use the same methods so that data will be comparable and changes over time can be identified. A combination of monitoring methods, including divers, acoustic imaging technology (sonar), and underwater videography will be used to collect data on areal distribution of eelgrass, density, substrate condition, and discernible construction-related impacts. Each method measures eelgrass habitat on a different scale (e.g., gross spatial extent, small-scale distribution, individual shoot density), yielding data that are complementary and can be used to a certain extent, to verify each other. The combination of these three methods will provide a robust eelgrass baseline dataset. Each method is described in detail below.

3.3.1 Diver Methodology

SCUBA divers will determine eelgrass densities in the Marine Outfall Corridor and Reference Area by establishing five parallel transects that are perpendicular to the shoreline. Specific methods in each area are described below.

Marine Outfall Corridor. The five survey transects are all approximately 190 ft in length and parallel to the outfall alignment centerline. The transects will be set at 5 ft vertical spacings and cover a total width of 20 ft from the alignment centerline from 0 to -25 ft MLLW. The transects will be numbered 1 through 5 with transects 1, 3, and 5 corresponding with previously surveyed transects (King County, 2003b). The endpoints for these three transects were marked with PVC pipe set into the substrate and were recorded using dGPS. Divers will locate these existing transect endpoints using a dGPS receiver (Trimble dGPS Pathfinder Pro-XR or comparable system). Shallow endpoints will be located on foot and deep endpoints will be located by boat and divers. At each deep water endpoint for transects 1 and 5, a line and buoy will be attached by a diver to a marker to temporarily mark them at the surface during high-water. Endpoints for transects 2 and 4 will be located using a fiberglass measuring tapes stretched across endpoints for transects 1, 3, and 5. All endpoints will then be recorded using a dGPS. For the deep endpoints, a diver will hold a line with attached buoy to the marker and a person in a boat at the surface will pull the line taut, positioning the dGPS over each endpoint recording the location. Measuring tapes will be deployed between transect endpoints and permanent markers (typically coated rebar stake) will be placed to mark sample points in 50 ft intervals. These permanent markers will remain in place until outfall construction as excavation of the outfall trench will remove the majority of the markers. All permanent markers will be sunk to less than 1 ft above the substrate. The markers will be removed at the completion of pre-construction monitoring.

Once all sample points in the outfall corridor have been marked at each transect, a measuring tape will be deployed on the substrate between the two endpoints. One diver per transect will walk (intertidal area) and swim along the transect line and record eelgrass shoot counts using the WDFW intermediate eelgrass/macroalgae habitat survey triplicate method. At each 10 ft

sampling interval, the diver will record shoot counts inside a 0.25 m^2 quadrat rotated around the marker so that the left edge is oriented at 2-, 6-, and 10-o'clock positions relative to the transect line (Figure 3). The inside corner of the quadrats will pivot around the same center point to ensure repeatability. The density for each sample point, reported as the number of eelgrass shoots per square meter, will be calculated from the mean of the three quadrat counts multiplied by four. Non-quantitative notes will be made on the presence and type of macroalgae and invertebrates. During the survey, divers will also record the distance along the transect where eelgrass areas begin and end. This data can be used to correlate with the sonar surveys.

At the completion of pre-construction monitoring and prior to construction, two permanent benchmark monuments will be established landward of the Outfall Corridor shallow endpoints above the mean higher high water line in an area undisturbed by construction activities. Locations of these markers will be recorded using survey equipment (employing electronic distance measuring equipment) in order to ensure the locations of the transect endpoints can be relocated following construction.

Reference Area. Five transects will be established in the Reference Area. As in the Marine Outfall Corridor, the transects will be set at 5 ft vertical spacings perpendicular to the shoreline and extend from 0 to -25 ft MLLW. The length of each transect will vary from about 400 to 440-ft, depending upon depth and slope. Shallow intertidal endpoints will be located by foot using a dGPS and marked with permanent markers. Deep transect endpoints at the -25 ft MLLW contour will be identified using a dGPS and marked with a buoy deployed by boat and verified by a diver. The depth contour is relatively unchanged between the endpoints and will be temporarily marked with a measuring tape. To ensure the transects are set straight and parallel, the sampling point 200 ft from the shallow endpoint on transects 1 and 5 will be located with a dGPS and permanently marked. This reference line, approximately midway down the transects, allows a single measuring tape to be stretched along each transect from 0 to 200 ft and also from 200 ft to the transect endpoint. This tape will remain in place until sampling points have been marked for all transects.

Once all endpoints and midline endpoints have been identified, each transect will be marked with permanent markers every 40 ft. Divers will walk in intertidal areas and swim in deeper water to deploy measuring tapes along each transect. Eelgrass will be assessed at 20 ft sampling intervals along each transect. Divers will record shoot counts the same as in the Marine Outfall Corridor.

3.3.2 Side-scan Sonar Methodology

Side-scan sonar will be used to determine the areal extent, landscape pattern, and patchiness in the Eelgrass Study Area, Reference Area, and Donor Site (2004 only). A sonar transponder will be towed by boat in overlapping swaths described below to obtain complete coverage of the survey area bottom including all areas where eelgrass is present. A survey track run parallel to shore will provide a 60 meter (m) swath on either side of the trackline (port and starboard), therefore, the total swath width is 120 m. The initial trackline will be closest to shore, with additional tracklines running parallel to the first trackline approximately 60 m in the offshore direction. This will provide a 50 percent overlap of the entire swath width of 120 m. The sonar will be linked to a dGPS on board the vessel, and real-time mosaiced (overlapped and matched) imagery will be displayed on a computer monitor as data is collected. The data will be stored for later processing of eelgrass polygon coverages. Dual frequency side-scan sonar with selectable 100- and 500-kilohertz (kHz) frequencies will be used for data collection. Data will be acquired at a ping rate and vessel speed sufficient to provide an approximate 0.1 m pixel resolution. Boat speed will not exceed 3 knots but may vary slightly dependent upon currents and wind speed. As stated above, survey track lines will be established in each area following the contour of the shoreline and be placed parallel to the shoreline.

Sonar data will be processed by creating a mosaic of tiff images of each area with a UTM grid overlay and associated coordinates imported into ArcView GIS software (or comparable system) for geocoding. Polygon delineations of eelgrass cover will be developed on the side-scan sonar imagery in GIS software and data from each sonar swath will be evaluated separately to determine the location of eelgrass patch or bed edges. After preliminary eelgrass polygons are defined from the sonar data, the video data will be overlaid on the mosaic of the sonar image. Decision rules about how the video data will be incorporated into the sonar interpretation were developed following the initial survey in 2004 to guide final GIS product layer development. Decision rules primarily involve the determination of the minimum eelgrass patch size and shape to be delineated at a particular site and the specific definitions of the cover classes (e.g. percentages of cover types). Following the 2004 survey, an eelgrass bed was considered as a separate polygon if its dimension on any one side, based upon both the sonar and video data, was at least 3 m across. The only exception to this rule was within the Marine Outfall Corridor where data were available on a finer scale. In this area, a 1.5 m polygon was delineated.

3.3.3 Underwater Video Methodology

Geographically referenced (georeferenced) underwater video data will be collected in 2004 and 2008 along a minimum of five track lines running parallel to shore over the Study and Reference Areas. Video data will be collected along additional transect lines placed in the Study Area in 2008, particularly in the area north of the Outfall Corridor between -15 and -30 ft MLLW. Inclusion of supplementary transect lines in 2008 is based upon results from the 2004 survey and the need to collect more video data in this area to aid side-scan sonar data interpretation.

Georeferenced video data were collected along five track lines in the Donor Area in 2004 only, and the track lines were spaced approximately 200 ft apart. For the Study Area in 2004, track lines were spaced no more than 100 ft apart running parallel to shore. In the Study Area in 2008, track lines will be spaced close enough to adequately assess eelgrass coverage in the area. Two or three tracklines of video data will also be collected perpendicular to shore in the Outfall Corridor and Reference Areas (a total of four to six perpendicular tracks). Tracklines will run from approximately -6 to -30 ft MLLW to encompass the deepest depth where eelgrass could be present. The video surveys will be conducted during high tides to cover as much of the shallow nearshore area as possible. The video camera will be towed behind the vessel at a speed of 3 knots or less with dGPS coordinates and time recorded at one second intervals. The video camera will be placed on a tow sled with a vertical stabilizer and bottom skids and be towed about 1 to 2 meters off the bottom, depending upon habitat type and vertical relief of the substrate. The camera, with a wide-angle lens, will be mounted in an oblique-looking position. The data are recorded in digital format, and a time and position stamp are permanently burned onto the video image for later post-processing. The video data will be used as an aid for the sonar post-processing, allowing visual confirmation of the sonar data. The video data can be post-processed for cover types and then overlaid onto the georeferenced sonar imagery for final interpretation of eelgrass cover.

The video interpretation will include four cover types: (1) no eelgrass present, (2) sparse coverage < 25% cover, (3) moderate coverage 26-75% cover, and (4) dense coverage 76-100% cover. Additional interpretation of the video data will include landscape form as either continuous or patchy. The final polygon delineations made with the combined sonar and video data will be some combination of cover type and landscape form. Comparison of final polygon delineations will be made in GIS software to examine the extent of any change in eelgrass patch size, shape, or cover over time.

The video imagery will provide a permanent visual record of the site over time that can be analyzed further at any time in the future.

4.0. EELGRASS TRANSPLANTING

Specifics about eelgrass transplanting (e.g., shoot counts, eelgrass transplanting elevations, and eelgrass replacement calculations) presented in this section are based on preliminary estimates and assumptions derived from data collected during previous eelgrass studies. Numbers will be revised based on pre-construction monitoring data.

4.1 Transplant Planning

For purposes of planning eelgrass transplant and restoration following outfall construction, areas to be planted will include wherever eelgrass loss has occurred in the Marine Outfall Corridor and in the broader Eelgrass Study Area due to construction activities. The 2003 eelgrass survey (King County, 2003) described a patchy distribution of eelgrass with a wide range of densities in the Outfall Corridor Area. The factors that control eelgrass coverage, density and distribution include light availability, substrate (slope, grain size, and nutritional content), temperature, salinity, landscape characteristics of adjacent uplands, and physical (e.g., wave and current) energy from natural or human causes. Of these factors, none will be changed from pre-construction (eelgrass bearing) conditions to post-construction conditions, with the possible exception of substrate. To replicate pre-construction conditions as closely as possible, the uppermost layer (upper 2 feet) of substrate on top of the corridor will consist of native substrate stockpiled on barges during construction. See *Baseline Sediment Characterization Study* report for a discussion of sediment and grain size analyses (King County, 2002b).

Outfall construction is expected to be completed in late fall of 2008. In order to provide the highest likelihood of transplant success by providing the greatest photoperiod, warming temperatures, and reduced storm occurrences, eelgrass transplanting will likely occur the following spring in 2009.

After the outfall has been installed and the sheet pile removed, the marine contractor will conduct a video and/or bathymetric survey to assure that the corridor has been returned to its pre-construction elevation and is flush in elevation with the surrounding undisturbed bottom area. Although the exact locations of transplant areas cannot be determined until initial post-construction monitoring, this plan assumes that the transplant area will consist of a 23 ft wide band centered on the outfall pipeline alignment, from 0 ft MLLW to –25 ft MLLW, covering about 4,255 ft^2. At a minimum, eelgrass will be restored within the Marine Outfall Corridor within the same depth range it occupied prior to construction. In 2006, those elevations were between about -2 ft MLLW to -11 ft MLLW (Grette Assoc., 2006). However replacement eelgrass may be transplanted along more of the outfall pipeline alignment, depending on the distribution of eelgrass documented during pre-construction monitoring and as determined by King County to be necessary to encourage maximum recovery of this patchy area.

Plant spacing and plot size will be specifically designed based on the restoration goals of returning habitat and eelgrass to pre-construction conditions. An attempt will be made to mimic former shoot densities and areal coverage by planting at densities documented during pre-construction monitoring within the site. If pre-construction shoot densities in the Marine Outfall Corridor indicate the presence of multiple sparse patches, the decision may be made to plant fewer yet denser patches in order to facilitate recovery. In the event more shoots are propagated than are needed to return densities to pre-construction conditions, the decision may be made to replant sparse patches at higher shoot densities than were present prior to construction. Post-project monitoring at the Port of Bellingham's large scale mitigation site in Drayton Harbor

indicates that dense transplant plots filled-in quickly, creating a high-density patch by the end of the second growing season (PIE 2001a, 2001b, and 2002, Grette Associates 2003). This was desirable at the Drayton Harbor Site, which is exposed to fetch and resulting wave action from Rosario Straits, as well as strong tidal currents. The Brightwater marine outfall site is also relatively open to wind driven wave energies and weak to moderate tidal currents. Past research has indicated that, under more exposed conditions such as this, transplant survival can be enhanced by planting in denser clumps (Fonseca et. al. 1998) and that mimicking existing patch sizes could improve chances of transplant success.

Eelgrass will also be transplanted where the initial post-construction sonar survey reveals a loss of eelgrass resulting from construction activities outside the Marine Outfall Corridor. Eelgrass will be replanted within the same general footprint that eelgrass occupied before construction as determined from pre-construction sonar surveys. In order to maintain the restoration goal of replacing like habitat, transplanted eelgrass will not be expanded into areas outside the Outfall Corridor that were unvegetated during the final pre-construction monitoring survey.

Any loss of eelgrass (determined by sonar/video GIS overlays) in the Eelgrass Study Area, but outside the Marine Outfall Corridor, will be planted at 100 percent of the pre-construction density. For the area within the Marine Outfall Corridor where all shoots are expected to be lost due to excavation, a baseline extent and total shoot count will be calculated from the eelgrass counted along transects during the first year (2004) of pre-construction monitoring prior to shoot harvesting, as described in the monitoring methods (Section 3.3.1). This baseline shoot count will be adjusted by the percentage change in the shoot count from the Reference Area transects between the first and last pre-construction survey to yield the total number of replacement shoots to be transplanted into the Marine Outfall Corridor. Eelgrass shoots will be planted in approximately the same locations, and at the approximate densities, as they occurred prior to construction. The concept is to use the pre-construction distribution of plants to assist in determining where eelgrass will likely grow after construction.

Bare-root eelgrass shoots will be harvested from the donor stockpile at Battelle Marine Sciences Laboratory (BMSL), processed into planting units, and attached to landscape anchors (see next section). The planting units will be transported to the Marine Outfall Corridor and hand-planted throughout the transplant area using a spatial planting interval to be determined by the number of replacement shoots required and the number of shoots per unit within a given area. Planting intervals will be no greater than 1.5 ft on center, based on success using similar spacing at other eelgrass transplants (e.g., West Point, Drayton Harbor, Clinton Ferry Terminal) and because eelgrass transplant survival decreases if intervals are too great. Published data indicates that planting at 0.5 m centers (or 1.6 ft) provides higher likelihood of plant survival in dynamic settings (Fonseca et al. 1998).

To accelerate the recovery of habitat function, eelgrass will be transplanted as soon after construction as possible, but only during the most active growing season. Eelgrass transplanting earlier in the growing season will allow four to five months for the transplanted eelgrass to establish a healthy root system and store energy for the approaching winter. Although eelgrass can survive transplanting throughout the year, the risk of damage from winter storms is significant enough at the alignment's exposed location to preclude transplanting later in the season. Assuming that construction activities will finish later than mid-July, eelgrass will most likely be transplanted the following spring (i.e., May timeframe).

4.1.1 Transplant Methods

4.1.1.1 Eelgrass Transplant Area, Pre-Construction Donor Harvesting

This plan initially proposed to harvest donor eelgrass from moderate to dense areas within the Marine Outfall Corridor area during two pre-construction years: 2004 and 2006. The plan was to harvest approximately 1,000 shoots during the summers of 2004 and 2006. However, due to the limited amount of eelgrass present in the Marine Outfall Corridor, only 305 shoots were harvested in 2004. Sufficient eelgrass was present in the Marine Outfall Corridor in 2006 and a total of 1,500 shoots were harvested. Additionally, this plan proposed that in 2005 and 2006, divers would harvest flowering shoots in the general vicinity of the Marine Outfall Corridor. These flowering shoots would be placed in the seawater tanks in order for their seeds to supplement the transplant stock. However, in both 2005 and 2006 flowering shoots were not present for harvest. In order to augment the eelgrass propagation effort and ensure sufficient stock is available at the time of transplanting, 490 eelgrass shoots were harvested in 2007. This donor eelgrass is being stockpiled in 29-m^2 circular, flow-through seawater tanks at BMSL.

Divers harvested eelgrass by hand from these moderate to dense patches using the "bare-root method" to minimize substrate and remaining shoot disturbance. Divers first removed substrate from around the rhizome, then uprooted the rhizome with roots and blades attached. This method creates minimum disturbance to surrounding eelgrass and substrate. Divers selected thick rhizomes, about 4 to 6 inches long, with multiple shoots and long blades, rather than thinner rhizomes with single shoots or short blades. They used a gentle vibrating motion while lifting the rhizomes from the sediments, resulting in liquefaction around the rhizomes and roots to allow extraction of viable plant material with healthy internodal segments and well-formed root initiates. Divers transferred these bare-root shoots to a boat where biologists separated and counted the individual shoots before placing them in totes or coolers full of seawater. These shoots were transported to BMSL where they were planted into a medium-grained sand substrate by inserting rhizomes into small holes dug in the substrate using a trowel. The sediment was then gently backfilled over the rhizomes. There is some unpublished evidence that plants may be "depth-adapted." For example, plants from shallow intertidal areas may not survive well if planted in deeper subtidal areas (i.e., near the lower depth limit of eelgrass). However, the previous survey conducted in the Eelgrass Study Area shows that eelgrass is present in a band within a fairly narrow depth range and that plants harvested prior to construction will survive well at all the depths expected for replanting.

Although not initially proposed by this plan, all eelgrass within the Marine Outfall Corridor which is expected to be lost due to trenching activities will be salvaged in 2008 prior to the start of construction. This decision to harvest all eelgrass within the Marine Outfall Corridor prior to construction was reached following consultation with the appropriate state agencies. Eelgrass will be harvested in this area and transported to the BMSL following the methods described above

Eelgrass will be maintained in the tanks at BMSL for post-construction transplanting in 2009, by which time a transplant stockpile of approximately 8,000 shoots is anticipated.

4.1.1.2 Pre- and Post- Harvest Monitoring

A common uncertainty with many eelgrass restoration projects is the effect of removal of eelgrass from donor meadows. To date, studies on donor meadow recovery are unpublished. Anecdotal observations indicate that removal may have a small and short-term effect on eelgrass density. However, there are no quantitative data to support these observations. In an effort to assist state agencies in their analysis of future plans and to begin to develop a dataset on recovery rates, King County monitored the eelgrass recovery rate within the Marine Outfall Corridor where eelgrass was salvaged for the stockpiling effort. The initial intent was to establish five semi-permanent 6-

m^2 (2 m x 3 m) rectangular plots within the Outfall Corridor where eelgrass was to be removed for transplanting (i.e., removal of groups of shoots with intact rhizome sections). Each plot was to be randomly located within moderate to dense eelgrass patches in the corridor and divided into six 1-m^2 sub-plots. There would be four harvest treatments: 5, 10, 25 and 50% of the shoots within a plot as well as two control sub-plots where no shoots (0%) would be harvested. The arrangement of the harvest and control treatments within a plot would be randomly assigned. However, there was insufficient eelgrass present in early fall 2004 to establish the treatment plots as originally planned. Instead, five semi-permanent 2.0-m^2 (1 m x 2.0 m) rectangular plots were established within the corridor. Each plot was then divided into eight sub-plots 0.5 m x 0.5 m (0.25 m^2). Four harvest treatments: 5, 10, 25, and 50% of the shoots within a plot were randomly assigned within the plot. In addition, two sub-plots where 100% of the shoots were removed and two control sub-plots where no shoots (0%) were removed were established. The arrangement of the 0% harvest treatment was randomly assigned, however the two 100% subplots were added at whichever end of the 2.0 x 1.0 m plot adequately encompassed an eelgrass patch. Typically, harvest levels have been restricted to 10% or less of the total abundance. Hence, this range of treatments examines harvest levels above and below the most often applied harvest level. Prior to harvest, shoot density was recorded within each plot. To examine short-term recovery rates, shoot density was assessed in each plot for the first year post-harvest in late summer/early fall towards the end of the optimal growing season in 2005. Another assessment was done in 2006 two years following the initial harvesting and a final assessment was done in 2007. Shoots harvested in 2006 were in areas outside the plots established in 2004 so as not to bias the assessments in 2006 and 2007. Harvest recovery data collected during the post-harvest monitoring program were compared to the control plots using standard analysis of variance (ANOVA) techniques. In addition to shoot density, notes were recorded on factors that may affect recovery including changes in substrate composition, presence of debris, presence of crabs, etc. Results of this harvest recovery rate experiment can be found in the *Fourth Annual Report: 2007 Pre-construction Eelgrass Monitoring and Propagation for the King County Outfall* (Woodruff et al., 2007).

4.1.1.3 Eelgrass Transplant Area, Post-Construction Transplant Installation

Immediately prior (1-2 days) to transplanting, eelgrass will be harvested from the BMSL tanks using the bare-root method described above. The bare-root material will be processed into planting units of four shoots interlaced and attached directly to a landscape anchor (1-inch-wide, 6-inch-long turf staple) using paper-coated wire twist ties. Following anchor attachment, the leaves of each planting unit will be cut to a length of approximately 30 cm to facilitate handling and planting (Merkel, 2004). Planting units will be placed in coolers filled with seawater and transported to the outfall site.

The areas to receive transplants will be determined prior to transplanting. Divers will locate the areas to be transplanted using differential global positioning system (dGPS) coordinates obtained from the post-construction monitoring survey. On-site, coolers will be loaded onto a boat from which divers will be handed planting units for installation. Individual planting units will be installed by excavating a hole (using a garden trowel or by hand) approximately equal to the size of the unit, and inserting the planting unit into the hole so that the rhizomes are at a depth of approximately 5 cm below the substrate. The hole is then back-filled with substrate. Leaf blades are then pulled free of the substrate and stood upright from the bottom.

5.0. POST-CONSTRUCTION MONITORING

5.1 Monitoring Goals

The post-construction monitoring goals are to:

(1) identify the spatial extent of eelgrass affected by construction activities within the Eelgrass Study Area (e.g., from substrate disturbance, propeller-caused scour, shading, barge grounding, etc.), and

(2) document eelgrass recovery.

Post-construction monitoring is intended to determine the development trends of restored eelgrass habitats and to detect adverse developments in a timely manner. This will allow resource agencies to track restoration success and to ensure fulfillment of the restoration goal.

5.2 Monitoring Activities

Post-construction monitoring will be conducted in the Eelgrass Study Area, the Marine Outfall Corridor, and Reference Area. Monitoring will continue to be based on sonar surveys, underwater video, and diver transects. Descriptors for eelgrass densities and coverage defined during the first year of pre-construction monitoring will continue to be used to describe and quantify eelgrass monitored during post-construction surveys.

The post-construction monitoring approach for each area is described below; in most cases, it is identical to the pre-construction monitoring. A video survey will be conducted by the outfall contractor within a month following outfall completion to assess seabed elevations and ensure no spilled materials are present in the Marine Outfall Corridor. A side-scan sonar and georeferenced video survey will be conducted in March 2009 in the Study Area in order to identify areas for eelgrass transplanting. Eelgrass transplanting is expected to take place in spring of 2009, which will be followed by quarterly underwater video monitoring with a remotely operated vehicle (ROV) in years 2009 and 2010. Additional annual monitoring will occur in Years 0 (2009), 1 (2010), 2 (2011), 5 (2014), and 10 (2019) if necessary following a discussion with state agencies. See Section 7.0 for detailed post-construction monitoring schedule.

5.2.1 Eelgrass Study Area

Post-construction monitoring of the Eelgrass Study Area, excluding the Marine Outfall Corridor, will be conducted using the same sonar and video methods presented in Section 3.2.1. Monitoring will be conducted in early 2009, around March, to determine if and where transplants are needed in the Study Area. The sonar mapping images will be digitally overlaid and the areas of change due to construction-related activities will be identified as polygons and described by dGPS coordinates. The georeferenced video data will be processed to confirm the disturbed areas, and wherever possible, the nature of disturbance.

Dependent upon the initial post-construction survey results in early 2009, georeferenced underwater video, ROV underwater video, sonar, and diver methods may be used to survey transplants in the Study Area.

If the area(s) receiving transplants is small (less than five meters in any direction), it is likely only divers and underwater video will be used due to spatial resolution limitations of sonar. If this is the case, annual monitoring at the transplant sites with georeferenced underwater video and divers will occur in 2009, 2010, 2011, and 2014. In addition, underwater video reconnaissance surveys will be conducted quarterly with an ROV in 2009 and 2010. The video camera on the ROV is a forward facing, wide-angle camera with tilt control and a 180 degree field of view with wide focus range. If the area(s) receiving transplants is large, than it is likely that sonar and georeferenced underwater video will be used.

The appropriate state agencies will be consulted following the initial 2009 survey in the Study Area to determine future monitoring methods in this area. If the initial post-construction survey indicates no eelgrass was disturbed in the Study Area, no post-construction monitoring will occur.

Data analysis and statistical comparisons are described in Section 6.0.

5.2.2 Marine Outfall Corridor

The Marine Outfall Corridor portion of the Eelgrass Study Area will be monitored using the same underwater video and diver methods as those employed pre-construction (Section 3.2.2). Following transplanting in 2009, monitoring that will occur in 2009, 2010, 2011, and 2014 will include georeferenced underwater video and divers along the transects that were established during pre-construction monitoring. If eelgrass densities in the Outfall Corridor do not meet the performance standards listed in Section 6.2.1 by Year 5 (2014), video and diver monitoring will occur in Year 10 (2019) following a discussion with state agencies.

In addition, underwater video reconnaissance surveys will be conducted quarterly with an ROV in 2009 and 2010. These surveys will occur in late winter, spring, and fall and will supplement the annual video monitoring conducted in the summer of 2009 and 2010. The intent of the reconnaissance surveys is to identify correctable disturbances which may affect eelgrass survival. Video data will be collected along the diver established transects. Transect endpoints will be pre-programmed into the Pathfinder software program (or other comparable software) and the camera towed along the tracklines at a speed of less than 3 knots. Video data will be recorded in DVD format. Real-time video data will be evaluated at the time of collection by a video monitor on board the boat. The location of any disturbances will be recorded. Disturbances that can readily be removed or corrected by divers will occur as soon as possible after detection.

Post-construction, transects 1 and 5 in the Marine Outfall Corridor will be re-established using the permanent benchmarks and survey information from the pre-construction staking. The location of each nearshore endpoint can be identified, with the remaining three transects located using the dGPS equipment, as the pre-construction eelgrass survey transects were located. Endpoints for transects 1 and 5 are 20 ft apart, end points for transects 2, 3, and 4 will be re-established in 5 ft intervals between them.

Data analysis and statistical comparisons are described in Section 6.0.

5.2.3 Eelgrass Reference Area

Post-construction monitoring of the eelgrass Reference Area will be conducted in the same manner in which pre-construction monitoring is conducted (Section 3.2.3). As with the Marine Outfall Corridor, georeferenced underwater video surveys (for extent) and diver transects (for shoot counts) will be employed annually, during the summer in 2009, 2010, 2011, and 2014. If eelgrass densities in the Marine Outfall Corridor do not meet the performance standards listed in Section 6.2.1 by Year 5 (2014), video and diver monitoring will occur in Year 10 (2019) in the Reference Area to assess eelgrass fluctuations in the area.

The same diver transects established and marked during pre-construction surveys will be used for this monitoring. Unlike the transect markers in the Marine Outfall Corridor that were removed during construction activities, the markers in the reference area will remain undisturbed from the time established until the end of the monitoring program.

Data analysis and statistical comparisons are described in Section 6.0.

5.2.4 Donor Site Area

If utilized, no post-construction monitoring will occur in the Donor Site.

6.0. DATA ANALYSIS AND STATISTICAL COMPARISONS

The data collected during the pre- and post- construction monitoring will be analyzed to determine:

1. pre-construction harvest plot analysis,
2. planting density and distribution,
3. survival of transplanted eelgrass, and
4. trends in eelgrass density or coverage.

6.1 Pre-Construction Harvest Plot Analysis

Data gathered from the eelgrass-salvage plots that were established prior to construction were analyzed to determine the effect of harvesting eelgrass at varying densities. Each of five plots was divided into eight 0.25 m^2 subplots with various removal scenarios (two subplots at 0% removal, one each at 5%, 10%, 25%, 50%, and two at 100% removal). The plots were monitored annually between 2005 and 2007 to determine eelgrass densities in each of the subplots. This data was compared to the initial (pre-harvest) densities, and recovery rates determined using information on percent removal and natural variability in the eelgrass population as determined from the Reference Area data.

The final shoot density and recovery rate of eelgrass was evaluated with respect to the initial shoot count densities of each plot, the percent harvested from that plot, and time. The relationship between each of the independent variables (i.e. initial shoot count density, harvest percent, time) was examined with respect to final shoot density (i.e. the dependent variable). Results of this harvest recovery rate experiment can be found in the *Fourth Annual Report: 2007 Pre-construction Eelgrass Monitoring and Propagation for the King County Outfall* (Woodruff et al., 2007). This information may assist in future eelgrass restoration planning efforts and help determine the method of removal that yields the highest number of plants while also allowing for rapid recovery of the donor bed.

6.2 Planting density and Distribution

In order to restore eelgrass as closely as possible to existing conditions, the approach adopted here is to replant matching the density and areal extent of the pre-construction eelgrass. However, this is complicated by the harvest of eelgrass shoots within the Marine Outfall Corridor to establish the transplant stock.

To account for the salvaging of eelgrass shoots prior to construction, the following method will be used to determine the number of shoots to be replanted following construction. The total number of eelgrass shoots to be planted within the Marine Outfall Corridor will be calculated as the greater of either the 2008 (Year -1) eelgrass abundance or the pre-harvest 2004 (Year -5) abundance, corrected for any trend observed in the Reference Area.

Eelgrass abundance for the Marine Outfall Corridor, is calculated as the mean eelgrass density (i.e. mean of all shoot counts including bare substrate counts within the Corridor) multiplied by the overall area (i.e. Marine Outfall Corridor). The Marine Outfall Corridor is considered the disturbed area (i.e. nominally the entire corridor, 23 ft x 185 ft); however, the exact area of disturbance will be calculated by GIS analysis of the pre- and post-construction sonar and video surveys.

The correction of the pre-harvest 2004 (Year -5) abundance for overall trends in eelgrass will be done by multiplying the pre-harvest abundance by the percent change in abundance in the Reference Area. The total number of shoots computed for replanting will be referred to as the "Baseline Abundance."

Within the Study Area, but outside the Marine Outfall Corridor, no harvesting will occur, and the 2008 (Year -1) pre-construction survey will be used to establish pre-construction conditions. As with the Marine Outfall Corridor, a GIS comparison between pre- and post- construction sonar images will be used to identify the impacted areas. Since the Study Area is a relatively large region and the location of any impacts is unknown, using divers to count density is not a feasible option. Instead, eelgrass patch shape and size will be used to estimate the density as high, medium, or low The sonar images will be ground-truthed with video images and assigned ranges of shoot counts based on diver counts along the transects in the Marine Outfall Corridor and the Reference Area. The median of each range will be used as the density for each category. Should the sonar images prove unable to distinguish patch densities, densities from similar depths along the Outfall Corridor will be used. Eelgrass in the Study Area will be replanted within the area delineated as disturbed by GIS at 100% of pre-construction density.

6.3 Eelgrass Survival Rates

After replanting is complete, the post-construction monitoring will be used to evaluate eelgrass survival and project success. The first two years of monitoring will provide indications of transplant failure and identify any replanting required. Subsequent monitoring will characterize eelgrass stability and attempt to identify any disturbances that have reduced eelgrass abundance. Monitoring in 2014 will be used to assess that the project goals of eelgrass habitat recovery have been met.

6.3.1 Performance Standards

Three eelgrass performance standards were developed to assess the restoration efforts over time using a set of measurable criteria that are indicative of eelgrass habitat. The performance standards are:

(1) Short-term (i.e., one year after planting in 2010) survival of transplanted eelgrass constitutes no more than 50% loss in eelgrass cover (area), or no greater than 75% loss in density.

(2) Long-term (i.e., 2014) survival of transplanted eelgrass within the Marine Outfall Corridor such that the total number of transplanted shoots, as measured along transects through the Marine Outfall Corridor, is statistically equivalent to pre-construction eelgrass abundance in the same area.

(3) Long-term (i.e., 2014) survival of transplanted eelgrass within the Eelgrass Study Area such that there is no significant loss in eelgrass coverage.

6.3.2 Short-Term Survival

The first two years of monitoring data will be examined for evidence of transplant failure. First year transplant success has a high correlation with long-term success. Since many transplant projects have greater than 50% decline in abundance during the first year, transplant failure will be identified by regions with greater than 50% loss in eelgrass cover (area), or regions with greater than 75% loss in density. The area and density from each monitoring survey will be corrected for any trend observed in the Reference Area between the monitoring year and 2008 (Year -1).

6.3.3 Long-Term Survival

Year 5 (2014) monitoring data will be used to assess the project success through evaluation of the performance goals. The eelgrass abundance within the Marine Outfall Corridor will be calculated as described in Section 3, and adjusted for any trend in the Reference Area between the monitoring year and Year -1 (2008).

The areal extent, as defined by the sonar imagery, of any replanted areas in the Eelgrass Study Area may be mapped in GIS dependent upon the extent of transplanting required, and corrected for any trends observed in the Reference Area. If only small areas are replanted in the Study Area, diver counts will be used to assess long-term survival The results will be evaluated to see if the Performance Standards are being met. If the long-term performance standard is not met for the Marine Outfall Corridor or Study Area in 2014, then monitoring will be conducted in Year 10 (2019) following a discussion with state agencies. Eelgrass abundance in 2019 will be calculated the same as previous years data and adjusted for any trend in the Reference Area. These results will be evaluated to see if the performance standards are met.

To compare the post-construction eelgrass abundance to the pre-construction abundance within the Marine Outfall Corridor, a statistical comparison will be made using a two-tailed T-test. The variance of each abundance estimate will be computed from the distribution of measured densities. The two abundances will be determined to be statistically similar if they agree at an 80% confidence level.

6.4 Trends in Eelgrass Density and Coverage

The monitoring program described for this study will provide an intensive mapping of eelgrass beds over more than a decade. The GIS maps of eelgrass coverage and density produced from each monitoring survey will provide a long term data set to analyze eelgrass trends and variability. After monitoring results from 2014 are obtained, the entire data set will be analyzed to establish changes in abundance and to create GIS maps showing changes in area. The changes in abundance and areal extents between the Reference Area and Study Area will be examined to document if the two areas are following similar patterns and their year-to-year variability. Correlations to external forcings, such as El-Nino, Coastal Upwelling Index, or annual solar radiation will be examined to see if significant correlations are obtained.

6.5 Reporting

Following each year in which monitoring activities occur (both pre- and post-construction), the data obtained will be evaluated by the end of each calendar year, and two short reports will be issued summarizing the years monitoring activities and results. Upon completion of all pre-

construction monitoring, one report will be issued providing a summary of the three monitoring events. The reports following the first and second year of post-construction monitoring will include a determination of initial transplant success and identify any areas that need to be replanted. Upon completion of Year 5 (2014) monitoring, a final report will be issued, documenting eelgrass transplant success and recovery against the project's performance standards and contingency actions that were necessary. If performance standards are not met in 2014, monitoring will occur in 2019 following a discussion with state agencies and a final eelgrass restoration report will be issued six months following completion of monitoring activities. All reports will be distributed to the appropriate state agencies.

7.0. EELGRASS RESTORATION, MONITORING, AND REPORTING SCHEDULE

This monitoring, restoration, and reporting schedule assumes an outfall construction period of about six months, beginning in May 2008. Construction details, including specific duration and timing of each task, are subject to change. To work with these uncertainties, this proposed monitoring and restoration schedule designates the year of construction as Year -1 (2008) and transplanting in 2009 as Year 0 (Table 7-1). A summary for each area is provided in Table 7-2. Uncertainties and contingency planning, discussed in Section 8.0, may affect the monitoring schedule specified in this document.

Post-construction annual monitoring will be scheduled for early summer (i.e., June) so that any eelgrass assessment and replacement can be completed within the same growing season (through September).

The Eelgrass Study Area, excluding the Marine Outfall Corridor, will be monitored pre-construction in 2004 and 2008 (Tables 7-1 and 7-2). The 2004 monitoring will provide information for additional planning efforts; the 2008 monitoring will provide additional information for assessing a range of eelgrass conditions. A post-construction survey for material spills or substrate alteration will occur immediately after construction in 2008 in the Marine Outfall Corridor Area, when construction contractors are still on site to remove or replace substrate. In early 2009, a post-construction sonar and georeferenced underwater video eelgrass survey will occur in the Study Area to identify areas that require transplants. If areas in the Eelgrass Study Area are to receive transplants, eelgrass transplanting is expected to occur in spring 2009. Any part of the Eelgrass Study Area that receives transplanted eelgrass due to eelgrass loss attributable to construction will be monitored for five years following eelgrass replacement. Transplanted eelgrass will be monitored post-construction in 2009, 2010, 2011, and 2014 (Years 0, 1, 2, and 5, respectively). If performance standards are not met by the end of 2014, then monitoring will be conducted in 2019 (Year 10) following a discussion with state agencies. If no decreases (relative to the pre-construction data) in eelgrass area are observed, then no further monitoring of the Eelgrass Study Area will be required after 2014.

The Marine Outfall Corridor will be monitored pre-construction during three years, in 2004, 2006, and 2008 (Tables 7-1 and 7-2). The 2004 monitoring will provide information for additional planning efforts; the 2006 and 2008 monitoring will provide additional information for assessing a range of eelgrass conditions. It is assumed that all eelgrass that was within the Outfall Corridor will need replacement. As stated above, eelgrass transplanting is expected to occur in spring 2009. The Marine Outfall Corridor will be monitored for five years following eelgrass replacement. Transplanted eelgrass will be monitored in 2009, 2010, 2011, and 2014 (Years 0, 1, 2, and 5, respectively). If performance standards are not met by the end of 2014, then monitoring will be conducted in 2019 following a discussion with state agencies.

The Reference Area will be monitored prior to construction during three years, in 2004, 2006 and 2008 (Tables 7-1 and 7-2) at the same time as the Marine Outfall Corridor. Pre-construction monitoring will provide information regarding natural eelgrass fluctuations in the area. Post-

construction monitoring will be conducted at the same time the Marine Outfall Corridor in Years 2009, 2010, 2011, and 2014. If performance standards are not met by the end of 2014, then monitoring will be conducted in 2019 as well.

The 2009 reconnaissance video surveys will be conducted in late summer and fall in areas that receive transplants to check the status of the transplanted eelgrass and note any problems that may have developed. Additional reconnaissance video surveys will be conducted in late winter, spring, and fall in 2010. Observations of potential disturbances (e.g., large numbers of crab or drift debris) or missing areas of transplanted eelgrass will be noted and discussed in the framework of contingency planning to determine if further corrective action is necessary.

Following each annual pre-construction monitoring event, two monitoring reports will be prepared that describes the survey, statistical methods, and results. One report will contain results from the diver survey and the other results from the sonar and underwater video surveys. The monitoring reports will include all survey work completed since the previous report. Each report will be issued within six months of the last data collected at the site and distributed to all state agencies involved in this plan. Following completion of the entire pre-construction monitoring program, a final report will be produced and distributed.

Following each year in which post-construction monitoring activities occur, the data obtained will be evaluated by the end of each calendar year, and a short report will be issued summarizing the years monitoring activities and results. Each report will be issued within six months of the last data collected at the site and distributed to all agencies involved in this plan. King County and resource agencies will meet following completion of each monitoring report to discuss the results and determine if alternative strategies are required to encourage transplant success. The reports following the first and second year of post-construction monitoring will include a determination of initial transplant success and identify any areas that were replanted, or are proposed for replanting the following spring. Upon completion of Year 5 (2014) monitoring, a final report will be issued, documenting eelgrass transplant success and recovery against the project's Performance Standards and contingencies actions that were necessary. If Year 10 (2019) monitoring is necessary, a report will be issued no longer than six months after data collection.

Table 7-1.
Eelgrass Habitat Activities Schedule

Year	Season	Activity	Area Monitored	Methods	Performance Standard
2004 Year -5	Summer	Reference site selection			
		Pre-construction monitoring and reporting	Study Area, Reference Area (& Donor Site, but don't process data)	Sonar, diver, georeferenced video	Initial Performance Standard value
		Establish harvest plots and pre-harvest eelgrass	Pre-harvested sections in Outfall Corridor	Diver	
2005 Year -4	Summer	Pre-harvest flowering shoots; pre-construction monitoring	Pre-harvested sections in Outfall Corridor	Diver	
2006 Year -3	Summer	Pre-harvest eelgrass; Pre-harvest flowering shoots	Pre-harvested sections in Outfall Corridor	Diver	
		Pre-construction monitoring and reporting	Pre-harvested sections in Outfall Corridor, Outfall Corridor, Reference Area	Diver	Monitor annual variation
2007 Year -2	Summer	Pre-harvest eelgrass; pre-construction monitoring	Pre-harvested sections in Outfall Corridor	Diver	
2008 Year -1	Summer	Pre-construction monitoring and reporting	Study Area, Reference Area, Outfall Corridor	Sonar, diver, georeferenced video	Develop Perfromance Standard; Monitor annual variation
	Spring to fall	Outfall construction			
	Fall	Post-construction monitoring	Outfall Corridor	Video by outfall contractor	Check for any spilled materials, equipment
2009 Year 0	Spring	Post-construction monitoring	Study Area	Sonar, georeferenced video	Determine locations (if any) for transplants; comparison with pre-construction data
	Spring	Eelgrass transplanting			
	Summer	Post-construction monitoring and reporting	Transplanted areas, Reference Area	Georeferenced video, diver	No test against Performance Standard
	Fall, winter	Reconnaissance survey	Only transplanted areas	ROV video	No test against Performance Standard
2010 Year 1	Summer	Post-construction monitoring and reporting	Transplanted areas, Reference Area	Georeferenced video, diver	Early evaluation testing
	Spring, fall, winter	Reconnaissance survey	Only transplanted areas	ROV video	No test against Performance Standard
2011 Year 2	Summer	Post-construction monitoring and reporting	Transplanted areas, Reference Area	Georeferenced video, diver	Early evaluation testing
2012 Year 3		No monitoring			
2013 Year 4		No monitoring			

Year	Season	Activity	Area Monitored	Methods	Performance Standard
2014 Year 5	Summer	Post-construction monitoring and reporting	Transplanted areas, Reference Area	Georeferenced video, diver	Test Against Performance Standard
2019 Year 10	Summer	Post-construction monitoring and reporting	Transplanted areas, Reference Area if performance standards are not met by end of 2014	Georeferenced video, diver	Final Test Against Performance Standard

Table 7-2. Monitoring Schedule by Area

	Pre-construction				
	2004	**2005**	**2006**	**2007**	**2008**
	Year - 5	**Year - 4**	**Year - 3**	**Year - 2**	**Year -1**
Marine Outfall Corridor	divers sonar UW [2] video	[1] nm	divers	nm	divers sonar UW video
Eelgrass harvest plots	established	divers	divers	divers	nm
Study Area	sonar UW video	nm	nm	nm	sonar UW video divers
Reference Area	sonar UW video divers	nm	divers	nm	sonar UW video divers
Donor Site	sonar UW video	nm	nm	nm	nm

	Post-Construction					
	2009	**2010**	**2011**	**2012**	**2013**	**2014**
	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5 ****
Marine Outfall Corridor	divers UW video ROV video [3]	divers UW video ROV video	divers UW video	nm	nm	divers UW video
Study Area	UW video [4] sonar [4] divers *	UW video * sonar * divers *	UW video * divers *	nm	nm	UW video * sonar * divers *
Reference Area	divers UW video	divers UW video	divers	nm	nm	divers UW video
Donor Site	nm	nm	nm	nm	nm	nm

[1] nm = no monitoring

[2] UW = georeferenced underwater video

[3] ROV video = quarterly reconaissance surveys

[4] Pre-transplant

* Study Area will only be monitored if receives transplants, methods may shift to divers & UW video only

** If performance standards are not met in 2014, monitoring will occur in 2019

8.0. UNCERTAINTIES AND CONTINGENCY PLAN

The Brightwater Treatment System marine outfall restoration and monitoring plan will be conducted within a contingency framework. The primary components of this framework are the restoration goals described in Section 2.0 with clearly defined monitoring and mitigation endpoints based on the monitoring goals. Contingency planning is appropriate for this project, considering the uncertainties associated with this effort and King County's strong commitment to expedite full recovery of the affected area. Contingency planning acknowledges uncertainties and provides an approach for effectively addressing them. Experience with past eelgrass restoration projects in the Northwest (Thom, 1990; Parametrix, 1994; 1997; Southard et al., 2003; Grette Associates, 2003a), along with a growing body of research on eelgrass in the region (e.g., Thom et al., 2001) and nationally (Fonseca et al., 1998), provide the foundation of literature for this contingency plan.

8.1 Uncertainties

The goal of this project is to restore disturbed eelgrass habitat to pre-construction conditions. The vision for the program is to restore eelgrass in a relatively short period following cessation of construction activities. Based on several factors including: (1) eelgrass existed at the study area prior to construction, (2) physical disturbances associated with construction will be discontinued or abated prior to restoration, (3) physical conditions (i.e., elevation, substrata) will be restored following construction, and (4) viable and dense eelgrass meadows exist adjacent to the study area, it is assumed that the disturbed portion of the study area has a moderate to high probability of recovering to pre-construction conditions. Although this goal is presently thought to be attainable, many factors could affect recovery rates and patterns, including:

- Natural variation in eelgrass abundance
- Natural variation in eelgrass reproduction level
- Effects of short-term shading from construction barges and other vessels
- Effects of accidental sediment spills, and removal actions
- Climate conditions such as severe storms or El Niño events
- Algal blooms (e.g., ulvoid seaweeds)
- Disturbance by crabs or other animals
- Beach erosion
- Disturbance by boating activities unrelated to Brightwater Treatment System construction
- Disturbance by floating large woody debris
- Spills of toxic material
- Vandalism.

Additional uncertainties in predicting restoration success include a lack of data on eelgrass recovery rates for the beds in proximity to the Point Wells shoreline and limited capabilities to predict actual spatial patterns of recovery.

This monitoring program is designed to characterize and document these factors through qualitative surveys as well as quantitative sampling. To help interpret the results of the monitoring program, information from ongoing monitoring programs in Puget Sound (e.g., Washington Department of Natural Resources eelgrass monitoring program), climate data, water quality data, and site observations will be included in annual assessments of the monitoring results. In addition, special short-term studies or observations may be conducted as needed to further evaluate and solve a suspected problem. The combination of onsite and reference area monitoring, problem solving, and consideration of regional conditions constitute a powerful approach to assessing and enhancing the progress of the restoration project.

8.2 Contingency Plan Framework

Under this framework, three basic actions can be taken:

- No action (make no changes, and monitor the outcome),
- Make changes of some sort (e.g., modify site conditions or replant) to enhance the chances of meeting the goal, and
- Change the goal (admit that the goal was incorrect for the project and develop a new, more realistic goal).

This framework is based on an understanding of eelgrass recovery rates and the factors that control recovery rates. The basic assumption is that as the conditions improve for eelgrass, eelgrass will recover. In this plan, optimal conditions are defined as the site-specific conditions (i.e., approximate number of eelgrass shoots) present prior to construction. If the appropriate number of transplanted shoots does not survive, probable reasons should be identified through the monitoring program. Once known, decisions on appropriate actions, as indicated in the flow diagram (Figure 4), will be taken. The assessment of the progress of eelgrass habitat recovery will be reported annually (except in 2014) to the applicable state agencies. If contingency actions are required, then meetings with state agencies will be proposed to discuss acceptable solutions. Appropriate actions will develop from these discussions. This basic approach will be applied to all areas monitored.

Under this adaptive management approach, it is likely the plans outlined in this document will be modified in order to obtain a successful outcome and meet the restoration goals. At the start of the post-transplant monitoring program, 6 years will have passed since this plan was proposed. Advances in monitoring techniques and eelgrass restoration may necessitate changes to the plans and/or goals of this project. This document will in effect, become a “living document” and be amended as needed.

8.3 Contingency Plans

8.3.1 Transplant Areas

If transplanted eelgrass shows a statistically significant decline from baseline shoot count (or mean density), the transplant data will be compared to reference area data and “scaled” to remove the effects of environmental fluctuations in the general area. If the short-term survival rate does not meet the Performance Standard, then contingency measures will be taken and lost eelgrass will be replaced towards the end of 2010. If the reconnaissance surveys conducted multiple times during the first and second year post-transplant show a readily-correctable factor which may be

affecting eelgrass survival, actions will be taken immediately to replant or correct the disturbance factor.

Factors affecting substrate and elevation (e.g., propeller scour or material spills) will be assessed for the level of effort needed to correct the problem. If the underlying cause cannot be identified, eelgrass will be transplanted into the affected area for one year only. If the underlying cause can be identified and rectified, eelgrass will be transplanted into the affected area with the intent to repeat the transplant one additional year, if necessary. If the underlying cause can be identified, but not rectified, consultation with state agencies will be initiated to determine appropriate adaptive strategies. Likewise, if eelgrass fails in two successive transplant attempts, alternative strategies will be considered. It is anticipated that the pre-construction monitoring, eelgrass transplanting, reconnaissance surveys and post-construction monitoring within all areas will provide valuable information for consideration in the unlikely event of a transplant failure.

Areas that cannot successfully support eelgrass, whether through multiple (failed) transplant attempts or unrectifiable circumstances, will be assessed to determine the area and density of lost eelgrass habitat. If the eelgrass decline in the Eelgrass Study Area corresponds to a natural decline in area and/or density in the reference site, King County will undertake no additional effort. Similarly, if the decline in the Eelgrass Study Area is attributable to activities unrelated to the outfall (e.g., Chevron Barge Dock oil spill, boat grounding, etc.), King County will commence discussions with state agencies to determine an adaptive approach site management. However, if the two successive eelgrass transplant failures are attributable to actions related to outfall construction, presence, or restoration approach, then to compensate for this lost habitat function, the County and state agencies involved with this plan will determine and agree upon how to compensate for the permanent loss of eelgrass in order of priority: on-site, in-kind; off-site, in-kind; on-site, out-of-kind; and off-site, out-of-kind. Once this process has been completed and no other alternatives are reasonable and available except for off-site, out-of-kind mitigation, derelict fishing gear will be removed preferentially from areas that are no longer actively fished and also provide function and value equal to or greater than the habitat lost.

9.0. MITIGATION FOR OTHER SPECIES

9.1 Mitigation for Physical Presence of Pipe:

The physical presence of the pipe on the seafloor from –80 ft Mean Lower Low Water (MLLW) seaward to the diffuser at approximately –605 ft MLLW will permanently displace benthic organisms beneath the pipe, including both invertebrates and fish. To mitigate for these losses, derelict fishing nets will be removed off-site to improve and /or reclaim habitat for benthic organisms.

Benthic infauna will be monitored both pre- and post-construction from -80 to approximately -605 ft MLLW. This mitigative monitoring will identify benthic community structure prior to construction and evaluate community structure post-construction to assess recovery. A sampling and analysis plan for benthic infauna was developed in 2006, prior to construction (King County, 2006).

After completion of nearshore construction landward to Portal 19, riparian habitat that has been disturbed will be replanted. Restoration of riparian habitat is also mitigation for physical presence of the pipe.

The pipe itself will provide hard substrate where none currently exists. It is expected that the pipe will provide substrate for many invertebrates such as anemones, encrusting and soft corals, and shrimps, and will be rapidly colonized. The presence of the pipe will create an artificial reef, providing habitat for invertebrates as well as benthic and epibenthic fish, such as some rockfish species. This reef effect has been seen at other County outfall pipes. The agencies involved in this plan, however, do not accept or approve the presence of the pipe's reef effect as acceptable mitigation.

9.2 Mitigation for Dungeness Crab

Nearshore construction from the intertidal zone down to –80 ft MLLW may cause mortality to Dungeness crabs that are entrained in the trenched sediments. Sheeted trench will be used to minimize such impacts to –30 ft MLLW since fewer crabs have the potential to suffer mortality in the sheeted trench area given that the impacted area is expected to be 23 ft or less. Although little information exists on the presence of crabs near the outfall alignment, the Marine Outfall Corridor area is not expected to contain an abundance of Dungeness crab as no crabs were observed in the vicinity of the corridor during a geoduck survey conducted in 2002 (King County, 2002a) and none were noted during the diver survey in September 2004. King County will provide $20,000 to WDFW to compensate for the loss of adult Dungeness crab during trench and outfall construction. As stated above, few adult Dungeness crab are expected to be present in the corridor and it is anticipated that the actual compensation value for loss of Dungeness crabs will be far less that $20,000, although whether or not this will be sufficient will depend upon results of the crab survey. If Dungeness crab compensation value is less than $20,000, the remaining funds will provide compensation to WDFW to conduct shellfish studies to gain information that is currently lacking for Dungeness crab and/or spot prawns. In the event more Dungeness crabs are lost than expected and the compensation value exceeds $20,000, King County will compensate for the full amount. King County is providing funds to the Suquamish Tribe to conduct studies to

fill data gaps regarding the presence and distribution of various Dungeness life stages as part of a separate mitigation agreement.

During construction, reasonable effort will be made to exclude adult Dungeness crabs from the trench area . The County will monetarily compensate WDFW for adult Dungeness crab mortalities suffered during construction based on the estimated number of crabs and the ex-vessel price of crabs at the time of construction.

The top layer (1 to 2 ft) of native substrate that was stockpiled during nearshore construction will be replaced in order to match sediment characteristics to those prior to construction. This mitigative measure will allow Dungeness crabs to resettle following construction into sediments with equivalent physical characteristics.

9.3 Mitigation for Intertidal Biota

Intertidal epifauna and infauna will be monitored both pre- and post-construction from +6.6 to -2 ft MLLW. This mitigative monitoring will identify epifauna and infauna biota structure prior to construction and evaluate biota structure post-construction to assess recovery. Biota will be assessed using standard transect and quadrat methodology. A sampling and analysis plan for intertidal biota was developed in 2006, prior to construction (Dethier et al., 2006).

In addition, the top layer (1 to 2 ft) of native substrate that was stockpiled during nearshore construction will be replaced in order to match sediment characteristics to those prior to construction. This mitigative measure will allow intertidal organisms to resettle following construction into sediments with equivalent physical characteristics.

9.4 Mitigation for Geoducks

King County will use existing geoduck survey information (King County 2002a) to estimate the number of geoducks that could potentially be removed or killed due to the construction of the nearshore section of the marine outfall (0 to –80 ft MLLW). The total pounds of geoducks will be estimated based on mean weights for the area documented in King County 2002a. As mitigation, King County will provide a one-time payment based upon total weight of geoducks impacted and the current value of geoducks at the time of construction.

The geoduck survey conducted in 2002 reported a mean geoduck density of 0.80 individuals/m^2 (0.074/ft^2) and a mean weight of 1.13 kg (2.5 lbs) for the area from Edwards Point south to Meadow Point (King County, 2002a). The reported mean geoduck density calculated from the transect surveyed closest to the outfall alignment (#22) contained 1.12 individuals/ m^2 (0.104/ft^2) and had a mean weight of 1.10 kg (2.42 lbs). The area of disturbance is calculated to be 1,900 m^2 (20,500 ft^2). Using data from the area surveyed closest to the outfall alignment, the compensatory mitigation is calculated as follows:

Total number of impacted geoducks = 0.104 individuals/ft^2 × 20,500 ft^2 = 2,132

Total pounds of impacted geoducks = 2,132 individuals × 2.42 lbs = 5,159.4

Monetary compensation = 5,159.4 × ex-vessel price of geoducks

9.5 Mitigation for Temporal Construction Impacts

King County proposes to mitigate the temporal impacts associated with construction of the Brightwater marine outfall through removal of derelict fishing gear from the Puget Sound area. This provides a direct and meaningful benefit to the aquatic resources by removing gear that kills fish and smothers or scours eelgrass. The temporal loss of habitat and disturbances to fish due to general marine construction activities will be mitigated through the removal of derelict fishing nets and abandoned crab pots. King County will provide $25,000 to the Derelict Fishing Gear Removal Project to remove gear in the vicinity of the project site.

Specific gear to be removed will be selected from existing inventories of derelict gear, based upon location, depth, and presence of eelgrass. Preference will be given to geographically clustered gear, proximity to Point Wells, and to gear located within known eelgrass beds.

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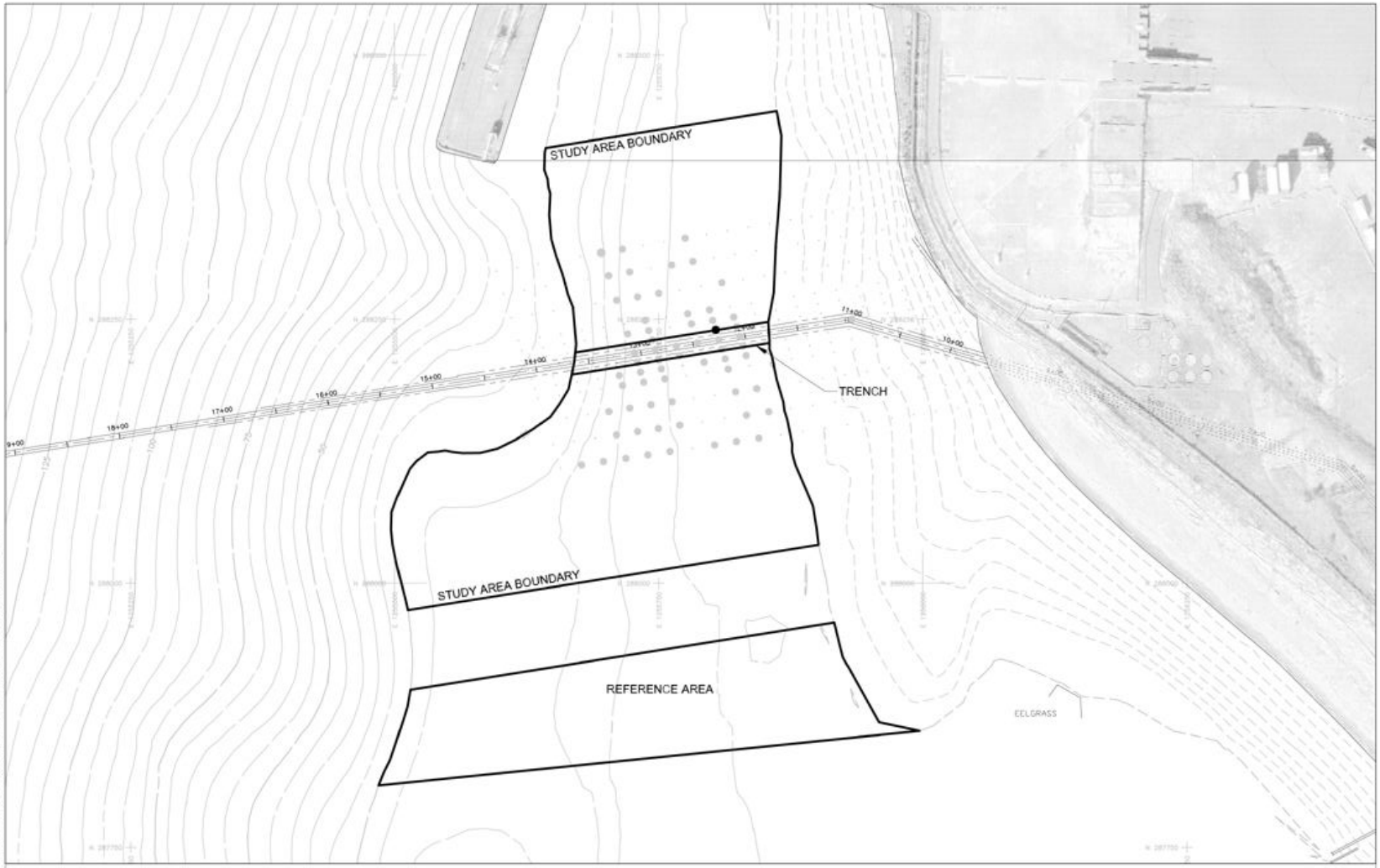
FIGURES



King County
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MEAN EELGRASS DENSITY
1 - 100 SHOOTS/METER SQ.
101 - 200 SHOOTS/METER SQ.

NOT TO SCALE

FIGURE 1
STUDY AREA LOCATION
BRIGHTWATER EELGRASS RESTORATION AND MITIGATION PLAN

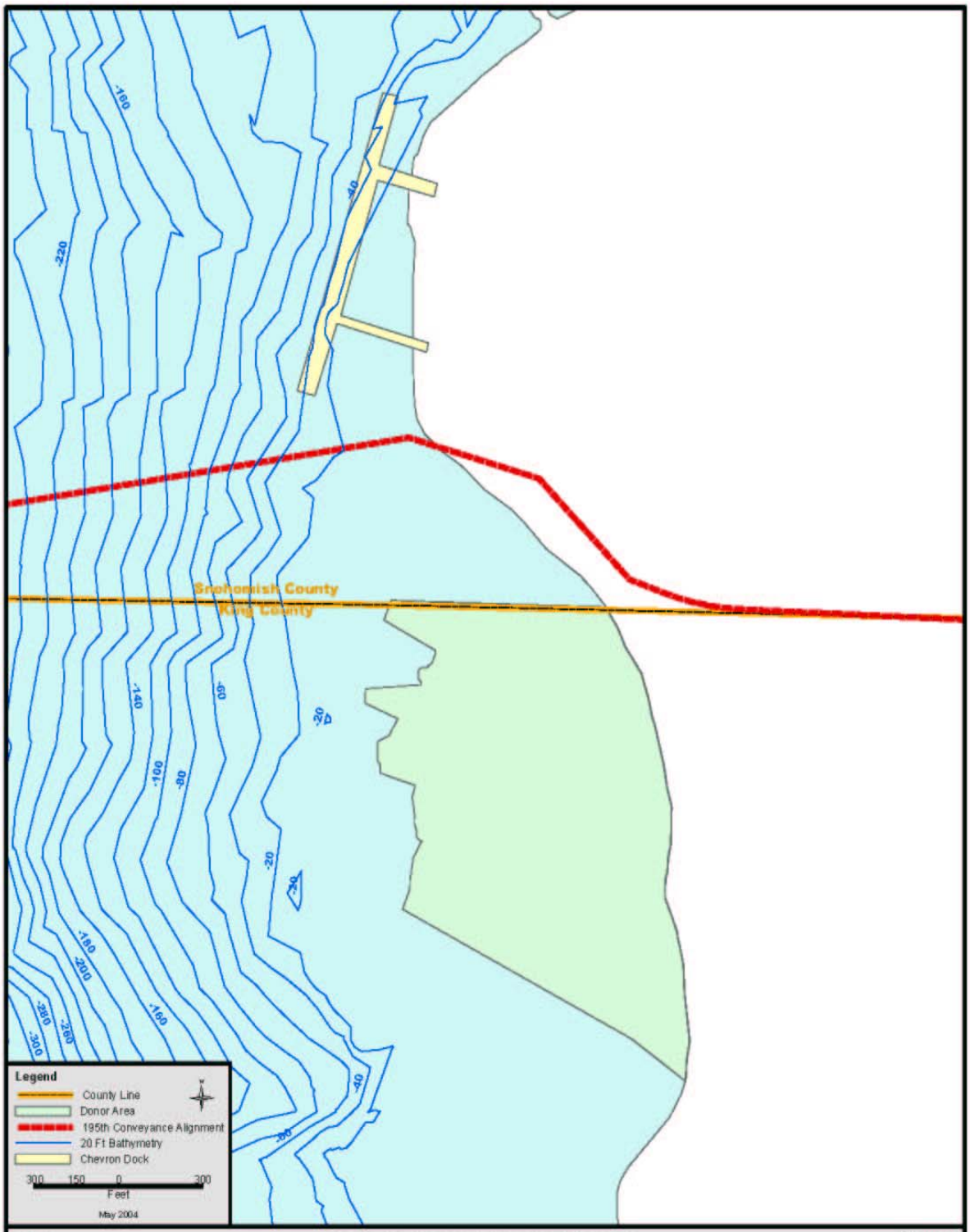

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Figure 2

Eelgrass Donor Bed

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

Figure 3. Depiction of 0.25-m^2 quadrat locations around sample points using WDFW triplicate method.

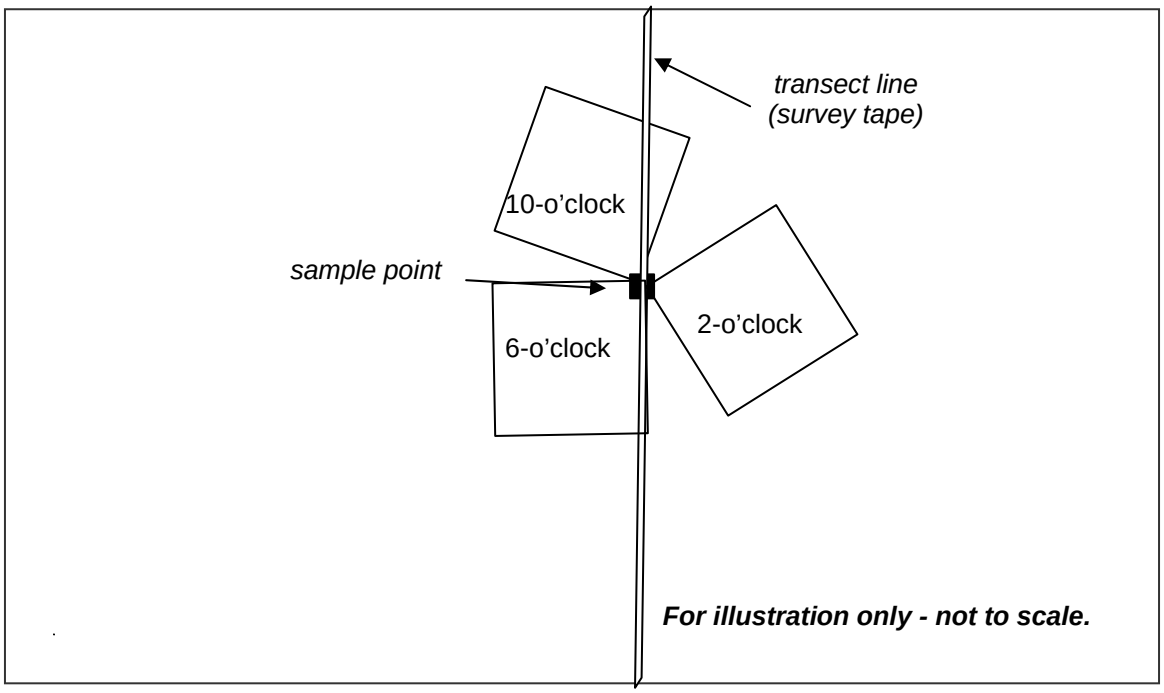
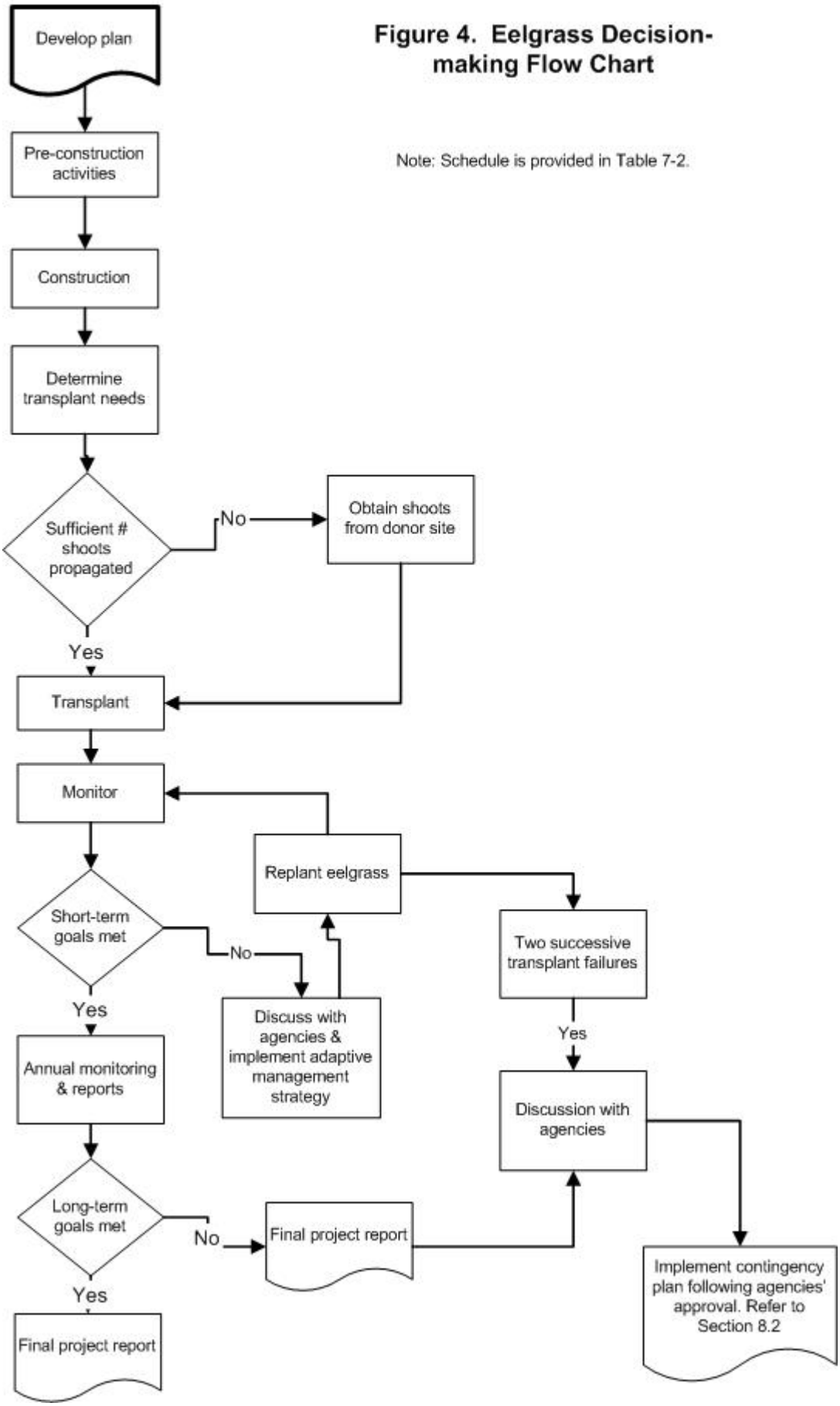


Figure 4. Eelgrass Decision-making Flow Chart

Note: Schedule is provided in Table 7-2.