King County Brightwater TREATMENT SYSTEM

BRIGHTWATER CONVEYANCE FINAL DESIGN

Eelgrass Program: 2006 Eelgrass Dive Survey Report

Task 200 – Permitting

Subtask 202- Outfall Support Services

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Rev 1

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Department of Natural Resources and Parks
Wastewater Treatment Division

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Chapter 1
Introduction

As part of the new Brightwater Treatment System, King County ("County") is planning to build a new sewer outfall immediately south of Point Wells, Washington (Figure 1), scheduled for construction in 2008. Although the outfall was sited at Point Wells to minimize effects on nearshore marine areas, specifically eelgrass (*Zostera marina*) beds, there will be unavoidable impacts to eelgrass during the construction phase of this project (King County 2003a, b). The County has prepared an *Eelgrass Restoration and Biological Resources Implementation Work Plan* (Work Plan) that describes a multi-year eelgrass monitoring program for the Brightwater outfall project (King County 2005). The eelgrass monitoring component of the Work Plan includes both dive-based density surveys and a combination of sonar and underwater video-based coverage surveys. The current construction schedule calls for pre-construction monitoring surveys to be conducted in 2004, 2006, and 2008. This report provides methods and results for the second dive survey conducted during the July 25-26, 2006 monitoring activities.

1.1 Previous Eelgrass Surveys

A dive-based eelgrass survey was completed in 2003 at the outfall site as part of the outfall siting process (King County 2003b). The survey included a series of 13 transects 420 feet (ft) in length (from Mean Higher High Water [MHHW] to at least -25 ft Mean Lower Low Water [MLLW]), centered on the proposed outfall alignment at a coarse resolution scale. The seven central transects were spaced at 10-ft intervals, while the outer six transects were at 25-ft intervals, encompassing a total distance of 210 ft (105 ft on either side of the outfall centerline). Eelgrass within the outfall corridor determined by the WDFW triplicate method (see Section 2.2), ranged from 4 to 113 shoots/meter^2 (m^2), and an average density of 31 shoots/m^2. Based on these data, the dive-based eelgrass monitoring program was designed to include only those elevations expected to include eelgrass, 0 to -25 ft MLLW. In 2004, a pre-construction dive survey was conducted at the site using the methods described in Chapter 2, which in brief have transects spaced at 5-foot intervals with measurements (triplicate counts) conducted every 10 feet in the outfall area and 20 feet at the reference location. See Chapter 2 for a detailed discussion of the survey methods. Also, in 2004 and again in 2005 the eelgrass within the entire Study Area (defined below) was mapped using Side-Scan sonar and roughly quantified using underwater videography (PNNL 2006). The results of those efforts are presented under separate cover.

1.2 Survey Areas

For pre-construction monitoring, the Work Plan defines three specific monitoring areas at Point Wells: the Eelgrass Study Area (sonar and underwater video only), the Marine Outfall Corridor, and the Eelgrass Reference Area. Based on 2003 eelgrass distributions at this site (King County 2003b), all monitoring areas include elevations between approximately 0 ft MLLW and -25 ft MLLW. The diver surveys in 2004 and described in this report were conducted only in the Marine Outfall Corridor and the Reference Area. For clarification purposes, a description of the Eelgrass Study Area is also included.

The Eelgrass Study Area surrounds the proposed outfall alignment 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.

The Marine Outfall Corridor is within the greater Eelgrass Study Area. It is a 20-ft wide area centered along the outfall pipeline alignment, including allowances for the 12-ft wide sheeted trench area with an additional 4-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).

The Eelgrass Reference area is approximately 332 ft SSE of the Marine Outfall corridor, well outside of the area in which construction impacts are anticipated (Figure 2).

1.3 Dive Survey Monitoring Schedule

Dive surveys on the transects at the Marine Outfall Corridor and Eelgrass Reference Area conducted in 2004 are the first in a number of years of pre- and post-construction monitoring planned for the site as presented in the Work Plan (Table 1). Assuming outfall construction occurs as scheduled (summer 2008) the 2006 monitoring effort is Project Year -2.

In addition to the dive surveys described above, the Work Plan also calls for sonar and video surveys and results of these surveys will be reported under a separate cover. A separate dive-based monitoring program will be implemented to monitor harvest areas in the Marine Outfall Corridor and this also will be reported under a separate cover.

Table 1. Dive Survey Monitoring Schedule.

Calendar Year*, Season	Monitoring Year	Survey Areas	Survey Purpose
2004, Summer	Year -5	Marine Outfall Corridor, Reference Area	Establish baseline and variation
2006, Summer	Year -2	Marine Outfall Corridor, Reference Area	Establish variation
2008, Spring/Summer	Year 0	Marine Outfall Corridor, Reference Area	Establish variation
OUTFALL CONSTRUCTION			
2009 Spring/Summer	Year 1	Marine Outfall Corridor**, Reference Area	Transplant monitoring
2010 Spring/Summer	Year 2	Marine Outfall Corridor**, Reference Area	Transplant monitoring
2011 Spring/Summer	Year 3	Marine Outfall Corridor**, Reference Area	Transplant monitoring
2012 Spring/Summer	Year 4	Marine Outfall Corridor**, Reference Area	Transplant monitoring
2014 Spring/Summer	Year 6	Marine Outfall Corridor**, Reference Area	Transplant monitoring

* Calendar year has been adjusted from the 2004 schedule based on anticipated construction one year ahead of schedule.
** Marine outfall corridor monitoring may be expanded to include the greater Eelgrass Study Area if transplanting beyond the corridor is required.

Chapter 2
Methods

In 2004, eelgrass density monitoring occurred in two areas: the Marine Outfall Corridor and the Eelgrass Reference Area. Five transects were defined ahead of time in each area, and end points coordinates were identified on base maps. Transects 1, 3, and 5 at the Marine Outfall Corridor, were defined using the shallow endpoints for the three center transects from the previous eelgrass diver survey in 2003 (King County 2003b). For both survey areas, transects were spaced at 5-ft intervals (Figure 3 and 5).

2.1 Identification of Survey Areas

Survey areas were first identified and marked during 2004 surveys. Coordinates for shallow (0 MLLW) and deep end points for transects 1 and 5 were uploaded into the dGPS system and located in the field (Table 2). For deep endpoints, weighted buoys were deployed to temporarily mark transects 1 and 5. Because transect length in the reference area (400 ft) is greater than 300 ft (standard survey tape length), coordinates for additional reference points 200 ft waterward of MLLW also were determined and temporarily marked with weighted buoys (Table 2).

Distance between the Transect 1 and 5 end points and additional reference points for both survey areas as identified using dGPS were confirmed at 20 ft. Transect end points for the remaining three transects were spaced at 5-ft intervals from each other, and all end and reference points were marked with permanent markers. A fiberglass survey tape was placed between end points (or an end point and mid point at the reference area) of each transect to place additional markers. At the Marine Outfall Corridor, the transect end points at -25 ft MLLW are 190 ft from MLLW, and additional markers were placed at 50 ft, 100 ft and 150 ft along the transect. Markers were placed at 40 ft intervals at the Eelgrass Reference Area, ending 400 ft from MLLW. Following sampling, markers at elevations subject to tidal exposure were driven to no more than 2 inches above the substrate in order to make them less noticeable to beach walkers. Subtidal markers were driven into the substrate leaving 4 inches exposed at the surface.

During 2006 surveys, a dGPS system was used to relocate shallow end points of the Marine Outfall Corridor. Shallow end point markers were not found in the Marine Outfall Corridor, so new rebar was installed and driven to 2 inches above the substrate. All other markers at the Marine Outfall Corridor remained from the 2004 surveys.

At the Eelgrass Reference Area, shallow end point markers were located according to location and elevation based on tide levels in the field. Transects were deployed from these markers, and all but the deep end point markers from the 2004 were located during dive surveys. During review of the field data, it was determined that transects in the Eelgrass Reference

Area had been started 40-ft waterward of the actual end points at the second set of transect markers, and therefore that sample points had been extended an additional 40-ft into water deeper than -25 ft MLLW.

Table 2. Transect End and Reference Point Coordinates (NAD 83).

Area, Transect, Point	Northing	Easting
WDNR Survey Monument 1	287663.56	1256628.75
WDNR Survey Monument 2	287662.59	1256670.75
Marine Outfall, 1, onshore	288247.63	1255853.58
Marine Outfall, 5, onshore	288227.55	1255854.88
Marine Outfall, 1, offshore	288218.42	1255671.01
Marine Outfall, 5, offshore	288197.56	1255667.62
Eelgrass Reference, 1, onshore	287924.36	1255927.13
Eelgrass Reference, 5, onshore	287905.71	1255937.91
Eelgrass Reference, 1, 200-ft midpoint	287863.86	1255505.96
Eelgrass Reference, 5, 200-ft midpoint	287842.75	1255498.97
Eelgrass Reference, 1, offshore	287863.86	1255729.16
Eelgrass Reference, 5, offshore	287877.26	1255739.94

2.2 Survey Methods

Survey methods established during the 2004 eelgrass surveys were repeated in 2006. Eelgrass survey methods are based on Washington Department of Fish and Wildlife (WDFW) Eelgrass/Macroalgae Habitat Survey Guidelines. At each sample location, divers recorded triplicate shoot counts within a 0.25-m^2 quadrat rotated around the sample location to the 2, 6, and 10 o'clock position (relative to waterward orientation on the survey tape). The inside corner of the quadrats pivot around the same center point to ensure repeatability. This center point is the appropriate distance measured on a fiberglass survey tape stretched between permanent markers, in sample intervals specific to each survey area.

Divers stretched a fiberglass survey tape along each transect. The permanent markers were used to provide assurance that the tapes were properly deployed. Triplicate shoot counts were recorded at 10-ft intervals in the Marine Outfall Corridor and at 20-ft intervals in the Eelgrass Reference Area, starting at the shallow end point. Semi-quantitative estimates of macroalgae cover and composition as well as qualitative notes on substrate type also were recorded at each sample point. In addition, divers noted eelgrass patch edges along each transect (e.g., begin at 25 ft, end at 32 ft; begin at 54 ft, end at 67 ft).

At the Marine Outfall Corridor, a total of 20 samples were recorded along each transect. At the Eelgrass Reference Area, a total of 22 samples were recorded along each transect area. This includes 21 counts along the marked transect length, and an additional shoot count 20 ft beyond the end point. This additional sampling point was added to account for the

bathymetry at the Eelgrass Reference Area; the 0 to -25 ft elevation range extended slightly beyond 400 ft for some transects. Pre-existing sonar data from this site indicated that eelgrass did not extend to the end of any Reference Area transects, but the total sampling length was extended by 20 ft so that any changes in coverage at this depth would be recorded during annual monitoring. Because the transects extend 40-ft waterward of the 2004 surveys, 2006 surveys included areas 40 to 460 ft along the Eelgrass Reference Area transects.

2.3 Density Calculations

Eelgrass shoot density for each sample, reported as the number of eelgrass shoots per square meter, is calculated from the mean of the triplicate shoot count at the sample location multiplied by four (as the quadrats are 0.25 m^2). The WDFW method for density calculations requires that samples that were taken where eelgrass is present are included in density calculations for either survey area (i.e., a sample where all three triplicates have a shoot count of zero is not included).

Chapter 3
Survey Results

3.1 Marine Outfall Corridor

In the Marine Outfall Corridor, 28 of the 100 samples (28 percent) included eelgrass. Where present, average eelgrass density in this area was 55 shoots/m^2. Individual density measurements ranged from 8 to 101 shoots/m^2 (Figure 3). Across all sample points, including those where eelgrass was not present, eelgrass density in the outfall corridor was 16 shoots/m^2. Eelgrass was present above -15 ft MLLW. Eelgrass patches were observed along most transects from 55-145 ft, with patchy or sparse distribution along the transects (Figure 4). The greatest eelgrass density by elevation was 63 shoots/m^2 between 0 and -5 ft MLLW; greatest coverage (70% of sampled locations) occurred between -5 and -10 ft MLLW (Table 3). No rooted eelgrass was observed in the debris mat at the toe of the slope in the Marine Outfall Corridor.

Patterns of substrate composition and algae coverage were similar on all five survey transects (Appendix A). Substrate was generally coarse (cobble and gravel) from MLLW to between 70 and 80 ft along the survey transects (above -5 ft MLLW) and sandy for the remainder of the survey area. The greatest area of macroalgae coverage (primarily *Ulva* sp.) correlated to coarser substrates and shallower elevations, although there were also sparse areas in deeper, sandy substrates. Macroalgae presence in the Marine Outfall Corridor is displayed in Table 4. Qualitative diver observation included the presence of a number of invertebrates, including both Dungeness and red rock crab.

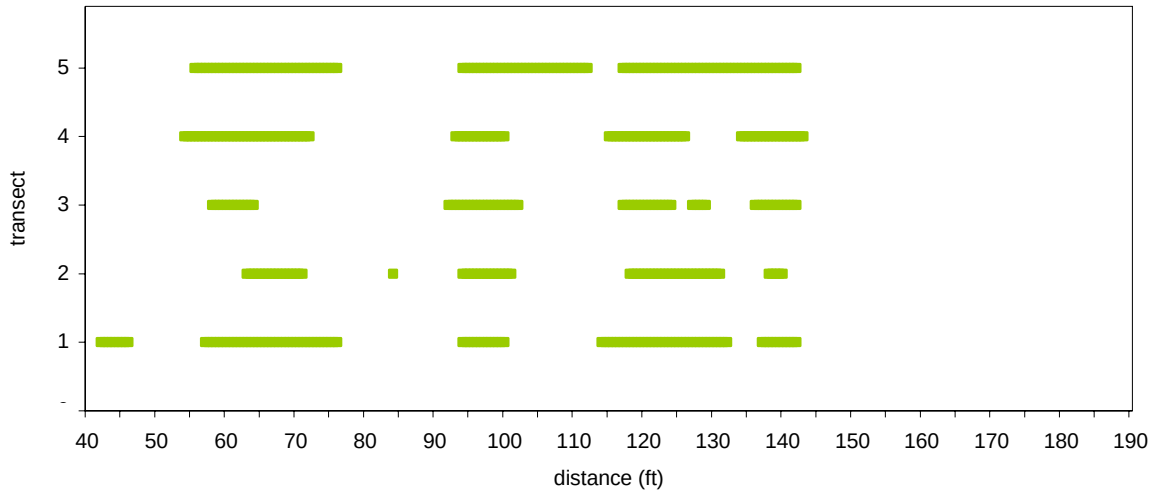

Figure 4. Eelgrass Edge Locations in the Outfall Corridor

3.2 Eelgrass Reference Area

In the Eelgrass Reference Area, 51 of the 110 samples (46 %) included eelgrass. Where present, average eelgrass density in this area was 49 shoots/m^2 (Figure 5). Across all sample points, including those where eelgrass was not present, eelgrass density in the outfall corridor was 23 shoots/m^2. Individual density measurements ranged from 5 to 168 shoot/m^2. Eelgrass was present between 70ft (~2ft MLLW) and 380 ft (<20 ft MLLW). Greatest eelgrass density by elevation was 91 shoots/m^2 between -5 and -10 ft MLLW; greatest coverage (86% of sampled locations) occurred between -10 and -15 ft MLLW (Table 3). While some eelgrass was present along the first 200 ft of the survey transects, most was part of a continuous band between approximately 200 and 380 ft (Figure 6). Eelgrass density tended to decrease between 240 and 300 ft along the transects, in correlation with increased macroalgae coverage. This is also an area where bathymetry changes quickly between -10 and -15 MLLW, before flattening out between -15 and -20 MLLW. The eelgrass patch ends between 376 and 390 ft along the survey transects, above -20 ft MLLW.

As with the Marine Outfall Corridor, substrate was generally coarser above -5 ft MLLW similar along all five transects, starting with cobble and gravel substrates at the shallow end and transitioning to mostly sandy substrate beyond 80 ft, with some coarser substrate as far as 120 ft along transect 5 (Appendix A).

Greater macroalgae coverage was observed in the area with coarser substrate in the shallow end of the survey area (primarily *Ulva* sp.), and also on the slope or its toe between -10 and -15 ft MLLW. Macroalgae composition in this area included large *Laminaria* spp. blades and a diverse assemblage of smaller species (Table 4). Beyond approximately 380 ft along the survey transects (just above -20 ft MLLW) macroalgae cover consisted of sparse single *Laminaria* blades with occasional other small taxa. The "sunken structure" observed at 260 ft on transect 4 in 2004 was located again in 2006.

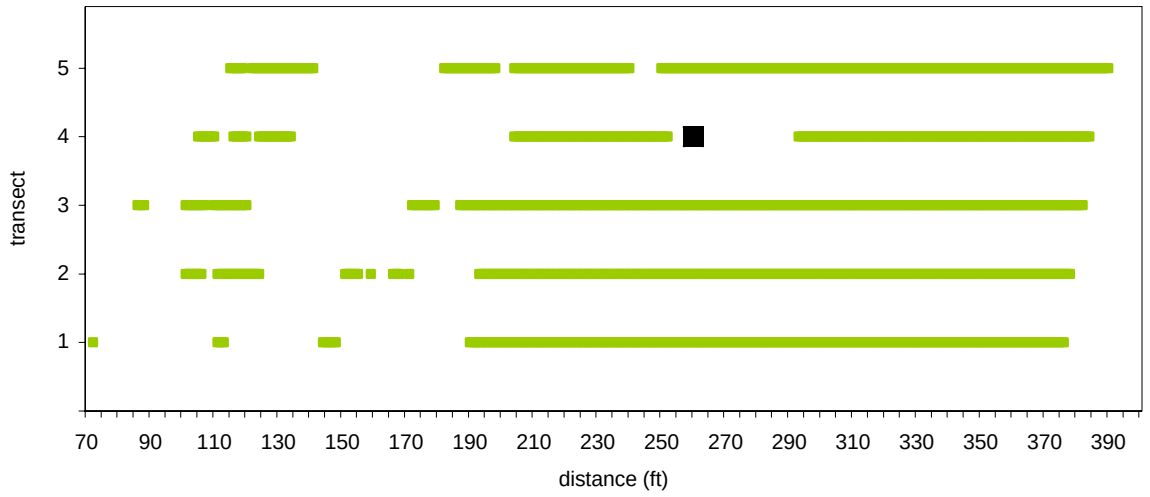

Figure 6. Eelgrass Edge Locations in the Reference Area (black square indicates sunken structure).

Table 3. 2006 Eelgrass observations by elevation at each survey area.

Elevation (ft below MLLW)	Marine Outfall Corridor				Eelgrass Reference Area			
	Average shoots/m^2 eelgrass*	n*	Average shoots/m^2 entire sample**	Samples**	Average shoots/m^2 eelgrass*	n*	Average shoots/m^2 entire sample**	Samples**
0 – 5	63	9	11	50	62	4	10	25
5 – 10	59	14	41	20	91	11	40	25
10 – 15	33	5	16	10	35	12	30	14
15 – 20	0	0	0	6	35	24	27	31
20 – 25	0	0	0	14	0	0	0	6
>25	--	--	--	--	0	0	0	9
All	55	28	16	100	30	50	23	110

* Based on observations with eelgrass (each observation is a density based on triplicate shoot counts)

** Based on all observations made at each elevation

Table 4. Macroalgae observed at each survey area.

Elevation (ft below MLLW)	Marine Outfall Corridor			Eelgrass Reference Area		
	Species	n*	Samples**	Species	n*	Samples**
0 – 5	*Ulva* spp.	40	50	*Ulva* spp.	19	25
	Smithora naiadium†	15		*Smithora naiadium*†	5	
	Laminaria spp.	18		*Cryptosiphonia woodii*	3	
	Enteromorpha sp.	20		*Gigartina* spp.	1	
	Cryptosiphonia woodii	3		*Sargassum* sp.	1	
	Porphyra perforata	5		*Enteromorpha* sp.	4	
	Gracilaria sp.	6		*Laminaria* spp.	2	
	Prionitis sp.	5		*Gracilaria* sp.	3	
5 – 10	*Ulva* spp.	15	20	*Ulva* spp.	16	25
	Smithora naiadium†	14		*Smithora naiadium*†	11	
	Sargassum sp.	1		*Cryptosiphonia woodii*	2	
	Laminaria spp.	2		*Laminaria* spp.	3	
10 – 15	*Ulva* spp.	6	10	*Ulva* spp.	14	14
	Smithora naiadium†	5		*Smithora naiadium*†	12	
	Laminaria spp.	2		*Cryptosiphonia woodii*	5	
				Laminaria spp.	11	
				Gracilaria sp.	8	
				Gigartina spp.	3	
				Prionitis sp.	2	
				Mazzaella spp.	1	
				Unknowns	2	
15 – 20	*Laminaria* spp.	2	6	*Ulva* spp.	27	31
	Ulva spp.	2		*Smithora naiadium*†	23	
	Gracilaria sp.	1		*Laminaria* spp.	21	
	Prionitis sp.	1		*Gracilaria* sp.	8	
				Mazzaella spp.	2	
				Cryptosiphonia woodii	1	
				Alaria sp.	2	
				Sargassum sp.	2	
				Gigartina spp.	1	
				Enteromorpha sp.	1	
				Prionitis sp.	1	
				Unknowns	6	
20 – 25	*Ulva* spp.	4	14	*Ulva* spp.	4	6
				Laminaria spp.	3	
				Gracilaria sp.	2	
				Gigartina spp.	1	
				Smithora naiadium†	1	
				Unknowns	1	
>25	not sampled			*Laminaria* spp.	2	9
				Ulva spp.	1	
				Gracilaria sp.	2	
				Gigartina spp.	1	
All		69	100		89	110

† Observed on eelgrass or *Ulva*

* Number of sampling locations where macroalgae species were observed

** Total number of observations made at each elevation

Chapter 4
Discussion

No plants were observed at depths greater than -15 ft MLLW in the Outfall Corridor during 2006 surveys. The elevation range at which eelgrass was observed was more similar to that observed in 2003, with no eelgrass observed deeper than -15 ft MLLW (Table 5). The few rooted plants observed in 2004 may have survived for a single season, but were unable to persist in the darker, deeper water. In Puget Sound, eelgrass typically becomes light limited at around -7 m relative to Mean Sea Level (Thom et al. 1999), which is approximately -13.5 ft based on 9.47 ft MSL at Edmonds. A number of other factors, including substrate and current as well as water quality and light transmission, can contribute to the lower extent of eelgrass. This may affect local differences like those observed between the outfall corridor and reference area, as well as differences observed at sites throughout Puget Sound. Inter-annual variation in site conditions, including light availability, also may have resulted in growing conditions favorable to eelgrass and influenced the increased densities observed at shallow elevations at both the outfall corridor and reference area compared to 2004. Overall, according to patch edges, eelgrass coverage was greater in 2006 than in 2004. Shoot density also was greater at all elevations where eelgrass persisted than observed during either 2003 or 2004 surveys, and had more than doubled above -10 ft MLLW (Table 5).

The Reference Area was not sampled during 2003 surveys. Eelgrass elevations were similar to those observed during 2004 surveys. Eelgrass coverage was greater in 2006, particularly above -10 ft MLLW. Shoot density also was greater at all elevations and had more than tripled above -5 ft MLLW (Table 5).

Table 5. 2004 and 2006 Eelgrass observations by elevation at each survey area.

Elevation (ft below MLLW)	Marine Outfall Corridor Average shoots/m^2	n*	Eelgrass Reference Area Average shoots/m^2	n*
2004				
0 – 5	26	9	18	3
5 – 10	29	10	52	11
10 – 15	20	4	29	12
15 – 20	3	1	23	24
20 – 25	7	4	0	0
All	23	28	30	50
2006				
0 – 5***	63	9	62	4
5 – 10	59	14	91	11
10 – 15	33	5	35	12
15 – 20	0	0	35	24
20 – 25	0	0	0	0
>25***	--	--	0	0
All	55	28	30	50

* Number of observations with eelgrass (each observation is a density based on triplicate shoot counts)

** Number reflects data from 40 to 460 along the Eelgrass Reference Area transect.

References Cited

King County. 2005. *Eelgrass Restoration and Biological Resources Implementation Workplan.* Prepared by Department of Natural Resources and Parks, Seattle, WA. October 2004.

King County. 2003a. *Final Environmental Impact Statement for the Brightwater Regional Wastewater Treatment System*. Prepared by Department of Natural Resources and Parks, Seattle, WA. November 2003.

King County. 2003b. Appendix 7-F Eelgrass *Survey Results for the Brightwater Marine Outfall Alternatives*. Final. Prepared for the Brightwater Project, Seattle, WA. September 2003.

PNNL. 2006. *2005 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation.* Prepared for King County Department of Natural Resources and Parks Wastewater Treatment Division, Brightwater Project. March 2006.

Thom, R.M., L.D. Antrim, A.B. Borde, W.W. Gardiner, D.K Shreffler, P.G. Farley, J.G. Norris, S.W. Echeverria, and T.P. McKenzie. 1999. *Puget Sound's Eelgrass Meadows: Depth Distribution and Spatial Patchiness. in Puget Sound Research '98, from Basic Science to Resource Management*, Olympia, Washington.

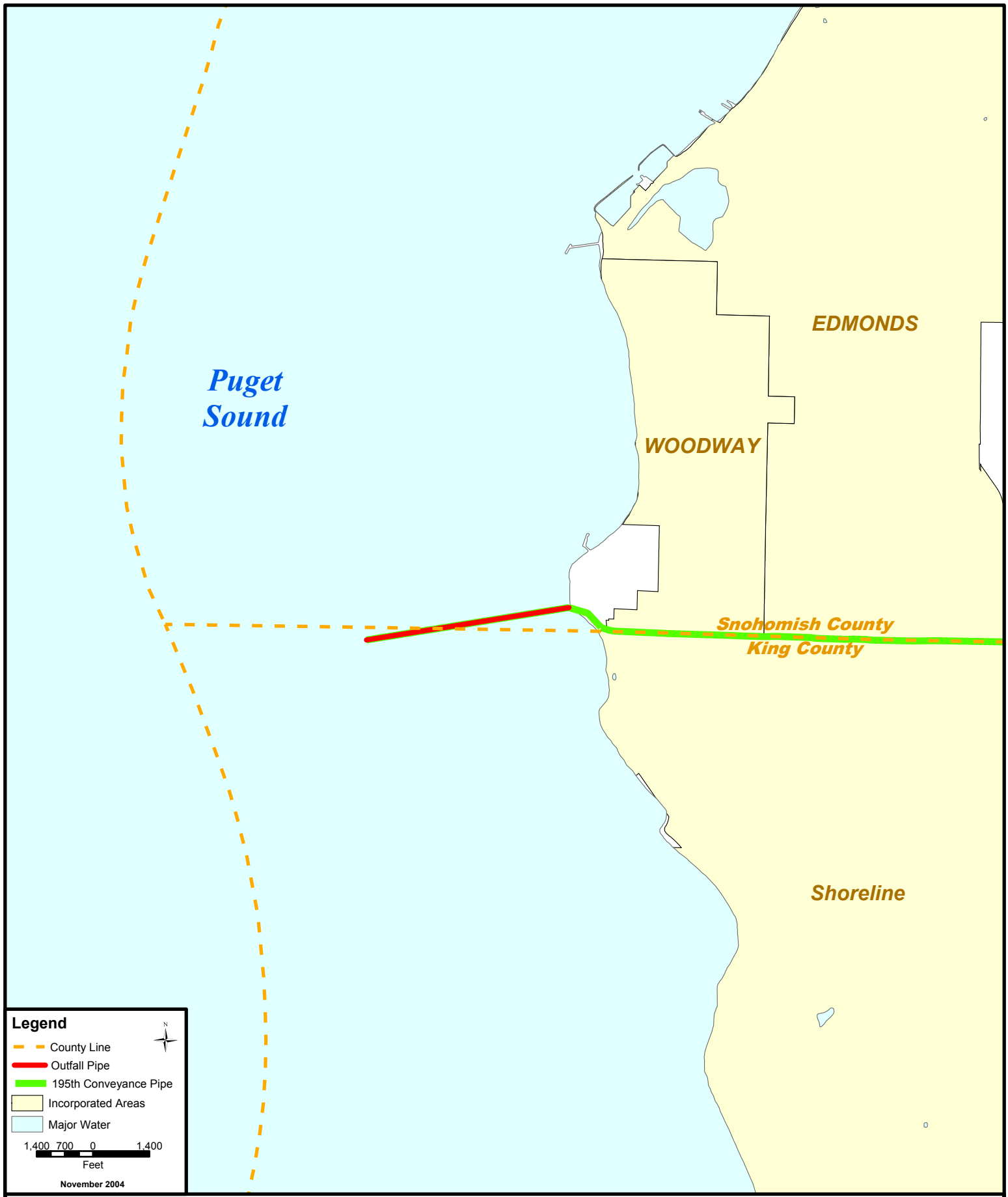

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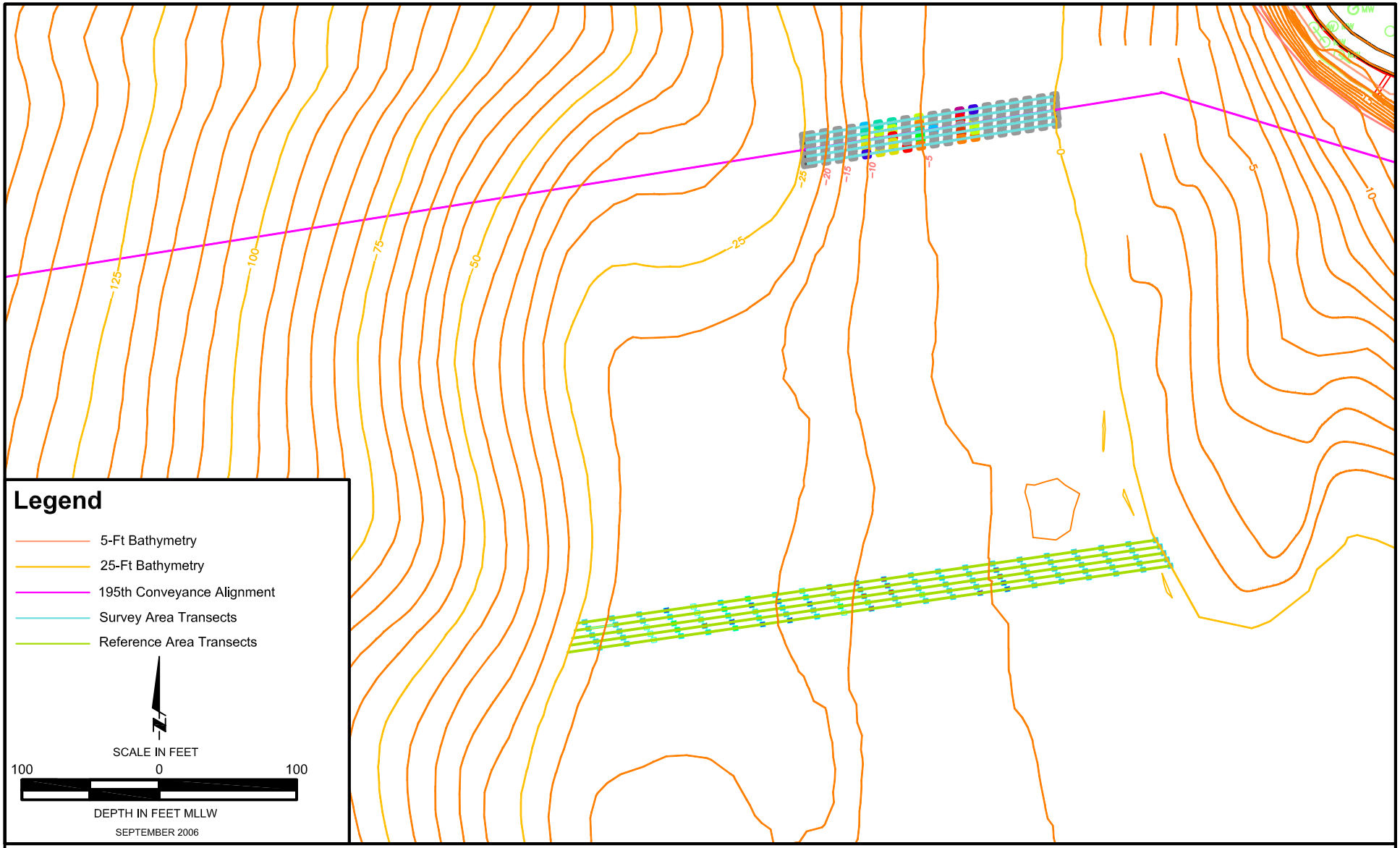
Figure 1

Marine Outfall Location

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM



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File Name: 312001100-4
Prepared By: Grette Associates, LLC

FIGURE 2

Marine Outfall Site
Survey and Reference Areas

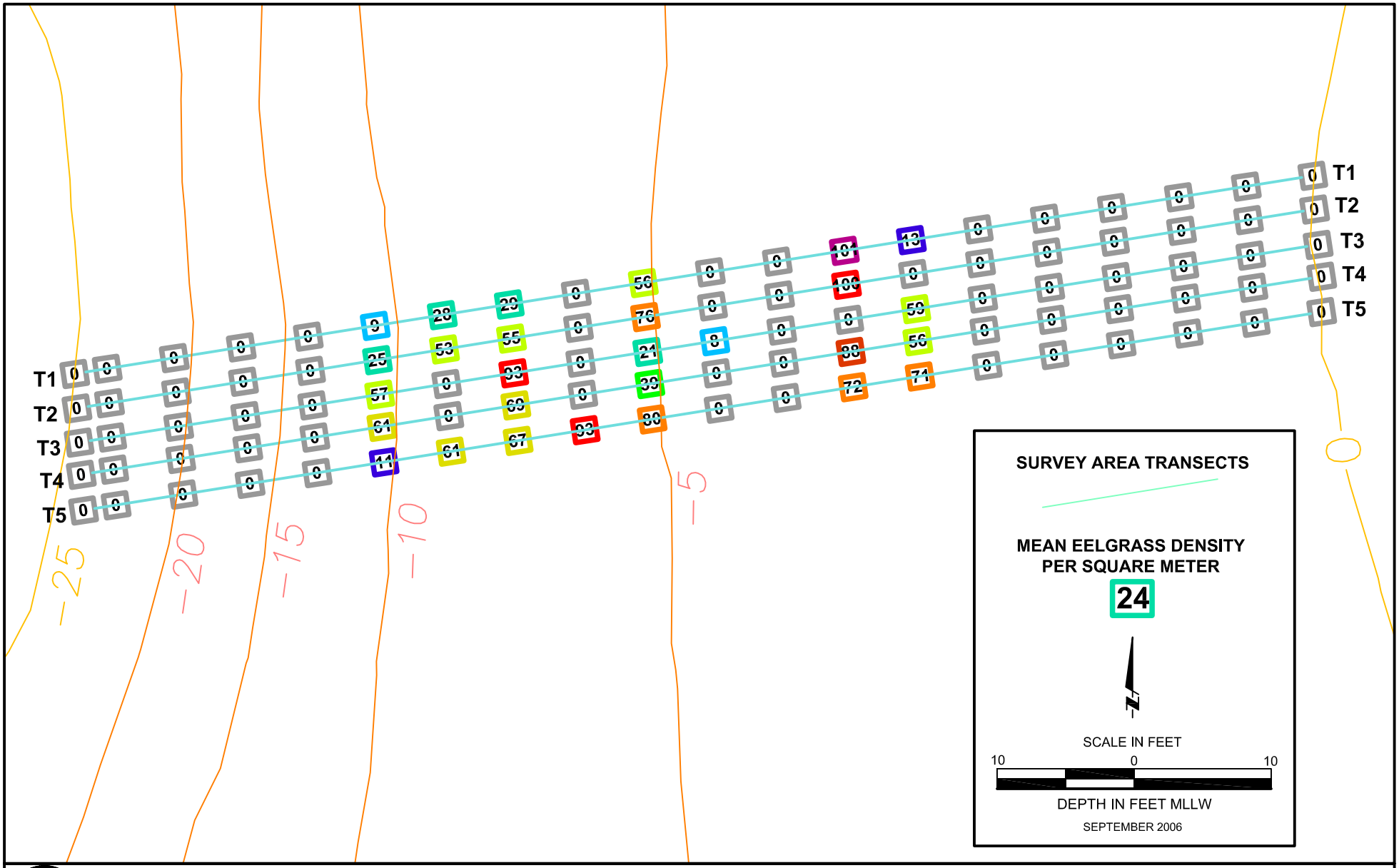

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FIGURE 3

MARINE OUTFALL CORRIDOR EELGRASS DENSITY

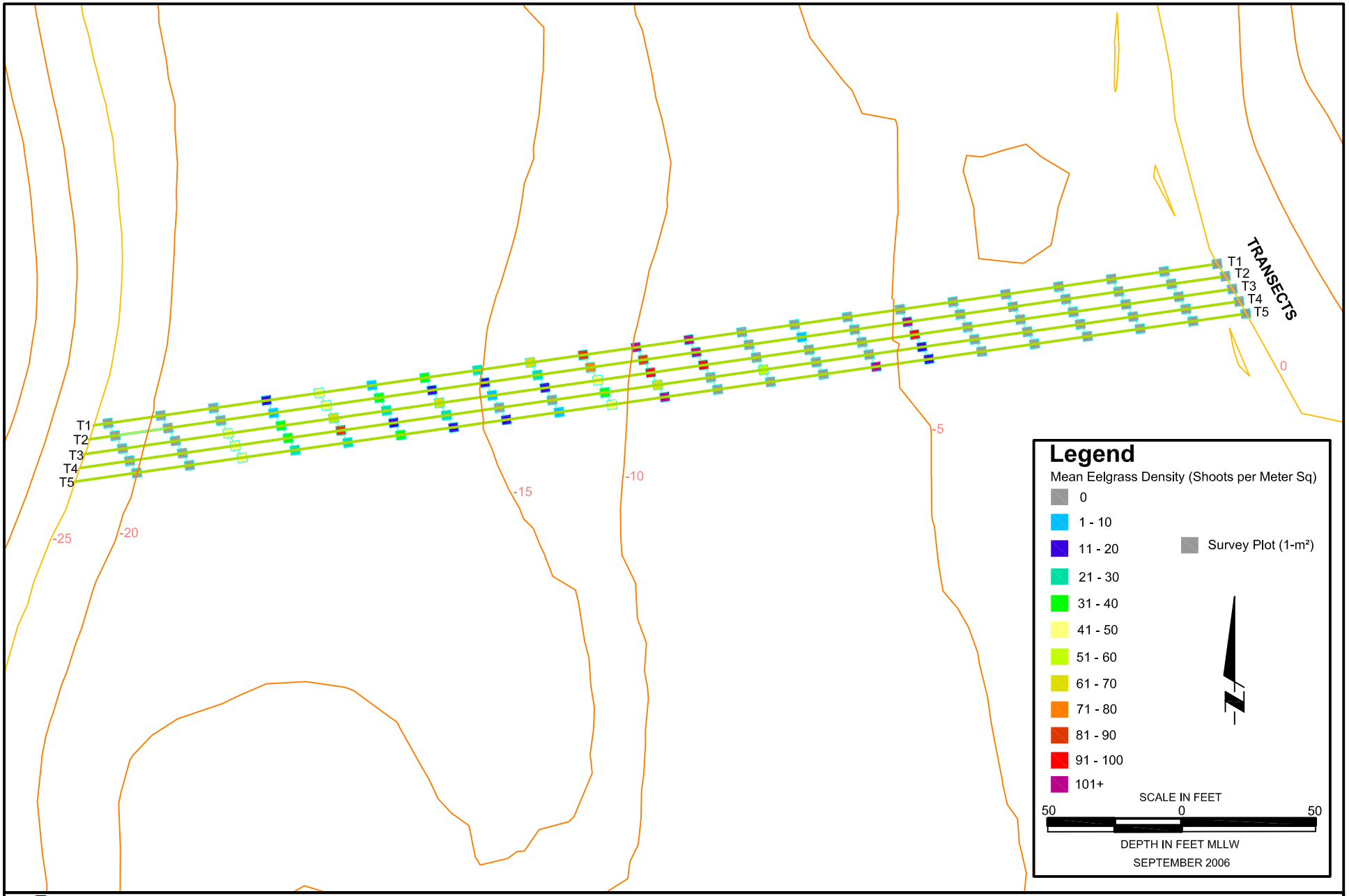

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FIGURE 5

REFERENCE AREA EELGRASS DENSITY

Appendix A

Brightwater Eelgrass Survey Data Table

2006

Table Legend

Transect:

SA, Study Area*
RA, Reference Area

Depth Bin:

1, 0 to -5 ft MLLW
2, -5 to -10 ft MLLW
3, -10 to -15 ft MLLW
4, -15 to -20 ft MLLW
5, -20 to -25 ft MLLW

Substrate (qualitative):

ro, rock
co, cobble
gr, gravel
sa, sand

Macroalgae Taxa:

al, *Alaria marginata*
cr, *Cryptosiphonia woodii*
en, *Enteromorpha* sp.
gi, *Gigartina* spp.
gr, *Gracilaria* sp.
la, *Laminaria* spp.
ma, *Mazzaella* sp.
po, *Porphyra perforata*
pr, *Prionitis* sp.
sa, *Sargassum* sp.
sm, *Smithora naiadium*
ul, *Ulva* spp.
unk., unknown

Eelgrass edge: b/e, begin/end

*Study Area refers to Marine Outfall Corridor Only

Year	Transect	Distance (ft)	Depth Bin	shoots / 0.25 m^2			Density (m^2)	Eelgrass edge	Substrate	Macro taxa	Notes
				2	6	10					
2006	SA-1	0	1	0	0	0	0		cb/sa	ul	
2006	SA-1	10	1	0	0	0	0		cb/sa	ul	
2006	SA-1	20	1	0	0	0	0		cb/sa	ul	
2006	SA-1	30	1	0	0	0	0		cb/sa	ul	
2006	SA-1	40	1	0	0	0	0	b 42 e 46	sa/cb	ul, sm	
2006	SA-1	50	1	0	0	0	0		sa/cb	ul	
2006	SA-1	60	1	0	5	5	13.333333	b 57 e 76	sa/cb	ul, la, cr, sm	
2006	SA-1	70	1	48	8	20	101.33333		sa/cb	ul, sm	
2006	SA-1	80	1	0	0	0	0		sa		
2006	SA-1	90	1	0	0	0	0	b 94 e 100	sa		
2006	SA-1	100	2	12	30	0	56		sa	sa,ul, sm	

Year	Transect	Distance (ft)	Depth Bin	shoots / 0.25 m^2			Density (m^2)	Eelgrass edge	Substrate	Macro taxa	Notes
				2	6	10					
2006	SA-1	110	2	0	0	0	0	b 114 e 132	sa		
2006	SA-1	120	2	0	13	9	29.333333		sa	sm,ul	BMSL test plot rebar
2006	SA-1	130	2	12	9	0	28	b 137 e 142	sa	sm,ul	
2006	SA-1	140	3	2	3	2	9.3333333		sa	sm	
2006	SA-1	150	3	0	0	0	0		sa		
2006	SA-1	160	4	0	0	0	0		sa		
2006	SA-1	170	5	0	0	0	0		sa		
2006	SA-1	180	5	0	0	0	0		sa		
2006	SA-1	190	5	0	0	0	0		sa	ul	debris mat
2006	SA-2	0	1	0	0	0	0		co/sa	ul, en	
2006	SA-2	10	1	0	0	0	0		co/sa	ul, en	
2006	SA-2	20	1	0	0	0	0		co	ul, en, la	
2006	SA-2	30	1	0	0	0	0		co/sa	ul, en	
2006	SA-2	40	1	0	0	0	0		co/sa	ul, en, sm	
2006	SA-2	50	1	0	0	0	0		co/sa	ul, en, la, sm	
2006	SA-2	60	1	0	0	0	0	b 63 e 71	gr/sa	ul, gr, la	
2006	SA-2	70	1	63	12	0	100		sa/gr	ul, la, cr, sm	
2006	SA-2	80	1	0	0	0	0	84 - 6 shoots	sa		
2006	SA-2	90	1	0	0	0	0		sa		
2006	SA-2	100	2	28	18	11	76	b 94 e 101	sa	ul, sm	
2006	SA-2	110	2	0	0	0	0	b 118 e 131	sa		reproductive shoots
2006	SA-2	120	2	17	8	16	54.666667		sa	ul, sm	
2006	SA-2	130	2	5	21	14	53.333333	b 138 e 140	sa	sm, la,ul	
2006	SA-2	140	3	8	0	11	25.333333		sa	sm, la,ul	
2006	SA-2	150	3	0	0	0	0		sa	ul	rebar
2006	SA-2	160	4	0	0	0	0		sa		
2006	SA-2	170	5	0	0	0	0		sa	ul	
2006	SA-2	180	5	0	0	0	0		sa		
2006	SA-2	190	5	0	0	0	0		sa	ul	debris mat, no turions
2006	SA-3	0	1	0	0	0	0		gr/co	po, ul, en	
2006	SA-3	10	1	0	0	0	0		gr/co	ul, po	
2006	SA-3	20	1	0	0	0	0		gr/co	ul, po	

Year	Transect	Distance (ft)	Depth Bin	shoots / 0.25 m^2			Density (m^2)	Eelgrass edge	Substrate	Macro taxa	Notes
				2	6	10					
2006	SA-3	30	1	0	0	0	0		gr/co	ul, po	
2006	SA-3	40	1	0	0	0	0		gr/co	ul, la, po	
2006	SA-3	50	1	0	0	0	0		gr/co/sa	ul, la, pr	
2006	SA-3	60	1	5	21	18	58.666667	b 58 e 64	gr/co/sa	ul, la, gr	
2006	SA-3	70	1	0	0	0	0		gr/co/sa	ul, pr, gr	
2006	SA-3	80	1	0	0	0	0		sa		
2006	SA-3	90	1	0	0	6	8	b 92 e 102	sa	sm	
2006	SA-3	100	2	4	12	0	21.333333		sa	sm,ul	
2006	SA-3	110	2	0	0	0	0		sa		
2006	SA-3	120	2	17	37	16	93.333333	b 117 e 124	sa	sm,ul	
2006	SA-3	130	2	0	0	0	0	b 127 e 129	sa	ul	
2006	SA-3	140	3	20	19	4	57.333333	b 136 e 142	sa	ul, sm	
2006	SA-3	150	3	0	0	0	0		sa		
2006	SA-3	160	4	0	0	0	0		sa	la, gr,ul, pr	
2006	SA-3	170	5	0	0	0	0		sa		
2006	SA-3	180	5	0	0	0	0		sa		
2006	SA-3	190	5	0	0	0	0		sa/mu		
2006	SA-4	0	1	0	0	0	0		co/sa	ul, en, pr	
2006	SA-4	10	1	0	0	0	0		co	ul, en	
2006	SA-4	20	1	0	0	0	0		co	ul, en, la	
2006	SA-4	30	1	0	0	0	0		co	ul, en, la, sm, gr	
2006	SA-4	40	1	0	0	0	0		co/sa	ul, en, la, sm, pr	
2006	SA-4	50	1	0	0	0	0		sa/co	ul, en, la, pr	
2006	SA-4	60	1	7	19	16	56	b 54 e 72	gr/sa	ul, en, sm, gr	
2006	SA-4	70	1	6	38	22	88		gr/sa	la, sm, en, gr,ul	
2006	SA-4	80	1	0	0	0	0		sa		
2006	SA-4	90	1	0	0	0	0	b 93.5 e 100	sa		
2006	SA-4	100	2	0	14	15	38.666667		sa	ul, sm	
2006	SA-4	110	2	0	0	0	0	b 115 e 126	sa		
2006	SA-4	120	2	23	14	15	69.333333		sa	ul, sm	
2006	SA-4	130	2	0	0	0	0	b 134 e 143	sa		
2006	SA-4	140	3	24	16	6	61.333333		sa	sm,ul	

Year	Transect	Distance (ft)	Depth Bin	shoots / 0.25 m^2			Density (m^2)	Eelgrass edge	Substrate	Macro taxa	Notes
				2	6	10					
2006	SA-4	150	3	0	0	0	0		sa		
2006	SA-4	160	4	0	0	0	0		sa		
2006	SA-4	170	5	0	0	0	0		sa		
2006	SA-4	180	5	0	0	0	0		sa		
2006	SA-4	190	5	0	0	0	0		sa		
2006	SA-5	0	1	0	0	0	0		co/sa	ul, en, sm	
2006	SA-5	10	1	0	0	0	0		co	ul, en	
2006	SA-5	20	1	0	0	0	0		co/sa	ul, en, la	
2006	SA-5	30	1	0	0	0	0		co/sa	ul, en, la	
2006	SA-5	40	1	0	0	0	0		sa/co	ul, en, la	
2006	SA-5	50	1	0	0	0	0		co/sa	ul, sm	
2006	SA-5	60	1	17	15	21	70.666667		co/sa	ul, sm	
2006	SA-5	70	1	15	29	10	72		co/sa	ul, la, sm, cr	
2006	SA-5	80	1	0	0	0	0	b 55 e 76	sa		
2006	SA-5	90	1	0	0	0	0		sa		
2006	SA-5	100	2	14	26	20	80		sa	sm,ul	
2006	SA-5	110	2	18	36	16	93.333333	b 94 e 112	sa	ul, sm, la	
2006	SA-5	120	2	14	16	20	66.666667		sa	ul, sm	many flowering shoots
2006	SA-5	130	2	9	19	18	61.333333		sa	ul, sm	
2006	SA-5	140	3	0	8	0	10.666667	b 117 e 142	sa	ul, sm, la	BMSL plot rebar
2006	SA-5	150	3	0	0	0	0		sa	ul	rebar
2006	SA-5	160	4	0	0	0	0		sa		
2006	SA-5	170	4	0	0	0	0		sa	ul, la	
2006	SA-5	180	5	0	0	0	0		sa		
2006	SA-5	190	5	0	0	0	0		sa	ul	debris mat, no turions
2006	RA-1	0	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-1	20	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-1	40	1	0	0	0	0		co/sa	ul	
2006	RA-1	60	1	0	0	0	0		sa/co	ul, en, gr	
2006	RA-1	80	1	0	0	0	0	b 72 e 72	sa/co	ul, la	
2006	RA-1	100	1	0	0	0	0	b 111 e 113	sa	ul	small patch
2006	RA-1	120	1	0	0	0	0		sa		

Year	Transect	Distance (ft)	Depth Bin	shoots / 0.25 m^2			Density (m^2)	Eelgrass edge	Substrate	Macro taxa	Notes
				2	6	10					
2006	RA-1	140	2	0	0	0	0	b 144 e 148	sa		patchy
2006	RA-1	160	2	0	0	0	0		sa		
2006	RA-1	180	2	0	0	0	0	b 190 e 265	sa		dense eelgrass
2006	RA-1	200	2	18	35	28	108		sa	ul, sm	
2006	RA-1	220	2	24	25	34	110.66667		sa	ul, sm	
2006	RA-1	240	3	21	23	19	84		sa	ul, sm, la	
2006	RA-1	260	3	9	12	27	64	b 265 e 376	sa	ul, sm, la, gr	sparse eelgrass
2006	RA-1	280	4	2	7	8	22.666667		sa	la, ul	dense mat of lam/ulva/eelgrass leaves
2006	RA-1	300	4	1	14	8	30.666667		sa	gr, ul, sm	
2006	RA-1	320	4	0	6	1	9.3333333		sa	la, ul	
2006	RA-1	340	4	0	13	18	41.333333		sa	ul, la,sm	
2006	RA-1	360	4	3	2	7	16		sa	ul, la,sm	
2006	RA-1	380	4	0	0	0	0		sa		
2006	RA-1	400	4	0	0	0	0		sa	la	attached to rebar
2006	RA-1	420	5	0	0	0	0		sa		macro (ulva) not attached
2006	RA-1	440	6	0	0	0	0		sa	la	
2006	RA-1	460	6	0	0	0	0		sa		
2006	RA-2	0	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-2	20	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-2	40	1	0	0	0	0		co	ul, en	
2006	RA-2	60	1	0	0	0	0		co/sa	ul, en	
2006	RA-2	80	1	0	0	0	0		sa/co	ul, en, gr, la, sm	
2006	RA-2	100	1	0	0	0	0	b 101.5 e 106	sa		
2006	RA-2	120	1	23	25	45	124	b 111 e 124	sa	ul, sm, gr	
2006	RA-2	140	2	0	0	0	0		sa		
2006	RA-2	160	2	0	4	0	5.3333333	b 151 e 155	sa	ul, sm	
2006	RA-2	180	2	0	0	0	0	b 159 e 159	sa		
2006	RA-2	200	2	33	51	42	168	b 166 e 168	sa	sm, ul	
2006	RA-2	220	2	25	22	14	81.333333	b 171 e 171	sa	ul, sm	
2006	RA-2	240	3	8	32	13	70.666667	b 193 e 378	sa	ul, sm, la, gr, pr, gi	sparse eelgrass
2006	RA-2	260	3	1	5	15	28		sa	ul, sm, gr, la, unk.	
2006	RA-2	280	3	0	11	0	14.666667		sa	ul, sm, la	

Year	Transect	Distance (ft)	Depth Bin	shoots / 0.25 m^2			Density (m^2)	Eelgrass edge	Substrate	Macro taxa	Notes
				2	6	10					
2006	RA-2	300	4	0	13	0	17.333333		sa	ul, sm, al, sa, gi	
2006	RA-2	320	4	2	9	12	30.666667		sa	ul, sm, en, la	
2006	RA-2	340	4	4	11	22	49.333333		sa	ul, sm, la	
2006	RA-2	360	4	0	5	0	6.6666667		sa	la, al, ul, sm	
2006	RA-2	380	4	0	0	0	0		sa		
2006	RA-2	400	4	0	0	0	0		sa	gr	
2006	RA-2	420	5	0	0	0	0		sa		
2006	RA-2	440	6	0	0	0	0		sa		
2006	RA-2	460	6	0	0	0	0		sa		
2006	RA-3	0	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-3	20	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-3	40	1	0	0	0	0		co/sa	ul	
2006	RA-3	60	1	0	0	0	0		gr/sa	ul	
2006	RA-3	80	1	0	0	0	0	b 86 e 88	gr/sa	ul	sparse eelgrass
2006	RA-3	100	1	0	0	0	0	b 101 e 107	sa		
2006	RA-3	120	1	39	34	0	97.333333	b 110 e 120	sa	ul, sm	some bare turions
2006	RA-3	140	2	0	0	0	0		sa	ul	
2006	RA-3	160	2	0	0	0	0	b 172 e 179	sa	la	
2006	RA-3	180	2	0	0	0	0	b 187 e 382	sa		continuous sparse eelgrass
2006	RA-3	200	2	0	35	37	96		sa	ul, sm	some flowering shoots
2006	RA-3	220	2	24	22	26	96		sa	ul, sm	
2006	RA-3	240	3	16	6	11	44		sa	ul, la, sm, gi, cr	
2006	RA-3	260	3	7	2	1	13.333333		sa	ul, sm, la, gr, pr, unk.	
2006	RA-3	280	3	3	2	0	6.6666667		sa	ul, sm, ma, la, gr	
2006	RA-3	300	4	17	16	16	65.333333		sa	ul, sm, la	
2006	RA-3	320	4	4	13	2	25.333333		sa	la, ul, sm, unk. (2)	
2006	RA-3	340	4	4	23	25	69.333333		sa	ul, sm, gr	
2006	RA-3	360	4	11	6	9	34.666667		sa	ul, sm	
2006	RA-3	380	4	15	18	3	48		sa	ul, sm, ma, unk.	
2006	RA-3	400	4	0	0	0	0		sa	ul, sm	
2006	RA-3	420	5	0	0	0	0		sa	ul, la, gr, unk.	
2006	RA-3	440	6	0	0	0	0		sa		

Year	Transect	Distance (ft)	Depth Bin	shoots / 0.25 m^2			Density (m^2)	Eelgrass edge	Substrate	Macro taxa	Notes
				2	6	10					
2006	RA-3	460	6	0	0	0	0		sa		
2006	RA-4	0	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-4	20	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-4	40	1	0	0	0	0		co/sa	ul	
2006	RA-4	60	1	0	0	0	0		sa/gr	ul, cr	
2006	RA-4	80	1	0	0	0	0		sa/gr	ul, cr	
2006	RA-4	100	1	0	0	0	0	b 105 e 110	sa		
2006	RA-4	120	1	0	9	0	12	b 116 e 120	sa	ul, sm	
2006	RA-4	140	2	0	0	0	0	b 124 e 134	sa	ul, cr	
2006	RA-4	160	2	0	0	0	0		sa	ul	
2006	RA-4	180	2	0	45	0	60		sa	sm	flowering shoots, adjacent N 173 - 175 S 177-180
2006	RA-4	200	2	0	0	0	0	b 204 e 252	sa		
2006	RA-4	220	2	13	16	18	62.666667		sa	sm, ul	
2006	RA-4	240	3	6	9	10	33.333333		sa	sm, ul, cr	flowering shoots
2006	RA-4	260	3	0	0	0	0		sa	ul, sm, la, gr	steel structure
2006	RA-4	280	3	0	0	0	0	b 293 e 384	sa	ul, la, gr, sm	log, sparse eelgrass
2006	RA-4	300	4	11	0	10	28		sa	ul, sm, la, gr, sa	
2006	RA-4	320	4	1	7	5	17.333333		sa	ul, sm, unk. brown	
2006	RA-4	340	4	24	25	13	82.666667		sa	ul, sm, la	
2006	RA-4	360	4	3	26	0	38.666667		sa	ul, sm, la, gr	
2006	RA-4	380	4	13	11	10	45.333333		sa	ul, sm, la, pr, unk. (2)	
2006	RA-4	400	4	0	0	0	0		sa	ul, sm, la, gr, unk.	
2006	RA-4	420	5	0	0	0	0		sa	ul, sm, la	
2006	RA-4	440	6	0	0	0	0		sa	ul, la, gr	
2006	RA-4	460	6	0	0	0	0		sa		
2006	RA-5	0	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-5	20	1	-	-	-	-	-	-	-	transect end point error, sample point missed
2006	RA-5	40	1	0	0	0	0		co/sa	ul	
2006	RA-5	60	1	0	0	0	0		co/sa	ul	
2006	RA-5	80	1	0	0	0	0		sa/gr	ul, cr, sa	
2006	RA-5	100	1	0	0	0	0		sa		b 65 e 67 imm south of tape, not on transect
2006	RA-5	120	1	0	0	10	13.333333	b 115 e 119	sa/gr	sm, gi	

Year	Transect	Distance (ft)	Depth Bin	shoots / 0.25 m^2			Density (m^2)	Eelgrass edge	Substrate	Macro taxa	Notes
				2	6	10					
2006	RA-5	140	2	35	31	15	108	b 122 e 141	sa/gr	sm, ul, cr	some flowering shoots
2006	RA-5	160	2	0	0	0	0		sa	ul, la	
2006	RA-5	180	2	0	0	0	0	b 182 e 198	sa	ul	
2006	RA-5	200	2	0	0	0	0	b 204 e 240	sa	ul	
2006	RA-5	220	2	26	24	25	100		sa	ul, la, sm	some flowering shoots
2006	RA-5	240	3	15	12	8	46.666667	b 250 e 390	sa	ul, sm, cr, gr	sparse eelgrass
2006	RA-5	260	3	0	0	5	6.6666667		sa	ul, la, cr, gi	
2006	RA-5	280	3	0	2	6	10.666667		sa	ul, cr, la	
2006	RA-5	300	4	6	8	0	18.666667		sa	la, ul, sm, gr	
2006	RA-5	320	4	6	10	12	37.333333		sa	la, ma, sm, ul, cr	
2006	RA-5	340	4	4	5	10	25.333333		sa	la, ul, gr	
2006	RA-5	360	4	7	10	5	29.333333		sa	la, ul, sm	
2006	RA-5	380	4	10	13	12	46.666667		sa	ul, sm, la, rh	
2006	RA-5	400	4	0	0	0	0		sa	la, ul	
2006	RA-5	420	5	0	0	0	0		sa	ul	
2006	RA-5	440	5	0	0	0	0		sa	ul, la, gr, gi	
2006	RA-5	460	6	0	0	0	0		sa	gi, gr	