

ATTACHMENT A

SEDIMENT PROFILE IMAGING PROCEDURES

PORT OF OLYMPIA
WEST BAY BERTHS 2 AND 3

Prepared for
Port of Olympia
915 Washington Street NE
Olympia, Washington 98501

and

Washington State Department of Ecology
P.O. Box 47600
Olympia, Washington 98504-7600

Prepared by
Anchor Environmental, L.L.C.
1423 Third Avenue, Suite 300
Seattle, Washington 98101

January 2009

Table of Contents

1	INTRODUCTION.....	A-1
2	SPI SAMPLE ACQUISITION.....	A-2
2.1	Field Personnel.....	A-2
2.2	Sampling Platform.....	A-2
2.3	Positioning, Station Locations, and Nomenclature.....	A-2
2.4	SPI Image Collection	A-3
2.4.1	SPI Camera Description.....	A-3
2.4.2	SPI Operation and Data Collection.....	A-5
2.5	Field Sampling Quality Assurance/Quality Control and Data Storage.....	A-5
3	SPI IMAGE ANALYSIS	A-6
3.1	Data Evaluation and Reporting	A-6

List of Figures

Figure A1 – SPI Camera Operation Sequence



1 INTRODUCTION

This Attachment details the approach and methods to be used for data collection and data analysis of a sediment profile imaging (SPI) survey of the Port of Olympia (Port) Berths 2 and 3 Interim Action cleanup area. The objective of this work is to provide additional information regarding the thickness of clean cover material placed in the dredged area within Berths 2 and 3. This information, in conjunction with bathymetry surveys conducted following dredging and following placement of the clean cover, will provide supporting information that adequate cover material has been placed in the dredge footprint (minimum placement of 6 inches). Sampling will consist of collecting SPI images at stations spaced equally over the area covered with clean material. Section 2 describes sample collection techniques, and Section 3 describes SPI image analysis methodology and reporting.



2 SPI SAMPLE ACQUISITION

2.1 Field Personnel

The field team that will collect the SPI data will be comprised of the following companies and their representatives:

Anchor Environmental, L.L.C. (Anchor)

- Mr. David Templeton, Principal, will be responsible for the overall management of project activities.
- Mr. Dan Berlin, Senior Environmental Scientist, will be responsible for the management of all field operations to ensure that the collection of data meets project objectives.

Germano and Associates, Inc.

- Dr. Joseph Germano, President, will lead the collection of SPI images and ensure that the collection of images meets project objectives.
- Mr. David Browning, Senior Scientist, will assist Dr. Germano in the collection of SPI images and be primarily responsible for on-deck operations.

2.2 Sampling Platform

The sampling vessel will be suitable for the collection of SPI images. It will safely deploy and retrieve the SPI camera. The SPI camera assembly weights 1,200 pounds fully weighted. Minimally, these vessels have:

- An enclosed wheel house
- A winch capable of lifting the camera
- An A-frame, boom, or davit (small crane attached to the boat) to deploy the camera off the vessel deck
- Steel winch cable 1/4-inch or greater
- Adequate deck space for the SPI camera and operators

2.3 Positioning, Station Locations, and Nomenclature

Navigation and positioning will be accomplished using a differential global positioning system (DGPS) interfaced to an integrated navigation system. Navigation and positioning

services will be provided by the research vessel. The DGPS system used by the vessel will be capable of providing positional accuracy of +/- 2 meters.

Because one of the primary goals of the survey is to ensure adequate aerial coverage of the clean cover area, it will be more important to document the location of sampling rather than navigating to a specific point for replicate sampling. Therefore, the locations of SPI sample acquisition will be recorded both digitally within the integrated navigation software package and in the field log. Actual locations will be refined in the field depending on field conditions in order to best characterize site conditions.

To best characterize the area while working in the field, a north-south grid will be superimposed over these areas. The grid will be alphanumerically labeled, with north-south columns receiving an alphabetic label (beginning at "A" from west to east) and rows receiving a numeric label with numbers increasing from north to south. For example, the northwestern-most grid cell would be labeled A-1, moving eastward in the upper row of grid cells, station names would be B-1, C-1, etc. This will allow the stations sampled in the field to be geographically referenced to the sample area by station name alone. Assuming 20 to 30 sample locations, grid cells are expected to be spaced less than 50 feet apart. The target sampling grid will be provided to Ecology prior to field data collection.

2.4 SPI Image Collection

2.4.1 SPI Camera Description

The SPI camera operates similar to an inverted periscope. A digital camera is mounted horizontally inside a water-tight housing located on top of a wedge-shaped prism. The prism has a Plexiglas® faceplate at the front with a mirror placed at a 45-degree angle at the back. The camera lens looks down at the mirror, which reflects the image from the faceplate. The prism has an internal strobe mounted inside at the back of the wedge to provide illumination for the image; this chamber is filled with distilled water, so the camera always has an optically clear path to shoot through. This wedge assembly is mounted on a moveable carriage within a stainless steel frame. The frame is lowered to the seafloor on a winch wire, and the tension on the wire keeps the prism in its "up" position. When the frame comes to rest on the seafloor, the winch wire goes slack (Figure A1) and the camera prism descends into the sediment at a slow, controlled rate

by the dampening action of a hydraulic piston so as not to disturb the sediment-water interface. On the way down, it trips a trigger that activates a time-delay circuit of variable length (operator-selected) to allow the camera to penetrate the seafloor before any image is taken. The knife-sharp edge of the prism transects the sediment, and the prism penetrates the bottom. The strobe is discharged after an appropriate time delay to obtain a cross-sectional image of the upper 20 cm of the sediment column. After the first image is obtained at the first location, the camera is then raised approximately 2 to 3 meters off the bottom to allow the strobe to recharge. The strobe recharges within 5 seconds, and the camera is ready to be lowered again for another replicate image, if required. The resulting images give the viewer a similar perspective as though looking through the side of an aquarium half-filled with sediment. Camera settings (f-stop, shutter speed, ISO equivalents, digital file format, color balance, etc.) are selectable through a water-tight USB port on the camera housing and camera software.

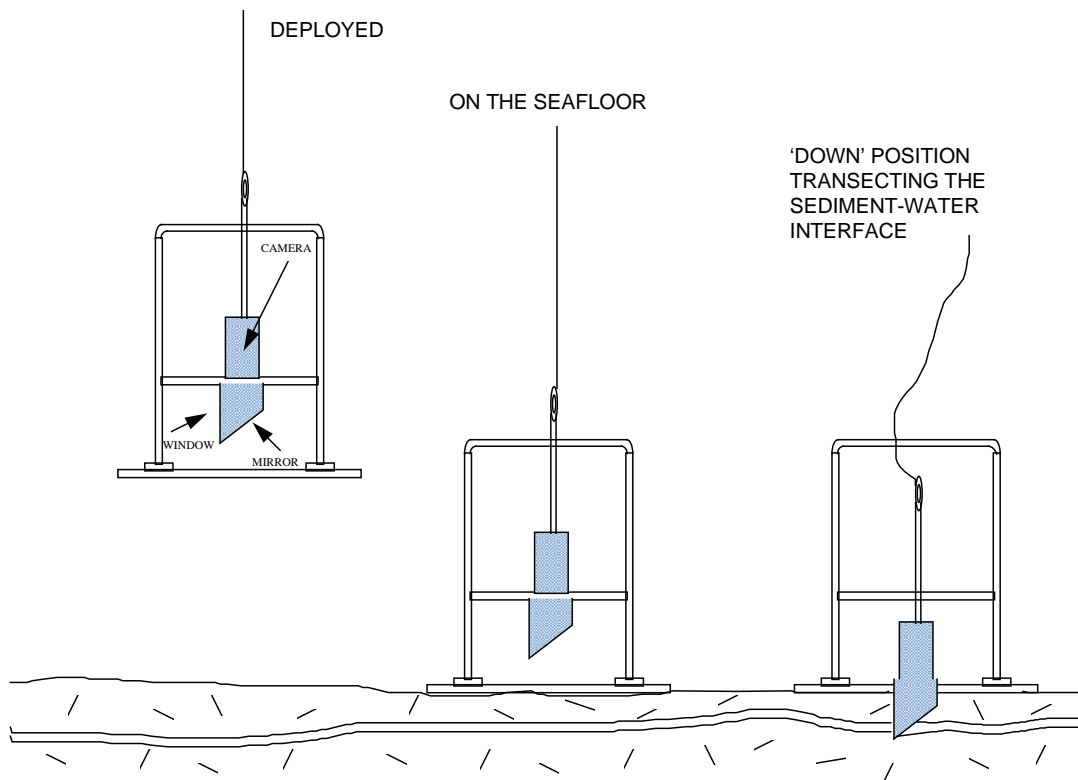


Figure A1 SPI Camera Operation Sequence

2.4.2 SPI Operation and Data Collection

At the beginning of the survey, the time on the sediment profile camera's internal data logger will be synchronized with the internal clock on the computerized navigation system. To maximize aerial coverage, one image will be taken at each station and three replicate images will be taken at a subset of the station (not to exceed 20 percent of the total station); each SPI replicate will be identified by the time recorded on the digital file and on disc, along with vessel position. In the case of multiple replicate images at a single sampling station, each image will be assigned a unique time stamp in the digital-file attributes by the data logger and cross-checked with the time stamp in the navigational system's computer data file. The field crew will keep redundant written sample logs. Images will be downloaded periodically throughout the day to verify successful sample acquisition or to assess the type of sediment present at a particular station. Digital image files will be re-named with the appropriate station name immediately after downloading on deck as a further quality assurance step.

2.5 Field Sampling Quality Assurance/Quality Control and Data Storage

Test exposures of the Kodak® Color Separation Guide (Publication No. Q-13) will be fired on deck at the beginning and end of each survey to verify that all internal electronic systems are working to design specifications, and to provide a color standard against which final images can be checked for proper color balance. A spare camera and charged battery will be carried in the field at all times to insure uninterrupted sample acquisition. After deployment of the camera at each station, the frame counter will be checked to make sure that the requisite number of replicates was taken. In addition, a prism-penetration depth indicator on the camera frame will be checked to verify that the optical prism actually penetrated the bottom to a sufficient depth to acquire a profile image. If images were missed (frame counter indicator or verification from digital download) or the penetration depth was insufficient (penetration indicator), chassis stops will be adjusted and/or weights will be added or removed, and additional replicate images will be taken. Changes in prism weight amounts, the presence or absence of mud doors, and chassis stop positions will be noted in the log for each replicate image.

3 SPI IMAGE ANALYSIS

Following completion of field operations, the digital images will be analyzed from this survey using Sigma Scan® software (Aspire Software International). Calibration information will be determined by measuring 1-cm gradations from the Kodak® Color Separation Guide. This calibration information will be applied to all analyzed SPI images. Linear and area measurements will be recorded as number of pixels and converted to scientific units using the calibration information.

Measured parameters will be recorded on a Microsoft Excel® spreadsheet. Germano and Associates' Senior Scientist, David Browning, will conduct the image analysis and all analyses will be subsequently checked by Dr. Joseph Germano. This step will provide an independent quality assurance/quality control review of the measurements before final interpretation is performed.

The distribution of these measured parameters across the survey area will allow cover thickness characteristics to be identified. SPI is effective in measuring layers ranging in thickness from 20 cm (the height of the SPI optical window) to 1 mm. During image analysis, the thickness of the sand cover can be determined by measuring the linear distance between the pre- and post-cover placement sediment-water interface. Recently deposited material, including clean cover, is usually evident because of its unique optical reflectance and/or color, relative to the underlying material representing the pre-cover placement surface. Also, in most cases, the point of contact between the two layers is clearly visible as a textural change in sediment composition, facilitating measurement of the thickness of the recently deposited layer.

Parameters to be measured from the SPI images will consist of:

- Prism-penetration depth
- Clean cover thickness
- Interpretive comment field detailing qualitative assessment of mixing between underlying sediment and clean cover discernible from the image

3.1 Data Evaluation and Reporting

After the image analysis results have been reviewed for accuracy, the distribution of the measured parameters will be plotted across the area sampled. In addition, all image

analysis results will be presented in table form. Images collected from the survey will be submitted in .jpg file format on compact disc (CD) or digital video disc (DVD).

An analysis letter report detailing the cover thickness in the area will be prepared and submitted to the Port within 5 days following the conclusion of field activities. The Port will provide this letter report to Ecology. This letter report will include the following elements:

- Summary of field activities
- Project map illustrating approximate locations of sample stations
- Summary of findings detailing the cover thickness at each location

Depending on the results, the Port may require the contractor to place additional cover material in specific locations if it is clear that a minimum of 6 inches of cover was not placed. The Port will coordinate with Ecology if additional placement is necessary.

