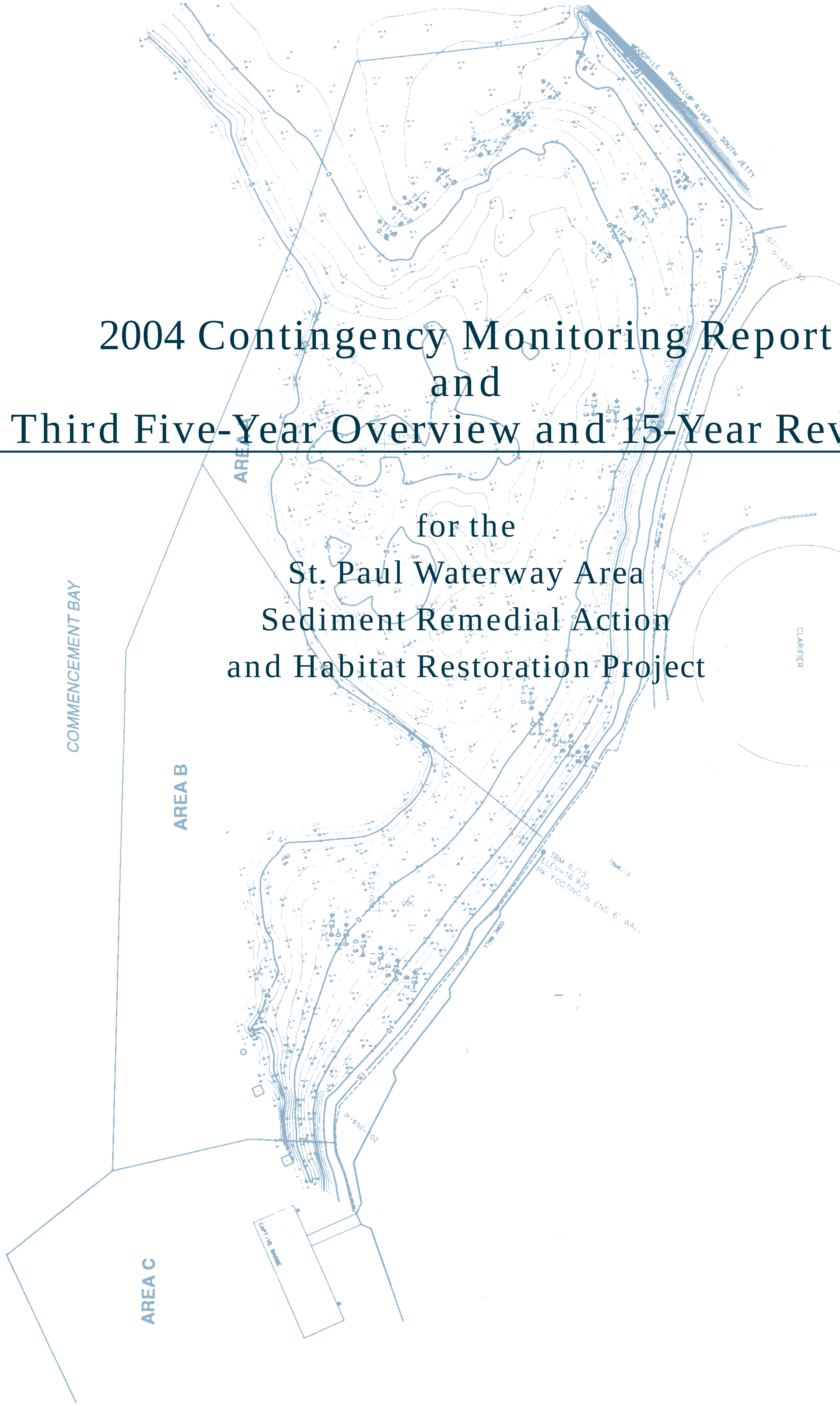
2004 Contingency Monitoring Report
and
Third Five-Year Overview and 15-Year Review

for the
St. Paul Waterway Area
Sediment Remedial Action
and Habitat Restoration Project



2004 CONTINGENCY MONITORING REPORT

and

THIRD FIVE-YEAR OVERVIEW AND 15-YEAR REVIEW

for the St. Paul Waterway Area Sediment Remedial Action and Habitat Restoration Project

Prepared for Simpson Tacoma Kraft Company, LLC,
International Paper Company, and
U.S. Environmental Protection Agency

Parametrix, Inc.

August 2004

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Superfund Project Manager
U.S. EPA, Region 10
1200 Sixth Avenue
M/S: ECL-111
Seattle, Washington 98101-1128

August 30, 2004

556-1650-068 (04)

RE: 2004 Contingency Monitoring Results - Draft
Third Five-Year Overview and 15-Year Review
St. Paul Waterway Area Sediment Remedial Action and Habitat Restoration Project

Dear Ms. Keeley:

Enclosed are the results of the 2004 Contingency Monitoring for the above referenced site, along with the Third Five-Year Overview and 15-Year Review (Appendix A). In accordance with the Post Ten-Year Contingency Monitoring and Adaptive Management Plan, the 2004 contingency monitoring consisted of an intertidal transects survey, visual examination, and a final bathymetric survey. The intertidal transects survey and visual examination were conducted on June 3, 2004. The predicted –3.8 ft MLLW low tide on June 3 represented one of the lowest predicted tides of 2004, and one of the lowest tides in the 19-year tide cycles. The bathymetric survey was conducted on June 14, 2004 during an evening high tide.

The transects survey involved determining elevations along five transect lines, each containing four to eight monitoring stations (Figure 1). The June 2004 and cumulative (1988 through 2004) transects survey data are provided in Table 1 and Figure 2.

Elevation changes in the two-year period since the transects were last surveyed as part of the contingency monitoring (June 2002) ranged from +2.6 ft (Station 4-2) to -0.5 ft (Station 1-2). All survey results were below the applicable contingency screening trigger level (1.0 ft elevation decrease over one year at one station, or 1.67 ft elevation decrease over two years at one station). Overall, 19 stations were unchanged or showed net elevation increases in the two-year period, and 9 stations had net elevation decreases. The elevations of the upper/middle intertidal stations on Transect 4 (stations 4-1 through 4-3), and to a lesser extent some of the upper/middle intertidal stations on Transect 5 (stations 5-1 through 5-3), were increased by the February 2004 Transect 4 area beach nourishment. This small-scale preventive beach nourishment was conducted as an adaptive management action at the constructed intertidal habitat at the Simpson Tacoma Kraft Mill to deal with naturally differential movement of sediment at middle intertidal levels of the restored habitat.

As described in the April 26, 2004 Project Completion Report, approximately 2,600 yd^3 of 75% sandy gravel mixed with 25% 3- to 6-inch diameter cobble was placed across the nourishment footprint. The average material thickness was approximately 2 to 3 ft over the +3 ft MLLW elevation, gradually declining to a thickness of approximately 0 to 1 ft at the 0 and +6 ft MLLW elevations.

Taking into account the elevation increases associated with the nourishment material recently added along the middle intertial stations along Transects 4 and 5, the 2004 contingency monitoring intertidal transect survey results are generally consistent with the results over the past 15 years from 1988 - 2004 (Appendix A of the Contingency Monitoring and Adaptive Management Plan and the 2000, 2001, and 2002 Contingency Monitoring Final Reports). For the most recent five-year period, the overall changes in elevation between 2000 and 2004 across all stations other than the nourishment area averaged only 0.2 ft (mean and median elevation change, regardless of whether the change was an increase or decrease); the net change on these stations over the past five years was approximately -0.1 ft (which is close to the level of accuracy for the transect monitoring method, indicating vary little change has occurred at these stations).

Concurrent with the intertidal transects survey, Don Weitkamp performed a visual examination of the intertidal habitat. Don's memorandum describing the results of his examination is provided in Attachment A. Don observed that both the physical integrity and overall biological conditions of the habitat appear to be essentially unchanged in recent years.

In addition to the intertidal transects survey and visual examination, the 2004 monitoring included a one-time final bathymetric survey covering all of areas A and B. This bathymetric survey was included in the monitoring plan to provide a final detailed bathymetric contour map to bookend the pre- and post-cap surveys conducted in 1987 (preconstruction) and 1988 (as-built) surveys that were performed when the project was constructed.

The survey was conducted by boat using multi-beam surveying equipment. The bathymetric contour map is provided in Figure 1. The field techniques and data processing used to create the bathymetric map are provided in the Bathymetric Survey Report (Attachment B). In summary, the bathymetric survey results match the elevations determined by the intertidal transects survey for the intertidal portions of Area A and B, and provide detailed elevation contours for the all deeper (sub-tidal) portions areas of Areas A and B. Comparison of bathymetry maps indicates that overall the primary features of the 1988 as-built map are readily visible in the 2004 map, with some smoothing of contours evident in the intertidal portions of the cap due to anticipated sediment redistribution.

The Third Five-Year Overview and 15-Year Review for the St. Paul Waterway Area Remedial Action and Habitat Restoration Project is provided in Appendix A. In accordance with Table 1 of the Post Ten-Year Contingency Monitoring and Adaptive Management Plan, ongoing St. Paul Waterway Area Remedial Action and Habitat Restoration Project monitoring has been completed. The site remains subject to emergency monitoring. As described in Table 1 of the Post Ten-Year Contingency Monitoring and Adaptive Management Plan, emergency monitoring will be required for a (1) major storm (with winds from the north or southeast at 30 miles-per-hour or greater, which persists for more than four hours), or (2) earthquake of significance. In the event either of these occurs an intertidal transects survey coupled with a visual examination will be conducted as soon as practicable after the event.

Thank you for your extension of the submittal of this report to August 31. Please contact me at 425-458-6373 if you have any questions.

Sincerely,

PARAMETRIX, INC.

Tom Atkins, P.E., L.G.

Attachments: Attachment A – Intertidal Habitat Visual Examination Memorandum
Attachment B – Bathymetry Survey Report
Appendix A – Third Five-Year Overview and 15-Year Review

cc: Greg Narum, Simpson Tacoma Kraft Company, LLC
Dave McEntee, Simpson Tacoma Kraft Company, LLC
Tom Ross, International Paper Company
Ken Weiner, Preston Gates and Ellis
Don Weitkamp, Parametrix, Inc.
Project File

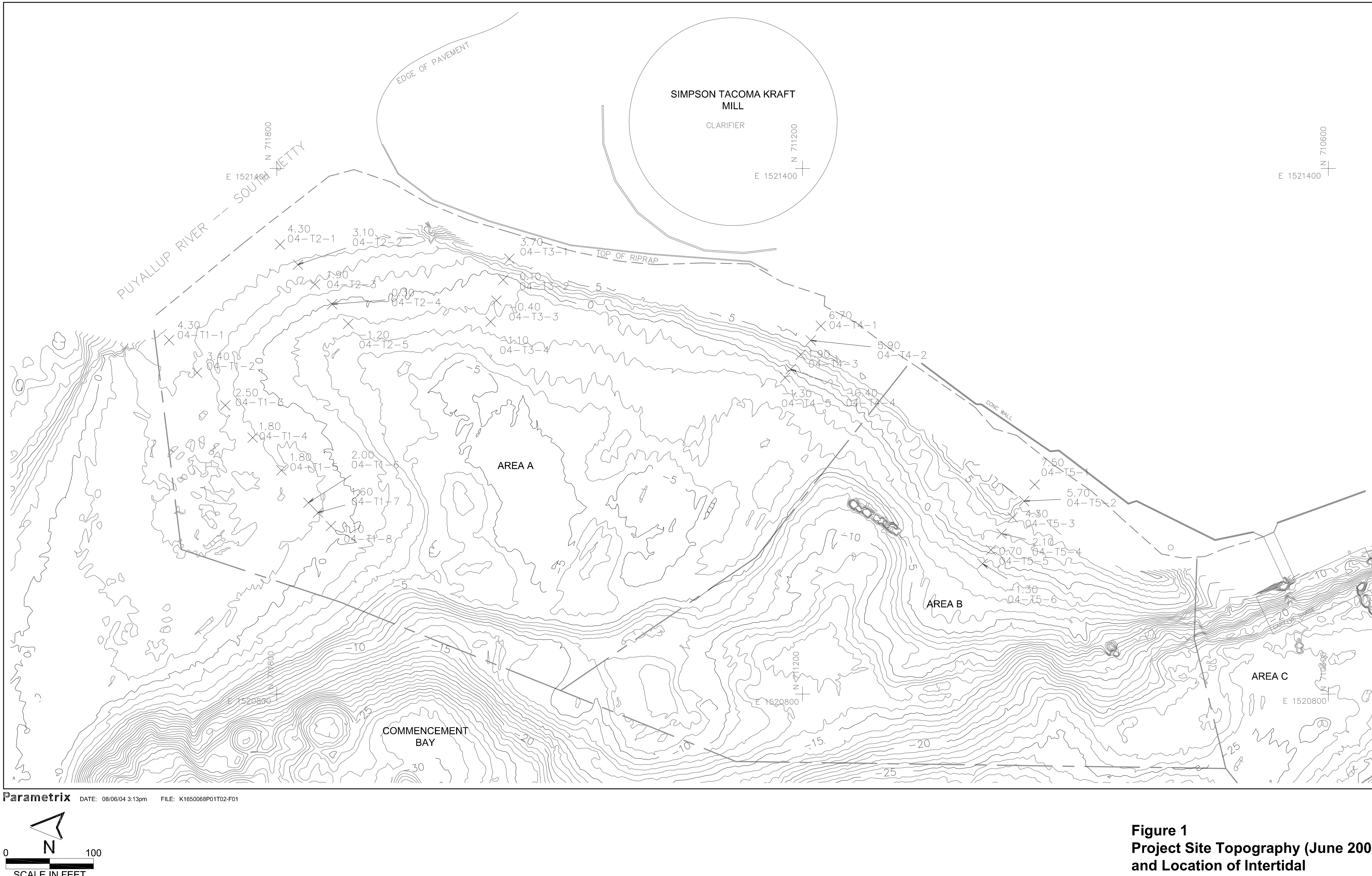

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Figure 1
Project Site Topography (June 2004) and Location of Intertidal Transect Stations

Table A-1. Elevations (ft MLLW) monitored on the Project site at five intertidal transects between 1988 and 2004.

Transect/ Station	12/88	6/89	6/90	6/91	6/92	6/93	6/94	6/95	7/96	6/97	5/98	6/00	6/01	6/02	6/04	Elevation Changes 6/02 to 6/04	Eleva Char 12/88 t
1-1	5.0	6.1	5.8	5.2	5.2	4.9	4.4	4.8	4.8	4.5	4.5	4.4	4.6	4.6	4.3	-0.3	-0
1-2	3.6	4.0	5.1	4.7	4.5	4.5	4.1	4.4	4.5	4.5	4.5	4.2	3.6	3.9	3.4	-0.5	-0
1-3	2.9	2.9	2.7	3.1	2.7	3.7	3.6	4.2	4.4	3.9	3.0	3.0	2.6	2.7	2.5	-0.2	-0
1-4	2.4	2.1	1.5	1.4	1.3	4.0	4.1	3.6	2.8	2.5	2.2	2.1	2.0	2.0	1.8	-0.2	-0
1-5	0.1	0.6	1.0	3.5	3.6	3.7	3.3	2.3	2.1	1.9	1.9	1.8	1.6	1.7	1.8	+0.1	+1
1-6	1.8	1.7	2.8	3.4	2.8	2.8	2.4	2.3	2.3	2.2	2.1	1.8	1.4	2.0	2.0	+0.0	+0
1-7	0.2	0.5	2.1	2.6	2.1	2.1	1.8	1.8	1.7	1.7	1.4	1.7	1.6	1.8	1.6	-0.2	+1
1-8	-0.3	-0.1	1.3	1.5	1.0	0.9	0.9	0.8	0.8	0.8	0.9	1.0	0.9	1.1	1.1	+0.0	+1
2-1	6.9	6.6	7.0	6.7	6.3	5.8	5.6	5.6	5.3	5.2	4.9	4.8	4.4	4.5	4.3	-0.2	-2
2-2	6.0	5.5	5.1	5.0	4.7	4.3	4.1	4.0	3.6	3.6	3.5	3.5	3.3	3.4	3.1	-0.3	-2
2-3	4.6	4.2	3.4	3.1	2.5	2.5	2.1	2.1	2.0	2.0	2.0	1.9	1.8	1.9	1.9	+0.0	-2
2-4	2.7	1.7	1.0	0.7	0.5	0.4	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.3	+0.0	-2
2-5	-1.9	-1.8	-1.0	-2.0	-2.1	-1.8	-1.8	-1.7	-1.6	-1.6	-1.6	-1.4	-1.6	-1.2	-1.2	+0.0	+0
3-1	5.7	5.3	4.7	4.7	4.8	4.4	4.3	4.2	4.5	4.5	4.0	3.9	4.1	3.9	3.7	-0.2	-2
3-2	2.9	1.9	0.6	0.1	-0.3	-0.4	-0.6	-0.5	-0.4	-0.2	-0.3	-0.2	-0.2	-0.1	0.1	+0.2	-2
3-3	-0.2	-0.4	-0.7	-1.2	-1.4	-1.1	-0.9	-0.9	-0.7	-0.5	-0.6	-0.6	-0.6	-0.5	-0.4	+0.1	-0
3-4	-1.4	-1.6	-1.6	-1.6	-1.8	-1.5	-1.4	-1.3	-1.4	-1.3	-1.4	-1.3	-1.3	-1.3	-1.1	+0.2	+0
4-1	5.2	7.6	8.4	7.6	7.7	7.0	6.7	6.6	6.7	6.7	6.3	6.3	6.2	6.1	6.7	+0.6	+1
4-2	6.2	5.7	5.0	4.8	4.7	4.3	4.0	3.9	3.7	3.7	3.6	3.6	3.4	3.3	5.9	+2.6	-0
4-3	4.4	3.6	2.8	2.5	2.2	2.1	1.9	1.5	1.3	1.3	1.0	1.0	1.0	0.8	1.9	+1.1	-2
4-4	1.4	0.9	0.5	0.5	0.3	0.0	-0.2	-0.3	-0.3	-0.3	0.2	-0.5	-0.5	-0.6	-0.4	+0.2	-1
4-5	-0.9	-0.8	-0.8	-0.7	-1.0	-1.0	-0.9	-1.0	-1.0	-1.0	-1.0	-1.2	-1.3	-1.3	-1.3	+0.0	-0
5-1	5.0	6.5	8.5	7.5	8.0	7.0	6.5	6.7	6.7	7.0	6.8	7.1	7.0	7.0	7.5	+0.5	+2
5-2	5.8	6.1	5.7	5.4	4.8	4.4	3.8	3.6	3.8	4.0	4.1	4.5	4.4	4.6	5.7	+1.1	-0
5-3	5.2	5.4	4.0	2.9	2.2	2.0	1.5	1.3	2.4	3.3	3.2	3.3	3.7	3.9	4.3	+0.4	-0
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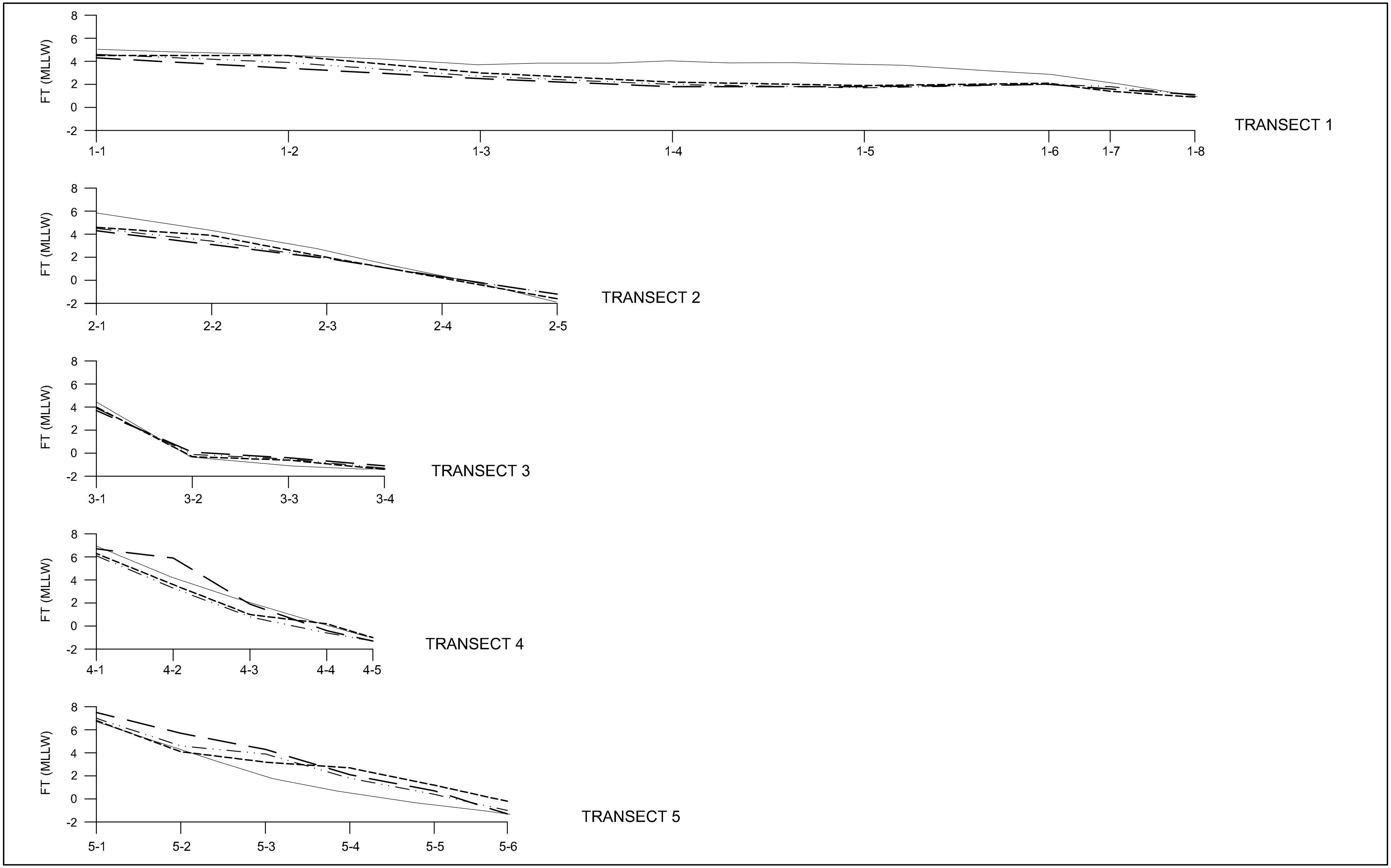
5-6	-0.8	-0.8	-0.7	-1.4	-1.4	-1.3	-0.9	-1.1	0.1	0.2	-0.2	-0.6	-1.3	-1.0	-1.3	-0.3	-0



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LEGEND

5-5	Station Numbers
(solid line)	June 1993 (Five Year Review)
(short dash)	May 1998 (Ten Year Review)
(dash-dot-dot)	June 2002
(long dash)	June 2004 (Fifteen Year Review)

Figure 2
Project Site Elevation Profiles
2004 Contingency Monitoring

ATTACHMENT A

INTERTIDAL HABITAT VISUAL EXAMINATION MEMORANDUM

M E M O R A N D U M

to: Greg Narum, Simpson Tacoma Kraft Company, LLC — July 19, 2004
Dave McEntee, Simpson Tacoma Kraft Company, LLC
Tom Ross, International Paper Company
Ken Weiner, Preston Gates and Ellis

from: Don Weitkamp — 558-1650-068 (01) (03)

re: 2004 Visual Inspection Simpson Tacoma Kraft Mill Habitat

On June 3, 2004 I again conducted a visual inspection of the intertidal habitat previously constructed in 1988 along the shoreline at the north end of the Tacoma Kraft mill. The inspection was conducted between 10:30 a.m. and 12:30 p.m. with the predicted extreme low tide of -3.9 ft MLLW at 11:49 a.m. in Commencement Bay. Parametrix surveyors were measuring surface elevations at previously measured points along established transects during the same time. I made a photographic record of the habitat area and the specific conditions that were present during our survey. In general, conditions at the site appeared very similar to those observed in recent years, although macro algae abundance was moderate to low in comparison to some previous years. This may be due to the timing of the survey in early June.

Both the physical integrity and the biological conditions of the habitat appear to be generally unchanged in recent years. The beach nourishment material placed during February 2004 at the upper to middle intertidal elevations toward the southwest end of the habitat (Transect 4 vicinity) was visually apparent. The gravel- and cobble-size material and the windrow nature of the new material made it visually obvious. Some macro algae has begun to grow on some of this material. The new material forms shallow tide pools at several places along its higher edge. It again appears that intertidal sediment (especially at higher tidal elevations) is continuously being gradually transported across the habitat to the mouth of St. Paul Waterway. The chip barge was grounded and slightly tilting during the extreme low tide indicating some filling of the edge of the waterway is occurring. Although the adaptive management actions recently included dredging sediment from the restoration site that had filled the adjacent slip area (Parametrix 2004 Project Completion Report), there is a tongue of sediment remaining under the barge mooring area.

The color and texture of sediments of the habitat remain generally uniform, as described below. In most of the eastern portion of the habitat the sediments are composed primarily of sandy material with a silty top layer in many areas, and occasional boulders. The lower levels of the enclosed basin are highly muddy with considerable organic material (alder leaves, twigs, fine wood debris, algae, etc.). Areas toward the northeastern end of the site continue to be siltier at the middle and lower intertidal levels. The silt layer in some low-lying areas has become relatively thick, giving the overall appearance of a mudflat (rather than sand). Generally, sediment color is black or dark brown, with occasional lighter variations.

The western beach is primarily silty gravel on the surface with scattered boulders. The gravel placed in 1995 toward the western end of this beach in the vicinity of Transect 5 retains a light gray coloration making it distinct from the original habitat material. The new material added in 2004 has an obvious amount of gravel- and cobble-size material and is relatively clean in comparison to older material.

The habitat still supports a wide variety of algae at the lower intertidal elevations where boulders and cobbles provide suitable substrate. Algae present on the boulders and surrounding areas include *Ulva lactuca, Laminaria saccharina, Enteromorpha intestinalis*, *Costaria costata, Rhodymenia pertusa, Gracilaria* sp., *Chondracantbus exasperatus* (formerly *Gigartina exasperata*). The scattered boulders also provide substrate for barnacles, rock jingle bivalves, limpets, shore crabs, and amphipods. Only a few exuvia (molted shells) of shore crabs and red crabs were present. Shells of various clams (*Macoma* sp.) were common, many showing signs of being preyed on by moon snails. Numerous bivalve and polychaete worm holes were present in the silty sand substrate.

The extreme low tide provided an opportunity to clearly observe the substrate below about –2 ft MLLW. The siphons of several large horse clams (*Tresus capax*) and one large geoduck (*Panope generosa*) were observed in this lower intertidal area. The geoduck siphon was about 2.5-3 inches wide, indicating a large clam that is probably nearly as old as the constructed habitat in which it resides.

Much of the shallower macro algae appears to have been grazed by geese. Only stipes remain on many of the shallower boulders. Approximately 150 Canadian geese were present on the site at the beginning of the inspection.

Riprap in the upper intertidal zone still supports substantial populations of barnacles, along with littorine snails (*Littorian scutulata*) and limpets (*Collisella pelta*). *Fucus* sp. is the only algae present at this tidal elevation. Scattered *Fucus* is present on the riprap around the habitat area.

ATTACHMENT B

BATHYMETRIC SURVEY REPORT

Bathymetric Survey Report

St. Paul Waterway Area Sediment Remedial Action and Habitat Restoration Project

June 14, 2004

Prepared for

Simpson Tacoma Kraft Company, LLC
801 Portland Avenue
Tacoma, Washington 98421-2711

and

International Paper Company
6400 Poplar Avenue – Tower 2
Memphis, Tennessee 38197

Prepared by

Parametrix, Inc.
411 108th Ave., NE, Suite 1800
Bellevue, Washington 98004

July 2004

Project No. 558-1650-068

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1. MULTI-BEAM SURVEY EQUIPMENT AND PROCEDURES

This report provides documentation of the procedures and techniques used to create a bathymetric map of the St. Paul Waterway Area Sediment Remedial Action and Habitat Restoration Project (Project) at the Simpson Tacoma Kraft site in Commencement Bay, Tacoma, Washington. The multi-beam bathymetric survey was conducted on June 14, 2004 and included mobilization and demobilization of equipment aboard Parametrix' ALMAR research vessel and completion of patch tests for calibration of the multibeam system.

In accordance with the Post Ten-Year Contingency Monitoring and Adaptive Management Plan for the Project, the multi-beam survey was conducted to provide full coverage of all portions of Areas A and B. The multi-beam system provided swath coverage of approximately four times the water depth. Weather and sea conditions were acceptable, with calm waters and little to no wind.

1.1 SURVEY VESSEL

Parametrix' 26-foot custom-built ALMAR survey vessel was utilized for all bathymetric data acquisition. The vessel was mobilized prior to the survey with the appropriate equipment as well as a custom mounting bracket for the transducer attached amidship on the starboard side of the vessel, as shown in Figure 1-1.

1.2 NAVIGATION

The Ashtech Model Z-Extreme RTK Global Positioning System (RTK GPS) was used for positioning. Horizontal and vertical control was established at the site. A Parametrix land survey crew, for a previous survey, established the control point, named 1650-102. Table 1-1 presents the vertical and horizontal coordinates for the control point. For the multi-beam survey, the RTK base station was setup at 1650-102 for transmission of GPS corrections to the RTK rover unit aboard the survey vessel.

Navigation, acquisition, and control were accomplished within the Triton-Elics International (TEI) Hydro Suite data acquisition and processing system. The survey system received data from the positioning system, performed the appropriate geodetic transformations, and stored the position information along with the data from all instrument packages. All surveys were conducted in North American Datum of 1927 (NAD27), State Plane Coordinate System (SPCS) Washington South Zone. Vertical control was adjusted to Mean Lower Low Water (MLLW).

Figure 1-1. Multi-beam System Mount

Table 1-1. Control Point Data

Point ID	Latitude	Longitude	Easting	Northing	Elevation (Ft, MLLW)
1650-102	47° 15’ 58.160"	122° 25’ 50.760”	1161090.73	710725.90	17.83

Note: Easting and Northing values in U.S. Survey Feet, NAD83, SPCS, Washington North Zone.

1.3 MULTIBEAM SYSTEM

The TEI Hydro Suite integrated multi-beam survey package assembled for this survey included the components shown in Table 1-2.

Table 1-2. Multi-beam System Components

Measurement	Model
Multi-beam Sonar	Simrad EM3000
Attitude (Heave, Pitch, and Roll) and Heading	Applanix POS M/V
Positioning	Ashtech Model Z-Extreme RTK GPS
Data Acquisition	TEI Isis Data Acquisition System

The attitude and heading sensor provides dynamic corrections for vessel motion and actual sonar orientation relative to water level. The attitude sensor provides real-time measurement of heading and transducer heave, pitch, and roll.

Figure 1-2. Sensor Alignment

1.3.1 Simrad EM3000

A Simrad Model EM3000 high-resolution focused multi-beam echosounder was utilized to collect the bathymetry. The EM3000 operates at a frequency of 300 kHz with a stated depth resolution of 1 centimeter. 125 beams, each with an across-track beam width of 1.5 degrees, provide swath coverage of up to 180 degrees or approximately four times the water depth. The survey was conducted at a maximum survey speed of 3 knots and a sonar ping rate of approximately 10 pings/sec.

The mounting bracket for the multi-beam (see Figure 1-1) was meticulously positioned to provide minimal operational offsets of the transducer head relative to vessel attitude. Actual transducer attitude was determined during calibration of the system.

1.3.2 System Installation

The multi-beam sonar transducer and RTK GPS antennae were mounted along the acoustic (vertical) axis of the sonar as shown in Figure 1-2. The attitude sensor was mounted along the starboard gunnel, adjacent to the acoustic axis. This configuration was designed to minimize the introduction of attitude and positioning errors due to instruments offset from the acoustic axis. The transducer head was mounted with a fixed starboard rotation of approximately 30 degrees (see Figure 1-1) to overcome surveying limitations in shallow waters along the shore by allowing the outer beams to approach 90 degrees (horizontal) from vertical.

1.3.3 Calibration

Calibration of the multi-beam system involves running a patch test on a newly installed or recently changed sonar mount location or position. The patch test is run to test for roll, pitch, and yaw (degrees) offsets of the multi-beam sensor as well as latency (milliseconds) from the navigation system. Procedures for the acquisition of the patch test data can be found in the TEI Bathy Pro user's manual[1]. In summary, a series of survey trials were performed over known seafloor configurations run in opposite directions and/or varying survey speeds. Data were then processed to determine actual offsets based on calculated differences in the data sets collected over the same bottom area. The roll test was conducted over fairly flat terrain, running a single survey line in opposite directions. A steeply sloping seafloor was used for the latency, pitch and yaw tests. For pitch, a single line oriented perpendicular to shore was run in opposite directions at normal survey speed. The yaw test required two parallel lines separated by a factor of 1.5 to 2 times the water depth, perpendicular to shore, run in the upslope direction at normal survey speed. The latency test was run over the same area but at different survey speeds. The data were post-processed using Caris HIPS to determine offset values for latency, roll, pitch and yaw. Patch test results are presented in Table 1-3.

Table 1-3. Patch Test Offset Corrections

Patch Test	Offset Correction
Roll (degrees)	-0.650
Pitch (degrees)	-0.450
Yaw (degrees)	-0.100
Navigation Latency (ms)	-350

1.4 DIGITAL DATA ACQUISITION SYSTEM

The TEI Isis data acquisition and processing system was used to acquire and store all multi-beam data. Data from all sensors were sent directly to Isis and integrated within the data packet for each sonar ping. Real-time acquisition displays provided data quality control and assessments during surveys. A real-time digital terrain model (DTM) of bathymetric conditions was used during the survey, as shown in Figure 1-3, via TEI's Delphmap and BathyRT programs to assure data quality and full bottom coverage. All data were stored in TEI's XTF data format for post-processing, analysis, and archiving.

Figure 1-3. Real-time Acquisition Mapping

[1] Triton Elics International, Inc. 2000. Using Bathy Pro, A User's Manual documenting the Bathy Pro software through Version 1.1.

1.5 MEASUREMENT OF TIDE AND SOUND VELOCITY

Tide data were acquired in real-time during the survey with RTK GPS. Tide corrections were delivered directly to the acquisition system and logged simultaneously with the multi-beam data. Additional control checks were conducted after the survey to verify local tide readings.

Full water depth sound velocity casts were performed during the multi-beam surveys. Water column sound velocity profiles were collected using a Valeport Soundbar sing-around. Velocity profiles were consistent among all casts. The profiles were applied to data at acquisition to correct for sound speed through the water.

2. POST PROCESSING

Multi-beam post-processing was performed using Caris HIPS bathymetric processing system. After completion of patch test calibrations (refer to Section 1.3.3) the data were edited to remove bad or low quality data points. Depths were automatically adjusted within Caris for navigation, attitude, tide, and speed of sound. A mapping grid resolution consistent with the spatial resolution of the survey was then projected onto the survey area. For this survey a 1-meter resolution grid was developed. The final processing step involved geoencoding all corrected data into the survey grid. An output file containing spatial coordinates for all data points (e.g., easting, northing, and depth elevation in MLLW) was created for input into AutoCAD and Terramodel for final chart development and generation of the DTM and contours, respectively. A final contour editing process was conducted to provide contours sufficient for CADD formatting.

Every attempt was made to provide the highest possible survey accuracy. The patch test procedure allows the static offsets, or bias, specific to the installation aboard the ALMAR to be removed and/or accounted for. The remaining potential errors affecting accuracy and resolution are vessel motion (dynamic, or underway, errors) and errors from ancillary measurements such as tides and GPS positioning.

Cumulative vertical resolution errors are estimated to be on the order of ±10 cm, excluding the tide adjustment, along the nadir beam of the multi-beam transducer. At the farthest beams (e.g, 30 to 90° port and starboard, respectively, of the nadir), it is estimated that during significant vessel roll that resolution could be reduced to ±15 cm. Fortunately, this 'maximum' error was seldom experienced during this survey.

RTK vertical accuracy was measured at ±1.1 cm. This was accomplished by placing the rover antenna over 1650-102 and comparing the measured versus the registered value. The rover was then placed at the water's edge at various tide elevations and compared with the actual tide readings. Tide readings compared within ±3 cm.

Horizontal positioning errors are primarily a function of RTK GPS performance. Field tests over known control points indicated static RTK GPS positional accuracy to within ±4 cm. Actual geoencoding of multibeam soundings is also affected by vessel attitude (e. g., heave, pitch, and roll), survey speed, and navigation latency between the GPS and the multi-beam system. Static offsets were determined and accounted for during the patch test; however, dynamic errors are a function of the responsiveness and resolution of each of the ancillary instruments (refer to Table 1-3). Maximum potential error has not been analytically derived for this survey.

APPENDIX A

THIRD FIVE-YEAR OVERVIEW AND 15-YEAR REVIEW

THIRD FIVE-YEAR OVERVIEW AND 15-YEAR REVIEW

ST. PAUL WATERWAY AREA SEDIMENT REMEDIAL ACTION AND HABITAT RESTORATION PROJECT

Introduction

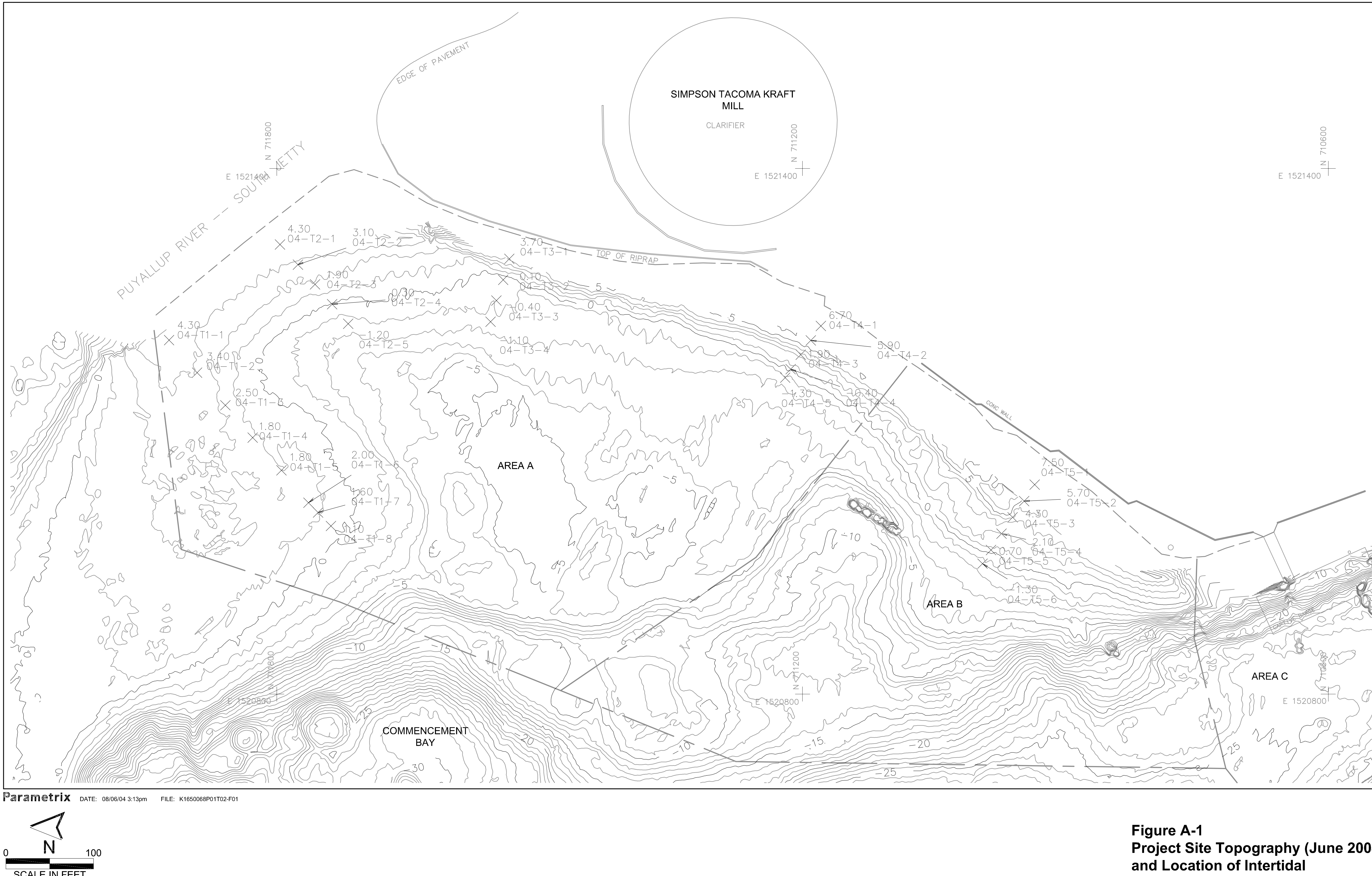
Physical, chemical, and biological characteristics of the St. Paul Waterway Area Sediment Remedial Action and Habitat Restoration Project (Project) have been monitored consistent with the requirements of the state and federal consent decrees' monitoring plan for 15 years (Parametrix 1990 through 1999a, 2000 through 2004). As noted in prior reports, the adaptive management program has tailored the annual monitoring requirements to the results obtained in the course of the long-term monitoring program. The 1993 Annual Monitoring Report provided a five-year overview (Parametrix 1994), and Appendix A of the Post-Ten Year Contingency Monitoring and Adaptive Management Plan (Parametrix 1999b) provided a ten-year overview. This appendix provides an overview of the past five years (2000 to 2004) and summarizes the results of the 15 years (1988 through 2004) of Project monitoring.

Physical Monitoring

Intertidal transects over the five-year period were conducted in 2000, 2001, 2002, and 2004. (The Post-Ten Year Contingency Monitoring and Adaptive Management Plan specified intertidal transects surveys for 2000, 2002, and 2004; one was also performed in 2001 due to the February 28, 2001 Nisqually earthquake [Parametrix 1999b]) The five intertidal elevation transects that were surveyed consisted of four to eight monitoring stations (Figure A-1). In addition, a bathymetric survey covering all portions of Areas A and B was conducted in 2004 (Figure A-1) to provide a final detailed reference survey of the site to accompany the pre- and post-cap surveys conducted in 1987 (preconstruction) and 1988 (as-built) surveys that were performed when the project was constructed (Weiner 1991).

As anticipated, surface features of the Project have changed as cap material has been redistributed over the site. The greatest changes of elevation occurred within two years following Project construction, however, both increases and decreases have continued over time. In general, redistribution of the materials appears to have become less rapid and the magnitude of change has become smaller within the past 10 to 13 years (Table A-1).

Transect surveys in years 10-to-15 indicate minor change (Table A-1). The overall changes in elevation between 2000 and 2004 across all stations other than the nourishment area averaged only 0.2 ft. (mean and median elevation change, regardless of whether the change was an increase or decrease); the net change on these stations over the past five years was approximately -0.1 ft (which is close to the level of accuracy for the transect monitoring method).



Parametrix DATE: 08/06/04 3:13pm FILE: K1650068P01T02-F01

Figure A-1
Project Site Topography (June 2004) and Location of Intertidal Transect Stations

Table A-1. Elevations (ft MLLW) monitored on the Project site at five intertidal transects between 1988 and 2004.

Transect/ Station	12/88	6/89	6/90	6/91	6/92	6/93	6/94	6/95	7/96	6/97	5/98	6/00	6/01	6/02	6/04	Elevation Changes 6/02 to 6/04	Eleva Char 12/88 t
1-1	5.0	6.1	5.8	5.2	5.2	4.9	4.4	4.8	4.8	4.5	4.5	4.4	4.6	4.6	4.3	-0.3	-0
1-2	3.6	4.0	5.1	4.7	4.5	4.5	4.1	4.4	4.5	4.5	4.5	4.2	3.6	3.9	3.4	-0.5	-0
1-3	2.9	2.9	2.7	3.1	2.7	3.7	3.6	4.2	4.4	3.9	3.0	3.0	2.6	2.7	2.5	-0.2	-0
1-4	2.4	2.1	1.5	1.4	1.3	4.0	4.1	3.6	2.8	2.5	2.2	2.1	2.0	2.0	1.8	-0.2	-0
1-5	0.1	0.6	1.0	3.5	3.6	3.7	3.3	2.3	2.1	1.9	1.9	1.8	1.6	1.7	1.8	+0.1	+1
1-6	1.8	1.7	2.8	3.4	2.8	2.8	2.4	2.3	2.3	2.2	2.1	1.8	1.4	2.0	2.0	+0.0	+0
1-7	0.2	0.5	2.1	2.6	2.1	2.1	1.8	1.8	1.7	1.7	1.4	1.7	1.6	1.8	1.6	-0.2	+1
1-8	-0.3	-0.1	1.3	1.5	1.0	0.9	0.9	0.8	0.8	0.8	0.9	1.0	0.9	1.1	1.1	+0.0	+1
2-1	6.9	6.6	7.0	6.7	6.3	5.8	5.6	5.6	5.3	5.2	4.9	4.8	4.4	4.5	4.3	-0.2	-2
2-2	6.0	5.5	5.1	5.0	4.7	4.3	4.1	4.0	3.6	3.6	3.5	3.5	3.3	3.4	3.1	-0.3	-2
2-3	4.6	4.2	3.4	3.1	2.5	2.5	2.1	2.1	2.0	2.0	2.0	1.9	1.8	1.9	1.9	+0.0	-2
2-4	2.7	1.7	1.0	0.7	0.5	0.4	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.3	+0.0	-2
2-5	-1.9	-1.8	-1.0	-2.0	-2.1	-1.8	-1.8	-1.7	-1.6	-1.6	-1.6	-1.4	-1.6	-1.2	-1.2	+0.0	+0
3-1	5.7	5.3	4.7	4.7	4.8	4.4	4.3	4.2	4.5	4.5	4.0	3.9	4.1	3.9	3.7	-0.2	-2
3-2	2.9	1.9	0.6	0.1	-0.3	-0.4	-0.6	-0.5	-0.4	-0.2	-0.3	-0.2	-0.2	-0.1	0.1	+0.2	-2
3-3	-0.2	-0.4	-0.7	-1.2	-1.4	-1.1	-0.9	-0.9	-0.7	-0.5	-0.6	-0.6	-0.6	-0.5	-0.4	+0.1	-0
3-4	-1.4	-1.6	-1.6	-1.6	-1.8	-1.5	-1.4	-1.3	-1.4	-1.3	-1.4	-1.3	-1.3	-1.3	-1.1	+0.2	+0
4-1	5.2	7.6	8.4	7.6	7.7	7.0	6.7	6.6	6.7	6.7	6.3	6.3	6.2	6.1	6.7	+0.6	+1
4-2	6.2	5.7	5.0	4.8	4.7	4.3	4.0	3.9	3.7	3.7	3.6	3.6	3.4	3.3	5.9	+2.6	-0
4-3	4.4	3.6	2.8	2.5	2.2	2.1	1.9	1.5	1.3	1.3	1.0	1.0	1.0	0.8	1.9	+1.1	-2
4-4	1.4	0.9	0.5	0.5	0.3	0.0	-0.2	-0.3	-0.3	-0.3	0.2	-0.5	-0.5	-0.6	-0.4	+0.2	-1
4-5	-0.9	-0.8	-0.8	-0.7	-1.0	-1.0	-0.9	-1.0	-1.0	-1.0	-1.0	-1.2	-1.3	-1.3	-1.3	+0.0	-0
5-1	5.0	6.5	8.5	7.5	8.0	7.0	6.5	6.7	6.7	7.0	6.8	7.1	7.0	7.0	7.5	+0.5	+2
5-2	5.8	6.1	5.7	5.4	4.8	4.4	3.8	3.6	3.8	4.0	4.1	4.5	4.4	4.6	5.7	+1.1	-0
5-3	5.2	5.4	4.0	2.9	2.2	2.0	1.5	1.3	2.4	3.3	3.2	3.3	3.7	3.9	4.3	+0.4	-0
5-4	3.7	3.1	1.7	1.1	0.6	0.5	0.4	0.5	2.8	2.5	2.7	2.4	2.3	1.8	2.1	+0.3	-1
5-5	1.5	0.7	0.6	-0.3	-0.4	-0.4	-0.3	-0.2	1.6	1.6	1.2	1.0	0.7	0.4	0.7	+0.3	-0
5-6	-0.8	-0.8	-0.7	-1.4	-1.4	-1.3	-0.9	-1.1	0.1	0.2	-0.2	-0.6	-1.3	-1.0	-1.3	-0.3	-0

A small-scale preventive beach nourishment was conducted in February 2004 (Parametrix and Anchor Environmental 2003). The beach nourishment was an adaptive management action to deal with naturally differential movement of sediment at middle intertidal levels of the restored habitat, similar to the successful beach nourishment performed at Transect 5 in 1995, described in the second five-year review (Parametrix 1999b).

There were no physical monitoring results above applicable early warning criteria in the period 2000 through 2004. Overall, 16 stations were unchanged or showed net elevation increases in the five-year period, and 12 stations had net elevation decreases. In the 15 years following project construction, eight stations had net increases and 20 stations had net decreases. As was found in the first two five-year reviews, the redistribution of materials at the site has not affected the integrity or function of the cap in any area measured. Comparison of bathymetry maps indicates that overall the primary features of the 1988 as-built map are readily visible in the 2004 map, with some smoothing of contours evident in the intertidal portions of the cap due to anticipated sediment redistribution. Comparison of elevation changes with core thicknesses (taken for 1988 through 1998 chemical monitoring) indicates the cap continues to exceed the three-foot performance standard in Areas A and B.

Chemical Monitoring

Chemical monitoring was not conducted during the final five-year period due to consistent results from the first ten years of extensive monitoring. Overall, chemical monitoring conducted 1988 through 1998 indicated: (1) no substantial levels of chemicals from off-site sources are being deposited on the cap; (2) chemicals in the underlying sediments are remaining in-place, and (3) the Project cap is functioning as designed (Parametrix 1999b).

Biological Monitoring

Biological monitoring was not conducted during the final five-year period due to the consistent results from the first ten years of extensive monitoring. Prior to Project construction in 1988, the site was essentially devoid of marine life. The restored intertidal beach and mudflats recolonized rapidly within the first two years (Parametrix 1990, Weiner 1991). Overall, biological monitoring conducted 1988 through 1998 indicated that the abundance and complexity of biological systems at the site was relatively similar following the initial recolonization (Parametrix 1999b).

Over the period 1988 through 1998, based on the number or benthic organisms per square meter obtained in the annual monitoring (averaging more than 7,000 organisms per square meter over 69,000 square meters), the site changed from an area with a few benthic organisms to intertidal habitat that has annually sustained a diverse population of approximately one-half billion benthic organisms, and the results indicate ongoing recruitment, biological diversity, and self-sustaining habitat (Parametrix 1999b). In addition, macrophyte coverage at the site has increased greatly since Project construction and was maintained over the last several years of biological monitoring (Parametrix 1999b).

The overall habitat results for the first ten years of the Project were similar to and consistent with the data and assessment made by EPA and the consulted agencies at the conclusion of the first five years of the Project, and abundance and diversity observed at the Project site were generally similar to those found at the various background stations sampled and indicate a biological community similar to a typical back-bay mudflat in Puget Sound (Parametrix 1999b).

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