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DEPT. OF ECOLOGY

A Report Prepared For :

Ms. Margaret Russell
Post Office Box 25
Orcas, Washington 98280

DRAFT

**SEDIMENT SAMPLING AND ANALYSIS PLAN
RUSSELL'S LANDING
ORCAS, WASHINGTON**

June 30, 1994

Mingta Lin
Environmental Chemist

Gary L. Laakso
Remediation Services Manager

AGI Technologies
300 120th Avenue N.E.
Building 4
Bellevue, Washington 98005
206/453-8383

AGI Project No. 15,676.001

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INTRODUCTION

This Sampling and Analysis Plan (SAP) is prepared by AGI Technologies (AGI) for sediment sampling and analysis at Russell's Landing at Orcas (the site) on Orcas Island, Washington.

The site is an active bulk fuel facility located on the waterfront, immediately west of the Washington State ferry dock in Orcas, Washington. **Figure 1** shows the vicinity of the site. Six aboveground fuel storage tanks are located on the west end of the site. Fuel pumps and a truck loading rack are located at the site center. A wood dock (the dock) extends out over the water from the middle of the site. Site features are shown in **Figure 2**. The ownership of the property and facilities and the Department of Natural Resources (DNR) tideland lease are being considered for transfer.

Based on the results of previous investigations conducted on the site by GeoEngineers Inc. (GeoEngineers 1990), a Remedial Action (RA) was performed on the site by AGI in June 1994 to excavate selected soils from the fuel dispenser area (pump area) and truck loading rack (AGI 1994). Prior to completing the property transfer, approximately 920 cubic yards of soil was excavated from the upland area. A soil sample collected from the east side of the storage building was analyzed for fuel hydrocarbons (FHC). Gasoline, diesel, and oil range fuel hydrocarbons were detected at levels ranging from approximately 2,000 to 4,900 parts per million (ppm) in this sample. FHC in all other samples were below Method A cleanup levels. The DNR require that sediments on leased tideland be evaluated for potential contamination prior to a lease transfer.

The sediment sampling and analysis to be conducted at the site is to 1) assess if the shoreline sediments in the vicinity of the site have been impacted by the upland FHC contamination and 2) evaluate if sediments adjacent to the dock impacted by the fueling activities related to the two pumps and associated piping on the dock. As required by the Washington Department of Ecology (Ecology), sediment samples will be collected and tested for biological toxicity. Aliquots of the sediment samples will be retained for chemical analysis if required by Ecology for comparison to the Sediment Quality Standards criteria. The scope of this work does not include the chemical analysis.

The testing results will be reviewed for quality by AGI, bound with a cover letter summarizing related sampling data, and submitted for Ecology's review.

This SAP defines the scope and approach to perform the sediment sampling and analysis in response to the Ecology's requirements. Key elements, as specified in Chapter 173-204 of the Washington Administrative Code (WAC-173-204-600), including sampling dates and schedule, sample type(s), sample depth(s), sample locations, sample positioning method, sampling personnel, sampling equipment and methods, biological analysis methods, and quality assurance/quality control methods will be identified and discussed in this SAP following Puget Sound Estuary Program (PSEP) guidelines (PSEP 1986a, 1986b, and 1991).

SAMPLE COLLECTION AND HANDLING

The following sections identify sample locations and field sample collection, documentation, and handling procedures.

SAMPLE LOCATIONS AND SAMPLE TYPE

Sample locations will be positioned as present in Figure 3. Samples will be collected from six locations, three along the shoreline and three below the water surface along the dock. The three samples along the shoreline are intended to provide data to assess potential transport of fuel hydrocarbons from the upland area of the site. Samples collected from the location adjacent to the storage building and the dock may also provide data to evaluate FCH contamination related to the pump area and truck loading rack. Three samples collected below the low tide water line are intended to assess if sediment has been impacted by the fueling activities associated with the pumps or piping on the dock. One composite sediment sample will be collected from each of the 6 locations.

SAMPLE COLLECTION

At each sampling location, sediment subsamples will be collected by a diver (below-water sediments) or field technician (shoreline area only) with a stainless steel corer which meets the PSEP guidelines' criteria. Subsamples will be examined for acceptability and the top 2 cm portion will be composited to the required volume (approximately 4 L) for toxicity tests and potential analytical testing in the future.

Personnel

Sampling procedures will be in general accordance with procedures described in the PSEP guidelines (PSEP 1991). The sampling team will consist of a diver and tender and a field technician. Sediment samples below the water surface will be collected by the diver with the assistance of the technician who will be stationed ashore or on the dock during the below-water sampling.

Sampler

As recommended in the PSEP guidelines (PSEP 1986b, 1991), an adequate sampler is one that consistently collects undisturbed samples to the required depth below the sediment surface without contaminating the samples. A 0.01-m² x 0.1-m stainless steel corer with plastic caps on both ends will be used for sample collection. With adequate operation, the following additional criteria, as recommended in the guidelines, will be met:

- Create a minimum sediment disturbance during sampling.
- Closes to form a leakproof seal after the sediment sample is taken.

- Prevents sediment washout and excessive sample disturbance when ascending.
- Allows easy access to the sample material.

Penetration Depth

The upper 2 cm of sediment is recommended by the PSEP guidelines to be submitted for toxicity tests as in such horizon most infaunal organisms reside and is most frequently contacted by epifaunal organisms. A minimum of 4-5 cm penetration is recommended to obtain acceptable samples. In order to obtain undisturbed sediment samples with the 6-inch-long corer (approximately 15 cm), samples will be collected at 10-cm penetration depth with 5-cm overlying water.

Sample Acceptability and Homogenization

Materials collected by the sampler from each below-water locations will be examined against the following criteria for acceptability prior to compositing in the stainless steel bow:

- The sampler is not overfilled with sample such that the sediment surface is pressed against the top of the sampler.
- Overlying water is present.
- The overlying water is not excessively turbid.
- The sediment surface appears to be relatively undisturbed.
- The desired penetration depth is achieved.

The overlying water will be removed from the accepted subsamples by slowly siphoning. A flat rubber scoop will be used to remove the top 2 cm sediment into the stainless steel bow. Once sufficient sample volume is collected at a location, the subsamples will be homogenized with a stainless steel spoon before loading into sample container(s).

Sampling Equipment Decontamination

The following decontamination procedures will be performed on sampling equipment between each sampling location to prevent the occurrence of cross-contamination:

- Wash with site seawater.
- Rinse with pesticide-grade acetone.
- Rinse with pesticide-grade methylene chloride.
- Allow residual methylene chloride to air dry before next use.

SAMPLE HANDLING

Sample containers will be provided by the biological testing laboratory (Parametrix, Inc. Kirkland, WA, [Parametrix]) where sample containers have been cleaned following procedures specified in the PSEP guidelines (PSEP 1991). Each sample container will be labeled with the following information:

- Project name and number.
- Sample identification number.
- Date and time of sample collection.
- Initial(s) of the sampling personnel.

If more than one container is required for a sample location, the containers will be identically labeled taped together and labeled with a sample tag. As a container is filled with sample, it will be placed in a cooler at 4°C. The cooler(s) will be sealed with AGI's chain-of-custody tape for shipment. A sample chain-of-custody form will be completed and shipped with samples to Parametrix for biological analyses. A sample AGI chain-of-custody form is provided in Appendix A. The tests will be performed within the 14-day holding time as recommended in the PSEP guidelines (PSEP 1991). Samples retained for further chemical analysis will be archived by Parametrix. If samples are required to be frozen during holding period, Parametrix will assure adequate head space in each sample container to be maintained.

DOCUMENTATION

All pertinent field activities associated with this sampling will be documented using appropriate AGI forms and records. Records and record keeping will be checked by project manager during the course of field activities to assure accuracy, precision, and completeness.

AGI Field Investigation Daily Reports (FIDR) will be used on a daily basis to record and summarize all activities and sampling effort. This include a discussion of any problem encountered during sampling and any deviation from this SAP. The field supervisor will be responsible for ensuring that the following details are recorded in the FIDR:

- Date and time of starting work.
- Name of field supervisor, team members, and visitor(s).
- Purpose of proposed sampling effort.
- Description of sampling site, including information on any photographs that may be taken.
- Location of sampling site.
- Details of actual sampling effort, particularly deviation from standard operating procedures.

- Field observations.
- Field measurements made (e.g., pH, Temperature).

AGI Sediment Sampling Records will be used to document the collected sediment samples. Information to be recorded include:

- Sampling date and time.
- Station location.
- Sample identification number.
- Sample textures, odor, and other observations.
- Sample penetration depth.

Examples of AGI forms and Records to be used are included in Appendix A. All records and forms documented during the course of sampling will be centralized in the project file in AGI's Bellevue Office.

LABORATORY SAMPLE ANALYSIS

Sediment samples collected from each location will be submitted to Parametrix, Inc. in Kirkland, Washington for biological tests. Two acute effect testing (*Amphipod* 10-day mortality and *Bivalve Larvae* 2-day mortality/abnormality) and one chronic testing (*Juvenile Polychaete* 20-day biomass) will be conducted following PSEP guidelines (PSEP 1991). Table 1 summarizes bio-species and response variables measured for these tests. Five replicates of each sediment sample will be used in each test. The salinity of sediment interstitial water will be measured prior to the tests and ammonia (measured with an ion-specific electrode) and sulfide contents in test water will be monitored at the beginning and the end of the tests. Deliverables reported in the laboratory reports for these tests will include all the parameters specified in the PSEP guidelines (PSEP 1991).

AMPHIPOD MORTALITY TEST

The Amphipod test is an acute test measuring mortality and failure to rebury in adult amphipods exposed for 10 days to test sediment. With the interstitial water salinity greater than 25 parts per trillion (ppt), *R. abronius* will be used or *Eohaustorius estuarius* will be used for test if interstitial water salinity is between 2 ppt and 28 ppt. For each test replicate, 20 adult amphipods, which are collected from the field 3 - 4 days prior to the test, will be exposed in 2-cm layer bedded sediment in a 1-L chamber filled with fresh seawater. After the 10-day exposure, percent mortality will be determined by sieving and counting the surviving amphipods in each chamber and compared to the 20 individuals initially added to each chamber. Percent nonreburial will be determined by comparing the number of individuals fail to rebury after exposing to clean sediment against the number of survivors in each chamber. The SQSs criteria are based on the 10-day mortality for this test.

Quality control and quality assurance (QA/QC) requirements are specified in the PSEP guidelines (PSEP 1991). Mean mortality of amphipod in the negative controls should not exceed 10 percent for the test results to be considered valid. If multiple amphipod species are used due to grain size considerations, at least three sediment per species will be tested. Positive and negative controls and daily measurements of test water quality (pH, temperature, salinity, and dissolved oxygen content) will be performed on each chamber. Clean sediment will be collected from West Beach of Whidbey Island for negative control and cadmium will be used as the reference toxicant.

BIVALVE LARVAE MORTALITY AND ABNORMALITY TEST

The Bivalve Larvae test is an acute test measuring mortality and developmental abnormality in bivalve larvae exposed for 48 hours to test sediment. The species that will be used in this study are *Crassostrea gigas* or *Mytilus edulis*. The salinity of test water is adjusted to 28 ppt for this test. Selected densities of the resulting embryos from the spawned adult bivalve are exposed to the test sediment for 48 hours, during which the embryos normally will develop into prodissoconch I larvae. Toxicity endpoints of this test are based on abnormal shell development and larval death.

Twenty grams of test sediment is bedded in a 1-L chamber and filled with clean seawater. For each replicate, 20,000 to 40,000 developing embryos will be added to the bottle within 2 hours of fertilizing for 48-hour exposure. The chambers are covered and incubated at $20 \pm 1^\circ\text{C}$ for oysters and $16 \pm 1^\circ\text{C}$ for mussels. The seawater will then be decanted and homogenized. A 10-mL subsample will be collected and fixed with a 5-percent formalin. Percent abnormality will be determined by comparing the number of abnormal larvae relative to the number of normal larvae. Percent mortality will be determined separately relative to the number of survivors after exposed to clean seawater for 48 hours. The SQSs are based on the sum of percent normality and percent normality.

QA/QC requirements are specified in the PSEP guidelines for this test. Cadmium chloride will be used as the reference toxicant and a clean seawater will be used for negative control.

JUVENILE POLYCHAETE BIOMASS TEST

The Juvenile Polychaete test is a chronic test measuring the survival and change in biomass of juvenile polychaete following a 20-day exposure to test sediment. The species will be used in this study are *Neanthes* sp. For each test, five polychaetes of uniform size will be exposed to 150 g of bedded test sediment in a 1-L chamber filled with clean seawater. Seawater will be maintained at a salinity of 28 ± 1 ppt and at a temperature of $20 \pm 1^\circ\text{C}$. Food such as prawn flakes will be provided to the organisms during the exposure period. A portion of the seawater will be renewed periodically to maintain the water quality. Following the 20-day exposure, all surviving organisms will be collected, dried to a constant weight, and total and average individual biomass are determined.

QA/QC requirements are specified in the PSEP guidelines (PSEP 1991). Clean sediment will be collected from West Beach of Whidbey Island as negative control.

SCHEDULE

The proposed schedule for this sediment sampling and analysis is present in **Figure 4**. Approximately 1 - 2 days will be required for sample collection. The laboratory analysis, from sample delivery through reporting, will require 4 - 5 weeks. One week will be needed for data validation and preparing a draft cover letter summarizing the related data.

REFERENCES

GEOENGINEERS

- 1990 Report of Remedial Action, Unocal Bulk Plant 0533, Orcas Island, Washington. GeoEngineers, Inc. Bellevue, WA.
- AGI 1994 Report of Remedial Action, Russell's at Orcas, Orcas, Washington. AGI Technologies, Inc. Bellevue, WA.
- PSEP 1986a General QA/QC Considerations for collecting Environmental Samples in Puget Sound. Tetra Tech, Inc. Bellevue, WA.
- PSEP 1986b Recommended protocols for measuring sediment conventional variables in Puget Sound. Final Report. Tetra Tech, Inc. Bellevue, WA.
- PSEP 1991 Recommended guidelines for conducting laboratory bioassays on Puget Sound Sediments. Interim Final Report. PTI Environmental Services, Bellevue, WA.

DISTRIBUTION

X Copies

Ms. Margaret Russell
Post Office Box 25
Orcas, Washington 98280

Quality Assurance/Technical Review by:

X
X

MTL/tag

TABLES

Table 1
Biological Testing Schedule
 Russell's/Sediment Sampling and Analysis
 Orcas, Washington

Test	Species	Primary Endpoint(s)
Amphipod (10-day)	Rhepoxynius abronius or Eohaustorius estuarius (adult)	Mortality Nonreburial
Bivalve (48-hour)	Crassostrea gigas	Abnormality Mortality
Polychaete (20-day)	Neanthes sp. (juvenile)	Biomass Mortality

Table 2
Methods and Sample Handling
 Russell's/Sediment Sampling and Analysis
 Orcas, Washington

Variable	Method		Holding Time	Container	Preservation
Amphipod bioassay	10-day static exposure	PSEP	14 Days	B/G	4°C/dark/airtight
Bivalve larvae bioassay	48-hour static exposure	PSEP	14 Days	B/G	4°C/dark/airtight
Juvenile polychaete bioassay	20-day static renewal exposure	PSEP	14 Days	B/G	4°C/dark/airtight
Total Sulfides	Titrimetric	EPA Method 376.1	7 Days	N/A	N/A
Ammonia	Electrometric	SM 417 F*	28 Days	N/A	N/A

Notes:

*Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington DC, 17th Edition.

N/A – Not applicable.

PSEP – Puget Sound Estuary Program.

FIGURES



Reference: From Report of Remedial Action Unocal Bulk Plant No. 0533
Orcas Island, Washington by Geo Engineers, dated July 19, 1990

Map source: USGS 15 min. quadrangle
titled Orcas Island



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

Vicinity Map
Russel's at Orcas
Orcas, Washington

FIGURE

1

JOB NUMBER
15,676.001

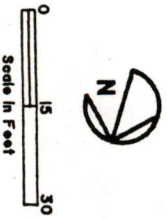
DRAWN
KM

APPROVED
SMB

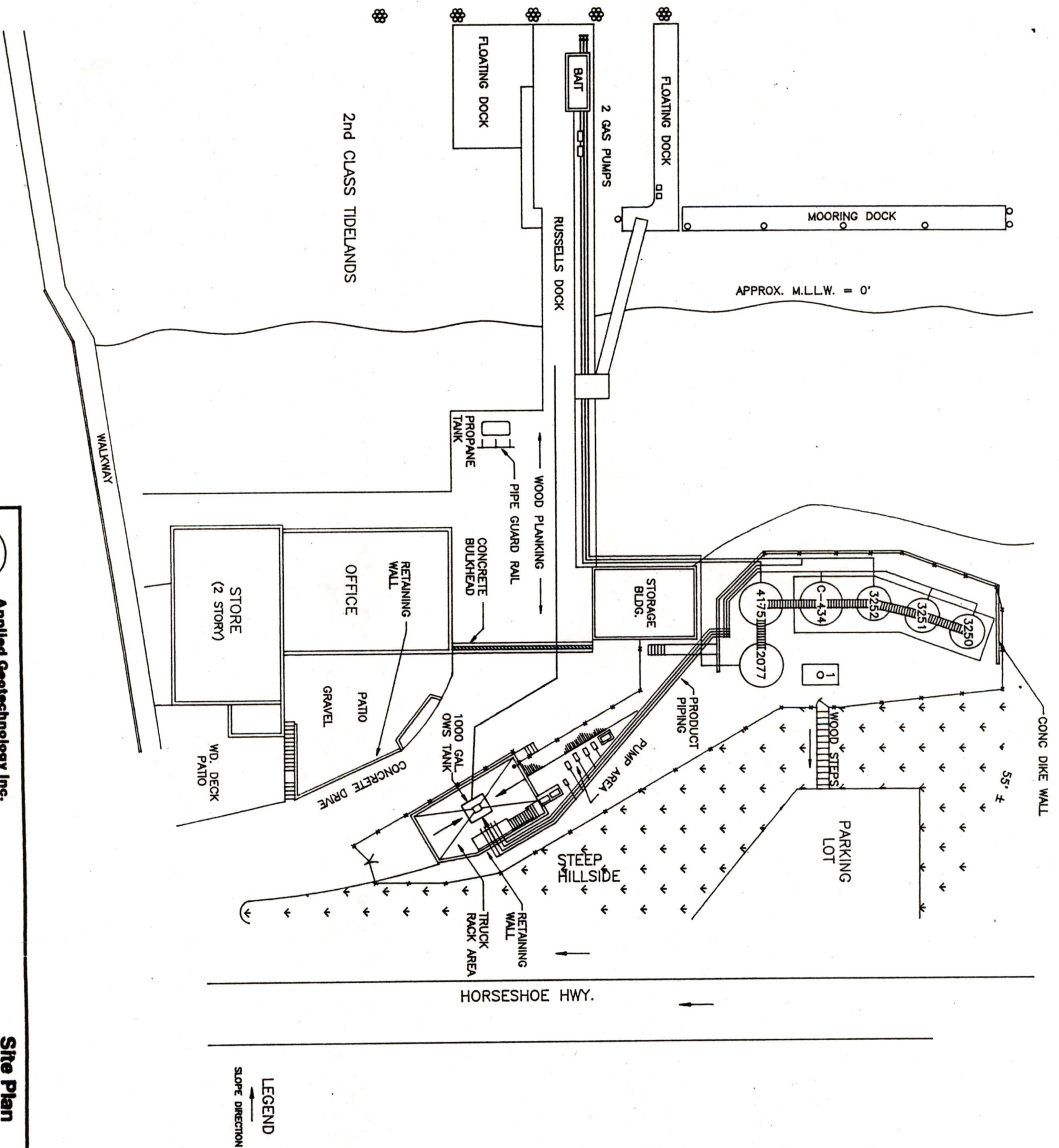
DATE
3/28/94

REVISED

DATE



HARNEY CHANNEL



Applied Geotechnology Inc.
Geotechnical Engineering
Geology & Hydrogeology

JOB NUMBER
15,676,001

DRAWN
JFL

APPROVED
GMB

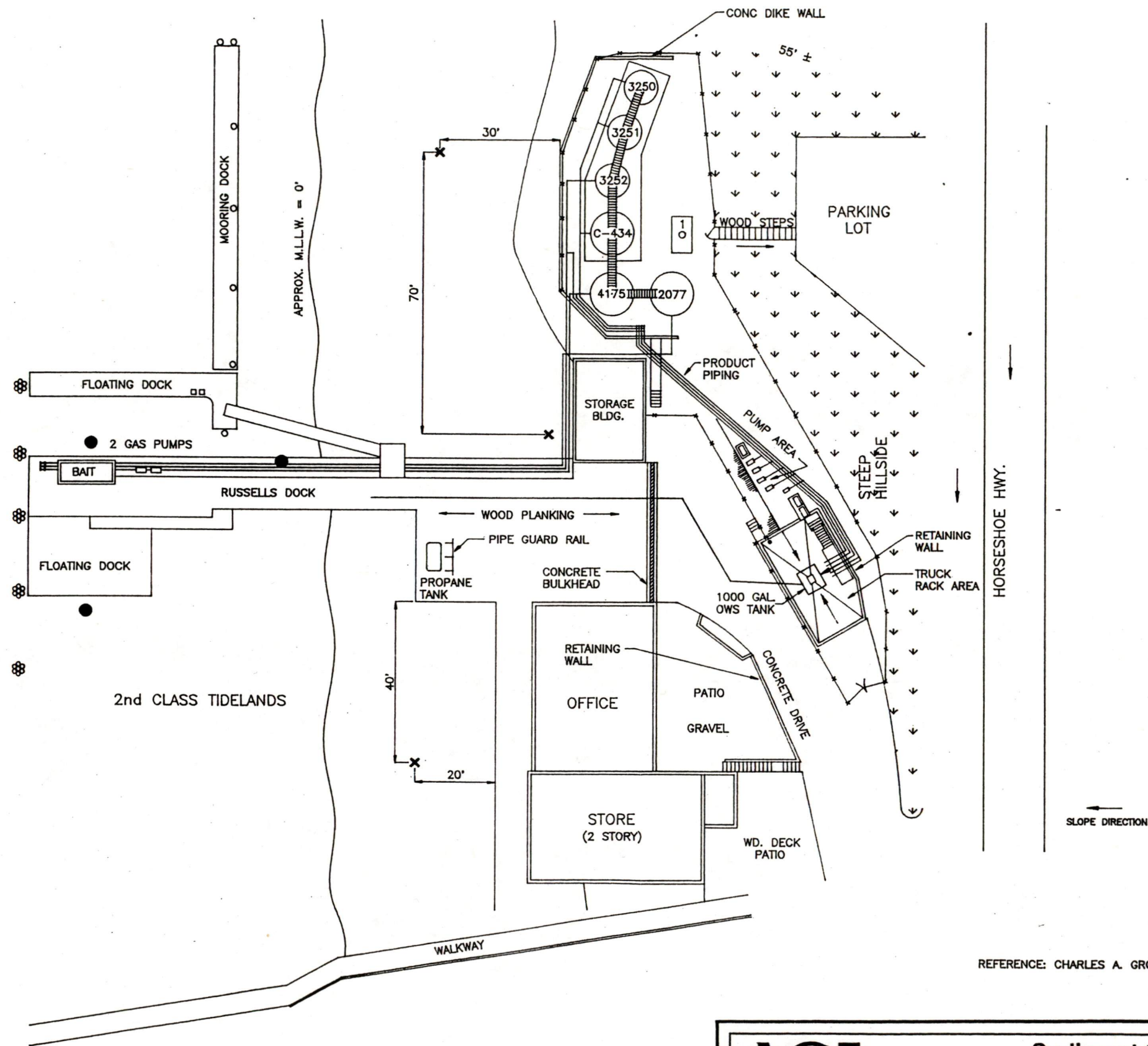
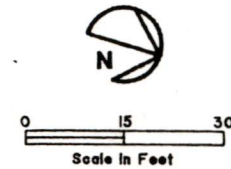
DATE
9/28/94

REVISED

DATE

Site Plan
Russell's at Orcas
Orcas, Washington

HARNEY CHANNEL



- LEGEND**
- x SHORELINE SEDIMENT SAMPLE LOCATION
 - BELOW-WATER SEDIMENT SAMPLE LOCATION

REFERENCE: CHARLES A. GROVE & ASSOCIATES, INC., DATED MAY 24, 1993.

AGI
TECHNOLOGIES

Sediment Sample Locations
Russel's at Orcas/Sediment Sampling and Analysis
Orcas, Washington

FIGURE
3

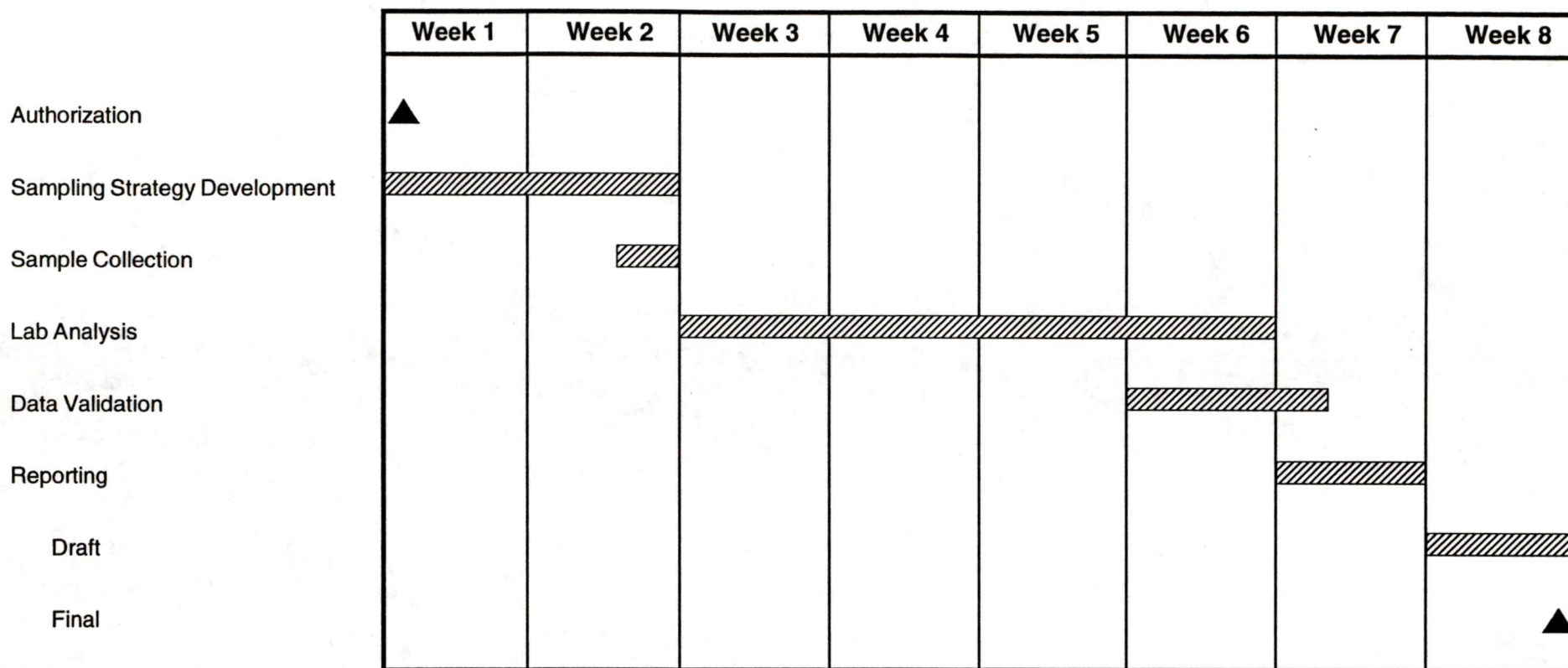
Sample.dwg	PROJECT NO. 15,676.001	DRAWN JFL	DATE	APPROVED	REVISED	DATE
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Figure 4

Sediment Sampling and Analysis Schedule

Russell's at Orcas

Orcas Island, Washington



APPENDIX A

AGI Forms

Applied Geotechnology Inc.

FIELD INVESTIGATION DAILY REPORT

Sheet _____ of _____

Project: _____ Job No.: _____
Location: _____ Date: _____
Equipment Rental: _____ Company: _____ To: _____
Equipment Hours: _____ F.E. Time from: _____ to: _____ By: _____

Visitors:

Attachments:

☐ Continued:

Distribution:

Initial:

SEDIMENT SAMPLING RECORD

Sheet _____ of _____

Project: _____		Date: _____	
Project No.: _____		Sampled by: _____	
Location: _____		Reviewed by: _____	
NO.	Sample No.:		
	Time collected:		
LOCATION	Location:		
	Depth:		
	Surface Elev.: (feet)		
SAMPLING	Sampling method:		
	Container:		
	Composited: (Yes/No)		
	Cooled by?		
SAMPLE DESCRIPTION	Soil Description/ Classification:		
	Odor:		
	Head Space Analysis:	Instrument	
		Background	
		Reading	
DISPOSITION	Split	Name:	
		Organization:	
	Duplicate No.:		
	Archive: (Yes/No)		
	AGI Lab: (Yes/No)		
	Other: (Describe)		
	Name of analytic lab:		
	Date sent:		
	Delivery method:		
Chain of Custody No.:			
COMMENTS:			



Date _____ Page _____ of _____

LAB INFORMATION		SAMPLE RECEIPT		RELINQUISHED BY: 1.		RELINQUISHED BY: 2.		RELINQUISHED BY: 3.	
Lab Name:		Total Number of Containers:		Signature: _____ Time: _____		Signature: _____ Time: _____		Signature: _____ Time: _____	
Lab Address:		Chain of Custody Seals: Y/N/NA		Printed Name: _____ Date: _____		Printed Name: _____ Date: _____		Printed Name: _____ Date: _____	
		Intact?: Y/N/NA		Company: _____		Company: _____		Company: _____	
Via:		Received in Good Condition/Cold:							
Turn Around Time: ☐ Standard ☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 1 wk.				RECEIVED BY: 1.		RECEIVED BY: 2.		RECEIVED BY: 3.	
PRIOR AUTHORIZATION IS REQUIRED FOR RUSH DATA				Signature: _____ Time: _____		Signature: _____ Time: _____		Signature: _____ Time: _____	
				Printed Name: _____ Date: _____		Printed Name: _____ Date: _____		Printed Name: _____ Date: _____	
				Company: _____		Company: _____		Company: _____	
Special Instructions:									

APPENDIX B

Quality Assurance Project Plan for Sediment Sampling and Analysis at Russell's Landing

PROJECT DESCRIPTION

This quality assurance project plan (QAPP) will be implemented by AGI Technologies (AGI). The objective of this investigation is to 1) assess if the shoreline sediments in the vicinity of the site have been impacted by the upland FCH contamination, and 2) evaluate if sediments adjacent to the dock have been impacted by the fueling activities related to the two pumps and associated piping on the dock. Sediment conditions at the site will be evaluated by performing acute and chronic sediment toxicity test (i.e., amphipod mortality, bivalve larvae mortality and abnormality, and juvenile polychaete biomass tests [including analyses of ammonia and sulfide content in bioassay water]).

This QAPP identifies the quality assurance and quality control (QA/QC) methods that will be followed at all stages of sample collections and analysis during the investigation. Descriptions of data quality objectives (DQOs); laboratory analytical procedures; and procedures of data reduction, validation, and reporting are also included.

PROJECT ORGANIZATION AND RESPONSIBILITIES

The following paragraphs provide detailed descriptions of individual responsibilities for each key project personnel.

QUALITY ASSURANCE OFFICER

Review and approve QAPP; ensure compliance with corporate quality assurance policies.

PROJECT MANAGER

Oversee project performance to ensure contract compliance; implement necessary action and adjustments to accomplish problem objectives; monitor field investigations, coordinate field and laboratory sample tracking; and act as liaison between client, agencies, and contract personnel.

QUALITY ASSURANCE COORDINATOR

Provide technical quality assurance assistance; prepare and review QAPP; direct implementation of QAPP; and review laboratory data for quality and prepare Quality Assurance Report.

LABORATORY QUALITY ASSURANCE OFFICER

Overview laboratory quality assurance performance and QA/QC documentation; conduct detailed data review; and decide upon laboratory corrective actions, if required.

The laboratory will maintain a Statement of Work (SOW) that specifies the following items:

- Summary of testing procedures that shall be performed and modifications of the procedures, total number of field samples, laboratory quality assurance analyses, price per analysis, and total cost of analytical services.
- Sample delivery, log-in, and storage procedures, including method of delivery, scheduling, requirements for physical storage of samples, and holding times.
- Turnaround time from date of sample delivery, including penalties for late delivery.
- Deliverable requirements, including supporting documentation and specification of any electronic data files.
- QA/QC requirements.

A laboratory Quality Assurance Report describing laboratory organization and personnel; facilities and equipment; analytical methods; and procedures for sample custody, quality control, and data handling will also be provided by the laboratory.

DATA QUALITY OBJECTIVES

The DQOs are qualitative and quantitative statements which specify a required level of field and laboratory data quality designed to meet the data use needs of the activities. The overall DQOs for measurement data is to ensure the collection of representative data of known and acceptable quality. The DQOs are determined based on the expected uses of the data. In this study, data will be used to characterize sediments collected in the vicinity of the site to evaluate if fuel-hydrocarbons related activities have resulted in adverse effects on the sediment biota.

The DQOs are expressed in terms of precision, accuracy, representativeness, completeness, and comparability. Table B-1 summarizes the DQOs for this study.

PRECISION

Precision is expressed in terms of the standard deviation to the mean. A lower deviation indicates a more reliable precision.

ACCURACY

The degree of conformity of a measurement, R, with an accepted reference true value, T, usually expressed as percent recovery ($R/T \times 100$).

REPRESENTATIVENESS

The degree to which data accurately and precisely represent the true value of a characteristic of a population, the parameter variations at a sampling point, or an environmental condition intended to be characterized.

COMPLETENESS

A measure of the amount of valid data, C, compared with the amount that was expected to be obtained under normal conditions, T, usually expressed as $(C/T \times 100)$ percent.

COMPARABILITY

The confidence with which one data set can be compared with another. Comparability may be assessed by comparing sampling methods, analytical methods, and units of reported data.

SAMPLING AND ANALYSIS STRATEGY

The sampling and analysis strategy for obtaining data that meet the project objectives is detailed in the sampling and analysis plan (SAP). Sediments will only be tested for biological toxicity. Sample aliquots will be archived if in the event that testing is required to characterize the sediment conditions.

SAMPLING SITE SELECTION AND SAMPLING PROCEDURES

Sampling sites are selected in a manner that assures the project objective is achieved and the information use is maximized through this sediment sampling and analysis. The quality of the samples collected depends on the quality of the collection and handling procedures. Procedures for sample collection, handling, custody, and shipping are detailed in the SAP.

The Laboratory Quality Assurance Officer will ensure that chain-of-custody records, completed and signed in the field, are properly signed upon receipt of the samples. The Laboratory Quality Assurance Officer will specifically note any coolers that are not cool upon receipt and any damage that may have occurred to samples during transport. The Laboratory Quality Assurance Officer will also ensure that a sample tracking record is maintained that will follow each sample through all stages of laboratory processing. The records will be used to determine compliance with holding time requirements.

ANALYTICAL AND CALIBRATION PROCEDURES AND QA/QC REQUIREMENT

Analytical and calibration procedures will be in accordance with requirements established in the most recent Puget Sound Estuary Program (PSEP) guidelines for laboratory operations (PSEP, 1991). Prior to initiating the bioassays, the interstitial water salinity of the sediments will be analyzed. In addition, ammonia and sulfide content will be measured in bioassay water at the beginning and termination of testing.

The following sections describe QA/QC requirements for each biological analysis.

AMPHIPOD TEST

The test species will be amphipod *Rhepoxynius abronius* (or *Eohaustorius estuarius*, depending on the measurement of the interstitial water salinity, as described in the SAP). The adult life stage will be evaluated. This test will be conducted only on sediment samples with a documented interstitial-water salinity ≥ 25 ppt. Prior to testing, the quality of the test organisms will be verified. The responsiveness of the test organisms will be verified by conducting a 96-hour Median Lethal Concentration (LC_{50}) positive control measurement using cadmium chloride as a reference toxicant. During testing, a negative control sample composed of clean sediment from West Beach off Whidbey Island, will be matched with each series of samples to ensure that test organisms are not unusually sensitive to natural factors. Results from the series will not be accepted if mean mortality in the control sample exceeds 10 percent. Water quality will be measured in the test and control beakers at the beginning and end of each 10-day exposure period. Appropriate ranges of water quality variables are as follows:

- Temperature: $15 \pm 1^\circ\text{C}$
- Salinity: 28 ± 1 ppt

The desirable water pH is within the range of 7.5 - 8.3. Dissolved oxygen level will be maintained by continuous aeration throughout the course of testing.

BIVALVE LARVAE TEST

The test species will be *Crassostrea gigas*. The first 48 hours of embryonic development will be evaluated. This test will be conducted only on sediment samples with a documented interstitial water salinity of ≥ 10 ppt. Prior to testing, the quality of the test organisms will be verified. The responsiveness of the test organisms will be verified by conducting a 48-hour (or longer, if required) LC_{50} and Median Effective Concentration (EC_{50}) positive control measurement using cadmium chloride as a reference toxicant. Negative control replicates containing only seawater will also be analyzed. Results from the tests will not be accepted if combined mortality and abnormality in the seawater control exceeds 50 percent. Water quality will be measured daily in the test and control chambers. Appropriate ranges of water quality variables are as follows:

- Temperature $20 \pm 1^\circ\text{C}$
- Salinity: 28 ± 1 ppt

The desirable water pH is within the range of 7.5 - 8.3. Aeration will be initiated if dissolved oxygen level is below 6 percent of the saturation concentration.

JUVENILE POLYCHAETE TEST

The test species will be the polychaete *Nedanthès* sp. The juvenile life stage will be evaluated. Prior to testing, the quality of the test organisms will be verified. The responsiveness of the test organisms will be verified by conducting a 96-hour LC_{50} positive control measurement using cadmium chloride as a reference toxicant. During testing, a negative control sample composed of clean sediment from West Beach off Whidbey Island will be matched with the test samples to ensure that test organisms are not unusually sensitive to natural factors. Results from the series will not be accepted if mean mortality in the control sample exceeds 10 percent. Water quality will be measured in the test and control beakers every third day during the 20-day exposure period. Appropriate ranges of water quality variables are as follows:

- Temperature $20 \pm 1^\circ\text{C}$
- Salinity: 28 ± 1 ppt

The desirable water pH is within the range of 7.5 - 8.3. Dissolved oxygen level will be maintained by continuous aeration throughout the course of testing.

DATA REDUCTION, VALIDATION, AND REPORTING

Laboratories will be responsible for internal checks on data reporting and will correct errors identified during the quality assurance review. The AGI quality assurance officer will review the data provided and will analyze the results. Laboratories for this project will be required to report results that are supported by all information recommended by this document and the SOW for the laboratory. Laboratory report deliverables are specified as follow:

AMPHIPOD TEST

- Water quality measurements during testing (i.e., temperature, pH, salinity, dissolved oxygen, sulfide, and ammonia)
- Daily emergence and reburial for each test chamber and the 10-day means and standard deviations for each treatment
- 10-day mortality and total effective mortality for each test chamber and the mean and standard deviation for each treatment
- Interstitial water salinity for control, reference, and test sediments
- 96-hour LC_{50} values for the positive control tests

BIVALVE LARVAE TEST

- Source, qualitative condition, and holding time of brood stock
- Water quality measurements during testing (i.e., temperature, pH, salinity, dissolved oxygen, sulfide, and ammonia)
- Individual replicate and mean and standard deviation data for larval percent mortality after 48-hour exposure
- Individual replicate and mean and standard deviation data for larval percent abnormality after 48-hour exposure
- Individual replicate and mean and standard deviation data for larval percent combined mortality and abnormality after 48-hour exposure
- 48-hour LC_{50} and EC_{50} values for positive control tests
- Data on larval presence in the sediment

JUVENILE POLYCHAETE TEST

- Water quality measurements during testing (i.e., temperature, pH, salinity, dissolved oxygen, sulfide, and ammonia).
- Interstitial water salinity values (initial and final) of control, reference, and test sediments.
- Initial biomass (dry weight) for three groups of five test organisms.
- 20-day percent mortality for each test chamber and the mean and standard deviation for each treatment.
- 20-day total and average biomass (dry weight) in each exposure chamber and the mean and standard deviation for each treatment.
- 96-hour LC_{50} values for the positive control tests.

Corrective actions and problems that may have influenced data quality will also be reported in the case narrative of laboratory reports.

INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

Sediment bioassays will be conducted using well-established positive and negative controls, blind testing of samples, and regular measurements of temperature, pH, salinity, and dissolved oxygen during testing. Procedures will be carried out in accordance with recommended PSEP guidelines (PSEP, 1991). Only healthy organisms will be used in the sediment bioassays. For the amphipod and juvenile polychaete tests, results from a bioassay series will not be accepted if more than 10 percent of the animals die in the negative controls. For the bivalve test, results from a series will not be accepted if the combined mortality and abnormality in the negative seawater controls is greater than 50 percent.

Reference toxicants will be used to provide insight into mortalities or increased sensitivity that may have occurred as a results of disease, salinity tolerance/sensitivity, or loading density. Reference toxicants will also provide insight into any nonlethal effects that may occur because of acclimation or stress tolerance developed during handling and testing. Accordingly, concurrent bioassays will be implemented for each species with a reference toxicant (e.g., cadmium chloride). Such tests constitute positive controls.

CORRECTIVE ACTIONS

Corrective actions fall into two categories: 1) handling of analytical or equipment malfunctions and 2) handling of nonconformance or noncompliance with the quality assurance requirements that have been set forth. During field operations and sampling procedures, the sampling team leader of the will be responsible for correcting equipment malfunctions. All corrective measures taken will be included in the field log.

Any corrective action required to meet the specifications will be recorded by the appropriate Quality Assurance Officer and reported to the Quality Assurance Coordinator within 3 days. Corrective actions will be documented in a project memorandum that specifies the samples concerned, acceptable data range, the individual initiating corrective action, problem areas requiring corrective action and how they were detected, measures undertaken to correct the problems, and the individual approving the corrective action.

Corrective action documentation should be reviewed by the Corporate Quality Assurance Officer, who has corporate authority to enforce necessary corrective measures. In addition, laboratory contracts specify performance standards tied to the requirements in this document that must be satisfactorily met for payment of invoices.

REFERENCES

Ecology. 1991. Sediment cleanup standard user manual. First Edition. Washington Department of Ecology, Sediment Management Unit, Olympia, WA.

PSEP. 1989. Recommended guidelines for measuring organic compounds in Puget Sound sediment and tissue samples. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Seattle, WA.

PSEP. 1991. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. Interim Final. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound. PTI Environmental Services, Bellevue, WA.

Table B1
Data Quality Objective Summary
 Russell's/Sediment Sampling and Analysis
 Orcas, Washington

Variable	Matrix	Units	Detection Limit	Sample Size	Accuracy (percent)	Precision (percent)	Completeness (percent)
Amphipod bioassay	Sediment	% Mortality	N/A	0.25 L	±0	±0	90
Bivalve larvae bioassay	Sediment	%Abnormality, % Mortality	N/A	20 g	±0	±0	90
Juvenile polychaete bioassay	Sediment	Biomass	N/A	0.25 L	±0	±0	90
Total Sulfides	Water	mg/L	1	N/A	±25	±20	90
Ammonia	Water	mg/L	0.01	N/A	±25	±20	90

Notes:

g – Grams.

mg/L – Milligrams per liter.

N/A – Not applicable.