

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
1.1 SITE HISTORY	3
1.2 SCOPE OF WORK	4
1.2.1 General Conditions	4
1.2.2 Overview of Project Tasks	6
1.3 PROJECT MANAGEMENT	7
1.3.1 Project Management	7
1.3.2 Safety and Health Program	9
1.3.3 Quality Assurance and Control	9
1.3.4 Project Integration and Management of Subcontractors	10
1.3.5 Project Scheduling	10
2.0 SCOPE OF WORK	11
2.1 SITE MOBILIZATION AND PREPARATION	13
2.1.1 Staging Area	13
2.1.2 Project Work Area	13
2.1.3 Temporary Services	14
2.1.4 Utility Location	14
2.1.5 Vegetation Clearing and Site Grubbing	15
2.2 MINE WASTE REMOVAL	15
2.3 TRANSPORTATION AND DISPOSAL	15
2.4 STREAM RESTORATION ACTIVITIES	16
3.0 SAMPLING AND ANALYSIS PLAN	16
4.0 COMPLETION REPORT	17
5.0 REFERENCES	17

LIST OF FIGURES

- FIGURE 1 Site Map
FIGURE 2 Removal Area

LIST OF APPENDICES

- Appendix A: POLREP #3 Final Emancipation Mine
Appendix B: Origins Laboratory Soil Sampling Report
Appendix C: Black Swan Stream Restoration Project Drawings
Appendix D: Health and Safety Plan
Appendix E: Emergency Call Down List
Appendix F: Sampling and Analysis Plan

**BLACK SWAN RESTORATION
MINE WASTE REMOVAL
WORK PLAN**

1.0 INTRODUCTION

A high-intensity rainfall event occurred across Boulder County in September of 2013. This rainfall caused flash flooding in many of the watercourses in western Boulder County, including Fourmile Creek. Fourmile Canyon Drive (Boulder County Road #118) and associated roadway infrastructure, private residences, and other infrastructure throughout the canyon were severely damaged in this flooding event, necessitating the construction of a resilient stream corridor to reduce the risk of future damage to the infrastructure from fluvial erosion events. The Fourmile Watershed Coalition (FWC) has contracted Frontier Environmental Services (Frontier) as its Contractor to provide design and construction services for the Black Swan Stream Restoration Project.

The Black Swan Restoration Reach along Fourmile Creek is approximately 4 miles upstream from the confluence of Fourmile Creek and Boulder Creek in Boulder Canyon. The entire drainage area for Fourmile Creek is located in Boulder County, Colorado, west of the incorporated city of Boulder. The coordinates (NAD83) for the upstream limits of the study reach are 40.0499 N latitude, 105.3696 W longitude, and the coordinates for the downstream limits of the study are 40.0410 N latitude, 105.3640 W longitude. The project reach is located in Township 1N, Range 71W, Sections 17 and 20 of the 6th Principal Meridian. The Black Swan Restoration Reach begins at the upstream property of 4726 Fourmile Canyon Drive and continues through the downstream property of 11 Logan Mill Road.

Many homes in the floodplain were damaged beyond repair during the flood event. Boulder County purchased some of these properties to prevent future development in the floodplain.

The damaged homes have been demolished. One of these “buyout” properties is located within the Black Swan Restoration area at 4389 Fourmile Canyon Drive. The contractor who demolished the property uncovered mine waste when they located the septic. The location of the waste is on the west side of Fourmile Creek (See Figure 1).

This Work Plan establishes the method by which the Site will be effectively and safely managed with respect to identified areas of mine waste deposition. The Plan provides a brief description of the scope of work, including the objectives of the mine waste removal activities, stream restoration and monitoring and maintenance. The mine waste material will be excavated and hauled to a designated off-Site landfill to prevent surface water inflow, thereby isolating the waste from the environment and reducing the potential for surface water runoff to be negatively impacted by Acid Rock Drainage (ARD) and potential dispersion from future flood events. Figure 2 delineates the approximate location of the mine waste on the subject property.

Section 1.3 describes the project management procedures and practices which will ensure the completion of the Work in a manner which achieves the project objectives in compliance with applicable environmental law and within the project schedule. Section 2.0 of the Work Plan describes in detail the implementation of the scope of work. Section 3.0 provides a description of the sampling and analysis procedures to be used by Frontier for the field screening of the mine waste. A discussion of the key components of the final construction completion report is provided in Section 4.0.

By reference in this Work Plan, the suggested *Site Specific Health and Safety Plan* assigns responsibilities to key personnel, identifies potential health and safety risks, cites employee training requirements, discusses personal protective equipment and medical surveillance monitoring requirements, identifies site control actions, identifies decontamination procedures and standard operating procedures, and discusses contingency plan issues.

1.1 BACKGROUND AND SITE HISTORY

The former location of the Black Swan Mill was at the current address of 4472 Fourmile Canyon Drive on the East side of the road. The Mill was located east of station 22+00 on the stream restoration design plans and is outside of the project area. The mill was built in 1902 and ceased operations in the early 1930s. Telluride and tungsten were processed at the mill. An old tailings pond located above the upstream boundary of the Black Swan restoration project was disturbed during the 2013 flood leaching arsenic into the stream. The tailings were removed by the EPA in 2014 as part of a time critical removal action. A project report from the EPA removal project is attached as Appendix A and contains trucking and tipping fee costs. Contaminated soil was hauled and disposed of at the Front Range Landfill in Erie.

The materials which will be removed as part of this project likely originated from processing activities at the Black Swan Mill, or from other historic mining activities in Fourmile Canyon. In July of 2017, Frontier mobilized a CAT 436 backhoe to the site and excavated a series of test pits to evaluate depth and extent of the mine waste. The depth to groundwater was also evaluated in each test pit. In total five test pits were dug. Average depth to groundwater across the impacted area was 6 feet bgs. An approximate surface area of 7500 SF was found to contain mine waste. All delineations were based upon visual inspection only. One composite sample was collected and sent for analysis of Total Metals by EPA 6010C/EPA 7471A. The results of this sampling event can be found in Appendix B. Mine waste was found to range in depth from 4 – 5 feet deep.



1.2 SCOPE OF WORK

The scope of work for the Black Swan Restoration Project includes 5,190 linear feet of stream restoration. Of that length, 1,252 linear feet are proposed for sediment and debris removal, 2,713 linear feet are proposed for full channel reconstruction, and 1,225 linear feet are proposed for no work. Proposed work includes increasing channel complexity and habitat, bank stabilization, revegetation and excavating mine waste and hauling it to Front Range Landfill in Erie, CO for off-site disposal. The estimated volume of mine waste is approximately 1400 CY. Frontier has added a 35% volume contingency for budgeting purposes for a total of approximately 1900 CY. The location or illustration of the areas of to be addressed during this scope of work are depicted on Figure 2.

1.2.1 General Conditions

1. Project Documents

Frontier has developed the *Project Drawings, Work Plan, Site Specific Health and Safety Plan, and the Sampling and Analysis Plan*. Each of the Site performance documents will be submitted to the Fourmile Watershed Coalition for review and approval

2. *Colorado Discharge Permit System (CDPS) - Construction Storm Water Discharge*

CDPHE requires that a *Construction Storm Water Management Plan* be prepared prior to the initiation of Site activities. The SWMP incorporates Best Management Practices (BMPs) for the control and proper discharge, if any, of storm water from the Site. The SWMP consists of the following six sections: Site Description, Site Map, BMPs for Storm Water Pollution Prevention, Final Stabilization and Long Term Storm Water Management, Other Controls, Inspection and Maintenance. The primary pollutant of concern at a construction site is sediment release during storm events with site run-off. At the Site it is sediment and heavy metal contaminated sediment that may be generated during the removal scope of work. The SWMP must describe the manner by which storm water BMPs will address the control and prevention of contaminated soils mixing with storm water. The conditions of the SWMP may require sampling of storm water to demonstrate compliance with the intent of the BMPs.

3. *Boulder County*

Excavation along public rights-of-way and utility easements may require excavation permits to ensure public safety and the structural integrity of the public utility, sewer and water system(s) from Boulder County, Colorado. Frontier will obtain the

necessary permits and will perform utility locates prior to the initiation of this Scope of Work.

4. *Health and Safety Standards*

The health and safety requirements of the U.S. Department of Labor, Occupational Safety and Health Act (29 CFR 1910 and 29 CFR 1926) apply to all remediation actions. All workers will require 40-hour OSHA hazardous materials training under 29 CFR 1910.120 during on-site activities required by the contracted scope of work. A *Site Specific Health and Safety Plan* has been developed and by reference is a supplement to this Plan.

1.2.2 *Overview of Project Tasks*

The scope of work for the Black Swan Stream Restoration Project includes the following:

1. Site preparation, including but not limited to:
 - Contractor mobilization;
 - Location of existing utility (i.e. sewer, storm drains, electrical, natural gas and potable water);
 - Establishment of site security, and
 - Placement of Site Offices, temporary utilities and contractor staging areas required for the Work;
2. Removal and stockpile of overburden and excavation, loading and transport of waste materials to the designated waste facility;
3. Sampling and verification by Frontier for verification of excavation limits as defined by the Project Drawings and Specifications;
4. The control of fugitive dust emissions during the excavation and movement of soils by acceptable dust abatement methodologies, e.g. wetting;

5. Importing clean fill, as necessary, from a local borrow source and compacting it in place to grades shown on the Site Construction Drawings;
6. Implementation of the stream restoration components;
7. Preparation of a project construction completion report suitable for detailing the completed construction scope of work.

1.3 PROJECT MANAGEMENT

The overall management structure of the project is the responsibility of Frontier Environmental Services, LLC. The technical components of the project will be coordinated through Frontier's Project Engineer and Site Management. This ensures that technical aspects are implemented at the management level, with relevant insight provided by experienced project personnel. Frontier will be cognizant of the need to perform work in full compliance with regulatory requirements and project specifications. We also appreciate the necessity to provide adequate staffing, equipment, and supplies to maintain schedule and project budgets. Staff, construction services, and materials must be readily available to allow for the efficient performance of daily tasks in construction, operations, inspections, equipment maintenance, sampling, and sample analyses to meet schedule milestone dates and compliance performance criteria.

1.3.1 Project Management

Frontier's approach to this scope of work incorporates the use of experienced personnel and effective communication with the Fourmile Watershed Coalition and EPA designated project representatives. In this fashion, Frontier will satisfy the project objectives outlined in this work plan. To ensure effective communication of project events, Frontier will provide the Fourmile Watershed Coalition with a Daily Site Activity Log. In addition, Frontier will provide brief weekly progress reports, and will meet with Coalition, County, and EPA

officials on a required or as-needed basis to discuss current project status and performance information. At the initiation of on-site activities, Frontier will implement the procedures outlined in this Work Plan and will comply with waste management policies and procedures established for this Project.

Frontier will ensure that each person performing tasks in support of the contract has valid professional certifications, if required, current levels of training as outlined in 29 CFR 1910.120, and evidence of that employee being fully covered by the medical monitoring program.

Frontier Project Manager: Frontier's Project Manager has the authority to assign financial resources to the project. The project manager will ensure that the project has the needed resources available to complete respective phases of the project on schedule and within the project estimate, and is responsible for the overall project quality assurance.

Frontier Project Engineer: Frontier's Project Engineer is completely familiar with every phase of the Project, reviews the performance of the project team which provides necessary quality assurance and quality control, and will address any problems that may arise. The Project Engineer is directly responsible for the day-to-day scope of work and the coordination of their respective phases of work, and will have the responsibility of ensuring timely performance of task work and reporting to FWC Project Management.

Frontier's Site Superintendent: Frontier's Site Superintendent is responsible for the day-to-day allocation of labor, materials and equipment on the Project. This person will be on-site on a daily basis, during normal business hours. Frontier's Site Superintendent will coordinate its work activities with the FWC Project Manager.

Frontier will perform construction services necessary for the Black Swan Mill Mine Waste Removal Project with the resources available from our local staff. Frontier has project personnel available that meet the daily task description work experience requirements.

1.3.2 Safety and Health Program

Frontier has developed a Health and Safety Plan (HASP) for activities associated with the implementation of this project work plan. The HASP discusses hazards associated with the Black Swan Mine Waste Removal Project as well as the Stream Restoration Project and discusses appropriate safety precautions to follow throughout work areas and for the duration of the project. These plans include emergency contacts and contingency plans relative to the project. The HASP also contains the elements necessary to complete site work in accordance with all appropriate and applicable requirements of OSHA 29 CFR 1910 and EPA guidance.

1.3.3 Quality Assurance and Control

Quality Assurance and Control (QA and QC) are key ingredients to the Project's formula for success in providing cost effective and technically sound services. The purpose of the Quality Assurance and Quality Control Programs are to ensure that high quality services and complete closure of the area of contamination is obtained. The following are the principal goals for the Project Construction Quality Assurance (CQA) and Quality Control (QC) programs:

- to attain professional and technical excellence;
- to assess and manage any environmental risk to the project, the environment, and the public health.

Primary reliance for quality control of Project performance is placed upon Frontier's Project Manager and Frontier's Site Superintendent, with reinforcement from Senior Management. Thus, staff with program and project responsibilities, are accountable not only for the quality

of their personal performance as individuals but also for the collective quality of performance of those who are accountable to them. The concept of self-accountability applies to all parts of the Black Swan Restoration Mine Waste Project Site activities and emphasizes the important responsibility of every individual employee for high quality personal performance.

The Project's Construction Quality Assurance and Construction Quality Control (CQA/CQC) Program will be strictly applied to the Black Swan Restoration Mine Waste Removal Project Site construction activities. It provides CQA/CQC implementation guidelines to ensure that data generated and collected are of known quality sufficient to support sound project management and valid scientific conclusions. In recognition of the importance of an effective CQA program in attaining the project objectives, Frontier has committed the personnel and managerial organization necessary to ensure that data meets quality objectives; thus project objectives are realized.

1.3.4 Project Integration and Management of Subcontractors

All Black Swan Restoration Mine Waste Removal Project activities and their implementation will be managed and coordinated by Frontier. Coordination and supervision of subcontractors for the scope of work will be the responsibility of Frontier's Project Manager. Frontier's Site Superintendent is charged with the day-to-day management of all field activities at the site and will be present whenever closure activities are occurring.

1.3.5 Project Scheduling

Frontier will provide a Project Schedule based on an anticipated timeframe to successfully complete the project. The project schedule will allow for project performance input and summary reporting. The report writing function will show schedule performance with respect

to actual data, which in turn will highlight areas ahead of schedule as well as those areas lagging.

Scheduling, resource loading and reporting will allow for the timely identification of problems, which are negatively impacting the project schedule, and allow corrective actions in a timely manner. The baseline schedule has been prepared in anticipation of receiving an NTP sometime in June 2018. The schedule will be periodically updated and discussed with the FWC. This will ensure that schedule impacts, which may require coordination, are discussed and resolved in a timely manner between Frontier and the FWC.

2.0 SCOPE OF WORK

The scope of work for the Black Swan Restoration Project includes 5,190 linear feet of stream restoration. Of that length, 1,252 linear feet are proposed for sediment and debris removal, 2,713 linear feet are proposed for full channel reconstruction, and 1,225 linear feet are proposed for no work. Proposed work includes increasing channel complexity and habitat, bank stabilization, revegetation and excavating mine waste and hauling it to Front Range Landfill in Erie, CO for off-site disposal. The location or illustration of the areas to be addressed during this scope of work are depicted on Figure 2.

The Mine Waste Removal consists of the excavation, transport, and disposal of approximately 1900 CY of mine waste from the buyout site located at 4389 Fourmile Canyon Drive in Boulder County, CO. This Site is located along Fourmile Creek, adjacent to the track of a former narrow-gauge railroad that connected the network of mines throughout Fourmile Canyon. Mine waste and tailings are scattered throughout the canyon. The canyon experienced a large wildfire in 2010 and a subsequent flood in 2013. It is assumed that the mine waste was deposited prior to residential use of the property which began in 1957.

Removal of the material will be based on a visual examination of the mine waste with confirmation soil sampling at frequencies to be determined. The mine waste consists of yellow powdered waste that is visually distinguishable from the native cobbles and alluvium. Only the material that appears to have the capacity to release low pH seepage with dissolved metals will be removed and only to the extent that the new stream channel alignment can be constructed within native materials. The proposed stream alignment can be seen on Figure 2. Based on previous site investigations, the mine waste is estimated to be in a lens that is approximately 4 foot thick with 1 foot of clean fill on top of it. The previous investigation found the waste to be contained in a fairly uniform lens above the water table.

During excavation, samples will be screened in situ with an XRF as needed to guide the removal to determine the vertical and lateral extent of the excavation. Deeper excavations in limited areas may be conducted at the EPA On-Scene Coordinator's discretion. When in situ guidance has determined the excavation is complete, the final excavated surfaces will be sampled. Samples of the excavation walls and floor will be collected to confirm removal of contaminated soil. The samples will be analyzed for total metals via the XRF in the field, and a percentage of samples will also be submitted for laboratory analysis. Following completion of excavation, the site will be backfilled with clean soil and gravel. A final map of the property with sample locations and concentrations will be produced for the EPA. The following data will be used to guide decision-making at the site:

1. Field data and documented observations from soil sampling including soil type and soil color,
2. XRF screening data from soil samples,
3. Analytical data from soil samples, and
4. Locational data from soil samples.

If ground water is encountered during excavation and dewatering is required it will be done in compliance with all State and Federal regulations. Frontier Environmental Services can obtain an on-site water treatment system, though the filtration system cannot be designed until the metal concentrations are known (post groundwater sampling). If groundwater is encountered a decision will be made as how to proceed with the removal and restoration project. Excavations will be shored according to OSHA Safety Standards.

The proposed scope of work will be performed as follows:

1. Site preparation, including but not limited to:
 - Contractor mobilization;
 - Location of existing utility (i.e. sewer, storm drains, electrical, natural gas and potable water);
 - Establishment of site security, and
 - Placement of Site Offices, temporary utilities and contractor staging areas required for the Work;
2. Removal and stockpile of overburden and excavation, loading and transport of waste materials to the designated waste facility;
3. Sampling and verification by Frontier for verification of excavation limits as defined by the Project Drawings and Specifications;
4. The control of fugitive dust emissions during the excavation and movement of soils by acceptable dust abatement methodologies, e.g. wetting;
5. Importing clean fill, as necessary, from a local borrow source and compacting it in place to grades shown on the Site Construction Drawings;
6. Implementation of the stream restoration components;
7. Preparation of a project construction completion report suitable for detailing the completed construction scope of work.

2.1 SITE MOBILIZATION AND PREPARATION

Site mobilization will commence upon notification from FWC Project Management to allow for the timely completion of Site removal activities. Site access will be established for Frontier and/or FWC personnel, security controls will be implemented, work areas will be physically defined, and exclusion and safety zones will be established during the site mobilization. Prior to mobilization, all required project documentation and necessary permits will be submitted to the FWC Project Manager for review and approval.

2.1.1 Staging Area

A temporary trailer will be mobilized to the site and placed in the support area for use as an office and first aid facility. The staging area will also be used for storage of equipment and materials necessary for the completion of this scope of work. This area will also be the designated parking area for site personnel and visitors. The Staging Area will be used for site access and security control.

2.1.2 Project Work Area

All work areas within the Site will be considered to be exclusion zones for the purpose of limiting and controlling access and providing controls for Site personnel safety and health. The boundaries of the zone(s) will be appropriately identified with signage and caution flagging, as well as made secure by limiting access points. Level-D personal protective equipment utilization will be required in all Project Work areas as determined by the HASP. The HASP provides for the change in protective status of personal protective equipment based upon the exposure or hazards anticipated on the Site. Level-D personal protective equipment includes, but is not limited to, steel-toed work boots, gloves, work clothes, eye protection and hearing protection (as required).

2.1.3 Temporary Services

The following details the anticipated use of temporary facilities:

Electrical: Electrical power, if necessary, will be provided by Frontier. The power will be used to provide service and lighting to the temporary office trailer and ancillary support equipment, as needed.

Water: Frontier will provide construction water from a Pine Brook Water District hydrant as required. Drinking water will be provided for separately by Frontier. Hand wash stations will be provided at the staging area. Potable water, if required for decontamination, will also be provided by Frontier.

Toilets: Frontier will provide sanitary services for its employees and Site visitors as required by site staffing requirements and numbers.

Trash/Waste/Scrap Services: Solid waste disposal and recycling services will be provided by Frontier according to project policies and procedures.

2.1.4 Utility Location

Frontier will be responsible for the location and/or verification of existing utilities (i.e. sewer, storm drains, electrical, natural gas and potable water). Frontier Site Drawings provide some information with respect to existing utility location. However, the exact location of all utilities on site is not known. Therefore, it is the sole responsibility of Frontier to locate and/or verify the location of any existing utilities on Site.

2.1.5 Site Grubbing and Vegetation Clearing

Grubbing and cleaning of existing site vegetation may be required to facilitate the principle environmental removal activities. Cleared vegetation will be managed on-site.

2.2 MINE WASTE REMOVAL

Frontier personnel will determine whether the overburden material can be stockpiled on-site for re-use or should be transported as solid waste for off-site for disposal if it passes the TCLP. Mine waste will be excavated and loaded directly into trucks for transport to the disposal facility. Excavation will begin from the west edge of the tailings and continue back to the east. The excavation will proceed in lifts benching down until native soils are encountered. The initial site investigation indicated that the mine waste does not extend all the way to creek in a n easterly direction. In any case, an earthen berm will be left in place to prevent sediment/tailings from being introduced to Fourmile Creek. All excavations will be benched in accordance with OSHA regulations. It is anticipated that all of the mine waste will be removed as part of this effort. The outside bend that will be re-constructed in this area will be stabilized with vegetated soil riprap and rootwad protections.

2.3 TRANSPORTATION & DISPOSAL

The waste material will be loaded into tandem axle dump trucks and transported to Waste Connection's Front Range Landfill in Erie, CO. The waste material will be profiled under the Bevill Exclusion. In 1980, Congress adopted the Bevill Amendment, which amends RCRA to exempt temporarily from Subtitle C regulation solid waste from ore and mineral extraction, beneficiation, and processing. Each load will be properly manifested and tarped for transport to the disposal facility. Frontier will ensure Vehicle Tracking Control pads are in-place and operationally sound prior to any trucking operations. In addition, Frontier will have a skid steer and broom provide daily sweeping to ensure no mud, rocks, or dirt are being tracked from the site. Frontier will provide traffic control and flaggers to assist the trucks with entering and exiting the site.

2.4 *STREAM RESTORATION ACTIVITIES*

The Black Swan Stream Restoration Project will be constructed per the approved Project Drawings attached here in Appendix C. The design has been conditionally approved by Boulder County and the Army Corps of Engineers and will be constructed in accordance with all permit guidelines.

3.0 *SAMPLING AND ANALYSIS PLAN*

Eagle Environmental has prepared a Sampling and Analysis Plan to cover the initial site investigation. This plan has been attached to this document as Appendix E.

4.0 *COMPLETION REPORT*

At the conclusion of this Black Swan Mine Waste Removal Project, Frontier will prepare a final project Construction Completion Report. Frontier's CQA/CQC Manager will prepare supporting information for the report detailing the various stages of construction. At a minimum, closure reports will summarize the methods, results, and conclusions of the closure program. The report will include information such as:

- As-Built Drawings and Figures illustrating the area of construction;
- Daily activity log reports summarizing activities, problems, and resolutions;
- A discussion of any modifications to the procedures described in the Work Plan;
- Site photographs;
- Waste Manifests and;
- Data interpretations and conclusions.

5.0 REFERENCES

Quality Assurance/Quality Control Guidance for Removal Activities. EPA/540/G-90/004. OSWER Directive 9360.4-01. April 1990. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC 20460

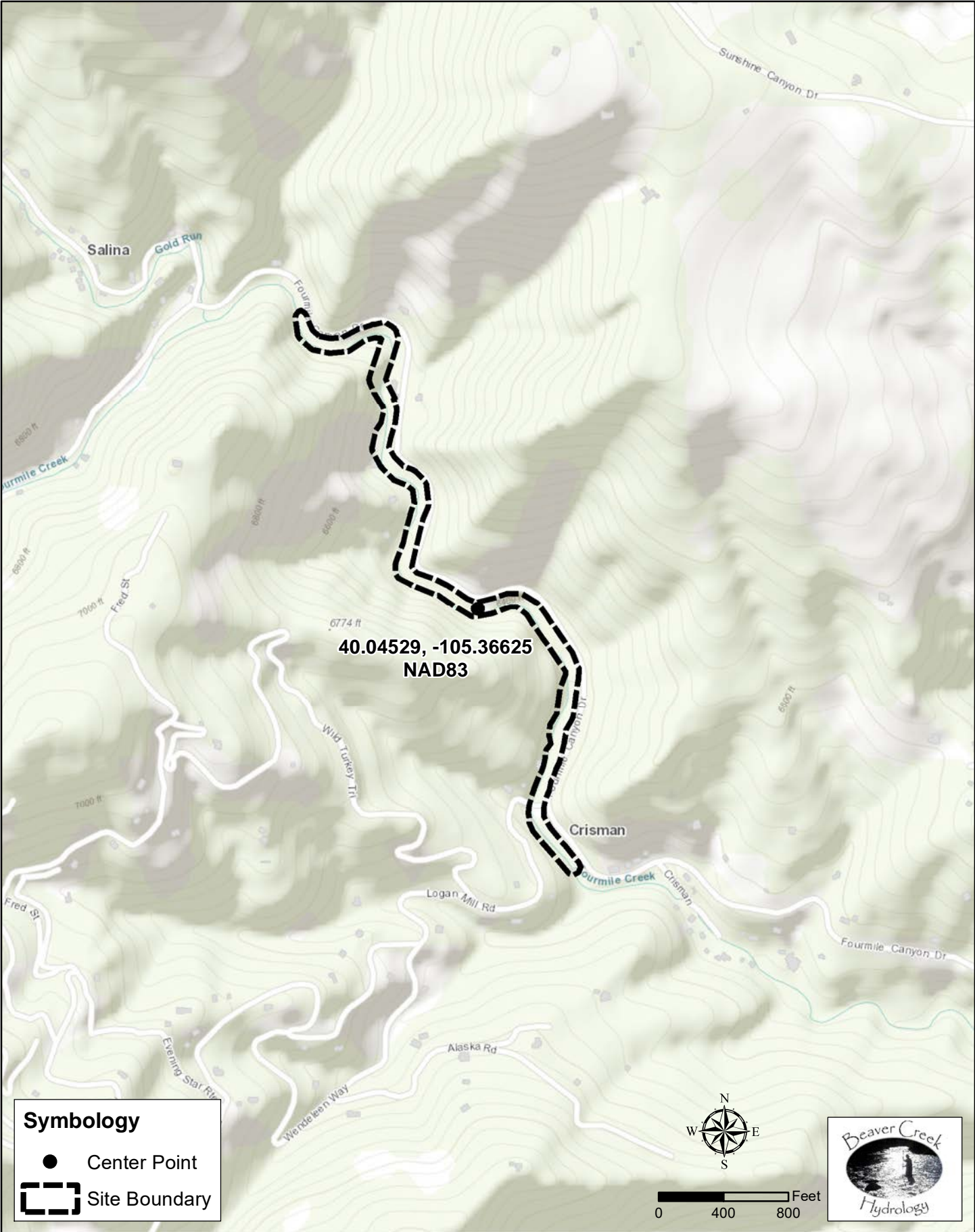
Compendium of ERT Surface Water and Sediment Sampling Procedures. EPA/540/P-91/005. January 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC 20460

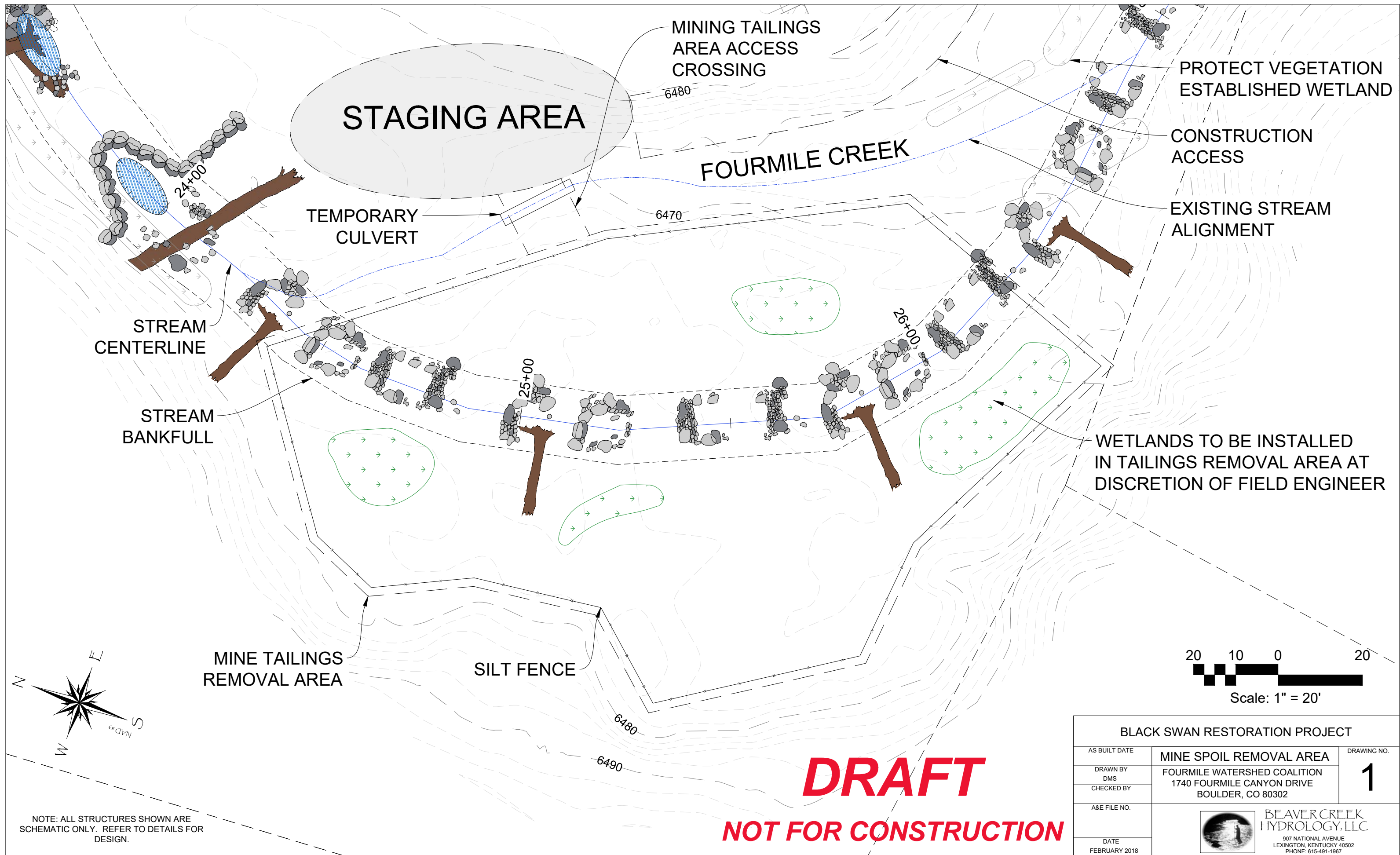
Compendium of ERT Soil Sampling and Surface Geophysics Procedures. EPA/540/P-91/006. January 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC 20460

Compendium of ERT Groundwater Sampling Procedures. EPA/540/P-91/007. January 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC 20460

Compendium of ERT Waste Sampling Procedures. EPA/540/P-91/008. January 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC 20460

Compendium of ERT Toxicity Testing Procedures. EPA/540/P-91/009. January 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC 20460





NOTE: ALL STRUCTURES SHOWN ARE SCHEMATIC ONLY. REFER TO DETAILS FOR DESIGN.

DRAFT
NOT FOR CONSTRUCTION

BLACK SWAN RESTORATION PROJECT		
AS BUILT DATE	MINE SPOIL REMOVAL AREA FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		1
CHECKED BY		
A&E FILE NO.		
DATE FEBRUARY 2018	 BEAVER CREEK HYDROLOGY, LLC <small>907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967</small>	



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region VIII

Subject: POLREP #3
Final
Emancipation Mine

Salina, CO
Latitude: 40.0507090 Longitude: -105.3710030

To: Susan Martino, Boulder County
Joshua Woodyard, OEM
Eugene Lee, OEM
David Ostrander, EPA Region 8
Laura Williams, EPA Region 8

From: OSC Joni Sandoval,
OSC Paul Peronard,
OSC Martin McComb

Date: 5/2/2015

Reporting Period: 2/1/15-4/30/15

1. Introduction

1.1 Background

Site Number:	A8E6	Contract Number:	
D.O. Number:		Action Memo Date:	10/28/2014
Response Authority:	CERCLA	Response Type:	Time-Critical
Response Lead:	EPA	Incident Category:	Removal Action
NPL Status:	Non NPL	Operable Unit:	00
Mobilization Date:	11/3/2014	Start Date:	11/3/2014
Demob Date:		Completion Date:	
CERCLIS ID:	CON000801923	RCRIS ID:	
ERNS No.:		State Notification:	Yes
FPN#:	N/A	Reimbursable Account #:	

Note: This Site was confusingly named in EPA's Superfund Enterprise Management System for the Emancipation Mine which is nearby but not located directly where the work is being performed. Once the name was entered into the database, it could not be changed.

1.1.1 Incident Category

Abandoned Mining Materials (Mill Tailings)

1.1.2 Site Description

The Site is a residential property along Fourmile Creek in the Front Range of the Rocky Mountains. The property contains, at best estimate, 30,000-40,000 cubic yards of re-processed mill tailings that were deposited in the floodplain sometime prior to 1950.

In September 2013, an extreme flash flood changed the course of the creek. The creek is now undercutting the tailings deposit resulting in erosion and the mass slumping of soil, contaminated with heavy metals, into the creek.

1.1.2.1 Location

The Site is located along Fourmile Creek immediately downstream of Salina, Colorado. It is approximately seven miles west of Boulder, Colorado, along Fourmile Canyon Drive. The latitude is 40.050869, and the longitude is -105.370810. The Site is at an elevation of roughly 6,500 feet.

1.1.2.2 Description of Threat

The mill tailings contain elevated levels of arsenic and other heavy metals which are harmful to human health and aquatic ecosystems. Several downstream residential properties obtain water directly from the creek or from shallow fluvial wells. There is also a community water diversion downstream of the Site.

Continued erosion of the mill tailings, resulting in the release of hazardous materials into the creek, threatens residential water supplies and adversely impacts Fourmile Creek's aquatic ecosystem. Due to a severe wildfire that occurred in the area in 2010, Fourmile Creek is now especially prone to flash flooding. This flash flooding could result in a mass failure of mill tailings into the creek.

1.1.3 Preliminary Removal Assessment/Removal Site Inspection Results

The tailings deposit was initially estimated to be 30,000 - 40,000 cubic yards in size and contains elevated levels of heavy metals, most notably arsenic. The average concentration of arsenic is approximately 200 mg/kg with some locations exceeding 2,000 mg/kg (EPA's screening level for arsenic is 50 mg/kg). This contaminated material readily and regularly migrates from the deposit into Fourmile Creek.

The following criteria exist for the initiation of a removal action in accordance with 40 CFR 300.415(b)(2) of the National Contingency Plan:

- Actual or potential exposure to nearby human populations, animals or the food chain from hazardous substances or pollutants or

contaminants;

- Actual or potential contamination of drinking water supplies or sensitive ecosystems;
- High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate;
- Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released;
- The lack of availability of other appropriate federal or state response mechanisms to respond to the release.

Work must be performed to stabilize the mill tailings before the upcoming spring snowmelt to prevent additional erosion of the tailings into Fourmile Creek.

2. Current Activities

2.1 Operations Section

2.1.1 Narrative

EPA's Response Unit assessed various options to address the continued erosion of the tailings into Fourmile Creek including:

1. Stabilizing the tailings in place.
2. Removing and disposing of a portion of the tailings and reconfiguring the remaining material so that it could be stabilized on Site
3. Completely removing and disposing of the the tailings to the extent practical.

Due to the proximity of the tailings to the creek, the lack of available space along this stretch of the water body and the likelihood of future flood events, EPA determined that the best course of action was to remove the tailings from the Site to the extent practical.

2.1.2 Response Actions to Date

Updated actions as of 4/30/15

EPA's Emergency and Rapid Response Services (ERRS) contractor, mobilized to the Site, has performed the following activities:

- Crew finished excavation of final lift of rocky/tailings layer and completed final T&D of all tailings.
- Crew worked with Boulder County Engineers for the construction of the new stream channel including habitat pools, boulder clusters, and riffle drop structures.
- Crew armored slope against the road with rock.
- Crew finished backfilling excavated areas with clean fill.
- Western ramp providing Site access was removed, while eastern ramp was only partially removed to provide access to the newly installed fire hydrant, per the property owner and Four Mile Fire Dept.
- Re-vegetation was completed including composting, hydroseeding, and tree planting.

EPA's Superfund Technical Assessment & Response Team (START) contractor provided Site documentation services. START also provided sampling and monitoring support.

EPA met with the newly formed Four Mile Canyon Watershed Coalition group to present on Site progress.

2.1.3 Enforcement Activities, Identity of Potentially Responsible Parties (PRPs)

Unknown at this time.

2.1.4 Progress Metrics

Emancipation Mine Site - Transportation and Disposal Tracking

ER - Environmental Restoration - Trucking

IW - Iron Woman - Sub Trucking

WC - Waste Connections - Landfill

Waste Connections & Iron Woman Trucking

Date	ER Loads	ER CY Transport	IW Loads	IW CY Transport	IW Price/CY	IW Total	WCA Price/CY	WCA Total
11/21/14	0	0	15	150	\$31.00	\$4,650.00	\$11.50	\$1,725.00
11/24/14	0	0	30	300	\$31.00	\$9,300.00	\$11.50	\$3,450.00
11/25/14	0	0	34	340	\$31.00	\$10,540.00	\$11.50	\$3,910.00
11/26/14	0	0	45	450	\$31.00	\$13,950.00	\$11.50	\$5,175.00
12/1/14	6	80	23	230	\$31.00	\$7,130.00	\$11.50	\$3,565.00
12/2/14	15	194	33	330	\$31.00	\$10,230.00	\$11.50	\$6,026.00
12/3/14	14	188	32	320	\$31.00	\$9,920.00	\$11.50	\$5,842.00
12/4/14	15	194	32	320	\$31.00	\$9,920.00	\$11.50	\$5,911.00
12/5/14	16	208	37	370	\$31.00	\$11,470.00	\$11.50	\$6,647.00
12/8/14	14	188	32	320	\$31.00	\$9,920.00	\$11.50	\$5,842.00
12/9/14	20	280	15	150	\$31.00	\$4,650.00	\$11.50	\$4,945.00
12/10/14	23	322	13	130	\$31.00	\$4,030.00	\$11.50	\$5,198.00
12/11/14	22	308	10	100	\$31.00	\$3,100.00	\$11.50	\$4,692.00
12/12/14	16	224	11	110	\$31.00	\$3,410.00	\$11.50	\$3,841.00
12/15/14	16	224	12	120	\$31.00	\$3,720.00	\$11.50	\$3,956.00
12/16/14	17	238	18	180	\$31.00	\$5,580.00	\$11.50	\$4,807.00
12/17/14	23	306	17	170	\$31.00	\$5,270.00	\$11.50	\$5,474.00
12/18/14	24	320	16	160	\$31.00	\$4,960.00	\$11.50	\$5,520.00
12/19/14	18	240	16	160	\$31.00	\$4,960.00	\$11.50	\$4,600.00
12/29/14	11	142	4	40	\$31.00	\$1,240.00	\$11.50	\$2,093.00
1/2/15	25	338	7	70	\$31.00	\$2,170.00	\$11.50	\$4,692.00
1/5/15	26	352	9	90	\$31.00	\$2,790.00	\$11.50	\$5,083.00
1/6/15	28	376	10	100	\$31.00	\$3,100.00	\$11.50	\$5,474.00
1/7/15	20	268	9	90	\$31.00	\$2,790.00	\$11.50	\$4,117.00
1/8/15	22	292	11	110	\$31.00	\$3,410.00	\$11.50	\$4,623.00
1/9/15	19	254	9	90	\$31.00	\$2,790.00	\$11.50	\$3,956.00
1/12/15	19	250	7	70	\$31.00	\$2,170.00	\$11.50	\$3,680.00
1/13/15	20	276	16	160	\$31.00	\$4,960.00	\$11.50	\$5,014.00
1/14/15	23	322	16	160	\$31.00	\$4,960.00	\$11.50	\$5,543.00
1/15/15	23	322	16	160	\$31.00	\$4,960.00	\$11.50	\$5,543.00

1/16/15	23	322	16	160	\$31.00	\$4,960.00	\$11.50	\$5,543.00
1/19/15	24	336	15	150	\$31.00	\$4,650.00	\$11.50	\$5,589.00
1/20/15	24	336	16	160	\$31.00	\$4,960.00	\$11.50	\$5,704.00
1/21/15	18	252	13	130	\$31.00	\$4,030.00	\$11.50	\$4,393.00
1/22/15	21	294	16	160	\$31.00	\$4,960.00	\$11.50	\$5,221.00
1/23/15	22	308	15	150	\$31.00	\$4,650.00	\$11.50	\$5,267.00
1/26/15	21	294	17	170	\$31.00	\$5,270.00	\$11.50	\$5,336.00
1/27/15	19	266	14	140	\$31.00	\$4,340.00	\$11.50	\$4,669.00
1/28/15	23	322	17	170	\$31.00	\$5,270.00	\$11.50	\$5,658.00
1/29/15	21	294	17	170	\$31.00	\$5,270.00	\$11.50	\$5,336.00
1/30/15	22	308	16	160	\$31.00	\$4,960.00	\$11.50	\$5,382.00
2/2/15	20	280	0	0	\$31.00	\$0.00	\$11.50	\$3,220.00
2/3/15	23	322	0	0	\$31.00	\$0.00	\$11.50	\$3,703.00
2/5/15	21	294	0	0	\$31.00	\$0.00	\$11.50	\$3,381.00
2/6/15	20	280	0	0	\$31.00	\$0.00	\$11.50	\$3,220.00
2/7/15	17	238	0	0	\$31.00	\$0.00	\$11.50	\$2,737.00
2/9/15	24	336	0	0	\$31.00	\$0.00	\$11.50	\$3,864.00
2/10/15	23	322	0	0	\$31.00	\$0.00	\$11.50	\$3,703.00
2/11/15	20	280	0	0	\$31.00	\$0.00	\$11.50	\$3,220.00
2/12/15	23	322	0	0	\$31.00	\$0.00	\$11.50	\$3,703.00
2/13/15	20	280	0	0	\$31.00	\$0.00	\$11.50	\$3,220.00
2/17/15	17	238	0	0	\$31.00	\$0.00	\$11.50	\$2,737.00
2/18/15	30	420	0	0	\$31.00	\$0.00	\$11.50	\$4,830.00
2/19/15	30	420	0	0	\$31.00	\$0.00	\$11.50	\$4,830.00
2/20/15	27	378	0	0	\$31.00	\$0.00	\$11.50	\$4,347.00
2/24/15	23	322	0	0	\$31.00	\$0.00	\$11.50	\$3,703.00
2/25/15	22	308	0	0	\$31.00	\$0.00	\$11.50	\$3,542.00
2/28/15	18	252	0	0	\$31.00	\$0.00	\$11.50	\$2,898.00
3/2/15	24	336	0	0	\$31.00	\$0.00	\$11.50	\$3,864.00
3/3/15	12	168	0	0	\$31.00	\$0.00	\$11.50	\$1,932.00
3/4/15	18	252	0	0	\$31.00	\$0.00	\$11.50	\$2,898.00
3/5/15	24	336	0	0	\$31.00	\$0.00	\$11.50	\$3,864.00
3/6/15	24	336	0	0	\$31.00	\$0.00	\$11.50	\$3,864.00
3/7/15	15	210	0	0	\$31.00	\$0.00	\$11.50	\$2,415.00
3/9/15	24	336	0	0	\$31.00	\$0.00	\$11.50	\$3,864.00
3/10/15	24	336	0	0	\$31.00	\$0.00	\$11.50	\$3,864.00
3/11/15	29	406	0	0	\$31.00	\$0.00	\$11.50	\$4,669.00
3/12/15	20	280	0	0	\$31.00	\$0.00	\$11.50	\$3,220.00
3/13/15	17	238	0	0	\$31.00	\$0.00	\$11.50	\$2,737.00

Totals:	1342	18564	727	7270	Iron W Total:	\$224,215.00	WCA Total:	\$297,654.32
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Total Loads	2,069
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Total CY Shipped	25,834
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2.2 Planning Section

2.2.1 Anticipated Activities

N/A

2.2.1.1 Planned Response Activities

Provide services to water and monitor the vegetation planted on Site during the restoration phase over the summer.

2.2.1.2 Next Steps

N/A

2.2.2 Issues

N/A

2.3 Logistics Section

Not applicable.

2.4 Finance Section

2.4.1 Narrative

The final cost for ERRS below will increase slightly to cover watering of the newly planted vegetation through the summer until a root system has been established.

The cost for START will also increase to cover preparation of the final report and sending out sampling result letters to the residents.

Estimated Costs *

	Budgeted	Total To Date	Remaining	% Remaining
Extramural Costs				

ERRS - Cleanup Contractor	\$1,850,000.00	\$1,707,607.14	\$142,392.86	7.70%
TAT/START	\$50,000.00	\$32,798.00	\$17,202.00	34.40%
Intramural Costs				
USEPA - Direct	\$30,000.00	\$30,000.00	\$0.00	0.00%
Total Site Costs	\$1,930,000.00	\$1,770,405.14	\$159,594.86	8.27%

* The above accounting of expenditures is an estimate based on figures known to the OSC at the time this report was written. The OSC does not necessarily receive specific figures on final payments made to any contractor(s). Other financial data which the OSC must rely upon may not be entirely up-to-date. The cost accounting provided in this report does not necessarily represent an exact monetary figure which the government may include in any claim for cost recovery.

2.5 Other Command Staff

2.5.1 Safety Officer

Not applicable.

2.5.2 Liaison Officer

Not applicable.

2.5.3 Information Officer

Not applicable.

3. Participating Entities

3.1 Unified Command

Not applicable.

3.2 Cooperating Agencies

EPA is cooperating with Boulder County's Flood Recovery Team and its Department of Transportation. EPA has also been in contact with several state of Colorado agencies including the Department of Public Health and Environment and the State Historical Preservation Office.

4. Personnel On Site

EPA Personnel through 04/20/15:

1 On-Scene Coordinator

ERRS Personnel:

1 Response Manager

1 Foreman

2 Equipment Operators

3 Field Technicians

4 Truck Drivers

START Personnel:

1 Sampling and Monitoring Technician

5. Definition of Terms

EPA: Environmental Protection Agency

ERRS: Emergency and Rapid Response Services (Contractor)

OSC: On-Scene Coordinator

START: Superfund Technical Assistance and Response Team (Contractor)

6. Additional sources of information

6.1 Internet location of additional information/report

www.epaosc.org/Emancipation

6.2 Reporting Schedule

This is the final site polrep.

7. Situational Reference Materials

Not applicable.



July 27, 2017

Frontier Environmental Services**Cole Miller****5350 Vivian Street, Unit B****Arvada CO 80002****Project Name - 4 Mile Canyon, Black Swan****Project Number - [none]**

Attached are your analytical results for 4 Mile Canyon, Black Swan received by Origins Laboratory, Inc. July 20, 2017. This project is associated with Origins project number Y707225-01.

The analytical results in the following report were analyzed under the guidelines of EPA Methods. These methods are identified as follows; "SW" are defined in SW-846, "EPA" are defined in 40CFR part 136 and "SM" are defined in the most current revision of Standard Methods For the Examination of Water and Wastewater.

The analytical results apply specifically to the samples and analyses specified per the attached Chain of Custody. As such, this report shall not be reproduced except in full, without the written approval of Origin's laboratory.

Unless otherwise noted, the analytical results for all soil samples are reported on a wet weight basis. All analytical analyses were performed under NELAP guidelines unless noted by a data qualifier.

Any holding time exceedances, deviations from the method specifications or deviations from Origins Laboratory's Standard Operating Procedures are outlined in the case narrative.

Thank you for selecting Origins for your analytical needs. Please contact us with any questions concerning this report, or if we can help with anything at all.

Origins Laboratory, Inc.
303.433.1322
o-squad@oelabinc.com



1725 Elk Place, Denver, CO 80211 | Phone: 303.433.1322 | Fax: 303.265.9645

Frontier Environmental Services
5350 Vivian Street, Unit B
Arvada CO 80002

Cole Miller
Project Number: [none]
Project: 4 Mile Canyon, Black Swan

CROSS REFERENCE REPORT

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Black Swan 001	Y707225-01	Soil	July 18, 2017 12:00	07/20/2017 11:05

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Jen Pellegrini For Noelle Doyle Mathis, President

Frontier Environmental Services
 5350 Vivian Street, Unit B
 Arvada CO 80002

Cole Miller
 Project Number: [none]
 Project: 4 Mile Canyon, Black Swan

www.originslaboratory.com

1707225

page of

Client: Frontier Environmental Services
 Address: 5350 Vivian Street, Unit B
Arvada, CO 80002
 Telephone Number: 303-234-9350
 Email Address: cole@frontierenvironmental.net

Project Manager: Cole Miller
 Project Name: 4 mile canyon, ^{pr} Boulder Black Swan
 Project Number: _____
 Samples Collected By: Cole Miller

1725 Elk Place | Denver, CO 80211 | Phone: 303.433.1322 | Fax: 303.265.9645

Sample ID Description	Date Sampled	Time Sampled	# of Containers	Preservative				Matrix				Analysis		Sample Instructions		
				Unpreserved	HCl	HNO ₃	Other	Groundwater	Soil	Air Summa Canister #	Other	H ₂	SPIN			
Black Swan w1	7-18-17	1200	1	1					1				X	X	1	
															2	
															3	
															4	
															5	
															6	
															7	
															8	
															9	
															10	
Relinquished By:	Date:	Time:	Received By:	Date:	Time:	Turnaround Time:										
<u>Cole Miller</u>	<u>7/20/17</u>	<u>11:05 AM</u>	<u>[Signature]</u>	<u>7-20-17</u>	<u>1105</u>	Same Day <input type="checkbox"/>	24 Hr <input type="checkbox"/>									
Relinquished By:	Date:	Time:	Received By:	Date:	Time:	48 Hr <input type="checkbox"/>	72 Hr <input type="checkbox"/>									
						Standard <input checked="" type="checkbox"/>										

Temp Received: 26.4°C Date Results Needed



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Jen Pellegrini

Origins Laboratory, Inc.

Jen Pellegrini For Noelle Doyle Mathis, President

Frontier Environmental Services
 5350 Vivian Street, Unit B
 Arvada CO 80002

Cole Miller
 Project Number: [none]
 Project: 4 Mile Canyon, Black Swan

Origins Laboratory

F-012207-01-R1
 Effective Date: 01/09/12

Sample Receipt Checklist

Origins Work Order: 1707225

Client: Frontier Env.

Client Project ID: 4 Mile Canyon, Black Swan

Checklist Completed by: D. Cole

Shipped Via: (H)

Date/time completed: 7-26-11 11:42

(UPS, FedEx, Hand Delivered, Pick-up, etc.)

Airbill #: N/A

Matrix(s) Received: (Check all that apply): Soil/Solid Water Other: _____

Cooler Number/Temperature: 1 26.4 °C °C °C (Describe)

Thermometer ID: 1004

Requirement Description	Yes	No	N/A	Comments (if any)
If samples require cooling, was the temperature between 0°C to ≤ 6°C ⁽¹⁾ ?		<input checked="" type="checkbox"/>		
Is there ice present (document if blue ice is used)		<input checked="" type="checkbox"/>		
Are custody seals present on cooler? (if so, document in comments if they are signed and dated, broken or intact)		<input checked="" type="checkbox"/>		
Are custody seals present on each sample container? (if so, document in comments if they are signed and dated, broken or intact)		<input checked="" type="checkbox"/>		
Were all samples received intact ⁽¹⁾ ?	<input checked="" type="checkbox"/>			
Was adequate sample volume provided ⁽¹⁾ ?	<input checked="" type="checkbox"/>			
Are short holding time analytes or samples with HTs due within 48 hours present ⁽¹⁾ ?	<input checked="" type="checkbox"/>			pH
Is a chain-of-custody (COC) present and filled out completely ⁽¹⁾ ?	<input checked="" type="checkbox"/>			
Does the COC agree with the number and type of sample bottles received ⁽¹⁾ ?	<input checked="" type="checkbox"/>			
Do the sample IDs on the bottle labels match the COC ⁽¹⁾ ?	<input checked="" type="checkbox"/>			
Is the COC properly relinquished by the client with date and time recorded ⁽¹⁾ ?	<input checked="" type="checkbox"/>			
For volatiles in water – is there headspace (> ¼ inch bubble) present? If yes, contact client and note in narrative.			<input checked="" type="checkbox"/>	
Are samples preserved that require preservation and was it checked ⁽¹⁾ ? (note ID of confirmation instrument used in comments) / (preservation is not confirmed for subcontracted analyses in order to insure sample integrity)/(pH <2 for samples preserved with HNO ₃ , HCL, H ₂ SO ₄) / (pH >10 for samples preserved with NaAsO ₂ +NaOH, ZnAc+NaOH)		<input checked="" type="checkbox"/>		
Additional Comments (if any):				

⁽¹⁾If NO, then contact the client before proceeding with analysis and note date/time and person contacted as well as the corrective action to in the additional comments (above) and the case narrative.

Reviewed by (Project Manager) [Signature]

Date/Time Reviewed 7/20/17

Origins Laboratory, Inc.

Jefe Pellegrini

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Frontier Environmental Services
 5350 Vivian Street, Unit B
 Arvada CO 80002

Cole Miller
 Project Number: [none]
 Project: 4 Mile Canyon, Black Swan

Black Swan 001
7/18/2017 12:00:00PM

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Notes
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Origins Laboratory, Inc.
Y707225-01 (Soil)

pH in Soil by EPA 9045D

pH	8.45		pH Units	1	B7G2506	07/25/2017	07/25/2017	
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Total Metals by 6010C

Arsenic	364	3.56	mg/kg dry	1	1684504	07/24/2017	07/25/2017	
Barium	117	0.593	"	"	"	"	"	
Cadmium	0.395	0.593	"	"	"	"	"	J
Chromium	3.46	0.593	"	"	"	"	"	
Lead	25.7	1.19	"	"	"	"	"	
Selenium	0.812	3.56	"	"	"	"	"	J
Silver	1.29	0.593	"	"	"	"	"	

Total Metals by 7471A

Mercury	2.52	0.282	mg/kg dry	20	1685252	07/25/2017	07/26/2017	
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Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Frontier Environmental Services
 5350 Vivian Street, Unit B
 Arvada CO 80002

Cole Miller
 Project Number: [none]
 Project: 4 Mile Canyon, Black Swan

Classical Chemistry Parameters - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch B7G2506 - NO PREP

Duplicate (B7G2506-DUP1)

Source: Y707250-01

Prepared: 07/25/2017 Analyzed: 07/25/2017

pH	9.11		pH Units		9.16			0.547	25	
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Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Frontier Environmental Services
 5350 Vivian Street, Unit B
 Arvada CO 80002

Cole Miller
 Project Number: [none]
 Project: 4 Mile Canyon, Black Swan

Total Metals by 6010C - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch 1684504 - SW846 3050B

BLANK (1203836413-BLK)

Prepared: 07/24/2017 Analyzed: 07/25/2017

Silver	ND	0.460	mg/kg				-			U
Arsenic	ND	2.76	"				-			U
Barium	ND	0.460	"				-			U
Cadmium	ND	0.460	"				-			U
Chromium	ND	0.460	"				-			U
Lead	ND	0.919	"				-			U
Selenium	ND	2.76	"				-			U

LCS (1203836414-BKS)

Prepared: 07/24/2017 Analyzed: 07/25/2017

Silver	47.4	0.484	mg/kg	48.4		97.8	80-120			
Selenium	47.1	2.91	"	48.4		97.2	80-120			
Lead	47.5	0.969	"	48.4		98	80-120			
Chromium	47.1	0.484	"	48.4		97.3	80-120			
Cadmium	46.9	0.484	"	48.4		96.8	80-120			
Arsenic	46.7	2.91	"	48.4		96.3	80-120			
Barium	47.3	0.484	"	48.4		97.7	80-120			

DUP (1203836415 D)

Source: Y707225-01

Prepared: 07/24/2017 Analyzed: 07/25/2017

Cadmium	0.281	0.616	mg/kg dry		0.395		0-20	33.7	20	J
Chromium	3.37	0.616	"		3.46		0-20	2.79	20	
Lead	23.1	1.23	"		25.7		0-20	10.7	20	
Selenium	ND	3.70	"		0.812		0-20	NR	20	U
Silver	1.03	0.616	"		1.29		0-20	22.8	20	
Barium	66.4	0.616	"		117		0-20	55	20	
Arsenic	345	3.70	"		364		0-20	5.44	20	

MS (1203836416 S)

Source: Y707225-01

Prepared: 07/24/2017 Analyzed: 07/25/2017

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Frontier Environmental Services
 5350 Vivian Street, Unit B
 Arvada CO 80002

Cole Miller
 Project Number: [none]
 Project: 4 Mile Canyon, Black Swan

Total Metals by 6010C - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1684504 - SW846 3050B

MS (1203836416 S)

Source: Y707225-01

Prepared: 07/24/2017 Analyzed: 07/25/2017

Barium	165	0.634	mg/kg dry	63.4	117	75.6	75-125			
Silver	60.7	0.634	"	63.4	1.29	93.7	75-125			
Selenium	60.9	3.80	"	63.4	0.812	94.7	75-125			
Lead	95.1	1.27	"	63.4	25.7	110	75-125			
Cadmium	59.1	0.634	"	63.4	0.395	92.6	75-125			
Arsenic	434	3.80	"	63.4	364	110	75-125			
Chromium	64.6	0.634	"	63.4	3.46	96.4	75-125			

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Frontier Environmental Services
 5350 Vivian Street, Unit B
 Arvada CO 80002

Cole Miller
 Project Number: [none]
 Project: 4 Mile Canyon, Black Swan

Total Metals by 7471A - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1685252 - SW846 7471A Prep										
BLANK (1203838293-BLK)					Prepared: 07/25/2017 Analyzed: 07/26/2017					
Mercury	ND	0.0113	mg/kg				-			U
LCS (1203838294-BKS)					Prepared: 07/25/2017 Analyzed: 07/26/2017					
Mercury	0.110	0.0106	mg/kg	0.106		104	80-120			
MS (1203838295 S)					Source: Y707225-01 Prepared: 07/25/2017 Analyzed: 07/26/2017					
Mercury	2.25	0.312	mg/kg dry	0.156	2.52	0	80-120			
MSD (1203838296 SD)					Source: Y707225-01 Prepared: 07/25/2017 Analyzed: 07/26/2017					
Mercury	3.86	0.279	mg/kg dry	0.139	2.52	966	80-120	52.7	20	

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Frontier Environmental Services
5350 Vivian Street, Unit B
Arvada CO 80002

Cole Miller
Project Number: [none]
Project: 4 Mile Canyon, Black Swan

Notes and Definitions

- U Result not detected above the detection limit
- J Greater than the detection limit but less than the reporting limit
- ND Analyte NOT DETECTED at or above the reporting limit
- RPD Relative Percent Difference
- All soil results are reported at a wet weight basis.

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Jen Pellegrini For Noelle Doyle Mathis, President

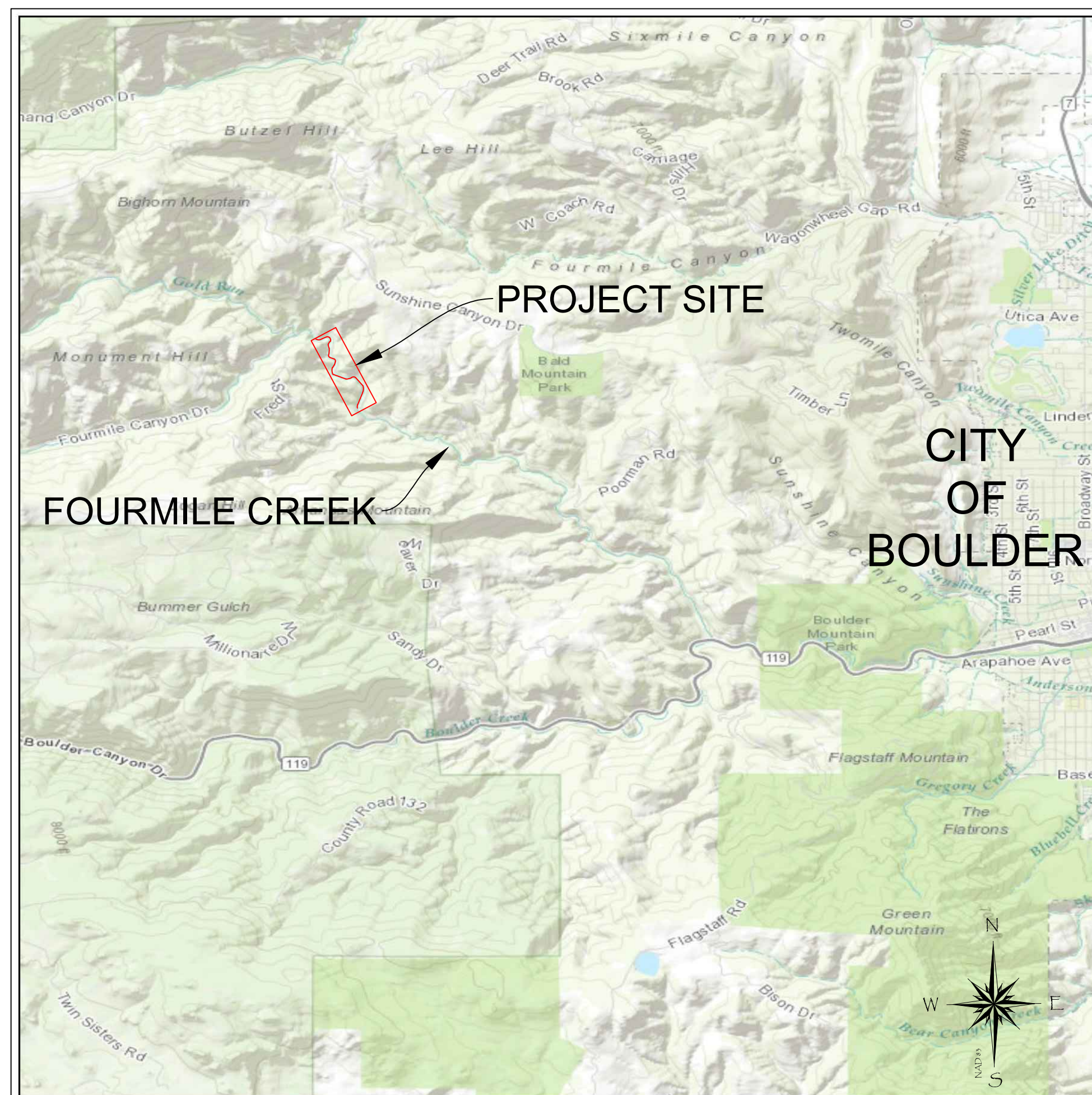
BLACK SWAN RESTORATION PROJECT

FOURMILE CANYON DRIVE
BOULDER, CO 80302
MAY 2018

PREPARED FOR:
MAYA MACHAMER
FOURMILE WATERSHED COALITION
1740 FOURMILE CANYON DRIVE
BOULDER, CO 80302

INDEX OF DRAWINGS

- 1 COVER SHEET
- 2 GENERAL NOTES
- 3 PLAN VIEW
- 4 PLAN VIEW
- 5 PLAN VIEW
- 6 PROFILE VIEW
- 7 PROFILE VIEW
- 8 EROSION CONTROL PLAN
- 9 EROSION CONTROL PLAN
- 10 EROSION CONTROL PLAN
- 11 DETAIL - A STREAM
- 12 DETAIL - B STREAM
- 13 DETAIL - CROSS-VANE
- 14 DETAIL - EROSION CONTROL
- 15 DESIGN TABLE & PLANTING PLAN

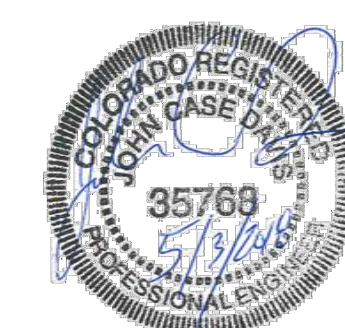


ESTIMATED QUANTITIES	UNIT	QTY.
MOBILIZATION/DEMOLITION	LS	1
CLEARING AND GRUBBING	ACRE	3.0
PLACED SP3 (BOULDERS)	TONS	1,020
EXCAVATION AND EMBANKMENT	CY	1,050
CONSTRUCTION ENTRANCE	LS	1
PLACED ROOTWADS	EA	28
PLACED SUBMERGED LOGS	EA	32
REVEGETATION	ACRE	2.3
SOIL RETENTION COVERING	SY	8,620
EROSION CONTROL	LS	1
CONSTRUCTION SURVEY	LS	1
DEWATERING/WATER CONTROL	LS	1
TRAFFIC CONTROL	LS	1

PREPARED BY:

BEAVER CREEK
HYDROLOGY, LLC

907 NATIONAL AVENUE
LEXINGTON, KENTUCKY 40502
PHONE: 615-491-1967



GENERAL NOTES:

- ALL BEARINGS ARE BASED ON COLORADO STATE PLANE NORTH ZONE. ALL DISTANCES AND COORDINATES SHOWN ARE IN UNITS OF FEET, UNLESS OTHERWISE NOTED.
- ALL ELEVATIONS ARE SHOWN IN FEET ABOVE NAVD88 VERTICAL DATUM. ALL DEPTHS AND HEIGHTS ARE MEASURED VERTICAL RELATIVE TO PROPOSED BANK-FULL ELEVATION.
- PLACEMENT OF SEDIMENTATION AND EROSION CONTROLS SHALL BE IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL EROSION CONTROL REGULATIONS AND THE EROSION CONTROL PLAN.
- THE CONTRACTOR SHALL KEEP ALL SURROUNDING PUBLIC ROADWAYS AND DRAINAGE SYSTEMS FREE FROM SEDIMENT AND CONSTRUCTION DEBRIS IN ACCORDANCE WITH THE EROSION CONTROL PLANS.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR OF ANY ITEMS DAMAGED DURING CONSTRUCTION, INCLUDING FENCING, ROADS, BRIDGES, ETC.
- ALL EARTH MOVING EQUIPMENT SHALL BE SERVICED PRIOR TO WORK COMMENCING EACH MORNING. EQUIPMENT SHALL BE MAINTAINED TO PREVENT FUEL, OIL AND LUBRICANT SPILLS IN THE VICINITY OF THE STREAM. CONSTRUCTION EQUIPMENT, FUELS, LUBRICANTS, AND OTHER PETROLEUM DISTILLATES SHALL NOT BE STORED OR STOCKPILED WITHIN 50 HORIZONTAL FEET OF THE CREEK OR OTHER AQUATIC HABITATS. EQUIPMENT FUELING AND SERVICING SHALL OCCUR ONLY WITHIN APPROVED DESIGNATED AREAS. BIODEGRADABLE HYDRAULIC FLUID SHALL BE USED IN ALL EQUIPMENT. A SPILL KIT AND WRITTEN CLEAN-UP PROCEDURES SHALL BE KEPT ON-SITE AT ALL TIMES.
- THE ENGINEER RESERVES THE RIGHT TO MAKE ADJUSTMENTS IN THE FIELD TO THE STREAM DIMENSIONS, STRUCTURE LOCATIONS, STRUCTURE DETAILS, AND ALL OTHER RELEVANT EROSION CONTROL PRACTICES AS NEEDED TO PRESERVE TREES AND OTHER HABITATS AND TO FIT SITE CONDITIONS.
- TOPOGRAPHIC CONTOURS AND OTHER PLANIMETRIC FEATURES SUCH AS UTILITIES, LOT LINES, ROADS, PROPERTY LINES, FENCES, BUILDINGS, TREES, ETC. SHOWN HEREIN ARE APPROXIMATE.
- ALL AREAS LABELED PROPOSED ROAD FILL AREA AND PROPOSED HEADWALL ARE TO BE CONSTRUCTED DURING THE BOULDER COUNTY ROAD PROJECT.

SUBSURFACE:

- NO SUBSURFACE DATA IS MADE AVAILABLE TO THE CONTRACTOR FOR THIS PROJECT. THE CONTRACTOR SHALL BE RESPONSIBLE FOR SUBSURFACE INVESTIGATIONS AS THEY RELATE TO THIS PROJECT.

MATERIALS:

- EXCAVATED MATERIAL SHALL TEMPORARILY BE STOCKPILED IN NON-FORESTED AND NON-WETLAND AREAS WITHIN THE LIMIT OF DISTURBANCE. THE EXACT LOCATION OF THE TEMPORARY STOCKPILE AREAS SHALL BE DETERMINED BY THE CONTRACTOR AND APPROVED BY THE ENGINEER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR INSTALLING APPROPRIATE STABILIZATION MEASURES OUTSIDE THE STOCKPILE AREAS TO PREVENT EROSION AND SEDIMENTATION.
- ALL WASTE SOILS WILL BE HAULED OFF-SITE TO THE FRONT RANGE LANDFILL.
- TREES OR OTHER NATURAL FEATURES MARKED WITH BLUE FLAGGING BY THE ENGINEER SHALL BE PRESERVED.
- SP3 - USE GRANITE BOULDERS HARVESTED ON-SITE FROM THE EXISTING CHANNEL OR APPROVED STONE QUARRIED LOCALLY. ALL BOULDERS, INCLUDING SURFACE BOULDERS AND FOOTING BOULDERS, SHALL HAVE AVERAGE DIAMETER NO LESS THAN 3.6 FEET. AVERAGE DIAMETER IS CALCULATED BY MEASURING (LENGTH + WIDTH + HEIGHT) / 3. DO NOT USE BOULDERS LESS THAN 12" IN LENGTH, WIDTH OR HEIGHT. ALL BOULDERS PLACED IN THE ACTIVE CHANNEL BETWEEN BANK-FULL LINES MUST BE PLACED ON A FOOTING BOULDER OR COMPETENT BEDROCK.
- SP2 - USE GRANITE COBBLE HARVESTED ON-SITE FROM THE EXISTING CHANNEL OR APPROVED STONE QUARRIED LOCALLY. COBBLE MATERIAL SHALL HAVE AN AVERAGE DIAMETER BETWEEN 2.5 IN AND 10 IN.
- SP1 - USE CLEAN, HARD, DURABLE GRAVEL HARVESTED ON-SITE FROM THE EXISTING CHANNEL SUBSTRATE OR APPROVED STONE QUARRIED LOCALLY. SP1 SHALL HAVE A PARTICLE SIZE DISTRIBUTION DETERMINED BY WET SIEVE ANALYSIS ON-SITE. THIS DISTRIBUTION HAS D16 = 0.20 IN, D35 = 0.46 IN, D50 = 0.51 IN, D84 = 3.4 IN, D95 = 4.7 IN AND D100 = 11.8 IN, WHERE DXX IS THE PARTICLE SIZE FOR WHICH XX PERCENT OF PARTICLES ARE FINER.

UTILITIES:

- THE CONTRACTOR SHALL FIELD VERIFY ALL UTILITIES INSIDE THE LIMIT OF DISTURBANCE.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE INCURRED TO ANY UTILITY SERVICE LINE AT NO COST OR OBLIGATION TO THE OWNER.
- THE CONTRACTOR MUST CALL THE "CALL BEFORE YOU DIG" NUMBER FOR UTILITY LOCATIONS (LOCAL 811).

GENERAL EROSION CONTROL NOTES:

- THE CONTRACTOR SHALL INSTALL AND MAINTAIN THROUGHOUT THE PROJECT ALL EROSION CONTROL MEASURES IN ACCORDANCE WITH THESE PLANS AND IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE AND FEDERAL EROSION CONTROL REGULATIONS.
- THE CONTRACTOR SHALL CONTINUOUSLY MAINTAIN ALL EROSION CONTROL DEVICES AND STRUCTURES TO MINIMIZE EROSION AND SEDIMENTATION.
- EROSION AND SEDIMENT CONTROL MEASURES SHALL BE MAINTAINED CONTINUOUSLY, RELOCATED WHEN NECESSARY, AND SHALL BE CHECKED AFTER EVERY RAINFALL. SEEDED AREAS SHALL BE CHECKED REGULARLY AND SHALL BE WATERED, FERTILIZED, RESEDED, AND MULCHED AS NECESSARY TO OBTAIN VEGETATION COVERAGE AS SPECIFIED IN THE MATERIAL SPECIFICATIONS.
- STABILIZATION IS THE BEST FORM OF EROSION CONTROL. STABILIZATION INCLUDES ALL SEEDING, MULCHING, CRIMPING, SILT CONTROLS, COIR MATTING, AND DIVERSIONS WHERE INDICATED ON THE PLANS. ALL DISTURBED AREAS THAT ARE NOT OTHERWISE STABILIZED SHALL BE AMENDED AND SEEDED, TEMPORARILY OR PERMANENTLY. PERMANENT SEEDING AND GRASS ESTABLISHMENT ARE REQUIRED PRIOR TO PROJECT COMPLETION AND ACCEPTANCE.
- SEED AND WOOD STRAW WILL BE PLACED ON EXPOSED SLOPES WITHIN 48 HOURS FOLLOWING COMPLETION OF ANY PHASE OF GRADING. PERMANENT SEED AND MULCH FOR ALL DISTURBED AREAS SHALL BE PROVIDED AS DIRECTED IN THE PLANTING PLAN.
- ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES CAN BE REMOVED WITHIN 14 DAYS AFTER FINAL SITE STABILIZATION (SEEDING AND MULCHING) OR AFTER THE TEMPORARY MEASURES ARE NO LONGER NEEDED AS DIRECTED BY THE ENGINEER. TRAPPED SEDIMENT AND THE DISTURBED SOIL AREAS RESULTING FROM THE DISPOSITION OF TEMPORARY MEASURES SHALL BE PERMANENTLY STABILIZED TO LIMIT FURTHER EROSION AND SEDIMENTATION.
- WHERE SEDIMENT IS TRANSPORTED ONTO A PAVED OR PUBLIC ROAD, THE ROAD SURFACE SHALL BE CLEANED THOROUGHLY AT THE END OF EACH DAY. SEDIMENT SHALL BE REMOVED FROM THE ROADS BY SHOVELING OR SWEEPING AND TRANSPORTED TO A SEDIMENT CONTROL DISPOSAL AREA. STREET WASHING SHALL BE ALLOWED ONLY AFTER SEDIMENT IS REMOVED IN THIS MANNER.
- WHEN A CRUSHED STONE CONSTRUCTION ENTRANCE HAS BEEN COVERED WITH SOIL OR HAS BEEN PUSHED INTO THE SOIL BY CONSTRUCTION TRAFFIC, IT SHALL BE REPLACED WITH A DEPTH OF STONE THAT WAS SPECIFIED.
- INSPECTIONS OF ALL CONTROL MEASURES AND DISTURBED AREAS MUST BE PERFORMED BEFORE ANTICIPATED STORM EVENTS (OR SERIES OF STORM EVENTS SUCH AS INTERMITTENT SHOWERS OVER ONE OR MORE DAYS), AND WITHIN 24 HOURS AFTER THE END OF A STORM EVENT OF 0.5 INCHES OR GREATER, AND AT LEAST ONCE EVERY FOURTEEN CALENDAR DAYS. INSPECTIONS MUST BE DOCUMENTED AND INCLUDE THE SCOPE OF THE INSPECTION, NAME(S) AND TITLE OR QUALIFICATIONS OF PERSONNEL MAKING THE INSPECTION, THE DATE(S) OF THE INSPECTION, MAJOR OBSERVATIONS RELATING TO THE IMPLEMENTATION OF THE CONTROL MEASURES (INCLUDING THE LOCATION(S) OF DISCHARGES OF SEDIMENT OR OTHER POLLUTANTS FROM THE SITE AND OF ANY CONTROL DEVICE THAT FAILED TO OPERATE AS DESIGNED OR PROVED INADEQUATE FOR A PARTICULAR LOCATION). BASED ON THE RESULTS OF THE INSPECTION, ANY INADEQUATE CONTROL MEASURES OR CONTROL MEASURES IN DISREPAIR MUST BE REPLACED OR MODIFIED, OR REPAIRED AS NECESSARY, BEFORE THE NEXT RAIN EVENT IF POSSIBLE, BUT IN NO CASE MORE THAN SEVEN (7) DAYS AFTER THE NEED IS IDENTIFIED.
- STRUCTURAL PRACTICES TO DIVERT FLOWS FROM AREAS OF LAND DISTURBANCE, STORE FLOWS OR OTHERWISE LIMIT RUNOFF AND THE DISCHARGE OF POLLUTANTS FROM EXPOSED AREAS OF THE SITE MUST BE IMPLEMENTED. SUCH PRACTICES MAY INCLUDE SILT FENCES, EARTH DIKES, DRAINAGE SWALES, SEDIMENT TRAPS, CHECK DAMS, SUBSURFACE DRAINS, PIPE SLOPE DRAINS, STORM DRAIN INLET PROTECTION, AND OTHER APPROVED PRACTICES. ALL BEST MANAGEMENT PRACTICES SHALL MEET OR EXCEED FEDERAL AND STATE REQUIREMENTS.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING ANY DAMAGE TO EXISTING ROADS, GATES, FENCES, ETC. CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT ALL ACCESS LOCATIONS PER THE PLANS AND SPECIFICATIONS.
- THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY IMPROVEMENT TO THE ROAD CONDITIONS, GATES, AND FENCES REQUIRED FOR ACCESS DURING CONSTRUCTION.
- DURING CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR INSTALLING ADDITIONAL EROSION CONTROL MEASURES NOT SHOWN ON THE PLANS BUT NECESSARY TO CONTROL EXCESS SEDIMENT, AS DETERMINED BY THE ENGINEER.
- ALL DESIRABLE WOOD OR VEGETATION SOURCE MATERIAL REMOVED FOR CONSTRUCTION SHALL BE REUSED ON-SITE AND NO MATERIAL SHALL BE DISPOSED OF (BY BURNING, BURYING, OR OTHERWISE) UNLESS DETERMINED BY THE ENGINEER ON-SITE TO BE UNDESIRABLE.

STAGING AND STOCKPILES AREAS:

- SPECIFIED AREAS SHOWN ON THE PLANS HAVE BEEN ESTABLISHED AS STAGING AND STOCKPIPING AREAS. ALL STAGING AND STOCKPIPING AREAS MUST BE INSIDE THE LIMITS OF DISTURBANCE AND ONLY IN APPROVED LOCATIONS. SILT FENCE WILL BE INSTALLED AROUND ALL STOCKPILE AREAS THAT HAVE BEEN DISTURBED AS DIRECTED BY THE ENGINEER OR AS SHOWN ON THE PLANS.
- THE USE OF CHEMICALS SUCH AS SOIL STABILIZERS, DUST PALLIATIVES, HERBICIDES, GROWTH INHIBITORS, FERTILIZERS, DEICING SALTS, ETC., SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDED APPLICATION RATES, FREQUENCY, AND INSTRUCTIONS. THESE CHEMICALS SHALL NOT BE USED, STORED, OR STOCKPILED WITHIN 50 HORIZONTAL FEET OF THE CREEK OR OTHER AQUATIC HABITATS.
- THE TEMPORARY CULVERT LOCATED AT 4389 FOURMILE CANYON DRIVE TO BE REMOVED BY THE CONTRACTOR WHEN CONSTRUCTION IS COMPLETED.

RAIN GAUGE:

- THE CONTRACTOR SHALL BE RESPONSIBLE FOR HAVING A RAIN GAUGE ON THE PROJECT SITE FOR RECORDING DAILY RAINFALL AMOUNTS DURING CONSTRUCTION. A RECORD OF DAILY RAINFALL AMOUNTS SHALL BE KEPT ON-SITE AND ACCESSIBLE TO THE ENGINEER THROUGHOUT THE DURATION OF CONSTRUCTION ACTIVITIES. WEEKLY REPORTS OF DAILY RAINFALL AMOUNTS SHALL BE SUBMITTED TO THE ENGINEER WHILE CONSTRUCTION EQUIPMENT REMAINS ON-SITE.

SEQUENCE OF CONSTRUCTION:

- THE CONTRACTOR IS RESPONSIBLE FOR FOLLOWING THE SEQUENCE OF CONSTRUCTION IN ACCORDANCE WITH THE PLANS. ANY CHANGES TO THIS SEQUENCE MUST BE APPROVED BY THE DESIGN ENGINEER.
- IDENTIFY ALL SIGNIFICANT PROJECT BOUNDARIES, UTILITIES, ACCESS POINTS, LIMITS OF DISTURBANCE, AND CONTRACTOR STAGING AREAS WITH THE ENGINEER.
- ESTABLISH HAUL ROUTES AND CONTRACTOR STAGING AREAS.
- INSTALL EROSION CONTROL MEASURES IN ACCORDANCE WITH THE EROSION CONTROL PLAN.
- CLEAR AS DIRECTED WITHIN THE LIMITS OF DISTURBANCE AS NEEDED TO EXCAVATE AND PLACE FILL MATERIAL WITHIN THE AREAS SHOWN ON THE PLANS. PROTECT TREES OR OTHER FEATURES MARKED FOR PRESERVATION WITH BLUE FLAGGING. REMOVE EXISTING TREES WITHIN THE LIMITS OF PROPOSED GRADING WITH ROOT WADS ATTACHED AND RECYCLE IN TOE WOOD STRUCTURES OR AS DIRECTED BY ENGINEER.
- REMOVE AND STOCKPILE TOPSOIL WITHIN THE AREAS OF PROPOSED GRADING. BEGIN WORK AT THE UPSTREAM END OF THE PROJECT REACH AND WORK IN THE DOWNSTREAM DIRECTION.
- EXCAVATE THE FLOODPLAIN (TO BANK-FULL STAGE ELEVATION) TO THE LINES AND GRADES SHOWN WITHIN THE LIMITS OF THE FLOODPLAIN LINES AND INCLUDING THE TERRACE (OUTSIDE) CUT/FILL SLOPES. THIS WORK MAY BE PERFORMED USING EXCAVATORS, DOZERS OR OTHER HEAVY EQUIPMENT.
- LAYOUT THE PROPOSED CHANNEL CENTERLINE.
- EXCAVATE THE PROPOSED CHANNEL TO THE DEPTHS SHOWN ON THE TYPICAL CROSS SECTIONS, PROFILE, DETAILS, AND COORDINATE LISTS.
- CONSTRUCT CHANNEL BANKS, STRUCTURES, COIR MAT, AND EROSION CONTROL MEASURES AS SHOWN ON THE PLANS, PROCEEDING IN THE DOWNSTREAM DIRECTION. THE STRUCTURE LOCATIONS ARE DENOTED BY THE POINT WHERE THE STRUCTURE CROSSES THE PROPOSED CHANNEL CENTERLINE AND SHOWN IN THE STRUCTURE TABLE. INVERT ELEVATIONS REFER TO THE ELEVATION OF THE TOP OF THE STRUCTURE IN THE CHANNEL BOTTOM ALONG THE CHANNEL BED AT THE CENTERLINE.
- REPLACE TOPSOIL, PLANT, SEED AND MULCH ALL DISTURBED AREAS IMMEDIATELY AFTER CONSTRUCTION PER THE EROSION CONTROL PLAN.
- PREPARE AND PLANT ALL RIPARIAN VEGETATION ACCORDING TO THE PLANS AND AT THE DIRECTION OF THE ENGINEER.
- WALK THE PROJECT SITE WITH THE ENGINEER AND TECHNICAL ASSISTANCE (TA) REPRESENTATIVE FOR DOLA TO DEVELOP A FINAL CHECK-LIST OF ITEMS LEFT TO BE COMPLETED.
- REPAIR/FINISH ITEMS IDENTIFIED ON THE FINAL CHECK-LIST.
- WALK THE PROJECT SITE WITH THE ENGINEER, OWNER, AND TA FOR DOLA TO APPROVE PROJECT COMPLETION.
- REMOVE ALL WASTE FROM THE PROJECT AREA AND RESTORE ALL STAGING AND STOCKPILE AREAS TO THEIR ORIGINAL APPEARANCE. SEED AND MULCH ALL DISTURBED AREAS WITH THE APPROPRIATE SEED MIX.

DEFINITIONS:

- HEIGHTS** ARE MEASURED VERTICALLY DOWN FROM BANK-FULL ELEVATION:
H = AVERAGE OR CENTERLINE BANK-FULL HEIGHT
Hm = MAXIMUM DEPTH
Ht = TRENCH HEIGHT
- WIDTHS** ARE MEASURED HORIZONTALLY AND PERPENDICULAR TO THE THALWEG OR CENTER LINE:
B = BANK-FULL WIDTH AND MIN. LENGTH OF ROOTWADS, CROSS LOGS, OR SUBMERGED LOGS
- LENGTHS** ARE MEASURED ALONG THE SECTION LINES:
L = POOL-TO-POOL SPACING OR WAVELENGTH; L VARIES IN THE STREAM WISE DIRECTION:
L = MEANDER WAVELENGTH, PLEASE REFER TO THE DESIGN TABLE.
C & E STREAM TYPE
L = MEANDER WAVELENGTH, PLEASE REFER TO THE DESIGN TABLE.
- Aa+, A, & B STREAM TYPE
L = 1.7B TO 2.6B FOR SLOPE RANGE OF 2% TO 4%
L = 0.8B TO 1.5B FOR SLOPE RANGE OF >4%
- VL = VANE LENGTH; VL = H / VS
- SLOPES:**
Sr = BANK-FULL WATER SURFACE SLOPE MEASURED IN THE STREAMWISE FLOW DIRECTION
VS = VANE SLOPE (RANGES FROM 2%-7%)
- ANGLES:**
VA = VANE ANGLE (RANGES FROM 20°-30°)

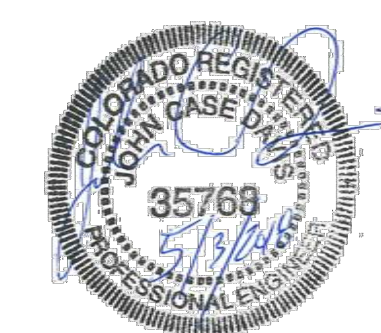
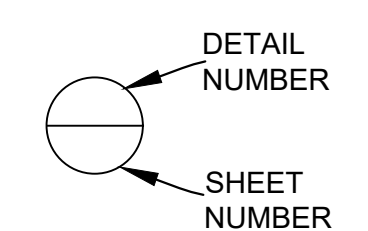
STREAM TYPE NOTES:

- BANK-FULL SLOPE (Sr) AND BANK-FULL WIDTH (B) ARE SHOWN ON THE PLAN SHEETS.
Sr RANGE: >0.04 - USE A-STREAM TYPE DETAIL.
Sr RANGE: 0.02 - 0.04 - USE B-STREAM TYPE DETAIL.
Sr RANGE: <0.02 - USE C-STREAM TYPE DETAIL.
- STEP-POOLS SHOULD VARY THE LOW-FLOW DIRECTION FROM LEFT TO RIGHT, ALTERNATING WITH EACH POOL.
- THE TOTAL LENGTH OF THE FINISHED THALWEG LINE SHOULD FOLLOW THE PROPOSED ALIGNMENT. SEE PLAN SET.
- ROOTWAD SPACING
VARIABLE: SEE PLAN SET
- CROSS LOG SPACING
VARIABLE: SEE PLAN SET
- DO NOT PLACE COVER LOGS IN ACTIVE FLOW OR ON THE FLOODPLAIN (BANK-FULL BENCH) OF RECEIVING STREAMS WHERE STEP-POOL CHANNEL ENTERS A LARGER STREAM.
- TRIM ALL TREE BRANCHES AND ROOTWADS EXPOSED ABOVE GROUND OR LOW FLOW WATER LEVEL AND AS DIRECTED BY THE ENGINEER.

SYMBOLOLOGY

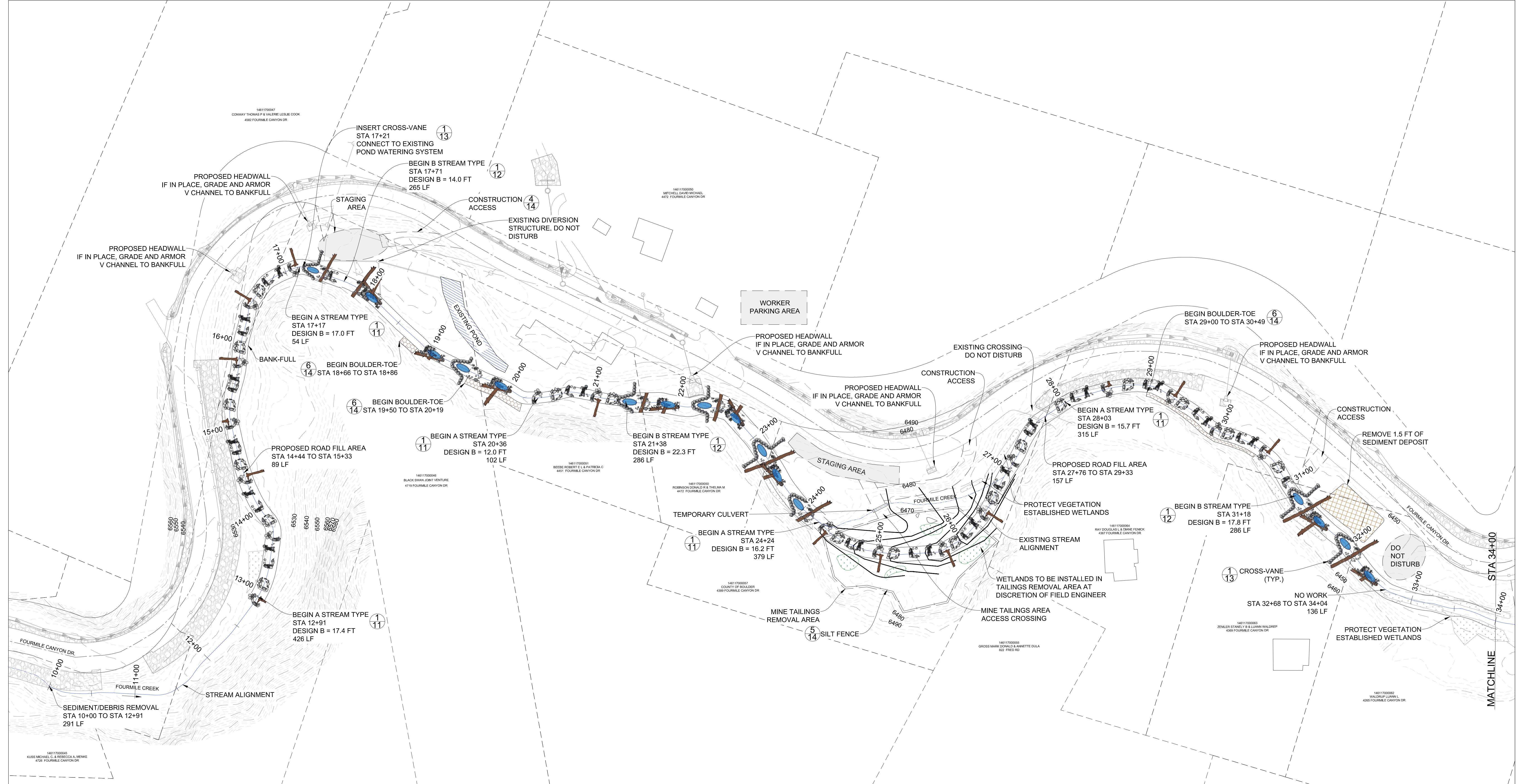
- FLOW DIRECTION
- EXISTING GRADE
- THALWEG
- BANK-FULL ELEVATION
- LIMITS OF LOW FLOW CHANNEL
- PROPOSED ALIGNMENT
- FINISHED GRADE
- GRADE SLOPE
- TRENCH
- HIDDEN STRUCTURE
- VALLEY BASELINE
- CENTERLINE
- GUARDRAIL
- SILT FENCE
- PARCEL BOUNDARY

DETAIL KEY

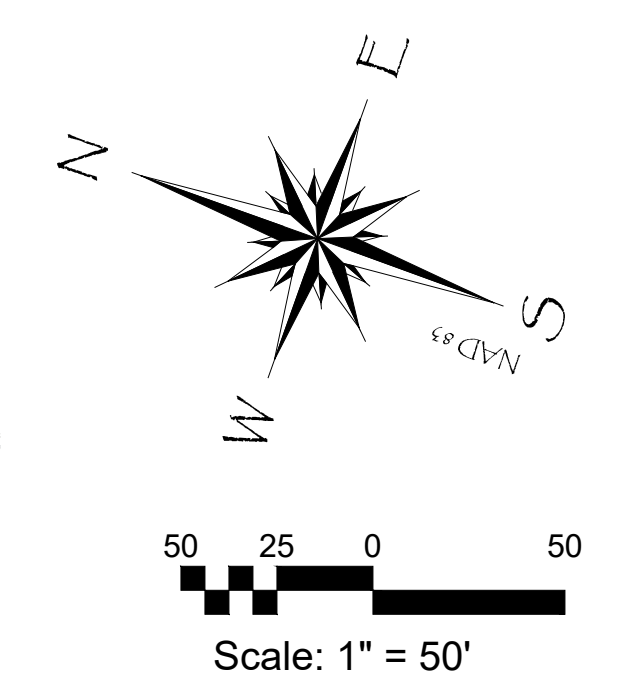


BLACK SWAN RESTORATION PROJECT

AS BUILT DATE	GENERAL NOTES FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		2
CHECKED BY BJB		
A&E FILE NO.		BEAVER CREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967
DATE MAY 2018		



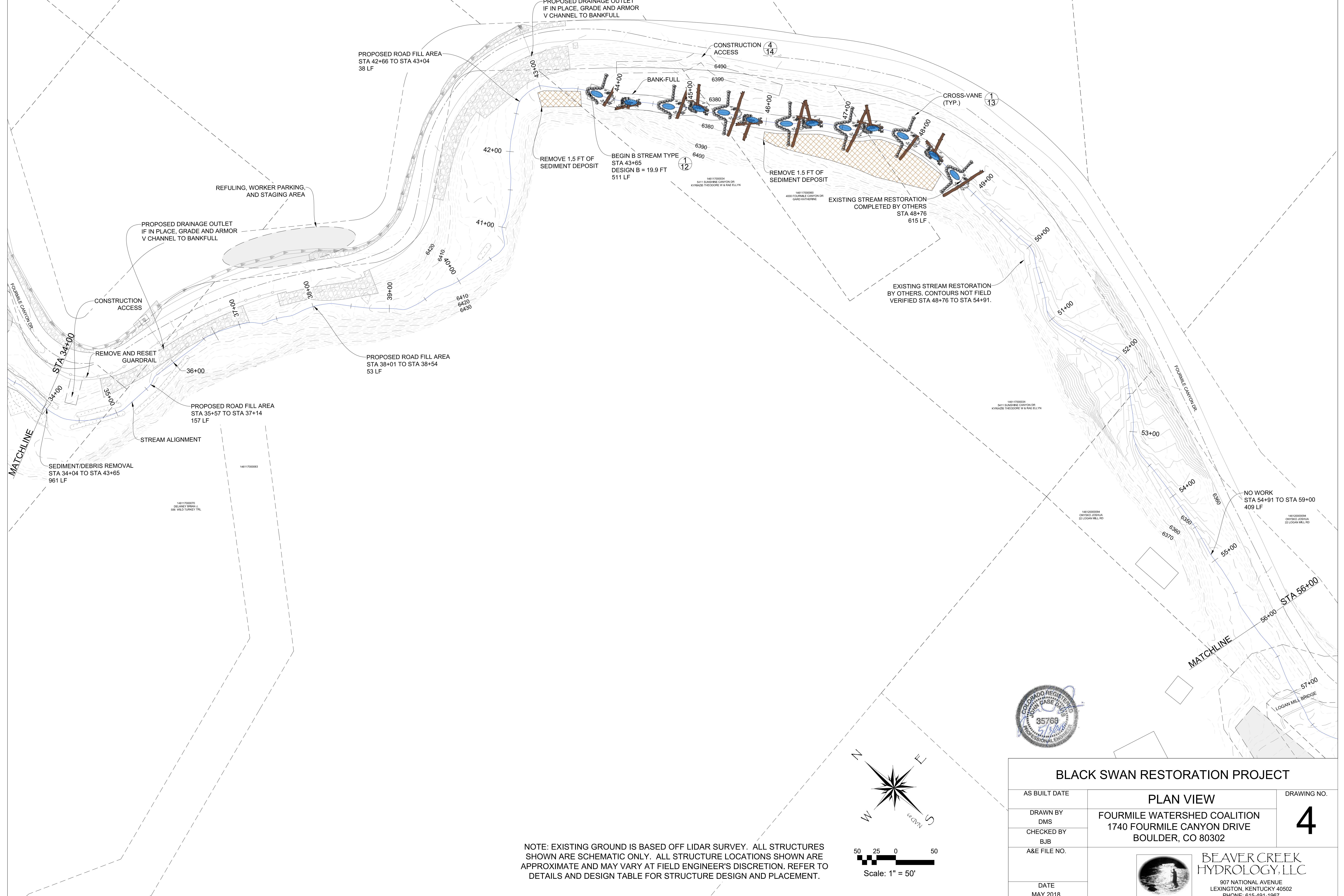
NOTE: EXISTING GROUND IS BASED OFF LIDAR SURVEY. ALL STRUCTURES SHOWN ARE SCHEMATIC ONLY. ALL STRUCTURE LOCATIONS SHOWN ARE APPROXIMATE AND MAY VARY AT FIELD ENGINEER'S DISCRETION. REFER TO DETAILS AND DESIGN TABLE FOR STRUCTURE DESIGN AND PLACEMENT.



BLACK SWAN RESTORATION PROJECT

AS BUILT DATE	PLAN VIEW FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY		3
CHECKED BY		
A&E FILE NO.		

DATE	 BEAVER CREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967
MAY 2018	



PROPOSED ROAD FILL AREA
STA 42+66 TO STA 43+04
38 LF

REFUELING, WORKER PARKING
AND STAGING AREA

PROPOSED DRAINAGE OUTLET
IF IN PLACE, GRADE AND ARMOR
V CHANNEL TO BANKFULL

CONSTRUCTION
ACCESS

REMOVE AND RESET
GUARDRAIL

PROPOSED ROAD FILL AREA
STA 35+57 TO STA 37+14
157 LF

STREAM ALIGNMENT

SEDIMENT/DEBRIS REMOVAL
STA 34+04 TO STA 43+65
961 LF

PROPOSED ROAD FILL AREA
STA 38+01 TO STA 38+54
53 LF

REMOVE 1.5 FT OF
SEDIMENT DEPOSIT

BEGIN B STREAM TYPE
STA 43+65
DESIGN B = 19.9 FT
511 LF

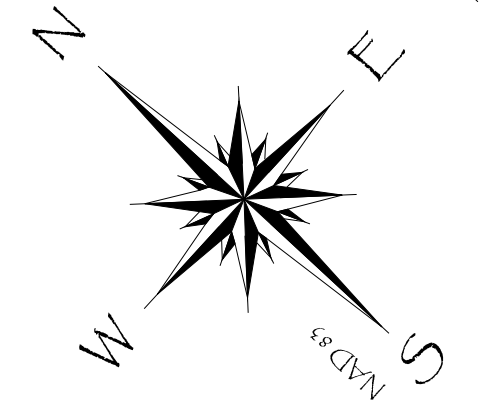
REMOVE 1.5 FT OF
SEDIMENT DEPOSIT

EXISTING STREAM RESTORATION
COMPLETED BY OTHERS
STA 48+76
615 LF

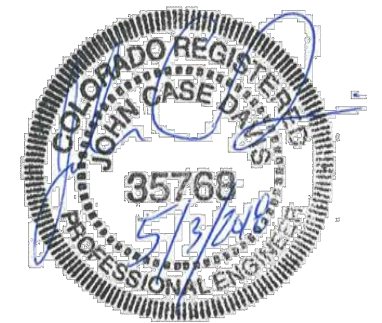
EXISTING STREAM RESTORATION
BY OTHERS, CONTOURS NOT FIELD
VERIFIED STA 48+76 TO STA 54+91.

NO WORK
STA 54+91 TO STA 59+00
409 LF

NOTE: EXISTING GROUND IS BASED OFF LIDAR SURVEY. ALL STRUCTURES SHOWN ARE SCHEMATIC ONLY. ALL STRUCTURE LOCATIONS SHOWN ARE APPROXIMATE AND MAY VARY AT FIELD ENGINEER'S DISCRETION. REFER TO DETAILS AND DESIGN TABLE FOR STRUCTURE DESIGN AND PLACEMENT.



Scale: 1" = 50'



BLACK SWAN RESTORATION PROJECT

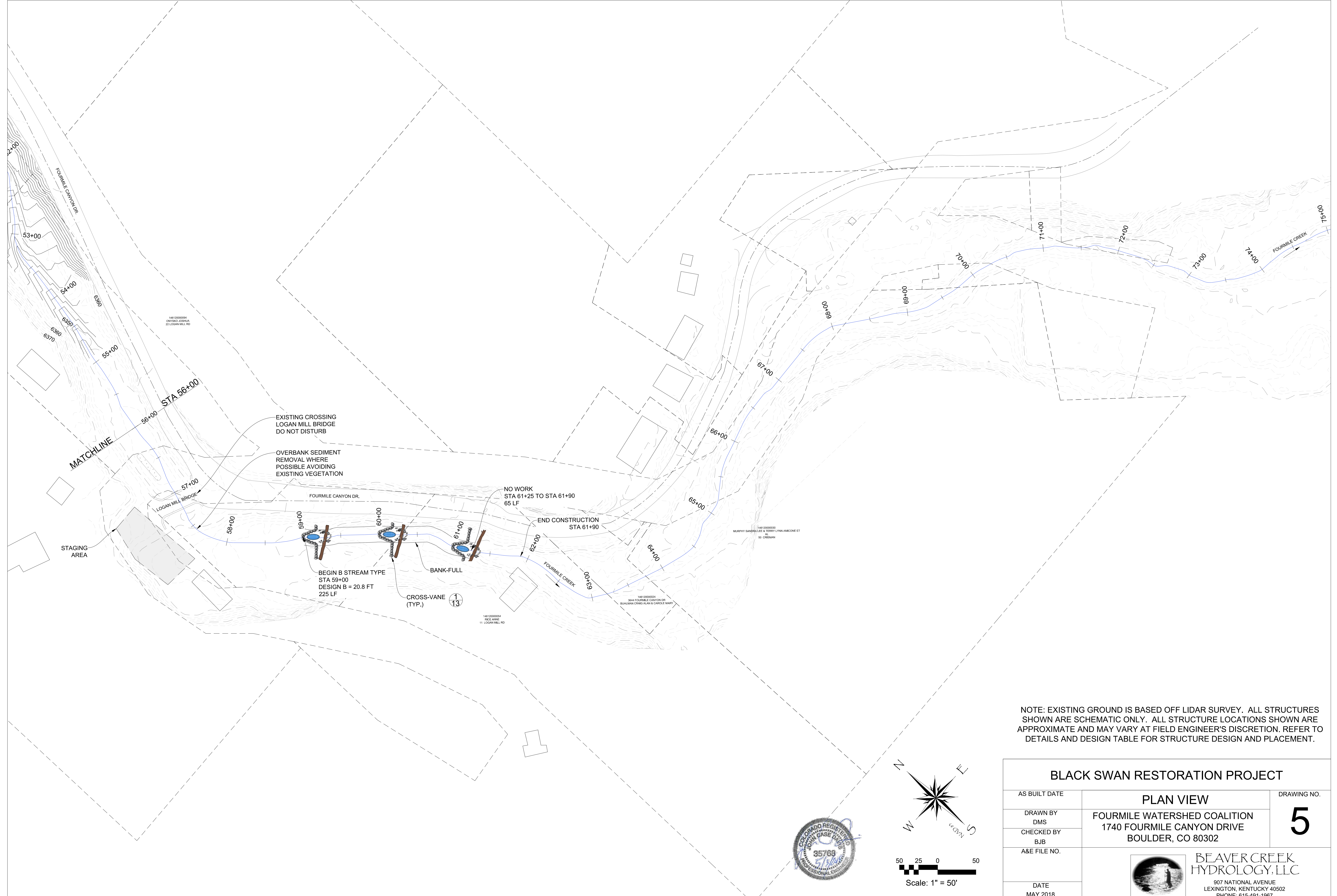
AS BUILT DATE	PLAN VIEW FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		4
CHECKED BY BJB		
A&E FILE NO.		



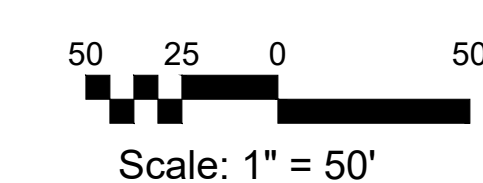
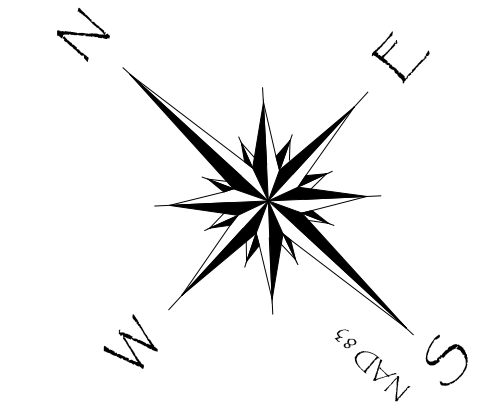
**BEAVER CREEK
HYDROLOGY, LLC**

907 NATIONAL AVENUE
LEXINGTON, KENTUCKY 40502
PHONE: 615-491-1967

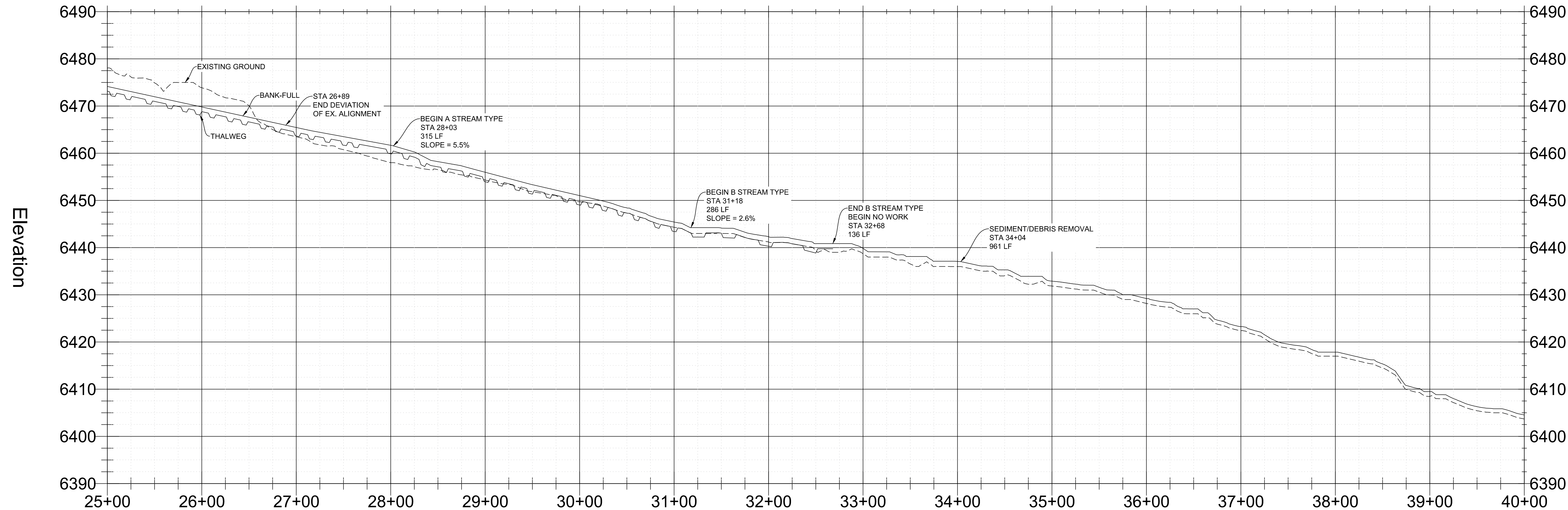
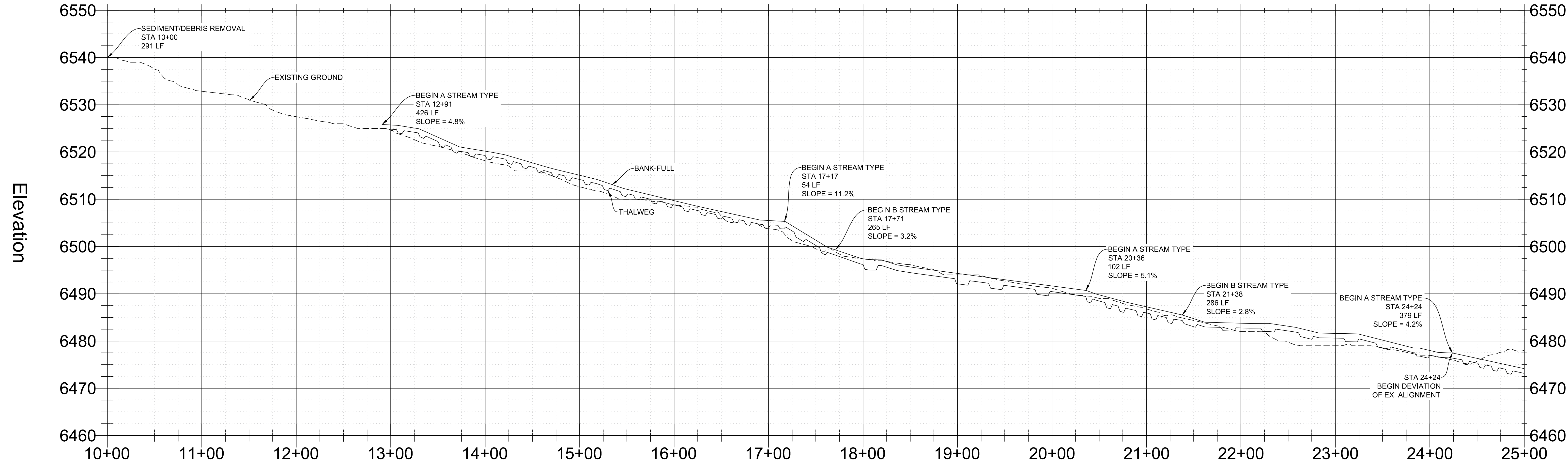
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MAY 2018



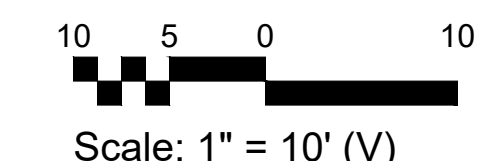
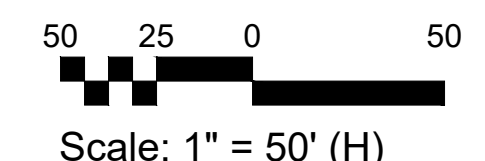
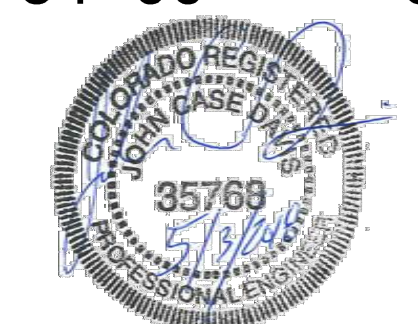
NOTE: EXISTING GROUND IS BASED OFF LIDAR SURVEY. ALL STRUCTURES SHOWN ARE SCHEMATIC ONLY. ALL STRUCTURE LOCATIONS SHOWN ARE APPROXIMATE AND MAY VARY AT FIELD ENGINEER'S DISCRETION. REFER TO DETAILS AND DESIGN TABLE FOR STRUCTURE DESIGN AND PLACEMENT.



BLACK SWAN RESTORATION PROJECT		
AS BUILT DATE	PLAN VIEW FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		5
CHECKED BY BJB	 BEAVERCREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967	
A&E FILE NO.		DATE MAY 2018

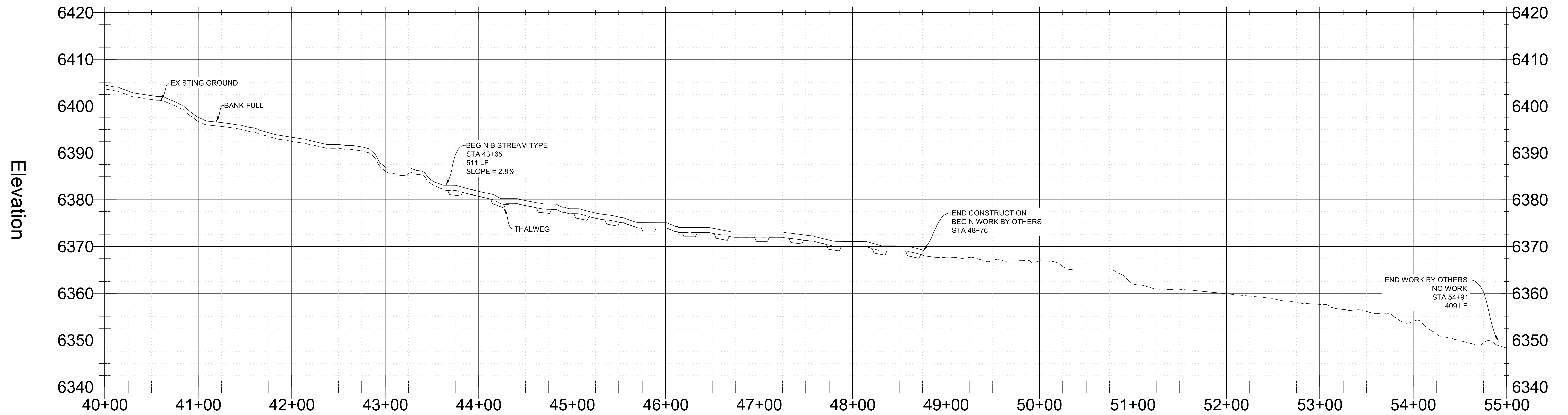


NOTE: EXISTING GROUND IS BASED OFF LIDAR SURVEY. ALL POOL AND STRUCTURE LOCATIONS SHOWN ARE APPROXIMATE AND ARE WITHIN CONSTRUCTION TOLERANCES. FINAL STRUCTURE LOCATIONS MAY VARY AT FIELD ENGINEER'S DISCRETION. REFER TO DETAILS AND DESIGN TABLE FOR STRUCTURE DESIGN AND PLACEMENT.

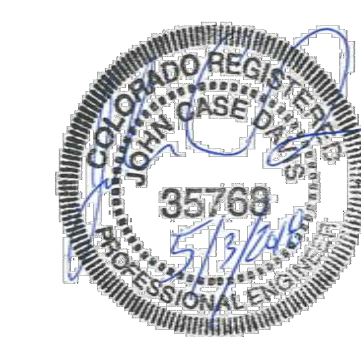
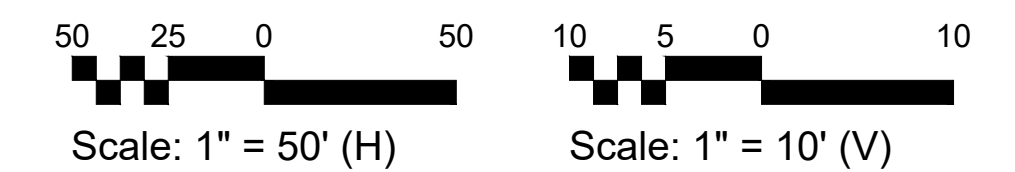
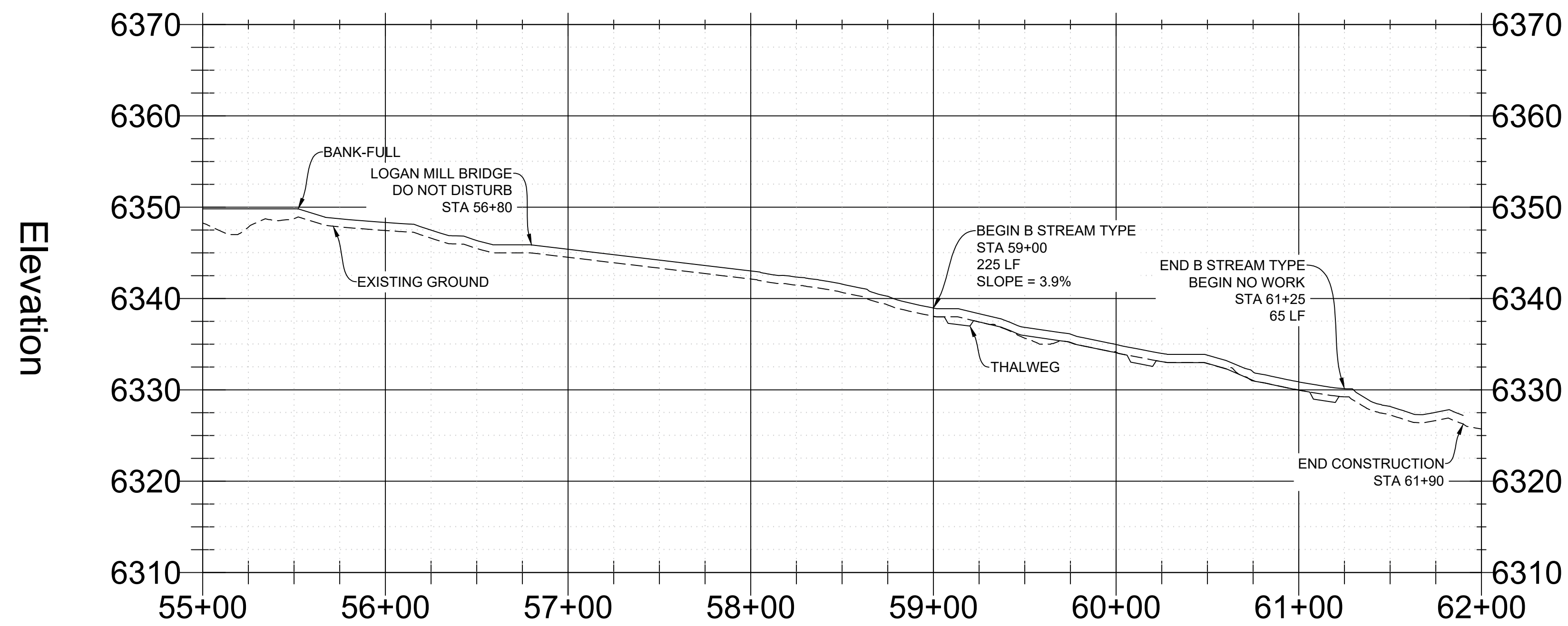



PROFILE VIEW
 FOURMILE WATERSHED COALITION
 1740 FOURMILE CANYON DRIVE
 BOULDER, CO 80302

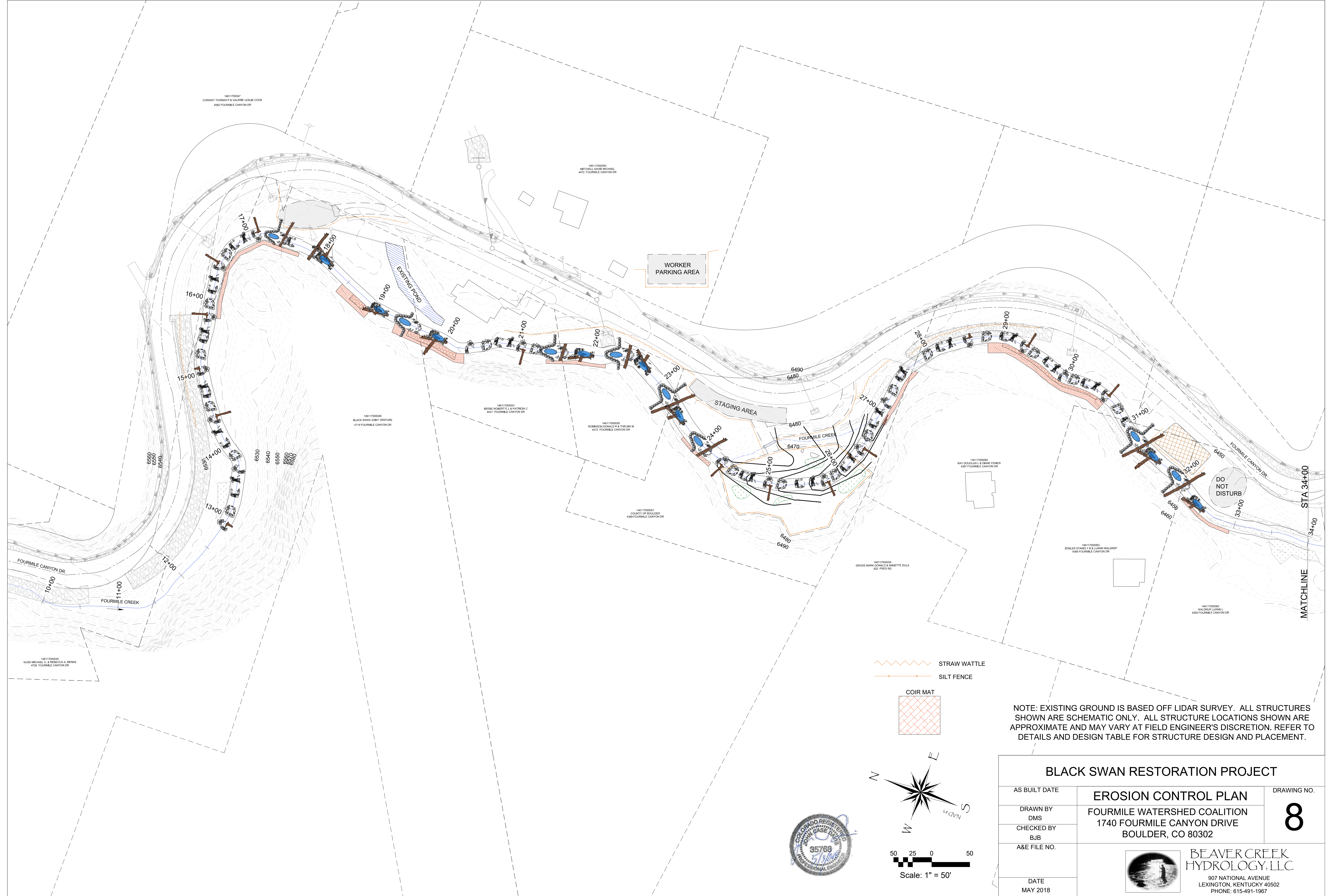
DRAWING NO.
6



NOTE: EXISTING GROUND IS BASED OFF LIDAR SURVEY. ALL POOL AND STRUCTURE LOCATIONS SHOWN ARE APPROXIMATE AND ARE WITHIN CONSTRUCTION TOLERANCES. FINAL STRUCTURE LOCATIONS MAY VARY AT FIELD ENGINEER'S DISCRETION. REFER TO DETAILS AND DESIGN TABLE FOR STRUCTURE DESIGN AND PLACEMENT.



BLACK SWAN RESTORATION PROJECT		
AS BUILT DATE	PROFILE VIEW	DRAWING NO.
DRAWN BY DMS		7
CHECKED BY BJB	FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	
A&E FILE NO.	 BEAVER CREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967	
DATE MAY 2018		

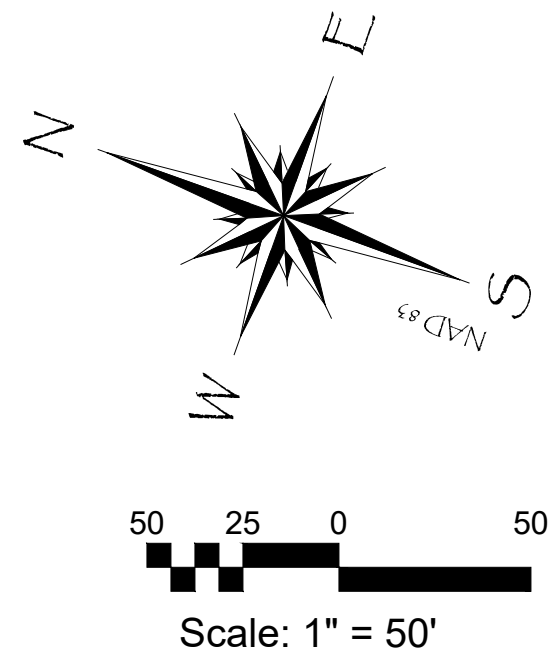


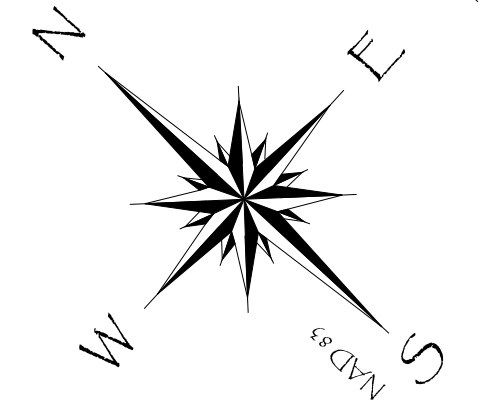
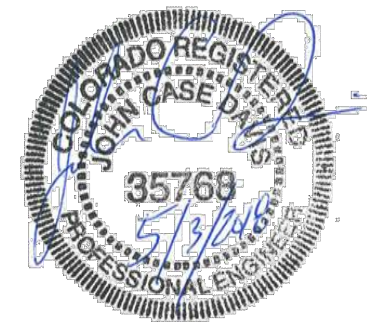
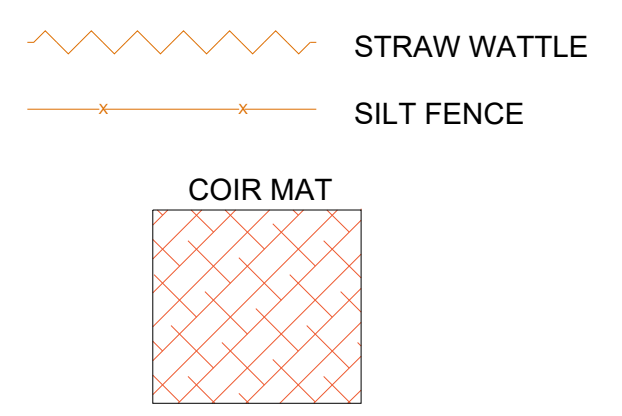
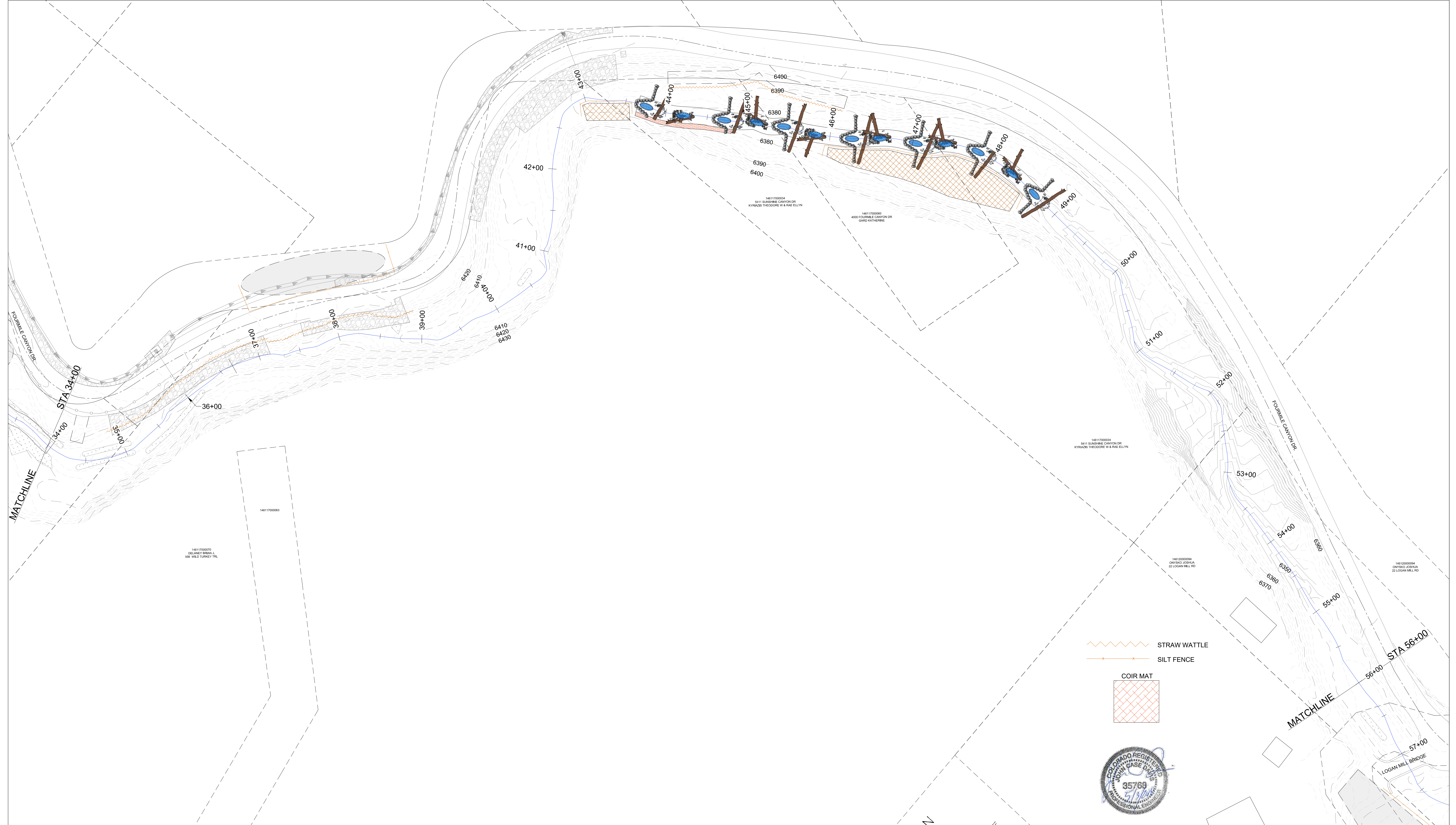
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BLACK SWAN RESTORATION PROJECT

AS BUILT DATE	EROSION CONTROL PLAN FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY		8
CHECKED BY		
A&E FILE NO.		

DATE	 BEAVER CREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967
MAY 2018	



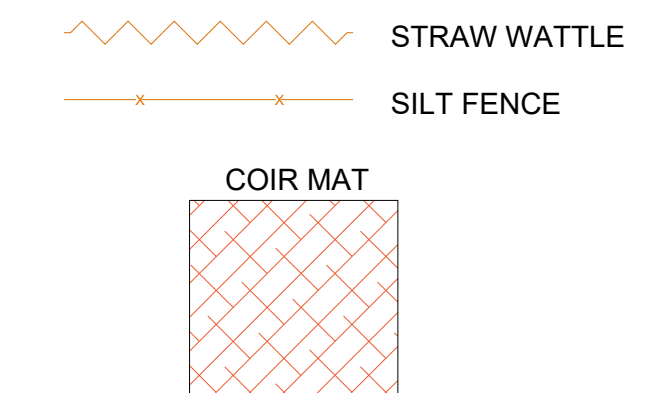
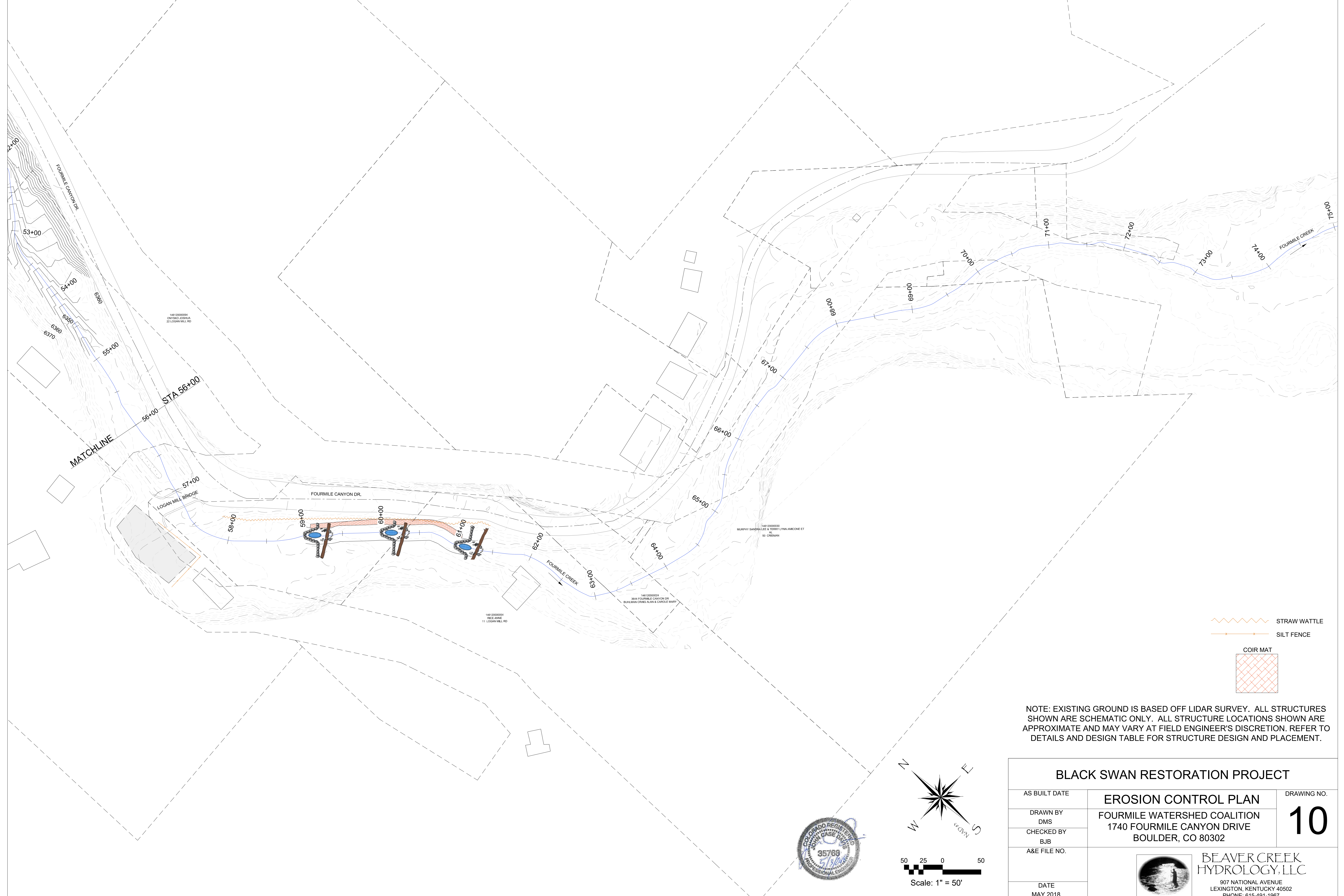


Scale: 1" = 50'

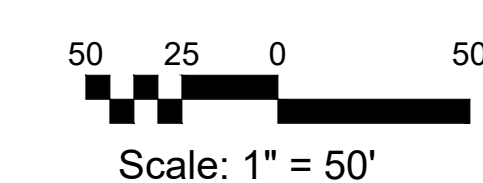
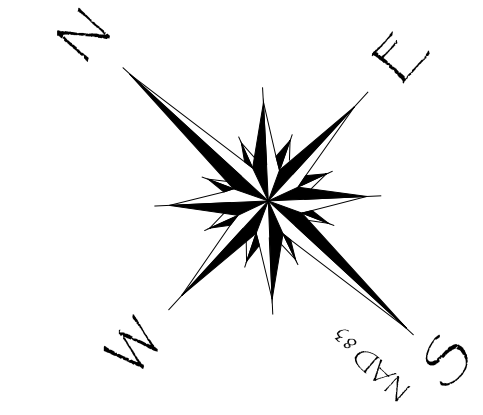
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BLACK SWAN RESTORATION PROJECT

AS BUILT DATE	EROSION CONTROL PLAN FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		9
CHECKED BY BJB	 BEAVERCREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967	
A&E FILE NO.		
DATE MAY 2018		



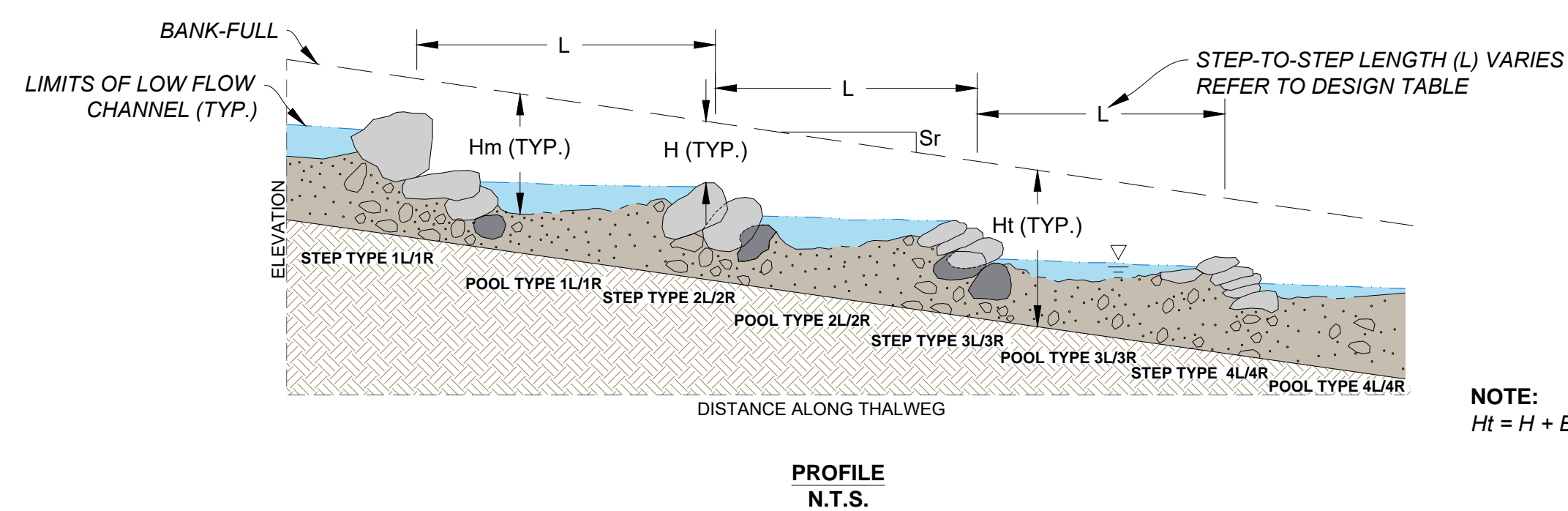
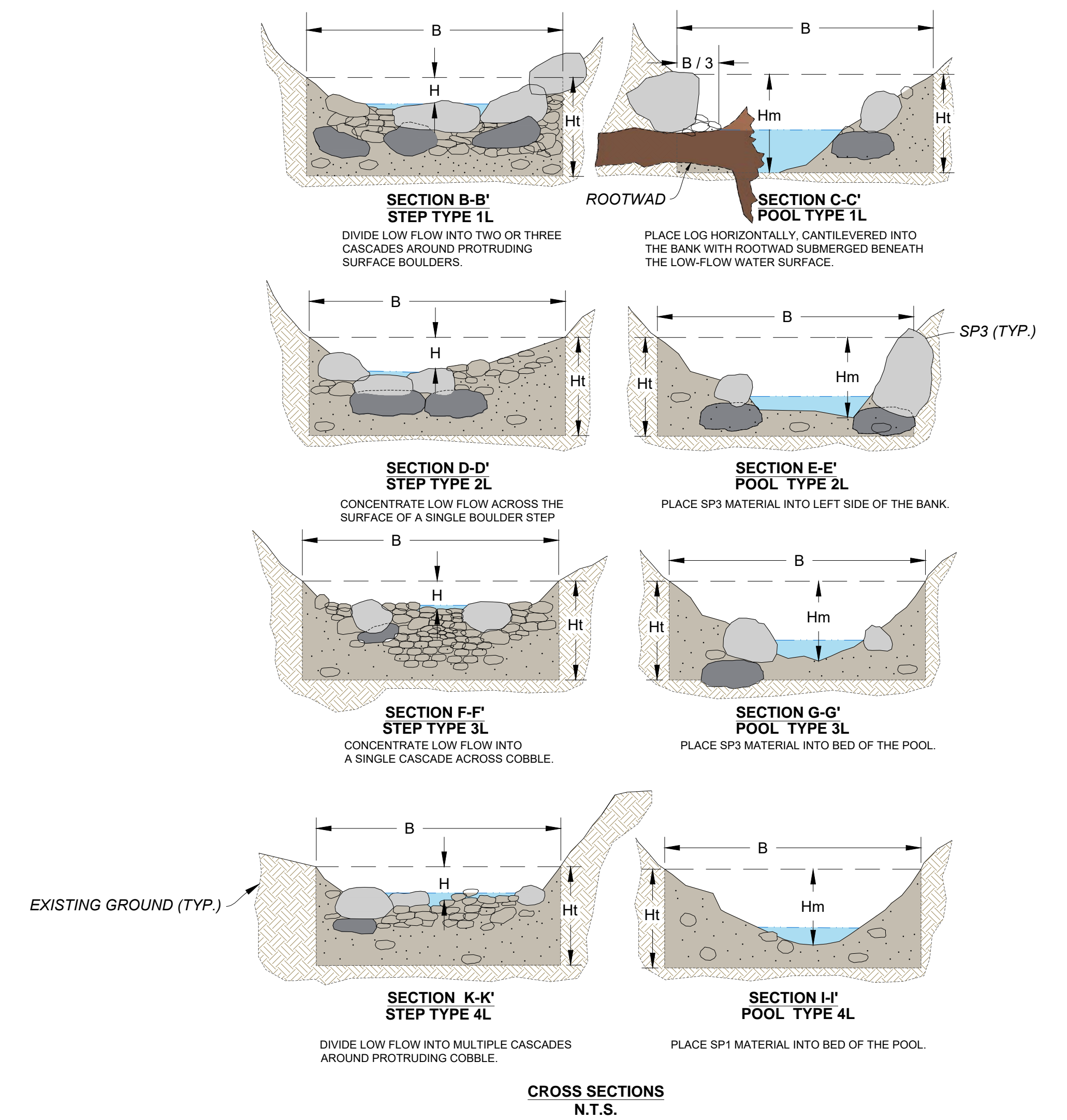
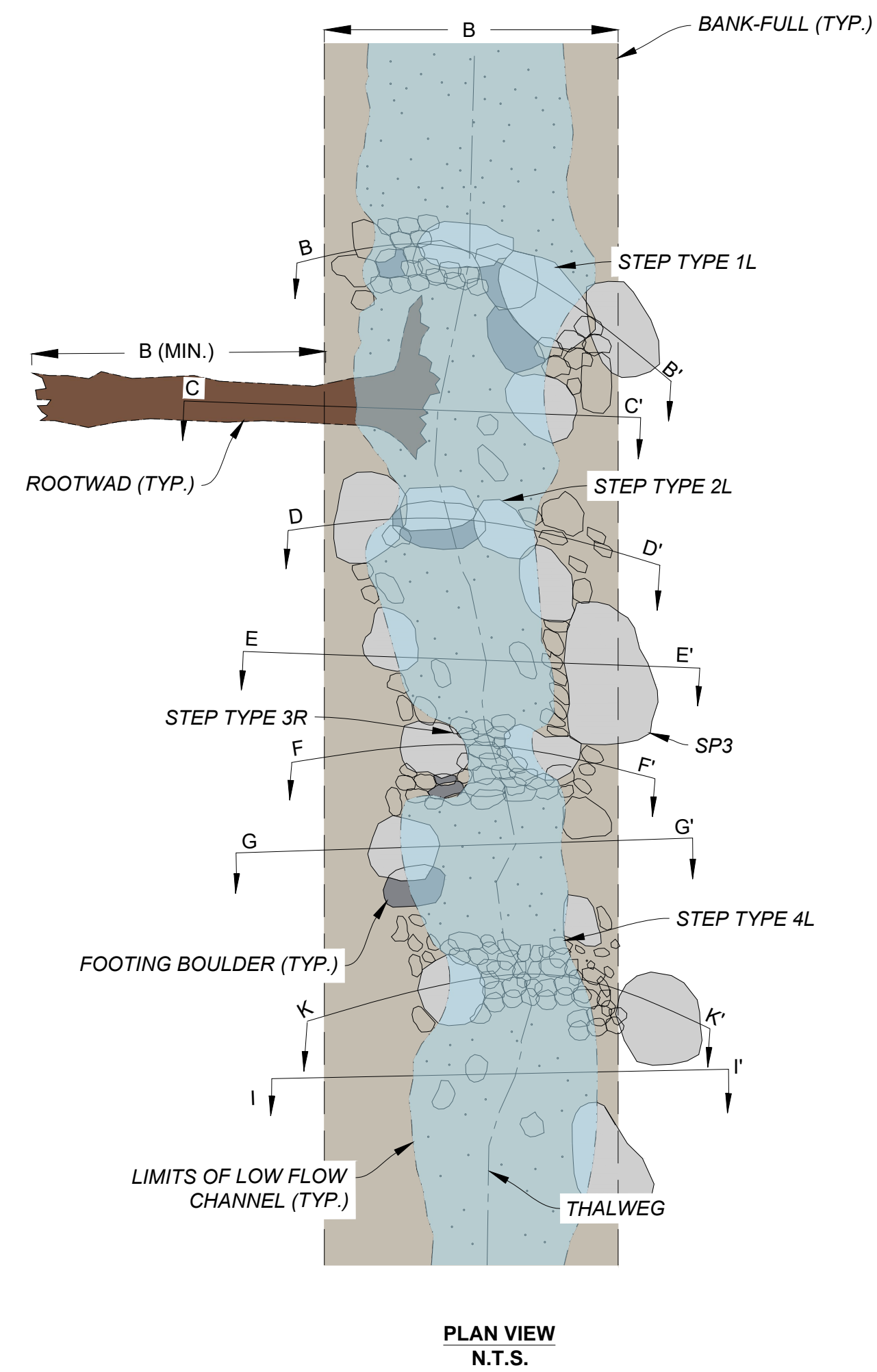
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BLACK SWAN RESTORATION PROJECT		
AS BUILT DATE	EROSION CONTROL PLAN FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		10
CHECKED BY BJB	 BEAVER CREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967	
A&E FILE NO.		DATE MAY 2018

SEQUENCE OF CONSTRUCTION

1. ESTABLISH AND MEASURE PROJECT BASELINE ALONG THE VALLEY DIRECTION.
2. DIVIDE THE VALLEY BASELINE LENGTH BY THE WAVELENGTH (L) TO GET THE TOTAL NUMBER OF STEP-POOLS +/- ONE STEP AT EACH END.
3. GENERATE A LIST OF RANDOM STEP-POOL TYPES.
4. RANDOM STEP-POOLS ARE PLACED SUCH THAT:
 - 4.1. FOR EACH STEP TYPE SELECTED PLACE THE SAME POOL TYPE ON THE DOWNSTREAM SIDE TO FORM A STEP-POOL UNIT, E.G. USE STEP TYPE 1L AND POOL TYPE 1L. LABEL THE UNIT STEP-POOL TYPE 1L.
 - 4.2. NO TWO SUCCESSIVE STEP-POOL TYPES ARE THE SAME, E.G. 1R, 1R, IS NOT PERMISSIBLE.
 - 4.3. IF TWO SUCCESSIVE STEP-POOL TYPES HAVE THE SAME NUMBER THEN ONE MUST BE THE ALTERNATE, E.G. 1L, 1R OR 1R, 1L IS PERMISSIBLE. THE ALTERNATE OF 1L IS 1R OBTAINED BY MIRROR IMAGE OF THE SECTION LINES, E.G. SWITCHING SECTION B-B' TO B'-B, OR USING THE MIRROR IMAGE OF THE PLAN VIEW ABOUT THE SYMMETRY LINE SHOWN.
 - 4.5. USE APPROXIMATELY THE SAME NUMBER OF ALTERNATES FOR EACH STEP-POOL TYPE, E.G. ABOUT THE SAME NUMBER OF 1R AS 1L.
 - 4.6. THE TERMS 1L AND 1R STAND FOR TYPE 1-LEFT AND TYPE 1-RIGHT. THESE DIRECTIONS ARE RELATIVE TO THE LAYOUT OF BOULDERS, E.G. IN STEP TYPE 1L THE BOULDERS ARE PLACED PREDOMINATELY ON THE LEFT SIDE OF THE CHANNEL LOOKING IN THE DOWNSTREAM DIRECTION. THESE DIRECTIONS DO NOT INDICATE THE FLOW DIRECTION. FLOW DIRECTION IS INDICATED ON THE SECTION VIEWS AT STEP LOCATIONS.
 - 4.7. NO THREE SUCCESSIVE STEP TYPES HAVE THE SAME NUMBER, E.G. 1L, 1R, 1L IS NOT PERMISSIBLE.
 - 4.8. ALL SEQUENCES HAVE ONE ROOTWAD PER 4L ON AVERAGE.
5. PLACE GRADE STAKES OFFSET FROM EACH STEP LOCATION. GRADE STAKES SHALL BE MARKED WITH STEP-POOL TYPE, THALWEG OFFSET DISTANCE(S), BANKFULL ELEVATION AT CENTER OF STEP, HEIGHT OF THE CENTER OF THE SURFACE BOULDERS IN THE STEP (H) AND HEIGHT OF THE TRENCH (Ht).
6. INSTALL TEMPORARY PUMP-AROUND IF CONDITIONS ARE WET.
7. GRADE TO BANK-FULL ELEVATION WITH HEAVY EQUIPMENT.
8. EXCAVATE A TRENCH OF WIDTH B AND HEIGHT Ht.
9. DUMP MATERIAL TYPE SP1 INTO THE TRENCH AND SPREAD TO AN APPROXIMATELY PARABOLIC CHANNEL SHAPE OF WIDTH B AND HEIGHT H.
10. WORKING IN THE STREAMWISE DIRECTION FROM UPSTREAM TO DOWNSTREAM, HAND PLACE MATERIALS SP2, SP3, AND ROOTWADS.
11. PERFORM FINAL GRADING OF THE CHANNEL BED.
12. PERFORM FINAL GRADING ABOVE BANKFULL ELEVATION WITH CUT/FILL SLOPES 2(H):1(V) OR FLATTER.
13. INSTALL TEMPORARY AND PERMANENT SEED MIXTURES INCLUDING TOPSOIL, FERTILIZER, AND MULCH.

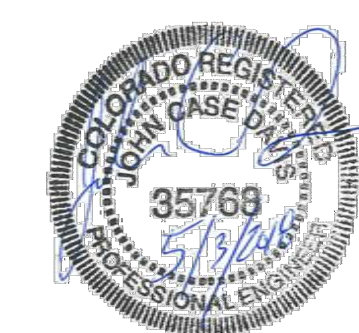


NOTE:
 $H_t = H + \text{BOULDER HEIGHT (SP3)}$

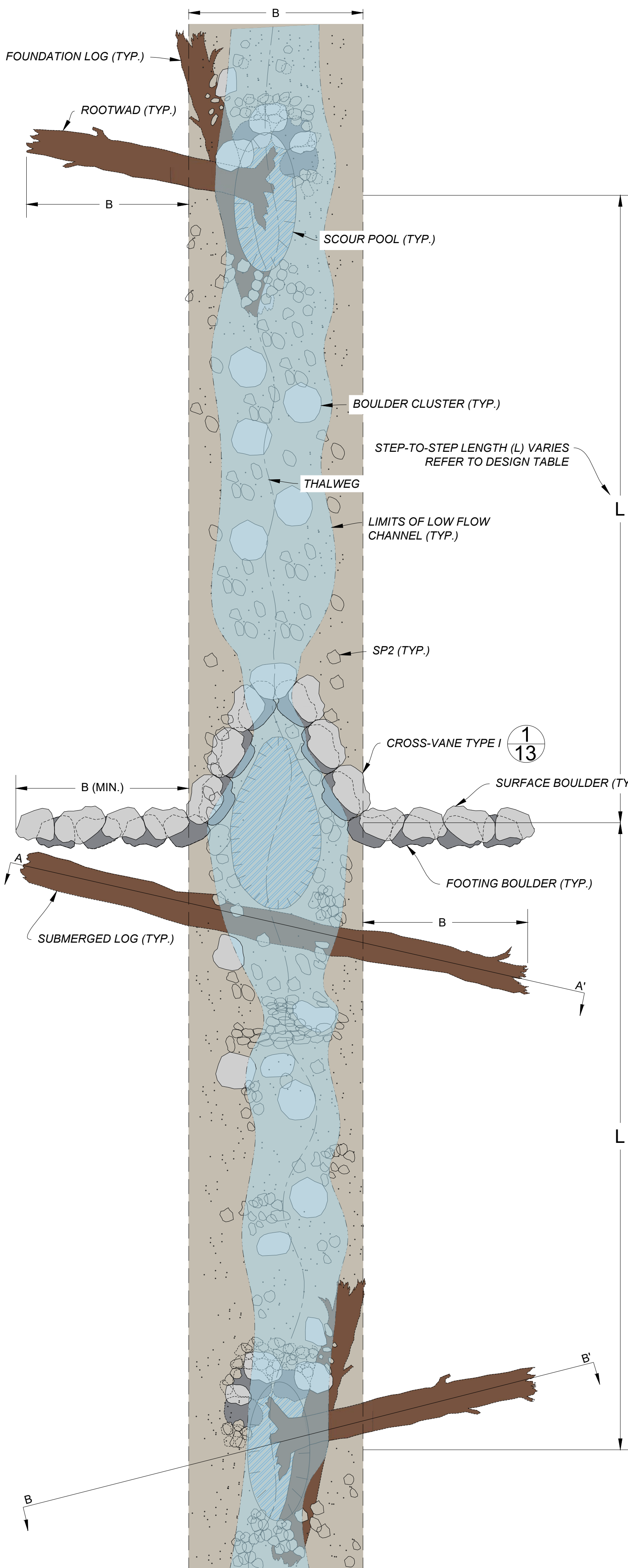
1 11 DETAIL - A STREAM TYPE N.T.S.

BLACK SWAN RESTORATION PROJECT

AS BUILT DATE	DETAIL - A STREAM FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		11
CHECKED BY BJB		
A&E FILE NO.		
DATE MAY 2018		



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LEXINGTON, KENTUCKY 40502
PHONE: 615-491-1967



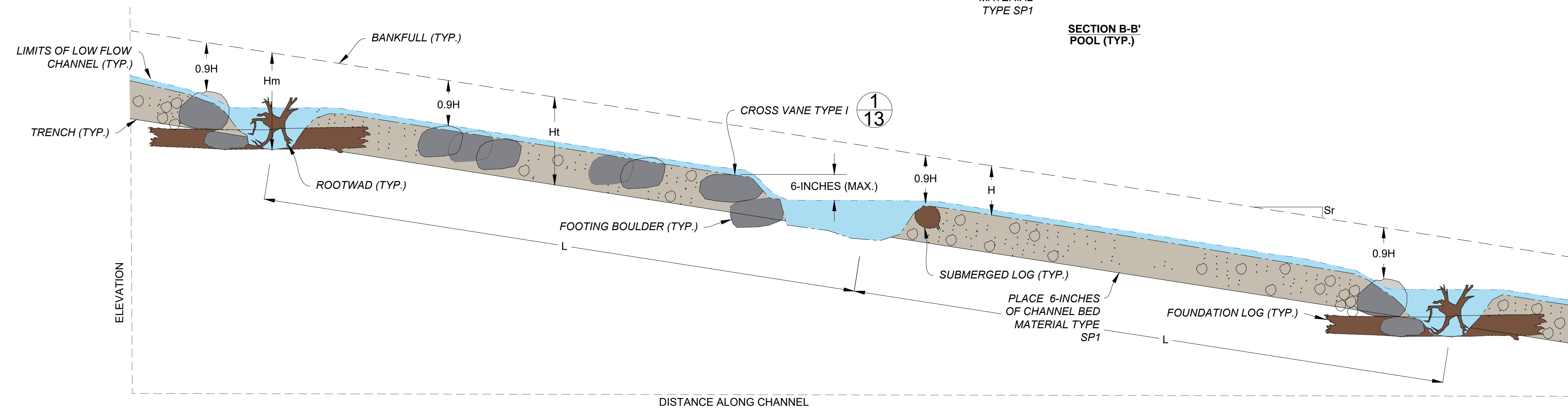
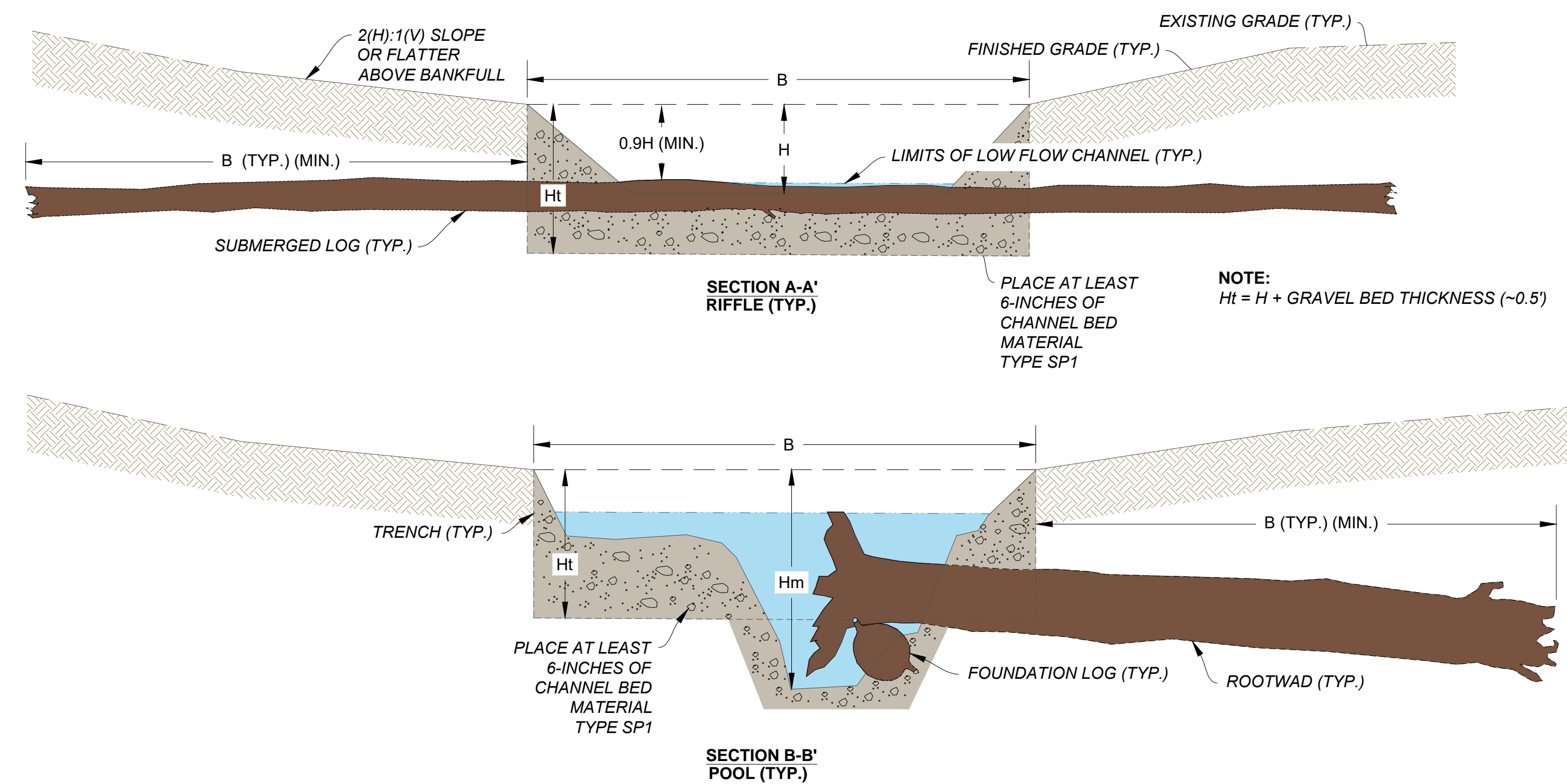
PLAN VIEW
N.T.S.

1
12
DETAIL - B STREAM TYPE
N.T.S.

NOTE:
CURVATURE IS OMITTED
FROM PLAN VIEW. REFER
TO PLANS FOR
ALIGNMENT.

SEQUENCE OF CONSTRUCTION

1. ESTABLISH AND MEASURE PROJECT BASELINE ALONG THE VALLEY DIRECTION.
2. DIVIDE THE VALLEY BASELINE LENGTH BY THE WAVELENGTH (L) TO GET THE TOTAL NUMBER OF SCOUR POOLS.
3. LAYOUT CHANNEL CENTERLINE WITH RANDOM SINUOUS PATTERN RELATIVE TO THE PROJECT BASELINE (SINUOSITY = 1.1 TO 1.2).
4. CLEAR TREES ALONG CHANNEL CENTERLINE AND ACTIVE GRADING LIMITS.
5. MARK LOCATIONS FOR SCOUR POOLS.
6. STOCKPILE BOULDERS, LOGS, AND OTHER MATERIALS AT SCOUR POOL LOCATIONS.
7. CONSTRUCT CHANNEL, WORKING FROM UPSTREAM TO DOWNSTREAM IN THE DRY, USING A PUMP-AROUND OR OTHER APPROVED FLOW DIVERSION AS NEEDED.
8. GRADE TO BANK-FULL ELEVATION WITH HEAVY EQUIPMENT.
9. EXCAVATE A TRENCH OF WIDTH B AND HEIGHT H.
10. DUMP MATERIAL TYPE SP1 INTO THE TRENCH AND SPREAD TO AN APPROXIMATELY PARABOLIC CHANNEL SHAPE OF WIDTH B AND HEIGHT H.
11. WORKING IN THE STREAMWISE DIRECTION FROM UPSTREAM TO DOWNSTREAM, HAND PLACE MATERIALS SP2, SP3, ROOTWADS, AND SUBMERGED LOGS.
12. PERFORM FINAL GRADING OF THE CHANNEL BED.
13. PERFORM FINAL GRADING ABOVE BANK-FULL ELEVATION WITH CUT/FILL SLOPES 2(H):1(V) OR FLATTER.
14. INSTALL TEMPORARY AND PERMANENT SEED MIXTURES INCLUDING TOPSOIL, FERTILIZER, AND MULCH.
15. TRIM ALL TREE BRANCHES AND ROOTWADS EXPOSED ABOVE LOW FLOW WATER LEVEL AND AS DIRECTED BY THE ENGINEER.

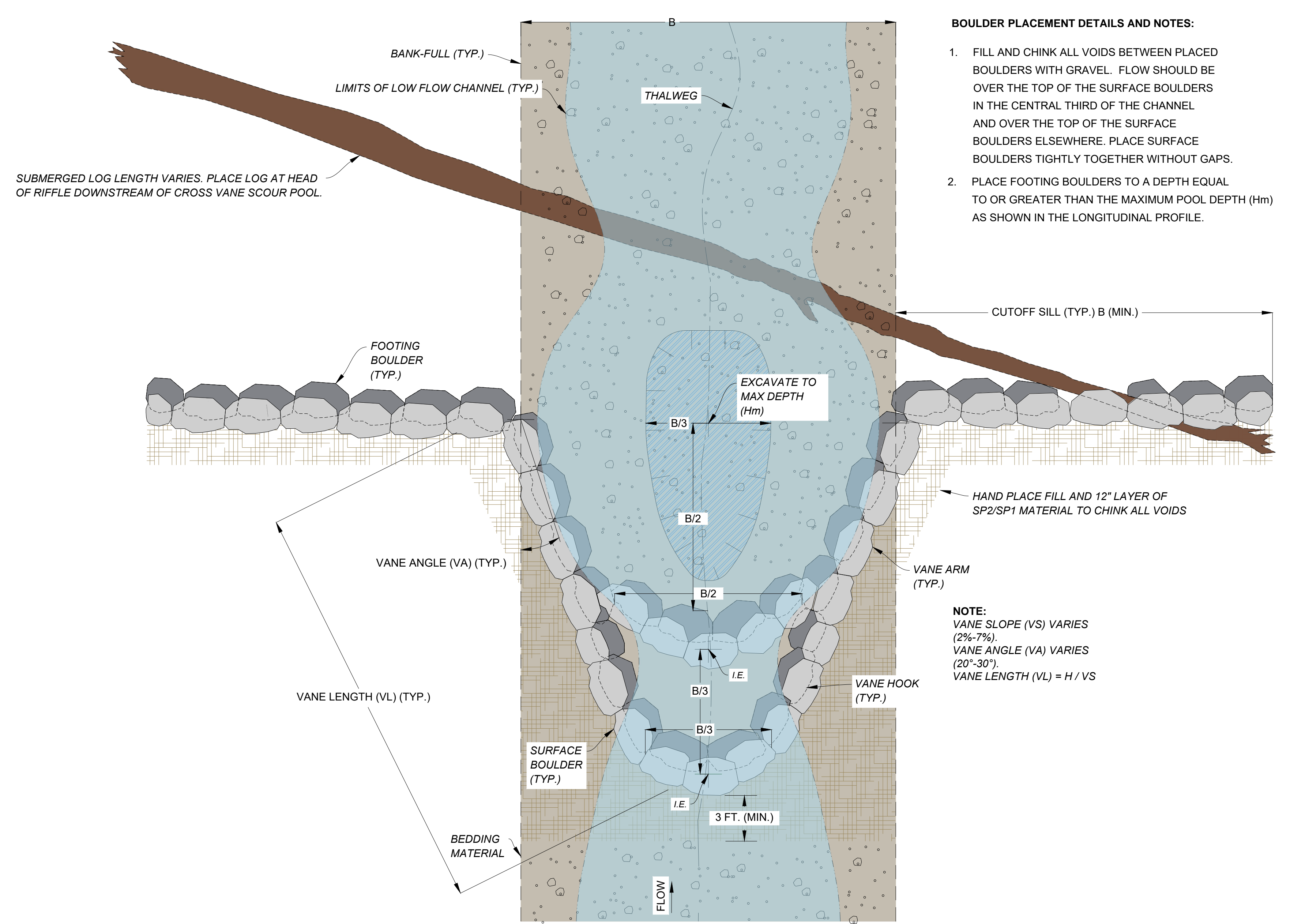
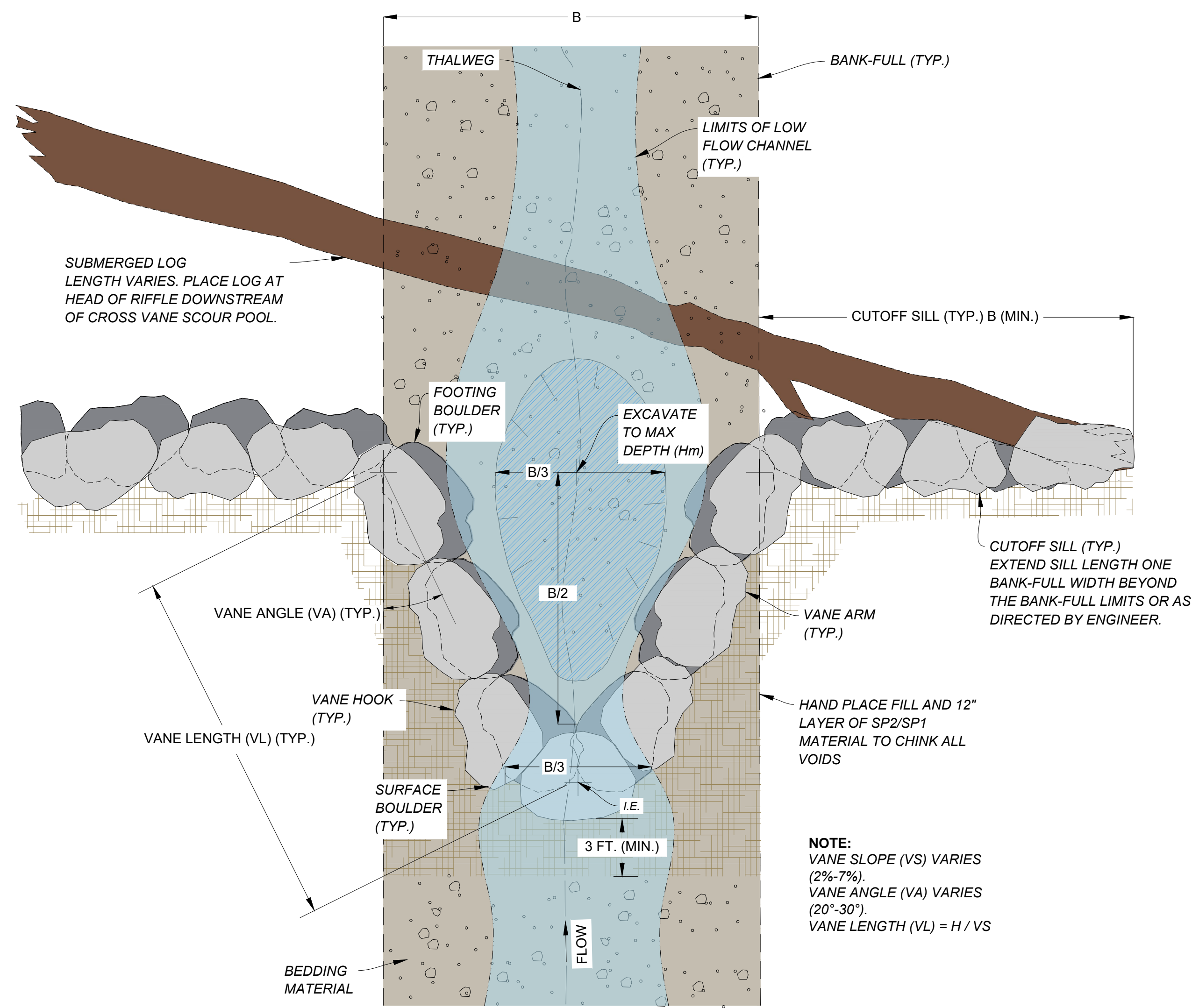


PROFILE
N.T.S.

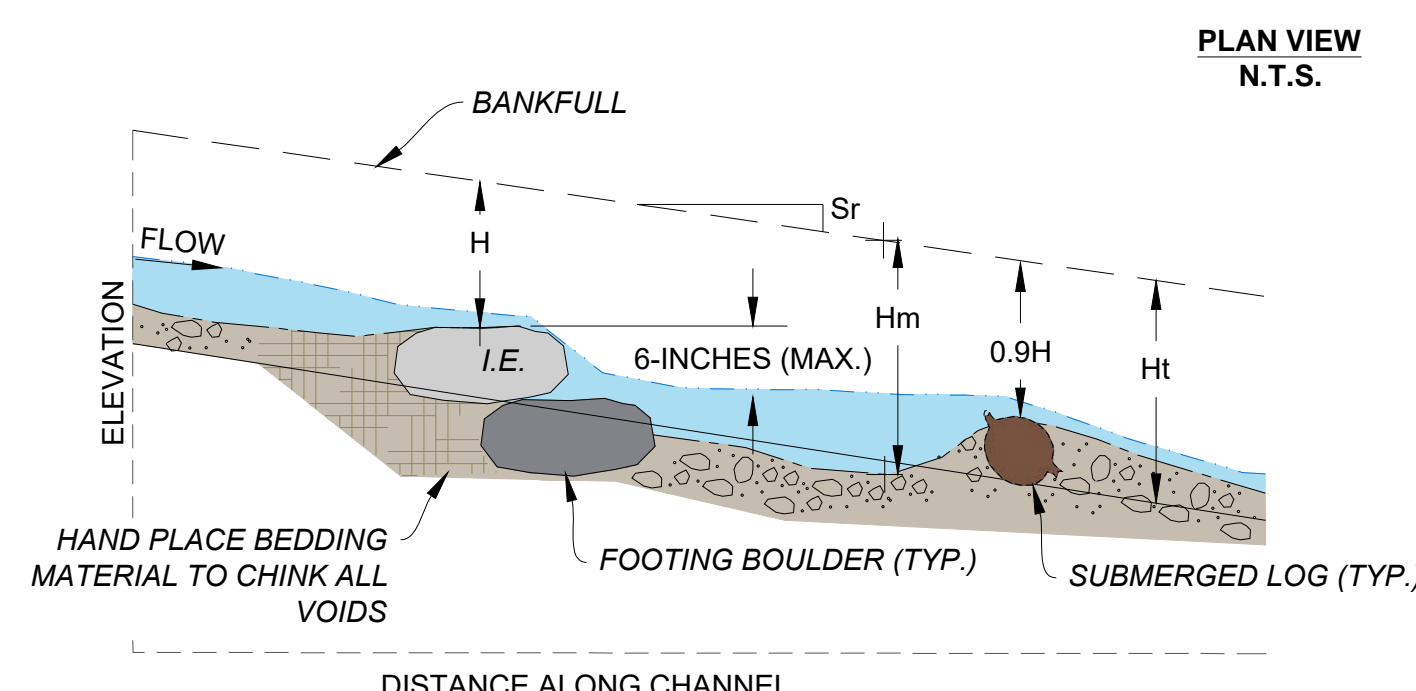
BLACK SWAN RESTORATION PROJECT

AS BUILT DATE	DETAIL - B STREAM FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		12
CHECKED BY BJB		
A&E FILE NO.		
DATE MAY 2018	 BEAVER CREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967	

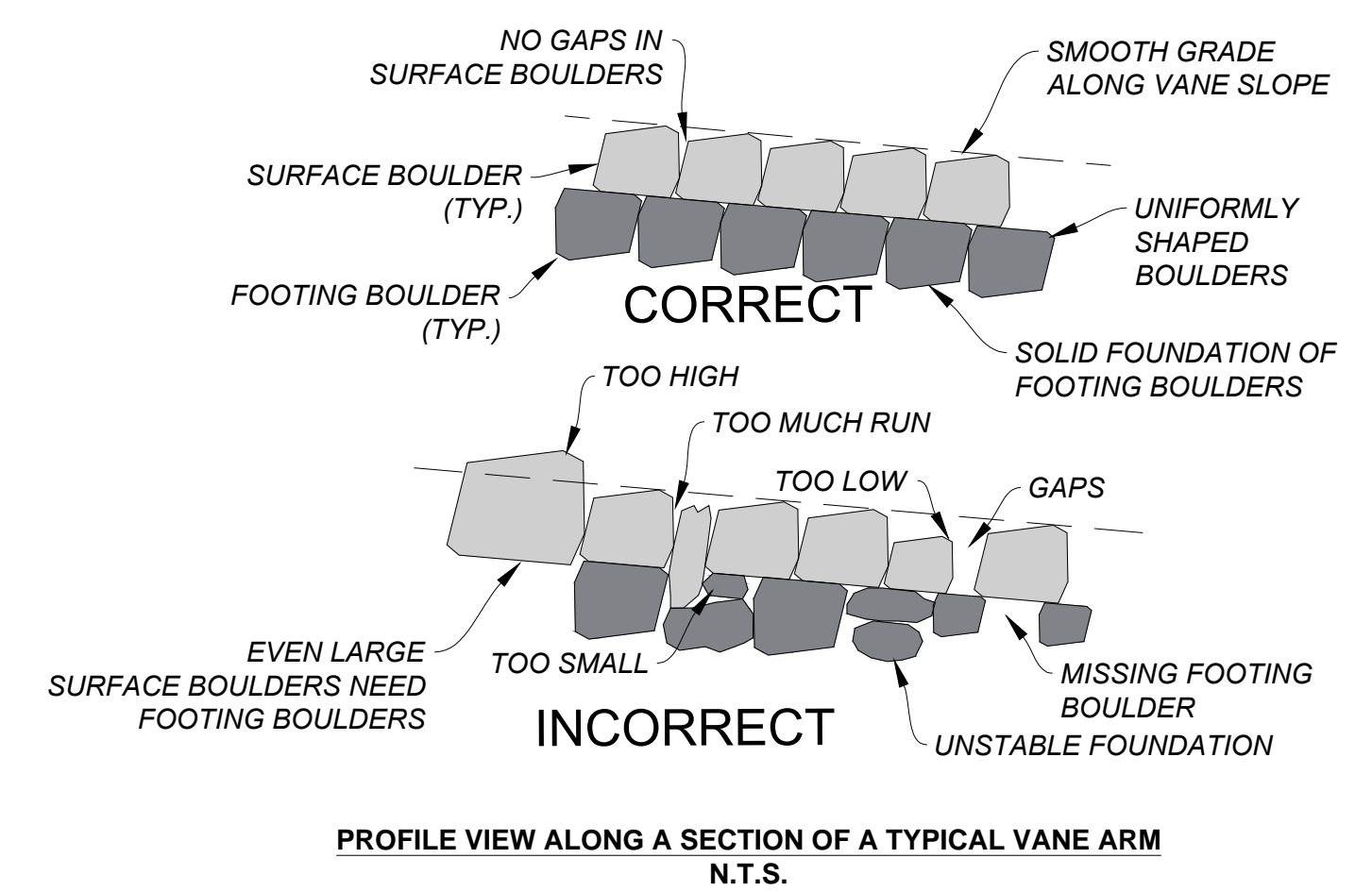




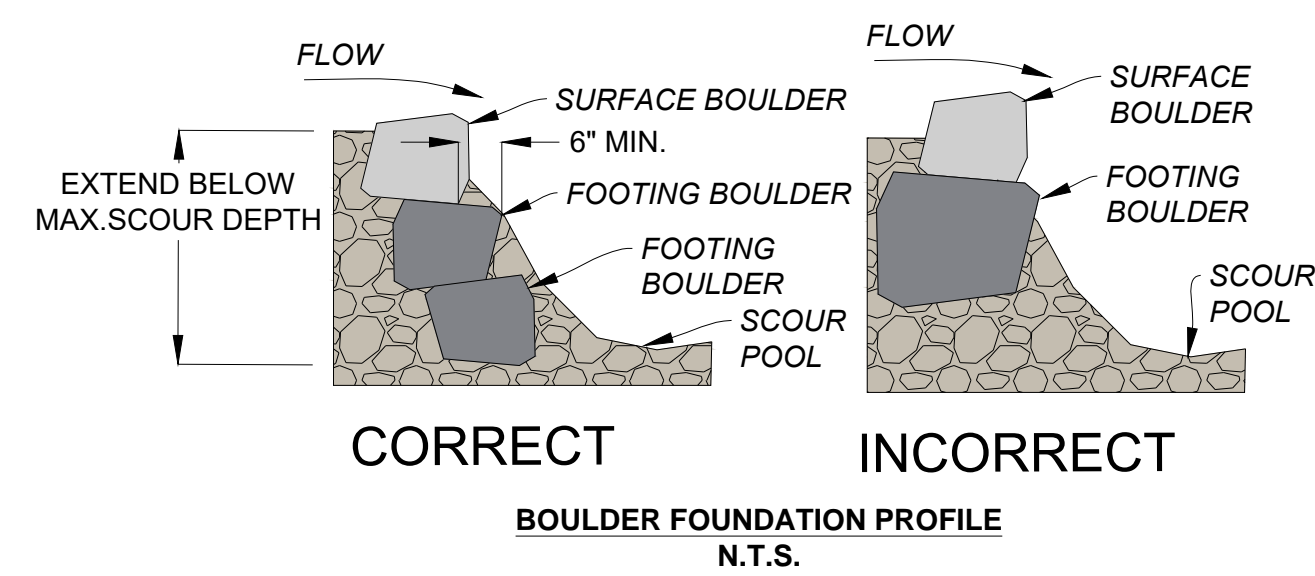
- BOULDER PLACEMENT DETAILS AND NOTES:**
1. FILL AND CHINK ALL VOIDS BETWEEN PLACED BOULDERS WITH GRAVEL. FLOW SHOULD BE OVER THE TOP OF THE SURFACE BOULDERS IN THE CENTRAL THIRD OF THE CHANNEL AND OVER THE TOP OF THE SURFACE BOULDERS ELSEWHERE. PLACE SURFACE BOULDERS TIGHTLY TOGETHER WITHOUT GAPS.
 2. PLACE FOOTING BOULDERS TO A DEPTH EQUAL TO OR GREATER THAN THE MAXIMUM POOL DEPTH (Hm) AS SHOWN IN THE LONGITUDINAL PROFILE.



1 **13** **DETAIL - CROSS-VANE TYPE 1**
N.T.S.

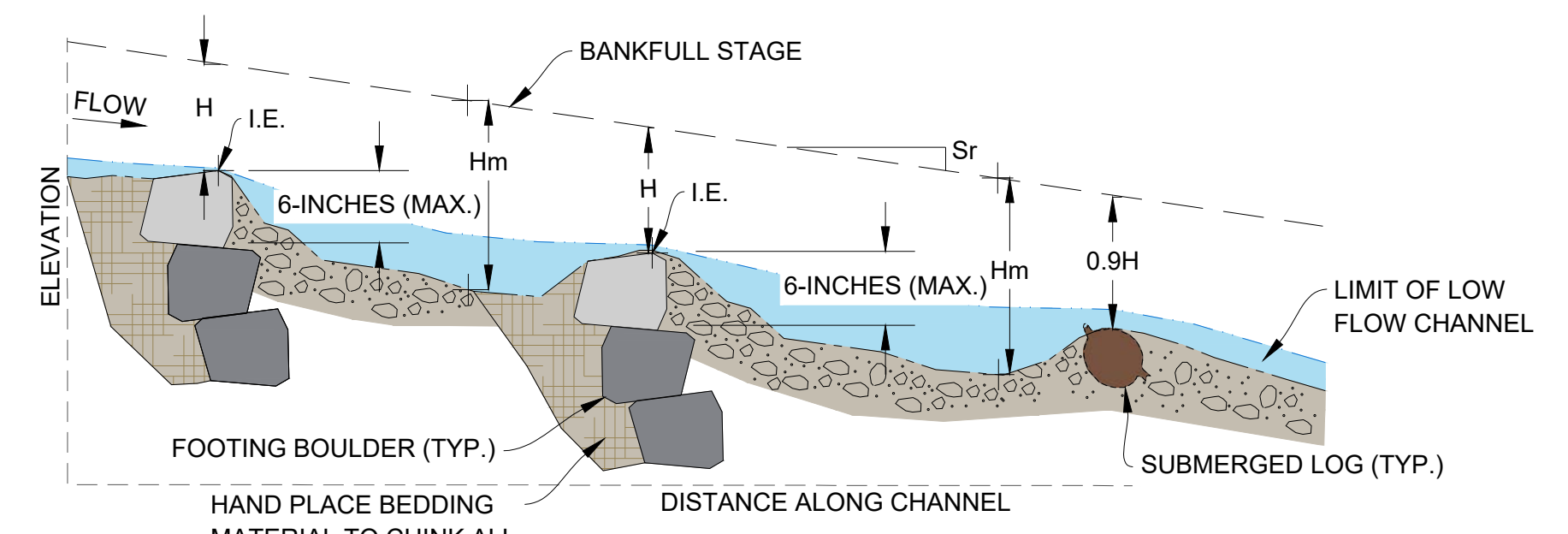


PROFILE VIEW ALONG A SECTION OF A TYPICAL VANE ARM
N.T.S.

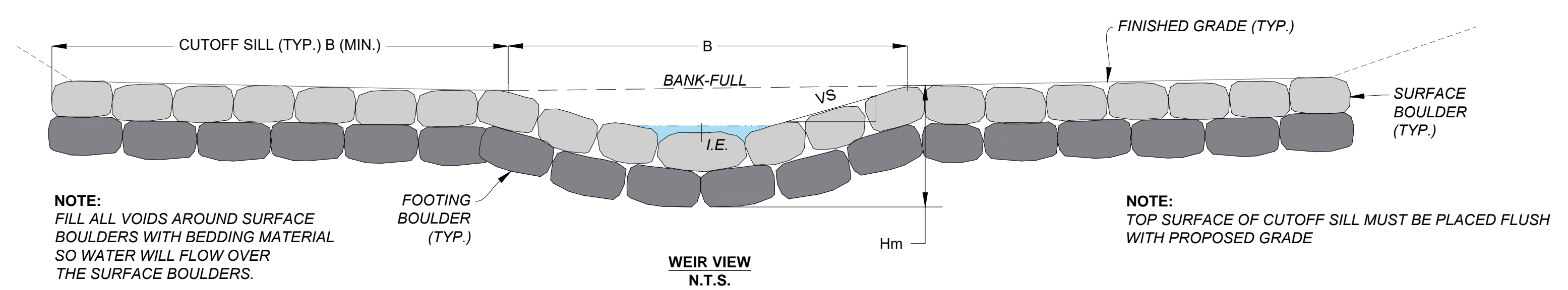


BOULDER FOUNDATION PROFILE
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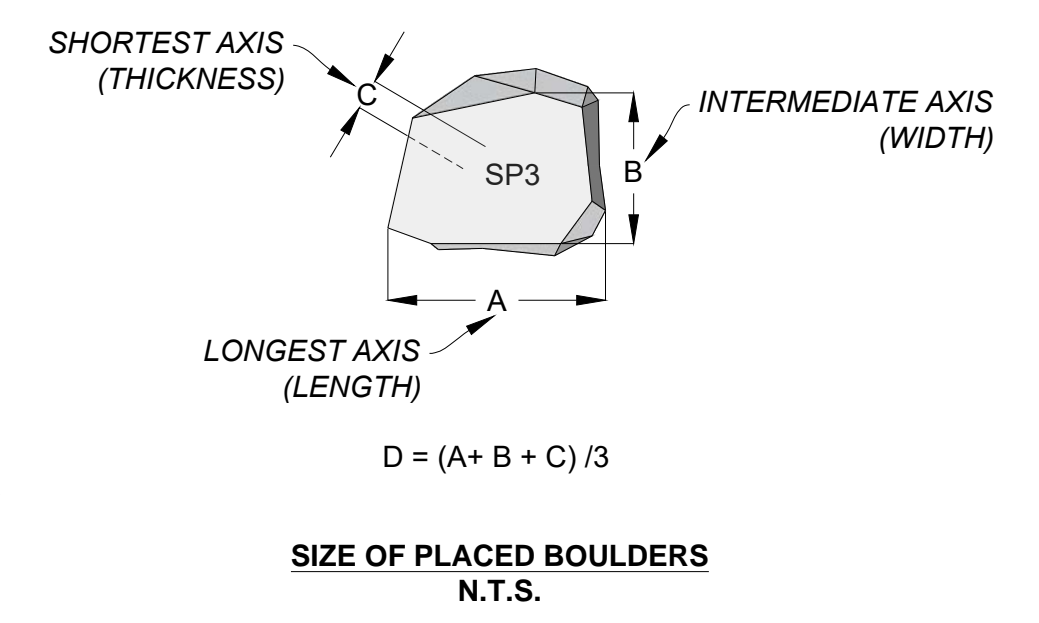
2 **13** **DETAIL - CROSS-VANE TYPE 2**
N.T.S.



NOTE: MAXIMUM FALL FROM THE I.E. OF THE CROSS VANE TO THE I.E. OF THE SUBMERGED LOG IS 6-INCHES.



WEIR VIEW
N.T.S.



SIZE OF PLACED BOULDERS
N.T.S.

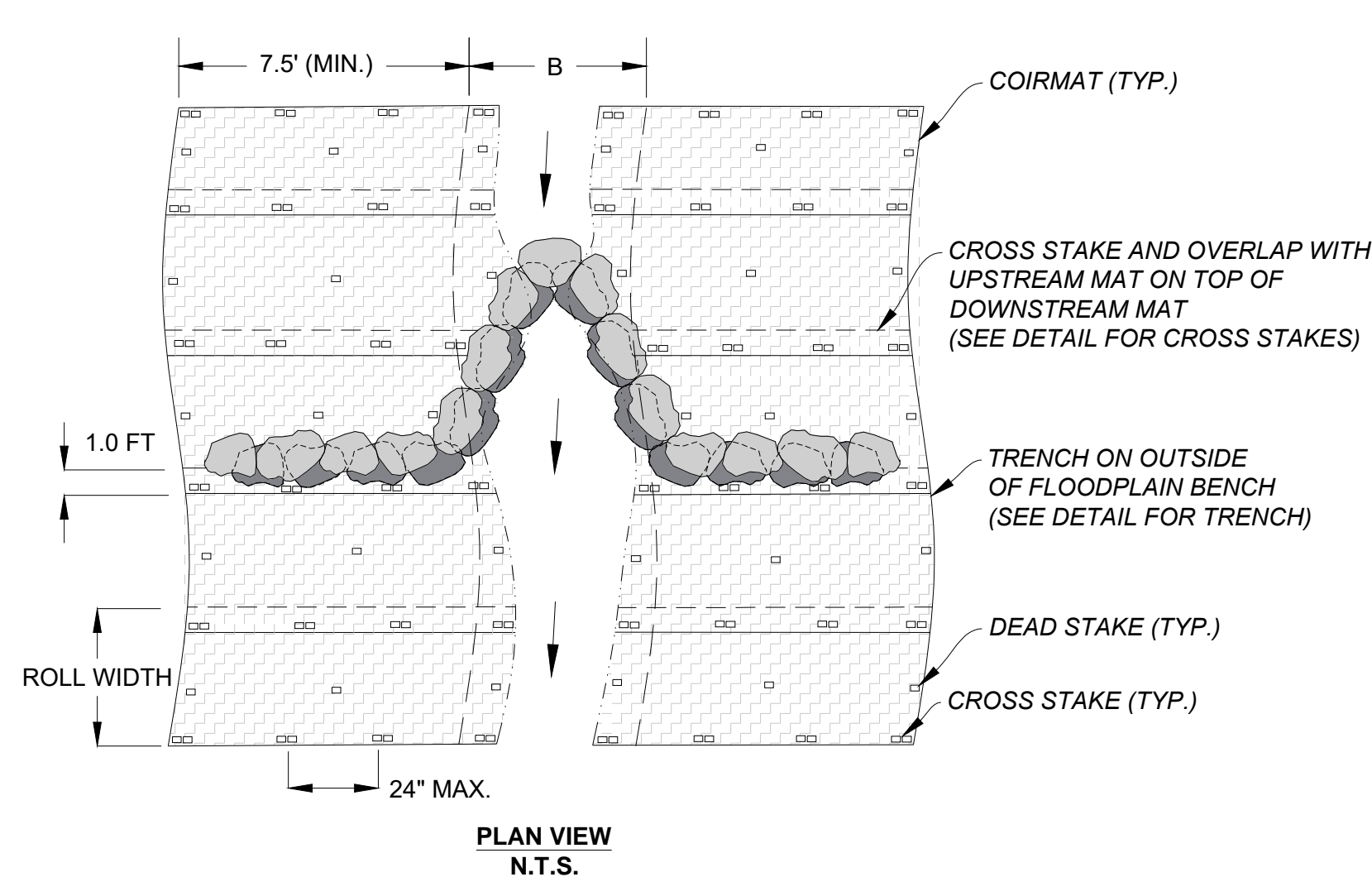
BLACK SWAN RESTORATION PROJECT

AS BUILT DATE	DETAIL - CROSS-VANE FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY DMS		13
CHECKED BY BJB		
A&E FILE NO.		



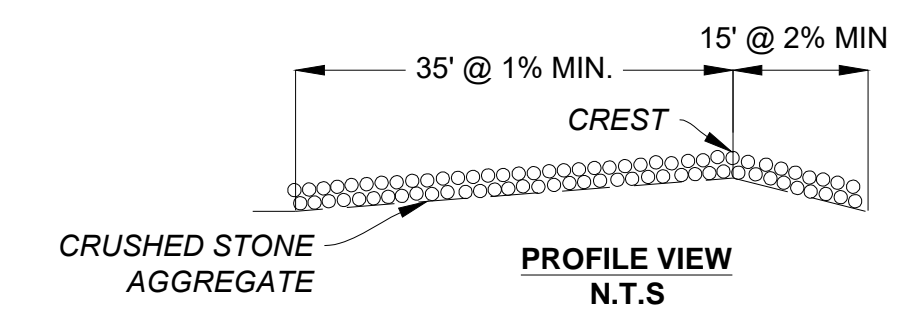
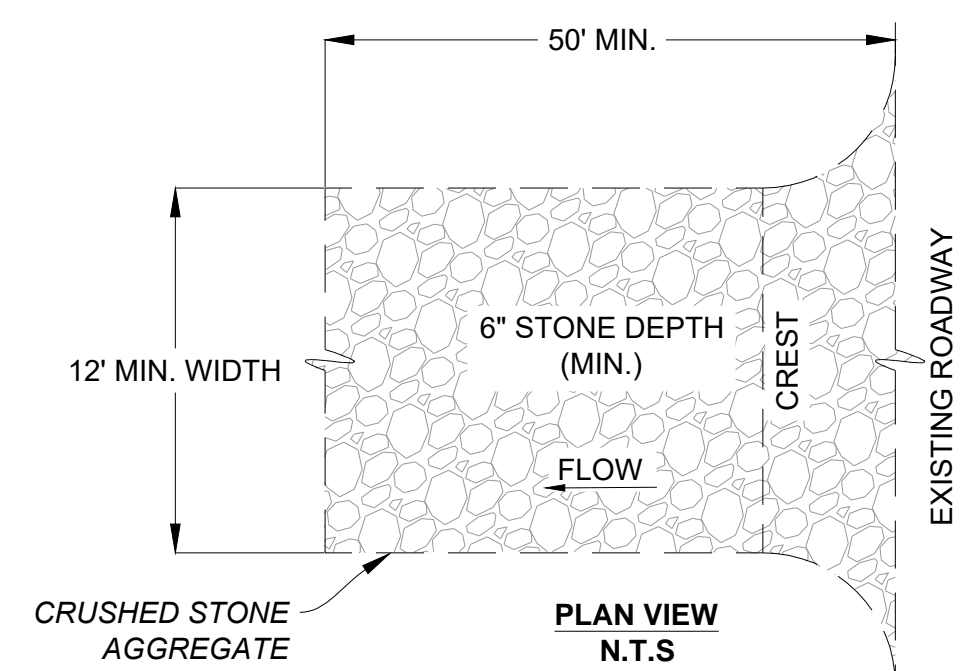
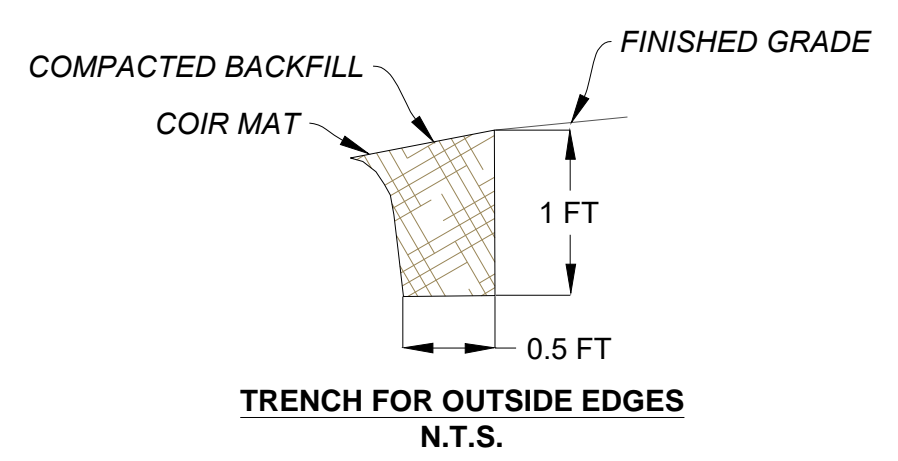
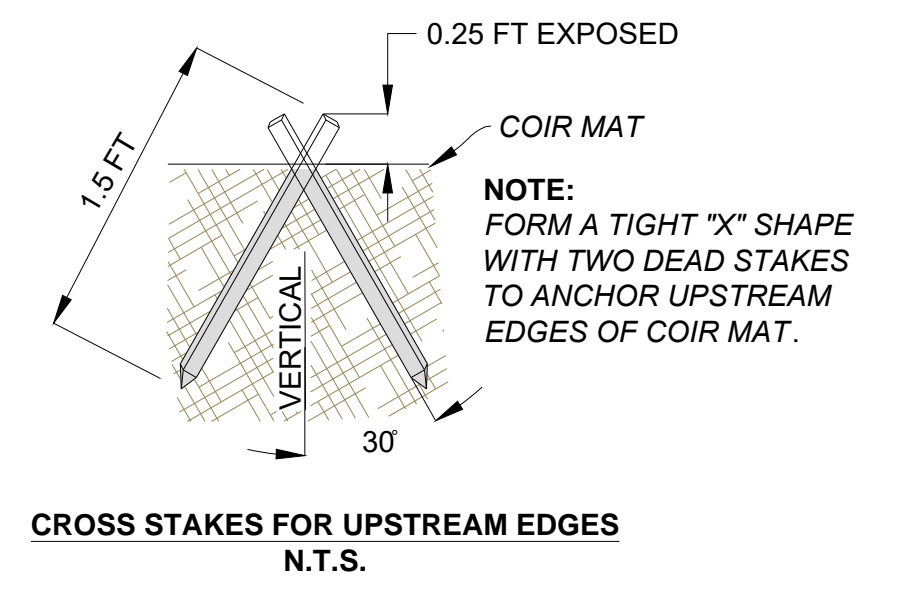
DATE
MAY 2018

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LEXINGTON, KENTUCKY 40502
PHONE: 615-491-1967

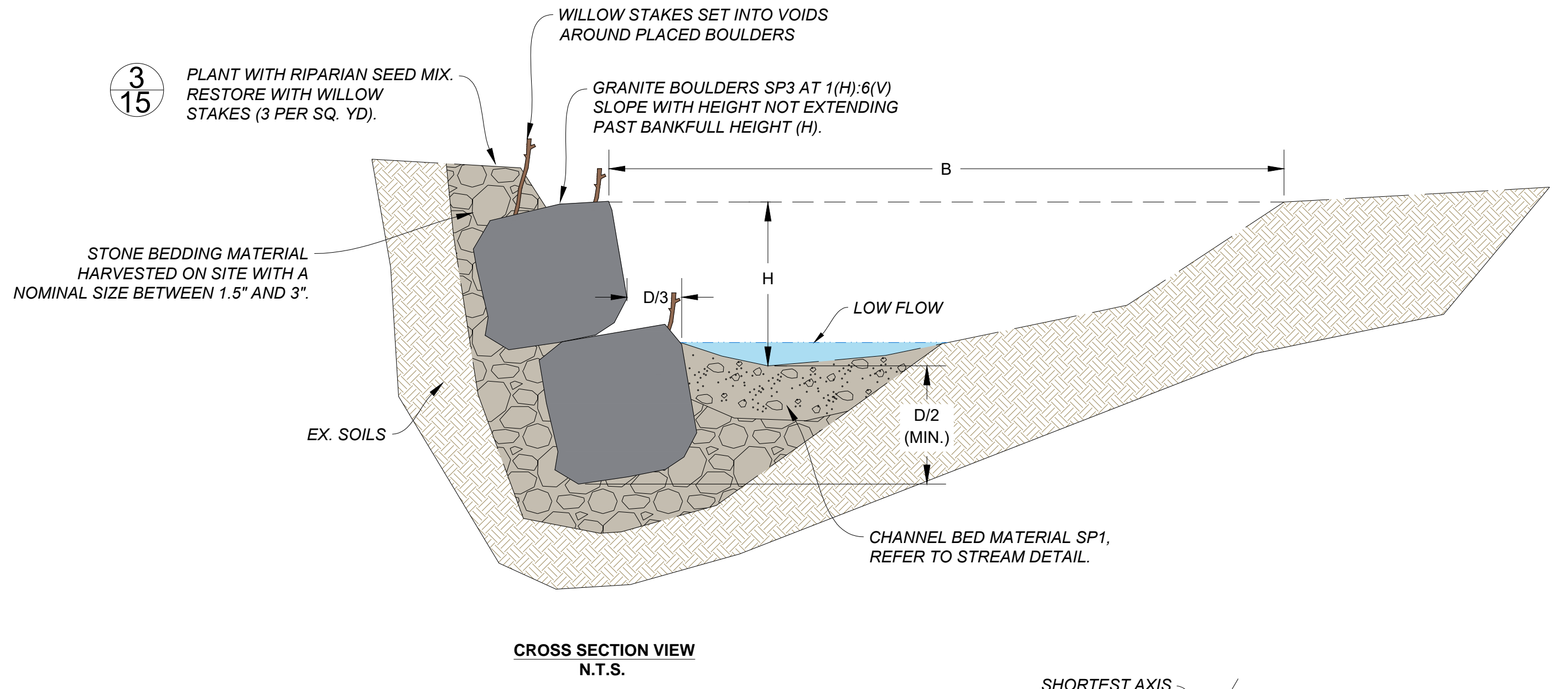


- NOTES:**
1. PLACE COIR MAT ON ALL DISTURBED BANKS AND ALL FINISHED SLOPES OF 2(H):1(V) OR STEEPER.
 3. USE 1" X 1" X 18" DEAD WOODEN STAKES TO FASTEN COIR MAT TO FINISHED GRADE.

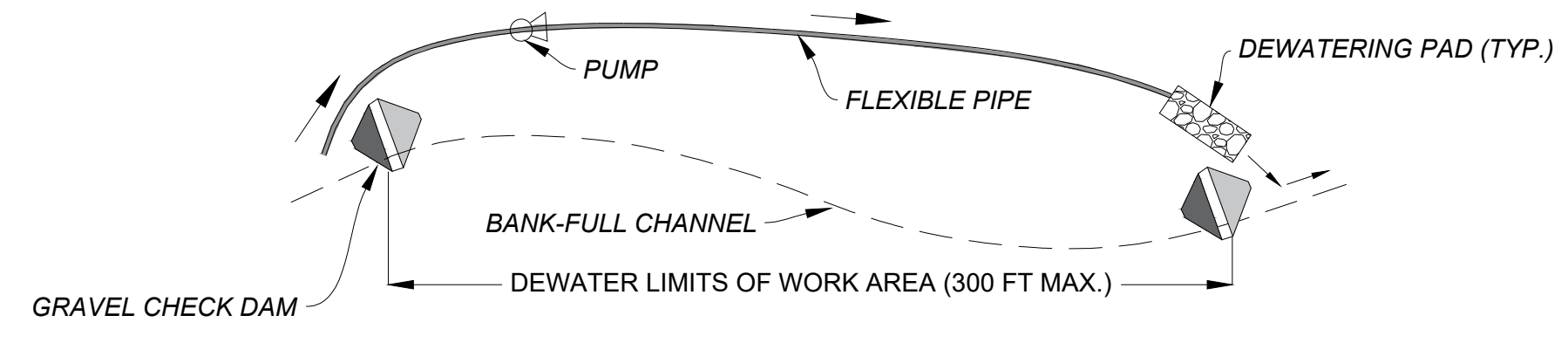
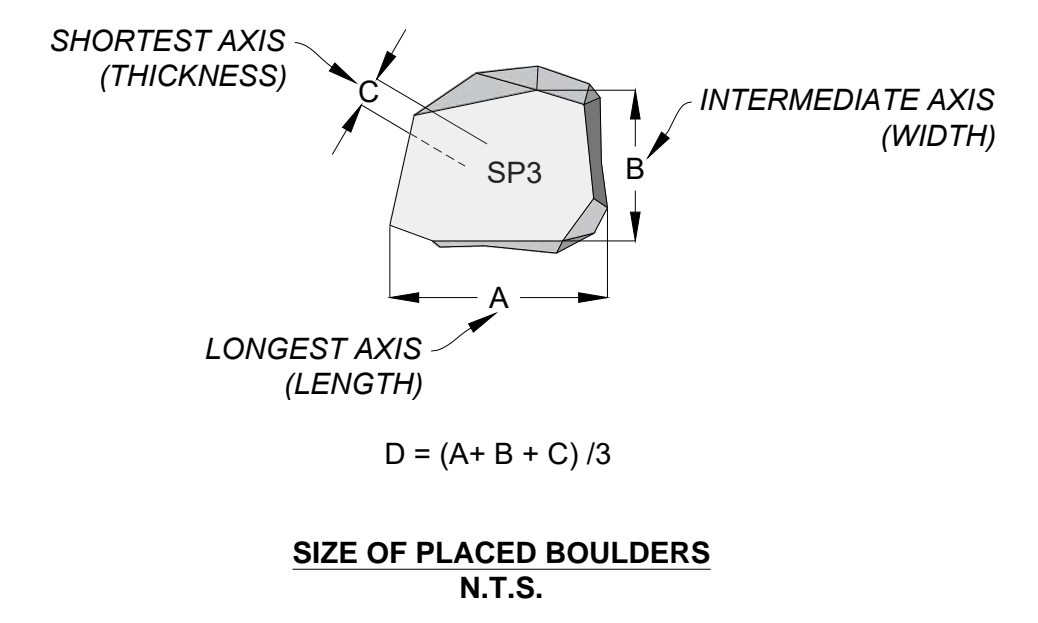
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14 **DETAIL - COIR MAT**
N.T.S.



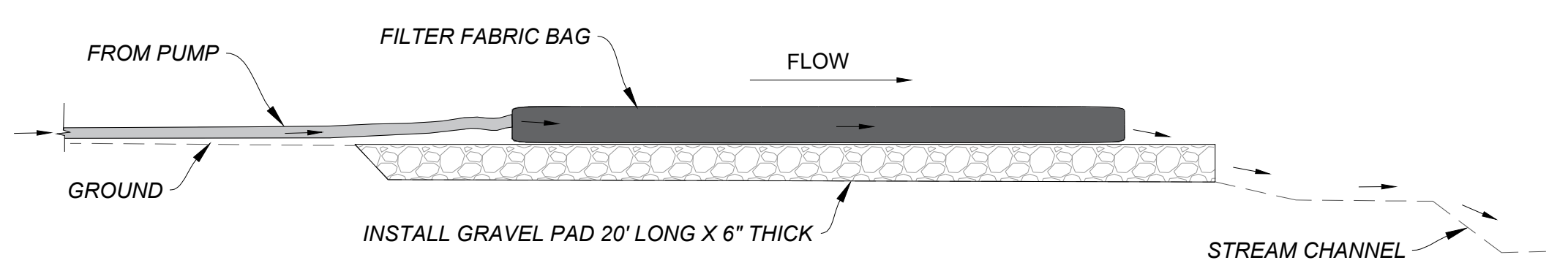
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14 **DETAIL - STABILIZED CONSTRUCTION ENTRANCE**
N.T.S.



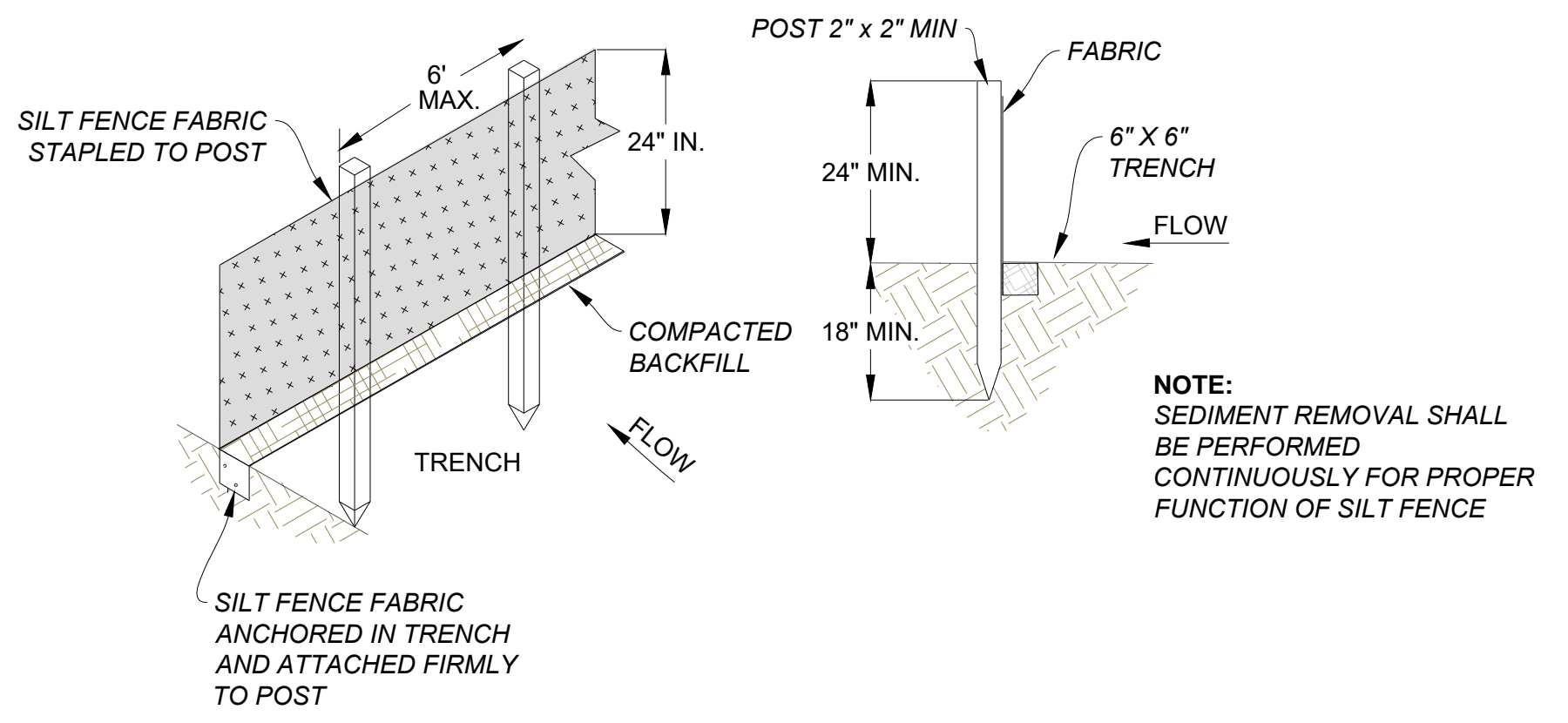
6
14 **DETAIL - BOULDER-TOE**
N.T.S.



2
14 **DETAIL - PUMP-AROUND DIVERSION OPERATION**
N.T.S.



3
14 **DETAIL - DEWATERING PAD**
N.T.S.



5
14 **DETAIL - SILT FENCE**
N.T.S.



BLACK SWAN RESTORATION PROJECT		
AS BUILT DATE	DETAIL - EP & SC FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	DRAWING NO.
DRAWN BY		14
CHECKED BY		
A&E FILE NO.		
DATE	 BEAVER CREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967	
MAY 2018		

PLANTS NEEDED FOR STANDARD RESTORATION¹

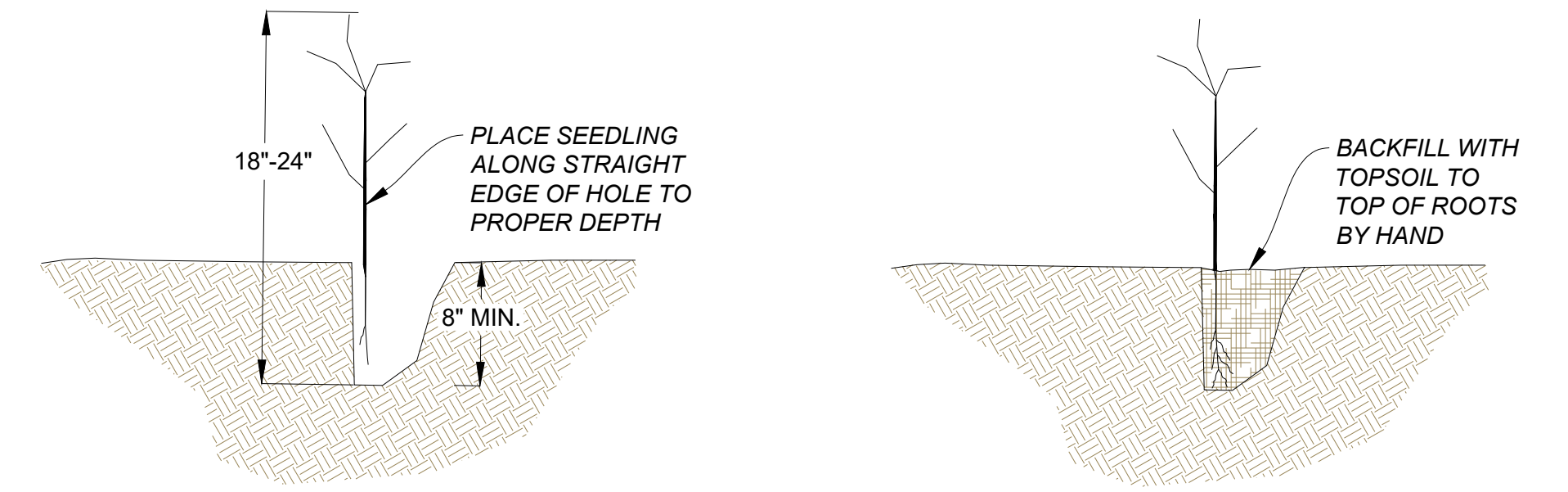
COMMON NAME	SCIENTIFIC NAME	PLANT SIZE (CUBIC INCH)	PLANTS PER ACRE
ZONE A: CHANNEL EDGE²			
BLUE JOINT	<i>Calamagrostis canadensis</i>	10	750
NEBRASKA SEDGE	<i>Carex nabrescensis</i>	10	1,500
WOOLLY SEDGE	<i>Carex peltita</i>	10	1,000
COMMON SPRINKLERUSH	<i>Eriochloa palustris</i>	10	1,000
BALTIC RUSH	<i>Juncus balticus</i>	10	1,000
RED-TINGE BULRUSH	<i>Scirpus microcarpus</i>	10	750
	TOTAL:		6,000
ZONE B: LOWER RIPARIAN²			
SPECKLED ALDER	<i>Atrus incana</i>	40	1,000
WATER BIRCH	<i>Betula occidentalis</i>	40	750
RED OSIER	<i>Cornus alba</i>	40	750
MIXED COTTONWOOD/WILLOW/ALDER	<i>Populus/Salix/Atrus spp</i>	Transplant	As Available
NARROW-LEAF COTTONWOOD	<i>Populus angustifolia</i>	40	1,250
NARROW-LEAF COTTONWOOD	<i>Populus angustifolia</i>	5 Cutting	2,000
MIXED WILLOW	<i>Salix spp</i>	5 Cutting	2,000
NARROW-LEAF WILLOW	<i>Salix exigua</i>	40	1,250
DEWY-STEM WILLOW	<i>Salix irrorata</i>	40	1,000
	TOTAL:		10,000
ZONE C: UPPER RIPARIAN²			
NARROW-LEAF COTTONWOOD	<i>Populus angustifolia</i>	40	350
CHICKE CHERRY	<i>Prunus virginiana</i>	40	350
COMMON SNOWBERRY	<i>Symphoricarpos albus</i>	40	350
WOODS' ROSE	<i>Rosa woodsii</i>	40	350
	TOTAL:		1,400

¹Zone A is 0-1'; Zone B is 1-2'; and Zone C is 2-3' above low-flow water surface; all plant nomenclature from Corps 2018
²Quantities based on approximately 3-foot centers for containerized stock
³Quantities based on approximately 6-foot centers

RIPARIAN SEED MIX¹

COMMON NAME	SCIENTIFIC NAME	VARIETY ²	SEEDS PER POUND ³	SEEDS PER SQUARE	POUNDS OF PURE LIVE SEED/ACRE
SIDEONTS GRAMA	<i>Bouteloua curtipendula</i>	Vaughn	191,000	5.3	1.2
BLUE GRAMA ⁴	<i>Bouteloua gracilis</i>	Birds Eye, Alma, Lovington, or native	825,000	11.4	0.6
G SLENDER WHEATGRASS	<i>Elymus trachycaulus</i>	San Luis or Firststrike	159,000	4.4	1.2
R IDAHO FESCUE ⁴	<i>Festuca idahoensis</i>	Winchester	450,000	8.3	0.8
A FOWL MARAIGRASS	<i>Glyceria striata</i>	-	180,000	5.0	2.0
M NEEDLE AND THREAD	<i>Hesperostipa comata</i>	-	115,000	5.3	2.0
I PRAIRIE JUNEGRASS ⁵	<i>Koeleria macrantha</i>	-	2.3 million	5.3	0.1
N BALTIC RUSH ⁶	<i>Juncus balticus</i>	-	10.9 million	25.0	0.1
O TORREY'S RUSH ⁶	<i>Juncus torreyi</i>	-	12.3 million	28.2	0.1
I GREEN NEEDLEGRASS	<i>Nassella viridula</i>	Cucharas or Lodorm	181,000	4.2	1.0
D WESTERN WHEATGRASS	<i>Pascopyrum smithii</i>	Arriba	110,000	10.1	4.0
S FOWL BLUEGRASS ⁵	<i>Poa palustris</i>	-	3.2 million	7.3	0.1
S SANDBERG BLUEGRASS ⁵	<i>Poa secunda</i>	Sims Mesa or High Plains	1 million	6.9	0.3
LITTLE BLUESTEM	<i>Schizochyrium scoparium</i>	Pasture, Cimarron, or Campler	290,000	6.0	1.0
F COMMON YARROW ⁶	<i>Achillea millefolium</i>	-	2.7 million	6.2	0.1
R ROCKY MOUNTAIN BEEPLANT	<i>Cleome serrulata</i>	-	66,000	3.0	2.0
O GOLDEN TICKSEED ⁶	<i>Coreopsis tricolora</i>	-	1.4 million	3.2	0.1
B BLANKETFLOWER	<i>Gallardia aristata</i>	Meriwether	132,000	1.5	0.5
S SHOWY GOLDENEYE ⁶	<i>Helianthus multiflorus</i>	-	1 million	2.3	0.1
S AMERICAN VETCH	<i>Vicia americana</i>	-	33,000	0.8	1.0
BULK RICE HULLS	-	-	-	-	6.7
	TOTAL:			153.0	25.0

¹Nomenclature follows PLANTS Database (USDA, NRCS 2018); seeding rate based on broadcasting; any substitutions must be native to Colorado and from a Colorado, New Mexico, Utah, or Wyoming seed source.
²Sources: USDA, NRCS 2018, Granite Seed 2018, Prairie Moon Nursery 2018, Western Native Seed 2018



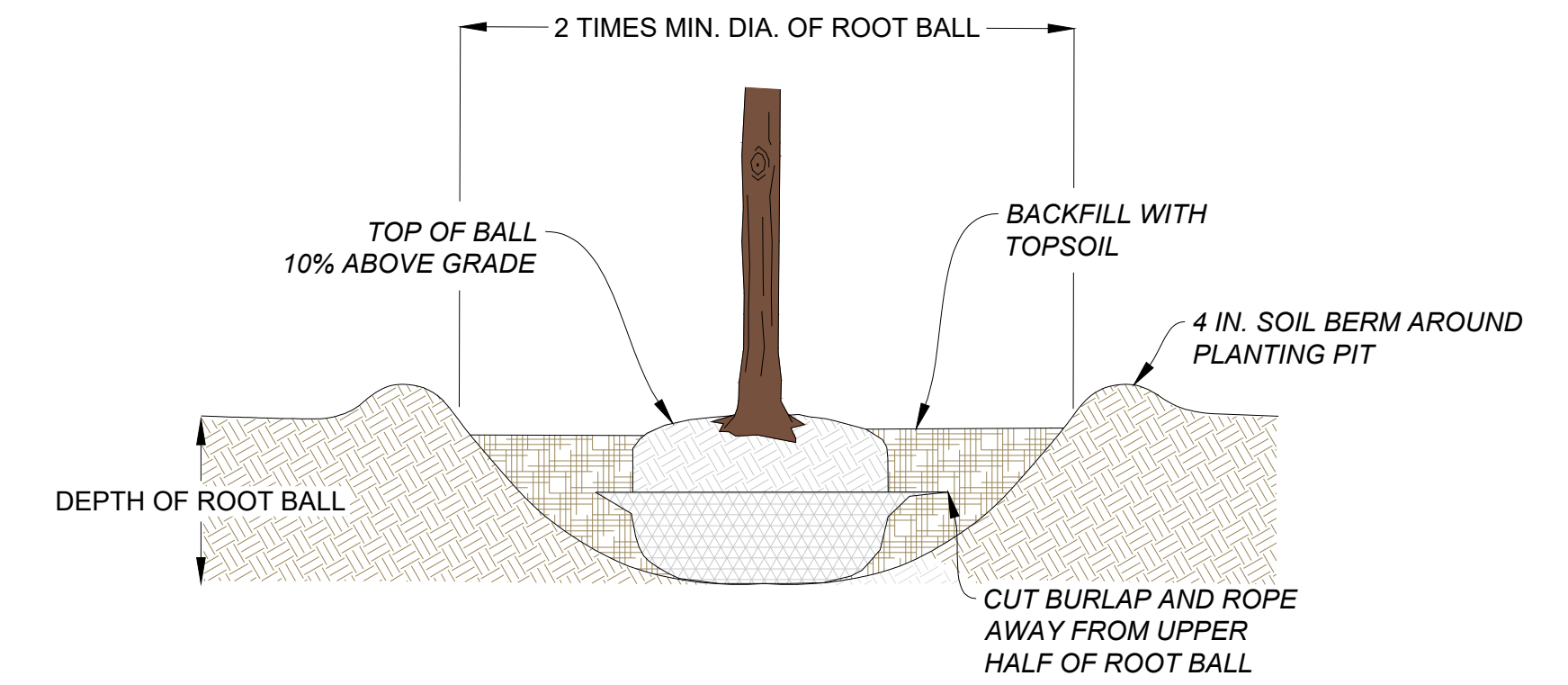
1 15 **DETAIL - PLANTING OF BARE ROOT SEEDLING**
N.T.S.

PLANTING PLAN NOTES:

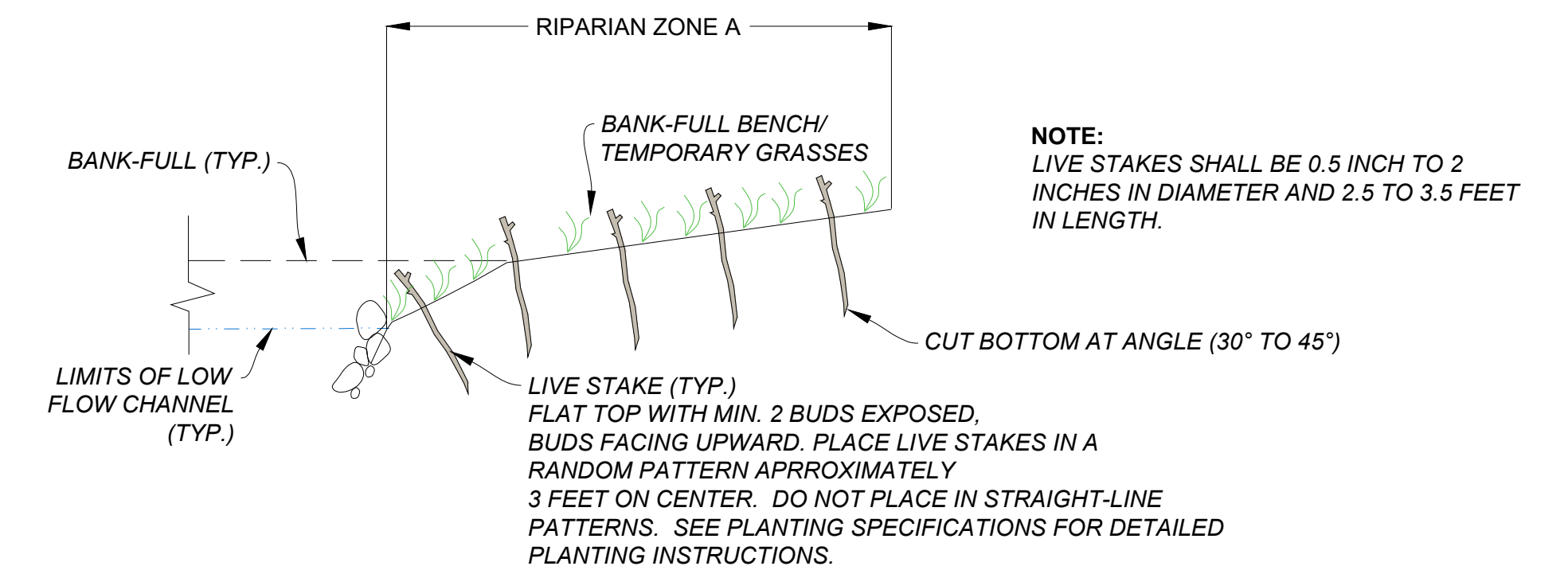
- ANY TREES TO BE REMOVED FOR THE PROJECT WILL BE REMOVED DURING THE NON-NESTING SEASON FOR MIGRATORY BIRDS (BETWEEN SEPTEMBER 1 AND MARCH 31). IF THIS IS NOT POSSIBLE, ACTIVE NEST SURVEYS FOR MIGRATORY BIRDS MAY BE REQUIRED.
- TO AVOID THE CONTINUED SPREADING OF NOXIOUS WEEDS, ALL DISCRETE POPULATIONS OF COLORADO LIST A AND B NOXIOUS WEEDS FOUND IN OR WITHIN 100 FEET OF THE RESTORATION AREA WILL BE SPRAYED WITH THE APPROPRIATE HERBICIDE(S) PRIOR TO CONSTRUCTION. WEED POPULATIONS MUST BE IDENTIFIED BY A QUALIFIED ECOLOGIST DURING THE GROWING SEASON.
- ALL FINISH GRADES WILL BE LOOSE AND ROUGH WITH SUBSTANTIAL "MICROTOPOGRAPHY" (PLUS OR MINUS 4 INCHES) AND STRAIGHT EDGES AND RIGHT ANGLES WILL BE AVOIDED. ALL WORK AREAS (OTHER THAN THE IMMEDIATE CHANNEL BANKS) WILL BE LOOSENEED TO A DEPTH OF 12 INCHES BEFORE PLANTING OR SEEDING.
- ALL AREAS DISTURBED BY THE PROJECT (INCLUDING SOIL LIFTS), EXCEPT ZONE A, WILL BE AMENDED WITH 300 CUBIC YARDS PER ACRE OF COMPOST. THE COMPOST WILL BE MIXED WITH NATIVE SOIL/ALLUVIUM TO A DEPTH OF 12 INCHES. THE COMPOST MUST HAVE THE FOLLOWING CHARACTERISTICS:
 - pH: 5.5-8.0
 - CARBON TO NITROGEN RATIO: 20:1 OR LOWER (10 TO 12:1 IDEAL)
 - SOLUBLE SALT CONCENTRATION: 5.0 dS (mmhos/cm) OR LESS PREFERRED
 - ORGANIC MATTER CONTENT: 30-70 PERCENT
- ALL WILLOW AND COTTONWOOD CUTTINGS WILL BE COLLECTED ON-SITE OR FROM ELSEWHERE IN BOULDER COUNTY (OR IMMEDIATELY ADJACENT COUNTIES) WITHIN 1,000 VERTICAL FEET OF NEAR THE SITE, AS APPROVED BY A QUALIFIED ECOLOGIST. ACCEPTABLE WILLOW SPECIES FOR "MIXED WILLOW" INCLUDE (NOMENCLATURE FROM CORPS 2018): SALIX EXIGUA, S. INTERIOR, S. IRRORATA, S. BEBBIANA, S. MONTICOLA, S. DRUMMONDIANA, S. LIGULIFOLIA, AND S. LASIANDRA. NO ONE SPECIES CAN ACCOUNT FOR MORE THAN 70 PERCENT OF THE MIX. ALL CUTTINGS WILL BE HARVESTED WHEN DORMANT (BEFORE LEAVES EMERGE OR AFTER THEY ARE DROPPED) FROM LIVE PLANTS 0.5 TO 1.0 INCH IN DIAMETER. THE STEM WILL BE STRIPPED OF ALL BRANCHES BEFORE CUTTING AND THEN TRIMMED TO THE DESIRED LENGTH. THE LOWER (ROOTING) END OF THE STEM WILL BE CUT AT A 45 DEGREE ANGLE AND THE UPPER END WILL BE CUT AT 90 DEGREE ANGLE. THE CUTTINGS WILL BE PLACED INTO WATER WITHIN TWO MINUTES OF CUTTING AND SOAKED—COMPLETELY SUBMERGED—FOR AT LEAST 72 HOURS, BUT NOT MORE THAN 14 DAYS, PRIOR TO PLANTING. THE CUTTINGS WILL BE KEPT WET UNTIL PLACED INTO THE GROUND AND WILL NOT BE ALLOWED OUT OF WATER FOR MORE THAN 10 MINUTES DURING PLANTING. ALL CUTTINGS WILL BE TRIMMED AFTER INSTALLATION TO ENSURE THAT NO MORE THAN ONE-THIRD OF THEIR LENGTH IS LEFT ABOVE GROUND.
- ALL PLANT MATERIAL (INCLUDING CUTTINGS) WILL BE INSPECTED BY A QUALIFIED ECOLOGIST PRIOR TO PLANTING. ANY IMMATURE, DEAD, DYING, STRESSED, OR BADLY "ROOTBOUND" PLANTS WILL BE REJECTED.
- A QUALIFIED ECOLOGIST WILL DIRECT AND SUPERVISE ALL PLANT HARVEST AND INSTALLATION
- THE EXACT LOCATIONS OF LIVE PLANT MATERIAL IN ZONES A, B, AND C WILL BE BASED ON THE FINAL GRADING, AS DETERMINED BY A QUALIFIED ECOLOGIST.
- NO EQUIPMENT WILL BE ALLOWED IN THE RESTORATION AREA AFTER THE SOIL IS LOOSENEED. SEED AND MULCH MUST BE APPLIED BY HAND OR BY WORKING FROM THE EDGE OF THE RESTORATION AREA.
- ALL DISTURBED AREAS WILL BE BROADCAST-SEEDED WITH THE RIPARIAN SEED MIX.
- SEEDING WILL ONLY BE PERFORMED BETWEEN SEPTEMBER 1 AND WHEN THE GROUND FREEZES, AND WHEN THE GROUND THAWS AND JUNE 1, UNLESS APPROVED BY A QUALIFIED ECOLOGIST.
- AFTER SEEDING, ALL AREAS (EXCEPT ZONE A) WILL BE HYDROMULCHED PER THE MANUFACTURER'S SPECIFICATIONS TO ACHIEVE APPROXIMATELY 80 PERCENT GROUND COVER. HYDROMULCH WILL INCLUDE A CELLULOSE-BASED TACKIFIER.
- ALL BEST MANAGEMENT PRACTICES (BMPs) SHALL BE SELECTED INSTALLED, IMPLEMENTED, AND MAINTAINED ACCORDING TO APPROPRIATE ENGINEERING, HYDROLOGIC, AND POLLUTION CONTROL PRACTICES.
- THE USE OF CHEMICALS SUCH AS SOIL STABILIZERS, DUST PALLIATIVES, HERBICIDES, GROWTH INHIBITORS, FERTILIZERS, DEICING SALTS, ETC., SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDED APPLICATION RATES, FREQUENCY, AND INSTRUCTIONS. THESE CHEMICALS SHALL NOT BE USED, STORED, OR STOCKPILED WITHIN 50 HORIZONTAL FEET OF THE CREEK OR OTHER AQUATIC HABITATS.
- IF FENCING WILL BE INSTALLED, IT WILL BE WILDLIFE FRIENDLY AND HAVE: (1) A SMOOTH BOTTOM WIRE AT LEAST 16 INCHES OFF THE GROUND, (2) A TOP WIRE NO HIGHER THAN 40 INCHES, AND (3) AT LEAST 12 INCHES BETWEEN THE TOP TWO WIRES.
- ALL WASTE MATERIALS GENERATED BY THE CONSTRUCTION OF THE MITIGATION SITE (SLASH, SOIL, ROCK, ETC.) WILL BE STOCKPILED AND DISPOSED OF IN AN APPROVED UPLAND LOCATION.

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2 15 **DETAIL - PLANTING OF SHRUBS/TREES**
N.T.S.



3 15 **DETAIL - PLANTING OF LIVE STAKES**
N.T.S.

DESIGN TABLE

Reach Name	STA (ft)	S (ft/ft)	Stream type	Q _{bkf} (ft ³ /s)	A (ft ²)	U (ft/s)	B/H	B (ft)	H (ft)	H _{max} (ft)	H _t (ft)	L (ft)	P2P (ft)	D ₈₄ (ft)	D _{stone} (ft)
1	12+91 - 17+17	0.05	A	55	15.9	3.6	19.0	17.4	0.9	1.6	2.6	52.1	26.0	2.3	3.6
2	17+17 - 17+71	0.11	A	55	17.8	3.1	16.1	17.0	1.1	1.9	2.8	50.8	25.4	2.3	3.6
3	17+71 - 20+36	0.03	B	55	17.3	3.2	11.3	14.0	1.2	2.2	3.2	59.5	29.8	2.3	3.6
4	20+36 - 21+38	0.05	A	55	15.1	3.7	9.5	12.0	1.3	2.3	3.2	35.9	18.0	2.3	3.6
5	21+38 - 24+24	0.03	B	55	21.2	2.7	23.5	22.3	1.0	1.7	2.7	95.2	47.6	2.3	3.6
6	24+24 - 28+03	0.04	A	55	16.1	3.6	16.3	16.2	1.0	1.8	2.7	48.6	24.3	2.3	3.6
7	28+03 - 31+18	0.05	A	55	17.3	3.2	14.2	15.7	1.1	2.0	2.9	47.1	23.5	2.3	3.6
8	31+18 - 34+04	0.03	B	55	20.0	2.8	15.9	17.8	1.1	2.0	3.0	76.0	38.0	2.3	3.6
9	34+04 - 36+66	0.04	A	55	16.9	3.4	15.5	16.2	1.0	1.9	2.8	48.6	24.3	2.3	3.6
10	36+66 - 43+65	0.06	A	55	16.9	3.4	23.5	19.9	0.9	1.5	2.5	59.7	29.9	2.3	3.6
11	43+65 - 48+76	0.03	B	55	21.6	2.6	18.3	19.9	1.1	2.0	2.9	84.6	42.3	2.3	3.6
12	48+76 - 54+91						COMPLETED BY OTHERS								
13	54+91 - 61+90	0.02	B	55	18.4	3.2	23.5	20.8	0.9	1.6	2.5	88.5	44.2	2.3	3.6

HEADING DEFINITIONS

- S: EXISTING CHANNEL SLOPE
- STREAM TYPE: PROPOSED STREAM TYPE
- Q_{bkf}: BANK-FULL DISCHARGE
- A: PROPOSED BANK-FULL AREA
- U: FLOW VELOCITY
- B/H: PROPOSED ASPECT RATIO
- B: PROPOSED BANK-FULL WIDTH
- H: PROPOSED BANK-FULL MEAN DEPTH
- H_{max}: PROPOSED BANK-FULL MAX DEPTH
- H_t: PROPOSED BANK-FULL TRENCH DEPTH
- L: PROPOSED WAVELENGTH
- P2P: PROPOSED POOL TO POOL SPACING
- D₈₄: PROPOSED 84% DIAMETER PARTICLE
- D_{stone}: PROPOSED BOULDER DIAMETER

BLACK SWAN RESTORATION PROJECT		
AS BUILT DATE	DESIGN TABLE & PLANTING PLAN	DRAWING NO.
DRAWN BY DMS	FOURMILE WATERSHED COALITION 1740 FOURMILE CANYON DRIVE BOULDER, CO 80302	15
CHECKED BY BJB		
A&E FILE NO.		
DATE MAY 2018	 BEAVER CREEK HYDROLOGY, LLC 907 NATIONAL AVENUE LEXINGTON, KENTUCKY 40502 PHONE: 615-491-1967	





FRONTIER
ENVIRONMENTAL SERVICES

5350 Vivian Street, Unit B, Arvada, CO 80002 • 303.234.9350 • frontierenvironmental.net

FOURMILE WATERSHED COALITION

**Black Swan Stream Restoration Project
Mine Waste Removal Action**

PROJECT SPECIFIC HEALTH AND SAFETY PLAN

**FRONTIER ENVIRONMENTAL SERVICES, LLC
5350 VIVIAN STREET, UNIT B
ARVADA, COLORADO 80002-1940**

**TELEPHONE NUMBER: (303) 234-9350
FAX NUMBER: (303) 234-9371**

April 2018

**FRONTIER ENVIRONMENTAL SERVICES
PROJECT HEALTH AND SAFETY PLAN**

Table of Contents

FRONTIER ENVIRONMENTAL SERVICES HEALTH AND SAFETY PLAN CERTIFICATION.....	1
I. FRONTIER ENVIRONMENTAL SERVICES HEALTH AND SAFETY PLAN.....	2
II. SITE SPECIFIC HEALTH AND SAFETY PLAN.....	5
III. SITE CONTROL.....	11
IV. INDUSTRIAL HYGIENE PROCEDURES.....	13
V. PERSONAL PROTECTIVE EQUIPMENT	17
VI. DECONTAMINATION PROCEDURES	20
VII. MEDICAL SURVEILLANCE	22
VIII. FIRST AID AND MEDICAL SUPPORT.....	26
IX. RESPIRATORY PROTECTION	28
X. HEARING CONSERVATION & PROTECTION.....	32
XI. PERSONNEL TRAINING.....	35
XII. HEAVY EQUIPMENT OPERATION AND SAFE MATERIALS HANDLING.....	40
XIII. HOT WORK PROCEDURES.....	44
XIV. EMERGENCY RESPONSE.....	51
XV. EMERGENCY COMMUNICATIONS.....	57
XVI. HAZARD ANALYSES	58
XVII. JOB SAFETY ANALYSES.....	60

FRONTIER ENVIRONMENTAL SERVICES PROJECT SPECIFIC HEALTH AND SAFETY PLAN

I. FRONTIER ENVIRONMENTAL SERVICES HEALTH AND SAFETY PLAN

A. Introduction

The Frontier Environmental Services ("Frontier") Project Specific Health and Safety Plan (H&SP) has been written to establish programs, develop plans and implement procedures which will comply with 29 CFR 1910.120 (p) and meet or exceed the requirement for the protection of Frontier personnel, vendors, sub-contractors and visitors.

This health and safety plan has been designed to identify, evaluate and control safety and health hazards encountered on Frontier projects for the purpose of employee protection. The implementation of this site specific health and safety plan will help provide Frontier employees, its suppliers and vendor, sub-contractors and the client with a safe and healthy working environment.

Protection of human health and the environment is the prime objective in performing project site activities. The realization of this objective during project activity depends on the efforts and attitudes of management, and the cooperation of all employees.

Work at this Frontier project site will be performed according to all applicable federal, state and local regulations and Frontier Environmental Services Standard Operating Procedures.

Frontier is an environmental design, engineering, remediation and construction company, which in the course of its implementation of this project may handle materials, including heavy metal contaminated soils, debris, and mine tailing wastes prior to permanent materials management alternatives defined by the Scope of Work.

Special employee work procedures and special handling requirements for ignitable, incompatible and reactive materials, e.g. fuel oil and ammonia containing fertilizers are addressed in this site specific health and safety plan. These work procedures and special handling procedures will effectively minimize the development of emergency situations.

B. Scope

All operations that involve management of contaminated materials or have the potential for exposing project personnel to potentially dangerous and/or infectious materials, vehicle traffic, site equipment and site soils preparation operations will be subject to this Project Specific Health and Safety Plan. All personnel will be responsible for continuous compliance with established safety procedures during the performance of their work.

In no case will work be performed in a manner that conflicts with the health and safety instructions described in this Health and Safety Plan, any standard operating procedures or other programs, plans and procedures in place for any activity at a Frontier project site. After having received warnings, personnel violating safety procedures may be subject to disciplinary action, which may include written reprimand, suspension without pay or termination of employment. All site employees will be instructed in the Health and Safety Plan standards.

The organizational structure of Frontier is described below and identifies those individuals responsible for all remedial and site reclamation operations and the individual who has the authority and responsibility to develop and implement the site Health and Safety Plan and to verify compliance.

Program Director: Brent Scarbrough, PE

As a Managing Member of Frontier, Mr. Scarbrough has overall responsibility for Frontier project operations and for the health and safety of employees, sub-contractors and visitors.

Project Manager: David Blowe

The Project Manager is responsible for regulatory and permit compliance for the project scope of work.

Project Superintendent: Sean Martinez

The Project Superintendent is responsible for day to day Frontier project operations.

Safety and Training Supervisor: Sean Martinez

The project Safety Supervisor is responsible for the implementation, documentation and supervision of site safety and health policies, programs and procedures. The safety supervisor is responsible for implementing and managing the site Health and Safety Plan.

Frontier Site Management and Supervisory Staff:

Each member of the project staff is responsible for the safety of individual employees in their work areas, work practices and hazard exposures.

Subcontractors:

Frontier holds their subcontractors responsible for following and complying with the Frontier project/site management for safe work practices and procedures as described in this plan.

Employees:

Avoiding adverse health effects and injuries is dependent on the active participation of all personnel. The person directly responsible for the employee's health and safety is the individual employee. As such, all site personnel have the authority to issue a "Stop Work" action if they recognize an unsafe site condition or unsafe activity/operation.

II. SITE HEALTH AND SAFETY PLAN

A. Objective and Purpose

Frontier intends to provide a safe and healthy working environment for all of its employees. Achieving compliance with health and safety regulations can only be accomplished through cooperation on the part of all personnel. The effectiveness of the Frontier Safety and Health Plan is dependent upon the efforts of management with the full and willing participation and cooperation of all Frontier employees.

To aid and effect the implementation of this plan, Frontier has implemented the following Safety and Health Plan objectives:

- To provide guidelines for uniform implementation of safety and health standards; which will ensure strict compliance with regulatory requirements;
- To develop and implement special safety and health procedures for work efforts not normally covered by regulatory guidelines;
- To establish requirements for continuing safety and health education, including but not limited to new-hire orientation, periodic general safety

education, special hazard recognition and control, Contingency Plan implementation and emergency response;

- To establish the requirements for Frontier emergency medical and first aid procedures and facilities;
- To use hazard analysis to develop engineering controls; identify job and design related safety and health concerns; evaluate new technology for systems currently in place and for new systems prior to their implementation; and
- To eliminate injuries, lost time accidents, other accidents, property damage and equipment failures.

B. Scope

Frontier's Project Health and Safety Plan includes policies for the safe operation of equipment, material handling; analyses of engineered systems; hazard recognition; and work behavior and personal conduct of on-site employees. The procedures, duties and responsibilities outlined in this plan will be in effect for the duration of Frontier operations. The plan may be amended as necessary.

C. Safety Objectives

It is the responsibility of Frontier management to enforce all applicable codes and regulations, which pertain to safety and health. Frontier safety and health policies and procedures are guides to realize the following principles:

- **Management is ultimately responsible for safety.** When senior management exerts sustained leadership in establishing consistent safety practices and establishes accountability for safety and health performance at the immediate supervisory level, a safety and health plan will be very effective. At Frontier, responsibility extends from the top executive, through middle management to a point of focus at first-line supervision. Effective safety and health management necessitates continuous management involvement and consistent employee implementation.
- **It is good business to prevent injuries and illnesses.** Accidents have a great impact on employee morale, operational effectiveness and the economic success of the company. Direct costs of accidents are far exceeded by hidden and indirect costs of loss of time, redirection of management effort and employee distraction.

- **All injuries are preventable.** This is a realistic goal, not a theoretical objective. Utilizing this premise, accidents can be prevented. All work place exposures, which may result in injuries, can be controlled; no matter what the exposure is, an effective safeguard can be provided.
- **It is preferable to eliminate the source of hazards.** Where this is not possible or practical, management must enact measures such as engineering controls, special training, administrative controls, specialized safety equipment or other personal protective equipment.
- **Safe work practices are a condition of employment.** The safety of each employee depends upon the attention, knowledge and prudent action of everyone. Therefore, the employees' acceptance of responsibility for their own safety and the safety of others is a prerequisite for continued employment.
- **Corrective discipline will be used as a sanction against safety violators in order to achieve acceptable performance.** Employees who habitually or arbitrarily engage in unsafe work practices will be disciplined using reprimand, suspension or dismissal.
- **Frontier requires that all employees be thoroughly trained to work safely.** An awareness of safety often does not come easily. Employees require training in order to meet realistic goals. Management will provide training in safety and health practices, policies, work methods and procedures. Training will help to ensure employees are able to work safely and respond effectively to emergency or other unexpected situations.
- **Keeping employees informed of safety and health hazards is an integral part of training.** Classroom and on-the-job training will be used effectively to teach, motivate and sustain safety knowledge and awareness. Through use of these methods, injuries can be eliminated.
- **Safety audits must evaluate performance in the work place to assess safety and health plan success.** Safety audits provide an ongoing assessment of safety and health conditions, procedures, and practices, and permit timely correction of any deficiencies. Without prompt corrective action to rectify an observed deficiency, risk of injury will increase and the credibility of the safety plan will suffer. Additionally, safety audits detect specific problems, identify weaknesses in safety and health management efforts and initiate corrective processes.

- **People are the most critical element of the Health and Safety Plan.** People provide the solutions to any safety problems. Management involvement in safety is a dynamic learning and teaching process, which serves as a stimulus for employee cooperation and participation. Providing opportunities for individual participation in safety management enhances both the plan's effectiveness and the employee's attitude about safety. Intelligent, trained and motivated employees are the company's greatest resource.

D. **Standards of Conduct**

In order to provide the safest work environment possible for Frontier employees, contractors and visitors, the following rules and standards of conduct must be adhered to:

1. As directed by management, safety equipment must be worn at all times. For employees and sub-contractor personnel this, at a minimum, will be customary construction dress (shirt and trousers or coveralls), hard hat, steel toed boots or shoes, and safety glasses. Sub-contractor personnel must have their own respirators and comparable safety equipment with them while working onsite.
2. Level D Personal Protective Equipment will be worn when in areas where work activities may be taking place, unless a greater level of protection is deemed necessary by the Project Safety Supervisor. Visitors who do not have their own safety equipment will be issued appropriate safety equipment with protective clothing, if necessary.
3. Visitors will turn in all Frontier supplied equipment to the Safety Supervisor prior to leaving the site.
4. Because of the nature of the work and the numbers of people who will work at and visit the Site, it is very important for everyone to work and behave in a professional manner. Care must be taken to work in the safest way possible. Actions or behavior, which may harm or endanger another person, must be avoided. Pushing, shoving, horseplay, rough-housing, throwing things, practical jokes, and other boisterous or disruptive behavior will not be tolerated. Fighting is grounds for immediate disciplinary action, which may include dismissal.
5. Consumption of controlled substances and alcoholic beverages on the project site being managed by Frontier is strictly forbidden.

6. Firearms are absolutely prohibited on any Frontier project site.
7. Electronic music devices and headphones are prohibited in hazardous materials management areas.
8. Decontamination procedures for work practices will consist of normal personal hygiene, unless a higher level of protection is instituted.
9. No smoking, eating, drinking, gum or tobacco chewing is allowed, except in designated areas as follows:

Smoking will only be allowed in posted areas of the project site.

Eating, drinking, chewing gum or tobacco will only be allowed in the designated break or lunch area, or the project parking lot.

Drinking water is available at locations in various designated project locations.

Absolutely no use of tobacco, food or drink will be allowed within the controlled hazardous materials operations area, exclusion zones, decontamination zones, including site vehicles and equipment except as described above.

10. Equipment will be operated only as described in company training, and then only by fully qualified and trained employees, contractors or vendor personnel. Faulty or inoperative equipment will be reported to management immediately after discovery.
11. Management must be notified when employees or visitors will be working onsite.
12. Employees removing property from a Frontier project must have written authorization from the Site Superintendent or Project Manager and must present it when leaving the project.
13. Unless authorized by Frontier management, employees and contractor personnel will not work alone in areas where construction hazards or the management of hazardous materials are managed. Personnel working by themselves or in remote areas of the site must have authorization from their supervisor and a site communications radio in their possession.

14. Confined spaces will absolutely not be entered without a permit from the Safety Supervisor. If any area is questionable as to whether or not it is a confined space, always ask your supervisor, escort, the Safety Supervisor or project management.
15. All clothing worn within a project-controlled area, including protective clothing will not be taken from the project by employees. Any personal protective equipment clothing worn into project management areas will stay on site.
16. Violation of established rules, standards of conduct or endangerment of employees, contractors or visitors must be brought to the attention of project management immediately. Safety violations or misconduct can threaten everyone. Willful disregard of safety cannot be tolerated. Failure to follow these or any other rules or standards of conduct as directed by management may result in removal of visitors, dismissal of contractors or disciplinary action against employees (which may include suspension without pay or immediate dismissal).

Compliance with these standards will help provide a safer work environment for everyone on the Project.

III. SITE CONTROL

Site control is an important aspect of minimizing the physical and chemical hazards to which personnel may be exposed. In emergency situations site control involves managing the movement of people and emergency response equipment.

A. Site Communications

An external communications system will be available to coordinate with outside agencies. Due to the remote nature of the site, Two-way radios provided by the Fourmile Fire Protection District will be the primary means of emergency communications.

B. Procedure for Visitors

1. After receiving authorization from project management and prior to arrival, the employee expecting the visitor or contractor will notify the Safety Supervisor of the visitor's name and company name.

2. A record of the visitor's name, company/affiliation, and date they visited the project will be entered onto the project sign-in log and into project daily project activity log.
3. Each visitor will be issued safety equipment, which will include hardhat safety glasses and any other PPE device deemed appropriate for the work area to be visited.
4. Site management will record in the daily activity log the visitor as being on site. The visitor will be allowed to visit an employee, work in a specified area, tour the project site if accompanied by an escort, and move about the project site unaccompanied if approved to do so by site or project management.
5. With the exception of property owners; visitors not employed by FWC, Frontier Environmental Services and/or their Subcontractors will not be allowed onto the site where material receiving, material handling, reclamation and remedial operations are being performed and/or implemented.
6. When visitors are ready to leave, they will turn in their safety equipment. An exit notation will be logged on the project sign-in and sign-out sheet.

IV. INDUSTRIAL HYGIENE PLAN

A. Industrial Hygiene Monitoring

Industrial hygiene monitoring is not anticipated to be necessary on this project. Should the Site Safety Supervisor or other management staff deem it necessary based on changing site conditions, project operations will be ceased until appropriate monitoring can be performed.

The Site Safety Supervisor is to ensure that monitoring personnel are qualified to operate the necessary equipment. Wendell Rahorst, Inc. (WRI) will provide independent project industrial hygiene consultation on a need be basis. The certified industrial hygienist is:

Wendell Rahorst, CIH
Wendell Rahorst, Inc.
2120 Lookout Mountain Road
Golden, Colorado 80401
Telephone Number: 720-240-4825
Facsimile Number: 720-221-6975

B. Air Monitoring

It is not anticipated that air monitoring will be required on this project. Best Management Practices for dust control will be employed. Should air monitoring be needed, monitoring will be accomplished according to NIOSH sampling methods.

Personnel monitoring samples taken for contaminant exposure will be analyzed. The laboratory used for analysis must be an accredited laboratory familiar with NIOSH methods.

- Monitoring instruments used for sampling will be calibrated according to the manufacturer's recommendations. Equipment will be calibrated before and after use, with a record kept of all calibrations. Real time readings will be recorded in the project safety and health daily reports with pages initialed and dated at the close of each day's activity. Action limits will be set by specific waste constituent present on-site.

C. Meteorological Monitoring

- Temperature
- Wind Direction
- Precipitation

1. Weather conditions at the site will vary from pleasantly warm and sunny to hot and windy to extremely cold with blowing snow. Other portions of the Health and Safety Plan and various standard operating procedures provide guidance for monitoring of employees and responding to emergency conditions, which may result from stressful or inclement weather conditions.

D. Heat Stress

During periods of high temperature and/or high humidity, the Site Safety Supervisor in lieu of monitoring by thermometer or other subjective indication will monitor work operations and observe employees for symptoms of heat stress, especially in areas where protective clothing is being worn. If the body's physiological processes which maintain a normal body temperature fail or are overburdened due to excessive heat exposure, a number of physical reactions can occur ranging from mild symptoms such as fatigue, irritability, anxiety, decreases

in concentration, and movement, to unconsciousness and death. Heat-related problems are presented below.

- Heat Rash. Caused by continual exposure to heat and humid air and is aggravated by chafing clothes. Heat rash decreases a person's ability to tolerate heat.
- Heat Cramps. Caused by profuse perspiration with inadequate water intake and chemical electrolyte imbalance. This results in muscle spasm and pain in the extremities and abdomen.
- Heat Exhaustion. Increased stress on various organs to meet increasing demands to cool the body will result in signs and symptoms, including shallow breathing, pale, cool, moist skin, profuse sweating, dizziness, and lassitude.
- Heat Stroke. The most severe form of heat stress, which must be treated immediately by cooling the body, can result in death. Signs and symptoms include red, hot, dry skin; no perspiration, nausea; dizziness and confusion; strong, rapid pulse; and coma.

One or more of the following control measures can be used to help control heat stress:

- Providing adequate liquids to replace lost body fluids. Employees must replace water and salt lost from sweating. Employees must be encouraged to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.
- Replacement fluids can be a 0.1 percent salt water solution, commercial mixes such as Gator-Aid or a combination of these and fresh water. The company will provide these fluids.
- As established by the observation of work regimen, Frontier will provide adequate rest periods for cooling down. This may require additional shifts for employees or earlier or later work schedules.
- Cooling devices such as vortex tubes or cooling vests can be worn beneath protective garments.
- All breaks are to be taken in a shaded rest area.
- Employees shall not be assigned other tasks during rest periods.

- In addition to site specific work operations during hot/humid periods; employees will be informed of the importance of adequate rest, acclimatization, and proper diet during off-project site time frames that may aid in the prevention of heat stress.

E. **Cold Stress**

Frontier will insure that employees are appropriately clothed for material receiving, material handling and site specific reclamation work performed during cold and inclement weather. Specific individual core body temperatures will not be monitored. Employees will be observed during on-site activities where the affects of cold weather may pose a concern. Employees will be required to wear appropriate cold weather apparel provided by Frontier at no expense to the employee. Exposure to extreme cold is not anticipated since site activities will be curtailed due to ground freezing and the inappropriateness of conducting site reclamation and/or remedial activities.

V. **PERSONAL PROTECTIVE EQUIPMENT**

Frontier has selected Level D personal protective equipment (PPE) for the project based on the best information pertaining to anticipated project activities. As determined by each work area hazard analyses, the level of PPE upgrade or down grading will be assessed and determined.

A. **Levels of Protection**

As established by the initial project conditions, the level of PPE for the project will be set as Level “D”. The Project Safety Supervisor may upgrade the level of protection to Level “C” if work activity hazards in specific areas cannot be controlled by engineering methods, i.e. dust control or work methods. These two levels are listed below:

1. **Level D** is customary construction clothing and will be worn only in all areas, unless otherwise specified by the Project Safety Supervisor. Level D consists of a hard hat, steel-toed shoes or boots, safety glasses, and gloves (while handling sharp, abrasive, corrosive, hot/cold materials and at any other time that a potential for hand injury requires the use of hand protection).
2. **Level C** should be worn when the criteria for using respiratory protection is met. Level C consists of:

- half-face, air-purifying respirator (MSHA/NIOSH approved),
- chemical-resistant clothing (one-piece coverall),
- gloves, outer, chemical-resistant,
- boots, steel toe and shank, chemical-resistant,
- safety glasses, and
- hard hat

B. **Clothing and Respirator Storage**

Clothing and respirators must be stored properly to prevent damage or malfunction due to exposure to dust, moisture, sunlight, damaging chemicals, extreme temperatures, and impact.

a. **Clothing**

Potentially contaminated clothing will be stored in an area separate from street clothing.

Different types and materials of clothing and gloves will be stored separately to prevent issuing the wrong type or material by mistake.

Protective clothing will be folded or hung in accordance with manufacturer's recommendations.

b. **Respirators**

Air-purifying respirators will be inspected, washed, and disinfected after each use. Air-purifying respirators should be stored individually in their original packaging or carrying cases, or in resealable plastic bags.

C. **Essential Inventory of Personal Protective Equipment for Frontier Operations**

It is the responsibility of the Site Safety Supervisor to ensure that the following personal protective equipment is available prior to the start of daily activities:

- Protective clothing: disposable outer-wear and uniforms
- Safety belts and lanyards

- Respiratory protection equipment consistent with identified hazards
- Safety glasses and goggles
- Hearing protectors
- Foot protection (chemical resistant steel-toed boots)
- Cutting goggles
- Welding hoods and lens
- Welding gloves
- Welding jackets and sleeves
- Chemical-resistant gloves
- Splash protection
- Full face shields

The above list represents the "basic" personal protective equipment, which may be used. Other equipment may be necessary, depending upon the type of work. The Site Safety Supervisor will ensure that an adequate inventory of this equipment is maintained.

VI. DECONTAMINATION PROCEDURES

A. Designated Decontamination Areas

If project activities require the use of Level C personal protective equipment, employees will exit the controlled active areas, proceed to designated decontamination areas, and remove gross contamination from boots and gloves before removing any protective clothing or their respirators.

If an employee develops a rip or tear on his/her protective outer wear, the employee will return to a decontamination area, wash any contaminated skin and put on new protective clothing.

B. Equipment Decontamination

If Level C protection is required, equipment will be decontaminated prior to their entering and leaving active project area(s). Equipment may be cleaned using methods and procedures outlined in the Equipment Cleaning Plan to assure proper removal of dirt, debris and/or other accumulated materials.

Site personnel will inspect all equipment leaving active areas to ensure that contaminated material has been removed.

All tools used within active areas will be decontaminated prior to being transferred to other areas of the site. The primary method of decontamination will be to remove clinging soil using brooms, shovels, and picks. Equipment decontamination will occur in the excavation or stockpile areas where the soil can be picked up and placed into a dump truck for off-site disposal. It is the goal to not use so that an additional waste stream is not created.

C. Routine Procedures for Decontamination

In the event that the level of PPE is upgraded to Level “C”, the following decontamination procedures will be used.

- a. Remove special work boots and chemical protective clothing and wash them thoroughly in a designated decontamination area to remove all visible signs of contamination.
- b. Remove any disposable contaminated clothing by undressing from the top down and from the inside out. Dispose of them in the designated collection containers for personal protective equipment.
- c. Remove the respirator, sanitize it and turn it in for evening cleaning. Cleaning and maintenance of respirators will be performed per manufactures recommendations. At a minimum, cleaning or sanitizing should be accomplished at the end of every work day and after each use.
- d. After completion of the decontamination, employees may dress in street clothing and shoes.

Under no circumstances will contaminated clothing or personal protective equipment leave the project. This includes entering personal vehicles and site vehicles for off-site travel.

VII. MEDICAL SURVEILLANCE PLAN

If deemed appropriate by WRI and in accordance with 10CFR1910.120 (OSHA); Frontier Environmental Services will provide Medical Surveillance of all project employees that have the potential for exposure 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, If medical examinations and procedures are performed under this plan; they will be performed by or under the supervision of the Frontier designated medical clinic at no cost to the employee, without loss of pay and at a reasonable time and place. The results and the examining physician's conclusions for suitability for work assignment as a result of the medical evaluations will become part of the personnel file for each project employee. The designated medical clinic/physician is:

Concentra Medical Clinic

Special emphasis will be placed on: 1) 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; 2) Employees who wear a respirator for 30 days or more a year; and 3) 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 operations.

Medical examinations will include a medical and work history (or updated history for existing employees) with special emphasis on symptoms related to the handling of hazardous substances and health hazards, and to fitness of the employee for duty including the ability to wear any required personal protective equipment under conditions (i.e., temperature extremes) likely to occur at a Frontier project.

Clinical tests performed on all employees:

- Blood Sample for metals content, i.e. Arsenic, Cadmium, Lead and Zinc.
- Cardiovascular screening
- Pulmonary function test (may include FVC and FEV-1)
- Audiometric examination
- Evaluation of the individual's physical ability to perform work involving potential exposure to contaminants and use of respiratory protection equipment.

- Determination of the near and distant visual acuity. If corrective lenses are required, lens inserts for respiratory face masks will be provided. If visual correction is required, prescription safety glasses will be required.

If any of the findings obtained during the examination are outside the normal range, the individual will be referred to his or her personal physician; a copy of the findings will be provided to their physician.

The content of all medical examinations will be made available to employees upon request from the employee or at the direction of the Frontier physician.

Frontier has provided a physical examination forms to the clinic/physician, which uses CFR 1910.120 as a reference for the scope of the medical examination. The following additional information about each employee has been supplied or will be supplied as it becomes available:

1. A description of the employee's duties (job description) as they relate to the employee's exposures.
2. The employee's exposure levels.
3. A description of any personal protective equipment to be used.
4. Information from previous medical examinations of employees.

Frontier will obtain a written opinion from the physician for each employee regarding whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations, emergency response or from respirator use. The physician's opinion will include any recommended limitations upon the employee's assigned work and a statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment.

Any written opinion about an employee, obtained by Frontier, will not include specific findings or diagnoses unrelated to occupational exposures. Employees will be provided with the results of the medical examination and tests at their request.

If any of the findings obtained during the examination are outside of the normal range, the physician's written opinion may be used by Frontier and the employee to evaluate any question of continued employment.

The frequency of medical examinations will be as follows:

1. Prior to hire and assignment.
2. At least once every 12 months for each employee unless the Frontier physician believes a longer period (not longer than biennially) is appropriate.
3. At termination of employment or reassignment to an area where the Frontier physician determines the employee may have a significantly different exposure risk. Upon termination, employees will receive an exit examination to determine their physical fitness and to review their occupational exposure histories from the preceding year. Special attention shall be given to the possibility of non-occupational exposures to substances producing effects similar to the effects of hazardous substance exposure.

A complete history will be obtained to identify signs or symptoms, which may be connected to hazardous substance exposure or to other occupational exposures, which could produce adverse acute or chronic effects. In addition to the review and update of occupational and medical histories, other examinations and clinical tests may be performed. These tests may be in addition to any other job specific surveillance tests required based on other exposures.

4. As soon as possible upon notification to Frontier by an employee that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards, or that the employee has been injured or exposed above the permissible exposure limits or published exposure levels in an emergency situation.
5. At any time the Frontier physician determines that an increased frequency of examination is medically necessary.
6. As soon as possible following an emergency response action at which an employee may have been injured, received a health impairment, developed signs or symptoms which may have resulted from exposure to hazardous substances resulting from the emergency incident, or been exposed during the emergency incident to hazardous substances at concentrations above the permissible exposure limits or the published exposure levels without the necessary personal protective equipment being used.
7. At additional times, if the Frontier physician determines that follow-up examinations or consultations are medically necessary.
8. At a minimum the following information will be retained in the records:
 - a. The employee's name and social security number;

- b. Any physician's written opinions, recommended limitations and results of examinations and tests;
 - c. Any employee medical complaints related to exposure to hazardous substances;
 - d. Copies of information provided to the examining physician by Frontier.
 - e. The following is a partial list of reports and records that pertain to this section:
 - Occupational Injury/Illness Case Record
 - Notice to Doctor and Doctors Release
 - Immediate Supervisor's Report of Accident
 - Supervisor's Occupational Injury/Illness Report.
 - Employer's First Report of Injury (Insurance Form)
 - Frontier Monthly Accident Summary
 - OSHA Form 300 - Log and Summary of Occupational Injuries and Illnesses
 - Monthly Safety Summary
 - Medical Surveillance Records
 - Occupational Illness Waiver Forms
 - Daily Injury Log
9. Employee medical surveillance records will be retained for the duration of an employee's employment plus 30 years.

VIII. FIRST AID AND MEDICAL SUPPORT & ACCIDENT REPORTING

Frontier will provide first aid medical support and arrange emergency transportation for employees and other persons authorized to access the Site, who sustain injuries or become ill. The Site Superintendent will have a Two-way radio supplied by the Fourmile Fire Protection District for communications in the event of an emergency. A landline phone is also available at the Frontier job trailer located in the parking lot of the Fire Station at 1740 Fourmile Canyon drive.

A. Medical Support

1. Facilities

A first aid kit will be equipped and maintained in a professional manner under the supervision of the Site Safety Supervisor.

The first aid kit will be utilized to treat minor injuries and stabilize more severely injured or critically ill personnel prior to transporting them offsite.

2. Personnel

At least one (1) fully trained first aid providers will be onsite during site activities. The project personnel file contains the names of those individuals who have the necessary first aid training.

3. Non-Emergency Medical Services

Boulder Community Health
4747 Arapahoe Avenue
Boulder, CO 80303
303-415-7000

4. Emergency Services

In the event that medical attention is needed. Any person needing immediate medical attention will be transported to the nearest medical center, which is the following:

Foothills Hospital
4747 Arapahoe Avenue
Boulder, CO 80303
303-415-7000

B. Emergency Phone Numbers

Ambulance: 911
Fire Department: 303-449-3333

C. Accident Reporting

If an accident, an explosion or fire, or a release of toxic materials occurs during the course of the project, Frontier shall notify the appropriate local authorities and Frontier Management immediately by telephone. Written notification shall be made to Frontier Management. By the close of business of the day officially notified of any reportable accident, Frontier will complete and submit to FWC an accident report addressing the following items:

- Name, title, telephone number and location of Frontier Environmental Services manager making the report.
- Date and time of the accident.
- Location of the accident/incident.
- Brief summary of the accident/incident giving pertinent details including type of operation ongoing at the time of the accident/incident.
- Apparent cause of the accident/incident, if known.
- Casualties (fatalities, disabling injuries).
- Details of any existing chemical hazard or contamination.
- Estimated property damage, if applicable.
- Nature of damage, effect on contract schedule.
- Action taken by Frontier Environmental Services to ensure safety and security.
- Other damage or injuries sustained, public or private.

IX. RESPIRATORY PROTECTION PLAN

This plan establishes the necessary guidelines and general requirements for use of respiratory equipment at the Black Swan Stream Restoration Project Site.

It is the objective of this plan to establish guidelines, which will minimize work, related respiratory risks to Frontier employees. After having been provided the properly selected, fitted and maintained respiratory equipment, employees will be able to accomplish their assigned tasks as efficiently as possible.

A. Procedures

1. Issue of Respirators

Employees at Frontier will be assigned a suitable respirator for their exclusive use during the performance of their specific job function. Replacement respirators will be issued to them, should a respiratory device become unserviceable.

2. Visitors and Contractors

Frontier will not supply visitors with respiratory protection. Visitors will not be allowed in areas where respiratory protection is required, unless specifically instructed to do so by FWC.

Sub-contractors will need to furnish their employees with their own respiratory protection while they are working at a Frontier project site. In

addition, the subcontractor prior to their employees being allowed to work at Frontier will present documentation of respiratory fit testing and protection to the Site Safety Supervisor.

3. Respirator Selection

Respirators issued to Frontier employees will only be of the NIOSH/MSHA approved type respirator. The selection of respirators shall be reviewed by the Site Safety Supervisor and shall be based on the following criteria:

- Nature of the Hazard - The chemical, physical, toxicity and concentration properties of the hazardous material.

If there will be exposure to materials for which OSHA has mandated specific respirators to be used, i.e. carcinogens, personnel will use that respirator or one which provides greater protection.

B. Respirator Inspection Cleaning, Maintenance and Storage

Standard Operating Procedures have been established which describe the methods for cleaning, inspecting and repairing respirators, including the following:

- Inspection for respirator defects and/or deterioration
- Cleaning and Disinfecting
- Repair
- Proper Storage

1. Inspection and Maintenance

All respirators will be inspected routinely before and after each use. Respirators maintained for emergency use must be inspected and sanitized after each use, as well as inspected at least monthly. A record will be kept and maintained by the Safety Supply Clerk indicating the following:

- Inspector Name
- Date of most current inspection
- Respirator type

2. Cleaning and Storage

Respiratory equipment that is used routinely will be cleaned, sanitized, inspected and repaired on a regular basis by a qualified individual. Respirators will be cleaned, sanitized and stored according to manufacturer's specifications and requirements of the OSHA standard.

Frontier management will ensure compliance of proper cleaning and maintenance requirements by periodic inspections and audits of cleaning and maintenance areas.

C. Medical Surveillance

Medical surveillance for the Respiratory Protection Plan will be provided by the Frontier designated physician. Medical surveillance will be conducted in accordance with the Medical Surveillance as described in this Health and Safety Plan.

Before an employee can be issued a respirator, a physician must certify them for respirator use. The physician must certify that the employee is physically able to perform the required work and use the respiratory equipment. The company physician will determine what health and physical conditions are pertinent. After hire, the employee will be re-evaluated for the ability to wear a respirator annually.

D. Fit Testing

Each employee at Frontier will be instructed and be required to demonstrate understanding of the methods used in conducting positive and negative pressure checks for each type of respirator assigned. Positive and negative fit checks (qualitative) performed by the employee are required each time the respirator is worn.

Qualitative fit testing will be in accordance with the individual respirator manufacturer's recommendations and will follow qualitative fit test protocols.

E. Facial Hair

Frontier has the responsibility under the Occupational Safety and Health Act CFR 29 1910.134 (e) (5) to ensure that all wearers of respirators can obtain a satisfactory seal between the respirator and the wearer's skin.

Facial hair between the sealing surface of a respirator face piece and the wearer's skin will prevent a good seal. Such a condition makes it possible for air contaminants to enter the face piece during inhalation and result in an exposure. Even a few days growth of stubble can permit excess contaminant penetration.

It is the policy of this company that employees who may be required to wear a respirator during the course of their employment shall not have facial hair, which intrudes, into the area where the respirator seals against the face. In addition, these employees shall not be fitted with a respirator. Every employee who is required to wear a respirator will receive the proper respirator, be trained in its use and have it satisfactorily fit-tested. Once an employee is informed they are subject to the requirements of wearing a respirator, it will be their responsibility to ensure that they do not have facial hair in the respirator seal area.

Any employee who refuses to comply with the requirements of this notice shall be subject to disciplinary action up to and including discharge.

F. Corrective Lenses

Persons requiring corrective lenses must have kits to hold corrective lenses inside the respirator face piece in such a manner as not to interfere with the seal of the respirator on the wearer's face.

G. General

Respiratory protection will only be worn at times designated by the Site Safety Supervisor.

Air purifying cartridges shall be replaced as necessary.

Only those persons who have had initial and annual qualitative fit tests will be allowed to work in atmospheres where respirators are required.

Contractors must certify that their employees have received respiratory training and fit testing before their employees are allowed to work at Frontier.

If an employee has demonstrated difficulty in breathing during the fitting test or during use, he or she must have a physical examination to determine whether they can wear a respirator while performing the required duty.

X. HEARING CONSERVATION PLAN

The following plan has been prepared in accordance with the OSHA regulation for occupational noise exposure (29 CFR 1910.95). It establishes standard operating procedures to be followed by all employees. The Hearing Conservation Plan and guidelines will be followed when engineering and/or administrative controls are not feasible and hearing protection devices are being relied upon to protect the employees.

Hearing protection is provided to all employees regardless of the exposure to a Time Weighted Average (TWA) of 85 decibels (dBA).

This Hearing Conservation Plan will be implemented and monitoring will be conducted when information indicates that an employee's exposure may be greater than a TWA of 85 dBA. The sampling strategy will be designed to identify employees for inclusion in the Hearing Conservation Plan and to enable the proper selection of hearing protection.

A. Sampling

Procedures for identifying employees who may be exposed to the TWA action level of 85 dBA or above are as follows:

1. Dosimeter monitoring in work areas.
2. Include all continuous, intermittent and impulsive sound levels between 85 and 90 dBA.
3. Calibrate instrument properly prior to each use.
4. Repeat monitoring whenever a production, process, controls or equipment change occurs which may involve additional personnel or render protective equipment inadequate.
5. Employees must be notified if they are exposed at or above the action level.
6. Employees affected shall be provided an opportunity to observe measurements.

B. Audiometric Testing Plan and Baseline Audiogram

Audiometric testing will be made available to all employees as part of their medical surveillance. This plan will be at no charge to the employee.

1. A baseline audiogram is included within the employee's initial medical examination for work at the site.
2. Another baseline audiogram will be established within six months of exposure.
3. The audiometric test will be repeated at the annual medical exam required of all site personnel.
4. The annual test will be compared to the baseline to determine any shifts in the hearing level.

C. Audiometric Re-Testing

Procedure to follow when an audiogram shows a significant threshold shift:

1. Retesting will be performed within 30 days to be used as the annual audiogram.
2. Review by an audiologist, otolaryngologist or physician to determine if further evaluation is needed.
3. Inform employee within 21 days.
4. An employee may be fitted for a pair of protective devices and trained in their use and care. An employee already having protective devices, may be refitted and retrained in their use or be provided with alternate hearing protection. Measures will be taken to reduce or eliminate the noise problem. These measures may include any or all of the following: engineering, work practice or administrative controls, and hearing protection.
5. Additional testing may be advised if a medical pathology of the ear is suspected of being caused or aggravated by wearing hearing protection.
6. Additional testing may also be advised for any medical pathology of the ear unrelated to wearing hearing protection.
7. An annual audiogram may be substituted for the baseline when a threshold shift is persistent or if there is significant hearing improvement.

D. Test Requirements

Audiometric test requirements will be conducted in accordance with OSHA 1910.96.

E. Employee Training

1. Training will consist of initial hearing conservation and annual refresher plans, which will include:
 - effects of noise on hearing,
 - purpose of hearing protectors,
 - advantages, disadvantages and attenuation of various types, and
 - instructions for selecting, fitting, using and caring for hearing protection devices.
2. Purpose of audiometric testing
3. Explanation of test procedures

F. Record Keeping

1. A record of monitoring measurements (other than audiometric testing) will be maintained in the archives and will be available at employees' requests.
2. Audiometric tests will be maintained in each employee's medical monitoring file.

XI. PERSONNEL TRAINING PLAN

Frontier Environmental Services has developed a training program consisting of instructional units including the basic 29CFR1910.120 HAZWOPER 40-hour OSHA course. Except for the HAZWOPER-OSHA 40 course, the training units are designed to be delivered by Frontier personnel on an ongoing basis. Where specialized instructors are required, off-site personnel will be utilized. The HAZWOPER-OSHA 40 classes will be given by an independent qualified organization.

At the mobilization of the project and as the project demand for additional labor is demonstrated, Frontier personnel working in areas where hazardous materials are expected, will be fully HAZWOPER Trained as prescribed by 29 CFR 1910.120. Project personnel files contain training certificates indicating their training status.

The objective of the Frontier Training Program is to develop and implement the appropriate training courses. The specific goals of the training program are as follows:

- Development, delivery, and updating of a Frontier site specific OSHA-40 hour training course which meets the requirements of 29 CFR 1910.120, and;
- Development, delivery and updating of a program of instruction for site activities, health, safety, environmental concerns, regulatory response, emergency response, and job specific orientation.
- Names of personnel and alternates responsible for safety and health.
- Injury, illness and other hazards present at the project site.
- Safe use of engineering controls and equipment on site.
- Work practices by which the employee can minimize risks from hazards.
- Selection, use, care and maintenance of PPE.
- Site control procedures, including login and logout.
- Site decontamination procedures.
- Standard operating safety procedures.
- Site emergency response plan.
- Procedures for any confined space entries that may be part of the project.

The Personnel Training Program is designed to provide Frontier employees with information they need to safely and efficiently perform their duties. Frontier Site Superintendent and Project Manager will manage personnel training.

The two major objectives of the Personnel Training Program are:

- To thoroughly train all employees in the proper performance of their individual job duties.
- To ensure that all designated employees are capable of effectively implementing the proper emergency procedures, should the need arise.

Accidents and emergency situations can be properly minimized by having a work force, which is trained to perform their jobs properly. If an emergency does occur, its consequences can be minimized through rapid and effective response.

A. **On-The-Job Training**

One of the most common and successful methods of personnel training is on-the-job training (OJT). It provides individualized training pertinent to normal daily operations of the project. A major advantage of this type of training is "hands on" experience, with supervision, for specific equipment and processes used on the

project. OJT is especially useful for it provides an effective explanation of concepts of the system and visual illustration of those concepts.

On-the-job training (OJT) at Frontier is an ongoing process, but will be used primarily for orientation purposes for new hires and transfers. This training will be based on job descriptions and administered by means of OJT work sheets. These work sheets break each training effort into its component parts with appropriate space for training certification by the OJT trainer. (i.e. area supervisor or foreman). The OJT work sheet also provides a section for evaluation of employee proficiency in this designated position. This may be an operating test (performance and written), a verbal test, or other performance evaluation demonstration administered by the area supervisor.

The OJT orientation training will provide the newly hired or transferred employee information pertaining to the correct performance of his job, the hazards associated with the job and the personal protection required. It will also be used to give him general training in emergency procedures and environmental protection.

B. Formal Training

Although OJT is effective, Frontier personnel must retain as much of the learned training as possible; therefore, supplemental training will be provided to reinforce basic procedures and precautions to be followed in the various areas of the project. The training will be documented in the employee's development record.

The Frontier training policy requires that all new employees must successfully complete their formal training at the time of their employment or assignment to the project. Upon transfer or promotion of an existing employee to a new position with training requirements that differ from those for the previous position.

Pending satisfactory completion of the specific training required for a particular job, an employee will receive intensive supervision to ensure that the job is performed properly and safely.

On-going continuing education and training will be provided to employees by Frontier. The frequency of continuing education and training activities will vary according to the type of job.

The Personnel Training Program presents an outline of the proposed formal Personnel Training Program along with the schedule for conducting the continuing training and the personnel who would be scheduled to participate. The frequency of formal training activities varies from quarterly for emergency response plan

functions, to annually for training which does not relate directly to emergency situations.

C. Training Program Management

The training program will be managed by the Frontier Project Manager and coordinated on a daily basis by the Site Safety Supervisor. The Personnel Training Program includes instruction which teaches project personnel safety and health policies and procedures and emergency response plan implementation.

D. Training Schedule

All personnel will complete the training program at time of their employment. New hire employees will work under the supervision until site orientation and training has been completed.

E. Training Program Review

All Frontier personnel will take part in an annual review of the initial training. Training will be reviewed periodically and modified as necessary. Records of the review shall specify the contents of each evaluation including such topics as:

- Changes in types or quantities of wastes received, accepted and their treatment, storage or disposal processes;
- Changes in project procedures, conditions and general operations.

Periodically, Frontier management will review each employee's personnel file against that person's job description and training requirements, to verify that the frequency and type of training required for that job is being provided.

F. Record Keeping

The Site Safety Supervisor will maintain documents and records at the Frontier which include the following information:

- Job titles for current positions on a Frontier project are outlined on the project organizational chart.
- Written job descriptions for each position listed on the organizational chart are presented in this Site Specific Health and Safety Plan. These job

descriptions include the requisite skill, education or other qualifications, and duties of employees assigned to each position.

- Type and amount of both introductory and continuing training administered to project personnel is summarized in this Site Specific Health and Safety Plan and itemized on the job description sheets.
- Documentation of training will be accomplished by completing the forms and placed into the operating record.

G. Training Records

All records of training on current personnel will be kept on file as a part of the project record. Records of former employees shall be kept for three years after the date the employee leaves the Frontier. Copies of training records of employees transferring to or from other company facilities will accompany them and may be used as a basis for satisfying, in part, Frontier formal training and on-the-job training requirements.

XII. HEAVY EQUIPMENT OPERATION AND SAFE MATERIALS HANDLING

The following information pertains to work around heavy equipment and the safe handling of heavy materials.

- Use common sense.
- Employees should pay attention to what they are doing and what they are being told at all times.
- Maintain visual contact with another person at all times.
- Establish hand signal communication when verbal communication is difficult. Identify one person per work group to give hand signals to equipment operators.
- Maintain secure footing at all times.
- All heavy equipment must have operational backup alarms of some type.
- Only qualified and trained personnel are to operate heavy equipment.
- Use designated chains hoists, straps, and other approved equipment to safely move heavy materials.

- Use proper manual lifting techniques. Employees are instructed to use their legs, not their back. Use the buddy system.
- Employees should never walk directly in back of, or to the side of, heavy equipment without notifying the operator of their presence and intent. To aid in the observance of personnel on-the-ground by equipment operators; site project personnel (Frontier and FWC) and authorized site visitors are encouraged to wear reflective safety vests.
- Never use a piece of equipment unless familiar with its purpose and trained in its operation. This applies to all equipment.
- Be sure that no underground or overhead power lines, sewer lines, gas lines, or telephone lines will present a hazard in the work area.
- Overhead Electrical Power Lines must be delineated with signage to alert equipment operators and truckers of the existing energized power lines and height of clearance from ground level. Minimum clearance height must be posted within the cab of operating equipment.
- Before excavation, grading, trenching and any other earth-moving-tilling-mixing-drilling operation; utility locates will be performed in areas that may have underground utilities present. Areas in open fields where agricultural activities are routinely/historically performed may not require utility locates.
- Get help when in doubt about a material's weight.

A. Heavy Equipment Safety

Heavy equipment is built for safe and economical operation, but it is only as safe as the operator. Therefore, it is the policy of Frontier to establish a heavy equipment safety performance program for the site. Heavy Equipment activities will conform to all federal standards as well as safe practices dictated by the equipment manufacturer and established safe work procedures.

B. Site Pre-Work Inspection of Equipment

Frontier will only use equipment that is in safe working order. All heavy equipment brought onto the site will be inspected for structural integrity, smooth operational performance, and proper function of safety devices in accordance with the

manufacturer's specifications. This inspection will be performed at the request of the Site Superintendent, by the Site Safety Supervisor and the equipment operator using the equipment. If equipment is determined to not conform to applicable operational and safety requirements it will not be put into service until all necessary repairs are made and the Site Safety Supervisor releases it for service.

C. Operator Qualifications

Only qualified heavy equipment operators familiar with the equipment to be used will be permitted to operate the equipment. Operators for these positions will be screened by the Frontier Site Superintendent or designated representative for proven ability and experience to operate the equipment in a smooth, safe and efficient manner.

D. Basic Heavy Equipment Operational Guidelines

Heavy equipment operation will be according to the manufacturer's specifications and established safe work practices. At no time will improper or unapproved crane operation be permitted. Basic safety guidelines to be used are as follows:

- Only one individual will issue operational hand signals to the operator unless it is established that relay hand signaling for blind craning situations is required. All hand signals used will be in accordance with American National Standard Institute's (ANSI) B30.5-68 "Basic Hand Signals for Boom Equipment Operation". A copy of "Basic Hand Signals" can be found in the cab of the lifting equipment unit.

E. Safe Rigging Practices

Construction and demolition work activities require extensive rigging capabilities. Therefore, Frontier policy dictates that a comprehensive rigging safety and inspection program be implemented. The following procedures will be enforced:

1. General Rigging Safety Inspection

Rigging components used in everyday work activities, will be inspected at the time of use by members of the rigging team. As an example; if there are six or more, randomly distributed, broken wires in any one lay, or when there are three or more broken wires in any one strand of a lay, the wire rope is to be taken out of service. Wire rope will also be taken out of service when extensive kinking, crushing, bird caging, or any other damage or distortion of the wire rope occurs. Chains will be inspected for distortion, and an indication of other mechanical stresses. If mechanical or physical stress damage is evident, the chains will be taken out of

service and given to the project site superintendent for proper management. Synthetic slings and ropes will be inspected for excessive wear and distortion. Where slings and synthetic ropes give evidence of stitching failure, fabric fraying in excess of 10% of the exposed surface area, cuts, and/or heat damage; that specific sling or rope will be removed from service and given to the project superintendent for proper management.

XIII. HOT WORK PROCEDURES

In recognition of the potential hazards associated with hot work (cutting or welding) operations, an established procedure must be designed to minimize the risk associated with such operations. The Occupational Safety and Health Administration (OSHA), in 29 CFR 1910.252, require that procedures and training be provided for these operations. To comply with this regulation, the potential hazards, the safety precautions, personnel responsibilities, permit procedures, and general cutting and welding procedures are discussed in this plan.

As with many flame-producing operations, there are four main hazards that might be encountered while conducting hot work procedures. These include:

- fire,
- explosion,
- burns, and
- toxic substances.

A. Fire

Whenever an open flame is produced, there is a chance that some adjacent material might be exposed to the flame, and a fire might be started. All of the elements required for a fire are available during hot work - heat, flame, fuel, and oxygen. Extreme caution must be taken to prevent a fire, from the initial set-up to the post-work inspection.

B. Explosion

Explosions can be associated with a fire, but other types of explosion can occur without fire or flame. Explosions can occur by over-pressurizing a non-vented vessel. During hot work, a non-vented tank might explode due to:

- the heat expanding the gases inside the tank, causing the tank to rupture,
- the flame of the torch ignites the tank's contents, or

- a combination of the heat and flame.

C. **Burns**

Burns can occur in conjunction with a fire or explosion, or through careless handling of the torch and heated surfaces. Contacting the torch's flame through carelessly leaving it lit while performing other operations or touching the surface of the metal being worked on can cause permanent damage and disfigurement, and a great deal of pain. With a little precaution and thought, most burns can be avoided.

D. **Toxic Substances**

Hot work can produce toxic substances through the combination of the acetylene, oxygen, and the surfaces being cut or welded. If the metal surfaces have been in contact with chemicals, the problem can be an even greater threat to health.

Through proper ventilation and surface cleaning, the toxic substance threat can be minimized.

E. **Safety Precautions**

Employees must always take the following safety precautions during hot work:

- wear specialized personal safety equipment,
- wear protective clothing,
- wear respiratory protection (if deemed necessary for that specific work task by project management),
- practice fire prevention,
- have immediate access to fire protection equipment, and
- pay attention to air monitoring.

F. **Personal Safety Equipment**

Hot work procedures require the wearing of some specialized personal safety equipment, such as:

- welder's goggles or face shield with the correct shading factor (see

Table 1),

- fire-resistant apron,
- fire-resistant gloves, and
- safety harness and emergency retrieval line, if required.

G. Protective Clothing

The following protective clothing must be worn, as a minimum, during hot work operations:

- clean uniform (free of oil or contamination),
- Steel-toed safety shoes with instep guard, and
- if overhead hazards are present, a hard hat.

H. Fire Prevention

Whenever possible, the area should be secured so that **NO** flammable material is present within a 50-foot radius. If the flammable material cannot be removed from the 50-foot radius, fireproof barriers and/or fire watches must be present. No ignitable or hazardous materials are allowed within 35 feet of the hot work area.

I. Fire Protection

An adequate number of the proper type of fire extinguishers must be present before the hot work operation takes place. With the high probability of fire and/or explosion during hot work activities, immediate access to fire extinguishers is critical for safe operations.

J. Air Monitoring

To help select the proper respiratory protection and ensure that the environment does not become explosive, the area's explosivity and oxygen concentration must be monitored during the hot work operations that use flammable gases and consume oxygen; and that may generate flammable off-gases as a result of the hot-work. As an example in confined space entry, combustible gas indicators (CGI) and oxygen detectors act as the basic air monitoring instruments. The CGI measures the lower explosive limit concentration (LEL) of the gas present in the atmosphere. With a reading greater than 25% of the LEL, the potential of a serious accident is high.

K. Personnel Responsibilities

The following personnel have key roles during hot work operations:

- Site Superintendent,
- Safety Supervisor, and
- the employee.

1. Site Safety Supervisor Responsibilities

The Site Safety Supervisor's responsibilities include:

- providing necessary training for employees,
- assisting supervisors with compliance, and
- updating procedures as necessary.

2. Site Superintendent Responsibilities

The site superintendent's responsibilities include:

- providing practical training for employees,
- ensuring the safe handling and storage of equipment,
- ensuring that an adequate grounding device is present,
- ensuring that fire extinguishers are present,
- providing necessary safety equipment, and
- securing the area in which the operations will take place. No flammable materials may be present within a 50-foot radius. Combustible materials are not allowed for a 35-foot radius without fireproof barriers and/or a fire watch. No ignitable or hazardous materials present within a 35-foot radius.

3. Employee Responsibilities

The employee's responsibilities include:

- abiding by hot work standard operating procedures,
- immediately notifying supervisor of any hazardous conditions or defective equipment, and
- acting as a fire watch, when necessary, in the cutting or welding area.

L. Permit Procedures

A permit system has been established for hot work operations to ensure that the appropriate personnel have been notified and the proper precautions have been taken. The Frontier permit procedure contains the following items:

- notification of appropriate personnel,
- filling out the permit,
- safety precaution check signatures, and
- a post-work inspection.

The hot work permit may be obtained from the Site Safety Supervisor.

M. General Cutting and Welding Precautions

The precautions and pointers below are provided to protect equipment and/or personnel from potential fire hazards associated with welding or cutting operations:

- never use acetylene if tank pressure is at or below 7 psi,
- never lift cylinders by their valve protector caps,
- never allow cylinders to lie in horizontal positions,
- never permit grease or oil to come in contact with cylinder valves or hoses (remember, oxygen is a necessary component for any fire: keep oxygen away from combustibles),
- never expose cylinders to extreme heat, sparks, or flames,
- never transport a cylinder by dragging, rolling, or sliding it along the ground,
- IMMEDIATELY notify the supervisor of any damaged or leaking cylinders,
- before moving a cylinder, ensure that the valves are closed,
- never tamper with or attempt to repair cylinder valves,
- keep valves closed on empty cylinders,
- never use a hammer, wrench, or other tool to open cylinder valves; always open by hand,
- keep cylinder caps on when cylinders are not in use,
- always ensure that cylinders are secured (so that they cannot tip over) by attaching the cylinder to a stable object with chains or straps,
- make sure the adjusting screw is released or turned out before the cylinder valve is opened,
- never use oil in the regulator,
- never interchange oxygen and acetylene regulators,
- oxygen hoses are green or black, acetylene hoses are red,
- never use matches or lighters to ignite the torch,
- never face the regulator when opening the cylinder valve,

- never use pressurized gases to remove soil or debris,
- never lay a torch on the ground; always place it in the storage tray,
- when leaving the area, follow all shut down procedures and start over upon returning (this includes breaks, restroom and lunch breaks, as well as any time you will be more than 25 feet away from the equipment),
- never carry a lighter into the work area,
- never place anything on top of a cylinder or use the cylinder as a support or roller even if it's empty, and
- never tamper with numbers or markings on the cylinders.

N. **General Cutting and Welding Procedure**

1. Be sure cylinders are secured to the cart.
2. Be sure that all the proper safety equipment is in place and that all personal protective equipment is being worn.
3. Prior to attaching the regulators to the cylinders, be sure that the regulator screws are turned out. NOTE: You need to see at least three threads.
4. Momentarily "crack" the cylinder valve to blow out dust or foreign particles from the valve.
5. Make sure the inlet connection filter is clean and in place.
6. Attach regulators to cylinder valves and tighten snugly. (NOTE: Over tightening will not increase the seal, but will only damage the fittings). Remember that acetylene connections are reverse threads.
7. Check the seal with a test solution. If bubbles form, the seal is not secure. If this occurs DO NOT over tighten the regulator; instead, contact the supervisor immediately.
8. Stand to one side of the regulator and VERY SLOWLY open the cylinder valve on the oxygen all the way. Open the acetylene valve no more than 1/2 turn. Take the T wrench out of the cylinder and keep it close at hand.
9. To adjust working pressure on the oxygen, depress the oxygen lever on the torch while maintaining 40 psi on the pressure gauge.
10. A working pressure of 6 pounds should be maintained on the gauge for acetylene with the acetylene valve open on the torch. The working pressure on the acetylene regulator should never exceed 7 pounds.
11. Keep cylinders as far away from the work area as possible.
12. Open the acetylene torch head and use the striker to ignite. Adjust the flame so that only smoke is visible coming off the torch head (no particles).
13. Turn on the oxygen torch head and adjust to obtain 6 short blue flames at the torch tip. The flame should be no longer than 1/4 inch in length.
14. To cut, hold the torch tip 1/8 to 1/4 inch away to heat the metal. When the metal begins to turn to liquid, depress the oxygen lever full on and slowly advance torch in the direction you want to cut. For best results, keep the torch tip vertical or slightly angled in the direction of the cut.

15. When cutting is completed, turn off the acetylene torch first, and then the oxygen. Turn off regulators and make sure valves at the torch head are closed. Be sure to clean the tips and put the cutting rig back in its proper storage area when the work is finished.

FOR CUTTING, set the acetylene pressure at 5-7 pounds per square inch (psi), and set the oxygen pressure at 40 psi.

ALWAYS SHUT OFF ACETYLENE FIRST, otherwise the flame can make its way up the hose, into the tank and result in an explosion.

O. Fire Watch Procedures

In rare instances when combustible materials cannot be blocked or removed from the area of cutting or welding, the area supervisor establishes a fire watch. An employee designated as the fire watch acts as an observer of the area to spot fires that the welder or cutter may not see. The sole responsibility of the fire watch is to monitor the area and extinguish any small fires, which may ignite. Welding or cutting will not be allowed if the presence of flammable or combustible materials will endanger personnel.

XIV. EMERGENCY RESPONSE PLAN

A. Elements of the Emergency Response Plan

The Frontier Emergency Response Plan is a combination of this Health and Safety Plan, the Contingency Plan and the Frontier Training Plan. The training units developed to implement the training plan, describe specific emergency response procedures for responding to situations which result or are likely to result in a release of a hazardous substance or waste.

In addition to these plans, numerous standard operating procedures have been implemented which provide guidance for employee actions involving routine and emergency situations.

Included in these documents are the following elements:

1. Pre-emergency planning and coordinating efforts with local emergency response agencies, such as the Fourmile Fire Protection District, Boulder County Sheriff's office, local ambulance services, and local hospitals.

For Emergency Response Notification:

Call 911 for local law enforcement
Call 911 for fire department assistance

Notify Frontier Environmental Services' Superintendent by Radio or Call the Project Superintendent (Sean Martinez) 941-544-8186.

2. Personnel roles and lines of authority, such as: responsibilities of the Site Superintendent and governmental agencies and the local public; reporting procedures for notification to local, state and federal governmental agencies.
3. Emergency recognition, emergency alarms and prevention and preparedness measures.
4. Written directions and maps which identify project site location, evacuation routes; safe reporting locations for emergency response and non-essential personnel; and, emergency alarms and evacuation signals for process and weather-related emergencies.
5. Fire and spill response procedures.
6. Site security, project site access and control.
7. Emergency recognition and control for site emergencies such as spills and fires.
8. Provisions for on-site first aid and off-site transfer for hospitalization and treatment.
9. Decontamination procedures.
10. Personal protective and emergency equipment.
11. Emergency recognition and prevention.
12. Plan amendment requirements.

Emergency procedures will be updated, when necessary, upon review after an emergency occurs which requires implementation of this Emergency Response Plan. The Emergency Response Plan is reviewed periodically by the Project Manager, Site Superintendent and the Site Safety Supervisor will review the plan and emergency response procedures and make changes, if necessary.

Emergency response training is covered in general during the OSHA 40 training seminar. Employee emergency response training places emphasis on the recognition of health and safety hazards in order for employees to protect themselves and their fellow employees. Training includes methods for minimizing the risk from safety and health hazards; safe use of spill and fire control equipment; selection and use of appropriate personal protective equipment; safe operating procedures for use at the scene of an emergency response incident; techniques for coordinating with other employees in order to minimize risks, such as medical monitoring of emergency responders and injured personnel; appropriate responses to over exposure of themselves or other employees to health hazards or injury; and recognition of symptoms which may result from over exposure.

Frontier provides employees with certifications for training received from third party trainers, i.e. OSHA 40 HAZWOPER and Annual Up-Date Training. Refresher training is provided periodically and the Site Safety Supervisor keeps training records.

Implementation of emergency response procedures as described in the above listed documents will be based on the information available at the time of the emergency. The Site Superintendent will evaluate the incident and the site response capabilities and proceed with the appropriate steps to implement the Emergency Response Plan.

B. Severe Weather Events

1. High Winds, Heavy Rains, Hail, Lightning, and Snow/Ice Storms

If an observation at the project site or information from an off-site source, such as the U.S. Weather Service or local radio or TV, indicates that a severe weather event such as lightning, heavy rain or hail storm may be in the area, the Site Safety Supervisor will initiate a Severe Weather Watch.

When a Severe Weather Watch is in effect the Site Safety Supervisor will personally notify the Site Superintendent and then all Frontier personnel, visitors and contractors in person, by telephone, or by two-way radio of the situation. The Site Superintendent will contact FWC project management and advise them of the situation. The Site Superintendent will advise FWC project management of any changes in weather conditions or impending storms.

During a Severe Weather Watch, all personnel will, from time to time, scan the horizon for lightning. If anyone observes a lightning strike near by, they will immediately report this to the Site Superintendent or the Site Safety Supervisor by radio or telephone. If necessary, the Site Superintendent has

the authority to order any visitors, contractors or employees to leave the project.

During a Severe Weather Watch, when lightening is possible, everyone will remain near a building or within hearing of a two-way radio. If lightning, heavy rain or hail is present or expected, everyone will remain inside a vehicle or a building. Movement outside of buildings and vehicles will be kept to an absolute minimum of transfer between a building and a vehicle. Under no circumstances will anyone walk around open areas of the project.

The Site Superintendent may issue a Severe Weather Warning and order the cessation of all on-site activities. If a Severe Weather Warning is announced, all personnel will return to the Project Office Trailer Area from remote areas, secure their work area, secure and vacate heavy equipment, halt outside work and seek shelter.

When using outside structures as shelter, pay particular attention to hail and rain. Open exposure to hail can be life threatening. Large amounts of rain can fall quickly and the ditches will carry high volume water flows in a short period of time. Every effort should be made to seek shelter inside before using outside structures.

When the storm event has passed or the Site Superintendent determines the situation has stabilized enough to allow the continuation of normal activities, an All Clear notice will be given to all on-site personnel and normal activities can resume. This notice will be given in person, over the public address system, by two-way radio or by telephone.

If a severe weather event hits the site, the Site Superintendent will account for all personnel before any activity is resumed. Everyone will assemble at the Project Site Office Trailer for an accounting of all project employees and visitors. If anyone is not accounted for, a search will be implemented until the missing person(s) can be found.

The Site Superintendent will take precautions and implement procedures as described in this project Emergency Response Plan. Reporting notices will be given to all agencies designated in the Emergency Response Plan.

The Site Superintendent will assess the area and determine what response is needed.

A project management team comprised of the Site Superintendent and Site Safety Supervisor will inspect the site for hazards and needed remedial

activities. The team will develop a corrective action plan to clean and repair the project site.

The Site Superintendent may recruit any site personnel to assess damage and recommend corrective action. The Site Superintendent will dispatch personnel for response activities as necessary.

The Site Superintendent will direct site project personnel to establish clean up crews to clear away debris, repair structures or equipment and prepare the site to return to normal operating activities.

When response activities have been completed, a second inspection of the site will be made. The inspection team with the advice of other key personnel will evaluate remedial activities and the ability of the project activities to safely proceed.

The Site Superintendent will review assessments made by the inspection team and allow the commencement of activities when corrective actions have been completed and the project is ready to function normally.

Reports will be drafted, submitted to the Project Manager and subsequently filed with the respective agencies in accordance with permit requirements.

2. Severe Snow Storms

During cold weather, snow storms may arrive at a project site with little or no warning. Snow can be expected anytime between September and May. Because of this, when a severe snow storm is in process or expected, management must be alert to quick changes in temperature and snow levels. The Site Superintendent will be consulted to determine if work will need to be stopped early in order for employees to leave for their homes.

If a snow storm warning is issued by the U.S. Weather Service, the Site Superintendent will be notified of the situation by the Site Safety Supervisor. The Site Superintendent will notify site personnel of the expected snow conditions and determine that appropriate site scheduling and closure conditions.

If conditions deteriorate and employees are directed to leave early, appropriate shut down procedures in accordance with standard operating procedures will be instituted.

Employees are strongly urged to frequently review and follow cold weather precautions and protective measures as outlined in their training. Particular attention should be given to maintaining cold weather protective clothing and emergency equipment in their personal vehicles. Fuel levels should be maintained as high as possible, half to three quarters full is recommended. Know the symptoms of hypothermia and be prepared.

XV. EMERGENCY COMMUNICATIONS

This plan establishes necessary actions and guidelines to keep communications open at Frontier in case of emergency, power outage, or other unforeseen events. These actions will help to maintain an open and functioning communication system during an emergency.

In the event of a communications system breakdown or emergency situation the following steps are necessary to reestablish the communications network.

A. Power Outages

Field operations should not be affected by local power outages.

B. Emergencies

In case of an on-site emergency, Frontier personnel should immediately contact the Site Safety Supervisor or the Site Superintendent. Site management will notify the proper authorities via radio or cellular telephone. In the event of a power outage, Frontier personnel should notify the Site Office Trailer where cellular telephone access is available.

XVI. HAZARD ANALYSIS, ASSESSMENT, AND CONTROL

A. Hazard Analysis

Hazards are defined as situations where there exists the potential for harm to human health or the environment. Hazard Analysis is a comprehensive analysis of processes, practices and equipment, which will identify potential hazards and generate recommendations, which will reduce the potential for the hazards to become a detriment to human health and the environment. At Frontier the Site Safety Supervisor is responsible for managing the hazard analysis process. These responsibilities include:

- initiating Hazard Analysis requirements in conjunction with safe work practices,

- scheduling and coordinating Hazard Analysis activities,
- obtaining toxicological, industrial hygiene or other relevant data as necessary,
- assisting in implementing recommendations,
- reviewing Hazard Analysis projects to ensure they are carried out and fully documented, and
- providing information to Frontier management.

B. Hazard Assessment

The types of materials to be handles, remediated, reclaimed, etc, by Frontier will generally be non-hazardous. However, in the course of site operations; materials that may be ignitable, corrosive, reactive or toxic may be encountered. The degree or extent of these materials being hazardous will vary and cannot be determined until waste streams are approved.

The health consequences of exposure to these types of materials will be determined at the time the material is evaluated for management by Frontier and in certain cases, after consultation with the Frontier designated physician. The information obtained from the project site and determined through laboratory analysis will define what health and safety warnings are given to employees when the material is managed onsite.

Employee exposure monitoring will be accomplished by industrial hygiene monitoring which will be provided by the Site Safety Supervisor. Monitoring information will be used to determine work place exposures and methods to reduce the potential for exposure.

C. Hazard Controls

Hazard controls have been built in during the construction of Frontier and control procedures have been incorporated into the waste management process to the maximum extent possible.

The employee in consultation with the Site Safety Supervisor will select personal protective equipment.

The Site Superintendent is responsible for the implementation of hazard elimination recommendations in their areas, and for assisting the Site Safety Supervisor as required.

Employees are responsible for creating, maintaining and ensuring safe work methods, conditions and habits in their respective areas.

In order to enhance job safety, a Job Safety Analysis Plan will be initiated to provide Frontier management with information which will assist in identifying, evaluating and controlling safety and health hazards for the purpose of employee protection. This program will help develop information which may be used to evaluate work procedures and/or material handling procedures. The Site Safety Supervisor will coordinate the evaluation of specific jobs and Job Safety Analysis results with Frontier Project Management. The Project Manager and the Site Superintendent will review recommended changes. Frontier's President will give final approval of work place changes. Approved job task changes will be incorporated into job descriptions and on-the-job training as soon as practicable.

XVII. JOB SAFETY HAZARD ANALYSIS

This program, in conjunction with the rest of the Frontier Health and Safety Plan, is designed to identify, evaluate and control safety and health hazards relating to specific jobs for the purpose of employee protection. Job safety hazard analysis will help Frontier management and employees improve individual job safety and the general operation of a project.

Job safety analysis will develop information, which will provide detailed knowledge of individual jobs comprising the work performed at Frontier. As a result, safety and training will improve, accidents and injuries will decrease and full regulatory compliance can be realized.

Site management is responsible for establishing and maintaining safe work practices, methods and conditions in their areas.

There are a number of things that managers and supervisors can do to carry out this responsibility, such as training, safety surveys, strict enforcement of safety standards, accident investigations, setting an example. Basic to all these activities is a thorough knowledge of all of the individual jobs performed in each area, knowledge of essential job tasks, the accident hazards involved and the safety procedures to be followed for each task.

By developing job safety hazard analysis, this knowledge can be acquired and put to use.

A Job safety hazard analysis is an evaluation of a sequence of work procedures (tasks or separate activities) that outlines (a) the health and safety hazards that do or can exist, (b) the actions which could result in accidents and (c) the safe procedures to be followed which will eliminate or control such hazards so the work goal can be accomplished safely.

There are certain important assumptions to be made:

- Every job can usually be improved. Jobs, which are revised after Job safety hazard analysis, should improve because of changes in the process, materials and equipment.
- It is important to work with people to change their work methods and behavior. It is important to help employees make improvements in their job.
- Those that do the job can make significant improvements. No one knows the job better than the employee who performs the work.

Four steps are essential to the development of Job safety hazard analysis:

1. Selecting the job to be analyzed.
2. Breaking the job down into tasks.
3. Identifying potential hazards in each task.
4. Development of solutions to eliminate the hazards.

The Site Safety Supervisor will determine which jobs have priority for hazard analysis. Jobs selected may have certain characteristics or result in the collection of pertinent information, such as accident and injury statistics; occurrence of serious accidents; repetitive jobs performed by multiple employees; new jobs; 'bottle neck' jobs where material or work piles up and interferes with safe and continuous operations; jobs which are critical to the whole operation; jobs which generate frequent complaints from employees; team or group jobs; isolated hazardous jobs; seasonal, infrequent or non-routine jobs; manual handling or materials handling jobs.

The Site Safety Supervisor will draw from a variety of methodologies and obtain the help of different individuals in order to analyze a particular job.

A. Observation and Discussion Method

Members of management, supervisors or other employees while in progress will make observations of the selected job. These observations will help describe each task and thus contribute to an understanding of the specific hazards involved. Observers will ask questions of the employee performing the work and discuss special methods, problems, difficulties or other individual aspects of the job.

The discussion method may involve a group of interested persons, supervisors, senior employees, safety personnel or any others involved in the job analysis project. These people will meet and discuss the particular job and complete the Job safety hazard analysis away from the immediate job location. This method will tap the experience of many more people, provide wider participation, develop greater acceptance of the results and can be done at times when the process is not in operation. However, some important parts of the job may be missed and therefore certain hazards may not be included in the analysis.

B. Recall and Check Method

Participants would prepare their analysis material individually or as a group, followed by checking their results at the job location.

Any combination of these methods may be used. The Site Safety Supervisor will select the one that works best.

The initial approach to the Job safety hazard analysis will involve dividing the job into individual tasks or steps. Care must be exercised not to break the job down into steps so small as to be meaningless nor so broad that some of the important steps are missed.

For example, assume someone was given a small tree for planting in the yard. How should the job be broken down? It could be (1) dig hole; (2) plant tree. In this analysis the steps listed are too broad. They do not describe any specific work tasks that would reveal hazards. On the other hand, it could be listed (1) pick up shovel; (2) position shovel; (3) put foot on shovel; (4) push shovel with foot, etc. Broken down this way the analysis is too detailed. Between these two extremes is a satisfactory division of job elements that makes sense. Such a breakdown would be as follows: (1) bring tools; (2) dig hole; (3) prepare hole; (4) position tree in hole; (5) back fill, tamp, water; (6) brace tree; (7) return tools. This analysis is a good breakdown, not too many or too few steps. Each one is an action step that can stand by itself. In each case something was done. These task descriptions would be listed in column number one of the Job safety hazard analysis form. This form is included in the Table of Documents.

The next step is to identify all of the accident possibilities inherent in each step. List them in column number two of the Job safety hazard analysis form, opposite the appropriate step. In searching out the possible hazards consider every possible indication of a health or safety hazard or cause of an accident. Appropriate questions to ask are:

1. What machine hazards are there?
2. Is the employee exposed to electrical hazards?
3. What falling or material handling hazards are there?
4. Is there exposure to dusts, fumes, chemicals, heat or gases?
5. What hazards exist from hand tools or portable equipment?
6. Is the work area uncluttered with work surfaces dry and free of tripping or other safety hazards?
7. Can the employee be struck by or contacted by anything?
8. Can the employee get caught in, or between anything?
9. Is there a potential for heat stress, cold stress or severe weather hazards?
10. Are there special personal protective equipment requirements?
11. Are there any confined space, lock-out/tag-out or hot work hazards?
12. Are there special air monitoring requirements?
13. What hazardous materials are used or present and have the applicable MSDSs been reviewed?
14. Is there a need for special emergency response equipment for fire or spill control?
15. Will special decontamination procedures be required?
16. What ergonomic problems or considerations are associated with operation of equipment or controls?

In making the search for possible hazards, do not overlook the use of information about accidents that have occurred on this or similar jobs before. Review the OSHA 200 form and other safety and accident reporting forms maintained by the Site Safety Supervisor. There is no hazard too trivial to list. Frequently, a minor hazard can produce a major accident and severe injury.

The Site Safety Supervisor and the affected supervisor or manager will use the above information to develop safe work practices designed to eliminate safety and health hazards and control the accident potential. These are listed in column three of the Job Safety Analysis form opposite the corresponding task and hazard. When listing these, the following questions will be asked:

1. How can health and safety hazards be eliminated?
2. What should the worker do to avoid accidents?
3. Exactly how should the job be done?

In determining the best method of doing a job, the following four approaches may be considered:

1. A better solution. An entirely new way of doing the job is developed which will accomplish the same goal but will eliminate hazards, be safer, improve efficiency, conserve resources, minimize waste, save time and save money. Identify the job goal and examine ways of doing the job better. Consider the use of improved personal protective equipment, new tools, materials, equipment and methods.
2. Engineering revision of existing methods. A better solution may not always be possible. Consideration must be given to how individual elements of the job can be improved through engineering changes. For example: relocating a valve to the operator does not have to stand in an aisle or an awkward position in order to operate it; or, installation of a conveyor so material can be mechanically or automatically transferred to or removed from a vessel.
3. Personnel requirements. Ergonomics and required physical abilities need to be evaluated. Physical requirements must be considered, such as visual acuity, suitable reach, sufficient height to accomplish the task without stretching, adequate strength and manual dexterity, and required job skills and experience.

4. Instructions and training. Determine criteria for classroom instruction and on-the-job training. Incorporate findings into the established classroom and on-the-job training program.

The Site Safety Supervisor will work with project facility management and supervisors to implement the results of the job analysis. After an analysis is completed, the findings will be incorporated into the applicable classroom and on-the-job training programs.

Copies of the Job safety hazard analysis will be maintained in the general work areas for reference by employees.

Periodic reviews by the Site Safety Supervisor will ensure that job revisions have been implemented and are effective in reducing and eliminating hazards and accidents.

APPENDIX E

Emergency Call Down List

Black Swan Removal Action, June 2018

The Black Swan stream restoration and mine waste removal project is located approximately 4.5 miles up Fourmile Canyon Drive between the addresses of 4726 Fourmile Canyon Drive and 11 Logan Mill Road. The coordinates (NAD83) for the upstream limits of the study reach are 40.0499 N latitude, 105.3696 W longitude, and the coordinates for the downstream limits of the study are 40.0410 N latitude, 105.3640 W longitude. The mine waste is located at 4389 Fourmile Canyon Drive (40.047790N latitude, W -150.368489 longitude).

There is no cell service in Fourmile Canyon. If there is a need to notify downstream users due to possible contamination calling 911 with a Haz Mat notification will activate a cascade of agency notifications and emergency response teams. There are four private residences in the vicinity with landlines that can be used (4451, 4472, 4367 & 4389 Fourmile Canyon Drive). The contractors on site (Frontier Environmental Services) will have a radio that can communicate with the Four Mile Fire Protection District that can respond to emergencies and alert other agencies if necessary. Agency phone numbers are included below.

In the event of an injury or entrapment emergency or in the event of a mine impacted water release, use the Notification Call Down List below to assist in making the proper notification in a timely manner. The Pre-Scripted Message below can help describe the nature of emergency and ensure all needed information is shared/provided.

1. This is (Identify yourself; name, position, etc.).
2. We have an imminent/ actual release of Mine Impacted Water from the Black Swan Restoration Mine Waste Removal Project, Located at xxxxxx. (physical address, direction, and coordinates)
3. We have experienced (describe unusual or emergency event) and, in the absence of the onsite OSC, are activating the Emergency Action Plan.
4. There are/ are not injuries or entrapment of workers in the mine associated with this release.
5. If injuries or entrapment are associated with the release) We have/have not initiated the emergency contact chain to request mine rescue or emergency medical support.
6. It is estimated that XXXX gallons of Mine Impacted Water has been released.
7. It is expected that Fourmile Creek and Boulder Creek will be colored orange with high turbidity levels (estimate Distance)
8. We have notified the following federal/state/local/stakeholders.
9. The best way to contact me for additional information and updates is

I. Agency Representatives

U.S. Environmental Protection Agency – Region 8

Duc Nguyen

Office: 303-312-6509

Cell: 303-886-1636

APPENDIX E

EPA Phone-Duty OSC 303-293-1788

National Response Center 800-424-8802

Colorado Department of Public Health and Environment (CDPHE)

Drinking Water Emergencies or Incidences 1-877-518-5608

III. County and Local Officials

Boulder County Public Health Department
Erin Dodge, Water Quality Program Coordinator Office: 303-441-1241
General Line Office: 303-441-1564

Boulder Community Hospital 303-415-7000
Flight For Life Colorado 720-321-3900
4389 Fourmile Canyon Drive coordinates (Black Swan):
40 0253.08"N 105 2205.78"W

Boulder County Sheriff's Office, Office: 303-441-4444
Joe Pelle, Sherriff

Office of Emergency Management (OEM), Office: 303-441-3390
Mike Chard, Director

Four Mile Fire Protection District, Office: 303-449-3333
Bret Gibson, Chief Cell: 303-579-1821

Fourmile Watershed Coalition, Office: 303-449-3333
Maya MacHamer, Coordinator Cell: 303-817-2261

Frontier Environmental Services Office: 303-234-9350
Brent Scarbrough, Project Manager Cell: 303-489-7740

Pine Brook Water District Office: 303-443-5394
Bob De Haas, Manager

City of Boulder Water Quality Line Office: 303-413-7350
Steven Chase, Utility Compliance Specialist Cell: 720-355-4634



May 8, 2018

Mr. Brent Scarbrough
Frontier Environmental Services, LLC
5350 Vivian Street, Unit B
Arvada, CO 80002

**Sampling and Analysis Plan
Black Swan Mine Tailing Site
40.047803 / -105.368287
Boulder County, Colorado**

Dear Mr. Scarbrough,

Eagle Environmental Consulting, Inc. (EAGLE) is pleased to present this Sampling and Analysis Plan (SAP) for the above referenced site.

1.0 INTRODUCTION

The Black Swan mine tailing site (Site) is located near Salina, Colorado in Boulder County along Fourmile Canyon Drive. The Site contains approximately 1,400 cubic yards of mine tailings located adjacent to Fourmile Creek. During the historic flooding event that occurred in the Fall of 2013, heavy rains and flash flooding within Fourmile Canyon caused Fourmile Creek to change course and erode the adjacent bank. The Site is located in the Fourmile Creek Watershed, a source of drinking water for local residents. EAGLE has been tasked with assessing the total extent of the mine tailings waste pile and determine if contamination has leached into the underlying soils and adjacent Fourmile creek.

2.0 BACKGROUND

The sampling area occupies approximately 7,500 square feet to a depth of approximately five to six feet below ground surface (bgs) in the Fourmile Creek Watershed. The sampling area is bordered on the North and East by Fourmile Creek and forested mountain terrain to the South and West. The proposed sampling area is presented in Figure 1.

2.1 Geological Background

Fourmile Creek is located within the Fourmile Creek Watershed and flows east from the mountains into Boulder Creek in West Boulder, Colorado. The topography consists primarily of forested mountain terrain. The section of Fourmile Creek being concentrated on was among the hardest locations affected by the 2013 flood causing the creek to experience significant erosion and channel migration.

2.2 Environmental and Health Impact

Fourmile Creek is a source of drinking water for local residents in Boulder County. Therefore, the presence of the tailings waste poses a threat to human health. Additionally the undercutting poses a potential threat to the health of the stream by increasing the concentration of metals and acidity levels in the water.

3.0 PROJECT DATA QUALITY OBJECTIVES

3.1 Project Objectives

Frontier Environmental Services, LLC (Frontier) has tasked EAGLE with assessing and determining the vertical and lateral extents of the mine tailings waste located at the Site. The following sections outline EAGLE's approach to the environmental investigation and data collection.

3.2 Data Quality Objectives

The goals of this assessment are to determine the area impacted by the proposed rerouting of Fourmile Creek which will undercut the mine tailings waste located along the floodplain of the creek.

- Confirm total extent of mine tailings waste
- Assess extents of potential contamination within ground and surface water underneath tailings pile and in adjacent creek.

4.0 SAMPLING RATIONALE

EAGLE plans to advance 3 borings (SB-01 through SB-03) within the approximate mine tailing area. A Geoprobe 7822 direct push rig will be utilized to advance the borings. One tailing and one soil sample will be collected from each boring to determine mine tailing extent and whether mine tailing contaminants have leached into the native soil beneath. Groundwater samples will also be collected from each boring if encountered. Additionally, EAGLE will collect surface water samples in the adjacent Fourmile Creek at upstream, source, and downstream locations to determine if contamination from the tailings has leached into the water.

4.1 Subsurface Soil Sampling

Subsurface tailing/soil samples will be collected continuously within 5-foot plastic sample liners. The samples within the plastic liners will be separated into 2.5-foot intervals for identification and analysis. A portion of the sample will be placed in a 4-ounce glass jar and packed in an iced cooler. Two samples will be collected from each borehole, one from the identified mine tailings and another beneath the assumed tailings interval to determine lateral extent and assess if leaching has occurred into the native soil.

4.2 Water Sampling

Ground and surface water samples will be collected in 500 milliliter (mL) and 250 mL poly containers using a peristaltic pump to field filter the water from selected locations in each boring and adjacent creek. New tubing will be utilized at each sample location to ensure no cross contamination from samples. Ground and surface water samples will be collected in unpreserved poly containers during the time of collection and later preserved with HNO₃.

4.3 Confirmation Soil Sampling

Following removal of the tailings, confirmation soil samples will be collected to ensure residual metal concentrations do not exceed Colorado regulatory limits. One sample will be collected from each sidewall per every 25-30 feet of lateral distance. Samples will also be collected from the floor of the excavated area per every 25-30 feet of lateral distance.

5.0 REQUEST FOR ANALYSIS

Samples collected at the Site will be delivered to Origins Laboratory, Inc. (Origins) located in Denver, Colorado under standard chain of custody procedures. The soil and tailing samples will be submitted for analysis of Resource Conservation and Recovery Act (RCRA) 8 metals (Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver) with additional analysis for Copper (Cu) and Manganese (Mn) following Environmental Protection Agency (EPA) Methods 6010/6020 and 7471 (Mercury). In addition, the mine tailing samples will be analyzed for toxic leaching procedure (TCLP) analysis following EA Method 1311. The ground and surface water samples will be submitted for analysis of dissolved RCRA 8 metals with additional analysis for Cu and Mn following EPA Methods 6010/6020 and 7471 (Mercury). In addition, the ground and surface water samples will laboratory analyzed for pH.

6.0 FIELD METHODS AND PROCEDURES

A description of the field method that will utilized during sampling activities is included in Attachment A.

6.1 Field Equipment

Table 6-1

Quantity	Equipment	Comments
1	Truck(s)	EAGLE owned – mobe from Denver
1	Geoprobe 7822	EAGLE owned – mobe from Denver
1	Peristaltic Pump	EAGLE owned
1	Trimble GEOXT 6000	EAGLE owned

6.2 Tailings/Soil

Specific tailing/soil sampling locations will be determined in the field based on accessibility and field observations. Sample locations will be recorded in field notes and global positioning system (GPS) coordinates will be collected for the exact location of each soil boring using a Trimble GeoXT 6000 series instrument.

6.3 Surface Water

Specific surface water sampling locations will be determined in the field based on proximity to the mine tailings waste. Samples will be collected from an upstream location before the mine tailings location, directly adjacent to, and from a downstream location. Sample locations will be recorded in the field notes with a sketch of sample locations and physical reference points. Sample locations will also be recorded using a Trimble GeoXT 6000 series instrument.

6.4 Decontamination Procedures

Decontamination procedures will be followed in accordance with the EAGLE SOP found in Attachment A. All equipment that contacts with potentially contaminated soil or water will be decontaminated. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal.

7.0 SAMPLE CONTAINERS, PRESERVATION PACKAGING AND SHIPPING

The number and type of sample containers, volumes and preservatives are listed in Table 7-1. The containers will be pre-cleaned by the laboratory and will not be rinsed prior to sample collection. Required preservatives will be added by the laboratory to appropriate samples prior to analysis.

7.1 Tailing/Soil Samples

Subsurface tailing/soil samples to be analyzed for metals will be transferred from the plastic liners directly into 4-oz glass jars and immediately packed and placed in an iced cooler to be delivered to Origins. Preservative is not required for the samples. One jar of each sample is required for analysis by the laboratory.

7.2 Water Samples

Water samples analyzed for dissolved metals will be collected in 500 mL polyethylene bottles. The samples will be preserved by adding nitric acid (HNO₃) to the sample bottle post collection by Origins. Water samples collected for analysis of pH will be collected in unpreserved 250 mL polyethylene bottles. The samples will be immediately packed and placed in an iced cooler to be delivered to Origins. One bottle of each water sample is required for analysis by the laboratory.

Table 7-1:

Matrix	Analyte	EPA Method	Container	Preservative	Analytical Holding Time
Tailing	TCLP	1311	4-oz glass jar	None	6 Months
Tailing/Soil	RCRA 8 Metals + Cu, Mn	6010/6020 and 7471 (Mercury)	4-oz glass jar	None	6 Months
Water	Dissolved RCRA 8 Metals + Cu, Mn	6010/6020 and 7471 (Mercury)	500-mL poly	HNO ₃	24 Hours + 6 Months ¹
Water	pH	9040C	250-mL poly	None	24 Hours

¹ Water samples must be filtered and preserved within 24 hours of collection prior to analysis.

8.0 FIELD HEALTH AND SAFETY PROCEDURES

All field activities will be conducted in accordance with EAGLE’s Health and Safety Plan (HASP) which will be developed prior to the start of any field activities. Prior to work a Job Safety Analysis (JSA) form will be completed, reviewed/discussed, and signed with all personnel onsite, as well as anyone who enters the work area. EAGLE anticipates that all work can be completed using Level D Personal Protective Equipment (PPE). When onsite personnel will need to at a minimum adorn steel toed boots and when in proximity to the GeoProbe wear hard hats, hearing protection, and safety glasses. When handling samples and tailing waste, personnel will need to wear nitrile gloves.

9.0 OPERATIONAL COSTS

Estimated costs to complete the scope of work:

- Labor, Materials, Preparation, and Field Supplies – \$4,300.00
- Drilling and Associated Materials – \$2,578.88
- Laboratory Analytical Costs - \$9,460.00

Please note the labor cost includes one mobilization for confirmation soil sampling following excavation activities. Additional charges may be incurred if additional mobilizations are required for confirmation soil sampling. Laboratory costs include analysis of 15 confirmation soil samples. Additional costs may be incurred if additional soil samples are required.

10.0 SITE SCHEDULE

EAGLE anticipates the assessment activities detailed in the SAP to cover no more than a day. The final schedule will be determined by Frontier.

EAGLE sincerely appreciates the opportunity to provide our services. If you have any questions or require further information, please contact us at (303) 433-0479.

Sincerely,

EAGLE ENVIRONMENTAL CONSULTING, INC.



Martin Eckert III
President/Senior Scientist

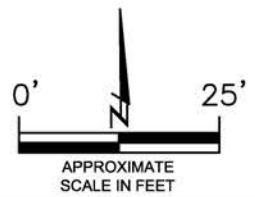
FIGURE

Figure 1: Proposed Sample Location Map



LEGEND

- - - - APPROXIMATE MINE TAILINGS BOUNDARIES
- SB-01 APPROXIMATE LOCATION OF PROPOSED SOIL BORINGS
- SW-01 APPROXIMATE LOCATION OF PROPOSED SURFACE WATER SAMPLES



PROPOSED SAMPLE LOCATION MAP
 BLACK SWAN MINE TAILINGS SITE
 40.047803 / -105.368287
 BOULDER COUNTY, COLORADO

DATE:
04/20/18
 DRAWN BY:
KF
 FIG.
NO. 1

EAGLE
 ENVIRONMENTAL
 CONSULTING, INC.
 4101 INCA STREET, DENVER, CO 80211
 Ph: 303-433-0479 - F: 303-325-5449

ATTACHMENT A

EAGLE's Standard Operating Procedures (SOP)



EAGLE
ENVIRONMENTAL
CONSULTING, INC.

STANDARD OPERATING PROCEDURES

**4101 INCA STREET
DENVER, COLORADO 80211
(303) 433-0479 (OFFICE)
(303) 325-5499 (FAX)
www.eagle-enviro.com**

The following is a general Standard Operational Procedures (SOP) Plan for typical field activities performed by Eagle Environmental Consulting, Inc. (EAGLE).

Note: The following procedures are general guidelines only, and may be altered depending on site specific field conditions. Consult the project manager if site conditions require any changes to a SOP.

Table of Contents

1.0 GENERAL FIELD WORK PREPARATION, GUIDELINES, AND REQUIRED PAPERWORK.....	1
1.1 Daily Vehicle Inspection	2
2.0 EQUIPMENT CALIBRATION.....	3
2.1 Photoionization Detector (PID)	3
2.1.1 Zero Calibration/Fresh Air	3
2.1.2 Span Calibration Using Isobutylene	3
2.2 YSI Pro-Series Multimeter	3
2.2.1 Temperature Check.....	4
2.2.2 Conductivity	4
2.2.3 pH.....	4
2.2.4 Oxidation Reduction Potential (ORP)	5
2.2.5 Dissolved Oxygen (DO)	5
2.2.6 DO Membrane Installation	5
3.0 MONITORING WELL INSTALLATION ACTIVITIES.....	6
3.1 Field Work Preparation and Planning	6
3.2 Drilling Methods	6
3.2.1 Central Mining Equipment (CME) Hollow Stem Auger	6
3.2.2 Direct Push Utilizing a Geoprobe Track Rig	7
3.2.3 Hand Auger	7
3.2.4 Hammer Drill with Solid Stem Auger	7
3.3 Soil Sample Collection and Logging	7
3.4 Monitoring Well Completion	8
3.5 Monitoring Well Development	9
3.6 Monitoring Well Abandonment	9
4.0 GROUNDWATER SAMPLING	10
4.1 Field Work Planning	10
4.2 Field Preparation	10
4.3 Groundwater Sampling Methods	11
4.3.1 Purging via Disposable PVC Bailer.....	11
4.3.2 Purging via Peristaltic Pump	12
4.4 Groundwater Sample Collection	12
4.4.1 Disposable PVC Bailer.....	12
4.4.2 Peristaltic Pump.....	13
4.5 Surface Water Sampling	13
4.6 Post Groundwater Sampling	13
5.0 WATER SURFACE VACUUM EVENT.....	15
5.1 Field Work Prep and Planning	15
5.1.1 Equipment	15
5.1.2 Personal Protective Equipment.....	15
5.2 Procedure	15
6.0 SOIL VAPOR INSTALLATION AND SAMPLING.....	17
6.1 Field Work Preparation and Planning	17
6.2 Soil Vapor Installation Methods	17
6.2.1 Geoprobe Direct Push or CME Hollow Stem Auger	17
6.2.2 Gas Vapor Probe Kit	19
6.3 Soil Vapor Sample Collection	20

7.0	AQUIFER TESTING.....	21
7.2	Prior to Field:	21
7.3	In Field:	21
8.0	INJECTION ACTIVITIES.....	25
8.1	Field Preparation	25
8.2	Injection Methods	25
8.2.1	Direct Push.....	25
8.2.2	Pressurized Packer System.....	26
8.2.3	Permanent Injection Well.....	26
8.3	Field Notes	26
8.3.1	Pre-Injection Parameters.....	26
8.3.2	Field Notes Collected During Injection Activities.....	27
8.3.3	Post-Injection Parameters.....	27
9.0	EXCAVATION ACTIVITIES.....	28
9.1	Field Preparation	28
9.2	Soil Sample Collection	28
9.3	Excavation Amendment	29
9.4	Backfilling	29
10.0	UNDERGROUND STORAGE TANK SYSTEM CLOSURE.....	30
10.1	UST Removal	30
10.1.1	Field Preparation.....	30
10.1.2	Soil Sampling.....	30
10.1.3	Backfill Activities.....	31
10.2	UST Permanent Closure and/Removal of Dispensers and Dispenser Lines	31
10.2.1	Field Preparation.....	31
10.2.2	Soil Sampling.....	31
11.0	LIQUID PHASE HYDROCARBON REMOVAL.....	32
11.1	Total Fluid Recovery (TFR)	32
11.1.1	Field Preparation.....	32
11.1.2	Data Collection.....	32
11.2	Hand Bailing	33
11.3	Hydrophobic Socks	34
11.4	Pneumatic Pumps	34
12.0	MECHANICAL REMEDIATION SYSTEM INSTALLATION ACTIVITIES.....	36
12.1	Field Preparation	36
12.2	Mechanical Remediation Systems	37
12.2.1	Air Sparge/Soil Vapor Extraction (AS/SVE).....	37
12.2.2	Dual Phase Extraction (DPE).....	37
12.3	Operation and Maintenance (O&M) Activities	38
12.3.1	Field Preparation.....	38
12.3.2	Operation and Maintenance Checklist Activities.....	39
12.4	Remediation System Decommissioning	39
13.0	PILOT TEST ACTIVITIES.....	40
13.1	Field Preparation	40
13.2	Baseline Data Collection	40
13.3	Soil Vapor Extraction Pilot Testing	41
13.3.1	Soil Vapor Extraction Pilot Test Preparation.....	41
13.3.2	Conducting SVE Pilot Testing.....	41

13.4 Air Sparge Pilot Testing	42
13.4.1 Preparation.....	42
13.4.2 Conducting AS Pilot Testing	42
13.5 AS/SVE Combined Pilot Testing	43
13.5.1 AS/SVE Combined Pilot Test Preparation	43
13.5.2 Completing the AS/SVE Combined Pilot Test.....	43
14.0 USING THE TRIMBLE	45
14.1 Prior to the field	45
14.2 Initial steps to setting the trimble up for data collection	45
14.2 Data Collection	46
14.2.1 Additional Notes on Data collection.....	47
14.3 Data view in the field	49
14.4 Following Data Collection	49
14.5 Download and Export Trimble Data	50
14.5.1 Download data file.....	50
14.5.2 Export to CAD.....	50
14.5.2 Export coordinates.....	50

ATTACHMENTS:

Attachment A:

Tailgate Safety Meeting Log
Job Safety Analysis
Materials and Equipment (M&E) List
Subcontractor Activity Summary
Post Field Work Inspection Checklist

Attachment B:

Field Boring Log

Attachment C:

Pilot Test Data Sheet

1.0 GENERAL FIELD WORK PREPARATION, GUIDELINES, AND REQUIRED PAPERWORK

Prior to any field work performed by EAGLE or a hired subcontractor, a site specific Health and Safety Plan (HASP) is required to be completed. The HASP will be prepared by the Project Manager or other assigned personnel in compliance with applicable US Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) guidelines. Additionally, all field personnel must be 40-hour HAZWOPER Certified and current with the 8-hour refresher.

The following forms are required for *all* field work activities and are to be completed each day of field work:

- **Journey Assessment Plan (JAP)** – to be completed prior to leaving the office. Should have schedule and route taken to site. Field employees should scan the JAP to the server and leave the hard copy on their desk. Send a Journey Management Plan (JMP) email to the project manager, stating when you leave the office, leave the field, and arrive back at the office.
- **Tailgate Safety Meeting Log/Job Safety Analysis (JSA)** – to be completed before any field work is initiated at the site. All subcontractors involved must be briefed and must sign the tailgate safety meeting prior to work beginning. Employees, client representatives, and subcontractors who arrive at the site after the safety meeting must be briefed on the topics, agree to comply with all provisions, and acknowledge by signing the form. JSA should include tasks for the day, associated hazards, and planned hazard mitigation.
- **Site Safety Verification Form** – to be completed in conjunction with the post-work checklist, documenting if changes to the JSA were completed throughout the day, and/if new hazards were observed during fieldwork.
- **Materials and Equipment (M&E) List** – include all mileage, materials, and equipment used onsite during each day of field work.
- **Subcontractor Summary Form** – Used to confirm subcontractor billing. To be completed for any subcontractor involved in field work at the site.
- **Post Field Work Checklist** - Used to ensure the work site is left in a similar condition prior to the work being performed. To be completed at the end of each day, prior to leaving the work site.
- **Site Specific Health and Safety Plan** – Have the HASP for that site in the field. All site specific HASPs should be on the server under each site folder, and include closest hospital and hospital directions.
- **Any additional paperwork required by the client (to be discussed with Project Manager)**

Copies of all required forms are included in Attachment A. All completed documents should be scanned and filed on the *same day* following field work activities.

As a supervisor for any subcontractor work, plan to be at the site at least 15-30 minutes before subcontractors arrive to ensure access is open, locations are marked, and any required traffic control is in place. Following field activities each day, the EAGLE representative does not leave the site prior to the subcontractors. If drums are to be left at the site, ensure they are out of the way of site operations, lids are closed, and properly labeled. If additional field work is required over additional days, ensure the work zone is adequately secure (e.g. safety

cones, caution tape, fencing). Do not leave any hazards outside of marked exclusion zones. Prior to leaving the site, ensure the site is clean.

If at any point the SOP cannot be followed due to site conditions, client requests, or weather, the contingency plan/corrective action plan must be discussed with the project manager for that site. Document in field notes why the SOP could not be followed, the agreed upon course of action instituted, and with whom the agreed upon course of action was discussed.

1.1 Daily Vehicle Inspection

Per Department of Transportation (DOT) regulations, all company vehicles must undergo a daily inspection prior to leaving the EAGLE office or starting location for the day. If using a personal vehicle, a daily inspection is still required to ensure the vehicle is safe and adequate for mobilization to the site.

- Complete the daily inspection form, provided in an inspection logbook within each company vehicle. Additional logbooks are available in the EAGLE office for personal vehicles.
- If a vehicle deficiency is noted, the deficiency must be corrected, or vehicle pulled out of service.
- To pull a vehicle out of service, remove the top white copy of the inspection out of the book, and give inspection form and vehicle keys to upper management so repairs can be made.
- If there are no deficiencies, keep both copies in the inspection book.

1.2 DOT Log Book

If driving more than 100 miles one way, the driver of the vehicle must complete the following:

- Have two weeks of timesheets printed out and in the vehicle.
- Fill out a driver's log book. Each employee should have their own logbook.

2.0 EQUIPMENT CALIBRATION/MAINTENANCE

Prior to completing any field work, ensure that the field instrument that will be utilized is properly calibrated prior to each use. Document confidence check and/or calibration activities on associated spreadsheets included with each instrument.

2.1 Photoionization Detector (PID)

The following calibrations are required to calibrate a PID.

2.1.1 Zero Calibration/Fresh Air

This procedure determines the zero point of the sensor calibration curve (calibration curve: is a general method for determining the concentration of a substance in an unknown sample by comparing the unknown to a set of standard samples of known concentrations).

1. Press and hold [MODE] and [N/-] until you see the Password screen.
2. Instead of inputting a password, enter calibration by pressing [MODE].
3. The Calibration screen is now visible with Zero Calibration highlighted.
4. Press [Y/+] to start calibration.
5. Press [Y/+] again.
6. Zero Calibration starts a 30 second countdown.
7. When Zero Cal is complete, the PID will show the Calibration Menu with Span Calibration highlighted. This concludes the Fresh Air Calibration.

2.1.2 Span Calibration Using Isobutylene

This procedure determines the second point of the sensor calibration curve for the sensor, using a known concentration.

1. Press [Y/+] to enter Span Calibration.
2. If you pressed [Y/+] to enter Span calibration, then you will see the name of your Span gas (the default is isobutylene) and the span value in parts per million (ppm).
3. Attach Isobutylene 100 ppm to MiniRae (do not use water filter) with tubing provided.
4. Turn on your span calibration gas.
5. Press [Y/+] to initiate calibration.
6. During Span Calibration process, there is a 30-second countdown.
7. The instrument then exits Span calibration and shows the Zero calibration menu on its display. (Note: The reading should be very close to the span gas value.
8. When calibrations are done, press [MODE], which corresponds with "Back" on the display. Settings will update and return to monitoring mode.

2.2 YSI Pro-Series Multimeter

A confidence check should be completed prior to use to ensure water quality meter accuracy.

2.2.1 Confidence Check

1. Power on water quality unit.

2. Fill storage cup with confidence solution
3. Based on the temperature reading, compare acceptable ranges (pH, Conductivity, ORP) found on the confidence solution label to actual readings (pH, Conductivity, ORP).
4. Record readings in the assigned water quality meter binder.
5. If confidence check passes, calibration is not required. If actual readings are not in range, unit fails and calibration or maintenance is required.

Calibration should be completed when the unit is unable to pass the confidence check. Section 2.2.7 covers dissolved oxygen membrane replacement instructions. Membrane replacement should be completed periodically, or if the dissolved oxygen reading is unable to calibrate.

2.2.2 Temperature Check

1. Place thermometer in clean container of water with probe.
2. Allow at least one minute for probe temperature to stabilize.
3. Compare the thermometer reading to probe temperature. Temperature can be within +/- 0.3 degrees Celsius (°C).

Trouble Shoot: If temperature sensor is not reading accurately, ensure that it is clean and free of debris.

2.2.3 Conductivity

1. Rinse clean cup and probe with conductivity solution then fill with conductivity solution to cover conductivity sensor; tap cup to release bubbles lodged inside probe.
2. Select Calibration → Select Restore Default Cal → Select Conductivity → Select Yes
3. Select Calibration → Select Conductivity → Select Sp Conductivity → Select SPC-μS/cm
4. Select Calibration Value → Input value of conductivity solution (located on solution bottle)
5. Accept Calibration when actual reading is stable.
6. Rinse cup and probe with water.

Trouble Shoot: Clean probe if unacceptable reading. Consult Manual.

Note: If you receive a warning message stating that any of the calibrations are questionable, do not continue with the calibration! Instead, select 'NO' and troubleshoot what is causing the response. Further troubleshooting options are available in the manual.

2.2.4 pH

1. Rinse clean cup and probe with pH 7.00 solution then fill with solution to cover probe and thermistor; tap cup to release bubbles lodged inside probe.
2. Select Calibration → Select Restore Default Cal → Select pH → Select Yes.
3. Select Calibration → Select pH → Select Calibration Value.
4. Input value of pH solution (located on solution bottle).
5. Accept Calibration when actual reading is stable (millivolt (mV) reading should range between 0 ±10).
6. Screen monitor will display "ready for point 2".
7. Rinse clean cup and probe with pH 10.00 solution then fill with solution to cover probe and thermistor; tap cup to release bubbles lodged inside probe.
8. Input value of pH solution (located on solution bottle).
9. Accept Calibration when actual reading is stable (mV reading should range between -17±50)

10. Press “Cal to finish”.
11. Rinse cup and probe with water.

2.2.5 Oxidation Reduction Potential (ORP)

1. Rinse clean cup and probe with ORP solution then fill with solution to cover probe, tap cup to release bubbles lodged inside probe.
2. Select Calibration → Select Restore Default Cal → Select ORP → Select Yes.
3. Select Calibration → Select ORP → Select Calibration Value.
4. Input value of ORP solution (located on solution bottle).
5. Accept Calibration when actual reading is stable.
6. Rinse cup with water.

2.2.6 Dissolved Oxygen (DO)

1. Make sure that the DO membrane is clean with clear electrolyte solution.
2. The membrane should not have air bubbles present under the membrane.
3. Rinse cup and probe and fill with ½ inch of tap water (DO sensor should not be submerged) .
4. Twist on cup two rotations.
5. Select Cal → Restore Default Cal → Select DO → Select Yes.
6. Select Cal → Select DO → Select DO %.
7. Allow 5 to 15 minutes for the cup to become completely saturated.
8. Accept Calibration when actual reading is stable.

2.2.7 DO Membrane Installation

1. Unscrew used yellow or blue membrane cap.
2. Sand DO probe with emery paper in the direction of the grain; use different sections for silver and gold sections of the probe.
3. Rinse sensor tip with distilled water.
4. Prepare DO probe solution according to the instructions on the solution bottle (distilled water is required).
5. Fill a new membrane cap with probe solution, tap sides to remove air bubbles, avoid touching the membrane portion of the cap.
6. Thread the membrane cap onto the sensor, moderately tight; a small amount of probe solution will overflow.
7. Calibrate DO once installation is complete (2.2.6).

3.0 MONITORING WELL INSTALLATION ACTIVITIES

3.1 Field Work Preparation and Planning

- Collect and review (when available) all applicable field and laboratory data from previous investigations to ensure proper well installation location and completion.
- Consult the prepared work plan for monitoring well locations, drilling, and sampling methods to perform.
- Call in public locates to the Utility Notification Center of Colorado (UNCC) system (811) at least three business days prior to monitoring well installation work. Discuss with the project manager if private locates are required. If required set up private locates.
- Complete a site visit to determine if site specific constraints are present. Speak with the onsite manager or representative to notify them of scheduled drilling activities.
- If proposed monitoring wells are located offsite, confirm signed access agreement is completed and/or right of way permit.
- Prior to any drilling method, discuss with the project manager if potholing will be performed at the site to determine the monitoring well location is free of any unmarked utilities.
- Determine whether impacted soil and groundwater generated during monitoring well installation process requires containment and disposal.
- Submit a Notice of Intent (NOI) to the Colorado Division of Water Resources for all wells to be installed within one quarter section at least three days prior to monitoring well installation work. If wells are installed within more than one quarter section for a site, an NOI will be required for each quarter section. If multiple addresses are involved, a separate NOI may be required. Refer to Colorado Division of Water Resources well permitting guidelines for more information.
- Calibrate the PID prior to leaving the office for the field. Refer to Section 2.1 for calibration instructions.
- Bring the following materials/equipment to the site for drilling activities:
 - Calibrated PID with water filters
 - Ice filled cooler
 - Resealable plastic bags (1-gallon)
 - Required sampling containers
 - Nitrile gloves
 - Hand Auger (scope dependent)
 - Survey Equipment

3.2 Drilling Methods

3.2.1 Central Mining Equipment (CME) Hollow Stem Auger

- Soil samples are collected via a 2-foot, stainless steel split spoon sampler or continuous core.
- If using a split spoon sampler:

- Collect soil samples every five feet, unless otherwise discussed with the project manager.
- Record the blow counts for every 6-inch advancement of the split spoon sampler.
- Ensure the split spoon sampler is decontaminated with an anionic detergent powder (e.g. Alconox) wash and rinse between each sample collection.

3.2.2 Direct Push Utilizing a Geoprobe Track Rig

- Soil samples will be collected continuously utilizing 5-foot poly vinyl chloride (PVC) sampling sleeves within 5-foot hollow steel rods.
- Prior to collecting the soil sample (see Section 3.3), split each 5-foot sample into 2-2.5 foot samples.
- If refusal is encountered, note depth of refusal on the boring log.

3.2.3 Hand Auger

Based on the approved work plan for a site, hand auguring may be necessary to collect soil samples at certain depths and locations on a site.

- Ensure the auger rods are properly connected prior to use.
- Twist hand auger clockwise to advance the auger and collect soil samples within the bucket of the hand auger.
- Remove the auger from the boring approximately every six inches to empty the bucket. Bag and jar soil samples collected from the bucket as outlined in the approved work plan. Consult the project manager if there are any questions regarding the sampling procedure for the hand auger.
- Decontaminate the hand auger sampling bucket with an anionic detergent powder (e.g. Alconox), wash and rinse between each sample collection and upon completion.

3.2.4 Hammer Drill with Solid Stem Auger

A hammer drill may be used to advance a soil boring to approximately 15 to 20 feet below ground surface (bgs) based on site lithology. Temporary 1-inch wells may be installed within the borings advanced with the hammer drill.

- When advancing the augers, spin the augers in and out of the boring to remove soil cuttings and prevent the augers from locking up within the subsurface.
- If a soil sample is requested from the boring, a grab sample can be collected from the soil cuttings. Observe the total depth to which the augers have been advanced when soil cuttings are removed from the soil boring. Collect the soil sample at a discreet depth and note the depth of soil sample collection.

3.3 Soil Sample Collection and Logging

- Once the soil sample is retrieved from the borehole, immediately place a portion of the sample in the appropriate sample container. Place as much soil within the jar as possible to prevent volatilization. Put the soil jars in an ice filled cooler, but do not allow the soil samples to freeze.

- Place the remainder of the soil sample within a sealable plastic bag. Breakup the sample and briefly shake the sample bag once or twice in a 10-15 minute period to allow for headspace development. Ensure the bag is at least 40 degrees Fahrenheit prior to screening with a PID. If necessary, place the bag in a warm vehicle to allow for volatilization.
- Following volatilization, field screen the soil sample within the sealable bag using a calibrated, portable PID. Unseal a small portion of the bag and insert the PID probe to measure any volatiles within the soil sample. Record the maximum meter response (should be within the first 2-5 seconds).
- Field log the soil samples within the boring according to the Unified Soil Classification System (USCS). An example of a field boring log is included in Attachment B.
- Discuss with the project manager which soil sample(s) to submit for laboratory analysis. The soil samples will be submitted for laboratory analysis based on PID readings and/or depth in relation to the groundwater table. Additional soil samples may be submitted for laboratory analysis to vertically define soil impacts.
- Decontaminate all soil sampling equipment and augers using an anionic detergent (e.g. Alconox) wash and rinse between soil boring locations to minimize the possibility of cross-contaminating the samples.

3.4 Monitoring Well Completion

- Follow site specific scope of work to determine the appropriate length of schedule 40, 0.010"-slotted or 0.020"-slotted PVC screen and PVC riser. The scope of work will also have listed the diameter of the well to be completed.
- Monitoring well screen placement should be installed approximately 6-10 feet below the water table with approximately 4-6 feet above the water table to accommodate fluctuations in seasonal groundwater level.
- Before a filter pack or annular seal is completed, insert a plug or cover into the top of the PVC to prevent the infiltration of sand or bentonite material from entering the monitoring well.
- The annular space between the well screen and the borehole wall is completed with a clean sand material (usually 10/20 grain size) to serve as a filter pack.
- Extend the filter pack approximately one to two feet (depending on site conditions) feet above the screened section to ensure that the bentonite seal does not compromise the top of the screened section of the well.
- Above the filter pack, fill the remaining annular space with bentonite granules/chips/pellets to grade. Hydrate the bentonite to ensure a proper seal to prevent the migration of contaminants to the sampling zone from the surface or intermediate zones.
- For monitoring wells completed at-grade, a traffic rated, protective cover with a gasket and steel skirt will be installed to protect the monitoring well (flush mount). A j-plug will be installed on the top of the well casing for a proper seal of the well casing.
- For monitoring wells completed above-ground:

- A 5-foot minimum length of metal casing extends approximately 1.5 to 3 feet above the ground surface and is set in concrete. The casing may be circular, square or rectangular. The casing size will be large enough to allow easy placement over the well.
- Bollards may be installed in addition to the protective casing in areas where vehicle traffic may pose a hazard. The bollards may consist of 3-inch diameter steel/concrete posts or tee-bar driven steel posts. Groups of three are radially located around each well.
- Following well completion, survey the new monitoring well, unless a licensed surveyor is hired to complete the surveying activities. Survey the new monitoring well off the north side of the PVC casing, and tie the monitoring well into the existing network of monitoring wells at the site.

3.5 Monitoring Well Development

- Develop the monitoring well to create an effective filter pack around the well screen and to assist in restoring natural groundwater quality in the vicinity of the well.
- Methods to be used when developing monitoring wells will be bailing and surging with a surge block.
- Surge blocking is the act of forcing groundwater in and out of the filter pack to clear the well of any fine soils that may clog the filter pack. Surge blocking can be performed using an aquifer testing slug or stainless steel bailer.
- Site conditions may dictate waiting for the well to reach static conditions prior to well development. Consult the project manager to determine when the well should be developed.
- Certain monitoring wells, based on site lithology, may require surge blocking with the addition of deionized water. Consult the project manager of the site prior to surge blocking a well to determine if surge blocking is required and what steps to take.

3.6 Monitoring Well Abandonment

- Monitoring wells will be abandoned in accordance with Colorado State Engineer standards once approval is received from a project manager.
- Monitoring wells will be abandoned with silica sand (10/20 grain size) from the bottom of the well to the top of the screened PVC section or to the top of the aquifer.
- Above the top of the screened PVC section or aquifer, a bentonite grout (or other materials that are not more permeable than the surrounding soils) will be placed, at a minimum covering the top five feet of the well, within the well casing to grade or approximately 1 foot bgs. (Discuss well abandonment with project manager.)
- If a bentonite grout is placed to approximately 1 foot bgs, concrete will be placed within the well casing to grade.
- The protective surface casing (steel flush mount or steel casing) will be removed along with any bollards.
- Resurfacing will be completed to match original surface (e.g. concrete, asphalt, landscaping, etc.) unless otherwise requested by client or landowner. (Discuss resurfacing with project manager.)

4.0 GROUNDWATER SAMPLING

Special Considerations for Volatile Organic Compound Sampling

The proper collection of a sample for volatile-organic compounds (VOCs) requires minimal disturbance of the sample to limit volatilization and therefore a minimal loss of volatiles from the sample.

4.1 Field Work Planning

- Determine the extents of the sampling plan, print the site sampling field data sheet, and ensure the sampling plan is accurate with current site work plan (discuss with site project manager). A sample groundwater field data sheet is included in Attachment C.
- Determine the sampling method to be utilized and the field equipment required.
- Determine if hydrochloric acid preserved sampling containers or non-preserved sampling containers are to be used, based on the constituents being analyzed.
- Decontaminate and inspect required equipment.
- Complete confidence check and/or calibrate necessary field sampling equipment (refer to Section 2.0).
- Determine how impacted groundwater generated during sampling activities will be containerized and transported (i.e. 55-gallon drum, tote, 5-gallon bucket, etc.).
- Schedule and coordinate with staff, clients, regulatory agencies and land owners (if required).
- Review site map to ensure correct locations are sampled. Review the previous quarter's groundwater sampling results to plan the order of wells sampled and determine what purge groundwater requires to be containerized.
- Prepare a cooler with ice for all groundwater samples.

4.2 Field Preparation

- Note site name, site location, time of day, weather condition, temperature, and date on the site sampling field data sheet or in the field logbook.
- Locate all monitoring well locations that are included in the site sampling plan.
- Begin at the least impacted monitoring well.
- Remove monitoring well lid and j-plug from top of PVC casing.
- Lower water level measuring device into well until water surface or free product is detected. Do not let the tape on the water level indicator rub against the edge of the PVC casing.
- Measure distance from water surface and/or free product to the north edge of the well casing and record depth, in feet (to the nearest hundredth), on site sampling field data sheet or in the field logbook.

- If the total depth of the well is unknown or questionable, measure total depth of the well with an open reel tape measure (NOT water level indicator) and record on site sampling field data sheet or in the field logbook.
- Calculate the volume of water in the well and the volume to be purged. See Section 4.3.1
- Decontaminate all field equipment with an anionic detergent (e.g. Alconox) wash and rinse after each monitoring well.

4.3 Groundwater Sampling Methods

- Groundwater samples will be collected via disposable PVC bailer or peristaltic pump.
- At a minimum, purge three well volumes (refer to section 4.3.1 to calculate volume of well) from the monitoring well via disposable PVC bailer or peristaltic pump prior to the collection of a groundwater sample. Document well volume to be purged, according to the calculation, on the field data sheet. NOTE: If well does not have a lot of water, and is slow to recharge, collect a groundwater sample before the well is bailed dry. If the bailer can only obtain ½ bailer volume while hitting the bottom of the well, collect a groundwater sample.
- Properly label sampling containers with monitoring well identification (ID), time sample was collected, date, site name, sampler name, type of preservative within sampling container, and analysis to be performed.

4.3.1 Purging via Disposable PVC Bailer

To calculate the water volume of a well (in gallons of water per foot of casing), utilize the following equation:

(Total depth of well – depth to water) X Well capacity (in gallons)

Some examples of well capacities for different well diameters are listed below.

Well diameter	2 inches	3 inches	4 inches	6 inches
Approximate Volume (gal/ft.)	0.1632	0.3672	0.6528	1.4688

The water volume of a well casing is typically tripled to determine the volume to be purged. For the first time sampling a well following well install, purge the well six well volumes instead of three.

- Attach poly line to disposable PVC bailer and slowly lower into the monitoring well until it is completely submerged. Do not remove plastic covering from the bailer until ready for use. Do not place uncovered bailers on the ground or any other surface other than inside the well casing.
- Slowly raise the bailer from well and pour purged groundwater into designated clean groundwater parameter sampling container.

- Insert a decontaminated and calibrated YSI 556 MPS MultiProbe or Pro-Series Multimeter into the designated clean groundwater parameter sampling container. Record site sampling plan parameters (i.e. DO, ORP, pH) on a site sampling field data sheet or in the field logbook. Ensure units on the equipment match units on the field sheet.
- Bail the calculated volume from the monitoring well to adequately purge the well.
- Pour purged groundwater into a container or ground surface for volatilization, taking note as to the direction of runoff of the surface. Groundwater is allowed to be poured on the ground surface if the well sampled has had four consecutive quarters of groundwater concentrations below Colorado Regulatory Limits. DO NOT impact surface water features or subsurface utilities. If purged water is poured into a container, dispose of as stated in the site-specific sampling plan.

4.3.2 Purging via Peristaltic Pump

- Assemble pump, hoses, battery, and lower hose into well. Make sure that hose is deep enough so that it remains submerged during purging.
- Attach the flow cell to the outlet of the pump to ensure that the proper amount of groundwater is being purged and that the groundwater is being purged at the approved flow rate (discuss with project manager if necessary).
- Groundwater quality parameters may be collected periodically to determine if groundwater quality parameters such as pH, temperature, and electrical conductivity have stabilized prior to sample collection.
- Purge well until specified volume of water has been evacuated.

4.4 Groundwater Sample Collection

4.4.1 Disposable PVC Bailer

- Label appropriate sample containers, as previously detailed.
- Attach poly line to clean decontaminated disposable PVC bailer. Do not remove plastic covering from the bailer until ready for use. Do not place uncovered bailers on the ground or any other surface other than inside the well casing.
- Following purging, lower bailer into the groundwater for the appropriate depth of sample collection (varies based on contaminant to be analyzed – groundwater sample should be collected from the top of groundwater column for hydrocarbons and from the bottom of the groundwater column for chlorinated solvents).
- Slowly raise bailer from the well and pour into appropriate sample containers.
- Filter and preserve samples if required by site sampling plan.
- Ensure the cap on the sample container is tightly secured, without overtightening. Check for air-bubbles within sample container. Refill sample container if necessary to ensure air-bubbles are absent within the sample container.

- Replace well j-plug and monitoring well lid.
- Log sample collection time in a site sampling field data sheet or in the field logbook.
- Place samples immediately in a cooler filled with ice to decrease the temperature to approximately 4°C. Note: if groundwater samples are submitted to the lab the same day of collection, the temperature does not need to be dropped to 4°C, but samples are still required to be on ice to prevent volatilization.
- Change nitrile gloves before sampling the next well.
- Decontaminate the water level indicator via an approved method (as detailed below).

4.4.2 Peristaltic Pump

- Ensure desired pumping rate is achieved.
- Label appropriate sample containers.
- Filter and preserve samples if required by site sampling plan.
- Ensure the cap on the sample container is tightly secured. Check for air-bubbles within sample container. Refill sample if necessary to ensure air-bubbles are absent within the sample container.
- Replace well j-plug and monitoring well lid.
- Log all samples into site sampling field data sheet or in the field logbook.
- Place samples in a cooler filled with ice to decrease the temperature to approximately 4°C. Note: if groundwater samples are submitted to the lab the same day of collection, the temperature does not need to be dropped to 4°C, but samples are still required to be on ice.

4.5 Surface Water Sampling

- Surface water samples will potentially be collected from excavations, streams, creeks, rivers, or lakes. Protocols for surface water sampling are identical to groundwater sampling, with the exception of the well purging process.

4.6 Post Groundwater Sampling

- Decontaminate all equipment in the field with an anionic detergent (e.g. Alconox) wash after each monitoring well. Acceptable methods for decontaminating the water level indicator are:
 - Method #1: Using a spray bottle of anionic detergent solution, spray down the water level indicator probe and any portion of the tape that was put into the well. Use a clean paper towel to dry the tape and probe.
 - Method #2: Using a clean bucket, make an anionic solution in the bucket. Place water level indicator probe and any portion of the tape that was put into the well into the anionic solution. As the tape is rolled back up, wipe the tape with a clean paper towel. Once the bucket of solution has been used once, discard the solution appropriately. The anionic solution in the bucket should only be used once. Repeat process of making new solution for additional decontamination, as needed.

- With both methods, ensure the probe is cleaned to the point of no visual or odor impacts remaining on the probe or tape following decontamination.
- Put up all equipment in appropriate cases, secured for transportation.
- Complete laboratory supplied chain-of-custody (COC) for the samples and transport or prepare samples to ship to the designated laboratory.

5.0 WATER SURFACE VACUUM EVENT

5.1 Field Work Prep and Planning

Have two employees to operate the procedure. One man to operate the hose, and the other to serve as a watchman.

5.1.1 Equipment

- Provide 2-inch hose to be hooked up to vacuum truck. Attachments will be provided by trucking company (confirm with project manager).
- Bring extending stick (ore, rod, or pole), duct tape, simple green, pads or paper towels, and trash bags.

5.1.2 Personal Protective Equipment (PPE)

- Hose Operator - Hard hat, protective eyewear, ear plugs, long sleeve shirt, nitrile gloves, neoprene gloves, long pants, hard toe boots, Tyvek suit, waders, life vest, harness, and a rope with a clip.
- Watchmen – Hard hat, protective eyewear, ear plugs, long sleeve shirt, nitrile gloves, work gloves, long pants, hard toe boots, Tyvek suit, waders, and life vest.

5.2 Procedure

- Applying PPE - Wear standard Level D PPE, covered by Tyvek suit, remove hard toe boots, put waders on top of Tyvek, put harness on top of waders, clip on support rope to harness, and put life vest on top harness as final layer. Use two layers of gloves, nitriles underneath neoprene for hose operator. Watchmen will duct tape neoprene cuffs around the Tyvek suit of the hose operator in order to create an impermeable seal. Avoid creating an extremely tight seal, as this could cut off circulation to the hose operator.
- Vacuum Event – Hose operator will find comfortable and safe position to operate hose. Tape the end of the extending stick to the end of the hose if needed to reach far into the water. Start vacuum event in between the source point, usually the water's edge, and the boom containment. Always keep hands or other body parts away from the end of the hose when it is under vacuum. Clear obstructions such as pond plant life or sticks from area of concentration. Slightly dip the end of hose in water as to only skim the water surface. Avoid dipping the entire hose end in the water. This will cause the hose to lose its vacuum after a short time. Keep hose in the area of concentration for an extended period of time. This will allow the hose to pull the contamination to it. Avoid moving hose frequently. Work in sections for a few hours at a time. If necessary for hose operator to enter the body of water, use slow but deliberate movements. Sinking into sediment could cause a dangerous footing situation.
- Watchman duties - The watchman will serve as a right hand man to the hose operator. He/she will assist with keeping the hose from thrashing around. He/she will retrieve equipment for the hose operator such as pads or extra gloves. He/she will always keep an eye on the hose operator in case

of emergency. If hose operator were to fall into water and could not get themselves out, the watchmen will use the attached rope to pull the hose operator to safety.

- Clean up – Detach 2-inch hose from vacuum truck. Spray it with Simple Green cleaning solution. Wipe down with pads or paper towels. Dispose of waste in trash bags.

6.0 SOIL VAPOR INSTALLATION AND SAMPLING

Soil vapor may be collected to determine if vapors volatilizing from the groundwater or soil is impacting subsurface utilities or structures.

Soil vapor samples are collected by inserting a sampling implant (usually ¾-inch or 1-inch PVC pipe) into the borehole. Once the implant is in place, and the borehole is completely sealed, soil gas samples are collected via plastic or Teflon tubing into a collection vessel using a vacuum device. Soil vapor points can be temporary or constructed as permanent points. This section will cover installation and sampling procedures.

6.1 Field Work Preparation and Planning

- Call in public locates to the UNCC system (811) at least 3 business days prior to monitoring well installation work. Discuss with the project manager if private locates are required and setup private locates if necessary.
- A site visit may be required to determine if site specific constraints are present.
- A work plan will be prepared detailing the scope of work to be completed during soil vapor installation activities. Discuss with the project manager to confirm what intervals to set for soil vapor sampling and if there is a particular soil vapor installation method that was approved.
- The location of the soil vapor point should be in a location where soil vapor samples collected will be a representation of the area in question. If analyzing the soil vapor pathway for a structure, position the soil vapor point to be as close to the structure as possible, with representative sample depth locations.
- Prior to any drilling method, discuss with the project manager if potholing will be required at the site to determine the soil vapor location is free of any unmarked utilities.

6.2 Soil Vapor Installation Methods

The soil vapor location should be advanced to above the water table or the soil source.

6.2.1 Geoprobe Direct Push or CME Hollow Stem Auger

If soil sampling is scoped for soil vapor point advancement, refer to sections 3.2 and 3.3 for soil sampling and logging procedures. The following sections provide directions for two types of soil vapor point installation.

6.2.1.1 Poly Tubing with Soil Vapor Implant

- Determine if the subcontractor is providing the poly tubing and soil vapor implant or if EAGLE needs to bring the materials to the site.
- Following the advancement of the boring, cut the poly tubing to a length equal to the sample collection depth.
- Attach the poly tubing to the barbed end of the soil vapor implant and secure with a hose clamp.
- Lower soil vapor implant to the desired interval. Before a filter pack or annular seal is

completed, insert a cap on the top end of the poly tubing to prevent sand or bentonite from entering the poly tubing.

- Fill the annular space between the poly tubing and the borehole wall with a clean sand media (usually 10/20 grain size) to serve as a filter pack.
- Extend the filter pack approximately 6-inches above the soil vapor implant to ensure that the annular seal does not compromise the top of the screened section of the soil vapor implant.
- Following the filter pack, fill the annular space with bentonite granules/chips/pellets.
- If installing a nested soil vapor point, fill the annular space with bentonite to the bottom of the next soil vapor implant.
- Hydrate the bentonite to ensure a proper seal to prevent the migration of contaminants to the sampling zone from the surface or intermediate zones.
- Repeat the steps for soil vapor installation for each nested soil vapor implant. Following the last soil vapor implant, fill the remaining annular space with bentonite granules/chips to grade.
- Hydrate the bentonite to ensure a proper seal.
- For each nested soil vapor point, ensure the cap covers are labeled for each soil vapor implant interval.
- Complete the soil vapor location with a traffic rated steel flush mount.

6.2.1.2 Slotted 1-inch PVC

- Determine if the subcontractor is providing the 1-inch PVC pipe or if EAGLE needs to bring the materials to the site.
- Following the advancement of the boring, cut a 1-foot section of 0.010-slotted or 0.0020-slotted 1-inch PVC pipe for the selected interval of the soil vapor point.
- Attach a slip cap to the end of the screened section. e1-inch PVC riser is placed above the screened section to surface grade. (Example: if the total depth of the boring is 20 feet, the soil vapor point will be installed with 1-foot of 1-inch screened pipe, and 19 feet of 1-inch riser).
- Before a filter pack or annular seal is completed, insert a plug or cover into the top of the PVC to prevent the infiltration of sand or bentonite media from entering the monitoring well.
- Fill the annular space between the well screen and the borehole wall with a clean sand media (usually 10/20 grain size) to serve as a filter pack.
- Extend the filter pack approximately 1 foot above the screened section to ensure that the annular seal does not compromise the top of the screened section of the well.
- Above the filter pack, fill the annular space with bentonite granules/chips/pellets.

- If installing a nested soil vapor point, fill the annular space with bentonite up to the bottom of the next soil vapor point.
- Hydrate the bentonite to ensure a proper seal to prevent the migration of contaminants to the sampling zone from the surface or intermediate zones.
- Repeat the steps for soil vapor installation for each nested soil vapor point.
- Following the last soil vapor point, fill the remaining annular space with bentonite granules/chips to grade.
- Hydrate the bentonite to ensure a proper seal.
- For each nested soil vapor point, make sure the slip cap covers are properly labeled for each soil vapor point interval.
- Complete the soil vapor location with a traffic rated steel flush mount.

6.2.2 Gas Vapor Probe Kit

- Ensure required implant materials are available in the office or if they need to be ordered.
- Equipment required:
 - Hammer drill
 - Generator and extension cord(s)
 - AMS Gas Vapor Kit (hard case and bag with attachments)
 - ¼" poly tubing
 - Retractable tip or dedicated tips with screen (depending on scope)
- Refer to a project manager or experienced field technician if there are any questions prior to using the Gas Vapor Probe Kit.
- Advance the soil vapor boring to total depth with the hammer drill, extension rods, and advancement tip. **IMPORTANT:** Make sure the rods are tightened with pipe wrenches. If they are not tightened completely, the threads on the rods may strip.
- Remove the advancement tip and extension rods once total depth is achieved.

6.2.2.1 Soil Vapor Sampling with a Retractable Tip

- Attach the retractable tip to clean, poly tubing and the hollow extension rods. Ensure the retractable tip has been properly decontaminated prior to use.
- Advance the retractable tip and extension rods to the desired depth. Prior to collection, pull up approximately 3-inches to expose the sampling screen.
- Make sure the surrounding borehole has an adequate seal, either by native soil or granular bentonite.
- Refer to Section 3.3 for sample collection directions.

- Following sample collection, remove the rods and retractable tip from the boring. Discard the poly tubing and properly decontaminate the retractable tip with deionized water and Alconox prior to additional sampling.

6.2.2.2 Soil Vapor Sampling with a Dedicated Tip

- Attach the dedicated tip and screen to clean poly tubing. Run the poly tubing through the hollow extension rods.
- Advance the dedicated tip and extension rods to the desired depth. Once the depth has been reached, remove the extension rods, leaving the poly tubing sticking out of the ground.
- Make sure the surrounding borehole is adequately sealed following installation activities, either with native soil or granular bentonite.
- Depending on the location of the soil vapor point, a traffic rated steel flush mount may be installed to protect the soil vapor point.

6.3 Soil Vapor Sample Collection

- Prior to soil vapor sample collection, reference the site work plan to determine which soil vapor points and which intervals within the soil vapor points will be sampled.
- Locate the soil vapor point and remove the flush mount lid. Identify if soil vapor point is installed via poly tubing or 1-inch PVC. If it is a nested soil vapor point identify each interval for accurate sampling.
- Attach Gil Air pump to either the poly tubing or 1-inch PVC well. Purge each soil vapor monitoring point for approximately 5 minutes prior to soil vapor sample collection.
- Once the soil vapor point has been purged, remove the Gil Air pump and attach the MiniRae 5-Gas Meter to the soil vapor point to collect carbon dioxide and oxygen readings. The oxygen and carbon dioxide measurements are used to evaluate aerobic degradation occurring in the vadose zone. Record carbon dioxide and oxygen readings on the site field data sheet or in the field logbook.
- After carbon dioxide and oxygen readings have been collected, attach the poly tubing to the soil vapor point and collect the soil vapor sample.
- Firmly press the fill port of the soil vapor sample container (summa canister or glass amber container) into the sample port attachment and hold for approximately 15 seconds. Remove the fill port from the sample port attachment and repeat the previous step to ensure adequate soil vapor sample collection.
- Label the soil vapor sample container with site name, date, time sample was collected, sampler name, and analysis to be run on the soil vapor sample.
- Avoid storing the soil vapor sample in direct sunlight and complete the COC.

7.0 AQUIFER TESTING

Purpose: During aquifer testing, groundwater recharge data is collected to calculate hydraulic conductivity using a pressure/temperature smart sensor and datalogger. The following aquifer testing procedure is formatted for the INW Aquistar PT2X Pressure/Temperature Smart Sensor and Datalogger.

Equipment Needed:Laptop w/Software (check battery as an outlet may not be available in the field).Smart Sensor with case.

- Appropriate tools to open well vaults.
- Interface Probe.
- Heavy item to hold clamp in place.
- Blue Pacific Hydrostar clear water pump.
- 3/4” clear braided hose with 1” female camlock fitting.
- 1” white/black braided hose with 2” female camlock fitting.
- One 2” female to 1” male reducer camlock fitting.
- Two 5 gallon buckets.
- Decontamination kit.
- Clean 5 gallon bucket of clean water with lid if no clean water will be available at site.

(MAKE SURE ALL EQUIPMENT HAS BEEN DECONTAMINATED PRIOR TO USE!)

7.2 Prior to Field

- Install Software
 - See equipment manager for correct software to install onto laptop.
 - Check the Smart Sensor battery by opening software and “scan” (if battery needs replacing, see equipment manager).
 - Choose which monitoring wells will be used for slug testing and order them from least to most contaminated. Perform slug testing in this order. If concentrations are unknown decontaminate all equipment between testing wells.

7.3 In Field

- At monitoring well, collect depth to water and total depth of the monitoring well.
- Connect Smart Sensor to laptop.
- Open Aqua4Plus Lite software and select “view-> sensor window ”.

- Verify sensor is connected. Window reads PT2X: INW Smart Sensor.
- If previous site data is displayed, right click data and select “erase all data”.
- Select “configure-> settings and calibration”.
- Place sensor in monitoring well no deeper than 1.5 to 2 feet above total depth of the monitoring well. Consider water column available above sensor depth. **(DO NOT RUB CABLE AGAINST SIDE OF WELL CASING WHEN LOWERING)**.
- With 3/4“ clear braided hose measure a length 1.5 to 2 feet less than the depth of where the bottom of where sensor is set and mark with tape. This is the depth the hose will be set for the purging process.
- Prime blue clear water pump by unscrewing the black cap from the top of the pump housing and filling with clean water.
- Attach 2” female to 1” male reducer camlock fitting to 2” male camlock fitting on bottom of pump housing.
- Place and orient pump near well so that the inlet (2” female to 1” male reducer camlock fitting) and the throttle can be operated with one hand.
- Attach the 1” female camlock fitting on 3/4” clear braided hose to 1” male camlock fitting and stage close to well.
- In program, select settings:
 - Channels select “pressure”.
 - Select setting type “depth to water (DTW)”.
 - Calculator enter DTW reading in “DTW: FtH20”.
 - Select “measure”, wait for reading to stabilize and select “accept”.
 - Select “apply”, select “ok”.

This converts the sensor’s pressure readings into depth to water readings at MW.

- Ensure unneeded cable including desiccant is set near laptop away from monitoring well and splashing of water during purging.
- Select “logging->new logging schedule” to enter a logging schedule.
 - Enter file name with site and monitoring well ID (ABC-MW-01).
 - Select “Set Sensor Clock”.
 - In Phase 1 enter “c” as logging interval. (This ensures the DTW is logged continuously)
 - Enter “524000” as # records.

- Select “start”
- Select “start” on sensor window

This marks the beginning of the data logging process.

- Begin purging Monitoring Well
 - Carefully lower bailer $\frac{3}{4}$ of the depth of the well, so as not to disturb sensor location or cable in the monitoring well.
 - Bail groundwater to remove ≥ 2 feet of water column, if possible. (If > 2 feet is not possible, get as much drawdown as possible. If drawdown is not able to be achieved, call the site PM and discuss).
 - Observe pressure readings (FtH₂O) in sensor window to confirm drawdown.
 - **Do not remove enough groundwater to uncover sensor.**
- Once appropriate drawdown is achieved and purging is ended, collect time from sensor window.
 - To continue viewing real time data from sensor window continue to select “start”.
 - This will not restart logging; it will restart viewing of data collected.
 - The status of the sensor should read active if sensor is currently logging data.
- Depth to water readings should decrease as recharge occurs.
 - Continue logging until sufficient recharge has occurred or pressure (FtH₂O) has returned to initial reading.
 - Sufficient recharge occurs when water level is equal to the initial water level or when readings change less than 0.01 feet per 10 minutes.
- To complete logging, select file name, right click, select “retrieve data”.
 - Save file on desktop, select “start” to retrieve.
 - Select “view”.
 - Select “graph icon”.
 - Select “down arrow, zoom to data”.
 - Examine graph to confirm accurate data collection (Discuss with project manager prior).
Note: Confirm pressure unit reading FtH₂O.
- Select “Export”.
 - Save file on desktop as Excel type.

- Reselect file name in sensor window, right click, select “Erase all data”.
- Remove sensor carefully.
- Collect final depth to water at monitoring well.
- Decontaminate sensor and used cable with an anionic detergent (e.g. Alconox) wash.
- Continue to next monitoring well.

Note: KEEP BLUE DESSICANT DRY, IF DESSICANT LOOSES BLUE COLOR CONTACT EQUIPMENT MANAGER. RECAP USB CONNECTION AT THE END OF THE SLUG TEST.

8.0 INJECTION ACTIVITIES

Purpose: To actively address dissolved and adsorbed phase impacts, in-situ, using chemical or biological materials.

8.1 Field Preparation

- Collect and review all soil/groundwater data from previous investigations to ensure proper injection point/injection well location and completion (when available).
- A work plan will be prepared detailing the scope of work to be completed during injection activities. Consult injection sub-contractor for amount of material, locations of injection points/wells, depths, intervals, and type of application.
- A site visit is required to determine if site specific constraints are present. Speak with manager on site or site representative to notify them of the activities.
- Submit an Underground Injection Control (UIC) Class V Rule Authorization Request to the Environmental Protection Agency (EPA), outlining the scope of work for the injection event. The injection event cannot be completed until a Rule Authorization has been received from the EPA.
- Submit a Notice of Intent to the Colorado Division of Water Resources for all permanent injection wells to be installed within one quarter section three days prior to installation. If wells are installed within more than one quarter section for a site, a Notice of Intent will be required for each quarter section.
- Call in public locates to the UNCC system (811) at least three business days prior to injection well install or injection point advancement. Discuss with the project manager if private locates are required, and setup private locates if necessary.
- Prior to any permanent injection well installation/temporary injection point advancement, discuss with the project manager if air knifing/potholing will be performed at the site to ensure the injection well or injection point location is free of any unmarked utilities.

8.2 Injection Methods

Permanent injection well installation/temporary injection point advancement is completed using hollow/solid stem auger or direct push technology. The remedial material is injected into the subsurface of the site via direct push rods, pressurized packer system, or permanent injection wells.

8.2.1 Direct Push

- The remedial material will be injected into the subsurface of the site via expandable tip or screen interval on a direct push rod.
- Supervise injection activities to ensure the approved injection plan is completed. (i.e. locations of injection points, injection interval depths, and amounts of remedial material injected)
- If surfacing of the remedial material is observed through any cracks or wells, stop the injection activities and clean up the surfaced remedial material immediately. Change locations, injection depth, and/or injection flow rate to prevent additional surfacing (contact project manager to discuss alternate

injection approaches).

8.2.2 Pressurized Packer System

- The remedial material will be injected into the subsurface of the site via a perforated rod with a packer on each end (pressurized packer system).
- Supervise the installation of the pressurized packer system within an open boring advanced by hollow/solid stem augers. Once the pressurized packer system is installed to the desired injection depth interval, a pressure is applied to seal the pressurized packer system in place.
- Supervise injection activities to ensure the approved injection plan is completed. (i.e. locations of injection points, injection interval depths, and amounts of remedial material injected)
- If surfacing of the remedial material is observed through any cracks or wells, stop the injection activities and clean up the surfaced remedial material immediately. Change locations, injection depth, and/or injection flow rate to prevent additional surfacing (contact project manager to discuss alternate injection approaches).

8.2.3 Permanent Injection Well

- The remedial material will be injected into the subsurface of the site via permanent injection well.
- Supervise injection activities to ensure the approved injection plan is completed if a sub-contractor is completing the injection activities on site. (i.e. amounts of remedial material injected)
- Ensure all hoses, pumps, and mixing containers have been decontaminated prior to application of material.
- Following injections utilizing the diaphragm pump, decontaminate the pump, all hoses, and mixing tote on the same day.

If surfacing of the remedial material is observed through any cracks or wells, stop the injection activities and clean up the surfaced remedial material immediately. Change locations injection flow rate to prevent additional surfacing (contact project manager to discuss alternate injection approaches).

8.3 Field Notes

The following data are collected before, during, and after each injection event.

8.3.1 Pre-Injection Parameters

- Based on the approved Injection Plan for the site, collect baseline depth to groundwater and groundwater quality parameters (dissolved oxygen, temperature, pH, oxygen-reduction potential, and specific conductance) from the approved monitoring wells prior to injections on the site pre-injection parameter data sheet or in the field logbook (discuss with project manager if necessary).
- Follow decontamination and calibration protocol for all field equipment utilized.

8.3.2 Field Notes Collected During Injection Activities

- During the injection event, the following information is required: locations of injection wells/points, injection well/point identification (ID), time injection started/ended at each injection well/point, amount of remedial material injected, interval remedial material was injected at, application of remedial material, pressure remedial material was injected, type of remedial material, and if any surfacing occurred during injections to be recorded on the site injection log data sheet or in the field logbook (discuss with project manager if necessary).

8.3.3 Post-Injection Parameters

- Based on the approved injection plan for the site, collect post-injection depth to groundwater and groundwater quality parameters (dissolved oxygen, temperature, pH, oxygen-reduction potential, and specific conductance) from the same network of monitoring wells that pre-injection parameters were collected. Record all data on the site post-injection parameter data sheet or in the field logbook (discuss with project manager if necessary).
- Follow decontamination and calibration protocol for all field equipment utilized.
- Additional site visits may be required to collect post injection parameters. Review the approved injection plan or project manager to determine if additional site visits are required.

9.0 EXCAVATION ACTIVITIES

Purpose: To remove adsorbed impacts/ address the release source at a site.

9.1 Field Preparation

- Collect and review all soil/groundwater data from previous subsurface investigations to determine excavation extents (when available) and whether groundwater is expected to be encountered during excavation activities.
- Call in public locates to the UNCC system (811) at least three business days prior to excavation activities. Discuss with the project manager if private locates are required, and setup private locates if necessary.
- A site visit is required to determine if site specific constraints are present that will limit the excavation extents (i.e. utilities, structures, etc.).
- Ensure all underground utilities/pipes located within the proposed excavation extents are disconnected or in-active.
- A work plan will be prepared detailing the scope of work to be completed during excavation activities. The work plan should include extents of the excavation, type of equipment to complete excavation activities, soil sampling activities, waste transport and disposal plan, traffic control plan, if shoring if necessary, and scheduling and coordination with staff, clients, regulatory agencies, and land owners.
- Determine what tasks the subcontractor will be responsible for (transportation, disposal, and/or backfilling/compaction) and what tasks are the responsibility of EAGLE.
- Ensure manifests are available and current.
- Bring the following equipment to site:
 - Field Book or Field sheets
 - PID
 - Sampling jars
 - Resealable plastic bags (usually 1-gallon)
 - Ice filled cooler
 - Measuring wheel
 - 4-gas meter

9.2 Soil Sample Collection

- Based on approved work plan, confirm the excavation extents, the number of soil samples to be collected, and location of soil samples. Discuss with project manager prior to excavation activities.
- Soil sampling plan should confirm source removal, as well as vertically and horizontally define soil impacts. Impacts may not be removed/defined if a structure limits the excavation extents or impacts extend into the saturated zone.
- Based on the approved work plan, ensure soil sample collection/field screening techniques are followed, discuss with project manager prior to excavation activities.

9.3 Excavation Amendment

Based on the approved work plan, confirm the proper amendment material, application process, and amount of amendment to be utilized during excavation activities. Discuss with project manager prior to any backfilling activities. Record the type of material, concentration, and amount added to an excavated area in the field logbook.

- Gypsum (calcium sulfate) and powdered reactivated carbon amendment application via excavator:
 - 1:1 ratio – 50 pounds of gypsum to 50 pounds of carbon;
 - Mix gypsum and carbon in bucket of excavator prior to applying to excavation;
 - Have the excavator operator apply the amendment to the excavation (floor and sidewalls - if adsorbed petroleum hydrocarbon impacts remain on sidewalls);
 - Apply 100 pounds of the amendment per 100 - 250 square foot area of excavation floor; additional amendment may be applied based on groundwater analytical data (discuss with project manager); and
 - Have excavator mix the applied amendment within the soil /groundwater at the base of the excavation, as able, prior to backfilling activities.

9.4 Backfilling

- Ensure proper backfilling material/materials are utilized, compaction techniques and testing is completed if required, and resurfacing is completed, per the approved work plan. Discuss with project manager prior to completing any backfilling activities.
- If the excavation extended into the groundwater table, utilize pea gravel or ¾-inch stone to backfill the portion of the excavation within the groundwater table, followed by structural fill.

10.0 UNDERGROUND STORAGE TANK SYSTEM CLOSURE

Purpose: To close an underground storage tank (UST) either by removal or filling the tank with an inert structural fill material. The corresponding dispensers and dispenser lines may also be removed depending on the scope of work and reason for UST closure.

10.1 UST Removal

10.1.1 Field Preparation

- Confirm all product is removed from the UST and any corresponding dispenser lines prior to removal.
- Call in public locates to the UNCC system (811) at least three business days prior to subsurface work. Confirm subcontractor completing the work also calls in locates. Discuss with the project manager if private locates are required, and request private locates if necessary.
- Complete a site visit to determine if site specific constraints are present. Speak with the onsite manager or representative to notify them of scheduled UST removal activities.
- Determine what tasks are the subcontractor's responsibility (i.e. excavation, vapor evacuation, removal, transportation, disposal) and what tasks are the responsibility of EAGLE.
- The fire department must be called prior to UST removal activities for oversight. Discuss with the subcontractor who will coordinate the fire department oversight.
- Calibrate the PID prior to leaving the office for the field. See Section 2.0 for calibration instructions.
- Bring the following equipment to site:
 - Field Book or Field sheets
 - PID
 - Sampling jars
 - Resealable plastic bags (usually 1-gallon)
 - Ice filled cooler
 - Measuring wheel
 - 4-gas multimeter and tubing

10.1.2 Soil Sampling

- Consult the project manager to determine the sampling scope. A minimum of three soil samples should be collected beneath the removed UST, unless otherwise discussed.
- Once sample is retrieved, immediately place a portion of the sample within the appropriate sample container. Place as much soil within the jar as possible to prevent volatilization. Put the soil jars in an ice filled cooler, but do not allow the soil samples to freeze.
- Place the remainder of the soil sample within a sealable plastic bag. Allow the soil to volatilize within the bag. Ensure the bag is at least 40 degrees Fahrenheit prior to PID screening. If necessary, place the bag in a warm vehicle for volatilization.
- Following volatilization time, field screen the soil sample within the bag using a calibrated, portable PID. Open the bag only enough to allow the tip of the PID in the bag, so that any volatiles do not

escape.

10.1.3 Backfill Activities

- Ensure proper backfilling material/materials are utilized, compaction techniques and testing is completed, and resurfacing is completed per the approved work plan. Discuss with project manager prior to completing any backfilling activities.

10.2 UST Permanent Closure and/Removal of Dispensers and Dispenser Lines

10.2.1 Field Preparation

- Follow field preparation steps in Section 9.1.1

10.2.2 Soil Sampling

- Consult the project manager to determine the sampling scope. At a minimum, soil samples must be collected beneath dispensers, at least one soil sample every 100 linear feet, and beneath each dispenser line elbow (unless otherwise discussed). If the system is being closed in place, borings must be advanced adjacent to the above listed areas.
- Follow soil sampling steps detailed in Section 9.1.3.

11.0 LIQUID PHASE HYDROCARBON REMOVAL

Purpose: To remove liquid phase hydrocarbons (LPH) from a groundwater monitoring well, outside of active remediation or in-situ remediation.

11.1 Total Fluid Recovery (TFR)

11.1.1 Field Preparation

- Consult the approved work plan to determine the duration of the TFR event and amount of impacted water scoped to be removed.
- Schedule the TFR subcontractor, including the length of time and amount of water allotted to be removed.
- Notify any property owners, managers, etc. of scheduled work and placement on the site.
- Prepare a blank TFR data sheet and site map (The subcontractor or EAGLE Employee is responsible for collecting required data during the TFR event.
- Bring the following equipment to site:
 - PID
 - Velocicalc (flow meter)
 - Interface Probe
 - Magnehelic gauges
- Confirm with the project manager which wells will be utilized to remove LPH during the TFR, and what monitoring wells to collect the TFR radius of influence data from. Ensure all equipment is calibrated and decontaminated.

11.1.2 Data Collection

11.1.2.1 Pre-TFR data collection

- Plan to arrive onsite at least 15 minutes prior to the subcontractor's scheduled arrival time.
- Collect the following data from the wells with LPH, as well as the chosen network of wells:
 - Depth to product, measuring to the nearest hundredth
 - Depth to water, measuring to the nearest hundredth
 - PID reading from wellhead.
- Once the subcontractor arrives, collect baseline PID reading from the effluent stack of the TFR unit.
- Subcontractor is responsible for placing PVC stingers in the chosen wells with LPH. Typically, the stingers are placed at an initial depth of approximately 2 feet below the depth to product.

11.1.2.2 TFR Event

- The subcontractor will start the liquid Ring Pump (LRP) or Positive Displacement (PD) blower, which will begin pulling groundwater/LPH from the monitoring wells via steel reinforced, flexible hose and collected in a poly tote.
- If the monitoring well is slow to recharge and the stingers cease pulling impacted groundwater/LPH, the stingers may be lowered further into the well.
- Collect the following data every 30 minutes for the duration of the TFR event:
 - At the surrounding network of monitoring wells (wells without stingers):
 - Time
 - Depth to water
 - Vacuum reading (using magnehelic gauges in “H₂O)
 - VOC concentrations with PID
 - At the TFR effluent stack:
 - Time
 - PID reading
 - Flow (SCFM) – ensure the correct diameter of effluent stack is entered in the Velocicalc
 - Velocity (in feet per minute)
 - Temperature (Deg. F)
 - Vacuum reading at knockout tank (note units)

11.1.2.3 Post TFR Data Collection

- Once the TFR has been completed (conducted for the allotted time), the subcontractor will turn off the LRP or PD blower, and remove stingers from the wells.
- Collect the following data:
 - Amount (in gallons) of LPH/impacted groundwater removed.
 - Data collected from each wellhead prior to the TFR event (depth to water, depth to product, PID reading).

11.2 Hand Bailing

- If a monitoring well is gauged and LPH is present, hand bailing may be required to remove the LPH.
- If a hydrophobic sock is present in the well, remove the sock and place it in a 1-gallon, resealable bag, for proper disposal. Record the approximate saturation of the hydrophobic sock.
- **Transport saturated hydrophobic sock to EAGLE office for proper disposal. Place sock in the sock disposal drum located in the EAGLE yard. Fill out the hydrophobic sock data sheet, located on a clipboard in the field office.**
- Measure and record the depth to water and depth to product, to the nearest hundredth a foot.
- Insert a poly bailer into the well, allowing it to fill approximately half full.

- Slowly pull the bailer out of the well, and pour the LPH and impacted groundwater into a 5-gallon bucket.
- Continue process until little to no LPH is present in the monitoring well.
- Measure and record the new depth to water, and if present, depth to product in the well.
- Record the amount of LPH and impacted groundwater removed from the well.
- **Dispose of all LPH or contaminated water to site specific 55-gallon drum or disposal container in truck to be properly disposed of when work is complete. Complete a waste manifest, and place in the manifest folder in the field office. When the tote is close to full (or winter temperatures require immediate disposal to avoid freezing), transport contaminated water and manifests to ACI for disposal (or other predetermined location).**

11.3 Hydrophobic Socks

- Following hand bailing, a hydrophobic sock can be placed in the well to passively recover LPH. Consult the project manager if a hydrophobic sock should be placed in a monitoring well.
- Tie the hydrophobic sock to a piece of polyline, long enough to reach the LPH in the well.
- Measure out the polyline and set the sock in the well so that it is placed in the LPH layer.
- Record that a sock was placed within the well on the field data sheet or field book.

11.4 Pneumatic Pumps

- Review work plan with sub-contractors on site to ensure the remediation system installation activities are completed in accordance with the approved work plan. If the work plan requests that the remediation system installation is completed in stages, determine adequate equipment/material staging areas.
- Ensure proper traffic control devices are used when necessary on and off site (i.e. candlesticks, cones, caution tape, etc.).
- Supervise/complete locations and dimensions of saw cuts.
- Stage conveyance line piping, fittings, saw, and glue near proposed trenching locations.
- Supervise/complete trenching to ensure proper trench dimensions, and that utilities are not damaged during trenching activities. (If trench crosses marked utilities or unmarked utilities are discovered, stop work and discuss trenching approaches with project manager and sub-contractor)
- Install groundwater pumps in designated wells. Ensure that all hose connections are tight, pipes/hoses are labeled, and the pumps set at the desired depth. Discuss desired pump depths with project manager.
- Install conveyance lines within the trench per the approved remediation system design. Make sure to label individual conveyance lines (from remedial well to stickup location) prior to backfilling activities.

- Supervise backfilling, resurfacing, and remediation shed/fence installation activities.
- Install pneumatic pump equipment; connect the conveyance lines and knockout tank to pneumatic pump housing unit.
- Ensure that a power source is supplied to the pneumatic pump housing unit.
- Ensure disposal/removal of any additional materials (backfill material, soil, asphalt, concrete, etc.) is completed.

12.0 MECHANICAL REMEDIATION SYSTEM INSTALLATION ACTIVITIES

Purpose: To mechanically address residual dissolved and/or adsorbed petroleum hydrocarbon/chlorinated solvent impacts.

12.1 Field Preparation

- Call in public locates to the UNCC system (811) at least 3 business days prior to remediation system installation activities. Discuss with the project manager if private locates are required, and setup private locates if necessary.
- A site visit is required to determine if site specific constraints are present (i.e. utilities, structures, etc.). Speak with manager on site or site representative to notify them of the activities.
- Complete installation and pilot testing to determine if remedial approach is technologically feasible (discuss location of pilot test wells and the pilot testing work plan with project manager).
- A remediation system will be designed based on pilot testing results, soil/groundwater data, and utilities/structures present on site.
- A work plan will be prepared detailing the scope of work to be completed during remediation system installation activities. The work plan should include: remedial well installation, saw cuts, trenching, conveyance lines, pump installation, backfilling, transportation, disposal, resurfacing, remediation shed, remedial equipment, power source, scheduling/coordination with staff, clients, regulatory agencies, and land owners.
- Submit an UIC Class V Rule Authorization Request to the EPA, outlining the scope of work for the remediation system installation. The installation of any air sparge remedial wells permanently completed within the water table cannot be completed until a Rule Authorization has been received from the EPA.
- Submit a Notice of Intent of the Colorado Division of Water Resources for all remedial wells completed within the water table within one quarter section. If wells are installed within more than one quarter section for a site, a Notice of Intent will be required for each quarter section.
- Based on pilot test results, discuss if an Air Pollutant Emission Notice (APEN) application needs to be completed with the project manager.
- Ensure all underground utilities/pipes located within the proposed remediation system trench are either disconnected/in-active or will be exposed via potholing/hand digging.
- Determine what tasks the subcontractor will be responsible for (remedial well installation, saw cuts, trenching, transportation, disposal, backfilling, resurfacing, etc.) and what tasks are the responsibility of EAGLE.
- Based on approved remediation system design, order all materials needed to install the remediation system (i.e. remedial equipment, piping, fittings, shed, flush mounts, etc.).
- Prior to any remedial well advancement, discuss with the project manager if potholing will be performed at the site to ensure the remedial well locations are free of any unmarked utilities.

12.2 Mechanical Remediation Systems

Pictures must be collected before, during, and after the remediation system installation to document the activities completed.

12.2.1 Air Sparge/Soil Vapor Extraction (AS/SVE)

- Review work plan with sub-contractors on site to ensure the remediation system installation activities are completed in accordance with the approved work plan. If the work plan requests that the remediation system installation is completed in stages, determine adequate equipment/material staging areas.
- Ensure proper traffic control devices are used when necessary on and off site (i.e. candlesticks, cones, caution tape, etc.).
- Supervise locations and dimensions of saw cuts.
- Stage conveyance line piping, fittings, saw, and glue near proposed trenching locations.
- Supervise trenching to ensure proper trench dimensions, and that utilities are not damaged during trenching activities. (If trench crosses marked utilities or unmarked utilities are discovered, stop work and discuss trenching approaches with project manager and sub-contractor)
- Ensure proper backfilling material (typically pea gravel) is placed on floor of trench prior to laying conveyance lines.
- Install conveyance lines within the trench per the approved remediation system design. Organize conveyance lines to ensure proper stickup locations within the proposed remedial shed location. Make sure to label individual conveyance lines (from remedial well to stickups) prior to backfilling activities. (Note: Approximately 10-15 feet of steel piping is typically used to complete the AS conveyance lines, discuss with project manager if necessary)
- Supervise backfilling, resurfacing, and remediation shed installation activities.
- Install remedial equipment and complete the plumbing of the conveyance line manifold.
- Ensure that control panel is installed and a power source is supplied to the remediation shed.
- Ensure disposal/removal of any additional materials (backfill material, soil, asphalt, concrete, etc.) is completed.

12.2.2 Dual Phase Extraction (DPE)

- Review work plan with sub-contractors on site to ensure the remediation system installation activities are completed in accordance with the approved work plan. If the work plan requests that the remediation system installation is completed in stages, determine adequate equipment/material staging areas.
- Ensure proper traffic control devices are used when necessary on and off site (i.e. candlesticks, cones, caution tape, etc.).

- Supervise locations and dimensions of saw cuts.
- Stage conveyance line piping, fittings, saw, and glue near proposed trenching locations.
- Supervise trenching to ensure proper trench dimensions, and that utilities are not damaged during trenching activities. (If trench crosses marked utilities or unmarked utilities are discovered, stop work and discuss trenching approaches with project manager and sub-contractor)
- Supervise the installation of a reinjection gallery or above ground storage tank (AST) if included in approved work plan.
- Supervise the installation of concrete vaults/manhole covers if included in the approved work plan.
- Supervise/install groundwater pumps in designated wells. Ensure that all hose connections are tight, pipes/hoses are labeled, and the pumps set at the desired depth. Discuss pump type, installation, and desired pump depths with project manager.
- Ensure proper backfilling material (typically pea gravel) is placed on floor of trench prior to laying conveyance lines.
- Install conveyance lines within the trench per the approved remediation system design.
- Organize conveyance lines to ensure proper stickup locations within the proposed remedial shed location. Make sure to label individual conveyance lines (from remedial well to stickups) prior to backfilling activities.
- Supervise backfilling, resurfacing, and remediation shed installation activities.
- Install remedial equipment, complete the plumbing of the conveyance line manifold, and complete the plumbing of groundwater pumps and treatment equipment.
- Ensure that control panel is installed and a power source is supplied to the remediation shed.
- Ensure disposal/removal of any additional materials (backfill material, soil, asphalt, concrete, etc.) is completed.

12.3 Operation and Maintenance (O&M) Activities

Purpose: Operation and Maintenance activities are completed on a monthly basis to monitor the operational status of a remediation system.

12.3.1 Field Preparation

- Print site O&M Checklist from server at the EAGLE office.
- Review the maintenance Site Log Book, previous month O&M Checklist located on sever to determine maintenance activities (oil change, vane replacement, filter replacement, etc.) to be completed at site. (Discuss maintenance, radius of influence (ROI), and effluent air sampling activities with project manager.).
- Obtain necessary equipment (PID, flow meter, magnehelic gauges, amber air sampling container,

interface probe, etc.) to complete O&M activities at the site and ensure all equipment is calibrated.

12.3.2 Operation and Maintenance Checklist Activities

All data collected during O&M activities is recorded on the site O&M Checklist, if additional data is collected it must be recorded in the field log book.

- Record if remediation system is operational or non-operational upon arrival at the site on the O&M Checklist. If the system is non-operation complete remediation system troubleshooting techniques (i.e. is knockout tank full of water, is Siemens switch tripped, does the remediation equipment have power, is system on timer, etc.) and discuss system status with project manager.
- Record operation hours from equipment timers on the O&M Checklist.
- If system is operating, shut remediation system off and check fluid levels (oil or lubricant) and clean filters on all equipment. Add fluids and change filters if necessary. Drain knockout tank and record all maintenance data on the O&M Checklist.
- If completing O&M activities on a remediation system that pumps water/product, gauge wells that house pumps for depth to product and depth to water measurements. Discuss thickness of product observed with project manager to determine if continued pumping is necessary.
- Operate remediation system and collect readings from the AS manifold, SVE manifold, knockout tank, control panel, SVE effluent stack, or AC Sipper Unit (if applicable), and record on the O&M Checklist.
- Collect air sample from SVE effluent stack if required, record the time and date the sample was collected, sampler name, site name, and analysis on the label of the sample container. Also, note the collection of a SVE effluent air sample on the O&M Checklist.
- Collect ROI readings from the network of designated monitoring wells once a quarter. Magnehelic gauges are utilized with fabricated j-plugs to collect vacuum/pressure readings from each monitoring well. (Note: Ensure that the j-plug and poly tubing are tightly connected and that the magnehelic gauges are zeroed before collecting any readings). Discuss with project manager if necessary.
- Once all O&M activities are completed and data collected, record on the O&M Checklist. Ensure that all plugs are replaced and monitoring wells are properly closed.
- Remove any trash from within the remediation shed/fence and lock the control panel/remediation shed/fence.
- Upon return to the office, all O&M Checklists and field notes need to be scanned in and filed within the appropriate folder on the server.

12.4 Remediation System Decommissioning

Only upon approval from a project manager, will remediation system decommissioning activities be completed.

- Remediation System Decommissioning includes:
 - abandoning all remedial wells following protocol outlined in Section 3.6.
 - removal of all remedial equipment

- removal of remediation system structure
- Discuss remediation system decommissioning schedule with project manager.

13.0 PILOT TEST ACTIVITIES

Purpose: To determine if proposed remedial technology will adequately address residual dissolved and/or adsorbed petroleum hydrocarbon/chlorinated solvent impacts beneath the site.

13.1 Field Preparation

- Ensure remedial pilot test wells were properly installed and completed based on soil/groundwater data, site lithology, and data points (network of monitoring wells surrounding the pilot test wells).
- Discuss test wells and durations of each pilot test with project manager. (Typically an 8-hour event, approximately 2-hours for the SVE test, approximately 2-hours for the AS test, and approximately 4-hours for the combined AS/SVE test.)
- Discuss selection of observation wells with project manager based on distances from the test wells.
- Discuss the initial vacuum applied during the SVE test and how the applied vacuum/pressure will be increased throughout the duration of each test.
- Ensure the trailer mounted generator, compressor, and blower are operating. Add fluids (gasoline, diesel, oil, etc.) to generator, blower, and/or AS compressor as needed.
- Collect the blower effluent stack, and all hoses and well head fittings need to complete pilot testing activities. (Discuss with project manager if necessary.)
- Collect necessary pilot testing field equipment (PID, multi-meter, interface probe, flow-meter, magnehelic gauges, measuring wheel, etc.). Ensure all field equipment is calibrated.
- Inform on site manager, site representative, clients, and/or landowner of the upcoming pilot testing activities.
- Discuss on site location of pilot test trailer with project manager. Do not block dispensers, entrances/exits, or store entrance if possible.
- Print pilot testing field data sheet to record data collected during pilot testing activities.
- Complete Department of Transportation (DOT) trailer injection log. Ensure all equipment (AS compressor, hoses, candlesticks, etc.) is secured to the trailer.

13.2 Baseline Data Collection

Park the pilot test trailer in the approved location on site. If limited space is available, disconnect trailer from work truck.

- Utilize measuring wheel to measure the distances from each test well to each surrounding observation well. Record the distances on the pilot testing field data sheet.
- Collect the following baseline parameters in the order presented from each test/observation well, and record on pilot testing field data sheet.
 - Remove j-plug on test/observation well and collect VOC readings from inside the PVC riser using a PID.
 - Measure depth to water/depth to product (DTW/DTP) to the nearest hundredth of a foot using an interface probe.
 - Purge one PVC bailer from the test/observation well (top of the water column for petroleum hydrocarbons or bottom of the water column for chlorinated solvents) and pour the purged water into a decontaminated parameter cup. Place a decontaminated multi-meter into the parameter cup and record the dissolved oxygen reading.
- Collect initial PID readings from the effluent stack and the test well manifold sampling port.

13.3 Soil Vapor Extraction Pilot Testing

13.3.1 Soil Vapor Extraction Pilot Test Preparation

- Connect hose from trailer mounted knockout tank to test well manifold (2-inch or 4-inch test well manifold based on the diameter of SVE test well). Do not secure to test well riser.
- Connect a magnehelic gauge (0-100 inches of water) to the well head manifold.
- Start generator and operate for approximately 5 minutes prior to increasing the throttle. Once the generator is warm, increase to full throttle.
- Insert the SVE effluent stack into the 90 degree elbow attached to the SVE blower.
- Start SVE blower and adjust dilution air value to achieve desired applied vacuum (previously discussed with project manager). Determine applied vacuum reading from vacuum gauge located on top of knockout tank.
- Once the desired applied vacuum is observed, shut off SVE blower and attach test well manifold to the test well riser via a rubber coupler.

13.3.2 Conducting SVE Pilot Testing

- Start SVE blower at the desired applied vacuum.
- Collect the following parameters from the knockout tank, dilution air value, effluent stack, well head manifold, and observation wells at the beginning of the test and every 30 minutes (Note: record time parameters were collected on pilot test field data sheet):
 - Collected from knockout tank:
 - Applied vacuum in inches of water (“H₂O) from vacuum gauge located on top of knockout tank.
 - Collected from dilution air value:
 - Percentage dilution air ball value is open in percentage (%) (estimated)

- Collected from effluent stack sampling port:
 - VOC in parts per million by volume (ppm-v) with PID
 - Temperature in degrees Celsius (°C) with Flow-meter
 - SCFM with Flow-meter
 - Velocity in feet per minute (ft/min) with Flow-meter
- Collected from well head manifold:
 - VOC in ppm-v with PID
 - Temperature in °C with Flow-meter
 - Flow in SCFM with Flow-meter
 - Velocity in ft/min with Flow-meter
 - Applied vacuum in “H₂O from the magnehelic gauge connected to the well head manifold
- Collected from each observation well:
 - VOC in ppm-v with PID from within PVC riser
 - Vacuum reading in “H₂O with magnehelic gauge
- The applied vacuum will be increased based on observed vacuum readings within the observation wells and VOC readings observed at the effluent stack until the SVE blower is maxed out or groundwater is drawn into the knockout tank. Discuss how much the applied vacuum will be increased throughout the duration of the test with project manager.
- If an SVE only effluent air sample is included in the work plan, collect the air sample from the SVE effluent sampling port at the optimal applied vacuum (discuss optimal applied vacuum with project manager).
- Discuss vacuum readings collected from the observation wells and the PID readings observed at the SVE effluent stack with project manager to determine an optimal applied vacuum.

13.4 Air Sparge Pilot Testing

13.4.1 Preparation

- Open the AS well and glue a female threaded PVC coupler to the top of the PVC riser.
- Screw in the dedicated PVC cap with the hose fitting connected to it. Ensure the dedicated PVC cap is on tight, as it will be under pressure during AS pilot testing activities.
- Operate the AS compressor to build pressure in the holding tanks. (Make sure release valves located on the bottom of each holding tank is closed.)
- Close valves on AS compressor manifold (flow meter with pressure and ball valve) and connect to AS compressor. Use the air hose to connect the AS compressor manifold to the PVC cap attached to the AS test well head.

13.4.2 Conducting AS Pilot Testing

- Complete breakthrough pressure test. The breakthrough pressure test is utilized to determine how much applied pressure is needed to overcome the hydraulic head (water column) within the AS test well and create air flow into the subsurface. Complete the following procedures:

- Slowly open the ball valve on the AS compressor manifold to apply a pressure on the AS test well. Increase pressure to 2.5 pounds per square inch (PSI) for approximately 30 seconds. Record time, pressure, and flow on pilot test field data sheet.
 - Every 30 seconds, slowly increase the pressure by 2.5 PSI and record time, pressure, and flow on the pilot test field data sheet. The applied pressure when a flow is observed is the breakthrough pressure.
 - Once the breakthrough pressure is determined, the breakthrough pressure test is completed.
- Collect the following parameters from AS compressor manifold and observation wells at the beginning of the test and every 30 minutes (Note: record time parameters were collected on pilot test field data sheet):
 - Collected from AS compressor manifold:
 - Applied Pressure in PSI from inline pressure gauge)
 - Flow rate in SCFM from inline flow-meter
 - Collected from each observation well:
 - VOC in ppm-v with PID from within PVC riser
 - Pressure reading in “H₂O with magnehelic gauge
 - Increase the initial applied pressure until a flow rate of 2.5 SCFM is observed on the AS compressor manifold. Slowly increase the applied pressure every 30 minutes until a constant flow rate of 5-10 SCFM is observed on the AS compressor manifold.
 - Once a constant flow rate of 5-10 SCFM is observed on the AS compressor for 30 minutes, the AS pilot test is complete and the AS compressor can be shut off.
 - Discuss pressure readings collected from the observation wells and the flow rates observed at the AS compressor manifold with project manager to determine an optimal applied pressure.

13.5 AS/SVE Combined Pilot Testing

13.5.1 AS/SVE Combined Pilot Test Preparation

- Once the SVE only and AS only pilot tests are complete, the AS/SVE combined pilot test will be completed.
- Determine the applied vacuum for the combined test based on data collected during the SVE only test. The applied vacuum should be a vacuum that had maximum vapor recovery, without pulling water. If groundwater mounding occurred during the AS only test, take this into account when choosing the applied vacuum.
- Close ball valve on AS compressor manifold and ensure all connections are secure.

13.5.2 Completing the AS/SVE Combined Pilot Test

- Operate both the SVE blower and AS compressor.
- Set the SVE blower to the optimal applied vacuum.

- Increase the applied pressure at the AS compressor manifold until an observed flow rate of 2.5 SCFM is achieved.
- Collect the following parameters from the knockout tank, dilution air value, effluent stack, well head manifold, AS compressor manifold, and observation wells at the beginning of the test and every 30 minutes (Note: record time parameters were collected on pilot test field data sheet):
 - Collected from knockout tank:
 - Applied vacuum in H₂O from vacuum gauge located on top of knockout tank.
 - Collected from dilution air value:
 - Percentage dilution air ball value is open in % (estimated)
 - Collected from effluent stack sampling port:
 - VOC in ppm-v with PID
 - Temperature in °C with Flow-meter
 - Flow in SCFM with Flow-meter
 - Velocity in ft/min with Flow-meter
 - Collected from well head manifold:
 - VOC in ppm-v with PID
 - Temperature in °C with Flow-meter
 - Flow in SCFM with Flow-meter
 - Velocity in ft/min with Flow-meter
 - Applied vacuum in “H₂O from the magnehelic gauge connected to the well head manifold
 - Collected from AS compressor manifold:
 - Applied Pressure in PSI from inline pressure gauge
 - Flow rate in SCFM from inline flow-meter
 - Collected from each observation well:
 - VOC in ppm-v with PID from within PVC riser
 - Vacuum/pressure reading in “H₂O with magnehelic gauge
- During the AS/SVE combined pilot test, a vacuum should be observed at the observation wells (surface) to ensure all vapors are being collected.
- Slowly increase the applied pressure on the AS compressor manifold every 30 minutes to determine the max pressure that can be applied to the subsurface while maintaining a vacuum at the observation wells.
- If an SVE only effluent air sample is included in the work plan, collect the air sample from the SVE effluent sampling port at the optimal applied vacuum/pressure (discuss optimal applied vacuum with project manager).
- Discuss AS/SVE combined pilot test results with project manager.
- While both the SVE blower and AS compressor are non-operational, disconnect all hoses, close all well heads, and cleanup work area.

14.0 GIS DATA COLLECTION

EAGLE models: Trimble GeoXT 6000 Series (Trimble 1); Trimble Geo7X (Trimble 2)

14.1 Prior to the field

- Equipment needed: Trimble only (power cord and download USB cords provided)
- Ensure battery level is sufficient for the day (minimum 25%)

14.2 Initial steps to setting the trimble up for data collection

1. Turn on trimble unit – Green power button
2. Trimble 1 – click “windows” icon in bottom left corner - select “TerraSync” program; Trimble 2 – TerraSync pops up as primary applicable. Select the application, and the program begins to load
3. When TerraSync opens, it should automatically begin searching for satellites. To the right of the “Status” drop down bar, there is a blinking “0” at first along the top of the screen, and as that number increases (minimum of 4 needed to record data), the more efficient the GPS data will be (± 20 inches vs ± 20 feet)
 - a. If the unit does not appear to be searching for satellites, you will need to reset the GNSS program on the trimble
 - i. Select the “Status” drop-down and choose “Setup”
 - ii. To the right of the “Options” drop-down, there is a “GNSS” button – push the button and the GNSS receiver should reset
 - b. After hitting the “GNSS” button, the screen will either return to the “Status” page, or you will need to select the drop-down menu and select “Status”
 - c. Confirm you have a minimum of 4 satellites, then select the “Status” drop-down and choose “Data”
4. After choosing the “Data” drop-down, a new window will appear, this is your “File Management” screen. The window includes a new drop-down option. Initial opening of the “Data” screen will present a “New” drop-down menu
 - a. When starting a NEW file for data collection, update the “file name” portion with a description of the file and include a date for further reference. Select “Create” at the bottom of the screen
 - i. When you select “Create”, another window pops up. We do not manipulate any pre-set parameters that may appear
 - ii. Select “OK” and the trimble will bring to the data collection screen, and you are ready to start collecting data.
 - b. If a current file exists, select the “New” drop-down, and choose “Existing File”, and scroll for the file you want to add to. When you select the file, it will take you to the data collection screen, and you are ready to add more data.
 - c. IF YOU ARE TRYING TO ADD TO A PREVIOUS FILE, OR ADDING TO A FILE YOU HAVE RECENTLY SET UP:
 - i. You **cannot** add or update files that are 7+ days old.
 - ii. The program will still “let you”, but any date 7+ days old on a file will not download.

14.2 Data Collection

The above steps are completed, and you are ready to start collecting data features

*See “Data view in the field” for Map use on the Trimble

1. You’ll have a “Data” drop-down, and a “Collect” drop-down. Ensure the “Collect” drop-down is selected
 - a. If you are opening a previously started file, you make change the “collect” to “update”
 - i. In “Update”, you will have the option to view a list of the data features already collected, and can:
 1. See any information associated with that data feature
 2. Change the name of the feature
 3. Delete or undelete a feature
 - ii. In “Update”, an “Options” drop-down appears on the right, which you can select to delete, filter, etc... This has really only ever been used to “delete” the feature. This will strike a line through the feature, but still shows the feature in the event you want to “undelete” it.
 - iii. If you do not need to update your data, keep the trimble in “Collect” mode to continue adding to the file.
 2. Trimble 1 and Trimble 2 differ in the types of “features” you can collect. Each feature is associated with a symbol that downloads in the CAD files (See download SOP for more details)
 - a. Trimble 1 allows you to collect:
 - i. Monitoring Well (MW) feature (MW symbol)
 - ii. Soil boring (SB) feature (Filled dot symbol)
 - iii. Utilities (color codes lines during download to show utilities versus other feature)
 - iv. Property Boundary (not used)
 - v. Excavation (not used)
 - vi. Remedial Wells (RW symbol)
 - vii. Point generic (sometimes used when you are collecting a random point)
 - viii. Line generic (typically used to outline property boundaries, excavation extents, utilities, etc.)
 - b. Trimble 2 allows you to collect:
 - i. Soil boring
 - ii. Point generic
 - iii. Line generic
 - c. Whether you choose: monitoring well, soil boring, or point generic; the files will still be available as a Lat/long, Google Earth file, and AutoCAD file when downloading the features (See download SOP). Choosing the specific feature only dictates the symbol associated with the feature when downloaded into AutoCAD

3. Tap the feature you wish to collect, and select “Create” at the bottom of the screen
4. With any feature selected for collection, you will need to label/name the feature so you can differentiate them post download.
 - a. Monitoring well features will need to be labeled in “Comments 1”. Also update the well diameter to reflect the appropriate sizing. Additional information can be collected on the MW feature, but those are the most commonly used
 - b. Soil boring features will allow you to choose soil type (but this should be in your notes) and record a “Sample ID”
 - c. With most feature windows, there is a “Comments” or “ID” frame for you to fill in
5. Once the type of feature is selected, and a name has been established, you are ready to actually collect the GPS data on that feature.
 - a. At the bottom of the screen, there is “Log” button. Select this button, and your Trimble will begin recording the GPS location of that feature
 - i. Monitoring wells, borings, and generic points will begin recording, and you will hear a “beep” that indicates the Trimble is collecting data. A number appears in the top right corner and indicates the number of “data points” collected for that feature
 - ii. These specific features need a minimum of 10 data points. The more data points collected for the feature, the more accurate the location will be when you download the data in the office.
 - iii. Lines, utilities, etc. These features will have a 1 data point delay. When you select “log” the first data point is collected, and you will hear a different beep at data point 2. This means you can begin to walk the line, boundary, extent, etc. These features do not require a specific number of data points. But you cannot move before you are on data point 2.
 - b. When you have the number of data points needed for each feature, select “Done” at the bottom of the screen, and your feature has been collected. After selecting “Done”, the Trimble will take you back to the “data”-“Collect” screen, and you can select a new feature to collect. If you want to update the feature you just collected, refer to 1a i-iii.

14.2.1 Additional Notes on Data collection

1. As the unit is collecting the data points for the feature of choice, there is a “range” icon next to the data point countdown icon at the top of the screen
 - a. The fewer satellites the Trimble is connected to, or interference near you (next to a building, in basement, in hole, etc.) the greater range of error you have. The greater the range of error the Trimble shows, the more data points you want to collect on that feature.
 - b. If you do not like the range of error on your feature collected, or more satellites have been collected since the initial collection, it would be best to delete the feature (see above), and collect a new feature for that point. Be sure to delete the old feature so you do not double

up on the points.

2. If you need to pause the data point collection, there is a “Pause” button at the bottom of the screen, simply push the button, and the data point collection will pause. To resume, click “Resume”.

14.3 Data view in the field

Once you have collected several features, or even just 1 feature, you have the ability to see your features relative GPS location in the field. Under the “Data” drop-down, select “Map”. This will bring you to a relative distance/GPS location screen plots the features collected. An “arrow symbol” drop-down is also available.

1. To see all of your features, select “Options” drop-down and choose “Zoom Extents”. Like CAD, this will display all the features in an easy to view format. The other “options” are typically not used
2. While in map mode, you have the option to click the screen and see a “Lat/Long” associated with the point you just clicked.
 - a. If you do not have a feature already established, but wish to find a specific Lat/long, the Map screen can be used to locate that position in the field.
 - b. It is not data corrected, but accurate for an approximation of the intended Lat/Long location.
3. There are several buttons at the bottom in the event you want to move the viewing screen around your features, or zoom in/out. Zoom in/out is also a selection in the “Arrow” drop-down. This will allow you to click the screen, and scroll a box you want to view in/out on.
4. The “arrow” drop-down also has a “Measure” feature which allows you to click on point to another on the map, and the Trimble will give you a footage and orientation (degrees) of the line drawn. This is a good feature to make sure your features are in the approximate locations relative to sidewall lengths, distances from other wells, etc.
5. At any point you wish to collect or update features, select “Map” and choose “Data” and you are back on the previous screens.

14.4 Following Data Collection

1. Return the unit to the “Data” Screen
2. Select “Close” at the bottom of the screen, click “Yes”
 - a. This will bring you back to the “File Management” Screen. On this screen you can start a whole new data file, or if you want to return to the file you just started, following the “existing file” procedures.
 - b. If you do not wish to continue using the Trimble, select the “Data” drop-down and choose “Exit”
 - i. This will close the TerraSync program and bring you back to the Windows/main screen.

DO NOT TURN OFF THE TRIMBLE WITHOUT:

- Closing the specific file, THEN

- Closing TerraSync

There is a chance the data will not download properly if you do not follow these steps to ending your data collection.

To turn off the unit:

1. Trimble 1 – hold power button for 2 to 3 second, select shut down
2. Trimble 2 – select power button and select shut down

14.5 Download and Export Trimble Data

14.5.1 Download data file

- Connect the Trimble unit to the computer and open the GPS Pathfinder Office software. Input the project name.
- Use the data transfer button to transfer the correct data file from the Trimble unit.
- Once the correct data file has been transferred, use the Differential Correctional button to make data points more accurate based on the Base Provider facility selected.

14.5.2 Export to CAD

- Use the export button to export the data file. Choose the “Sample Legacy AutoCAD DXF Setup with Blocks” option. Make sure that your GIS Coordinate System is:
 - System: US State Plane 1983 (2011)
 - Zone: Colorado Central 0502
 - Datum: NAD 1983 (2011)
 - Coordinate Units: feet
 - Export coordinates as XY
- To change the properties of the exported file, on the export window click on properties coordinate system change. Choose the output folder which you would like the exported data to be saved in and click OK. The CAD file will be saved in the output folder you chose.

14.5.2 Export coordinates

- Use the export button to export the data file. Choose the “Sample dBASE Setup” option. Make sure that your GIS Coordinate System is:
 - System: Lat/Long

- Zone: Colorado Central 0502
- Datum: WGS 1984
- Coordinate Units: feet
- Export coordinates as XY

To change the properties of the exported file, on the export window click on properties coordinate system change. Choose the output folder which you would like the exported data to be saved in and click OK. The lat/long coordinates will be presented in a word document under the output folder you chose.