FINAL

Focused Feasibility Study for Flow Control

Nelson Tunnel/Commodore Waste Rock NPL Site

Near Creede, Colorado

September 2020

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US Environmental Protection Agency

Region 8

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ARARs	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Control Criteria
BERA	Baseline Ecological Risk Assessment
CCR	Code of Colorado Regulations
CDMG	Colorado Division of Minerals and Geology
CDPHE	Colorado Department of Public Health and Environment
CDRMS	Colorado Division of Reclamation Mining and Safety
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CRS	Colorado Revised Statutes
EPA	United States Environmental Protection Agency
FS	Feasibility Study
FFS	Focused Feasibility Study
ft.	feet
gpm	gallons per minute
MCLGs	Maximum Contaminant Level Goals
MCLs	Maximum Contamination Levels
MG	million gallons
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OMB	Office of Management and Budget
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act of 1976
TCRA	Time Critical Removal Action
TBC	To Be Considered
USC	United States Code
WCRC	Willow Creek Reclamation Committee
µg/l	micrograms per liter

1 INTRODUCTION

1.1 Purpose of the Report and Report Organization

This Focused Feasibility Study (FFS) identifies and evaluates remedial alternatives to prevent a sudden and large release of mine-impacted water from the Nelson Tunnel/Commodore Waste Rock National Priorities List (NPL) Site (Nelson Tunnel or "Site") to the environment. The remedial alternatives are identified and evaluated for an Interim Action. A comprehensive remedial action for the Site will be evaluated in the future.

The FFS follows the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Feasibility Study process (United States Environmental Protection Agency (EPA), 1988). Traditionally, a CERCLA Feasibility Study (FS) evaluates a wide range of alternatives for the Site that is narrowed through screening processes and detailed evaluation. For this Interim Action FFS, engineering evaluation has identified limited alternatives to meet the remedial objective, making formal screening steps unnecessary. Each of the remedial alternatives identified are evaluated in detail against nine criteria specified in the National Oil and Hazardous Substances Pollution Contingency Plan, or National Contingency Plan (NCP). A comparative analysis then compares and contrasts retained alternatives using nine NCP criteria as the measure. The following provides the report organization:

Section 1.0 – Introduction – This section describes the purpose of the FFS, summarizes NPL Site history, and provides an overview of the FS process.

Section 2.0 – Summary of Site Characterization – This section describes the physical setting and current underground conditions.

Section 3.0 – Remedial Action Objectives – This section identifies the remedial action objectives (RAOs) for the Site.

Section 4.0 – Applicable or Relevant and Appropriate Requirements – This section discusses potentially Applicable or Relevant and Appropriate Requirements (ARARs) for remedial alternatives at the Site.

Section 5.0 – *Identification and Description of Remedial Alternatives* - This section identifies and describes remedial alternatives for the Site.

Section 6.0 – Detailed Analysis of Alternatives – This section evaluates alternatives against nine criteria specified in the NCP.

Section 7.0 – Comparative Analysis of Alternatives – This section compares and contrasts retained alternatives using nine NCP criteria as the measure.

Section 8.0 References – This section provides full references for all citations in the body of the report.

1.2 Site Location and Topography

The Site is located in the San Juan Mountains in south central Colorado and lies one mile north of the town of Creede in Mineral County, Colorado (**Figure 1**). The Site consists of the abandoned Nelson Tunnel, which drains directly into West Willow Creek, and the Commodore Waste Rock (**Figure 1**). The Site lies approximately 9,184 feet (ft.) above sea level in the bottom of a steep canyon with nearly vertical walls. The surrounding canyon walls reach roughly 10,600 ft. above mean sea level. A topographic map illustrating the Nelson Tunnel alignment and location of major mines in the area are provided as **Figures 1 and 2**.

1.3 Site History

Mining in Mineral County started in 1876 when the first claim was staked along the Alpha Corsair vein. Soon after, the Amethyst vein was discovered and staked as the Bachelor Claim in 1878. Mining in Mineral County did not draw investors and was not highly profitable until 1890, spurred by discovery of the Solomon-Holy Moses vein. The find increased interest in the Creede mining district, and over 15 mines were developed in the Willow Creek Watershed. Silver was the primary mineral mined in Mineral County, however, significant amounts of gold, copper, lead and zinc were also extracted.

The population of Creede peaked at 12,000 residents in 1892 during the height of mining. More recent population estimates of Creede and Mineral County are approximately 450 and 1,000, respectively (EPA, 2005).

The Amethyst vein was the most profitable of the major vein systems. In the early stages of mining, seven separate mines, primarily shafts, were mined along the Amethyst vein, including:

- Bachelor
- Commodore
- Del Monte
- Last Chance
- Amethyst
- Happy Thought
- Park Regent

Ore from the mines was processed in multiple mills including the Amethyst and Humphreys Mills, located at the junction of East and West Willow Creek. In order to drain the mines and haul ore more efficiently, the Nelson Tunnel was constructed in the 1890s. Eventually, the tunnel was extended to a total of 13,100 ft. as the Nelson, Wooster, Humphreys Tunnel and accessed all the major mines along the Amethyst vein. The Nelson Tunnel system provided both haulage and

drainage for the mines in the Amethyst Vein. A second adit, the Commodore 5 level, was driven approximately 45 feet above the Nelson Tunnel system to access the same mines (Graves, 2006). The resulting Commodore Waste Rock Pile is enriched in heavy metals.

Mining continued on the Commodore 5 level until 1976, and in Mineral County until 1989. Currently, multiple collapses in the Nelson Tunnel system have rendered it inaccessible except through vertical connections (mine shafts, raises, winzes) from the Commodore 5 level. In the mid-2000s, the Colorado Division of Reclamation, Mining, and Safety (CDRMS) rehabilitated portions of the Commodore 5 level and access points to the Nelson level to provide safe working conditions. Rehabilitation work included stabilization, cleanup, and improvements to ventilation (Colorado Division of Minerals and Geology (CDMG), 2003).

In 2008-2010 EPA conducted a Time Critical Removal Action (TCRA) to stabilize the Commodore Waste Rock pile after a severe wash out in 2005. The TCRA involved regrading the waste material to create stable slopes and creating a rip-wrap channel to direct West Willow Creek along the toe of the pile. In 2008 the Site was listed on the National Priorities List.

Starting in 2018, the EPA undertook a second TCRA, to rehabilitate the Commodore 5 level from the portal to the Bachelor shaft and north, several hundred feet past the Del Monte Raise (see Figure 3). This project is ongoing and scheduled to be completed in 2021. Improvements include:

- rail repair to provide access to work area with a small locomotive and flat car,
- regrading the drainage ditch along the Commodore 5 level to drain standing water,
- rehabilitation of unstable areas of the Commodore 5 level using rock bolts, wire mesh, steel sets, or a combination of these methods,
- installation of new fiberglass ladders and landings at the Bachelor Shaft and Daylight Winze,
- at locations where overhead workings connect to the Commodore 5 level, opening were supported with steel sets and sealed with foam, and
- removal of rotten timber lagging from areas with high roof areas and replacement with steel stulls and lagging, to maintain safe worker access.

Contamination of Willow Creek and its tributaries by mining related activities and waste has been documented for over 40 years. In 1999, the Willow Creek Reclamation Committee (WCRC) was formed by Creede stakeholders to investigate the nature and extent of contamination originating in the watershed. Since that time, Nelson Tunnel portal discharge has been found to be the largest single source of contamination in Willow Creek and the portion of the Rio Grande (Segment 4) downstream of the confluence with Willow Creek (CDPHE, 2010).

Due to adverse impacts of Nelson Tunnel discharge to water quality in Willow Creek and the Rio Grande and the necessity for prompt and properly funded action, the WCRC, State of Colorado, and EPA supported a recommendation for Site placement on the NPL.

The following is a brief chronological summary of major regulatory actions at the Site and study area.

1998	Segment 4 of the Rio Grande from Willow Creek to the Rio Grande and Alamosa County line placed on Colorado's 303(d) list of impaired waters
March 2008	NPL Proposal (Hazards Ranking System) Documentation Record
2008- 2010	TCRA for the Commodore Water Rock Pile
Sept. 3, 2008	Site placement on the NPL
2018-2021	TCRA to Rehabilitate Commodore 5 level

2 SITE CHARACTERISTICS

A primary feature within the Creede Mining District is the Nelson Tunnel, which was constructed to access and dewater the underground mines along the highly productive Amethyst vein and to provide a haulage route for ore from mines operating on the Amethyst vein complex (**Figures 2, 3, and 4**). The Nelson Tunnel is the lowest tunnel constructed along the Amethyst vein system and functions as a drain for the underground workings that are connected via shafts, winzes and raises (near vertical internal connections between mine levels). The collapsed tunnel portal is located on the west side of West Willow Creek about one mile north of the town of Creede. At present, access to the Nelson Tunnel is through the Commodore 5 level, which was driven above the Nelson Tunnel to intersect the Amethyst vein complex and allow development of mines farther north. The Nelson Tunnel was driven at varying gradients between one-half and one percent while the Commodore 5 level was driven at a quarter percent or less, resulting in eventual junction at the Park Regent Mine (**Figure 4**).

There are numerous studies of the mine area geology (e.g., Meeves and Darnell, 1968; Steven and Ratte', 1965; Steven and Eaton, 1975; Emmons and Larsen, 1923). The regional geology and geology of the Commodore Mine Complex are well summarized by Graves (2006). The following excerpt of the regional geology from that report is provided for reference:

> *The Creede mining district occupies a geologically complex region of Tertiary aged volcanic activity. The majority of rocks exposed regionally throughout the San Juan Mountains can be closely tied to the formation and eruption of at least 17 separate volcanic calderas. Eruption and formation of the numerous calderas deposited thick sequences of ash flow tuffs across hundreds of square miles. The collapse and eventual resurgence of many of the calderas resulted in substantial fracturing and faulting that provided pathways for the migration of ore forming solutions. Magma associated with caldera development was generally responsible for heating of circulating meteoric waters which carried metal rich solutions towards the surface for eventual precipitation. Within the Creede district, ore deposition appears linked to post formational processes of the Creede caldera.*

A thorough review of the status of known collapses, mine pools, and accessible points within the Commodore-Nelson complex is provided in **Appendix A** (Graves, 2015). There are three known and primary collapses within the Nelson Tunnel, forming three distinct mine pools, referred to as the Nelson Portal Pool, Lower Mine Pool, and Upper Mine Pool (**Figures 3** and **4**). Volumes of water stored behind collapses and in each of these pools are conservatively estimated to be 1.2 million gallons (MG), 1.4 MG, and 19.5 MG, respectively. Other recent studies and investigations have been performed or commissioned by the WCRC, CDRMS, Colorado Department of Public Health and Environment (CDPHE) and EPA (e.g., CDMG, 2003; CDMG, 2005; Cowie et al., 2014;

Graves, 2006; Graves, 2007; HDR, 2012; Millennium Geoscience, 2012; McCulley, Frick & Gilman, Inc. (MFG), 1999; and WCRC, 2003).

The Nelson portal has discharged an average of approximately 375 gallons per minute (gpm) from 2012 through 2017 and is the single largest source of dissolved zinc and cadmium to Willow Creek (MFG, 1999 and WCRC, 2003). Since 2000, the pH of the portal discharge has remained between 3 and 6 and the dissolved zinc concentrations range from 40,900 micrograms per liter (µg/l) to 89,800 µg/l. Dissolved cadmium concentrations have ranged from 9.51 to 998 µg/l since 2000. Based on 2012 through 2016 concentration and flow data presented in the Remedial Investigation Report Addendum (EPA, 2019), the Nelson Tunnel contributed an average of 50% and 78% of the load of cadmium and zinc, respectively, measured in Willow Creek during periods of low flow and an average of 65% and 56% of the load of cadmium and zinc, respectively, during periods of high flow.

Site condition observations listed are based on a May 24, 2016 site visit. Areas observed included Commodore 5 level, the McClure Crosscut, Bachelor Shaft into the Nelson (Wooster) Tunnel, the Bachelor Shaft to the Overholt Crosscut and Corkscrew Raise, the Daylight Winze, the main haulage tunnel, No Name Winze, Del Monte Raise, OH Vein workings to the Mechanics Shop and Berkshire shaft. These areas are shown on **Figures 2** and **3**. Selected photographs from May 24, 2016 are found in **Appendix B**. Conditions in Commodore 5 Level, Bachelor Shaft, and Daylight Winze have significantly improved since the May 24, 2016 site visit because of the TCRA rehabilitation. Improvements are noted in the observations below.

Mine conditions are expected to change over time. During Remedial Design, it will be important to conduct inspections and investigations into underground conditions.

2.1 Observations

- Ground support is typically installed only at stopes, raises, shafts, winzes, and ore chutes. The remainder of the mine workings are mostly bald.
- The first half of Commodore 5 level was driven through slabby, closely spaced vertically jointed rhyolitic tuff. The second half is in a much more densely welded and massive rhyolitic tuff that eventually became the footwall of the Amethyst Vein (specifically the Willow Creek Member of the Bachelor Mountain Tuff). Both areas were dry. The track was generally in good shape. Several gallons per minute of water flowed through a ditch at the side of the track. The track and ditch were rehabilitated in 2018-2019.
- The rock in the McClure Crosscut in the hanging wall also consisted of massive rhyolitic tuff, specifically the Campbell Mountain Member of the Bachelor Mountain Tuff. It was also dry and contained some ore chutes from upper levels. Goslarite crystals were visible at various locations.

- The Bachelor Shaft was the only location where the underground team entered the Nelson Tunnel level. Access was limited to approximately 100 feet from the bottom of the shaft. Downstream the Nelson Portal Pool became too deep while progress upstream was blocked by the collapse that formed the Lower Mine Pool. Unlike Commodore 5 level, which is dry, the Nelson Tunnel had orange mine-impacted water one to two feet deep. Based on the capacity of the overflowing weir, it is estimated that the flow rate was higher than 1 cubic foot per second. The Bachelor Shaft was rehabilitated with fiberglass ladders and landings in 2018.
- The Overholt Cross Cut was dry, but at the Corkscrew Raise that leads to workings above, as well as to the Nelson Tunnel below, the ground was very wet with heavy dripping. The water was not discolored as it was in the Nelson Tunnel.
- From the Daylight Winze to the Commodore Shaft, the Commodore 5 level main haulage tunnel generally follows the Amethyst Vein. While mined in some areas, the Amethyst Vein was often visible as hard, silicified breccia with altered, clayey gouge material near its edges. The hanging wall and footwall were well defined in many areas and dipped steeply to the west. Occasional roof falls were visible and ranged in volume from a few cubic feet to a few cubic yards. The tunnel was moist with water visible as minor pools behind collapses and dipping from various stopes and the Archimedes Raise. Timber ground support was failing at various stopes. Just before reaching the Commodore Shaft, an old blacksmith shop was visible on the west side. This area was rehabilitated in 2018-2019 as discussed previously.
- The Commodore Shaft area consisted of two rather large underground chambers, neither of which had any ground support. This demonstrated the generally good rock quality in the footwall. Access was possible down to the Nelson Tunnel level through the shaft.
- North of the Commodore Shaft, the ground became blockier and weaker. A significant roof fall caused a mine pool two to three feet deep to build up behind it. This blockage was removed in 2019 as part of the rehabilitation efforts. At various locations, the tunnel curved into the more competent footwall around sections of bad ground where the main drive had been abandoned. North of the No Name (Y02) Winze, iron staining was visible on the floor. When the Upper Mine Pool elevation exceeded that of the Del Monte Raise collar, the mine impacted water would flow from the Del Monte Raise through the Commodore 5 level to the No Name Winze where it would drop back into the Nelson Tunnel. Rehabilitation was completed to the Del Monte Raise in 2020.
- North of the Del Monte Raise, the Amethyst Vein and OH Vein diverged. CDRMS noted extensive stoping, bad ground, and collapses near the base of the Last Chance Shaft; hence, the team proceeded along the OH Vein. In the West Drift, the wood bulkheads from the recent pump test were visible. At the mechanic's shop, bolts and mesh were installed in the

back. There the team turned off the OH Vein and returned to the Amethyst Vein near the Berkshire Shaft. This area was very dry.

- The Nelson Tunnel and its Upper Mine Pool was visible throughout the Berkshire Shaft area, as it had been stoped up into the Commodore 5 level. The walkway above the Nelson Tunnel consisted of timbers and planking. South of the Berkshire Shaft, large quantities of Goslarite were visible.

3 REMEDIAL ACTION OBJECTIVE

The preliminary RAO is to prevent a sudden and large release of the mine-impacted water impounded within the Nelson Tunnel and associated workings. Such a release would result in human and ecological exposure to contaminated water and sediments discharged to surface water, groundwater, and stream and river bed substrates. An additional consideration of this FFS is to develop a near-term remedy that provides long-term protection against large mine pool releases while not precluding other work that may be needed for other overall remedies. The RAOs will be finalized in the Interim Action Record of Decision.

Preliminary remediation goals are not being defined in this FFS because improving surface water quality is not the focus of this Interim Action.

4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of CERCLA and NCP §300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

ARARs also include "To Be Considered" (TBC) requirements that are criteria, advisories, guidance that are neither statutes nor regulations but provide useful information or recommended procedures for consideration in evaluating specific alternatives. Examples are executive orders and published agency guidance documents.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of Federal and State environmental statutes or provides a basis for invoking a waiver.

A preliminary discussion of specific ARARs for the FFS at the Site is presented below. Chemical-specific, location specific, and action-specific ARARs are identified in Tables 4-1, 4-2, and 4-3, respectively. The tables provide citations, a description of the citation, an indication as to whether the citation is applicable or relevant and appropriate (except where noted), and a short discussion on the applicability of the ARAR in the "Comment" column.

4.1 Chemical-Specific ARARs

Chemical-specific ARARs include those laws and regulations governing the release of materials possessing certain chemical or physical characteristics, or containing specified chemical compounds (EPA, 1988). These requirements generally set health or risk-based concentration limits or

discharge limitations in various environmental media for specific hazardous substances, contaminants, and pollutants. These requirements may be used to set cleanup levels for the chemicals of concern in the designated media, or to set a safe level of discharge (e.g., water, air, etc.) that may occur as part of the remedial activity. Examples include drinking water standards and ambient air quality standards.

Sources for potential target cleanup levels included selected standards, criteria, and guidelines that are typically considered as ARARs for remedial actions conducted under CERCLA. Table 4-1 summarizes the chemical-specific ARARs.

4.2 Location-Specific ARARs

Location-specific ARARs are design requirements or activity restrictions based on the geographical or physical position of the site and its surrounding area (EPA, 1988). Examples include activities in areas such as a floodplain, a wetland, or a site with historic significance.

The location of a site may be an important characteristic in determining its impact on ecological receptors and the environment; therefore, individual States may establish location-specific ARARs. These ARARs may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Examples of location-specific ARARs include Federal and State requirements for preservation of historic landmarks, endangered species, and wetlands protection, and the restrictions on management of hazardous waste in floodplain areas.

Potential location-specific ARARs for the Site are presented in Table 4-2.

4.3 Action-Specific ARARs

Action-specific ARARs are technology based or activity based and establish performance, design, or other similar action-specific controls or regulations on activities related to the management of hazardous and nonhazardous wastes, substances, or pollutants (EPA, 1988). An example includes National Pollutant Discharge Elimination System discharge regulations. These action-specific requirements do not, by themselves, determine the remedial alternative; rather, they indicate how a selected remedial alternative must be achieved.

The action-specific ARARs presented in this FFS report are intended to cover the potential remedial alternatives that may be applied. Table 4-3 summarizes the action-specific ARARs.

Table 4-1 Chemical-Specific ARARs

STATE CHEMICAL SPECIFIC REQUIREMENTS			
Chemical	**Requirements**	**Prerequisite**	**Citation**
Constituents in water treatment system discharges and sludges	This regulation establishes statewide surface water quality standards for acceptable concentrations of specified parameters including chemical constituents and pH. The regulation also establishes methodologies for assigning and implementing those standards. The standards are used to establish effluent limits pursuant to 5 CCR 1002-62 identified as an action specific ARAR.	Chemical constituents in surface water at concentrations above state surface water standards.	Colorado Basic Standards and Methodologies for Surface Water, 5 CCR 1002-31, pursuant to C.R.S. § 25-8-101 et seq.
	This regulation assigns segment specific classifications and numeric surface water quality standards chemical constituents in surface waters within the Rio Grande River Basin. The standards are used to establish effluent limits pursuant to 5 CCR 1002-62 identified as an action specific ARAR.	Chemical constituents in surface water at concentrations above state surface water standards.	Colorado Surface Water Quality Classifications and Numeric Standards, 5 CCR 1002-36, pursuant to C.R.S. §§ 25-8-203 and 204

Table 4-2 Location-Specific ARARs

FEDERAL LOCATION SPECIFIC REQUIREMENTS			
Location	**Requirements**	**Prerequisite**	**Citation**
Creede National Historic District	Prohibits willfully damaging or destroying any wildlife den or nest, or their eggs, or harassing any wildlife. "Harass" means to unlawfully endanger, worry, impede, annoy, pursue, disturb, molest, rally, concentrate, harry, chase, drive, herd, or torment wildlife. See C.R.S. § 33-1-102(24) (Definitions)	The Site is part of the Creede National Historic District.	National Historic Preservation Act, 16 U.S.C. § 470 and Implementing Regulations 36 CFR Part 800
Potential habitat for migratory birds	This statute and implementing regulations makes it unlawful for anyone to take, possess, import, export, transport, sell, purchase, barter, or offer for sale, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to these regulations. If migratory birds are identified during remedial design and remedial action, activities must be modified and conducted to conserve the species and their habitat.	Actions that may negatively impact the migratory birds and their habitat.	Migratory Bird Treaty Act, 16 U.S.C. § 703 *et seq.*, 50 CFR 10.13
Potential habitat for bald or golden eagles	Prohibits anyone from "taking" bald eagles, including their parts, nests, or eggs without a permit issued by the Secretary of the Interior. If bald or golden eagles are identified during remedial design or remedial action, activities must be modified and conducted to conserve the species and their habitat.	Identification of bald or golden eagles and actions that could impair the species and their habitat.	Bald and Golden Eagle Protection Act, 16 U.S.C. § 668-668c

Table 4-2 Location-Specific ARARs (Con't)

STATE LOCATION SPECIFIC REQUIREMENTS			
Location	**Requirements**	**Prerequisite**	**Citation**
Relevant Wildlife Habitat	Prohibits willfully damaging or destroying any wildlife den or nest, or their eggs, or harassing any wildlife. "Harass" means to unlawfully endanger, worry, impede, annoy, pursue, disturb, molest, rally, concentrate, harry, chase, drive, herd, or torment wildlife. See C.R.S. § 33-1-102(24) (Definitions)	Performing response activities in relevant wildlife habitat.	Colorado Wildlife Enforcement and Penalties Act, C.R.S. §§ 33-6-128
	Prohibits harassment, taking or possession of nongame species and subspecies, including threatened or endangered wildlife, with limited exceptions. The designations of species as endangered, threatened, or a nongame species, are made pursuant to 2 C.C.R. 406-10:1002-4. This regulation incorporates definitions of terms found in the Colorado Wildlife Enforcement and Penalties Act, C.R.S. § 33-1-102.	Performing response activities in relevant wildlife habitat.	Colorado Wildlife Commission Regulations, 2 C.C.R. 406-10:1000 (Protected Species), pursuant to the Colorado Non-game, Endangered, or Threatened Species Act, C.R.S. §§ 33-2-101-108
Wetlands, seismic impact zones, faults, floodplains	Solid waste landfills must not be located in wetlands, floodplains, seismic impact zones, or within 200 ft of a fault.	Wetlands, seismic impact zones, faults, floodplains	Solid Waste Regulations section 3.1 (Location restrictions)
Unstable area	Solid waste landfills located in an unstable area must incorporate engineering measures to ensure that the integrity of the structural components will not be disrupted. Unstable area determinations shall consider on-site or local soils conditions, geologic or geomorphologic features, and human-made features or events (both surface and subsurface).	Unstable areas	Solid Waste Regulations section 3.1.5 (Site standards – unstable areas)
Aquifer recharge area	No significant aquifer recharge areas, as may be designated by the Colorado State Engineer's Office or Water Quality Control Commission, shall be adversely impacted by solid waste disposal.	Performing response activities in a designated aquifer recharge area.	Solid Waste Regulations section 2.1.5 (Aquifer recharge areas)

Table 4-2 Location-Specific ARARs (Con't)

STATE LOCATION SPECIFIC REQUIREMENTS			
Location	**Requirements**	**Prerequisite**	**Citation**
Repository area and areas where bulkhead, flow control structure and other engineered features constructed	Requires environmental covenants (ECs) or notice of environmental use restrictions (RNs) whenever residual contamination not safe for all uses is left in place or an engineered feature or structure that requires monitoring, maintenance, or operation is included in the remedy.[1]	Performing response activities leaving waste in place above standards for unrestricted use or incorporating engineered features or structures.	Colorado Environmental Covenants Statute, CRS § 25-15-317 et seq.
Relevant Land Use Zone	<table><tr><th>Zone</th><th>7:00 a.m. to next 7:00 p.m.</th><th>7:00 p.m. to next 7:00 a.m.</th></tr><tr><td>Residential</td><td>55 db(A)</td><td>50 db(A)</td></tr><tr><td>Commercial</td><td>60 db(A)</td><td>55 db(A)</td></tr><tr><td>Light industria</td><td>70 db(A)</td><td>65 db(A)</td></tr><tr><td>Industrial</td><td>80 db(A)</td><td>75 db(A)</td></tr></table> Sound levels that exceed the above limits at a distance of 25 feet from the property line or greater are prima facie evidence of a public nuisance. Activities must be conducted in a manner so that any noise produced is not objectionable due to intermittence, beat frequency, or shrillness. For construction projects, maximum noise levels will be those specified for industrial zones for the time period within which construction is to be completed.	Location of response activities is within a designated land use zone subject to noise regulation.	Colorado Noise Abatement Statute, C.R.S. § 25-12-103 (Maximum Permissible Noise Levels)

[1] The repository is an engineered feature as well as an area where waste will remain above unrestricted use standards. An EC or RN will be required for the repository and any other area within the site where engineered components exist or where waste is left in place above unrestricted use standards. C.R.S. § 25-15-321 authorizes CDPHE to accept, refuse to accept, conditionally accept, hold, modify and terminate ECs and RNs. Concurrence on the IROD constitutes CDPHE's agreement to accept land use restrictions associated with remaining waste and engineered remedial features. Further, CDPHE states through concurrence on the IROD that ECs and RNs will only be modified or terminated to reflect changes made to the Superfund remedy (i.e. changes to the engineered remedial features).

Table 4-2 Location-Specific ARARs (Con't)

STATE LOCATION SPECIFIC REQUIREMENTS			
Location	**Requirements**	**Prerequisite**	**Citation**
Relevant Land Use Zone	Sets forth maximum permissible noise levels specific to off-highway vehicles defined in 25-12-102 (5.6) as a self-propelled vehicle with wheels or tracks in contact with the ground that is designed primarily for use off the public highways: (a) If manufactured before January 1, 1998; 99 db(A); (b) If manufactured on or after January 1, 1998; 96 db(A). Measurements should be conducted using SAE J1287.	Use of off-highway vehicles in response activities	Colorado Noise Abatement Statute, C.R.S. § 25-12-110 (Off-highway vehicles)
FEDERAL TBC			
Federally managed lands within the Rio Grande National Forest	Activities conducted during remedial action on federally managed lands within the Site would consider the substantive requirements of the Rio Grande National Forest Land Management Plan. The Rio Grande National Forest Plan can be found at: https://www.fs.usda.gov/main/riogrande/landmanagement/planning`	Activities conducted within the Rio Grande National Forest	Rio Grande National Forest Land Management Plan

Table 4-3 Action-Specific ARARs

FEDERAL ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Discharging water from the water treatment plant into West Willow Creek.	Requires a permit for the discharge of pollutants from any point source into waters of the United States. Compliance with the substantive provisions of the Colorado Discharge Permit System regulations satisfies these requirements.	Discharging a pollutant from a point source to waters of the United States.	National Pollutant Elimination System, 40 CFR Parts 122, 125, pursuant to 33 USC 1342.
Disposal of waste generated by remedial activities including, but not limited to tunnel rehabilitation, blockage removal, drift excavation, and water treatment.	Establishes certain location standards for facilities where treatment, storage, or disposal of solid waste will occur. These include location restrictions on proximity to airports, floodplains, wetlands, fault areas, seismic impact zones, and unstable areas. Compliance with the substantive provisions of Colorado's Solid Waste regulations, section 3.1., identified herein, satisfies these requirements.	Disposal of solid waste.	RCRA, Subtitle D Regulations, 40 CFR Part 258.10-15.
Potential transportation of hazardous materials off the Site.	Sets forth requirements for the safe transport of hazardous materials. If hazardous materials need to be transported off the Site, this statute and implementing regulations will be followed.	Transporting hazardous materials off-site.	Hazardous Materials Transportation Act, 49 U.S.C. § 5101, *et seq.*; 49 CFR Parts 107, 171-177.

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Discharging water from the water treatment plant into West Willow Creek or Willow Creek.	Colorado's discharge permit system regulations apply to persons discharging pollutants from a point source into waters of the State. Permits contain effluent limitations determined pursuant to Colorado Water Quality Regulation No. 62 identified below. While permits are not required pursuant to CERCLA 121(e)(2), the substantive provisions of this Regulation are applicable to the response action.	Discharging a pollutant from a point source to waters of the State.	Colorado Discharge Permit System Regulations, 5 CCR 1002-61, pursuant to CRS § 25-8-501
	Sets numeric concentrations and other limits for point source discharges resulting from the response actions. Effluent limits are determined based on water quality standards set forth in 5 CCR 1002-31 and 36 cited as chemical specific ARARs herein.	Discharging a pollutant from a point source to waters of the State.	Colorado Effluent Limitations, 5 CCR 1002-62, pursuant to CRS § 25-8-205
Handling and disposing mine waste generated during Nelson Tunnel rehabilitation, blockage removal, portal reconstruction, and new adit drilling.	Acid forming or toxic producing mined materials must be handled and disposed in a manner that will control unsightliness and protect the surface and groundwater drainage system from pollution.	Handling and disposing mine waste.	MLRB Regulations Rule 3.1.5(5), (10), (11)
Locating the repository.	Solid waste landfills must not be located in wetlands, floodplains, seismic impact zones, or within 200 ft of a fault. Wastes shall not be placed in surface or groundwater. (see also section 2.1.17)	Locating a solid waste landfill.	Solid Waste Regulations section 3.1 (Location restrictions)

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Designing and constructing the repository.	Solid waste landfills located in an unstable area must incorporate engineering measures to ensure that the integrity of the structural components will not be disrupted. Unstable area determinations shall consider on-site or local soils conditions, geologic or geomorphologic features, and human-made features or events (both surface and subsurface).	Designing/constructing a solid waste landfill.	Solid Waste Regulations section 3.1.5 (Site standards – unstable areas)
	Solid waste landfills must meet design requirements based on geologic, hydrologic and engineering data. Requirements include liner design components in section 3.2.5 that incorporates, among other things, a leachate collection and removal system. Alternatives to the above designs may be considered in consultation with CDPHE based on waste type and site-specific technical information.	Designing/constructing a solid waste landfill.	Solid Waste Regulations section 3.2.5(B)-(D) and 3.2.6[2] (Design Requirements)

[2] As part of the schematic design and design development reports prepared to support construction documents and specifications for the repository, EPA will collect and consider data to illustrate that the repository design will achieve the minimum elements outlined in sections 3.1.5, 3.2.3, and 3.2.4 of the Colorado Regulations Pertaining to Solid Waste Sites and Facilities (6 C.C.R. 1007-2).

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Designing and constructing the repository.	If more than 5 acres of land are cleared in attainment areas, or more than one acre of land is cleared in nonattainment areas, then any owner or operator engaged in clearing land, or owners or operators of land that has been cleared, shall "use all available and practical methods which are technologically feasible and economically reasonable" in order to minimize fugitive emissions. Construction activities shall not result in fugitive emissions that exceed 20% opacity or result in off-property transport of emissions. Control measures or operational procedures to be employed may include, but are not necessarily limited to, planting vegetation cover, providing synthetic cover, watering, chemical stabilization, furrows, compacting, minimizing disturbed area in the winter, wind breaks and other methods or techniques approved by CDPHE's Air Quality Control Division.	Construction activities generating fugitive dust.	Colorado Fugitive Dust Control Plan/Opacity, Regulation No. 1., 5 C.C.R. 1001-3(III)(D)(2)(b) (Particulate Matter – Construction Activities)

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Managing storm water runoff during repository construction and closure.	From Colorado Discharge Permit System general permit COR40000: 1. Control measures must be installed before the commencement of activities at the site that could contribute pollutants to stormwater discharges. Such control measures should minimize the discharge of pollutants at the site. The control measures must meet the following requirements: a. Where vehicle tracking occurs, vehicle tracking controls that minimize vehicle tracking of sediment from disturbed areas. b. Containment or filtration of stormwater flows from disturbed areas and soil storage areas, such that flows from such areas must go to at least one control measure. c. Where there are discharges from basins and impoundments, outlets that withdraw water from or near the surface (unless infeasible). d. Maintenance of pre-existing vegetation or equivalent control measures for areas within 50 horizontal feet from receiving waters. e. Minimization of soil compaction where there are infiltration control measures, or final stabilization, from vegetative cover. f. In areas where vegetative final stabilization is utilized, preservation of topsoil (unless infeasible). g. Minimization of soil exposed during construction activity. h. Where there is bulk storage of liquid chemicals (including petroleum products), secondary containment or equivalent protection. i. Concrete washout control measures sufficient to ensure the washing activities do not add pollutants to stormwater runoff or receiving waters. Discharges to the ground of concrete washout waste must go through soil with buffering capacity, and cannot occur in areas near natural drainages, shallow groundwater, springs, or wetlands. j. For earth disturbing activities, temporary stabilization measures such as tarps, soil tackifier, and hydroseed, which must be implemented wherever construction activity disturbed the ground and has ceased for fourteen days or is permanently ceased. k. For all construction sites after all ground surface disturbing activities have ceased, final stabilization that achieves vegetative cover with plant density at least 70% of pre-disturbance levels, or an equivalent stabilization measure.	Discharging storm water from a construction activity that results in land disturbance greater than or equal to one acre.	Colorado Discharge Permit System (CDPS) Regulations, 5 C.C.R. 1002-61.3(2)(a) and (f)(ii), and CDPS general permit No. COR400000 (Stormwater discharges associated with construction activity), pursuant to C.R.S. § 25-8-501 Permit available at: https://drive.google.com/file/d/1CsnfVYo-sTVmStX9pwtnpKoN7DYmumYP/view

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Managing storm water runoff during repository construction and closure (con't).	2. All control measures must remain in effective operating condition and be protected from activities that would make them less effective. 3. The adequacy of control measures must be monitored, and corrective action must be taken when a measure becomes inadequate. 4. Discharges may not cause, have the reasonable potential to cause, or measurably contribute to an exceedance of any applicable water quality standard. 5. Site inspections with one of the following minimum frequencies: a. One per every 7 calendar days b. One per every 14 calendar days, and post storm event inspections within 24 hours after the end of any precipitation or snowmelt event that causes surface erosion. c. If the two options above are impractical, an alternate schedule. d. If the site is temporarily idle or completed, less frequent inspections depending on the circumstances.		
Operating the repository during disposal activities.	Solid waste Sites and facilities shall not knowingly receive any hazardous waste.	Operating a solid waste disposal site and facility.	Solid Waste Regulations section 2.1.2 (Hazardous Waste Prohibited)
	Nuisance conditions shall not exist at or beyond the site boundary. Sites and facilities must be managed to control noise, dust and odors to avoid hazards to human health.[3]	Operating a solid waste disposal site and facility.	Solid Waste Regulations section 2.1.3 (Nuisance conditions prohibited)
	Water pollution shall not occur at or beyond an established point of compliance.	Operating a solid waste disposal site and facility.	Solid Waste Regulations section 2.1.4 (Water pollution prohibited)

[3] Compliance with the Fugitive Dust and Noise Control laws identified herein satisfies this Regulation.

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Operating the repository during disposal activities.	Solid waste Sites and facilities must maintain: a run-on control system to prevent flow onto the facility during the peak discharge from a 25-year, 24-hour storm; and a run-off control system to collect run-off from a from a 25-year, 24-hour storm event, and control the water volume resulting from a 100-year, 24-hour storm event (see also section 2.5.7).	Operating a solid waste disposal site and facility.	Solid Waste Regulations section 2.1.6 (Run-on and run-off control systems required)
	Solid waste sites and facilities must control public access and prevent unauthorized vehicular traffic. Effective artificial barriers, or natural barriers, or both may be used in lieu of fencing.	Operating a solid waste disposal site and facility.	Solid Waste Regulations section 2.1.8 (Public access restricted)
	Solid waste sites and facilities must demonstrate groundwater protection standards are met at an established point of compliance.	Operating a solid waste disposal site and facility.	Solid Waste Regulations section 2.1.15 (Groundwater protection standards compliance)
	Solid waste disposal sites and facilities shall not place wastes below or into surface or ground water. (see also section 3.1.9)	Operating a solid waste disposal site and facility.	Solid Waste Regulations section 2.1.17 (Disposal below or into surface or groundwater prohibited)
	Solid waste sites and facilities shall implement a groundwater monitoring program unless a waiver is appropriate pursuant to Section 1.5 and Appendix B.	Operating a solid waste disposal site and facility.	Solid Waste Regulations section 2.2 **(**Groundwater monitoring required)
	Use of "all available practical methods which are technologically feasible and economically reasonable" to minimize emissions. Emissions shall not exceed 20% opacity or be transported off-property. Control measures or operational procedures to be employed may include, but are not necessarily limited to, the use of enclosures, covers, stabilization, compacting, watering, limitation of fines and other methods or techniques approved by CDPHE's Air Quality Control Division.	Operation activities generating fugitive dust.	Colorado Fugitive Dust Control Plan/Opacity, Regulation No. 1., 5 C.C.R. 1001-3(III)(D)(2)(c) (Particulate Matter – Storage and Handling of Materials)

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Operating the repository during disposal activities.	Use of "all available practical methods which are technologically feasible and economically reasonable" to minimize emissions. Emissions shall not be allowed to go off-property. Control measures or operation procedures to be employed may include but are not necessarily limited to, covering the materials, washing or otherwise treating loaded haul trucks to remove materials from the exterior of the vehicle prior to transporting materials, limiting load size, wetting the load and other methods or techniques approved by CDPHE's Air Quality Control Division.	Use of haul trucks generating fugitive dust during Repository operations.	Colorado Fugitive Dust Control Plan/Opacity, Regulation No. 1., 5 C.C.R. 1001-3(III)(D)(2)(f) (Particulate Matter – Haul Trucks)
Closing the repository.	Precautions must be taken after closure at solid waste sites and facilities to prevent unauthorized disposal.[4]	Closing a solid waste disposal site and facility.	Solid Waste Regulations section 2.5.4 (closure - prevent unauthorized disposal)
	Water pollution shall not occur at or beyond an established point of compliance after closure.	Closing a solid waste disposal site and facility.	Solid Waste Regulations section 2.5.5 (closure - prevent water pollution)
	Nuisance conditions shall not exist at or beyond the site boundary after closure.	Closing a solid waste disposal site and facility.	Solid Waste Regulations section 2.5.6 (closure – prevent nuisance conditions)

[4] Compliance with the Colorado Environmental Covenants law identified below satisfies this Regulation. Compliance with the EC law requires placing an Environmental Covenant (EC) or Restrictive Notice (RN) on the repository. The EC or RN must contain activities and use restrictions prohibiting further disposal.

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Closing the repository.	Permanent surface water diversion structures remaining after closure shall control run-on and run-off from the 100 year, 24-hour storm event.	Closing a solid waste disposal site and facility.	Solid Waste Regulations section 2.5.7 (Closure – run-on/run-off controls required)
	Solid waste landfills shall meet final closure grading criteria to promote surface water run-off and minimize erosion, and shall have slopes no less than 5% (20:1) and no greater than 25% (4:1).	Closing a solid waste landfill.	Solid Waste Regulations section 3.5.2 (Closure – grading requirements)
	Final covers for solid waste landfills shall not exceed permeability of the landfill liner and shall be comprised either: 1) an earthen material soil cover with an eighteen (18) inch infiltration layer and a six (6) inch erosion layer capable of sustaining native plant growth; or 2) a composite cover with a six (6) inch soil foundation layer and a minimum thirty (30) millimeter thick geomembrane layer adequate for the intended purpose. Alternatives to the above designs may be considered in consultation with CDPHE based on waste type and site-specific technical information.	Closing a solid waste landfill.	Solid Waste Regulations section 3.5.3 (Closure – cover permeability)

Table 4-3 Action-Specific ARARs (Con't)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Maintaining repository post-closure.	Solid waste landfills must meet post closure care requirements to: prevent nuisance conditions; maintain cover integrity; operate, maintain and monitor the leachate collection system and groundwater and gas monitoring systems; and monitor groundwater.	Maintaining a solid waste landfill post-closure.	Solid Waste Regulations section 3.6 (Post Closure requirements)
	Requires environmental covenants (ECs) or notice of environmental use restrictions (RNs) whenever residual contamination not safe for all uses is left in place or an engineered feature or structure that requires monitoring, maintenance, or operation is included in the remedy.[5]	Performing response activities leaving waste in place above standards for unrestricted use or incorporating engineered features or structures.	Colorado Environmental Covenants Statute, CRS § 25-15-317 *et seq.*

[5] The repository is an engineered feature as well as an area where waste will remain above unrestricted use standards. An EC or RN will be required for the repository and any other area within the site where engineered components exist or where waste is left in place above unrestricted use standards. C.R.S. § 25-15-321 authorizes CDPHE to accept, refuse to accept, conditionally accept, hold, modify and terminate ECs and RNs. Concurrence on the IROD constitutes CDPHE's agreement to accept land use restrictions associated with remaining waste and engineered remedial features. Further, CDPHE states through concurrence on the IROD that ECs and RNs will only be modified or terminated to reflect changes made to the Superfund remedy (i.e. changes to the engineered remedial features).

5 IDENTIFICATION AND DESCRIPTION OF REMEDIAL ALTERNATIVES

Remedial alternatives were developed based on consideration of the categories defined by the NCP (40 CFR 300.430(e)) including, as appropriate, No Further Action, source controls, and treatment. All alternatives include the use of best management practices and institutional controls to prohibit unauthorized access and protection of the remedy.

5.1 Alternative 1: No Further Action

The No Further Action Alternative would involve no remedial action or controls beyond those already completed. This alternative provides a baseline against which the other remedial action alternatives are compared. Completed actions at the mine site include the following:

1. Regrading of the Commodore Waste Rock Pile and associated channelization and stabilization of West Willow Creek adjacent to the Nelson Tunnel and Commodore 5 level portals (performed as part of the Operable Unit 1 removal action). This action has reduced the amount of waste rock that would be mobilized downstream in the event of a large release from the mine.

2. Extensive rehabilitation of the Commodore 5 level and some associated drifts during the 2018-2021 TCRA. The rehabilitation work provides for medium-term (15 year design life) access for on-going inspection and characterization of conditions behind known blockages in the Nelson Tunnel. Once fully complete, rehabilitation will extend approximately 6,500 ft. inby of the Commodore portal, including shoring openings and upgrading ladders to access the Nelson Tunnel.

   In addition to maintaining access, the TCRA rehabilitation of the Commodore 5 level maintains a means to prevent the buildup of pressure against the blockage that creates the Upper Mine Pool. Pressure relief is provided when Upper Mine Pool water flows into the Commodore 5 level through the Del Monte Raise, inby of blockage, and returns to the Nelson Tunnel level through the No Name Winze, which is outby of Upper Mine Pool Blockage. This is an important aspect of the TCRA rehabilitation work because if further collapses in Commodore 5 level eliminate the means for water to bypass Upper Mine Pool Blockage and return to the Nelson Tunnel level, then a buildup of pressure in the Upper Mine Pool could conceivably result in a blowout of Upper Mine Pool Blockage, which could result in an uncontrolled release from Nelson Tunnel.

On-going activities include occasional visual inspection of current known collapses and monitoring of flow rates and mine pool levels. There is no formal plan currently in place for on-going inspection and monitoring activities, so they are performed only as opportunities arise and funding allows.

5.2 Alternative 2: Maintain Rehabilitation of Mine Workings and Periodic Inspections and Monitoring

This alternative is similar to Alternative 1 in that no action is performed to mitigate the threat of sudden releases from Nelson Tunnel or through the Commodore 5 level. Therefore, Alternative 2 does not meet the RAO, but is evaluated in this FFS as a baseline activity.

Alternative 2 provides for long-term safe access to the mine to observe and monitor known collapses and mine pool levels. The Commodore 5 level has been rehabilitated to the Del Monte Raise (see Figure 3) during the 2018-2021 TCRA. In addition, rehabilitation is planned to be extended to several hundred feet beyond the Del Monte Raise. The rehabilitation design life is expected to be 15 to 30 years. However, on-going maintenance and inspection of the rehabilitation work, will be required to maintain access to the Commodore 5 level and points for monitoring conditions in the Nelson Tunnel. This alternative provides a means to allow long-term access for monitoring conditions in the Commodore 5 level and Nelson Tunnel. In addition, it maintains the ability of Commodore 5 level to provide pressure relief for the Upper Mine Pool, as described in Alternative 1.

5.3 Alternative 3: Clear Nelson Portal Pool, Tunnel Rehabilitation, Install Bulkhead in Nelson Tunnel and Flow Control Structure in Commodore 5 Level

Alternative 3 includes maintenance of the Commodore 5 level, dewatering the Nelson Portal Pool, removal of the Nelson Portal blockage, installation of a permanent flow-through bulkhead in Nelson Tunnel out-by of the Nelson-Wooster junction, and installation of a permanent flow control structure in the Commodore 5 level (**Figure 5**). As part of this alternative, the tunnel out-by of the bulkhead would be rehabilitated for long-term stability. This alternative would provide protection against an uncontrolled release from Nelson Tunnel and from Commodore 5 level, meeting the RAO. The construction duration is estimated to be two years.

The targeted Nelson Tunnel bulkhead location is within a region of densely welded and massive rhyolitic tuff in the footwall of the Amethyst Vein. Based on observations on the Commodore 5 level, this rock would likely have few fractures and be relatively impermeable. The depth of rock cover at this location is sufficient for bulkhead design requirements. The bulkhead would be a concrete plug, grouted radially to reduce seepage. The plug would have a stainless steel pipe with a valve to allow water through. The intent would be to allow all normal flow through; and not to impound water beyond the depth of the pipe. The valve and pipe would limit flows during a mine surge or major release from an inby collapse. If the decision were made in the future to further restrict flow from the mine, the bulkhead valve could be closed.

Installing the bulkhead out-by of the Nelson-Wooster junction will allow control of a sudden release with a single bulkhead in Nelson Tunnel. If the bulkhead were placed inby of the Nelson-Wooster junction, mine water could bypass the bulkhead via the Overholt Crosscut, and thus require a

second bulkhead. The exact bulkhead location would be determined after further geologic reconnaissance, but would likely be as close to the Nelson-Wooster junction as geology and ground conditions allow. The design head will be determined after further study and consultation with EPA and CDPHE. The bulkhead would be a permanent installation and withstand the maximum pressure head anticipated, which would be determined during design. The design pressure would accommodate water levels beyond the height of the Commodore 5 level in case that is needed in the future.

The first step of this alternative would be to inspect and perform any necessary maintenance and/or additional rehabilitation of the Commodore 5 level, as well as portions of the McClure Crosscut, Bachelor Shaft, and Nelson Tunnel, to allow installation of construction dewatering equipment. For worker safety, as soon as practicable after entering the Nelson Tunnel level and prior to dewatering, a structural steel grizzly would be installed in the Nelson Tunnel just downstream of the Lower Mine Pool collapse and upstream of the Bachelor Shaft access point to protect against unlikely but potential releases of debris from upstream blockages.

Access to Nelson Tunnel would be established. Access could be developed using the existing turn off and access road that was used during the waste rock pile grading. Regrading of Willow Creek near the Commodore Waste Rock Pile and installation of a bridge could be used to access Nelson Tunnel.

Dewatering would occur by installing a coffer dam and sump downstream of the steel grizzly near the Bachelor Shaft access point, and pumping the Nelson Tunnel flow up the Bachelor Shaft and out the Commodore 5 level. After the Nelson flow is diverted to the Commodore 5 level, the Nelson Portal Pool would dissipate by seepage through the current collapse. The progress of mine pool dissipation can be monitored from inside Nelson Tunnel. After the pool is largely drained, additional dewatering by pumping back to the sump or slowly excavating the portal collapse may be necessary to completely evacuate the mine pool. This would require significant downstream controls to limit the discharge of mine impacted waters into Willow Creek. Even if the water is fully drained, the sediments in the portal area are likely saturated with iron hydroxide and other metals. The possibility of dewatering the Nelson Portal Pool via horizontal or directional drilling would also be investigated during the remedial design phase.

The estimated volume of water in the Nelson Portal Pool is 1.2 MG (Graves, 2015). If the mine pool passively drains at an average of 40 gpm, approximately 20 days may be required to drain the mine pool. However, it is anticipated that several months will be required to evacuate the mine pool water because the flow will be slow as the pool head dissipates. Active pumping, excavation of the portal collapse, or both may be needed to complete the dewatering.

After the Nelson Tunnel Pool is drained, the collapse removed, and portal reconstructed, workers would enter through the Nelson portal to rehabilitate the Nelson Tunnel to the bulkhead location

and to install the flow-through bulkhead. Prior work (Emmons and Larson, 1923) indicates that some areas of running ground may be encountered, requiring extensive rehabilitation. Other areas may be more like the Commodore 5 adit and require little rehabilitation. After bulkhead installation in the Nelson Tunnel, the final requirement for Alternative 3 would entail installation of an accessible, removable flow control structure in the first leg of the Commodore 5 level, in the massive bedrock between the portal and the Daylight Winze. This would provide protection against mine discharges if further collapses or internal releases within the Nelson Tunnel result in water pressure building to that level. In such case, the accessible, removable flow control structure would provide a means to control and regulate flows in order to prevent a sudden release. The structure would include a man-way, which would allow continued access to and ventilation of the deeper mine workings.

Material conditions, logistics, and disposal volumes of wastes generated from the Nelson Tunnel rehabilitation, blockage removal, and portal reconstruction would make it necessary to dispose wastes outside the mine. The Commodore Waste Rock Pile would be modified to incorporate the waste to the extent practicable. Some off-site disposal may be necessary.

This alternative requires diversion of Nelson Tunnel flows through the Commodore 5 level and construction dewatering of the Nelson Portal Pool. An interim measures waiver will be implemented such that discharge of water to West Willow Creek would be prevented from exacerbating the existing conditions but would not be required to meet current water quality standards. This alternative assumes the application of limestone on the floor of the Commodore 5 level would not be adequate since the pumped water would not settle out and filter through the portal collapse. Hence, provisions for a modular, temporary water treatment plant located on the Commodore Waste Rock Pile to provide supplementary treatment to maintain current water quality have been included in the cost for this alternative. The system is envisioned to be a containerized, caustic addition and sedimentation system. Final treatment schemes during construction will be determined during Remedial Design. It is assumed that the plant would treat a portion of the flow (up to approximately 200 gpm) and be operated to maintain existing water quality. Treatment sludge would be disposed at an on-site repository. Site selection and design of the on-site repository would be completed during Remedial Design. Off-site disposal may be determined to be necessary.

5.4 Alternative 4: Drive New Adit to Intersect Nelson Tunnel, Tunnel Rehabilitation, Install Bulkhead in Nelson Tunnel and Flow Control Structure in Commodore 5 Level

Alternative 4 is similar to Alternative 3, except a new adit would be driven parallel to and south of the Nelson Tunnel to bypass the Nelson Portal Pool (**Figures 6 and 7**). Nelson Tunnel would be rehabilitated from the bypass connection to the bulkhead location. This would be a short distance because the bypass would intersect the Nelson Tunnel just below the planned bulkhead location. A shorter bypass would be riskier since the extent of the collapses are not known. Similar to

Alternative 3, a flow-through bulkhead would be installed in the Nelson Tunnel and a flow control structure would be installed in the Commodore 5 level. This alternative would provide protection against an uncontrolled release from Nelson Tunnel and from Commodore 5 level, meeting the RAO. The construction duration is estimated to be two years.

The new adit portal would be located south of the Nelson portal and would be headed at an elevation two feet below the Nelson portal along West Willow Creek (**Figure 7**). Based on survey data, the estimated invert elevation of the new adit would be 9182 feet above mean sea level. Regrading of Willow Creek near the Commodore Waste Rock Pile and installation of a bridge would be needed to establish access to the new portal location. A preliminary plan and profile of the grading and access bridge are shown on Figures 8, 9, and 10. Access would be from the existing turn off and access road that was used during the waste rock pile grading. The northern part of this existing road has a 25% grade. The bridge would match this.

Based on available geologic mapping of the Nelson Tunnel (**Figure 6**), driving the adit south of the Nelson Tunnel could encounter permeable rock or fractures, which could potentially provide a hydraulic connection to the current Nelson Portal Pool. While driving the new adit south of the Nelson Tunnel, probe drilling would be performed in the face as the bypass adit is being driven as a precaution against encountering a permeable rock conduit for inflow from the Nelson Portal Pool. If inflows are encountered, pre-excavation grouting would be performed.

As with Alternative 3, this alternative includes installation of an accessible, removable flow control structure in the first leg of Commodore 5 level after bulkhead installation in the Nelson Tunnel. This would provide protection against mine discharges if further collapses or internal releases within the Nelson Tunnel result in water pressure building to that level. In such case, the accessible, removable flow control structure would provide a means to control and regulate flows in order to prevent a sudden release. The structure would include a man-way, which would allow continued access to and ventilation of the inby mine workings.

Material conditions, logistics, and disposal volumes of wastes generated from the bypass adit excavation would make it necessary to dispose wastes outside the mine. The Commodore Waste Rock Pile would be modified to incorporate the waste to the extent practicable. Some of the rock generated from driving the new bypass could potentially be used as a construction material.

This alternative would eliminate the need to rehabilitate the existing portal and tunnel before or after bulkhead installation. The other primary differences compared to Alternative 3 are the anticipated reduced water treatment requirements. During construction of the bypass adit, the Nelson Portal would continue to be drained by gravity. Only just before connecting into the Nelson would the portal mine pool be reduced by pumping from the Lower Mine Pool or from an outby cofferdam. Pumping rates would be incrementally increased and water treated to avoid exacerbating the existing water quality in West Willow Creek during construction. After the new

adit is constructed, Nelson Tunnel discharge would be diverted to the new adit. As with Alternative 3, it is assumed that a water treatment plant located on the Commodore Waste Rock Pile would treat a portion of the flow to prevent exacerbating the water quality in West Willow Creek. After completion of the new adit, dewatering would be done by gravity flow, eliminating the operation and maintenance costs of pumps. A diversion wall (thin bulkhead) would direct all flow into the new bypass adit. Treatment sludge would be disposed at an on-site repository. Site selection and design of the on-site repository would be completed during Remedial Design. Off-site disposal may be determined to be necessary.

The use of explosives on site for driving a new adit is controlled by laws and regulations for public safety. When explosives are used and stored on site, this would include strict site access control, secure storage, and 24-hour guard. It would also likely require road closure or traffic control of the adjacent county road at certain times during blasting, or both. Blasting for the bypass adit would be designed to limit vibrations in the Nelson Due to the close proximity of the new adit to the existing collapsed portal, blasting would need to be controlled to ensure that ground movement does not cause failure of the existing portal collapse. Blasting engineers would design and simulate the blasting to eliminate the potential for blast-induced forces that could cause failure of the collapse material and to determine if other specific control measures are required.

As with Alternative 3, for worker safety, as soon as practicable after entering the Nelson Tunnel and prior to dewatering, a structural steel grizzly would be installed in the Nelson Tunnel just downstream of the Lower Mine Pool collapse and upstream of the Bachelor Shaft access point to protect against unlikely but potential releases of debris from upstream blockages. The steel grizzly would detain debris and may mitigate surge flows from upstream blockages, improving worker safety.

Similar to Alternative 3, mine water would need to be pumped, stored and treated prior to release to West Willow Creek consistent with the interim measures waiver. In Alternative 4, however, the time period over which water would need to be managed would be shorter in duration as this would not be necessary while constructing the bypass adit. Some groundwater, including recharge from the ground above the Nelson, would still seep into the Nelson Tunnel inby of the Bypass Adit and out the portal. These flows are expected to be minor.

5.5 Alternative 5: Dewatering of Stored Mine Pool Water, Rehabilitation of Nelson Tunnel, and Removal of Blockages

Alternative 5 involves dewatering each of the three known Nelson Tunnel blockages and removal of the blockages to re-establish gravity drainage, without water being retained behind mine collapses. Similar to Alternatives 3 and 4, the first step would entail inspection and maintenance of rehabilitation of the Commodore 5 level to provide safe worker access for establishing the dewatering system and long-term inspection purposes. Access to Nelson Tunnel would be

established, similar to Alternative 3. Dewatering pumping of the pools behind the three blockages would likely occur from the Nelson Portal area (Nelson Portal Pool), the Daylight Winze (Lower Mine Pool), and the Del Monte Raise or a new winze (Upper Mine Pool). These locations are shown on **Figure 4**. A dewatering pilot test via the Del Monte Raise in 2007 by CDRMS (Graves, 2007) was not successful due to collapses so it would require substantial rehabilitation or development of a new winze to access the Upper Mine Pool. The possibility of dewatering mine pools by horizontal or directional drilling would also be investigated during the remedial design phase. It is anticipated that water treatment would be needed throughout the construction period.

In order to drain the water contained behind the collapses, water would need to be pumped in excess of the average flow from the tunnel at a rate that would accomplish dewatering in a reasonable amount of time. As an example, assuming a stored volume of 22.1 MG, a combined dewatering rate of 410 gpm (50 gpm above the recent years' average flow of 365 gpm), and that no significant additional inflow is induced by dewatering or excessive precipitation, approximately one year would theoretically be required to drain the water behind the blockages. However, based on challenges of dewatering the Upper Mine Pool experienced during previous trials (Graves, 2007) this alternative is expected to require at least three years. It is assumed that dewatering of the mine pools would occur simultaneously at times, but also be staged over time as the Upper Mine pool is drawn down. After the mine pools are drained, existing blockages would be cleared and the Nelson Tunnel rehabilitated and stabilized to maintain access and avoid further collapses and blockages (assumed design life of 30 to 50 years).

Material conditions, logistics, and disposal volumes of wastes generated from the Nelson Tunnel rehabilitation, blockage removal, and portal reconstruction would make it necessary to dispose wastes outside the mine. The Commodore Waste Rock Pile would be modified to incorporate the waste to the extent practicable. Some off-site disposal may be necessary.

As with Alternative 3, water will likely be pumped from a sump out-by of the Lower Mine Pool collapse into the Commodore 5 level for discharge. Any water extracted directly from the Upper and Lower Mine Pools will be discharged through the Commodore 5 level. In this manner, the Nelson Portal Pool can be allowed to dissipate by seepage through the portal collapse in the same manner as with Alternative 3. Some active dewatering of the Nelson Portal Pool may also be required.

It is assumed that the entire volume of discharge would be routed through a treatment plant, but only treated to the extent necessary to maintain existing quality. Treatment would occur throughout the process of draining the existing mine pools, and then cease after blockages are removed and the Nelson Tunnel is rehabilitated. Due to the duration and design flow of the treatment plant and space requirements, it is assumed that the plant would need to be located below Creede. A new pipeline would be installed along Willow Creek to deliver flow to the plant. The plant would be a containerized system along with two sedimentation ponds, occupying approximately one acre. It

would treat for pH, solids and metals via caustic and flocculent addition. Treatment sludge would be disposed at an on-site repository. Site selection and design of the on-site repository would be completed during Remedial Design. Some off-site disposal may be determined to be necessary.

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6 DETAILED EVALUATION OF ALTERNATIVES

Alternatives 3, 4 and 5 were developed as approaches to meeting the remedial action objective, while alternatives 1 and 2 were evaluated as baselines. Detailed analysis is conducted on each of the alternatives developed. This analysis consists of an assessment of individual alternatives against each of nine evaluation criteria defined in the NCP:

- Threshold Criteria:
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Balancing Criteria:
  - Long-term effectiveness and permanence
  - Reduction in toxicity, mobility, or volume through treatment
  - Short-term effectiveness
  - Implementability – technical and administrative
  - Cost
- Modifying Criteria
  - State acceptance
  - Community acceptance

6.1 Threshold Criteria

Any selected remedy must meet the Threshold Criteria. Only those alternatives that meet these criteria are considered further by the EPA.

6.1.1 Overall Protection of Human Health and the Environment

Alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling human and exposures. Because the RAO is limited to mitigation of a sudden large release from Nelson Tunnel, the evaluation of this criterion focuses on the ability of the alternative to protect human health and the environment from a sudden large release.

6.1.2 Compliance with ARARs

ARARs are separated into three categories, 1) Chemical- Specific, 2) Location-Specific, and 3) Action-Specific. This Interim Action is not intended to bring the Site into compliance with the State of Colorado surface water quality standards but is focused on mitigating further migration of contaminants from a large release. Therefore, the Alternatives are not evaluated for compliance with the Chemical-Specific Colorado surface water quality standards.

Alternatives 3, 4, and 5 would increase water flow from the Nelson Tunnel during construction while managing water around the construction or rehabilitation areas. Managed water during the construction would be treated to prevent further migration of contamination and prevent further degradation of existing water quality within West Willow. Appendix C provides an example demonstrating how water treatment operations can be implemented to prevent water quality degradation in West Willow Creek.

Treated water may not meet all surface water quality standards; therefore, an Interim Measures Waiver will be included in the record of decision, waiving the Action-Specific Colorado surface water quality standard ARAR relating to discharges during construction. Meeting surface water quality standards for the construction discharge is possible but is judged infeasible because it would be logistically difficult due to the limited space available for construction activities, would provide limited benefit to the environment because treatment would be temporary, and would substantially increase costs. More significantly, the time required to construct and operate a full-scale system that can provide a higher level of water treatment will significantly delay achievement of the RAO to prevent a sudden and large uncontrolled release.

It is expected that Location-Specific ARARs would be met by each of the alternatives. Because Alternatives 3, 4, and 5 would require Interim Measures Waivers for the Chemical and Action-Specific water quality ARARs during construction, they are ranked moderate for compliance with ARARs. Alternatives 1 and 2 would comply with ARARs associated with the RAO of this response action, since no water management during construction is required, the Action-Specific surface water quality standards also do not apply. Therefore, these alternatives are ranked high in this category.

6.2 .Balancing Criteria

The Balancing Criteria are used by the EPA to identify and consider major trade-offs between the alternatives.

6.2.1 Long-Term Effectiveness and Permanence

Alternatives are assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. An important consideration for this Interim Action is how well it complements the final remedy for the site.

6.2.2 Reduction of Toxicity, Mobility or Volume through Treatment

Alternatives are assessed for the degree to which they employ recycling or treatment that reduces toxicity, mobility, or volume. . While treatment of water discharged during construction is envisioned for some of the alternatives, treatment schemes to address the toxicity, mobility or volume of wastes are beyond the scope of the Interim Action alternatives evaluated for this FFS.

6.2.3 Short-Term Effectiveness

The short-term impacts of alternatives are assessed considering the following:

- Short-term risks that might be posed to the community during implementation of an alternative.
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures.
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigation measures during implementation; and
- Time until protection is achieved.

6.2.4 Implementability

The ease or difficulty of implementing the alternatives shall be assessed by considering the following types of factors as appropriate:

- Technical feasibility, including technical difficulties and uncertainties associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.
- Administrative feasibility, including activities needed to be coordinated with other offices and agencies and the ability and time required to obtain any necessary approval and permits from other agencies (for off-site actions).
- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies.

6.2.5 Cost

Cost estimates developed at the detailed analysis of alternatives phase of the FFS have an accuracy range of -30% to +50% (EPA, 2000). These cost estimates are used to compare alternatives and support remedy selection. Cost estimates at this stage are intended to provide a measure of total resources over time associated with any given alternative.

The types of costs assessed in this FFS include the following:

- Capital costs, including both direct and indirect costs;
- Annual operations and maintenance costs; and
- Net present value of capital and O&M costs.

EPA guidance (EPA, 2000) suggests the use of a 7% discount factor when calculating net present value of capital and O&M costs for all non-Federal Facilities. However, EPA guidance recognizes times when a discount rate other than 7% is appropriate. This FFS uses the current 30-year real interest rate from the Office of Management and Budget (OMB) Circular A-94, which is 0.4% (OMB, 2019).

6.3 Modifying Criteria

State acceptance and community acceptance, is evaluated after the preferred remedy is selected, to the extent that information is available, and then more thoroughly after the public comment period.

6.4 Detailed Analysis of Alternative 1 - No Further Action

Description

The No Further Action Alternative would involve no further remedial action or controls beyond those already completed or currently undertaken. This Alternative does not meet the RAO but is included for comparison purposes.

Analysis

Overall Protection of Human Health and the Environment: This alternative does not address the risks to human health and the environment posed by a sudden large release of mine influenced water from the Nelson Tunnel.

Compliance with ARARs: Since no-action would be taken under this alternative, action- and location-specific ARARs do not apply. Attainment of chemical-specific ARARs are not the objective of the interim action evaluated in this FFS.

Long-Term Effectiveness: Long-term effectiveness would remain unchanged under this alternative. Deterioration of existing support may lead to surges, large mine pool releases, and changes in flow.

Reduction in Toxicity, Mobility, and Volume through Treatment: No treatment is proposed under this alternative.

Short-Term Effectiveness: Short-term effectiveness would remain unchanged under this alternative.

Implementability: Implementation of the No-Action Alternative would require no effort.

Cost: There are no direct costs associated with the No-Action Alternative.

6.5 Detailed Analysis of Alternative 2 - Maintain Rehabilitation of Mine Workings and Periodic Inspections and Monitoring

Description

This alternative would involve maintaining rehabilitation and stabilization of the Commodore 5 level along the Amethyst and OH Vein to allow safe access to existing monitoring points. Alternative 2, by itself, does not meet the RAO, but was evaluated as a baseline.

Analysis

Overall Protection of Human Health and the Environment: By maintaining the Commodore 5 level and a stable connection to Nelson Tunnel, a measure of protection against an uncontrolled release is provided (because a hydraulic head higher than that of the Commodore 5 level could not build up).

Compliance with ARARs: This alternative will not alter discharges from Nelson Tunnel or require water treatment. State and RCRA waste management and disposal requirements triggered by the generation of treatment sludges would not apply.

Because the Site is limited to underground areas and the Commodore Waste Rock Pile and adjacent areas that would be directly impacted by construction have undergone recent alteration from previous removal action and are devoid of trees, the potential for impact to protected animals and habitat is low. Similarly, although the Site is within the Creede National Historic District, based on the scope and location of the planned work activities, the potential to impact to cultural and historic resources is low. Work outside the mine would be support activities, thus ARAR compliance for noise, odor, dust, and reclamation are not expected to be difficult.

Long-Term Effectiveness and Permanence: Long-term effectiveness would remain unchanged under this alternative.

Reduction in Toxicity, Mobility, and Volume through Treatment: No treatment is proposed under this alternative.

Short-Term Effectiveness: Short-term risks to the community would remain unchanged under this alternative. The remedial action would require underground work, which entails mitigating inherent hazards associated with working within spaces with limited means of egress and natural ventilation.

Implementability: Components of this alternative would require specialized labor and construction equipment that may not be locally available, but would be available regionally. Construction components include standard of practice materials that are expected to be reliable with regular maintenance. Lead time may be needed in delivery of the equipment and materials required to implement these alternatives.

Cost: The estimated costs for this alternative are summarized below. Details on the estimated cost for Alternative 2 are provided in **Appendix D**.

Alternative 2 Summary of Costs	
Capital Costs	$239,000
30 Year O&M Costs at 0.4% Discount Rate	$1,411,000
Total	**$1,650,000**

6.6 Detailed Analysis of Alternative 3 - Clear Nelson Portal Pool, Tunnel Rehabilitation, Install Bulkhead in Nelson Tunnel and Flow Control Structure in Commodore 5 Level

Description

Alternative 3 includes maintenance of current rehabilitation of the Commodore 5 level, and selected shafts and winzes to provide safe access to the Nelson Tunnel, dewatering the Nelson Portal Pool, removal of the Nelson Portal blockage, installation of a flow-through bulkhead in Nelson Tunnel out-by of the Nelson-Wooster junction, and installation of a bulkhead flow control structure in the Commodore 5 level.

Analysis

Overall Protection of Human Health and the Environment: With respect to the RAO, this alternative is protective because it provides a means to prevent large and sudden releases of mine impacted water to the environment.

Compliance with ARARs: As described in Section 6.1.2, an ARAR waiver may be required for discharges during construction.

This alternative would alter discharges from Nelson Tunnel and require water treatment, triggering State and RCRA waste management and disposal requirements for the generation of treatment sludges.

Because the Site is limited to underground areas and the Commodore Waste Rock Pile and adjacent areas that would be directly impacted by construction have undergone recent alteration from previous removal action and are devoid of trees, the potential for impact to protected animals and habitat is low. Similarly, although the Site is within the Creede National Historic District, based on the scope and location of the planned work activities, the potential to impact to cultural and historic resources is low. Work outside the mine would be support activities, thus ARAR compliance for noise, odor, dust, and reclamation are not expected to be difficult.

Long-Term Effectiveness and Permanence: It is anticipated that the final remedy at the site will need to provide an effective and durable means to control the discharge from Nelson Tunnel.

Bulkheads provided for in this alternative will provide discharge control, which will likely be a part of the final remedy.

Reduction in Toxicity, Mobility, and Volume through Treatment: No treatment is proposed under this alternative, except water treatment during construction to prevent exacerbating existing conditions.

Short-Term Effectiveness: Because this alternative involves dewatering Nelson Portal Pool, flows of mine impacted water in West Willow and Willow Creeks will be increased during implementation. Temporary treatment measures would be employed to mitigate the impact to the environment. The remedial action would require underground work, which entails mitigating inherent hazards associated with working within spaces with limited means of egress and the potential for poor ventilation.

Implementability: The construction of the major components of this alternative would require specialized labor and construction equipment that may not be locally available but would be available regionally. Construction components include mostly standard of practice materials that are expected to be reliable with regular maintenance. Lead-time may be substantial for delivery of the equipment and materials required to install the bulkhead and flow control structure. Defining the level of stabilization required for underground works is technically challenging due to uncertainties in rock conditions. This can lead to project delays and cost over-runs. Dewatering prior to safely removing blockages will present some technical challenges to implement safely.

Cost: The estimated costs for this alternative are summarized below. Details on the estimated cost for Alternative 3 are provided in **Appendix D**.

Alternative 3 Summary of Costs	
Capital Costs	$13,313,000
30 Year O&M Costs at 0.4% Discount Rate	$1,776,000
Total	**$15,089,000**

6.7 Detailed Analysis of Alternative 4 - Drive New Adit to Intersect Nelson Tunnel, Tunnel Rehabilitation, Install Bulkhead in Nelson Tunnel and Flow Control Structure in Commodore 5 Level

Description

Alternative 4 is similar to Alternative 3, except a new adit would be driven parallel to and south of the Nelson Tunnel to bypass the Nelson Portal Pool. Nelson Tunnel would be rehabilitated from the bypass connection to the bulkhead location. Same as Alternative 3, a flow control bulkhead would be installed in the Nelson Tunnel and a flow control structure would be installed in the Commodore

5 level. This alternative would provide protection against an uncontrolled release from Nelson Tunnel, meeting the RAO.

Analysis

Overall Protection of Human Health and the Environment: With respect to the RAO, this alternative is protective because it provides a means to prevent large and sudden releases of mine impacted water to the environment.

Compliance with ARARs: As described in Section 6.1.2, an ARAR waiver may be required for discharges during construction.

This alternative would alter discharges from Nelson Tunnel and require water treatment, triggering State and RCRA waste management and disposal requirements for the generation of treatment sludges.

Because the Site is limited to underground areas and the Commodore Waste Rock Pile and adjacent areas that would be directly impacted by construction have undergone recent alteration from previous removal action and are devoid of trees, the potential for impact to protected animals and habitat is low. Similarly, although the Site is within the Creede National Historic District, based on the scope and location of the planned work activities, the potential to impact to cultural and historic resources is low. Work outside the mine would be support activities, thus ARAR compliance for noise, odor, dust, and reclamation are not expected to be difficult.

Long-Term Effectiveness and Permanence: It is anticipated that the final remedy at the site will need to provide an effective and durable means to control the discharge from Nelson Tunnel. Structures provided for in this alternative will provide discharge control, which will likely be a part of the final remedy.

Reduction in Toxicity, Mobility, and Volume through Treatment: No treatment is proposed under this alternative, except water treatment during construction to prevent exacerbating existing conditions. Dewatering and treatment of a portion of the Nelson Portal Pool would be required to safely connect the Bypass Adit to Nelson Tunnel, because the Nelson Portal Pool extends inby of the proposed bulkhead location (see **Figures 3 and 7**).

Short-Term Effectiveness: Because this alternative involves dewatering mine pools, flows of mine impacted water in West Willow and Willow Creeks will be increased during implementation. Temporary treatment measures would be employed to mitigate the impact to the environment. The remedial action would require underground work, which entails mitigating inherent hazards associated with working within spaces with limited means of egress and the potential for poor ventilation.

Implementability: The construction of the major components of this alternative would require specialized labor and construction equipment that may not be locally available but would be available regionally. Construction components include mostly standard of practice materials that are expected to be reliable with regular maintenance. Lead-time may be substantial for delivery of the equipment and materials required to install the bulkhead. Defining the level of stabilization required for underground works is technically challenging because of uncertainties in rock conditions. This can lead to project delays and cost over-runs.

Uncertainties exist with the extent of the Manhattan Cross-cut and the drift that is mapped as being located between Stations 6+00 and 7+00 in the Nelson Tunnel. Mitigation plans would need to be developed to avoid these structures.

Cost: The estimated costs for this alternative are summarized below. Details on the estimated cost for Alternative 4 are provided in **Appendix D**.

Alternative 4 Summary of Costs	
Capital Costs	$10,318,000
30 Year O&M Costs at 0.4% Discount Rate	$1,411,000
Total	**$11,729,000**

6.8 Detailed Analysis of Alternative 5 - Dewatering of Stored Mine Pool Water, Rehabilitation of Nelson Tunnel, and Removal of Blockages

Description

Alternative 5 involves dewatering each of the three known Nelson Tunnel blockages and removal of the blockages to re-establish gravity drainage. Similar to Alternatives 3 and 4, the first step would entail maintenance of current rehabilitation of the Commodore 5 level and rehabilitating Nelson Tunnel to provide safe worker access and long-term inspection purposes.

Analysis

Overall Protection of Human Health and the Environment: While water and known impoundments would be removed, there is no long-term measure to prevent future collapses inby of the rehabilitated section of Nelson Tunnel and the Commodore 5 level from creating mine pools and subsequent releases of impacted water. With respect to the RAO, this alternative would not provide protection from development of a new impoundment and subsequent sudden release in the future.

Compliance with ARARs: As described in Section 6.1.2, an ARAR waiver may be required for discharges during construction.

This alternative would alter discharges from Nelson Tunnel and require water treatment, triggering State and RCRA waste management and disposal requirements for the generation of treatment sludge.

Because the Site is limited to underground areas and the Commodore Waste Rock Pile and adjacent areas that would be directly impacted by construction have undergone recent alteration from previous removal action and are devoid of trees, the potential for impact to protected animals and habitat is low. Similarly, although the Site is within the Creede National Historic District, based on the scope and location of the planned work activities, the potential to impact to cultural and historic resources is low. Work outside the mine would be support activities, thus ARAR compliance for noise, odor, dust, and reclamation are not expected to be difficult.

Long-Term Effectiveness and Permanence: As the tunnel system ages, additional blockages are likely to occur in areas inby of the portions of the Nelson Tunnel and Commodore 5 level that are rehabilitated. This alternative will not provide protection against sudden releases from pools that will eventually form upgradiant of or within the rehabilitated tunnel.

The impact of Alternative 5 on the quality and quantity of mine discharge is uncertain. Lowering water levels and exposing additional mine workings to oxygenation could result in an increase in flow and a decrease in water quality, respectively.

Reduction in Toxicity, Mobility, and Volume through Treatment: No treatment is proposed under this alternative, except water treatment during construction to prevent exacerbating existing conditions.

Short-Term Effectiveness: Because this alternative involves dewatering mine pools, flows of mine impacted water in West Willow and Willow Creeks will be increased during implementation. Temporary treatment measures would be employed to mitigate the impact to the environment. The remedial action would require underground work, which entails mitigating inherent hazards associated with working within spaces with limited means of egress and the potential for poor ventilation.

Implementability: The construction of the major components of this alternative would require specialized labor and construction equipment that may not be locally available but would be available regionally. Construction components include mostly standard of practice materials that are expected to be reliable with regular maintenance.

Defining the level of rehabilitation required in Nelson Tunnel will be technically challenging because incomplete information on conditions. This can lead to project delays and cost over-runs. Dewatering of the mine pools, especially the Upper Mine Pool, may be technically challenging and difficult to implement. Also, the processes of dewatering may increase inflow into the mine pool, increasing the time required for dewatering.

Cost: The estimated costs for this alternative are summarized below. Details on the estimated cost for Alternative 5 are provided in **Appendix D**.

Alternative 5 Summary of Costs	
Capital Costs	$55,237,000
30 Year O&M Costs at 0.4% Discount Rate	$2,822,000
Total	**$58,059,000**

7 COMPARATIVE ANALYSIS

This section provides a comparative analysis of the alternatives against the Threshold and Balancing Criteria. Because Alternative 2 does not meet the RAO, it was not included in this comparative analysis. A summary of the comparative analysis for each alternative is provided in Table 7-1. For each of the criteria, the alternative judged as the most favorable based on comparative analysis is listed as high ranking in Table 1 and the least favorable alternative is listed as low ranking. Those alternatives in between the most and least favorable are listed as moderate ranking. Where alternatives are judged to be equal based on the criteria, they receive the same rank.

7.1 Overall Protection of Human Health and the Environment

Each of the alternatives, except the No-Action alternative, provide a level of protection to human health and the environment by eliminating, reducing, or controlling risks posed by the site through treatment of contaminants, engineering controls, and/or institutional controls. Implementation of Alternatives 3 and 4 would essentially eliminate the threat of a sudden uncontrolled release. Both have risks associated with a release of some form during implementation of the remedy, but those risks can be substantially reduced by the engineering controls and treatment associated with each remedy. Alternative 5 removes existing blockages and allows for inspection and maintenance, but does not provide a means to control drainage or prevent a sudden release should future collapses occur in the tunnel or workings that drain into it.

7.2 Compliance with Applicable or Relevant and Appropriate Requirements

It is anticipated that all of the alternatives can be in compliance with ARARs. Alternatives 3, 4, and 5 would increase water flow from the Nelson Tunnel during construction, requiring treatment. Each of these alternatives will require an Interim Measures Waiver to allow treated water to be discharged without fully meeting surface water quality standards.

7.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once the RAO has been met. This criterion includes the consideration of residual risk that will remain onsite following remediation and the adequacy and reliability of controls.

Each alternative, except the No Action alternative, provides some degree of long-term protection. Alternatives 3 and 4 are equally effective in removing the long-term threat of a sudden uncontrolled release from the Nelson and Commodore 5 level tunnels. Under Alternatives 3 and 4, mine discharge remains as a source of surface water contamination, but the RAO is met through installation of structures in Nelson Tunnel and Commodore 5 level that regulate flow. The mine discharge also remains a source under Alternative 5, but it does not allow for regulation of flow and future collapses could lead to an uncontrolled release. The impact of Alternative 5 on the quality

and quantity of mine discharge is uncertain. Lowering water levels and exposing additional mine workings to oxygenation could result in an increase in flow and a decrease in water quality, respectively. Conversely, elimination of the mine pools would decrease mine water residence time, which may be responsible for a significant portion of the metal loading.

7.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. Except during construction, treatment is not required to satisfy the RAO. This criterion will be evaluated for the future final remedy.

7.5 Short-Term Effectiveness

Short-term effectiveness addresses the period needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until RAOs are achieved.

Alternatives 3 and 4 could be completed in approximately two years (drive bypass adit or clear Nelson Tunnel to bulkhead location the first year, and then drain Nelson Portal Pool and investigate, design, and install bulkhead). The amount of time for these alternatives could vary depending upon treatment requirements and length of the work season due to weather and run-off conditions.

The time to implement Alternative 5 is uncertain but could be substantial. It is assumed that construction would require at least 3 years and design and coordination may require a substantial amount of time. Siting of the treatment plant is complex due to the topography in the immediate area of the tunnel discharge. While it is estimated that treatment for Alternatives 3 and 4 could be cited on the Commodore Waste Rock Pile, due to the duration and design flow of the treatment plant and space requirements, it is assumed that the plant for Alternative 5 would need to be located below Creede. Property agreements will likely be required along with a pipeline to convey the water from the mine workings to a treatment plant south of Creede, Colorado. Acquisition or lease of property for the treatment plant will also be required.

Working with the water right on the Nelson Tunnel discharge is anticipated to complicate the implementation of Alternative 5 as well. The location of the water treatment discharge is a key item with respect to the water right. Also, water treatment involves waste sludge containing an amount of water that is consumed (by disposal or evaporation), and other evaporative losses that are not returned to the creek. These water rights issues are expected to increase the complexity and time line required for selecting a water treatment technology and siting of the plant. It will also require coordination with additional parties including the Colorado Division of Water Resources, town of Creede, US Forest Service, and private parties.

Alternative 1 is not effective at reducing the short-term threat of a sudden release. Alternatives 3 and 4 are comparable in reducing the short-term threat of a sudden release. Alternative 5 would have less to no short-term effectiveness due to the time required to implement, thereby extending the period of threat of sudden release. Alternatives 3 through 5 have short-term risks to workers, primarily associated with mine rehabilitation, underground mining, and bulkhead installation, but also due to exposure of workers to a potential sudden uncontrolled release during construction. Compared to Alternative 3, Alternative 4 requires less exposure of workers being directly downstream of the Lower and Upper Mine Pools. Alternative 5 would involve the greatest exposure of workers underground.

7.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Implementation of Alternatives 3 and 4 is relatively straightforward. Materials and equipment are available within the region. Each requires mine tunnel stabilization. Defining the level of stabilization required for underground works is technically challenging due to uncertainties in rock conditions and Alternative 3 requires a greater amount of mine stabilization. Dewatering required for Alternative 3 prior to removing the Nelson Portal blockage will present some technical challenges to implement safely.

Alternative 4 requires less stabilization than Alternative 3, but requires the use of explosives, and could at times affect public access to the county road along West Willow Creek.

Alternative 5 is by far the most difficult to implement due to the need to remove all three blockages, land access and procurement requirements, and design of the water treatment plant. The pipeline to convey water to the plant would need to cross a large number of properties with different owners. Acquisition or lease of property upon which to construct and operate the plant would also be required.

Water rights issues with respect to volume and point of diversion may also complicate and increase difficulties with implementing Alternative 5. No significant impact on existing water rights is anticipated in Alternative 3 and 4. Additional flow is not anticipated to be significantly larger than the natural range of flows and the outflow location can be maintained in a location compatible with the water right diversion point in both alternatives. Alternative 1 does not alter flow and therefore do not impact existing water rights.

7.7 Cost

A summary of the costs are provided in Table 7-2. Details on the estimated cost each alternative is provided in **Appendix D**.

The cost estimates are generally based upon recent experience with similar work, adjusted for inflation, escalation, and professional judgment. O&M costs include yearly inspections and annual costs to maintain rehabilitation of the adits. Cost differences between alternatives reflect the length of adit that would require maintenance. Completion of the TCRA to rehabilitate the Commodore 5 level is reflected in the estimated costs. As shown on the cost tables, we estimate the costs of Alternatives 3 and 4 to be similar. Alternative 3 relies on pumping to cut off the inflow to the Nelson Tunnel while the tunnel is being rehabilitated. Failure of the pumps (mechanical, power loss, plugs, etc.) could drive up the pumping cost and cause delays and damage as water entered the Nelson Tunnel construction area. The cost per foot of driving a new tunnel, Alternative 4, is more predictable than rehabilitating the Nelson Tunnel in Alternative 3, thus Alternative 4 has a lower risk of cost overrun.

Table 7-1 Alternative Comparison Summary

Evaluation Criterion	Alternative				Notes About Rankings
	1	3	4	5	
Overall Protection of Human Health and the Environment	o	⊗	⊗	•	Alternatives 3 and 4 are the most effective source control alternatives and are provide the greatest protection to surface water quality.
Applicable or Relevant and Appropriate Requirements (ARARs)	⊗	•	•	•	Alternatives 3 through 5 will require Interim Measures Waivers to allow treated water to be discharged without exacerbating current conditions but not meeting current standards
Long-Term Effectiveness	o	⊗	⊗	•	Alternatives 3 and 4 will meet the RAO by installing bulkheads and other flow control devices; whereas Alternatives 5 will remove existing blockages, but is not expected to provide long-term protection from sudden releases
Reduction of Toxicity, Mobility, and Volume through Treatment	o	o	o	o	The RAO of this Interim Action does not include long-term measures to improve surface water quality.
Short-Term Effectiveness	o	⊗	⊗	•	The schedule for completing construction is approximately two years for both Alternatives 3 and 4.
Implementability	⊗	•	⊗	o	Alternative 4, which includes constructing a bypass adit to avoid unstable portions of Nelson Tunnel, is considered easier to implement than Alternative 3.
Cost	⊗	•	•	o	Cost for Alternatives 3 and 4 are similar. In comparison, the cost for Alternative 5 is about four times greater than estimated costs for Alternatives 3 and 4.
State Acceptance	o	•	⊗	o	The State of Colorado concurs with the selection of the Alternative 4 as the Preferred Alternative.
Community Acceptance					To be identified during public comment period.

o Low Ranking • Moderate Ranking ⊗ High Ranking

Table 7-2 Summary of Alternative Costs

Alternative	Capital Cost	Net Present Value 30 Years of O&M	Total Cost
Alternative 1: No Further Action	$0	$0	$0
Alternative 3: Clear Nelson Portal Pool, Tunnel Rehabilitation, Install Bulkhead in Nelson Tunnel and Flow Control Structure in Commodore 5 level	$13,313,000	$1,776,000	$15,089,000
Alternative 4: Drive New Adit to Intersect Nelson Tunnel, Tunnel Rehabilitation, Install Bulkhead in Nelson Tunnel and Flow Control Structure in Commodore 5 level	$10,318,000	$1,411,000	$11,729,000
Alternative 5: Dewatering of Stored Mine Pool Water, Rehabilitation of Nelson Tunnel, and Removal of Blockages	$55,237,000	$2,822,000	$58,059,000

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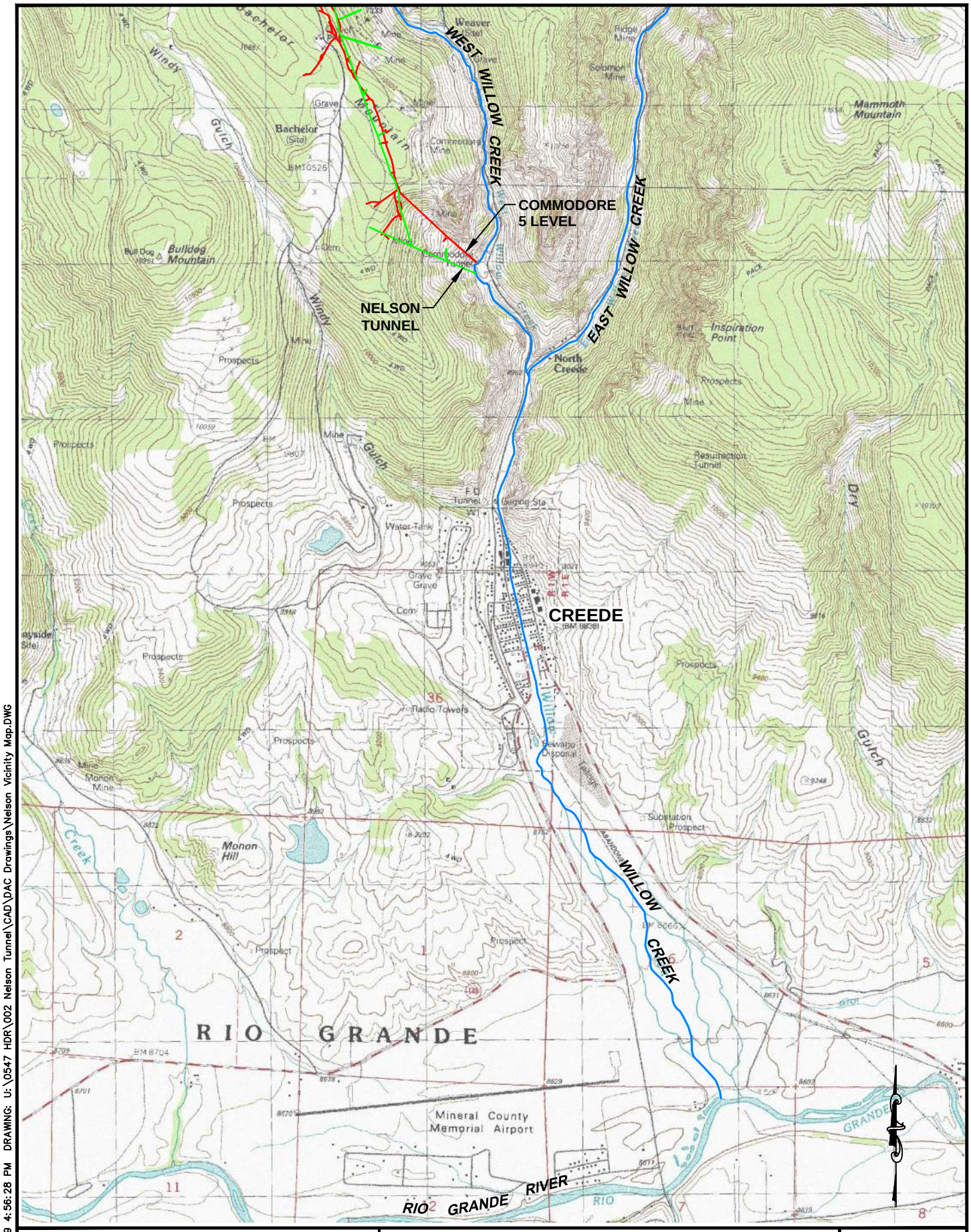
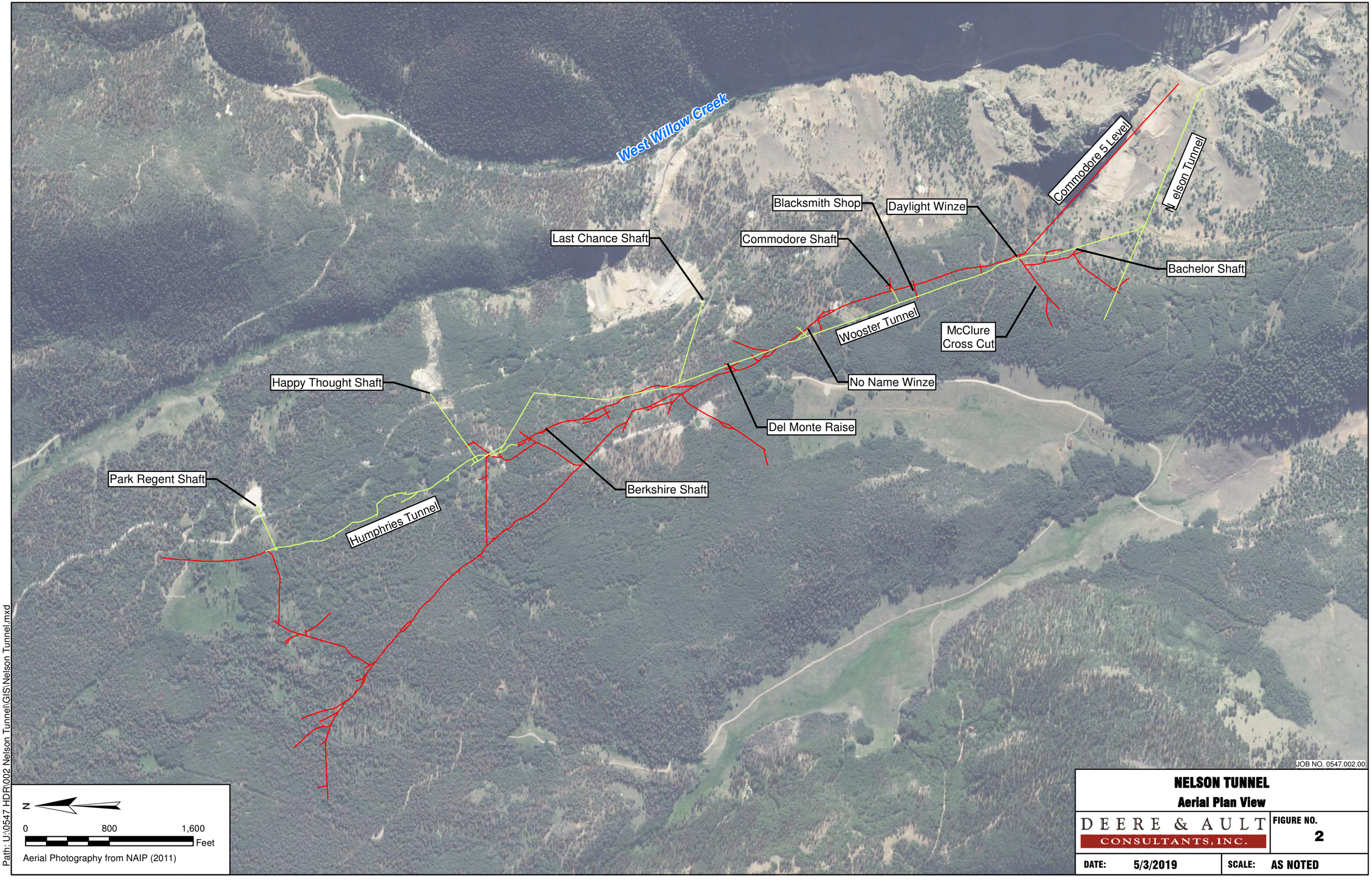
FIGURES



DEERE & AULT CONSULTANTS, INC.

NELSON TUNNEL VICINITY MAP		FIGURE NO. 1
JOB NO. 0547.002.00	SCALE: 1" = 2180 ft	

Friday, May 3, 2019 4:56:28 PM DRAWING: U:\0547 HDR\002 Nelson Tunnel\CAD\DAC Drawings\Nelson Vicinity Map.DWG



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JOB NO. 0547.002.00

NELSON TUNNEL

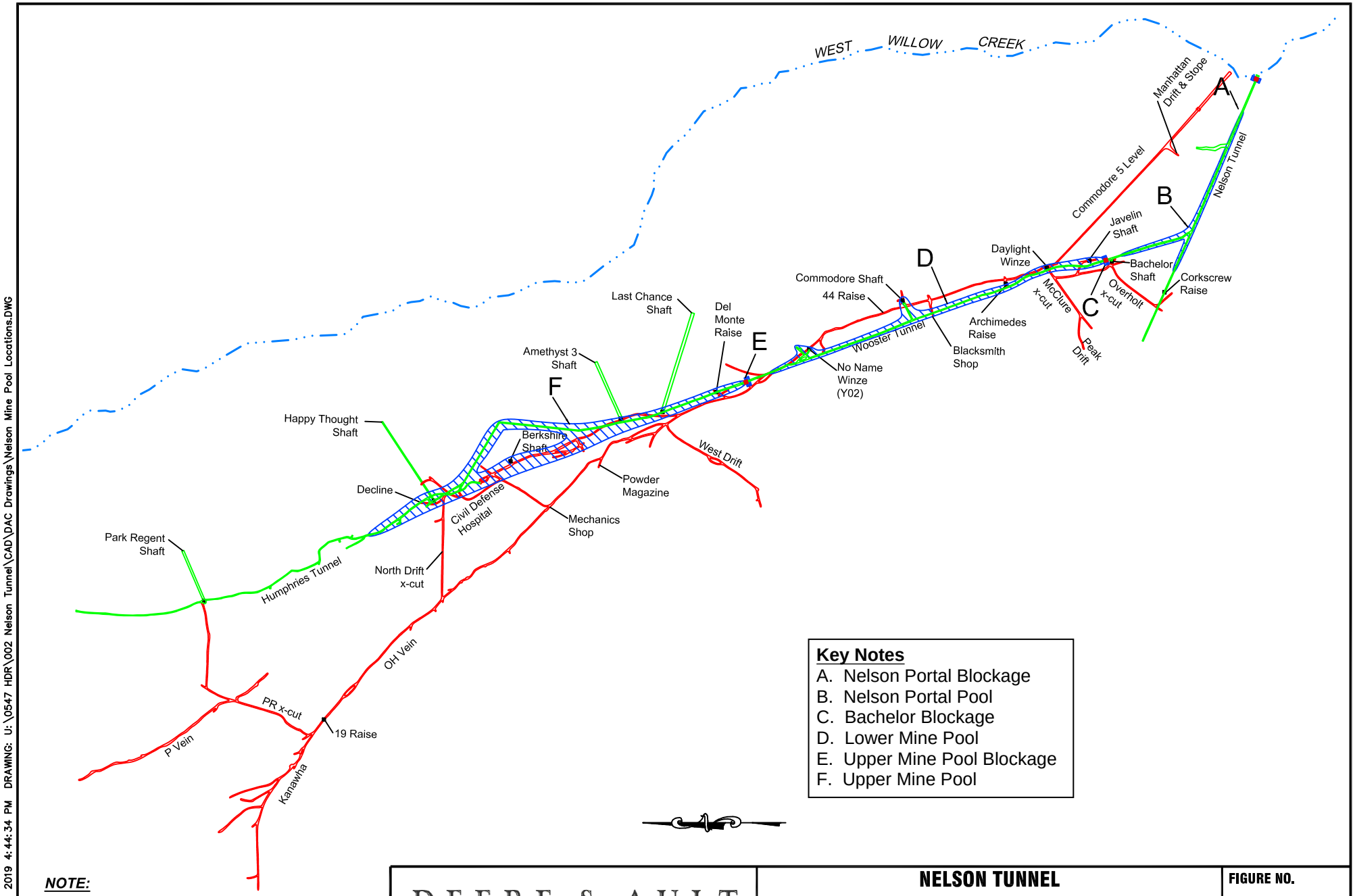
Aerial Plan View

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. **2**

DATE: **5/3/2019**

SCALE: **AS NOTED**



Key Notes

A. Nelson Portal Blockage
B. Nelson Portal Pool
C. Bachelor Blockage
D. Lower Mine Pool
E. Upper Mine Pool Blockage
F. Upper Mine Pool

NOTE:

MINE MAP BY CDRMS

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NELSON TUNNEL

MINE POOL LOCATIONS

JOB NO.	SCALE:	FIGURE NO.
0547.002.00	None	3

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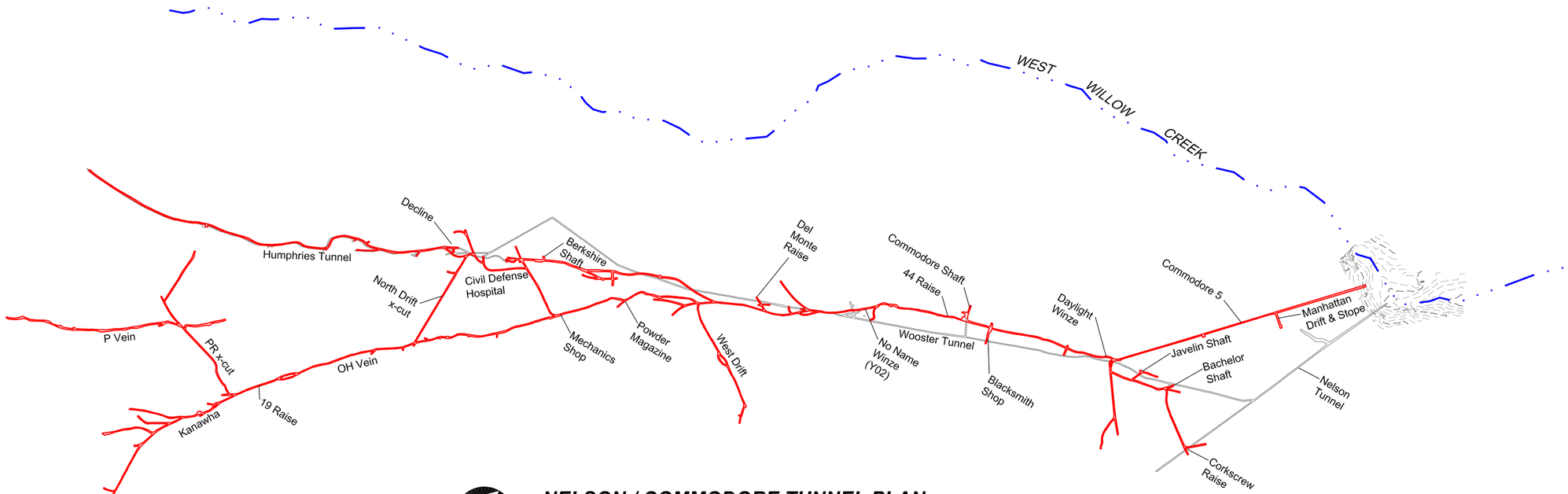

NELSON / COMMODORE TUNNEL PLAN

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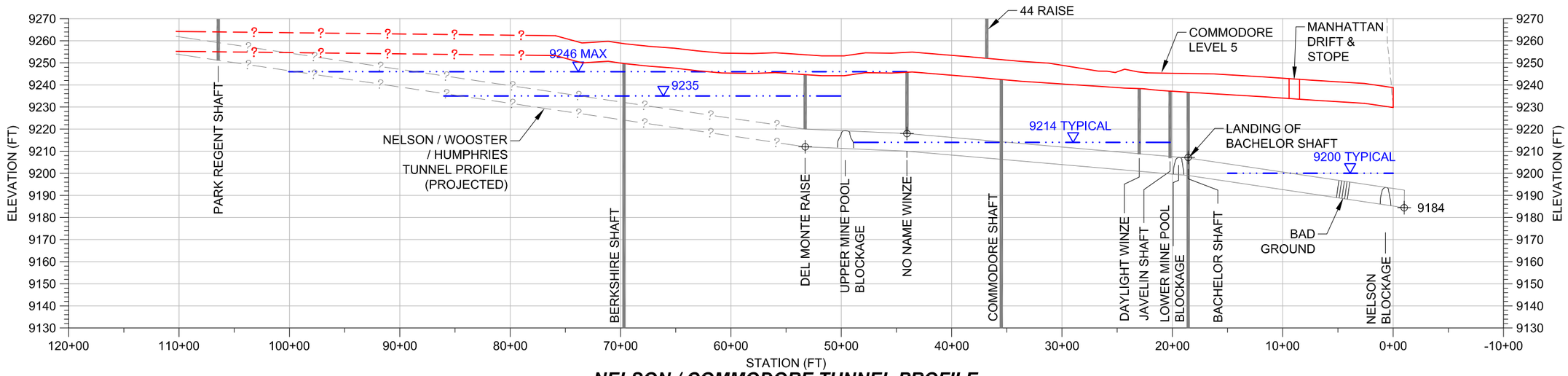
SCALE IN FEET



NELSON / COMMODORE TUNNEL PROFILE

Vertical Scale (FT) 0 25' 50'
Horizontal Scale (FT) 0 500' 1000'

NOTES:

1. TOPOGRAPHICAL SURVEY BY ENVIRONMENTAL RESEARCH, INC LINDEN, VIRGINIA. DATE OF PHOTOGRAPHY: 5-17-18.
2. TUNNEL SURVEY POINTS PROVIDED BY ITC RESOURCES, DATED 3-13-19.

JOB NO. 0547.002.00

NELSON TUNNEL

PLAN AND PROFILE OF UNDERGROUND WORKINGS

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 4

DATE: MAY 2019

SCALE: AS NOTED

JAVELIN SHAFT
LOWER POOL BLOCKAGE
BACHELOR SHAFT
PROPOSED STEEL GRIZZLY
DEWATER SUMP
CORKSCREW RAISE
COMMODORE 5 LEVEL
MANHATTAN DRIFT & STOPE
NELSON TUNNEL
PROPOSED BULKHEAD (APPROX)
PROPOSED DIVERSION DAM
FLOW CONTROL STRUCTURE (LOCATION TO BE DETERMINED)
ZONE OF BAD GROUND
NELSON PORTAL BLOCKAGE TO BE CLEARED

25+00 24+00 23+00 22+00 21+00 20+00 19+00 18+00 17+00 16+00 15+00 14+00 13+00 12+00 11+00 10+00 9+00 8+00 7+00 6+00 5+00 4+00 3+00 2+00 1+00 0+00

10600 10500 10400 10300 10200 10100 10000 9900 9800 9700 9600 9500 9400 9600 500 0

NOTES:

1. SITE WIDE TOPOGRAPHY PROVIDED BY USGS DEM.
2. TOPOGRAPHICAL SURVEY AROUND PORTALS BY ENVIRONMENTAL RESEARCH, INC LINDEN, VIRGINIA. DATE OF PHOTOGRAPHY: 5-17-18.
3. TUNNEL SURVEY POINTS PROVIDED BY ITC RESOURCES, DATED 3-13-19.

ALTERNATIVE 3 PROPOSED PLAN

0 100' 200'
SCALE IN FEET

JOB NO. 0547.002.00

NELSON TUNNEL

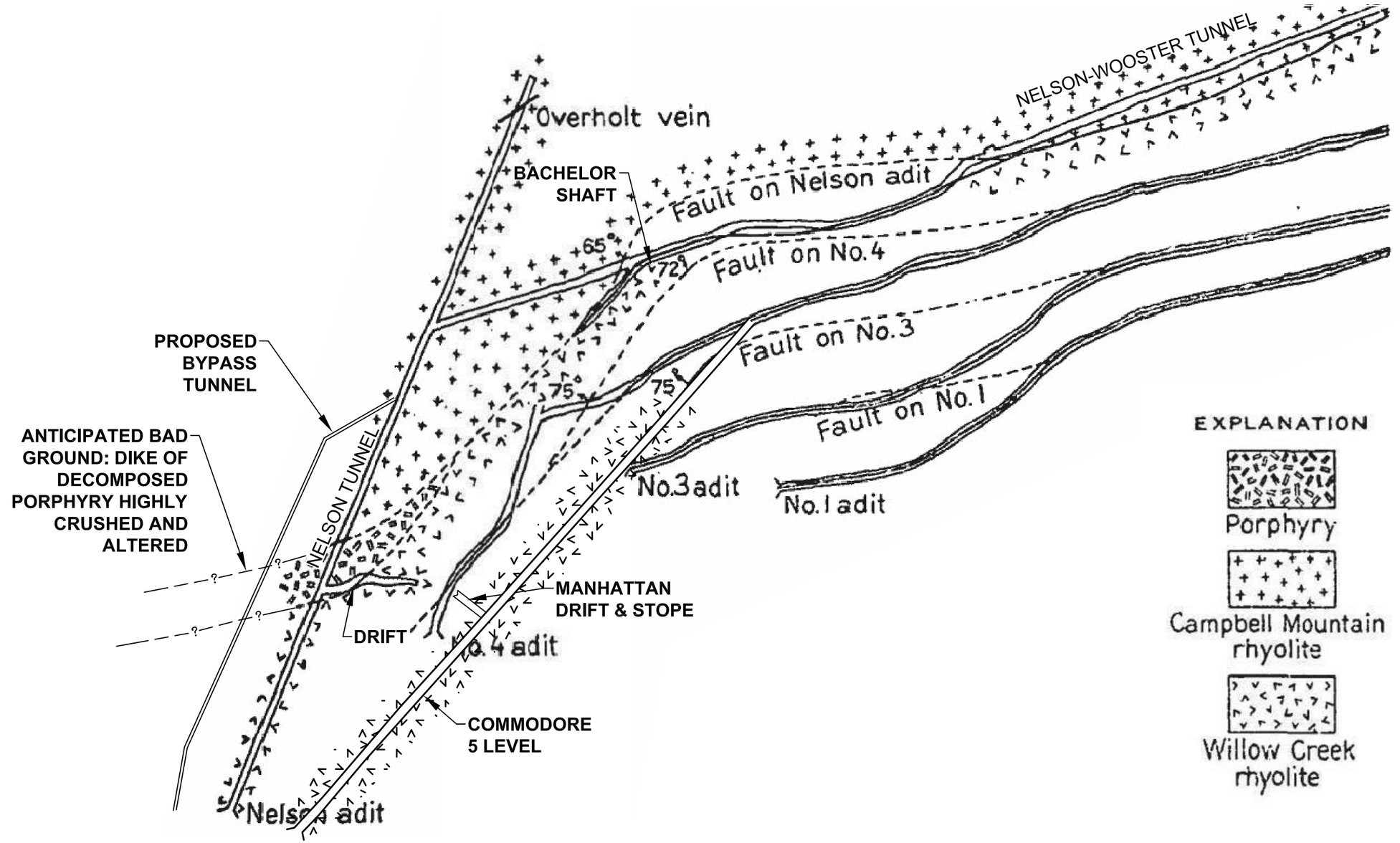
PROPOSED REMEDIAL PLAN - ALTERNATIVE 3

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. **5**

DATE: **MAY 2019**

SCALE: **AS NOTED**



NOTE:

MAP BASED ON:
EMMONS AND LARSEN, 1923, GEOLOGY AND ORE DEPOSITS OF THE CREEDE DISTRICT, COLORADO, USGS BULLETIN 718, FIGURE 18 AND PLATE XII

GEOLOGIC MAP

0 150 300
SCALE IN FEET

JOB NO. 0547.002.00

NELSON TUNNEL
GEOLOGIC MAP

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. **6**

DATE: **MAY 2019**

SCALE: **AS NOTED**

Friday, January 31, 2020 8:53:29 AM DRAWING: U:\0547 HDR\002 Nelson Tunnel\CAD\DAC Drawings\Nelson Geologic Map.DWG

JAVELIN SHAFT
LOWER POOL BLOCKAGE
BACHELOR SHAFT
PROPOSED STEEL GRIZZLY
CORKSCREW RAISE
COMMODORE 5 LEVEL
PROPOSED BULKHEAD (APPROX)
MANHATTAN DRIFT & STOPE
NELSON TUNNEL
FLOW CONTROL STRUCTURE (LOCATION TO BE DETERMINED)
13+31
PROPOSED DIVERSION DAMS
ZONE OF BAD GROUND
PROPOSED BYPASS ADIT
NELSON PORTAL BLOCKAGE TO REMAIN

24+00 23+00 22+00 21+00 20+00 19+00 18+00 17+00 16+00 15+00 14+00 13+00 13+00 11+00 10+00 9+00 8+00 7+00 6+00 5+00 4+00 3+00 2+00 1+00 0+00

10600 10500 10400 10300 10200 10100 10000 9900 9800 9700 9600 9500 9400 9300 9200 9100 9000 9600 9500 9400 10400 10300 10200 10100 10000 9900 9800 9700

NOTES:

1. SITE WIDE TOPOGRAPHY PROVIDED BY USGS DEM.
2. TOPOGRAPHICAL SURVEY AROUND PORTALS BY ENVIRONMENTAL RESEARCH, INC LINDEN, VIRGINIA. DATE OF PHOTOGRAPHY: 5-17-18.
3. TUNNEL SURVEY POINTS PROVIDED BY ITC RESOURCES, DATED 3-13-19.

ALTERNATIVE 4 PROPOSED PLAN

0 100' 200'
SCALE IN FEET

JOB NO. 0547.002.00

NELSON TUNNEL

PROPOSED REMEDIAL PLAN - ALTERNATIVE 4

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 7

DATE: MAY 2019

SCALE: AS NOTED

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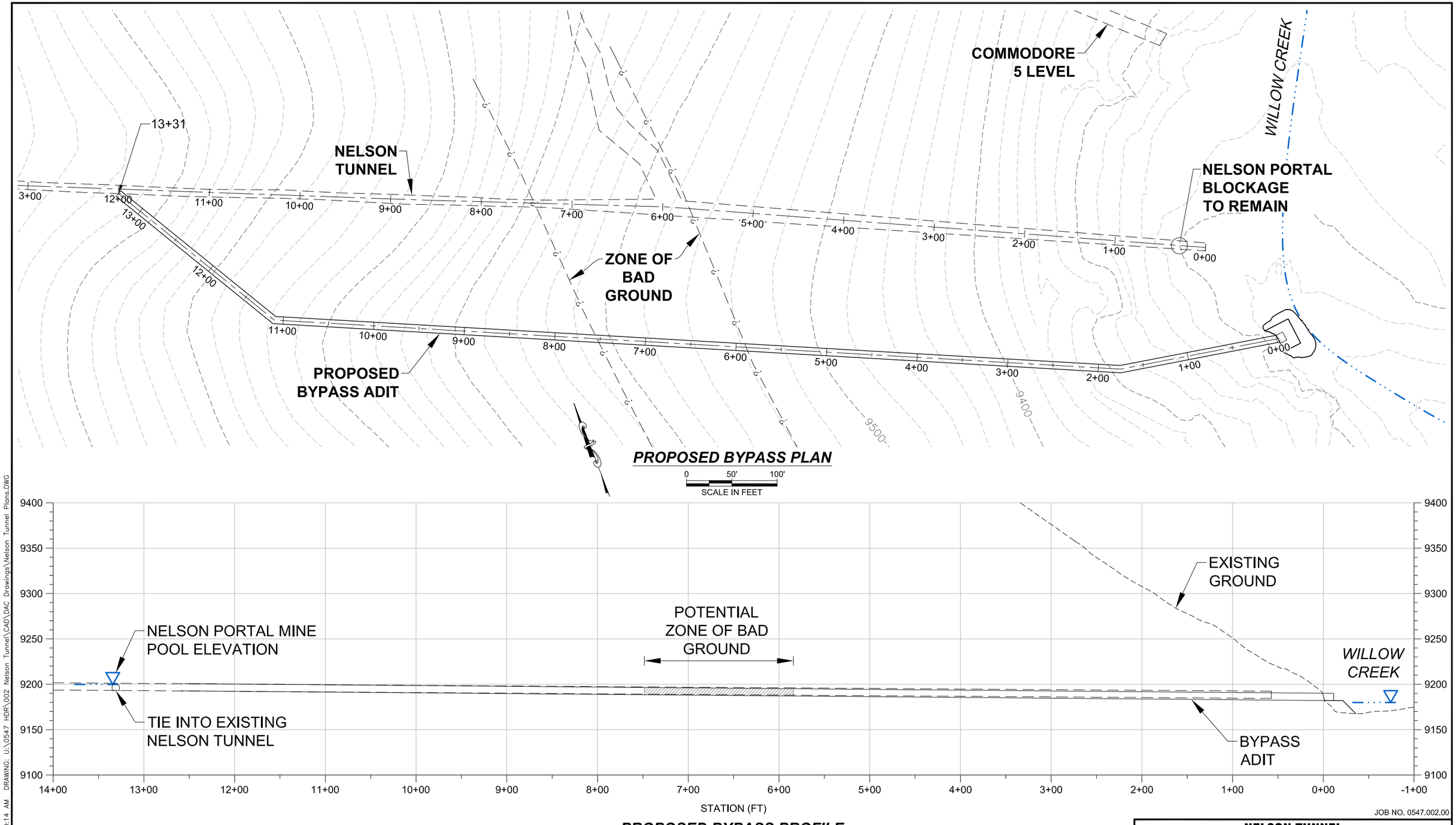

JOB NO. 0547.002.00

NELSON TUNNEL

ALTERNATIVE 4 - PROPOSED BYPASS ADIT PLAN & PROFILE

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. **8**

DATE: **MAY 2019**

SCALE: **AS NOTED**

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Friday, January 31, 2020 9:00:14 AM

NELSON TUNNEL PORTAL

WILLOW CREEK

NELSON FLOW

NELSON BYPASS CHANNEL

20' MINIMUM CHANNEL WIDTH

PROPOSED BYPASS ADIT

A
2

10'

30' WORK PLATFORM

20'

PORTAL CANOPY

PROPOSED BRIDGE

RIPRAP FACE

EXISTING ACCESS ROAD

9180 9175 9170 9165 9160

9275 9270 9265 9260 9255 9250 9245 9240 9235 9230 9225 9220 9215 9210 9205 9200 9195 9190 9185 9180

9250 9245 9240 9235 9230 9225 9220 9215 9210 9205 9200 9195 9190 9185 9180

JOB NO. 0547.002.00

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NELSON TUNNEL

ALTERNATIVE 4 - BYPASS ADIT GRADING PLAN

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 9

DATE: MAY 2019

SCALE: AS NOTED

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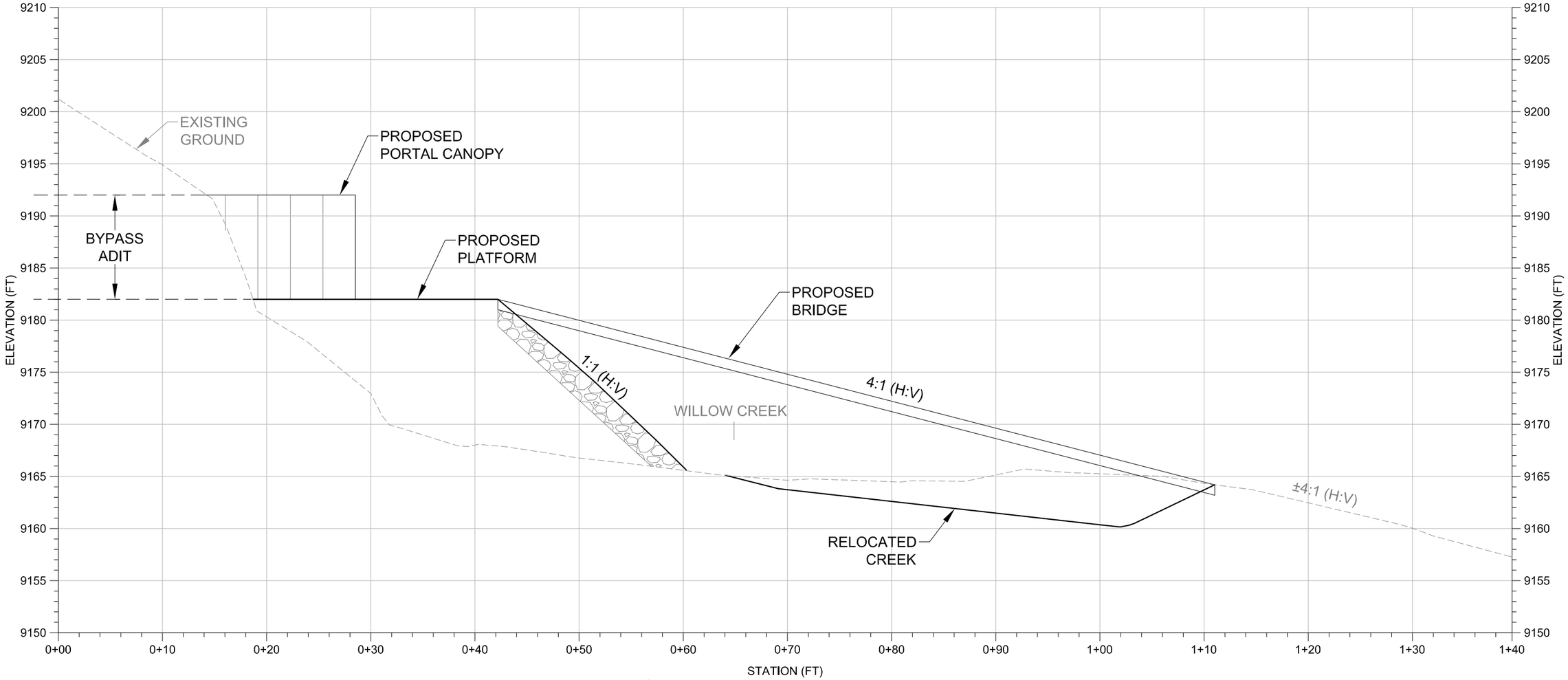


A/1 ***BRIDGE CROSS SECTION***

0 5 10
SCALE IN FEET

DRAFT

JOB NO. 0547.002.00

NELSON TUNNEL

ALTERNATIVE 4 - BRIDGE CROSS SECTION

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. **10**

DATE: **MAY 2019**

SCALE: **AS NOTED**

Friday, May 3, 2019 4:45:11 PM DRAWING: U:\0547 HDR\002 Nelson Tunnel\CAD\DAC Drawings\Nelson Bypass Tunnel.DWG

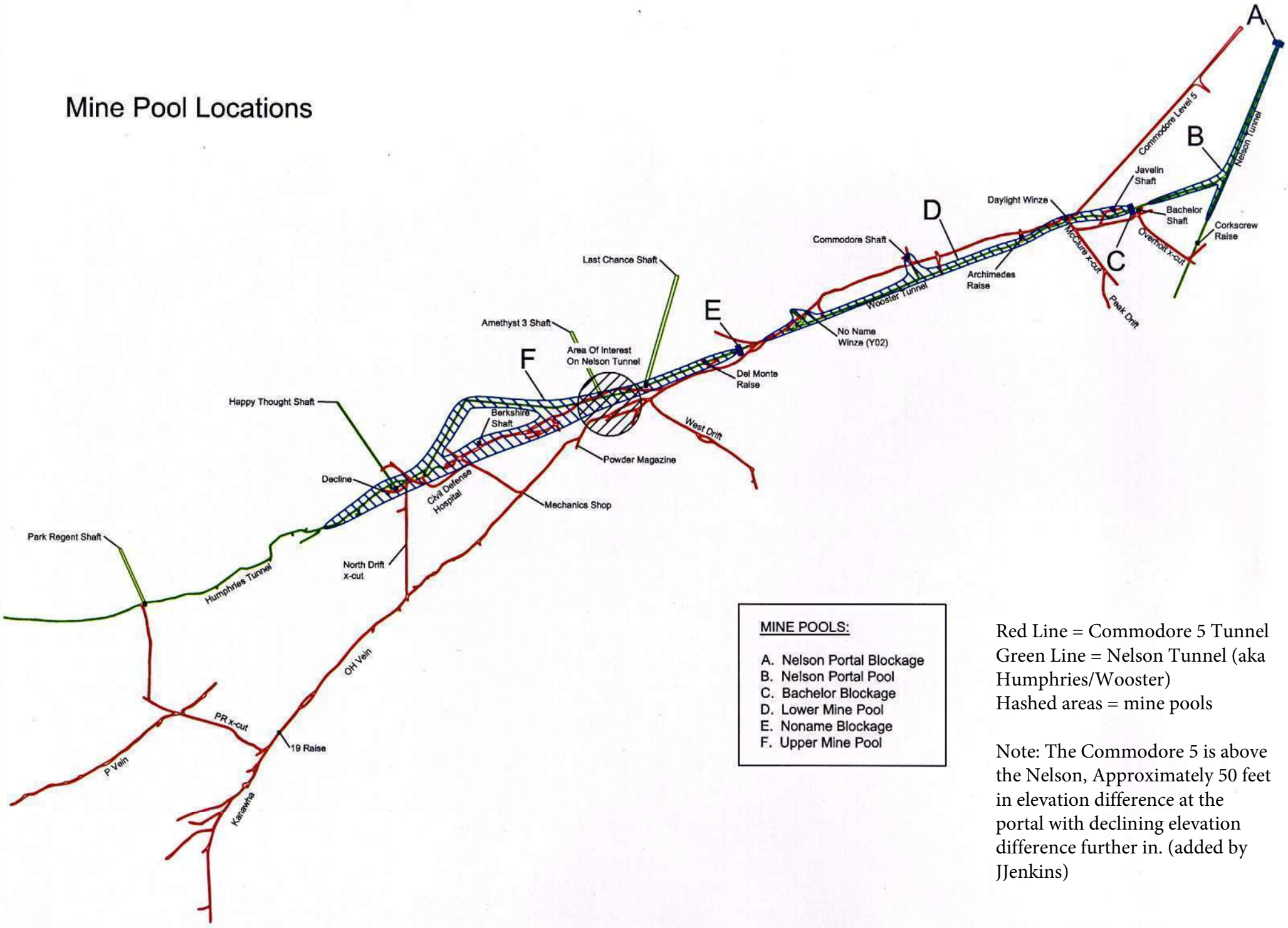
APPENDICES

APPENDIX A
TECHNICAL MEMORANDUM RE: COMMODORE-NELSON TUNNEL MINE POOL OBSERVATIONS, CDRMS NOVEMBER 6, 2015

pectfully Subm

ff G es

Mine Pool Locations



MINE POOLS:

A. Nelson Portal Blockage
B. Nelson Portal Pool
C. Bachelor Blockage
D. Lower Mine Pool
E. Noname Blockage
F. Upper Mine Pool

Red Line = Commodore 5 Tunnel
Green Line = Nelson Tunnel (aka Humphries/Wooster)
Hashed areas = mine pools

Note: The Commodore 5 is above the Nelson, Approximately 50 feet in elevation difference at the portal with declining elevation difference further in. (added by JJenkins)

APPENDIX B
SELECTED PHOTOGRAPHS FROM SITE VISIT
MAY 24, 2016

Photo 1: Commodore Levels 3, 4, and 5 with Willow Creek in Front

Photo 2: Willow Creek at portal looking upstream; Note bridge for access

Photo 3: Commodore Level 5 Tunnel near portal

Photo 4: Close up view of slabby rhyolitic tuff in Commodore Level 5 Tunnel

Photo 5: More massive welded rhyolitic tuff in Commodore Level 5 Tunnel

Photo 6: McClure cross cut in hanging wall

Photo 7: Typical ore pass

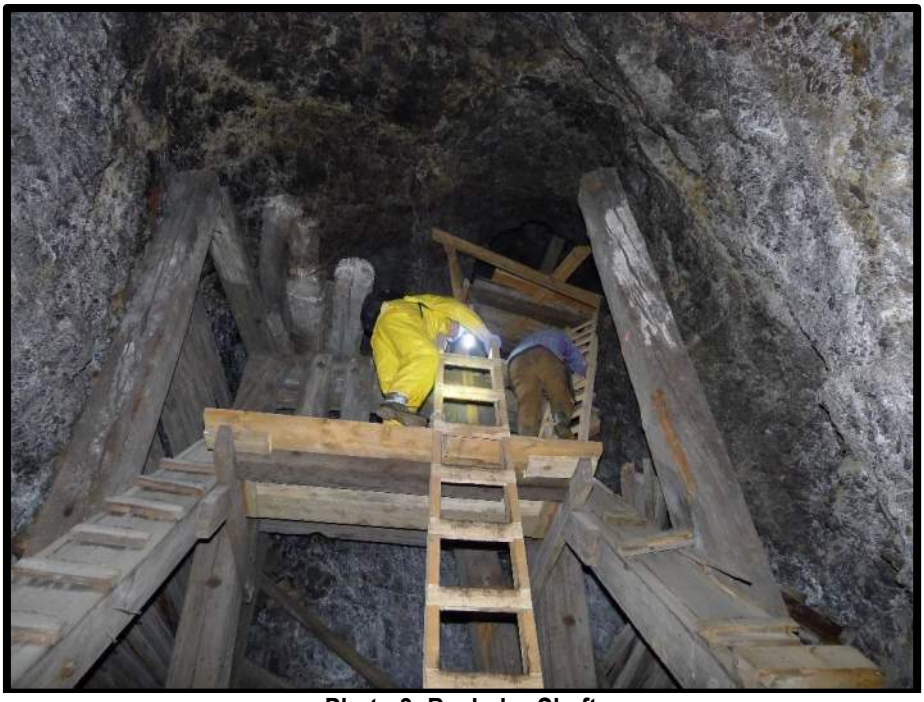


Photo 8: Bachelor Shaft

Photo 9: Bottom of Bachelor shaft looking into Nelson Tunnel

Photo 10: Looking downstream into Nelson Pool; Note stope on left

Photo 11: Nelson Tunnel looking upstream

Photo 12: Nelson Tunnel flume at bottom of Bachelor Shaft

Photo 13: Collapse in Nelson Tunnel holding back Lower Mine Pool

Photo 14: Old stope above Nelson Tunnel at Bachelor Shaft

Photo 15: Overholt Cross Cut with rail removed

Photo 16: Corkscrew Raise down to Nelson Tunnel; Note water

Photo 17: Daylight Winze

Photo 18: Typical view of Amethyst Vein; Note clayey gouge at contact with foot wall

Photo 19: Commodore Level 5 main haulage tunnel looking north; Note Amethyst Vein between hanging wall at left and foot wall at right

Photo 20: Amethyst Vein with wood stulls

Photo 21: Looking up stope

Photo 22: Roof fall between Archimedes Raise and Commodore Shaft; Note minor water pool

Photo 23: Blocky Amethyst Vein that will require scaling and new support

Photo 24: Blacksmith shop south of Commodore Shaft

Photo 25: Hoist room for Commodore Shaft

Photo 26: Commodore Shaft with rails for hoisting cage; Note ladder down to Nelson Tunnel

Photo 27: Looking up hoist rails for Commodore Shaft

Photo 28: :Looking down Commodore Shaft into stub drift to Nelson Tunnel

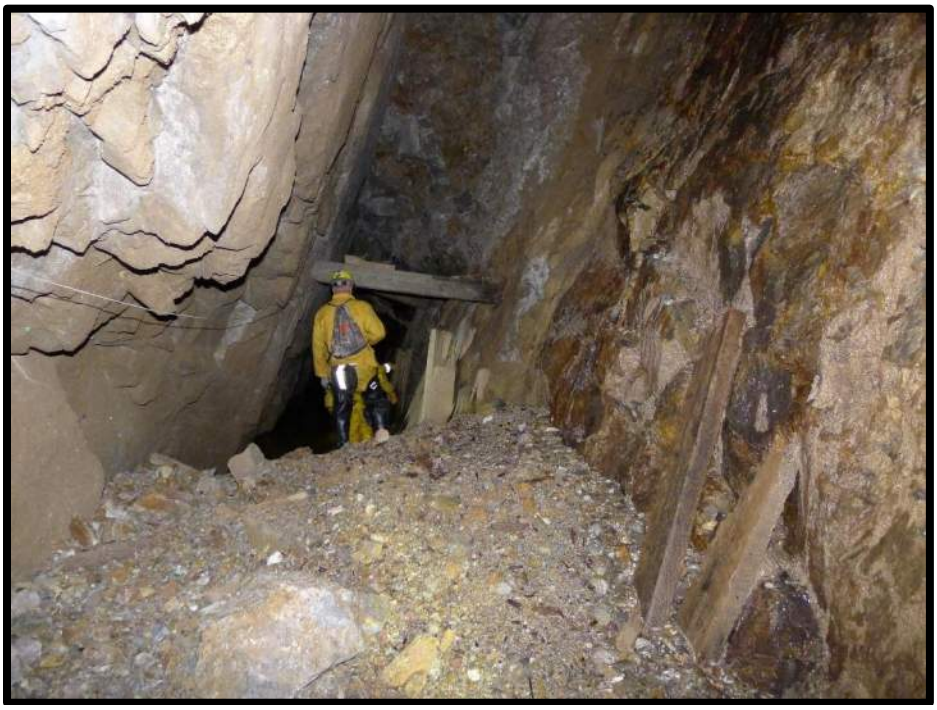


Photo 29: Large roof fall north of Commodore Shaft

Photo 30: Pool behind roof fall

Photo 31: Tunnel driven around area of bad ground on the left

Photo 32: Looking down No Name (Y02) Winze into Nelson Tunnel

Photo 33: Iron staining visible from flow between Del Monte Raise and No Name Winze

Photo 34: Standing from Upper Mine Pool near Del Monte Raise

Photo 35: Reading pressure transducer in Del Monte Raise

Photo 36: West Drift bulkhead from pump test

Photo 37: OH Vein south of Mechanic's Shop

Photo 38: Mechanic's Shop; Note bolts and mesh

Photo 39: Drift from Mechanic's shop to Amethyst Vein

Photo 40: Wood planks above Upper Mine Pool near Berkshire Shaft

Photo 41: Goslarite south of Berkshire Shaft

Photo 42: View into Nelson Tunnel Upper Mine Pool near Berkshire Shaft

Photo 43: Nelson Tunnel discharge into Willow Creek; Note flume and algae

Photo 44: Nelson Tunnel collapsed portal

Photo 45: Amethyst Number 5 Portal

Photo 46: Park Regent Shaft at surface

APPENDIX C
WATER TREATMENT OPERATIONS TO PREVENT EXACERBATING WATER QUALITY IN WEST WILLOW CREEK

Water Treatment Operations to Prevent Exacerbating Water Quality in West Willow Creek

To avoid exacerbating water quality in West Willow Creek during construction of flow control structures, treatment of a portion of the flow exiting Nelson Tunnel will be required. Based on observations and measurements of flow from the mine workings, it is believed that the origin of 90%+ of the flow from Nelson Tunnel is inby of the Lower Mine Pool. Water from below the Lower Mine Pool blockage will be captured in a cofferdam and pumped to the surface, where all or a portion of the flow can be treated. The best location to accomplish this is from the Bachelor Shaft, piping the water through Commodore 5 Level.

To demonstrate that water quality will not be exacerbated; mass balance calculations comparing the existing conditions in West Willow Creek to the conditions during construction are presented for zinc, assuming a conservative treatment removal efficiency of 50%. During the Remedial Design, each of metals that consistently exceed Colorado Water Quality Standards in West Willow Creek will be evaluated for treatment.

To simplify the conceptual model for the calculations, it is assumed that the pumping rate will be equal to the decrease in flow from Nelson Tunnel. However, because of the collapse zone inby of the Nelson Tunnel Portal, the decrease will not occur instantaneously. It will take time for the flow from Nelson Tunnel to equilibrate to the reduced inflow. To account for this, initially, water pumped will need to be stored. Once equilibrium is reached, (i.e. the flow pumped equals the reduction in flow from Nelson Tunnel) treatment and discharge to West Willow Creek will begin. Flow rates will be increased incrementally, allowing the flow from Nelson Tunnel to stabilize after increasing the pumping rate.

The attached figures present an example of the sequence of pumping and water treatment that can be used to avoid exacerbating water quality in West Willow Creek during construction. Figures include tables with mass balance calculations and a schematic of inflows into West Willow Creek. Mass balance calculations are for zinc during low flow conditions. Concentrations and flow rates are averages of low flow monitoring results from 2012 through 2016. Figure 1 shows the baseline conditions. Since water quality standards and toxicity are based on concentration, the zinc concentration of the combined flow in West Willow Creek is the baseline.

Figure 2 shows the condition at the start of pumping at 20 gallons per minute (gpm). Initially, if the pumped water is treated and discharged, the flow into West Willow Creek would be theoretically increased by 20 gpm and the baseline concentration would be exceeded. To prevent this, the flow will need to be stored until flow from Nelson Tunnel equilibrates (at 20 gpm, the quantity of one day of flow is 28,800 gallons) as is shown on Figure 3. As can be seen in Figure 3, once flow from Nelson Tunnel equilibrates, presumably at a rate 20 gpm lower, treatment begins and the concentration of the combined flow is below the baseline. In this example, the treatment flow rate 10 gpm of stored water as well as 20 gpm pumped from the cofferdam. Eventually, the need for storing water would be eliminated.

The process of incrementally increasing the pumping rate would continue until all of the flow captured by the cofferdam is pumped through the Commodore 5 Level and the Nelson Portal Pool is drained. A portion of the pumped water would be treated and the remainder would be discharged directly to West Willow Creek. The desired flow rate to be treated during construction would need to account for removal efficiencies, construction activities causing degradation of the water quality, seepage into the Bypass Adit, seepage into Nelson Tunnel downstream of the Lower Mine Pool, and other uncertainties. Treatment of 10% of the flow entering the Nelson Portal Pool may be adequate to avoid exacerbating water quality in West Willow Creek, depending on these variables. Figure 4 provides a schematic depicting operating conditions when 100% of the flow is pumped through Commodore 5 Level. Mass balance calculations assuming treatment of 10% of the flow are summarized on the table in the left hand corner.

In this example, Alternative 4, which involves driving a new adit to intersect Nelson Tunnel inby of the Nelson Tunnel Portal blockage, is contemplated. Figure 4 depicts the “bypass adit” under construction. Following completion of the bypass adit, the water pumped through the Bachelor Shaft and Commodore 5 Level can be discharged via gravity through the new adit. A portion of the flow, in this example 10%, can be pumped to the treatment plant. Figure 5 displays a schematic of these operating conditions.

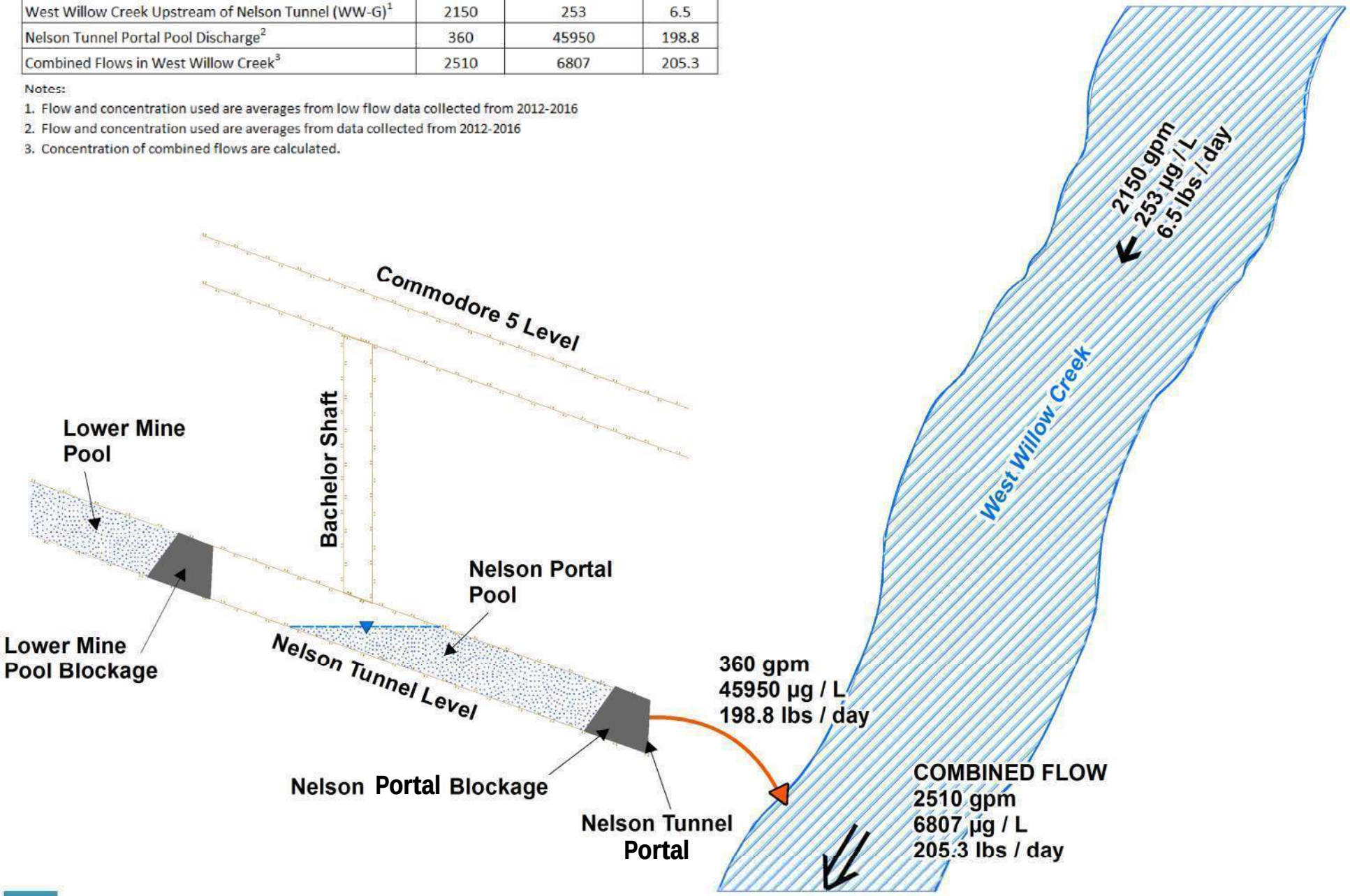
There are a number of assumptions and several uncertainties with the analysis presented. During the Remedial Design, a thorough review of treatment technologies, removal efficiencies, and temporary storage requirements will be completed. Uncertainties regarding the flow rate from Nelson Tunnel and the Lower Mine Pool can be evaluated by a pump test conducted during Remedial Design.

During construction, actual flows and concentrations, to the extent practical, will be used to verify water quality in West Willow Creek is not exacerbated. Construction plans will need to be flexible to accommodate the inherent variability and uncertainties associated with pumping fluids impounded by underground collapses.

Table 1: Existing Conditions (Zinc)			
Source	Flow (gpm)	Zinc Concentration (ug/L)	Zinc Load (lbs/day)
West Willow Creek Upstream of Nelson Tunnel (WW-G)[1]	2150	253	6.5
Nelson Tunnel Portal Pool Discharge[2]	360	45950	198.8
Combined Flows in West Willow Creek[3]	2510	6807	205.3

Notes:

1. Flow and concentration used are averages from low flow data collected from 2012-2016
2. Flow and concentration used are averages from data collected from 2012-2016
3. Concentration of combined flows are calculated.



EXISTING CONDITIONS

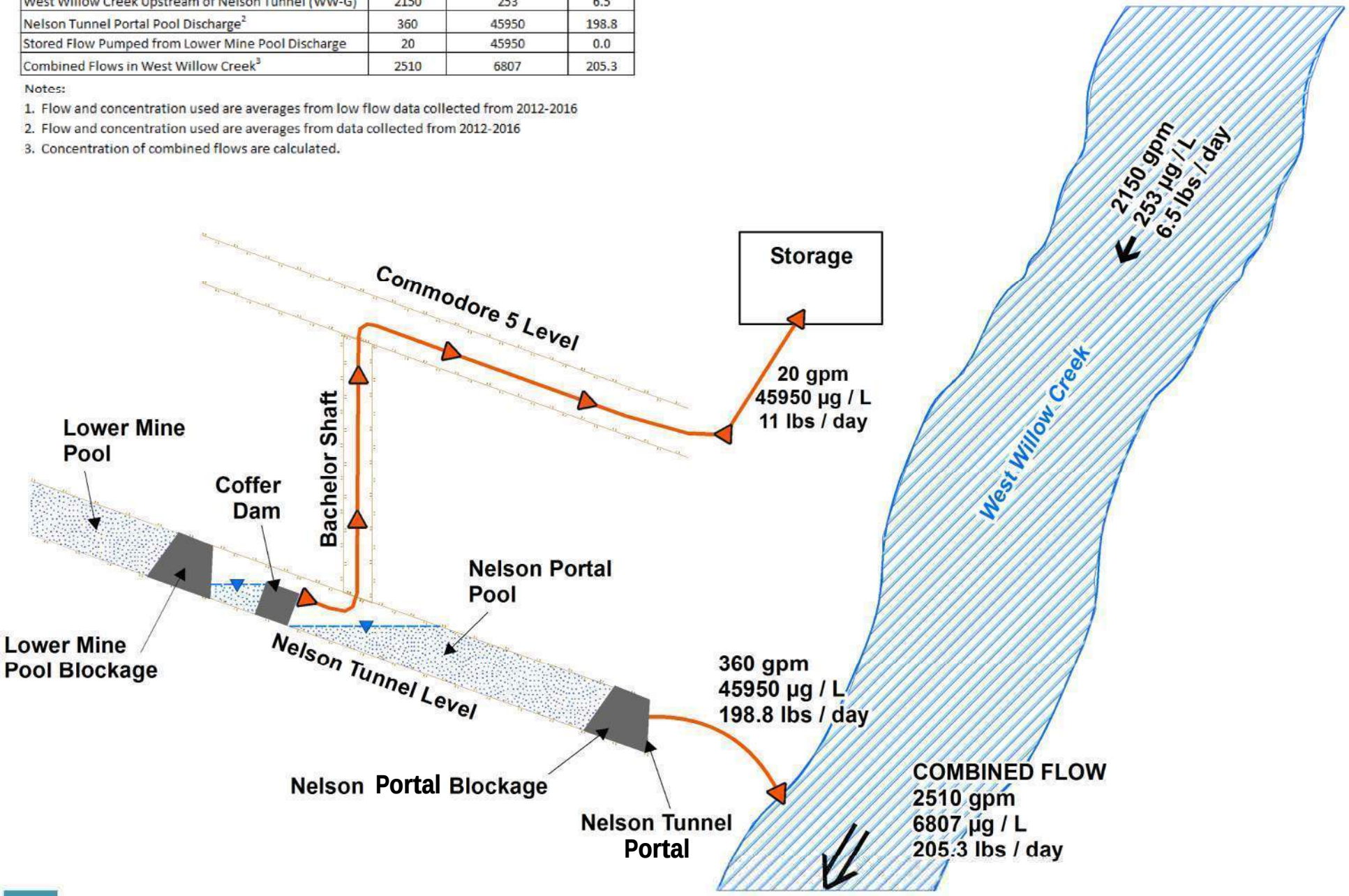
NELSON TUNNEL: WATER TREATMENT DURING CONSTRUCTION

FIGURE 1

Table 2: Pumping 20 gpm Prior to Equilibration			
Source	Flow (gpm)	Zinc Concentration (ug/L)	Zinc Load (lbs/day)
West Willow Creek Upstream of Nelson Tunnel (WW-G)[1]	2150	253	6.5
Nelson Tunnel Portal Pool Discharge[2]	360	45950	198.8
Stored Flow Pumped from Lower Mine Pool Discharge	20	45950	0.0
Combined Flows in West Willow Creek[3]	2510	6807	205.3

Notes:

1. Flow and concentration used are averages from low flow data collected from 2012-2016
2. Flow and concentration used are averages from data collected from 2012-2016
3. Concentration of combined flows are calculated.



PUMPING 20 GPM PRIOR TO EQUILIBRATION

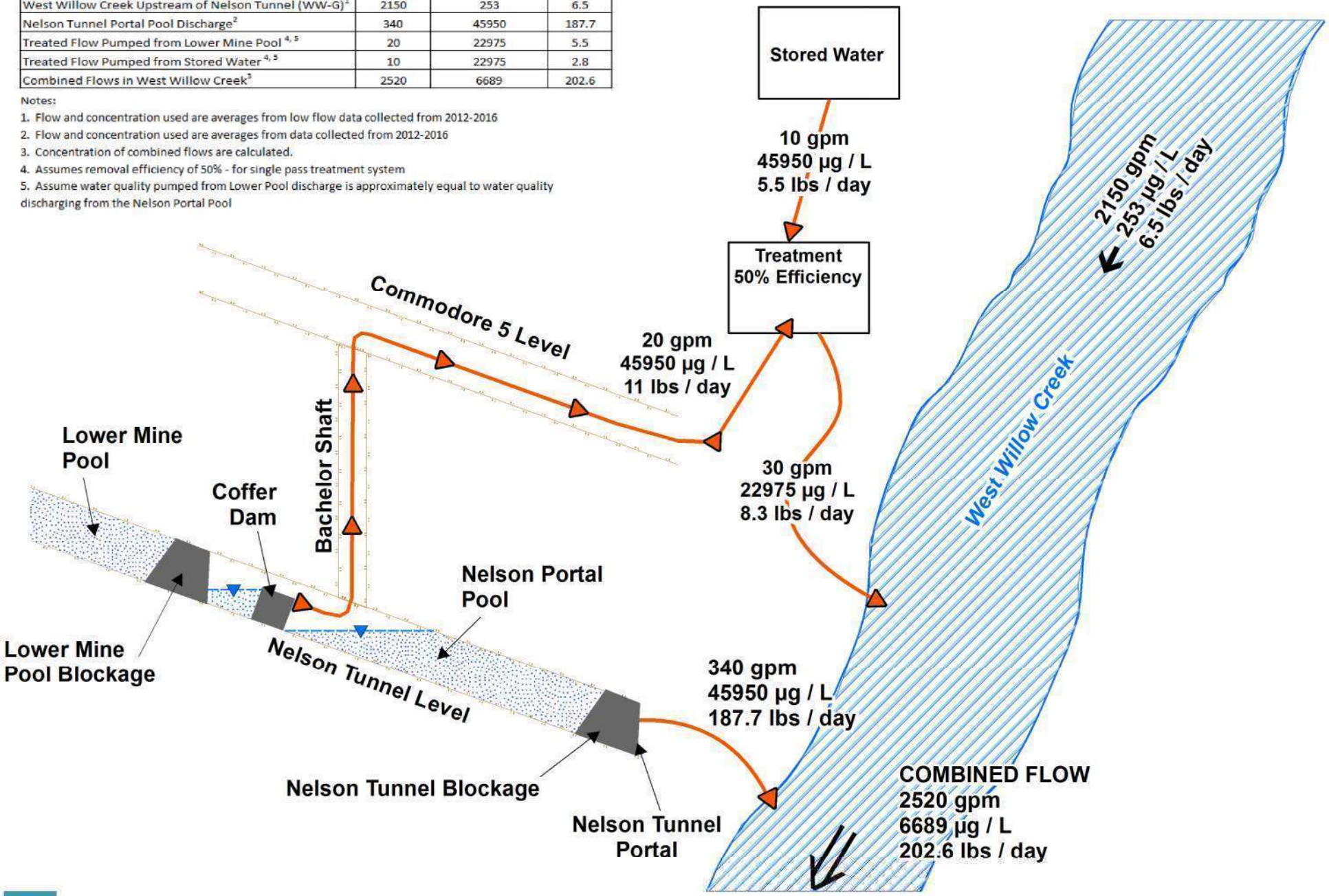
NELSON TUNNEL: WATER TREATMENT DURING CONSTRUCTION

FIGURE 2

Table3: Pumping 20 gpm and Treating 30 gpm After Equilibration			
Source	Flow (gpm)	Zinc Concentration (ug/L)	Zinc Load (lbs/day)
West Willow Creek Upstream of Nelson Tunnel (WW-G)[1]	2150	253	6.5
Nelson Tunnel Portal Pool Discharge[2]	340	45950	187.7
Treated Flow Pumped from Lower Mine Pool [4, 5]	20	22975	5.5
Treated Flow Pumped from Stored Water [4, 5]	10	22975	2.8
Combined Flows in West Willow Creek[3]	2520	6689	202.6

Notes:

1. Flow and concentration used are averages from low flow data collected from 2012-2016
2. Flow and concentration used are averages from data collected from 2012-2016
3. Concentration of combined flows are calculated.
4. Assumes removal efficiency of 50% - for single pass treatment system
5. Assume water quality pumped from Lower Pool discharge is approximately equal to water quality discharging from the Nelson Portal Pool



PUMPING AND TREATING AT 20 GPM AFTER EQUILIBRATION

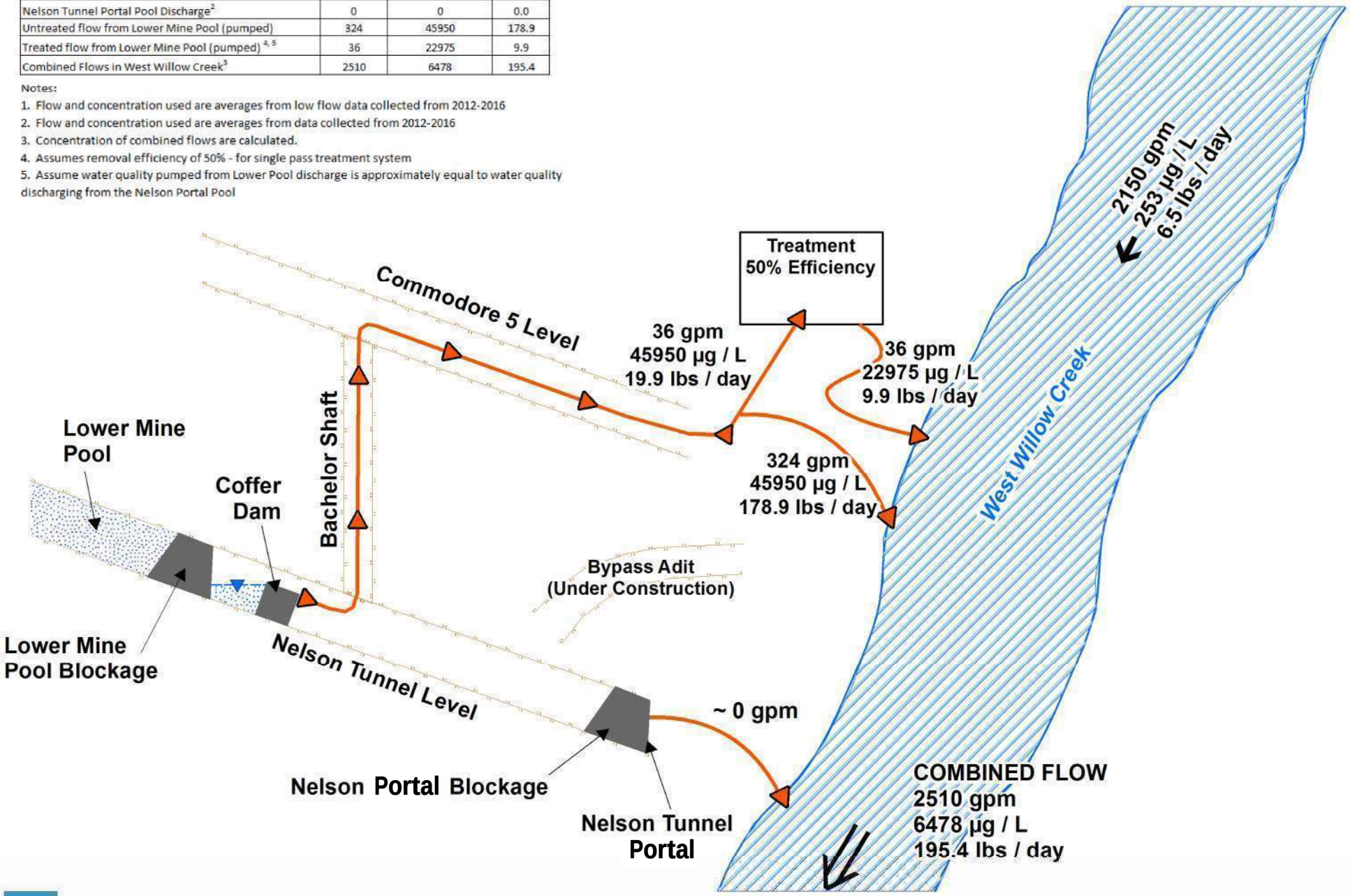
NELSON TUNNEL: WATER TREATMENT DURING CONSTRUCTION

FIGURE 3

Table 4: Conditions Prior to Bypass Adit Construction Completion			
Source	Flow (gpm)	Zinc Concentration (ug/L)	Zinc Load (lbs/day)
West Willow Creek Upstream of Nelson Tunnel (WWG)[1]	2150	253	6.5
Nelson Tunnel Portal Pool Discharge[2]	0	0	0.0
Untreated flow from Lower Mine Pool (pumped)	324	45950	178.9
Treated flow from Lower Mine Pool (pumped)[4, 5]	36	22975	9.9
Combined Flows in West Willow Creek[3]	2510	6478	195.4

Notes:

1. Flow and concentration used are averages from low flow data collected from 2012-2016
2. Flow and concentration used are averages from data collected from 2012-2016
3. Concentration of combined flows are calculated.
4. Assumes removal efficiency of 50% - for single pass treatment system
5. Assume water quality pumped from Lower Pool discharge is approximately equal to water quality discharging from the Nelson Portal Pool



CONDITIONS PRIOR TO BYPASS ADIT CONSTRUCTION COMPLETION

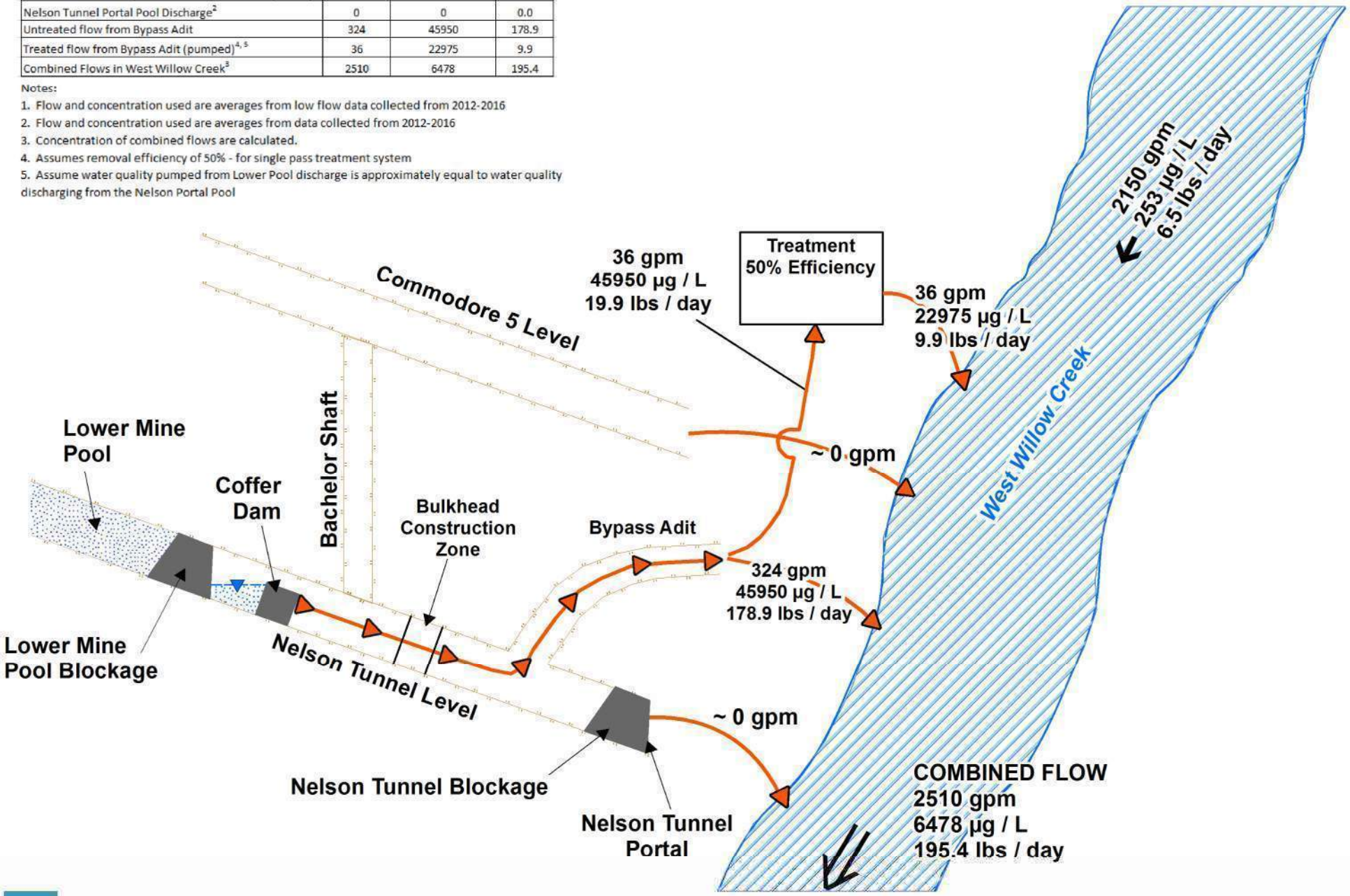
NELSON TUNNEL: WATER TREATMENT DURING CONSTRUCTION

FIGURE 4

Table 5: Conditions After Bypass Adit Construction Completion			
Source	Flow (gpm)	Zinc Concentration (ug/L)	Zinc Load (lbs/day)
West Willow Creek Upstream of Nelson Tunnel (WW-G)[1]	2150	253	6.5
Nelson Tunnel Portal Pool Discharge[2]	0	0	0.0
Untreated flow from Bypass Adit	324	45950	178.9
Treated flow from Bypass Adit (pumped)[4, 5]	36	22975	9.9
Combined Flows in West Willow Creek[3]	2510	6478	195.4

Notes:

1. Flow and concentration used are averages from low flow data collected from 2012-2016
2. Flow and concentration used are averages from data collected from 2012-2016
3. Concentration of combined flows are calculated.
4. Assumes removal efficiency of 50% - for single pass treatment system
5. Assume water quality pumped from Lower Pool discharge is approximately equal to water quality discharging from the Nelson Portal Pool



CONDITIONS AFTER BYPASS ADIT CONSTRUCTION COMPLETION

NELSON TUNNEL: WATER TREATMENT DURING CONSTRUCTION

FIGURE 5

APPENDIX D
ALTERNATIVES COST ESTIMATES

TABLE D-1
Nelson Tunnel Alternatives Analysis
Construction Cost Estimate
Alternative 2: Maintain Rehabilitation of Mine Workings and Routine Inspections/Monitoring

Item No.	Description	Estimated Quantity	Unit	Unit Price	Item Cost	Notes
1	Mobilization/Demobilization	1	Lump Sum	$ 15,000	$ 15,000	Preliminary estimate/judgment
2	Setup (C5/NT)	1	Lump Sum	$ 5,000	$ 5,000	Preliminary estimate/judgment
3	Re-establish temporary equipment access across West Willow Creek (C5)	1	Lump Sum	$ 2,000	$ 2,000	Preliminary estimate/judgment
4	Check ventilation and inspect/touch-up prior rehabilitation (C5)	6500	LF	$ 10	$ 65,000	Preliminary estimate/judgment (extent of rehab supports additional studies on Nelson source water)
5	Shore/enhance ladders at access points to Nelson Tunnel (C5/NT)	1	Lump Sum	$ 20,000	$ 20,000	Preliminary estimate/judgment

Construction Subtotal		$	107,000	
Contractor Overhead (10% Field + 5% Home Office)	15%	$	16,050	% based on EPA FS costing guidance and professional judgment
Contractor Profit (10%)	10%	$	10,700	% based on EPA FS costing guidance and professional judgment
Construction Subtotal		**$**	**133,750**	
Contingency (15% Scope + 10% Bid)	25%	$	33,438	% based on EPA FS costing guidance and professional judgment
Subtotal w/ Contingency		**$**	**167,188**	
Project Management	6%	$	10,031	% based on EPA FS costing guidance and professional judgment
Remedial Design	12%	$	20,063	% based on EPA FS costing guidance and professional judgment
Construction Management	8%	$	13,375	% based on EPA FS costing guidance and professional judgment
Health & Safety and Mine Rescue	5%	$	8,359	% based on professional judgment
Adjustment for Inflation on Prior Cost Estimating	12.0%	$	20,063	Based on RS Means (2017 - 2020)
Total Estimated Alternative Cost		**$**	**239,078**	

TABLE D-2
Nelson Tunnel Alternatives Analysis
Construction Cost Estimate
Alternative 2: Maintain Rehabilitation of Mine Workings and Routine Inspections/Monitoring

PRESENT DAY COSTS (2019 Dollars)	
Total Project Costs	$239,078
Annual O&M Cost	$10,000
Annual Labor Cost	$40,000
Future Capital Costs	
None anticipated	

Discount Rate	0.40%

Year	Capital Cost	O&M COSTS		Subtotal	Present Value
		O&M	Labor		
0	$239,078	--	--	$239,078	$239,078
1		$10,000	$40,000	$50,000	$49,801
2		$10,000	$40,000	$50,000	$49,602
3		$10,000	$40,000	$50,000	$49,405
4		$10,000	$40,000	$50,000	$49,208
5		$10,000	$40,000	$50,000	$49,012
6		$10,000	$40,000	$50,000	$48,817
7		$10,000	$40,000	$50,000	$48,622
8		$10,000	$40,000	$50,000	$48,428
9		$10,000	$40,000	$50,000	$48,235
10		$10,000	$40,000	$50,000	$48,043
11		$10,000	$40,000	$50,000	$47,852
12		$10,000	$40,000	$50,000	$47,661
13		$10,000	$40,000	$50,000	$47,471
14		$10,000	$40,000	$50,000	$47,282
15		$10,000	$40,000	$50,000	$47,094
16		$10,000	$40,000	$50,000	$46,906
17		$10,000	$40,000	$50,000	$46,719
18		$10,000	$40,000	$50,000	$46,533
19		$10,000	$40,000	$50,000	$46,348
20		$10,000	$40,000	$50,000	$46,163
21		$10,000	$40,000	$50,000	$45,979
22		$10,000	$40,000	$50,000	$45,796
23		$10,000	$40,000	$50,000	$45,614
24		$10,000	$40,000	$50,000	$45,432
25		$10,000	$40,000	$50,000	$45,251
26		$10,000	$40,000	$50,000	$45,071
27		$10,000	$40,000	$50,000	$44,891
28		$10,000	$40,000	$50,000	$44,712
29		$10,000	$40,000	$50,000	$44,534
30		$10,000	$40,000	$50,000	$44,357

TOTAL*= $1,649,919

*Note: Total is in 2020 dollars.

TABLE D-3
Nelson Tunnel Alternatives Analysis
Construction Cost Estimate
Alternative 3: Clear Nelson Portal Pool, Tunnel Rehabilitation, Install Bulkhead and Flow Control Structure

Item No.	Description	Estimated Quantity	Unit	Unit Price	Item Cost	Notes
1	Mobilization/Demobilization	1	Lump Sum	$ 200,000	$ 200,000	Contractor preliminary estimate
2	Setup (C5/NT)	1	Lump Sum	$ 100,000	$ 100,000	Contractor preliminary estimate/judgment
3	Regrade/compact waste rock and re-route West Willow Creek for access to Nelson Tunnel	600	CY	$ 100	$ 60,000	Preliminary grading plan/estimate
4	Establish equipment access across West Willow Creek (C5/NT)	1	Lump Sum	$ 160,000	$ 160,000	Contractor preliminary estimate (4 days plus $120K for bridge/abutment)
5	Establish rockfall protection above current portal location (NT)	1	Lump Sum	$ 30,000	$ 30,000	Preliminary estimate/judgment
6	Check ventilation and inspect/touch-up prior rehabilitation (C5)	6500	LF	$ 10	$ 65,000	Preliminary estimate/judgment
7	Shore/enhance ladders at access points to Nelson Tunnel (C5/NT)	1	Lump Sum	$ 20,000	$ 20,000	Preliminary estimate/judgment
8	Purchase and install Nelson Pool dewatering system	1	Lump Sum	$ 180,000	$ 180,000	Contractor preliminary estimate/judgment
9	Operate Nelson Pool dewatering system	5	Months	$ 90,000	$ 450,000	Contractor preliminary estimate/judgment
10	Remove collapse at Nelson Portal and four more assumed locations	5	Lump Sum	$ 50,000	$ 250,000	Contractor preliminary estimate/judgment
11	Capture, handling and stabilization of iron hydroxides behind collapses	2000	CY	$ 200	$ 400,000	Preliminary estimate/budget allocation
12	Remove portal structure and construct new stabile portal structure	1	Lump Sum	$ 250,000	$ 250,000	Contractor preliminary estimate/judgment
13	Rehab Nelson Tunnel and select bulkhead location	1300	LF	$ 1,000	$ 1,300,000	Contractor preliminary estimate/judgment
14	Scale and prepare tunnel surface for new bulkhead structure	20	Hours	$ 1,000	$ 20,000	Contractor preliminary estimate/judgment
15	Perform radial grouting at new bulkhead section	400	LF	$ 250	$ 100,000	Contractor preliminary estimate/judgment
16	Place steel grizzly, diversion dam and bulkhead drain pipe	1	Lump Sum	$ 50,000	$ 50,000	Contractor preliminary estimate/judgment (4 days + mat'l)
17	Install 2 rings of 6 ft rock bolts around new bulkhead section	180	LF	$ 30	$ 5,400	Contractor preliminary estimate/judgment
18	Construct new 20' concrete bulkhead in Nelson Tunnel	1	Lump Sum	$ 300,000	$ 300,000	Contractor preliminary estimate/judgment (75 cy @ $4000/cy)
19	Perform contact grouting around newly completed bulkhead structure	1	Lump Sum	$ 40,000	$ 40,000	Contractor preliminary estimate/judgment
20	Perform radial grouting near face of bulkhead	300	LF	$ 250	$ 75,000	Contractor preliminary estimate/judgment
21	Install and grout 8-inch-diameter drain pipe	40	LF	$ 400	$ 16,000	Contractor preliminary estimate/judgment
22	Install flow and pressure control systems at drain outlet	1	Lump Sum	$ 20,000	$ 20,000	Contractor preliminary estimate/judgment
23	Extend pipe to portal	1300	LF	$ 25	$ 32,500	Contractor preliminary estimate/judgment
24	Insulate exposed outlet works	1	Lump Sum	$ 15,000	$ 15,000	Contractor preliminary estimate/judgment
25	Complete drainage outlet structure protection shed	1	Lump Sum	$ 5,000	$ 5,000	Contractor preliminary estimate/judgment
26	Install pressure transducer and cable to measure head behind plug	1	Lump Sum	$ 10,000	$ 10,000	Contractor preliminary estimate/judgment
27	Install Nelson Tunnel closure gate with cutoff and drainpipe	1	Lump Sum	$ 15,000	$ 15,000	Contractor preliminary estimate/judgment
28	Install removable flow control structure in Commodore 5 with access door	1	Lump Sum	$ 150,000	$ 150,000	Contractor preliminary estimate/judgment
29	Treatment plant at C5 WRP (lease)	12	Months	$ 15,000	$ 180,000	Contractor preliminary estimate/judgment
30	Treatment operation during construction	12	Months	$ 90,000	$ 1,080,000	Contractor preliminary estimate/judgment
31	Waste (mine muck) disposal	1	Lump Sum	$ 150,000	$ 150,000	Allowance/professional judgment

Construction/Treatment Subtotal				$ 5,728,900	
Contractor Overhead (10% Field + 5% Home Office)	15%			$ 859,335	% based on EPA FS costing guidance and professional judgment
Contractor Profit (10%)	10%			$ 572,890	% based on EPA FS costing guidance and professional judgment
Construction/Treatment Subtotal				**$ 7,161,125**	
Contingency (20% Scope + 10% Bid)	30%			$ 2,148,338	% based on EPA FS costing guidance and professional judgment
Subtotal w/ Contingency				**$ 9,309,463**	
Project Management	6%			$ 558,568	% based on EPA FS costing guidance and professional judgment
Remedial Design	12%			$ 1,117,136	% based on EPA FS costing guidance and professional judgment
Construction Management	8%			$ 744,757	% based on EPA FS costing guidance and professional judgment
Health & Safety and Mine Rescue	5%			$ 465,473	% based on professional judgment
Adjustment for Inflation on Prior Cost Estimating	12.0%			$ 1,117,136	Based on RS Means (2017 - 2019)
Total Estimated Alternative Cost				**$ 13,312,531**	

TABLE D-4
Nelson Tunnel Alternatives Analysis
Construction Cost Estimate
Alternative 3: Clear Nelson Portal Pool, Tunnel Rehabilitation, Install Bulkhead and Flow Control Structure

PRESENT DAY COSTS (2019 Dollars)	
Total Project Costs	$13,312,531
Annual O&M Cost	$15,000
Annual Labor Cost	$50,000
Future Capital Costs	
	None anticipated

Discount Rate	0.40%

Year	Capital Cost	O&M COSTS		Subtotal	Present Value Cost
		O&M	Labor		
0	$13,312,531	--	--	$13,312,531	$13,312,531
1		$15,000	$50,000	$65,000	$64,741
2		$15,000	$50,000	$65,000	$64,483
3		$15,000	$50,000	$65,000	$64,226
4		$15,000	$50,000	$65,000	$63,970
5		$15,000	$50,000	$65,000	$63,715
6		$15,000	$50,000	$65,000	$63,462
7		$15,000	$50,000	$65,000	$63,209
8		$15,000	$50,000	$65,000	$62,957
9		$15,000	$50,000	$65,000	$62,706
10		$15,000	$50,000	$65,000	$62,456
11		$15,000	$50,000	$65,000	$62,207
12		$15,000	$50,000	$65,000	$61,960
13		$15,000	$50,000	$65,000	$61,713
14		$15,000	$50,000	$65,000	$61,467
15		$15,000	$50,000	$65,000	$61,222
16		$15,000	$50,000	$65,000	$60,978
17		$15,000	$50,000	$65,000	$60,735
18		$15,000	$50,000	$65,000	$60,493
19		$15,000	$50,000	$65,000	$60,252
20		$15,000	$50,000	$65,000	$60,012
21		$15,000	$50,000	$65,000	$59,773
22		$15,000	$50,000	$65,000	$59,535
23		$15,000	$50,000	$65,000	$59,298
24		$15,000	$50,000	$65,000	$59,061
25		$15,000	$50,000	$65,000	$58,826
26		$15,000	$50,000	$65,000	$58,592
27		$15,000	$50,000	$65,000	$58,358
28		$15,000	$50,000	$65,000	$58,126
29		$15,000	$50,000	$65,000	$57,894
30		$15,000	$50,000	$65,000	$57,664

TOTAL*= $15,088,960

Note: Total is in 2020 dollars.

TABLE D-5
Nelson Tunnel Alternatives Analysis
Construction Cost Estimate
Alternative 4: Drive New Adit to Intersect Nelson Tunnel, Tunnel Rehabilitation, Install Bulkhead and Flow Control Structure

Item No.	Description	Estimated Quantity	Unit	Unit Price	Item Cost	Notes
1	Mobilization/Demobilization	1	Lump Sum	$ 200,000	$ 200,000	Contractor preliminary estimate
2	Setup (C5/NT)	1	Lump Sum	$ 100,000	$ 100,000	Contractor preliminary estimate/judgment
3	Regrade/compact waste rock and re-route West Willow Creek for access to new adit	600	CY	$ 100	$ 60,000	Preliminary grading plan/estimate
4	Establish equipment access across West Willow Creek (NT)	1	Lump Sum	$ 160,000	$ 160,000	Contractor preliminary estimate (4 days plus $120K for bridge/abutment
5	Establish rockfall protection above new portal location (NT)	1	Lump Sum	$ 30,000	$ 30,000	Preliminary estimate/judgment
6	Re-establish temporary equipment access across West Willow Creek (C5)	1	Lump Sum	$ 5,000	$ 5,000	Preliminary estimate/judgment
7	Check ventilation and inspect/touch-up prior rehabilitation (C5)	6500	LF	$ 10	$ 65,000	Preliminary estimate/judgment
8	Shore/enhance ladders at access points to Nelson Tunnel (C5/NT)	1	Lump Sum	$ 20,000	$ 20,000	Preliminary estimate/judgment
9	Establish new portal for bypass tunnel	1	Lump Sum	$ 250,000	$ 250,000	Contractor preliminary estimate/judgment
10	Drive new adit to intersect Nelson Tunnel at bulkhead location	1330	LF	$ 1,800	$ 2,394,000	Contractor preliminary estimate/judgment
11	Install limestone drain in bypass tunnel and release water slowly	1	Lump Sum	$ 45,000	$ 45,000	Contractor preliminary estimate/judgment
12	Rehab Nelson Tunnel at selected bulkhead location	250	LF	$ 500	$ 125,000	Contractor preliminary estimate/judgment
13	Scale and prepare tunnel surface for new bulkhead structure	20	Hours	$ 1,000	$ 20,000	Contractor preliminary estimate/judgment
14	Perform radial grouting at new bulkhead section	400	LF	$ 250	$ 100,000	Contractor preliminary estimate/judgment
15	Place steel grizzly, diversion dam and bulkhead drain pipe	1	Lump Sum	$ 50,000	$ 50,000	Contractor preliminary estimate/judgment (4 days + mat'l
16	Install 2 rings of 6 ft rock bolts around new bulkhead section	180	LF	$ 30	$ 5,400	Contractor preliminary estimate/judgment
17	Construct new 20' concrete bulkhead in Nelson Tunnel	1	Lump Sum	$ 300,000	$ 300,000	Contractor preliminary estimate/judgment (75 cy @ $4000/cy
18	Perform contact grouting around newly completed bulkhead structure	1	Lump Sum	$ 40,000	$ 40,000	Contractor preliminary estimate/judgment
19	Perform radial grouting near face of bulkhead	300	LF	$ 250	$ 75,000	Contractor preliminary estimate/judgment
20	Install and grout 8-inch-diameter drain pipe	40	LF	$ 400	$ 16,000	Contractor preliminary estimate/judgment
21	Install flow and pressure control systems at drain outlet	1	Lump Sum	$ 20,000	$ 20,000	Contractor preliminary estimate/judgment
22	Extend pipe to portal	1300	LF	$ 25	$ 32,500	Contractor preliminary estimate/judgment
23	Insulate exposed outlet works	1	Lump Sum	$ 15,000	$ 15,000	Contractor preliminary estimate/judgment
24	Complete drainage outlet structure protection shed	1	Lump Sum	$ 5,000	$ 5,000	Contractor preliminary estimate/judgment
25	Install pressure transducer and cable to measure head behind plug	1	Lump Sum	$ 10,000	$ 10,000	Contractor preliminary estimate/judgment
26	Install Nelson Tunnel closure gate with cutoff and drainpipe	1	Lump Sum	$ 15,000	$ 15,000	Contractor preliminary estimate/judgment
27	Install removable flow control structure in Commodore 5 with access door	1	Lump Sum	$ 150,000	$ 150,000	Contractor preliminary estimate/judgment
28	Treatment plant at C5 WRP (lease)	4	Months	$ 15,000	$ 60,000	Contractor preliminary estimate/judgment
29	Treatment operation during construction	4	Months	$ 50,000	$ 200,000	Contractor preliminary estimate/judgment
30	Waste (mine muck) disposal	1	Lump Sum	$ 50,000	$ 50,000	Allowance/professional judgment

Construction/Treatment Subtotal				$ 4,617,900	
Contractor Overhead (10% Field + 5% Home Office)	15%			$ 692,685	% based on EPA FS costing guidance and professional judgment
Contractor Profit (10%)	10%			$ 461,790	% based on EPA FS costing guidance and professional judgment
Construction/Treatment Subtotal				**$ 5,772,375**	
Contingency (15% Scope + 10% Bid)	25%			$ 1,443,094	% based on EPA FS costing guidance and professional judgment
Subtotal w/ Contingency				**$ 7,215,469**	
Project Management	6%			$ 432,928	% based on EPA FS costing guidance and professional judgment
Remedial Design	12%			$ 865,856	% based on EPA FS costing guidance and professional judgment
Construction Management	8%			$ 577,238	% based on EPA FS costing guidance and professional judgment
Health & Safety and Mine Rescue	5%			$ 360,773	% based on professional judgment
Adjustment for Inflation on Prior Cost Estimating	12.0%			$ 865,856	Based on RS Means (2017 - 2019)
Total Estimated Alternative Cost				**$ 10,318,120**	

TABLE D-6
Nelson Tunnel Alternatives Analysis
Construction Cost Estimate
ative 4: Drive New Adit to Intersect Nelson Tunnel, Tunnel Rehabilitation, Install Bulkhead and Flow Control Str

PRESENT DAY COSTS (2019 Dollars)	
Total Project Costs	$10,318,120
Annual O&M Cost	$10,000
Annual Labor Cost	$40,000
Future Capital Costs	
	None anticipated

Discount Rate	0.40%

Year	Capital Cost	O&M COSTS		Subtotal	Present Value Cost
		O&M	Labor		
0	$10,318,120	--	--	$10,318,120	$10,318,120
1		$10,000	$40,000	$50,000	$49,801
2		$10,000	$40,000	$50,000	$49,602
3		$10,000	$40,000	$50,000	$49,405
4		$10,000	$40,000	$50,000	$49,208
5		$10,000	$40,000	$50,000	$49,012
6		$10,000	$40,000	$50,000	$48,817
7		$10,000	$40,000	$50,000	$48,622
8		$10,000	$40,000	$50,000	$48,428
9		$10,000	$40,000	$50,000	$48,235
10		$10,000	$40,000	$50,000	$48,043
11		$10,000	$40,000	$50,000	$47,852
12		$10,000	$40,000	$50,000	$47,661
13		$10,000	$40,000	$50,000	$47,471
14		$10,000	$40,000	$50,000	$47,282
15		$10,000	$40,000	$50,000	$47,094
16		$10,000	$40,000	$50,000	$46,906
17		$10,000	$40,000	$50,000	$46,719
18		$10,000	$40,000	$50,000	$46,533
19		$10,000	$40,000	$50,000	$46,348
20		$10,000	$40,000	$50,000	$46,163
21		$10,000	$40,000	$50,000	$45,979
22		$10,000	$40,000	$50,000	$45,796
23		$10,000	$40,000	$50,000	$45,614
24		$10,000	$40,000	$50,000	$45,432
25		$10,000	$40,000	$50,000	$45,251
26		$10,000	$40,000	$50,000	$45,071
27		$10,000	$40,000	$50,000	$44,891
28		$10,000	$40,000	$50,000	$44,712
29		$10,000	$40,000	$50,000	$44,534
30		$10,000	$40,000	$50,000	$44,357

TOTAL*= $11,728,961

Note: Total is in 2019 dollars.

TABLE D-7
Nelson Tunnel Alternatives Analysis
Construction Cost Estimate
Alternative 5: Dewatering and Treatment of All Stored Mine Pool Water

Item No.	Description	Estimated Quantity	Unit	Unit Price	Item Cost	Notes
1	Mobilization/Demobilization	1	Lump Sum	$ 300,000	$ 300,000	Contractor preliminary estimate
2	Setup (C5/NT)	1	Lump Sum	$ 120,000	$ 120,000	Contractor preliminary estimate/judgment
3	Regrade/compact waste rock and re-route West Willow Creek for access to new drift location (NT)	600	CY	$ 100	$ 60,000	Preliminary grading plan/estimate
4	Establish equipment access across West Willow Creek (C5/NT)	1	Lump Sum	$ 160,000	$ 160,000	Contractor preliminary estimate (4 days plus $120K for bridge/abutment)
5	Establish rockfall protection above current portal location (NT)	1	Lump Sum	$ 30,000	$ 30,000	Preliminary estimate/judgment
6	Check ventilation and inspect/touch-up prior rehabilitation (C5)	6500	LF	$ 10	$ 65,000	Preliminary estimate/judgment
7	Shore/enhance ladders at access points to Nelson Tunnel (C5/NT)	1	Lump Sum	$ 20,000	$ 20,000	Preliminary estimate/judgment
8	Establish dewatering systems for Nelson, Lower and Upper mine pools	3	Each (avg)	$ 150,000	$ 450,000	Contractor preliminary estimate/judgment
9	Dewater Upper Mine Pool	36	Months	$ 90,000	$ 3,240,000	Contractor preliminary estimate/judgment
10	Dewater Lower Mine Pool	16	Months	$ 90,000	$ 1,440,000	Contractor preliminary estimate/judgment
11	Dewater Nelson Portal Pool	6	Months	$ 90,000	$ 540,000	Contractor preliminary estimate/judgment
12	Remove collapse at Nelson Portal and seven more assumed locations	8	Lump Sum	$ 50,000	$ 400,000	Contractor preliminary estimate/judgment
13	Capture, handling and stabilization of iron hydroxides behind collapses	6000	CY	$ 200	$ 1,200,000	Preliminary estimate/budget allocation
14	Construct new stable Nelson Portal structure	1	Lump Sum	$ 250,000	$ 250,000	Contractor preliminary estimate/judgment
15	Rehabilitate Nelson-Wooster Tunnel and establish free drainage	5800	LF	$ 1,200	$ 6,960,000	Contractor preliminary estimate/judgment
16	Install Nelson Tunnel closure gate with cutoff and drainpipe	1	Lump Sum	$ 15,000	$ 15,000	Contractor preliminary estimate/judgment
17	Treatment plant (lease land, purchase and erect)	1	Lump Sum	$ 2,100,000	$ 2,100,000	Contractor preliminary estimate/judgment
18	Plant intake and pipeline	1	Lump Sum	$ 500,000	$ 500,000	Contractor preliminary estimate/judgment
19	Plant electrical	1	Lump Sum	$ 100,000	$ 100,000	Contractor preliminary estimate/judgment
20	Treatment operation during construction	36	Months	$ 120,000	$ 4,320,000	Contractor preliminary estimate/judgment
21	Waste (mine muck) disposal	1	Lump Sum	$ 150,000	$ 150,000	Allowance/professional judgment

Construction/Treatment Subtotal				$ 22,420,000	
Contractor Overhead (10% Field + 5% Home Office)	15%			$ 3,363,000	% based on EPA FS costing guidance and professional judgment
Contractor Profit (10%)	10%			$ 2,242,000	% based on EPA FS costing guidance and professional judgment
Construction/Treatment Subtotal				**$ 28,025,000**	
Contingency (25% Scope + 10% Bid)	35%			$ 9,808,750	% based on EPA FS costing guidance and professional judgment
Subtotal w/ Contingency				**$ 37,833,750**	
Project Management	6%			$ 2,270,025	% based on EPA FS costing guidance and professional judgment
Remedial Design	12%			$ 4,540,050	% based on EPA FS costing guidance and professional judgment
Construction Management	8%			$ 3,026,700	% based on EPA FS costing guidance and professional judgment
Health & Safety and Mine Rescue	8%			$ 3,026,700	% based on professional judgment
Adjustment for Inflation on Prior Cost Estimating	12.0%			$ 4,540,050	Based on RS Means (2017 - 2019)
Total Estimated Alternative Cost				**$ 55,237,275**	

TABLE D-8
Nelson Tunnel Alternatives Analysis
Construction Cost Estimate
Alternative 5: Dewatering and Treatment of All Stored Mine Pool Water

PRESENT DAY COSTS (2019 Dollars)	
Total Project Costs	$55,237,275
Annual O&M Cost	$20,000
Annual Labor Cost	$80,000
Future Capital Costs	
None anticipated	

Discount Rate	0.40%

Year	Capital Cost	O&M COSTS		Subtotal	Present Value Cost
		O&M	Labor		
0	$55,237,275	--	--	$55,237,275	$55,237,275
1		$20,000	$80,000	$100,000	$99,602
2		$20,000	$80,000	$100,000	$99,205
3		$20,000	$80,000	$100,000	$98,810
4		$20,000	$80,000	$100,000	$98,416
5		$20,000	$80,000	$100,000	$98,024
6		$20,000	$80,000	$100,000	$97,633
7		$20,000	$80,000	$100,000	$97,244
8		$20,000	$80,000	$100,000	$96,857
9		$20,000	$80,000	$100,000	$96,471
10		$20,000	$80,000	$100,000	$96,087
11		$20,000	$80,000	$100,000	$95,704
12		$20,000	$80,000	$100,000	$95,323
13		$20,000	$80,000	$100,000	$94,943
14		$20,000	$80,000	$100,000	$94,564
15		$20,000	$80,000	$100,000	$94,188
16		$20,000	$80,000	$100,000	$93,812
17		$20,000	$80,000	$100,000	$93,439
18		$20,000	$80,000	$100,000	$93,066
19		$20,000	$80,000	$100,000	$92,696
20		$20,000	$80,000	$100,000	$92,326
21		$20,000	$80,000	$100,000	$91,959
22		$20,000	$80,000	$100,000	$91,592
23		$20,000	$80,000	$100,000	$91,227
24		$20,000	$80,000	$100,000	$90,864
25		$20,000	$80,000	$100,000	$90,502
26		$20,000	$80,000	$100,000	$90,141
27		$20,000	$80,000	$100,000	$89,782
28		$20,000	$80,000	$100,000	$89,424
29		$20,000	$80,000	$100,000	$89,068
30		$20,000	$80,000	$100,000	$88,713

TOTAL= $58,058,956

Note: Total is in 2020 dollars.