GeoEngineers

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Memorandum

To:	Erik Gerking, Port of Everett
From:	John Herzog and Abhijit Joshi, GeoEngineers, Inc.
Date:	April 18, 2014
File:	0676-021-01
Subject:	Geochronology Sampling and Analysis Plan Memorandum Bay Wood Products Site

This Geochronology Sampling and Analysis Plan Memorandum (SAP Memorandum) is prepared to describe the sampling and analysis approach that will be implemented to complete geochronology study at the Port of Everett's (Port's) Bay Wood Products Site (Site). The geochronology study is being performed at the request of the Washington State Department of Ecology (Ecology) to help evaluate sediment stability and net sedimentation rates at the Site. The data resulting from this sampling will be used to support evaluation of cleanup alternatives for the Site. The cleanup alternative evaluation will be documented in the supplemental feasibility study (FS). This SAP Memorandum also describes the laboratory analytical methods and data quality objectives that will be used for the proposed geochronology sediment analysis. A Site-specific Health and Safety Plan (HASP) will be used for sediment sampling field activities and is attached to this SAP Memorandum (Attachment A).

The Site is generally located at 200 West Marine View Drive, in Everett, Washington (Figure 1). The geochronology sediment sampling and analysis approach for the Bay Wood Products Site described in this SAP Memorandum is consistent with the approach outlined in the JELD-WEN site's Quality Assurance Project Plan (QAPP) Addendum titled "JELD-WEN Former Nord Door Site Sediment Second Quality Assurance Project Plan Addendum – Remedial Investigation/Feasibility Study Data Gaps".

SAMPLING AND ANALYSIS

Sediment cores will be collected from two target sediment sampling areas BW-GC1 and BW-GC2 located in the inter-tidal area of the Site. The approximate locations and photographs of these target sediment sampling areas are shown on Figure 2. The sediment sampling areas are intended to be accessed by foot from the shoreline. The actual sediment sampling areas may be modified in the field based on accessibility.

Sediment sample collection activities will be completed by GeoEngineers, Inc. (GeoEngineers) field personnel. Sediment cores will be collected by hand and will be advanced approximately 3 feet (92 centimeters) below mudline at each sampling area. Multiple cores will be advanced at each sampling area to ensure sufficient sample quantities for the proposed analysis; a minimum of 3 cores will be required at each sampling area using 3.75-inch internal diameter core liners.

Sediment cores will be advanced using hand collection methods to minimize the potential for disturbing the sediment lithology. Coring will include hand-advancing a core tube followed by extraction of the sampler. The sampler may be hand excavated to ensure that the collected sample remains intact. An undisturbed vertical accumulation of sediment in each core is required for accurate geochronology evaluation. The sediment lithology encountered in the cores will be documented on a core log form and classified according to the Unified Soil Classification System (USCS). The cores will also be photographed at resolution high enough to

evaluate sediment lithologies from photographs. If evidence of disturbed sedimentation rates, such as layers of sawdust, ash or other wood waste is detected during initial logging of core lithologies or if recovery is less than optimal, additional cores will be obtained, as needed, until a minimum required number of cores at each sampling area are obtained in a complete, relatively undisturbed condition. Optimal recovery for each core should be at or above 80 percent. If it is not possible to obtain undisturbed core from the sampling areas proposed on Figure 2, Ecology will identify alternate sampling areas. Disturbed cores will be collected in the event that wood waste contamination is observed to be widespread. In this scenario, the age-depth model will be qualified to be based on disturbed cores.

The cores obtained from each sampling area will be processed in 2-centimeter intervals for following analysis:

- Radioisotope analysis of lead-210 (Pb-210) and cesium-137 (Cs-137), and
- Total volatile solids (TVS) by method SM2540G.

The cores will be logged and processed at GeoEngineers' laboratory located in Redmond, Washington. Core material will be visually classified in general accordance with Unified Soil Classification System. Additionally, core material will be visually characterized for wood waste. Cores used to visually characterize wood waste will be photographed for evidence of presence, absence, and type of wood waste along the entire core. Radioisotope analysis will be performed at the Teledyne-Brown Engineering (TBE) laboratory located in Knoxville, Tennessee and TVS analysis will be performed at Analytical Resources, Inc. (ARI) laboratory located in Tukwila, Washington.

To provide sufficient sample volume for radioisotope analysis, samples representative of same depth intervals obtained from more than one core at each sampling area may be combined, upon Ecology's approval. Samples for radioisotope analysis will be collected in laboratory-supplied containers and shipped to TBE laboratory. Initially, every third sample interval will be analyzed for Pb-210 and every other sample interval will be analyzed for Cs-137 for each sampling area. Remaining sample intervals will be archived for potential follow-up analysis of Pb-210 and Cs-137. Follow-up analysis on archived sample intervals may be required to refine geochronology evaluation. Analysis will be performed on a standard turn-around time (TAT) basis. The TBE laboratory's standard TAT for Pb-210 and Cs-137 analysis is anticipated to be 25 days.

TVS analysis will be performed to quantify sawdust and wood debris content. Samples submitted for TVS analysis will be collected every 2 cm in laboratory-supplied containers and shipped to ARI laboratory.

DATA QUALITY OBJECTIVES

The laboratory analytical methods, maximum holding times, data quality indicators, and quality control frequencies for the Pb-210 and Cs-137 analyses are summarized in Tables 1 through 3.

TABLE 1 – LABORATORY ANALYTICAL METHODS AND MAXIMUM HOLDING TIMES

Parameter	Method	Maximum Holding Time	Preservative
Pb-210	TBE 2015[1]	10 years	None
Cs-137	EPA Method 901.1	1 year	None

Note:
[1] Teledyne-Brown Engineering Laboratory's in-house method 2015 (Attachment B)
EPA = Environmental Protection Agency

TABLE 2 – DATA QUALITY INDICATORS FOR SEDIMENT ANALYSES

Parameter	Precision	Accuracy	Completeness	Sensitivity (Method Detection Limit)
Pb-210	± 30%	70–130%	95%	0.1 piC/g dw
Cs-137	± 30%	70–130%	95%	0.1 piC/g dw

Note:
piC/g dw = picocurie per gram dry weight

TABLE 3 – QUALITY CONTROL SAMPLES

Parameter	Field Duplicate	Method Blank	Matrix Replicates	Laboratory Control Standard	Matrix Spike	Matrix Spike Duplicate
Pb-210	N/A	1/20	N/A	1/20	1/10	1/20
Cs-137	N/A	1/20	N/A	1/20	1/10	1/20

Note:
N/A = Not Applicable

REPORTING

A brief data summary memorandum will be prepared by GeoEngineers summarizing the activities associated with the Bay Wood Product Site geochronology sediment sampling and analysis. At a minimum, the following will be included in the data summary memorandum:

- Sampling equipment and protocols used.
- Photographs and description of cores used to visually characterize wood waste.
- Age-depth model and calculated sedimentation rates.
- A narrative description of validated data results.
- Table summarizing coordinates of actual sampling locations, core penetration, recovery data and analytical results.
- Figure showing actual sampling locations.
- Sampling core logs showing the sediment lithology at the sample location.
- Chemical analytical data report and chain of custodies in an appendix.

In conjunction with the data summary memorandum, analytical data will also be submitted to the Ecology Information Management (EIM) System. Care will be taken to ensure that the data is accurate and that it has been loaded correctly into the data base.

SCHEDULE

The sampling and analysis will be performed following approval of this Geochronology Sampling and Analysis Plan Memorandum by Ecology. It is anticipated that the sampling will be conducted in May of 2014.

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Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.

Data Sources: ESRI Data & Maps

Projection: NAD 1983 UTM Zone 10N

Vicinity Map

Bay Wood Products Site
Everett, Washington

GeoEngineers

Figure 1

Office: SEA Path: \\sea\Projects\0\0676021\GIS\0676021 00_VicinityMap.mxd Map Revised: 21 March 2012 amanza

Legend

- Property Boundary
- MHHW Line (el. 11.09)
- MHHW — Mean Higher High Water
- BW-GC1 — Target Sediment Sampling Area

N
W E
S

300 0 300
FEET

Notes

1. Horizontal Datum: NAD83 WA SP N.
2. Vertical Datum: Mean Lower Low Water (MLLW).
3. The locations of all features shown are approximate.
4. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Base aerial photo from Aerials Express, 2009. Base Survey by Metron and Associated Inc. dated June 2012.

Site Plan

Bay Wood Products Site
Everett, Washington

GeoEngineers

Figure 2

ATTACHMENT A
Health and Safety Plan (HASP)

Health and Safety Plan (HASP)

Bay Wood Products Site
Everett, Washington

April 18, 2014

GeoEngineers

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Table of Contents

GEOENGINEERS, INC.
HEALTH AND SAFETY PLAN
BAY WOOD PRODUCTS SITE SEDIMENT SAMPLING
FILE NO. 0676-021-01

This HASP is to be used in conjunction with the GeoEngineers Safety Program Manual. Together, the written safety programs and this HASP constitute the site safety plan for this site. This plan is to be used by GeoEngineers personnel on this site and must be available on-site. If the work entails potential exposures to other substances or unusual situations, additional safety and health information will be included, and the plan will need to be approved by the GeoEngineers Health and Safety Manager. All plans are to be used in conjunction with current standards and policies outlined in the GeoEngineers Health and Safety Program Manual.

Liability Clause: If requested by subcontractors, this site safety plan may be provided for informational purposes only. In this case, Form C-3 shall be signed by the subcontractor. Please be advised that this Site Safety Plan is intended for use by GeoEngineers Employees only. Nothing herein shall be construed as granting rights to GeoEngineers' subcontractors or any other contractors working on this site to use or legally rely on this Site Safety Plan. GeoEngineers specifically disclaims any responsibility for the health and safety of any person not employed by them.

1.0 GENERAL PROJECT INFORMATION

Project Name:	Bay Wood Products Site Sediment Sampling
Project Number:	0676-021-01
Type of Project:	Sediment coring using hand tools
Start/Completion:	March, 2014
Subcontractors:	NA

2.0 SAMPLING AND ANALYSIS PLAN

GeoEngineers will conduct sediment sampling and analysis activities at Port of Everett's (Port's) Bay Wood Products Site (Site). The purpose of the investigation is to complete a geochronology study at the Site to evaluate sediment stability and net sedimentation rates. As part of the investigation, our scope includes:

- Sediment coring using hand collection methods,
- Core processing, and sampling,
- Submitting samples to a laboratory for testing of lead-210 (Pb-210) and cesium-137 (Cs-137) and wet sieve analysis.

2.1 List of Field Activities

X	Site reconnaissance	X	Field Screening of Soil Samples
X	Sediment coring		Vapor Measurements
X	Hand digging		Groundwater Sampling
	Surveying		Groundwater Depth and Free Product Measurement
	Test Pit Exploration		Product Sample Collection
	Monitoring Well Installation		Soil Stockpile Testing
	Monitoring Well Development		Remedial Excavation
X	Sediment Sample Collection		Underground Storage Tank (UST) Removal Monitoring
	Remediation System Monitoring		Recovery of Free Product

3.0 LIST OF FIELD PERSONNEL AND TRAINING

Anticipated field personnel include the following:

- Nate Solomon
- Chris Brown
- Abhijit Joshi
- Robert Trahan

Field personnel will have appropriate training and up to date certifications.

- Establish and identify the chain of command;
- Identify the site safety and health supervisor and other personnel responsible for employee safety and health;
- Specify the overall responsibilities of supervisors and employees; (this is in HAZWOPER written program)
- Include the name and title of the person with responsibility and authority to direct all hazardous waste operations;
- Include a site safety and health supervisor responsible for developing and implementing the HASP and verifying compliance;
- Identify the functions and responsibilities of all personnel needed for hazardous waste operations and emergency response;
- Identify site specific lines of authority, responsibility, and communication.

Chain of Command	Title	Name	Telephone Numbers
1	Project Manager	John Herzog	206.297.0708
2	HAZWOPER Supervisor	Abhijit Joshi	206.240.2300
3	Field Engineer/Geologist	Abhijit Joshi Chris Brown	425.223.9028 206.427.7706
4	Site Safety and Health Supervisor*	Abhijit Joshi	206.239.3256
5	Client Assigned Site Supervisor	TBD	TBD
6	Health and Safety Program Manager	Wayne Adams	253.722.2793
N/A	Subcontractor(s)	N/A	
N/A	Current Owner	Port of Everett	800.729.7678

*** Site Safety and Health Supervisor –** The individual present at a hazardous waste site responsible to the employer and who has the authority and knowledge necessary to establish the site-specific health and safety plan and verify compliance with applicable safety and health requirements.

4.0 EMERGENCY INFORMATION

Hospital Name and Address:

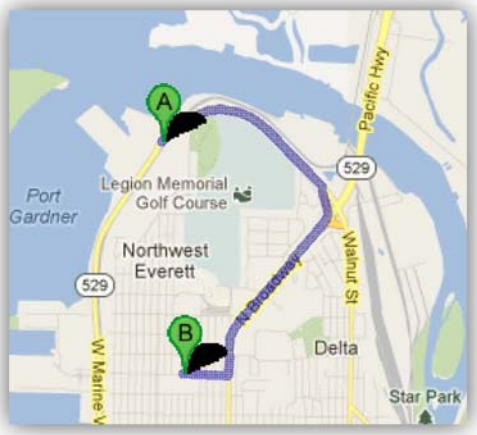
Providence Regional Medical Center
1321 Colby Avenue
Everett, WA 98201

Phone Numbers (Hospital ER):
Distance:
Route to Hospital:

Phone: **(425) 261-2000**

1. Head northeast on W Marine View Dr toward Alverson Blvd
2. Exit onto N Broadway
3. Turn right onto 13th St

Destination will be on the left



Ambulance: 9-1-1
Poison Control: Seattle (206) 253-2121; Other (800) 732-6985
Police: 9-1-1
Fire: 9-1-1
Location of Nearest Telephone: Cell phones are carried by field personnel.
Nearest Fire Extinguisher: Located in the GeoEngineers vehicle on-site.
Nearest First-Aid Kit: Located in the GeoEngineers vehicle on-site.

4.1 Standard Emergency Procedures

Get help

- send another worker to phone 9-1-1 (if necessary)
- as soon as feasible, notify GeoEngineers' Project Manager

Reduce risk to injured person

- turn off equipment
- move person from injury location (if in life-threatening situation only)
- keep person warm
- perform CPR (if necessary)

Transport injured person to medical treatment facility (if necessary)

- by ambulance (if necessary) or GeoEngineers vehicle
- stay with person at medical facility
- keep GeoEngineers manager apprised of situation and notify Human Resources Manager of situation

5.0 HAZARD ANALYSIS

- Identification and evaluation of on-site safety and health hazards;
- A safety and health risk (hazard) analysis for each site task and operation that is identified in the comprehensive work plan.

A hazard assessment will be completed at every site prior to beginning field activities. Updates will be included in the daily log. This list is a summary of hazards listed on the form.

5.1 Physical Hazards

X	Sediment Coring,
X	Near-Water Work (see attached Boat, Over Water and Near Water Safety Program)
X	Hand digging tools (e.g. shovel, etc.)
	Trackhoe
	Crane
	Front End Loader
	Excavations/trenching (1:1 slopes for Type B soil)
	Shored/braced excavation if greater than 4 feet of depth
	Overhead hazards/power lines
X	Tripping/puncture hazards (debris on-site, steep slopes or pits)
	Unusual traffic hazard – Street traffic
X	Heat/Cold, Humidity
	Utilities/ utility locate

- Field personnel will be aware at all times of the location and motion of heavy equipment in the area of work to ensure a safe distance between personnel and the equipment. Personnel will be visible to the operator at all times and will remain out of the swing and/or direction of the equipment apparatus. Personnel will approach operating heavy equipment only when they are certain the operator has indicated that it is safe to do so through hand signal or other acceptable means.
- Personnel will avoid tripping hazards, steep slopes, pits and other hazardous encumbrances. If it becomes necessary to work within 6 feet of the edge of a pit, slope or other potentially hazardous area, appropriate fall protection measures will be implemented by the Site Safety and Health Supervisor in accordance with OSHA/DOSH regulations and the GeoEngineers Health and Safety Program.
- Cold stress control measures will be implemented according to the GeoEngineers Health and Safety Program to prevent frost nip (superficial freezing of the skin), frost bite (deep tissue freezing), or hypothermia (lowering of the core body temperature). Heated break areas and warm beverages shall be available during periods of cold weather.
- Heat stress control measures required for this site will be implemented according to GeoEngineers Health and Safety Program with water provided on-site.

5.2 Engineering Controls

_____ Trench shoring (1:1 slope for Type B Soils)
__X__ Location work spaces upwind/wind direction monitoring
_____ Other soil covers (as needed)
_____ Other (specify) _____

5.3 Chemical Hazards

CHEMICAL HAZARDS (POTENTIALLY PRESENT AT SITE)

Substance	Pathways
Dioxins and Furans	Sediment/Water

5.4 Biological Hazards and Procedures

Y/N	Hazard	Procedures
	Poison Ivy or other vegetation	
Y	Insects or snakes	Work gloves and long sleeve shirt
	Used hypodermic needs or other infectious hazards	
Y	Others: Bird droppings	Hard hat, gloves and long sleeve shirt

5.5 Additional Hazards

Update in Daily Report. Include evaluation of:

- *Physical Hazards* (excavations and shoring, equipment, traffic, tripping, heat stress, cold stress and others)
- *Chemical Hazards* (odors, spills, free product, airborne particulates and others present)
- *Biological Hazards* (snakes, spiders, other animals, discarded needles, poison ivy, pollen, bees/wasps and others present)

6.0 SITE CONTROL PLAN

Use this section to provide an up-to-date Site Control Plan for cleanup operations to minimize employee exposure to hazardous substances.

6.1 Traffic or Vehicle Access Control Plans

Explorations will be completed in the intertidal areas away from vehicular traffic.

6.2 Site Work Zones

Exclusion zones will be established within approximately 10 feet around each coring location. Only persons with the appropriate training will enter this perimeter while work is being conducted there.

A contamination reduction zone will be established just outside the exclusion zone for the decontamination of sampling equipment. Care will be taken to prevent the spread of contamination.

Method of delineation/ excluding non-site personnel

	Fence
	Survey Tape
	Traffic Cones
X	Other – verbal communication

6.3 Buddy System

Personnel on-site should use the buddy system (pairs), particularly whenever communication is restricted. If only one GeoEngineers employee is on-site, a buddy system can be arranged with subcontractor/ contractor personnel.

6.4 Site Communication Plan

Positive communications (within sight and hearing distance or via radio) should be maintained between pairs on-site, with the pair remaining in proximity to assist each other in case of emergencies. The team should prearrange hand signals or other emergency signals for communication when voice communication becomes impaired (including cases of lack of radios or radio breakdown). In these instances, you should consider suspending work until communication can be restored; if not, the following are some examples for communication:

1. Hand gripping throat: Out of air, can't breathe.
2. Gripping partner's wrist or placing both hands around waist: Leave area immediately, no debate.
3. Hands on top of head: Need assistance.
4. Thumbs up: Okay, I'm all right: or I understand.
5. Thumbs down: No, negative.

6.5 Decontamination Procedures

Decontamination consists of removing outer protective clothing and washing soiled waders, boots and gloves using bucket and brush provided on-site in the contamination reduction zone. Inner gloves will then be removed, and respirator, hands and face will be washed in either a portable wash station or a bathroom facility in the support zone. Employees will perform decontamination procedures and wash prior to eating, drinking or leaving the site.

6.6 Waste Disposal or Storage

PPE disposal (specify): Used PPE, disposable field equipment will be discarded in local trash.

7.0 PERSONAL PROTECTIVE EQUIPMENT

PPE will consist of standard Level D equipment. Additionally, waders will be used by field personnel if wet conditions/soft sediment conditions are observed.

Air monitoring will be conducted to determine the level of respiratory protection.

- Half-face combination organic vapor/high efficiency particulate air (HEPA) or P100 cartridge respirators will be available on-site to be used as necessary.
- Level D PPE unless a higher level of protection is required will be worn at all times on the site. Potentially exposed personnel will wash gloves, hands, face and other pertinent items to prevent hand-to-mouth contact. This will be done prior to hand-to-mouth activities including eating, smoking, etc.
- Adequate personnel and equipment decontamination will be used to decrease potential ingestion and inhalation.

Check applicable personal protection gear to be used:

x Hardhat (if overhead hazards, or client requests)
x Steel-toed boots (if crushing hazards are a potential or if client requests)
x Safety glasses (if dust, particles, or other hazards are present or client requests)
x Hearing protection (if it is difficult to carry on a conversation 3 feet away)
x Rubber boots and/or waders (if wet conditions or soft sediment observed)

Gloves (specify):

x Nitrile
x Latex
_____ Liners
_____ Leather
_____ Other (specify) _____

Protective clothing:

_____ Tyvek (if dry conditions are encountered, Tyvek is sufficient)
_____ Saranex (personnel shall use Saranex if liquids are handled or splash may be an issue)
x Cotton
x Rain gear (as needed)
x Layered warm clothing (as needed)

Inhalation hazard protection:

x Level D
_____ Level C (respirators with organic vapor/HEPA or P100 filters)

7.1 Personal Protective Equipment Inspections

PPE clothing ensembles designated for use during site activities shall be selected to provide protection against known or anticipated hazards. However, no protective garment, glove or boot is entirely chemical-resistant, nor does any PPE provide protection against all types of hazards. To obtain optimum performance from PPE, site personnel shall be trained in the proper use and inspection of PPE. This training shall include the following:

- Inspect PPE before and during use for imperfect seams, non-uniform coatings, tears, poorly functioning closures or other defects. If the integrity of the PPE is compromised in any manner, proceed to the contamination reduction zone and replace the PPE.
- Inspect PPE during use for visible signs of chemical permeation such as swelling, discoloration, stiffness, brittleness, cracks, tears or other signs of punctures. If the integrity of the PPE is compromised in any manner, proceed to the contamination reduction zone and replace the PPE.
- Disposable PPE should not be reused after breaks unless it has been properly decontaminated.

7.2 Respirator Selection, Use and Maintenance

If respirators are required, site personnel shall be trained before use on the proper use, maintenance and limitations of respirators. Additionally, they must be medically qualified to wear a respiratory protection in accordance with 29 CFR 1910.134. Site personnel who will use a tight-fitting respirator must have passed a qualitative or quantitative fit test conducted in accordance with an OSHA-accepted fit test protocol. Fit testing must be repeated annually or whenever a new type of respirator is used. Respirators will be stored in a protective container.

7.3 Respirator Cartridges

If site personnel are required to wear air-purifying respirators, the appropriate cartridges shall be selected to protect personnel from known or anticipated site contaminants. The respirator/cartridge combination shall be certified and approved by the National Institute for Occupational Safety and Health (NIOSH). A cartridge change-out schedule shall be developed based on known site contaminants, anticipated contaminant concentrations and data supplied by the cartridge manufacturer related to the absorption capacity of the cartridge for specific contaminants. Site personnel shall be made aware of the cartridge change-out schedule prior to the initiation of site activities. Site personnel shall also be instructed to change respirator cartridges if they detect increased resistance during inhalation or detect vapor breakthrough by smell, taste or feel, although breakthrough is not an acceptable method of determining the change-out schedule.

7.4 Respirator Inspection and Cleaning

The Site Safety and Health Supervisor shall periodically (weekly) inspect respirators at the project site. Site personnel shall inspect respirators prior to each use in accordance with the manufacturer's instructions. In addition, site personnel wearing a tight-fitting respirator shall perform a positive and negative pressure user seal check each time the respirator is donned, to ensure proper fit and function. User seal checks shall be performed in accordance with the GeoEngineers respiratory protection program or the respirator manufacturer's instructions.

8.0 ADDITIONAL ELEMENTS

8.1 Cold Stress Prevention

Working in cold environments presents many hazards to site personnel and can result in frost nip (superficial freezing of the skin), frost bite (deep tissue freezing), or hypothermia (lowering of the core body temperature).

The combination of wind and cold temperatures increases the degree of cold stress experienced by site personnel. Site personnel shall be trained on the signs and symptoms of cold-related illnesses, how the human body adapts to cold environments, and how to prevent the onset of cold-related illnesses. Heated break areas and warm beverages shall be provided during periods of cold weather.

8.2 Heat Stress Prevention

State and federal OSHA regulations provide specific requirements for handling employee exposure to heat stress. GeoEngineers' program complies with these requirements and will be implemented in all areas where heat stress is identified as a potential health issue.

General requirements for preventing heat stress apply to outdoor work environments from May 1 through September 30, annually, only when employees are exposed to outdoor heat at or above an applicable temperature listed in Table 1. To determine which temperature applies to each worksite, select the temperature associated with the general type of clothing or personal protective equipment (PPE) each employee is required to wear.

TABLE 1. HEAT STRESS

Type of Clothing	Outdoor Temperature Action Levels
Nonbreathing clothes including vapor barrier clothing or PPE such as chemical resistant suits	52°
Double-layer woven clothes including coveralls, jackets and sweatshirts	77°
All other clothing	89°

Keeping workers hydrated in a hot outdoor environment requires that more water be provided than at other times of the year. GeoEngineers is prepared to supply at least one quart of drinking water per employee per hour. When employee exposure is at or above an applicable temperature listed in Table 1, Project Managers shall ensure that:

- A sufficient quantity of drinking water is readily accessible to employees at all times; and
- All employees have the opportunity to drink at least one quart of drinking water per hour.

8.3 Emergency Response

Indicate what site-specific procedures you will implement.

- Personnel on-site should use the "buddy system" (pairs).
- Visual contact should be maintained between "pairs" on-site, with the team remaining in proximity to assist each other in case of emergencies.
- If any member of the field crew experiences any adverse exposure symptoms while on-site, the entire field crew should immediately halt work and act according to the instructions provided by the Site Safety and Health Supervisor.
- Wind indicators visible to all on-site personnel should be provided by the Site Safety and Health Supervisor to indicate possible routes for upwind escape. Alternatively, the Site Safety and Health Supervisor may ask on-site personnel to observe the wind direction periodically during site activities.
- The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should result in the evacuation of the field team, contact of the PM, and reevaluation of the hazard and the level of protection required.
- If an accident occurs, the Site Safety and Health Supervisor and the injured person are to complete, within 24 hours, an Accident Report for submittal to the PM, the Health and Safety Program Manager and Human Resources. The PM should ensure that follow-up action is taken to correct the situation that caused the accident or exposure.

8.4 Boat, Over Water and Near Water Safety Program

See attached supplement.

9.0 MISCELLANEOUS

9.1 Spill Containment Plans (Drum and Container Handling)

N/A

9.2 Sampling, Managing and Handling Drums and Containers

Drums and containers used during field activities shall meet the appropriate Department of Transportation (DOT), OSHA and U.S. Environmental Protection Agency (EPA) regulations for the waste that they contain. Site operations shall be organized to minimize the amount of drum or container movement. When practicable, drums and containers shall be inspected and their integrity shall be ensured before they are moved. Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled. Before drums or containers are moved, all employees involved in the transfer operation shall be warned of the potential hazards associated with the contents.

Drums or containers and suitable quantities of proper absorbent shall be kept available and used where spills, leaks or rupture may occur. Where major spills may occur, a spill containment program shall be implemented to contain and isolate the entire volume of the hazardous substance being transferred. Fire extinguishing equipment shall be on hand and ready for use to control incipient fires.

9.3 Personnel Medical Surveillance

GeoEngineers employees are not in a medical surveillance program because they do not fall into the category of "Employees Covered" in OSHA 1910.120(f)(2), which states a medical surveillance program is required for the following employees:

- All employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year;
- All employees who wear a respirator for 30 days or more a year or as required by state and federal regulations;
- All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and
- Members of HAZMAT teams.

9.4 Sanitation

Washrooms are present in nearby retail facilities.

9.5 Lighting

Sediment coring activities will be conducted during hours of light.

10.0 DOCUMENTATION TO BE COMPLETED FOR HAZWOPER PROJECTS

The following forms shall be completed:

- FORM C-1 HEALTH AND SAFETY PRE-ENTRY BRIEFING
- FORM C-2 SITE SAFETY PLAN – GEOENGINEERS' EMPLOYEE ACKNOWLEDGMENT
- FORM C-3 SUBCONTRACTOR AND SITE VISITOR SITE SAFETY FORM

In addition, the following forms are required for Hazardous Waste Operations and Emergency Response (HAZWOPER) projects:

- Field Log
- Conditional forms available at GeoEngineers office: Accident Report

The Field Log is to contain the following information:

- Updates on hazard assessments, field decisions, conversations with subcontractors, client or other parties, etc.;
- Actions taken;
- Action level for upgrading PPE and rationale.

11.0 APPROVALS

1.	Plan Prepared	Abhijit R. Joshi Signature	04/18/2014 Date
2.	Plan Approval	John Herzog PM Signature	04/18/2014 Date
3.	Health & Safety Officer	Wayne Adams Health & Safety Program Manager	04/18/2014 Date

FORM C-1
HEALTH AND SAFETY PRE-ENTRY BRIEFING
BAY WOOD PRODUCTS SITE
FILE NO. 0676-021-01

Inform employees, contractors and subcontractors or their representatives about:

- The nature, level and degree of exposure to hazardous substances they're likely to encounter;
- All site-related emergency response procedures; and
- Any identified potential fire, explosion, health, safety or other hazards.

Conduct briefings for employees, contractors and subcontractors, or their representatives as follows:

- A pre-entry briefing before any site activity is started; and
- Additional briefings, as needed, to make sure that the Site-specific HASP is followed.

Make sure all employees working on the Site are informed of any risks identified and trained on how to protect themselves and other workers against the Site hazards and risks

Update all information to reflect current sight activities and hazards.

All personnel participating in this project must receive initial health and safety orientation. Thereafter, brief tailgate safety meetings will be held as deemed necessary by the Site Safety and Health Supervisor.

The orientation and the tailgate safety meetings shall include a discussion of emergency response, Site communications and site hazards.

Company Employee

Date	Topics	Attendee	Name	Initials

FORM C-2
SITE SAFETY PLAN – GEOENGINEERS' EMPLOYEE ACKNOWLEDGMENT
BAY WOOD PRODUCTS SITE
FILE NO. 0676-021-01

(All GeoEngineers' Site workers shall complete this form, which should remain attached to the Safety Plan and filed with other project documentation).

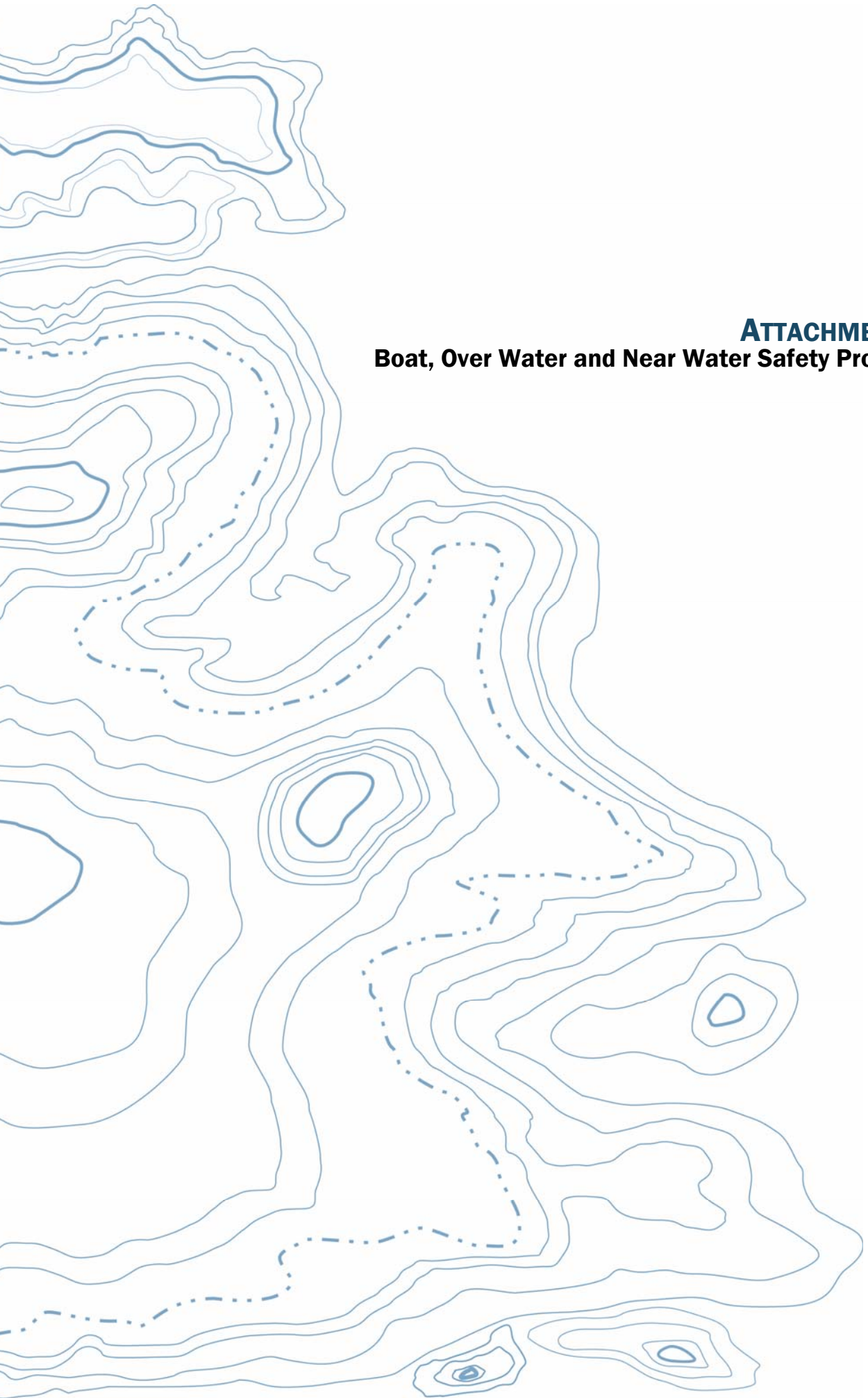
I hereby verify that a copy of the current Safety Plan has been provided by GeoEngineers, Inc., for my review and personal use. I have read the document completely and acknowledge an understanding of the safety procedures and protocol for my responsibilities on Site. I agree to comply with all required, specified safety regulations and procedures.

Print Name	Signature	Date

FORM C-3
SUBCONTRACTOR AND SITE VISITOR SITE SAFETY FORM
BAY WOOD PRODUCTS SITE
FILE NO. 0676-021-01

I verify that a copy of the current Site Safety Plan has been provided by GeoEngineers, Inc. to inform me of the hazardous substances on Site and to provide safety procedures and protocols that will be used by GeoEngineers' staff at the Site. By signing below, I agree that the safety of my employees is the responsibility of the undersigned company.

Print Name	Signature	Firm	Date



ATTACHMENT A
Boat, Over Water and Near Water Safety Program

BOAT, OVER WATER AND NEAR WATER SAFETY PROGRAM

Table of Contents

GENERAL

Use of a boat for work requires safe boating practices, good equipment, and training. These procedures are not meant to replace the safety manuals that are provided by the U.S. Coast Guard. Instead they should highlight some of the areas of concern and address specific GeoEngineers, Inc. work procedures. While working near water over waist deep or while on a boat, use a Coast Guard approved flotation device. Remember that being submersed in water increases the chance of hypothermia. Have a dry set of clothes and work with a buddy if you are working around water. If an employee is required to work in the water, they will wear appropriate gear including a wet suit or dry suit if necessary for safe accomplishment of the task.

The US Coast Guard's Federal Requirements state, "All recreational boats must carry one wearable PFD (Type I, II, II, or Type V) for each person aboard… [and that] any boat 16ft and longer (except canoes and kayaks) must also carry one throwable Type IV PFD."

GeoEngineers' Insurance for working over water is covered under the USL&H policy (worker's comp over water) and is not specific to the individuals participating. For work in arctic waters an additional site safety plan will be created to address the additional hazards of working in extremely cold waters.

For work on barges or boats or areas near water that have an OSHA standard height and strength guardrail, PFDs are not required while working behind the guardrail. The access to the barge or near water area also requires that the gangway be protected by guardrails. If employees are not wearing PFDs, there cannot be a risk of falling in the water. Fall protection rules can be utilized on projects where employees are not within 6 feet of a leading edge and there is no risk of falling in the water.

REGULATORY REFERENCES

When working near water, over water or on a barge, OSHA has authority. The U.S, Coast Guard has authority 12 miles off shore and until international waters.

Life Jackets--Employees wear Coast Guard Approved vests that meet the water conditions (See PFD section) they can wear the self-inflating vests.

This safety program is based on the following state and federal regulations:

- OSHA 1926.106 Working over or near water; 1926.605 Marine operations and equipment; Access to vessels 1915.74 and Access to barges and river towboats 1918.26 (Idaho, Missouri)
- WAC 296-800-160 Personal Protective Equipment for PFD
- OR-OSHA 1926 (Oregon)
- AAC Title 8 (Alaska)
- HIOSH Title 12 (Hawaii)
- Cal/OSHA Title 8 (California)

PROCEDURES FOR USING BOATS

Two people will be involved with the use of the boat. The boat operator should always plan a course of travel which is the safest and minimizes the distance to the shore. As a general courtesy, the boat should be cleaned up by the user after each day.

Maneuvering a boat

- To move boat from dock, move stern away then bow (but not into waves or wind)
- Try not to depend on fendering, slow down
- Communicate with other person in boat when:
    - increase or decrease speed
    - dramatically change direction
    - approach pilings so hands can come inside boat

Right-of-Way

- Watch out for ferry traffic-- large vessels have right of way and cannot stop
    - Don't cut them off, they move much faster than they appear to. If the boat breaks down in a ferry lane, use radio, flares, and wave and make sure they see you until help arrives.
- Larger vessel has right of way over smaller
- With boats of similar size, sailboat has right of way
- When lights are visible, green has the right of way over red

Load Limits

Cargo should be evenly distributed and there should be a safe amount of freeboard which depends on water conditions. When loading up the boat for travel that goes beyond the protection of the pier, the employee should drive to the end of the pier and check wave conditions before entering.

Engine Use

When using an outboard motor, the boat operator will use the tether kill switch. This will hook to the employee's wrist and turn off the engine if the employee were to be launched into the water.

Personal Floatation Device (PFD)

Type 1 PFDs will be worn in the boats at all times. PFD will be the correct size for the wearer and will be securely fastened. The PFD should be inspected for damage prior to each use.

In water with PFD -- to reduce water from lowering body temperature:

- One person: cross arms pull knees up
- Two persons: huddle together

Chance of swimming 100 yards is not very good, so the best strategy is to stay with the boat. The boat should always be closer to shore than this distance during transport and the employee would be close enough to swim to shore.

Throwing lines

- Make first two coils larger
- Kneel in boat
- Shoulder pointed to victim
- Throw over their head

Water on board

- A five gallon bucket will always be available on the boat to bale water that comes inside the boat.

Towing

- Take time to set up
- Look at lines
- Stay in step with waves
- For logs, may want to tow from bow. use timber hitch, shackle to weigh down
- Don't overstress lines
- Don't shock load lines
- Sea anchor -- can use to slow down tow, make more controllable. For some situations, a sea anchor is not necessary and could make things worse.

Safety and Signals

- Horn blasts: 5 short signals danger
- Lights: Employees will not be traveling between terminals in the dark. If it becomes dark while working, the operator will moor the boat at that terminal for the night. A flashlight will be available in the waterproof box stored in the workboat.

BARGE OR PLATFORM PROCEDURES

Any work within six feet of a leading edge will require a life jacket if water is below the leading edge. Railings must be present if a leading edge is above a hard surface. Refer to GeoEngineers' Fall Protection Program for additional details.

Employees shall not be permitted to walk along the sides of covered lighters or barges with coamings more than 5 feet high, unless there is a 3-foot clear walkway, or a grab rail, or a taut hand line is provided. (Coaming is any vertical surface on a ship designed to deflect or prevent entry of water. It usually refers to raised section of deck plating around an opening, such as a hatch. Coamings also provide a frame onto which to fit a hatch cover.)

Employees shall not be permitted to walk over deck loads from rail to coaming unless there is a safe passage. If it is necessary to stand at the outboard or inboard edge of the deck load where less than 24 inches of bulwark, rail, coaming, or other protection exists, all employees shall be provided with a suitable means of protection against falling from the deck load.

The employer shall ensure that there is in the vicinity of each barge in use at least one U.S. Coast Guard-approved 30-inch life ring with not less than 90 feet of line attached, and at least one portable or permanent ladder which will reach the top of the apron to the surface of the water. If the above equipment is not available at the pier, the employer shall furnish it during the time that he is working the barge.

Whenever practicable, a gangway of not less than 20 inches walking surface of adequate strength, maintained in safe repair and safely secured shall be used. If a gangway is not practicable, a substantial straight ladder, extending at least 36 inches above the upper landing surface and adequately secured against shifting or slipping shall be provided. When conditions are such that neither a gangway nor a straight ladder can be used, a Jacob's ladder meeting the requirements of paragraphs (d)(1) and (2) of this section may be used.

Cranes/ Hoists/ Cables

Employees need to use caution when working in areas where cranes, hoists and cables are in use. Refer to the GeoEngineers' Drilling and Rigging Safety Program.

WORKING NEAR WATER PROCEDURES

GeoEngineers' employees working over or near water, where the danger of drowning exists, shall be provided with U.S. Coast Guard-approved life jacket or buoyant work vests.

Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used.

Ring buoys with at least 90 feet of line shall be provided and readily available for emergency rescue operations. Distance between ring buoys shall not exceed 200 feet.

At least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water.

EMERGENCY PROCEDURES

The following topics are items that are important for handling an emergency. The boat operator should know these procedures and follow them at all times.

Communication

The Marine Radio will be with the boat operator at all times. Before entering the boat, the operator will call in to the Dispatcher and notify them of the location and destination of the boat. Each time an

employee enters or exits the boat, this will be recorded by the Dispatcher. This contact should occur at departure and arrival for long transits.

Engine problems

In the event of engine problems, contact the Dispatcher and notify them of the situation immediately. Depending on the situation, a rescue could be dispatched by the Coast Guard, another employee or a contractor. If a repair is made in the interim while waiting for the tow, call the Dispatcher again and notify them of the situation.

Spare plugs will be in the waterproof kit for offshore engine problems only. The boat operator will be required to take a spare tank and line for fuel, thus eliminating the need for spare line.

Distress flares

Are located in the waterproof boxes that the boat operator needs to ensure are on the boat before each travel session. Boat operators should also make sure that they are familiar with the operation of these flares.

Person Overboard / Rescue

Boat operators should be familiar with in water rescue techniques. The Coast Guard recommends that people not try to swim long distances to shore but wait for a rescue. This is because of hypothermia. Please see the section on Personal Floatation Devices. Access back into the boat will be from the stern. The engine will be turned off while the employee re-enters the boat.

Fire

Each workboat will be equipped with a 5 lb. ABC fire extinguisher located near the bow. The fire extinguisher should be checked each time the boat is used to ensure that it is ready to operate.

Work related injuries

Work related injuries that are not threatening to the safety of the persons on board should be reported to the Supervisor as soon as possible. Any work related injury that impairs operation of the boat should be called in to the GeoEngineers' office immediately. The office will call for the Coast Guard and or the Fire Dept. in the event of a serious injury.

WEATHER / TIDES

If the visibility is very low due to fog, the operator will not take the boat out.

Fog

In fog employees will stay within sight of the shoreline and/or head in and tie up. Whereas the MTC class instructed employees to drop anchor and use horn alert those nearby, employees are not likely to be caught unexpected in dense fog and should not go out if visibility is not sufficient for travel. Remember, ferry boats can't pick you up on radar and can't stop quickly.

Rough water

- Look for lee, can be another boat
- Head into swells, throttle up when approaching, throttle down when dropping down
- Check wave conditions before taking the boat out
- Head in at 45 degree angle at times, depending on wave size

Tides

Tidal changes in the Puget Sound and northern areas can be significant. Employees should always be aware of the tide changes and plan their work accordingly. There have been several instances where work under the docks became dangerous due to changing tides and lack of planning.

LIST OF SUPPLIES

In addition to the list of supplies generated in the training at the Maritime Training Center, the U.S. Coast Guard identified the following items to be critical for safe boating.

Items to be stored with the boat at all times:

- Oars and oarlocks
- Anchor
- Bucket for baling water
- Fire Extinguisher
- One spare fuel tank and line

Items that will be brought onto the boat when in use:

- Marine radio
- Watertight box with: first aid kit, flashlight, flares
- Personal Floatation Device(s)
- Carry a knife with serrated edge
- Tide book
- Spare plugs and wrench

PERSONAL FLOATATION DEVICE (PFD) SPECIFICATIONS

Personal Flotation Device (PFD) use applies to terminals and piers and employees working near other bodies of water. It also applies to all activities conducted by GeoEngineers employees at these facilities, including construction, maintenance, inspections, tours and operations. Type 1 PFDs will be worn in the boats at all times. PFD will be the correct size for the wearer and will be securely fastened.

The PFD should be inspected for damage prior to each use. Boats longer than 16 feet must carry at least one Type I, II, III, or V PFD for each person on board.

In addition, at least one Type IV (throwable device) must be carried. This is important, you may not use a Type IV "flotation cushion" as your sole PFD in your small rowboat or sailing dingy. Note: If a Type V device is used to count toward requirements, it must be worn. Federal regulations require PFDs on canoes and kayaks of any size; they are not required on racing shells, rowing skulls, or racing kayaks. State laws may vary.

PFDs are required for:

- Any employee in a boat/skiff/barge,
- Any employee is working on top of, or beyond the bull rail (a railing for docking the boat), or
- employees working near water where the danger of drowning exists.

PFDs are not specifically required when:

- Employees are not exposed to the danger of drowning when:
- Employees are working behind standard height and strength guardrails.
- Employees are working inside operating cabs or stations that eliminate the possibility of accidentally falling into the water.
- Employees are wearing an approved safety harness with a lifeline attached that prevents the possibility of accidentally falling into the water.
- Working behind a guardrail of standard height and strength or other stable restraint.
- A single person is working more than 6 feet from the edge.
- Working over shallow water (less than chest deep) where floatation would not be achieved (other protective measures required).

Provide your employees with PFDs approved by the United States Coast Guard for use on commercial or merchant vessels. The following are appropriate or allowable United States Coast Guard-approved PFDs:

Type of PFD	General description
Type I	Off-Shore Life Jacket-effective for all waters or where rescue may be delayed.
Type II	Near-Shore Buoyant Vest- intended for calm, inland water or where there is a good chance of quick rescue.
Type III	Flotation aid- good for calm, inland water, or where there is a good chance of rescue.
Type V	Flotation aids such as boardsailing vests, deck suits, work vests and inflatable PFD's marked for commercial use.

Off-Shore Life Jacket (Type I PFD)

Best for open, rough or remote water, where rescue may be slow coming.

- Advantages:
  - Floats person the best.
  - Turns most unconscious wearers face-up in water.
  - Highly visible color.
- Disadvantages:
  - Bulky.

Near-Shore Buoyant Vest (Type II PFD)

Good for calm, inland water, or where there is good chance for fast rescue.

- Advantages
  - Turns some unconscious wearers face-up in water.
  - Less bulky, more comfortable than Off-Shore Life Jacket (Type I PFD).
  - Compromise between Type I PFD performance and wearer comfort.
- Disadvantages
  - May be uncomfortable wearing for extended periods.
  - Will not turn as many people face-up as a Type I PFD will.
  - In rough water, a wearer's face may often be covered by waves.
  - Not for extended survival in rough water.

Flotation Aid (Type III PFD)

Good for calm, inland water, or where there is good chance of fast rescue.

- Advantages
  - Generally the most comfortable type for continuous wear.
  - Freedom of movement for water skiing, small boat sailing, fishing, etc.
  - Available in many styles, including vests and flotation coats.
- Disadvantages
  - Not for rough water.
  - Wearer may have to tilt head back to avoid face-down position in water.

Inflatable PFD's come in Types I, II, and III. Although the different "Types" of inflatable PFD's are intended for use in the same areas as inherently buoyant types of PFD's, the characteristics of inflatable PFD's are different. Inflatable PFD's are not inherently buoyant and will not float without inflation. For Types I, II, and III inflatables, the lower the Type number, the better the PFD's performance (e.g., Type I is better than Type II).

Although inflatable PFD's are considered one of the most comfortable PFD's to wear when it's hot, inflatable PFD's require regular maintenance and are not recommended for children or individuals who can't swim. Inflatable PFD's are not for use where water impact is expected as when waterskiing, riding personal watercraft, or whitewater paddling.

TRAINING

Personnel Using Boats

Each state is specific boat training requirements. In addition the U.S. Coast Guard can also be contacted for local training opportunities. All GeoEngineers employees operating a boat should have documented training.

The topics are copied from the Basic Use section of these Policy and Procedure Training materials provided by Maritime Training Center (MTC) are available from the Health and Safety Program Manager to use as a guide for additional training.

- Boat safety
- Boat operations, maneuvering (hands on)
- Towing
- Communications
- Emergency situations
- Rescue (hands on)
- Use of ropes (hands on)

Personnel Working Over or Near Water

GeoEngineers employees working over or near water should be trained in the contents of the Boat, Over Water and Near Water Safety Program. At the start of each project in which working over or near water presents a danger of drowning employees should have a tailgate safety meeting and discuss the following:

- The danger of drowning where it exists.
- Use of U.S. Coast Guard-approved life jacket or buoyant work vests.
- Life jacket or buoyant work vests inspections.
- Location of ring buoys for emergency rescue operations.
- Location of a lifesaving skiff for rescue if needed.

ATTACHMENT B

Teledyne-Brown Engineering Laboratory's
In-house Method 2015

Procedure	Number:	TBE-2015	Revision:	4
	Issue Date:	12/05/03 (reissue)	Revision Date:	10/05/2011
Responsible Individual:	Laboratory Production Manager		Review Date:	10/05/2014
Subject:	Lead-210 Activity in Various Matrices			

TELEDYNE BROWN ENGINEERING ENVIRONMENTAL SERVICES

TBE-2015

Revision 4

Lead-210 Activity in Various Matrices

Prepared by: _____ **Date:** 10/5/11
Susan Ogletree
Technician

Reviewed by: _____ **Date:** 10/5/11
Lynne Perry
Quality Assurance Manager

Approved by: _____ **Date:** 10/5/11
Keith O. Jeter
Laboratory Operations Manager

Procedure	Number: TBE-2015	Revision: 4
	Issue Date: 12/05/03 (reissue)	Revision Date: 10/05/2011
Responsible Individual:	Laboratory Production Manager	Review Date: 10/05/2014
Subject:	Lead-210 Activity in Various Matrices	

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Procedure	Number: TBE-2015	Revision: 4
	Issue Date: 12/05/03 (reissue)	Revision Date: 10/05/2011
Responsible Individual:	Laboratory Production Manager	Review Date: 10/05/2014
Subject:	Lead-210 Activity in Various Matrices	

DOCUMENT ISSUE AND REVISION CONTROL FORM

DOCUMENT: TBE-2015, Lead-210 Activity in Various Matrices

SECTION: Environmental Analysis Department

COVERAGE: Environmental Analysis Program

ISSUE AND REVISIONS	PAGES	PREPARED BY	DATE	EFFECTIVE DATE	APPROVED BY
Revision 1	Revised 2.2, 4.3, 7.3, 9.2.1, 9.2.2, 10.1, 11.1, 11.3 thru 11.7, and deleted 11.8 thru 11.10	Bill Meyer	10/20/05	11/09/05	Bill Meyer
Revision 2	Sections 3.4, 6.2, 6.3, 8.2, 9.3.6	Lynne Perry	11/15/07	11/15/07	Keith Jeter
Revision 3	Sections 8.1, 8.2, MDA table 9.3.5, 9.3.6, 9.4.5, 9.4.8, 9.5.4, 9.5.5, 9.5.7, 9.5.9, 9.5.10, 9.5.11, 9.6.3, 9.6.4, 9.7.2, 10.1, 10.3, 11.7, 12.2	Lynne Perry	09/09/08	09/09/08	Keith Jeter
Revision 4	Sections 1.1, 5.1, 8.1&2, 9.3 note, 9.3.4, 9.3.6, 9.4.1&2, 9.4.8&9, 9.6, Deleted 9.5.10, 9.7.1	Lynne Perry	10/05/11	10/05/11	Keith Jeter

Procedure	Number: TBE-2015	Revision: 4
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1.0 SCOPE AND APPLICABILITY

1.1 This procedure presents the radiochemical beta assay method for determining the leachable lead-210 (Pb-210) activity in sediments and soils.

2.0 SUMMARY OF METHOD

2.1 The Pb-210 activity of soils and sediments is determined radiochemically by separating the daughter product Bi-210 and assaying its beta activity. The method presented here measures the Pb-210 fraction from which Bi-210 may be dissolved by leaching with hydrochloric acid; activity in the interior of mineral grains may be excluded.

2.2 Stable lead and bismuth carriers are added to the dried sample and it is leached with 6 M hydrochloric acid. The sample is then filtered and the filtrate is evaporated, oxidized with nitric acid, and finally dissolved in 1.8 M hydrochloric acid. The solution is passed through an anion exchange column. Lead is eluted first with 9 M hydrochloric acid and with deionized water, then bismuth is eluted with 2 M sulfuric acid. The bismuth is precipitated as the oxychloride and is collected by vacuum filtration on a glass fiber disc. The bismuth yield is determined gravimetrically. The filter disc is mounted on a nylon planchet and covered with 3 mg/cm^2 aluminum absorber for beta assay in a low level, gas-flow proportional counter.

3.0 DEFINITIONS

3.1 MSDS — Material Safety Data Sheet

3.2 NIST — National Institute of Standards and Technology

3.3 TBE-ES — Teledyne Brown Engineering – Environmental Services

3.4 See procedure TBE-1004.

4.0 HEALTH AND SAFETY

4.1 At a minimum, personnel performing this procedure are required to wear the following protective equipment: laboratory coats, safety glasses, and disposable gloves.

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4.2 When using or preparing reagents that consist of concentrated caustic or acidic materials, or solutions producing excessive heat, the analyst is required to wear an apron over his/her laboratory coat and an appropriate face shield over his/her safety glasses.

4.3 All potentially hazardous chemicals or hazardous reagents must be prepared and used only in a hood.

4.4 MSDS are available in locations convenient to the laboratories and from the Safety Manager. Refer to these for other specific safety instructions for chemicals and reagents.

4.5 Appropriate precautions, as specified in the TBE-ES Radiation Protection Program Manual, will be followed when handling radioactive material.

4.6 Before commencing any laboratory work activities at TBE-ES, all employees receive orientation and training on the TBE Knoxville Facility Safety Manual, and TBE Radiation Worker Training, as applicable.

5.0 CAUTIONS

5.1 When adding concentrated acids, particularly sulfuric acid (H_2SO_4), to water, do so very slowly since significant heat is generated during dissolution. Prepare acid solution in a hood and cool the solution in an ice bath during dissolution, if required. Wear an apron, gloves and face shield, as appropriate.

6.0 INTERFERENCES

6.1 NA.

7.0 PERSONNEL QUALIFICATIONS

7.1 It is the responsibility of the analyst to heed any precautions noted by the procedure, to adhere to the instructions contained in the procedure, to report any deviation from this procedure, and to perform this procedure independently only when formally qualified.

7.2 It is the responsibility of the analyst performing this procedure to inspect worksheets and/or logbooks for accuracy and completeness, samples for correct volume and size, labels and tags for accuracy, equipment for correct operation, and to ensure that all calibrations for equipment used are current and not expired.

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7.3 Analysts performing this procedure must be trained, qualified, and certified in accordance with the TBE-ES Quality Assurance Manual and procedure TBE-1007. Procedure specific training documentation for designated analysts is maintained in the QA office.

7.4 Analysts in training may perform this procedure only under the direct supervision or observation of a technician certified to perform this procedure.

8.0 EQUIPMENT AND SUPPLIES

8.1 Apparatus and Materials

- Aluminum foil absorber (3 mg/cm^2)
- Balance, Analytical
- Balance, top loading
- Beakers, 400 mL, 250 mL or as required
- Desiccator
- Filter discs, 2.8 cm fiberglass
- Filter discs, 15 cm fiberglass or paper
- Filter rack
- Funnel, 4" diameter
- Gas flow proportional counting system, low level
- Graduated cylinders, 100 mL
- Hot plate
- Ion exchange column with 200 mL reservoir
- Logbooks, worksheets, marking pens, labels, scissors and/or razor blades
- Magnetic stirring apparatus with stirring bars
- Nylon planchets, retaining rings
- Oven, hot air drying
- Petri dishes, 4-Way partitioned
- pH meter and pH 4 and pH 7 buffer solutions, or appropriate range pH paper
- Pipettes, Volumetric Spatula, stirring rods, watch glasses, glass wool
- Vacuum filtering apparatus

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Standards and Reagents

- Amberlite IRA-400 C.P. Anion exchange resin, or equivalent
- Ammonium hydroxide (NH_4OH), concentrated: 15 M
- Bismuth carrier (nominal value 30 mg Bi/mL), standardized. See procedure TBE-2025, Preparation and Standardization of Carrier Solutions
- Ethanol, reagent grade
- Hydrochloric acid (HCl), concentrated: 12 M
- Hydrochloric acids (HCl), 6 M: dilute 500 mL of concentrated acid to 1 liter with deionized water
- Hydrochloric acid (HCl), 1.8 M: dilute 300 mL of 6 M hydrochloric acid to 1 liter with deionized water
- Hydrochloric acid (HCl), 9 M: dilute 750 mL of concentrated acid to 1 liter with deionized water
- Lead carrier (nominally 20 mg Pb/mL), standardization is not required. See TBE-2025, Preparation and Standardization of Carrier Solutions
- Nitric acid (HNO_3), concentrated: 16 M
- Sulfuric acid (H_2SO_4), concentrated: 18 M
- Sulfuric acid (H_2SO_4), 2 M: dilute 110 mL of concentrated acid to 1 liter with deionized water (Add acid to water with great care).

8.2 Use appropriate graduated cylinders and transfer pipettes during the preparation of the solutions cited above.

9.0 PROCEDURE

9.1 Detection Capability

Detection capability depends upon initial sample size, chemical yield, counting interval, and the background and efficiency of the counting instrument. Lower detection limits may be obtained by increasing the sample size or the counting interval.

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Lead-210 Minimum Detectable Activity

Matrix	MDA	Sigma Level [a]	Sample Volume	Chem Yield	Counting Interval (minutes)	Counting Efficiency (cpm)	Bkgd (cpm)
Sediments & Soils [b]	0.2 pCi/gm	4.66	10 gm	0.5	100	0.23	0.3

a Sigma multiplier will be 4.66 unless otherwise specified by the customer

b A representative decay factor of 0.9 allows for one day delay in counting the planchet after lead separation.

c Efficiency of 0.23 for Bi-210 counting using a 3 mg/cm^2 aluminum absorber.

9.2 Sample Selection

9.2.1 Using the Request for Analysis with the LIMS number, locate the sample (or sample group) in the sample receiving and storage room. Log the samples out of the Receiving Room and return with them to the laboratory.

9.2.2 Begin entering into LIMS and/or the laboratory logbook the customer name, the sample ID numbers in order, the desired analyses, sample type, the sample preparation date and the initials of the analyst.

9.3 Sample Preparation

NOTE: Perform % moisture, if required, prior to aliquoting for lead analysis.

9.3.1 Write the sample ID number on the outside of a glass beaker using a laboratory marking pen.

9.3.2 Using a clean spatula add approximately 25 grams of sample into the beaker. (If analyses other than Pb-210 are required, additional sample may be decanted to accommodate them.)

9.3.3 Place the beaker in a hot air oven (105-120°C) overnight to dry.

9.3.4 After the sample is dry, remove and allow to cool.

9.3.5 Write the sample ID number on a clean 150 mL beaker. Weigh the beaker using a balance and enter this tare weight in LIMS/and or the laboratory logbook. Transfer approximately 2-10 grams of the dried sample to the beaker. Different sample weights may be used as necessary to meet customer requirements. Enter the aliquot weight in LIMS and/or the laboratory logbook.

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9.3.6 Add 6 M HCl to the beaker, filling to the 100 mL mark. Using a calibrated pipette add 1.0 mL standardized Bi carrier to the beaker. Using a disposable pipette, add 1 mL Pb carrier to the beaker.

9.3.7 Cover the beaker with a watch glass and place on a moderate (approximately 200°F) hot plate. Allow the sample to leach for approximately 2 hours. Remove from the hot plate and allow to cool.

9.3.8 Fold a 15 cm fiberglass or paper filter disc in quarters to make a cone and place it in a 4-inch diameter funnel. Write the sample ID number on a clean 400 mL beaker and place it under the funnel in a filter rack. Gravity filter the sample. Rinse the solids with deionized water and collect the washings with the filtrate. Discard the filter and solids.

9.3.9 Add approximately 5 mL HNO_3 to the sample. Place the sample beaker on a moderate (approximately 200°F) hot plate and evaporate to dryness. Check that the sample does not spatter during evaporation and reduce hot plate temperature if necessary.

9.3.10 Add approximately 20 mL concentrated HCl to the sample. Place the sample beaker on a moderate (approximately 200°F) hot plate and evaporate to dryness. Check that the sample does not spatter during evaporation and reduce hot plate temperature if necessary.

9.3.11 Add 1.8 M HCl to the sample beaker, filling to the 150 mL mark. Warm gently on a low (approximately 100°F) hot plate to dissolve solids.

9.3.12 Remove the beaker from the hot plate and allow to cool. Stir the sample with a glass rod to homogenize the sample.

9.3.13 Further filtration may be required.

9.4 Chemical Separation and Purification

9.4.1 Obtain a ½-inch diameter 12-inch glass ion exchange column with a 200 mL reservoir and equipped with a stopcock at the bottom. Insert a small wad of glass wool above the stopcock.

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9.4.2 Make a slurry of anion exchange resin (e.g. Amberlite IRA-400 C.P., or equivalent) and deionized water in a beaker. With the column stopcock open, pour the slurry into the column until the resin occupies approximately 10 inches of the column.

NOTE: New resin is used for each sample.

9.4.3 Condition the column by passing through approximately 60 mL of 1.8 M HCl. Close the stopcock when the liquid level reaches the top surface of the resin.

9.4.4 Pass the sample solution through the column with the stopcock fully open. Collect the effluent in a beaker and discard. Close the stopcock when the liquid level reaches the top surface of the resin.

9.4.5 Using extreme caution, pass approximately 150 mL of 9 M HCl through the column to elute the lead. Collect the effluent in a beaker and discard (unless advised to save the effluent by the Laboratory Operations Manager). Close the stopcock when the liquid level reaches the top surface of the resin. Enter the midpoint of the elution period in LIMS and/or the laboratory logbook.

9.4.6 Pass approximately 150 mL of deionized water through the column. Close the stopcock when the liquid level reaches the top surface of the resin. Discard the effluent.

9.4.7 Measure 150 mL of 2 M H_2SO_4 and pass through the column to elute the bismuth. Collect the effluent in a clean, labeled 400 mL beaker.

9.4.8 Adjust the pH of the sample to 5 using a pH meter or pH paper. Add 35 mL concentrated NH_4OH to the sample beaker and add a magnetic stirring bar. Place the sample beaker on a magnetic stirring plate. Add NH_4OH using a disposable transfer pipette until a pH of 5 is obtained. If the pH exceeds 5, use 2 M H_2SO_4 to adjust the pH to 5.

9.4.9 Remove the sample beaker from the magnetic stirrer and add 2 mL of 6 M HCl using a disposable pipette. Bring to the 350 mL mark using deionized water.

9.4.10 Place the sample beaker on a moderate (approximately 200°F) hot plate and digest until the white BiOCl precipitate forms and falls to the bottom of the beaker (approximately 2 hours). Remove from the hot plate and allow to cool.

9.5 Mounting of Precipitate

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9.5.1 Prepare a 2.8 cm glass fiber filter disc for each sample by mounting it on a vacuum filtration apparatus and rinsing with deionized water and ethanol.

9.5.2 Place the prepared discs in 4-way partitioned petri dishes that have been marked with sequence numbers (one number per partition, beginning with 1). Enter a corresponding sequence number beside each sample ID number entry in the laboratory logbook.

9.5.3 Place the petri dishes containing the prepared filters in a hot air oven (105-120°C) for 10 minutes or longer to dry. Remove petri dishes and allow to cool in a desiccator.

9.5.4 Weigh the filter discs on the analytical balance, using a clean spatula to handle them. Enter this tare weight beside the corresponding sequence number and sample ID number in LIMS and/or the laboratory logbook. Take care to replace each filter after weighing in the numbered petri dish partition from which it came.

9.5.5 Using a spatula, take the tared filters in sequence number order and transfer to the vacuum filtration apparatus. Wet with deionized water. Using LIMS and/or the laboratory logbook to establish the correspondence between sequence number and sample ID number, transfer each sample from its beaker onto the corresponding filter disc using the filtration apparatus.

9.5.6 Rinse the precipitate on the filter with deionized water and then with ethanol. Transfer each filter from the vacuum filtration apparatus back to the numbered petri dish partition from which it came. Place the petri dish in a hot air oven (105-120°C) for 10 minutes or longer until the filter is dry.

9.5.7 Remove the petri dish and allow to cool in a desiccator. Weigh the filters on the analytical balance and enter the weights beside the corresponding sequence numbers in LIMS and/or the laboratory logbook. Return each filter to its original partition in the petri dish. LIMS automatically calculates the mount weight and carrier yield.

9.5.8 Prepare a label for each sample, showing the analysis, the sample ID number and the customer. Attach each label to a nylon planchet.

9.5.9 Using LIMS and/or the laboratory logbook to establish the correspondence between sample ID number, and sequence number, transfer each filter to its planchet and fix in

place with a 2-inch piece of 3 mg/cm^2 aluminum absorber foil and a nylon ring. Trim excess aluminum with a razor blade or scissors.

9.5.10 Submit finished planchets and worksheets to the counting room for radioassay.

9.6 Sample Counting

Bismuth-210 mounts are typically counted 100 minutes for beta activity in a low level gas flow proportional counter.

9.6.1 Assign a low level, gas-flow proportional counter to each prepared bismuth mount by writing the counter number in the space provided on the Radiochemical Worksheet.

9.6.2 Arrange the worksheets in order according to counter number. Take the first sheet, locate the nylon planchet bearing the indicated sample ID number, and load the planchet into the detector tray indicated on the sheet.

9.6.3 Set the counter timer to 100 minutes and start the counters (different counting intervals may be used). Leave the worksheets on the tray in front of the counters

9.6.4 After all samples in the group have been counted, copy the raw data file and transfer to the appropriate calculation raw data folder. Remove the mounts from the counter trays and place them in the labeled container.

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9.7 Calculation of the Sample Activity or of the MDA

9.7.1 Sample activity and the 2-sigma counting error are calculated as follows:

$$\frac{Net\ pCi\ on\ Collection\ Date}{Unit\ Volume\ or\ Weight} = Net\ Activity \pm Counting\ Error \quad \text{or,}$$

$$\frac{Net\ pCi\ on\ Collection\ Date}{Unit\ Volume\ or\ Weight} = \frac{\frac{N}{\Delta t} - \beta}{2.22(v)(y)(DF)(\varepsilon)} \pm \frac{2 \times \sqrt{\frac{\frac{N}{\Delta t} + \beta}{\Delta t}}}{2.22(v)(y)(DF)(\varepsilon)}$$

Where:
- N = total counts from sample (counts)
- Δt = counting time for sample (minutes)
- β = background rate of instrument blank (cpm)
- 2.22 = dpm/pCi or: 2.22×10^6 dpm/μCi
- v or w = volume or mass of sample analyzed
- y = yield
- DF = decay factor of Bi-210 from the mid-elution time to the mid-count time
- ε = efficiency of the counter for Bi-210 beta counting, using a 3 mg/cm^2 aluminum absorber
- 2 = sigma multiplier

9.7.2 If no activity is found, the MDA is reported and calculated as follows unless otherwise specified by the customer:

$$MDA = \frac{4.66 \sqrt{\frac{\beta}{\Delta t}}}{2.22\ (v)(y)\ (\varepsilon)(DF)}$$

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10.0 DATA AND RECORD MANAGEMENT

10.1 Data and records management is per procedure TBE-1003.

10.2 All laboratory data and ancillary information shall be documented in LIMS and/or laboratory logbooks or appropriate worksheets. Appropriate supervisory personnel shall review bound logbook entries as required by the TBE-ES Quality Assurance Manual and procedure TBE-4015.

10.3 Corrections to recorded data in logbooks or on worksheets shall be noted by drawing through the incorrect data with a single line and recording the date of the correction and the initials of the person making the correction. The correct data will be recorded in an unambiguous location in the immediate proximity of the incorrect data. Unless obvious, an explanation for the change is also required. Correction to recorded data in the electronic logbook requires a reason in order to save the change in LIMS.

11.0 QUALITY CONTROL AND QUALITY ASSURANCE

11.1 Sample collection, reagents and standards preparation, quality control and data acceptance, sample preparation and instrument procedures, calculations, precision and accuracy, reporting of results, attachments and references, as they apply to this procedure, are discussed in other procedures.

11.2 From a health and safety perspective, the TBE Knoxville Facility Safety Manual shall guide execution of this procedure.

11.3 Analysis blanks and spikes shall be run on each batch, as required by the TBE-ES laboratory QC program.

11.4 Sample duplicates shall be run to meet customer requirements or as required by the TBE-ES laboratory QC program.

11.5 A matrix spike consisting of a sample spiked with an appropriate standard (NIST traceable when possible) shall be run to meet customer requirements or as required by the TBE-ES laboratory QC program.

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11.6 If any batch control sample fails laboratory established quality control criteria or fails to meet specific customer contract requirements, the samples comprising the controlled batch shall be reanalyzed.

11.7 Control samples may be statistically analyzed following the guidance of procedure TBE-4011.

12.0 REFERENCES

12.1 TBE Knoxville Facility Safety Manual, current version.

12.2 TBE-ES procedure TBE-3003, Calibration and Control of Alpha and Beta Counting Instruments.

12.3 TBE-ES Quality Assurance Manual, current version.

12.4 TBE-ES Radiation Protection Program Manual, current version.

12.5 U.S. Environmental Protection Agency, August 1980, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water,* EPA-600/4-80-032.

12.6 U.S. Nuclear Regulatory Commission, Regulatory Guide 4.15, revision 1, February 1979; *Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Streams and the Environment.*