Nelson Tunnel/Commodore Waste Rock Superfund Site
Creede, Colorado

EPA ID: CON000802630

Early Interim Action Record of Decision
Operable Unit 2

April 2021

U.S. Environmental Protection Agency, Region 8
1595 Wynkoop Street
Denver Colorado 80202-1129

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LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
ATV	All-terrain vehicle
BERA	Baseline Ecological Risk Assessment
CAG	Community Action Group
CCR	Code of Colorado Regulations
CDMG	Colorado Division of Minerals and Geology
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
CDRMS	Colorado Division of Reclamation Mining and Safety
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIP	Community Involvement Plan
COC	Contaminant of Concern
COPC	Chemicals of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CR	County Road
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
CWA	Clean Water Act
CY	cubic yards
DIC	Dissolved Inorganic Carbon
EC	Environmental Covenant
EDD	Estimated Daily Dose
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
EU	Exposure Unit
F	Fahrenheit
FS	Feasibility Study
FFS	Focused Feasibility Study
ft.	feet
GIS	Geographic Information System

gpm	gallons per minute
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
IC	Institutional Control
INSTAAR	Institute of Arctic and Alpine Research
IUR	Inhalation unit risk factor
IRA	Interim Remedial Action
IROD	Interim Record of Decision
LOE	Line(s) of Evidence
LUC	Land Use Controls
MG	million gallons
m/h	meters per hour
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OU	Operable Unit
PP	Proposed Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OSWER	Office of Solid Waste and Emergency Response
PW	Public Works
RAO	Remedial Action Objective
RBC	Risk-Based Concentrations
RD	Remedial Design
RfC	Reference concentration
RfD	Reference Dose
RGS	Rio Grande Silver
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization
SF	Slope Factor
SLERA	Screening-level Ecological Risk Assessment
TCRA	Time Critical Removal Action
TBC	To Be Considered

TCLP	Toxicity Characteristic Leaching Procedure
TMDL	Total Maximum Daily Load
TRV	Toxicity Reference Value
TVS	Table Value Standard
USC	United States Code
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WCRC	Willow Creek Reclamation Committee
WQCC	Water Quality Control Commission
WQS	Water Quality Standards
µg/l	micrograms per liter
µg/dl	micrograms per deciliter

GLOSSARY OF MINING TERMS

Adit – A horizontal passage from the surface by which a mine is entered, with only one entrance.

Country Rock – unmineralized rock encountered during mining.

Crosscut – A horizontal connection between drifts, typically perpendicular to a vein.

Drift – A horizontal passage underground that follows the vein or ore deposit.

Inby – Toward the working face, or interior, of the mine.

Lagging – Lumber planks or steel channel set between wooden or steel sets to keep rockfall and muck from entering the drift, adit, or tunnel. Typically installed close together to support foam installation; however, lagging may be installed farther apart to allow inspection of the rock surface behind it.

Muck – Materials generated during excavation including country rock, mineralized material, sludge already within the mine, wood or steel debris and clay gauge.

Outby – Farther from the working face or toward the mine entrance.

Portal – The structure surrounding the immediate entrance to a mine; the mouth of an adit or tunnel.

Raise – A vertical or near-vertical opening driven upward from a level to connect with the level above, or to explore the ground for a limited distance above one level.

Set – A lumber or steel structure designed to support the drift, adit, or tunnel through areas of unstable rock. Commonly referred to by construction material – i.e. "steel set". Also, sets may have one or two vertical supports, commonly called posts or legs – i.e. "single post steel set."

Shaft – A vertical or near-vertical opening through mine strata used for ventilation or drainage and/or for hoisting of personnel or materials; typically connects the surface with underground workings.

Stope – An excavation in a mine from which ore has been extracted.

Stull – A wooden post or steel beam installed between the ribs or in a stope to support large slabs of rock or combined with lagging to provide overhead protection from rock fall. Similar to a wooden or steel set but lacking vertical posts.

Tunnel – A horizontal, underground passage, entry, or haulage-way, that is open to the surface at both ends. Colloquially the term is also used to describe an adit or drift whose primary purpose is drainage or haulage.

Winze – A vertical or near-vertical opening sunk from inside a mine for connecting with a lower level or of exploring the ground for a limited depth.

1 Declaration

1.1 Site Name and Location

The Nelson Tunnel/Commodore Waste Rock Site ("Nelson Tunnel Site" or "Site") is in the San Juan Mountains in south central Colorado and lies one mile north of the Town of Creede (Town) in Mineral County, Colorado. The Site consists of the abandoned Nelson Tunnel, which discharges mine-impacted water directly into West Willow Creek, and the Commodore Waste Rock Pile. The Site lies approximately 9,184 feet above sea level in the bottom of a steep canyon with nearly vertical walls. The surrounding canyon walls reach roughly 10,600 feet above sea level.

The Site is divided into two areas known as operable units (OUs). The Commodore Waste Rock Pile is operable unit 1 (OU1). The Nelson Tunnel is operable unit 2 (OU2). This document describes the planned interim action to be implemented at OU2. The interim action described in this document is limited in scope and only addresses specific components of OU2. Nelson Tunnel, the focus of this interim remedial action, consists of an abandoned underground hard rock mine and drainage tunnel approximately 11,000 feet in length with several shafts, cross-cuts and drifts branching off the main tunnel.

1.2 Statement and Basis of Purpose

This interim decision document presents the selected early interim action remedy to reduce the likelihood of a sudden and large release of mine-impacted water from the Nelson Tunnel OU to the environment. This Interim Record of Decision (IROD) has been developed in accordance with the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, 42 U.S. Code (USC) §9601 *et seq.* as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300. This decision is based on the Administrative Record for this interim action for the Site. The Administrative Record for this action is available at the United States Environmental Protection Agency (EPA) Nelson Tunnel website: https://www.epa.gov/superfund/nelson-tunnel and at the following information repositories:

- Creede Town Hall Meeting Room, 2223 N. Main Street, Creede, Colorado 80113
- EPA Superfund Records Center, 1595 Wynkoop Street, Denver, Colorado 80202 (by appointment)
- Colorado Department of Public Health and Environment, 4300 Cherry Creek Drive South, Denver, Colorado 80246

The EPA Site Identification Number is CON000802630.

The Colorado Department of Public Health and Environment (CDPHE) participated in the development of the remedy selected by the EPA. CDPHE concurs with the selected remedy.

1.3 Assessment of the Site

Mining related activities have contributed to contamination of Willow Creek and its tributaries and have been documented for over 40 years. Investigations into the sources, nature and extent of this contamination have determined that the Nelson Tunnel portal discharge is 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 River, the Site was placed on the EPA's National Priority List (NPL) in September 2008.

Nelson Tunnel, also called the Nelson-Wooster-Humphries Tunnel, is the lowest level of the mine complex, which includes but is not limited to, Nelson Tunnel, Commodore Mine, Amethyst Mine, Happy Thought Mine, and Last Chance Mine. Nelson Tunnel was driven to serve as a drainage and haulage tunnel for the complex in the 1890s. Shortly thereafter, the owner of Commodore Mine drove the Commodore 5 level tunnel to serve as a haulage tunnel for Commodore ore and to compete with the Nelson Tunnel.

The Commodore 5 level tunnel is approximately 50 feet higher in elevation than the Nelson Tunnel at its portal, though it was driven at a lesser slope along the same mineralized vein as the Nelson Tunnel, resulting in the two tunnels joining inside the mountain approximately 11,000 feet from the surface portal. The two tunnels are connected by numerous vertical workings (called winzes, raises, or shafts) along the accessible length of the Commodore 5 level tunnel.

Inspections and data collected by Jeff Graves, Program Director for the Colorado Division of Reclamation, Mining, and Safety (CDRMS), starting in 2002, indicate a series of impoundments (collapses) in the Nelson Tunnel resulting in the formation of three mine pools. The final discharge from the Nelson Tunnel is approximately 300-400 gallons per minute (gpm). The volume of the Nelson Portal Pool is estimated to be 1.2 million gallons (MG) and can be measured by accessing the Nelson Tunnel through the Bachelor Shaft. There is a second collapsed area approximately 2,000 feet into the Nelson Tunnel that partially blocks the tunnel creating the Lower Mine Pool, which is estimated to be 1.4 MG. This Lower Mine Pool blockage forms a weir-type dam within Nelson Tunnel, creating an impoundment of water while still allowing water to flow freely over the top of it into the Nelson Portal Pool.

Further inside the Nelson Tunnel there is an impoundment at approximately 5,000 feet from the portal that creates the Upper Mine Pool (~19.5 MG). Water seeps through this impoundment and flows into the Lower Mine Pool. The Upper Mine Pool water level can be measured at the Del Monte Raise. If the pool elevation rises high enough, it discharges from Del Monte Raise into the Commodore 5 level flowing downgradient and re-entering the Nelson Tunnel Lower Mine Pool through downstream mine connections, particularly the No Name/Y02 Winze.

The EPA conducted a remedial investigation (RI) that was published in 2011 (EPA, 2011). The RI included a human health risk assessment (HHRA), an ecological risk assessment, sampling data for West Willow Creek and Willow Creek, and a description of blockages within the Nelson Tunnel. As work proceeded on the site-wide feasibility study (FS) and further investigations on possible hydrologic control remedy alternatives were conducted, the agencies identified the need for an interim action to mitigate the potential hydraulic hazards associated with the mine pools in the Nelson Tunnel. A hydraulic hazard, in this case, is the likelihood of a sudden and large release of the mine-impacted water in the event of a blockage failure within the Nelson Tunnel and associated workings. In recent years, deterioration of the Commodore 5 level had been observed and required a time critical removal action to install new ground support and maintain access. If additional roof fall, collapse, or blockage develops in the Nelson Tunnel or Commodore 5 level that creates a barrier to water flow, additional pressure could build on the impoundment holding back the mine pools in the Nelson Tunnel.

If a large, uncontrolled flow from the Nelson Tunnel were to occur, it could increase the migration of metals contamination further downstream of the Site than currently occurs. Metals contamination would migrate directly as dissolved constituents in the water, as well as in sediments that could be carried further downstream by a larger flow rate. A sudden, large release coincident with obstructions in the concrete flume that runs through the Town could result in the banks of that channel overtopping and cause localized flooding. A hydraulic study of the flume indicated that the concrete flume would still have capacity in the unlikely event of a sudden and large release occurring at the same time as a 10-year flow event in West Willow Creek (Yochum, 2002; HDR, 2015). One unpredictable factor is the influence of a sudden, large release mobilizing debris and restricting flow at some location within the flume, thus reducing flume capacity (Graves, 2015).

Additionally, the physical safety of individuals recreating on West Willow Creek or the lower section of Willow Creek could be impacted in a high flow rate event. The EPA, in consultation with CDPHE, completed a focused feasibility study (FFS) to identify remedial alternatives to reduce the likelihood of a sudden and large release of the mine-impacted water impounded within the Nelson Tunnel and associated workings.

1.4 Description of the Selected Interim Remedy

The selected remedy, Alternative 4 in the FFS, is focused on installing flow-control structures in the Nelson Tunnel and the Commodore 5 level to control discharge. This alternative would reduce the likelihood of a sudden and large release from the Nelson Tunnel. Remedy components include:

- Installation of a new adit that intersects Nelson Tunnel to bypass the Nelson Tunnel Portal Pool
- Rehabilitation of the Nelson Tunnel from the bypass adit connection to the location where bulkhead construction is planned
- Installation of a flow control bulkhead in the Nelson Tunnel to reduce the likelihood of a sudden and large release through the Nelson Tunnel
- Installation of an accessible flow-control structure in the Commodore 5 level to reduce the likelihood of a sudden, large release through this level

Implementation of this remedy will reduce the likelihood of sudden, large mine discharges if further collapses or internal releases within the Nelson Tunnel result in water pressure building to the Commodore 5 level. In such case, the accessible, removeable flow-control structure in Commodore 5 level will provide a means to control and regulate flows to decrease the likelihood of a sudden and large release. The structure will include a manway to allow continued access to, and ventilation of, the mine workings.

1.5 Statutory Determinations

This interim action is protective of human health and the environment in the short-term and is intended to provide adequate protection until a final Site-wide Record of Decision (ROD) is signed. The action complies with federal and state requirements that are applicable or relevant and appropriate for this limited-scope action and is cost-effective. This action is considered an interim solution because it focuses on mitigating a sudden and large release of the impounded water within the Nelson Tunnel and does not address remediation of the contaminated mine water discharging from the Nelson Tunnel. Because this remedy will result in hazardous substances above health-based levels remaining on-site, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within five years after commencement of the remedial action. Because this is an interim action, review of the Site and remedy will be ongoing as the EPA continues to develop alternatives for a final remedy at the Site.

1.6 Interim ROD Data Certification List

The following information is included in the Decision Summary section of this IROD. Additional information can be found in the Administrative Record file for this Site.

- Chemicals of concern and their respective concentrations (**Section 2.7**)
- Baseline risk represented by the chemicals of concern (**Section 2.7**)
- Cleanup levels established for chemicals of concern and the basis for these levels (Not applicable to this action)
- How source materials constituting principal threats are addressed (**Section 2.11**)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and IROD (**Section 2.6**)
- Potential land, surface water and groundwater use that will be available at the Site because of the selected Interim Remedial Action (IRA) (**Section 2.12**)
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (**Section 2.12**)
- Key factor(s) that led to selecting the remedy (i.e., describe how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (**Section 2.12**)

1.7 Authorizing Signatures and Support Agency Acceptance of Interim Remedy

USEPA Region 8

This IROD documents the selected remedy to reduce the likelihood of a sudden and large release of the mine-impacted water in the event of a blockage failure within the Nelson Tunnel, OU2, of the Nelson Tunnel/Commodore Waste Rock Site.

The following authorized official at U.S. Environmental Protection Agency, Region 8 approves the selected remedy as described in this IROD.

BETSY SMIDINGER Digitally signed by BETSY SMIDINGER Date: 2021.04.05 14:32:40 -06'00'

4/5/21

Betsy Smidinger, Director
Superfund and Emergency Management Division
USEPA Region 8

Date

State of Colorado

This IROD documents the selected remedy to reduce the likelihood of a sudden and large release of the mine-impacted water in the event of a blockage failure within the Nelson Tunnel, OU2 of the Nelson Tunnel/Commodore Waste Rock Site.

The following authorized official at the Colorado Department of Health and Environment approves the selected remedy as described in this IROD.

Jennifer Opila — Digitally signed by Jennifer Opila Date: 2021.04.06 14:07:20 -06'00'

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Jennifer Opila, Division Director
Hazardous Materials and Waste Management Division
Colorado Department of Public Health and Environment

Date

2 Decision Summary

2.1 Site Name, Location and Description

The Nelson Tunnel/Commodore Waste Rock Site ("Nelson Tunnel Site" or "Site") is 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 mine-impacted water directly into West Willow Creek, and the Commodore Waste Rock pile. The Site lies approximately 9,184 feet above sea level in the bottom of a steep canyon with nearly vertical walls. The surrounding canyon walls reach roughly 10,600 feet above sea level.

The Site is divided into two areas known as operable units. The Commodore Waste Rock pile is Operable Unit 1 (OU1). The Nelson Tunnel is Operable Unit 2 (OU2).

2.2 Site History

2.2.1 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 more than 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 (EPA, 2005). More recent population estimates of Creede and Mineral County are approximately 312 and 824, respectively (U.S. Census Bureau, 2019).

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 feet 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 (**Figures 2, 3, 4 and 5**). A second adit, the Commodore 5 level, was driven approximately 50 feet above the Nelson Tunnel system to access the same mines

(Graves, 2006). The resulting Commodore Waste Rock pile, located at the portal of the Commodore 5 level, lies adjacent to West Willow Creek and 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, CDRMS (formerly the Colorado Division of Minerals and Geology [CDMG]) rehabilitated portions of the Commodore 5 level and access points to the Nelson Tunnel level to provide safe working conditions. Rehabilitation work included stabilization, cleanup, and improvements to ventilation (CDMG, 2003).

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. The collapsed tunnel portal is located on the west side of West Willow Creek about one mile north of the Town of Creede. 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**).

A thorough review of the status of known collapses, mine pools, and accessible points within the Commodore-Nelson complex was documented by 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, 4** and **5**). Volumes of water stored behind collapses, and in each of these pools, are conservatively estimated to be 1.2 MG, 1.4 MG and 19.5 MG, respectively.

Discharge from the collapsed Nelson Portal averaged approximately 375 gpm (2012-2017 data), has depressed pH and high concentrations of zinc, cadmium and other metals. Additional characterization of the discharge is described in Section 2.5.1.

A baseline reconnaissance of site conditions was performed on May 24, 2016. Areas observed included the 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 Commodore 5 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**. Conditions in the Commodore 5 level, Bachelor Shaft and Daylight Winze have significantly improved since the May 24, 2016, site visit because of a Time Critical Removal Action (TCRA) performed by the EPA beginning in 2018 to rehabilitate the ground control structures. Improvements are noted in Section 2.2.2. Mine conditions are expected to change over time, and these improvements will require scheduled inspection and maintenance. During the Remedial Design (RD) phase for the IRA, it will be important to conduct inspections and investigations into underground conditions to determine if further rehabilitation is needed.

2.2.2 History of Regulatory Activities

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 Waste Rock pile (OU1)
- September 3, 2008 – Site placement on the NPL
- 2018-2020 – TCRA to Rehabilitate the Commodore 5 level

In 2008-2009, the EPA conducted a TCRA to stabilize the Commodore Waste Rock pile after high flows in West Willow Creek caused a severe washout in 2005. The TCRA involved re-grading the waste material to create stable slopes and a riprap channel to direct West Willow Creek along the toe of the pile. In 2008 the Site was listed on the NPL.

Site inspections in recent years indicated that conditions in the mine complex required more immediate attention. Therefore, extensive rehabilitation of the Commodore 5 level and some associated drifts was completed during the 2018–2020 TCRA, with additional work planned for 2021. The rehabilitation work provides for medium-term (15- to 50-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 feet inby of the Commodore 5 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 helps mitigate the buildup of pressure against the blockage (No Name Blockage) that creates the Upper Mine Pool. Pressure relief is provided when the Upper Mine Pool water flows into the Commodore 5 level through the Del Monte Raise, inby of the No Name Blockage, and returns to the Nelson Tunnel level through the No Name Winze, which is outby of the No Name Blockage (**Figures 3, 4 & 5)**. This is an important aspect of the TCRA rehabilitation work because if further collapses in the Commodore 5 level prevent water from bypassing the No Name Blockage and returning to the Nelson Tunnel level, then a buildup of pressure in the Upper Mine Pool could potentially result in a blowout of the No Name Blockage. This could result in a sudden and large release from Nelson Tunnel or the Commodore 5 level. Additionally, a geologic event, such as an earthquake, could also change the stability of the system. Therefore, it is difficult to predict future long-term stability.

Specific improvements completed under the TCRA include:

- Repaired rail to provide access to work areas with a small locomotive and flat car
- Cleaned the drainage ditch along the Commodore 5 level to drain standing water
- Rehabilitated unstable areas of the Commodore 5 level using rock bolts, wire mesh, steel sets, steel stulls, or a combination of these methods
- Installed new fiberglass ladders and landings at the Bachelor Shaft and Daylight Winze
- Supported openings at locations where overhead workings connect to the Commodore 5 level using steel sets and foam sealing
- Removed rotten timber lagging from areas with high roof cavities and replaced with steel stulls and lagging to maintain safe worker access

2.2.3 History of Investigative Activities

2.2.3.1 PRE-NPL DESIGNATION ACTIVITIES

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 the 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, Town of Creede, and the EPA supported a recommendation for Site placement on the NPL in 2008.

Other Pre-NPL studies and investigations have been performed or commissioned by the WCRC, CDRMS, CDPHE and the EPA (e.g., CDMG, 2003; CDMG, 2005; Graves, 2006; Graves, 2007; McCulley, Frick & Gilman, Inc. (MFG), 1999; and WCRC, 2003).

2.2.3.2 REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

The RI for the Nelson Tunnel/Commodore Waste Rock Pile was completed in 2011 (EPA, 2011). As work proceeded on the site-wide FS and further investigations on possible hydrologic control remedy alternatives were conducted, the agencies identified the need for an interim action to mitigate the potential hydraulic hazard associated with the likelihood of a sudden and large release of the mine-impacted water in the event of a blockage failure within the Nelson Tunnel and associated workings. An RI addendum was released in 2019 (EPA, 2019) summarizing data from additional studies since 2011. The FFS to develop alternatives to address the hydraulic hazards was completed in 2020 (EPA, 2020).

The RI was conducted to determine the nature and extent of mining-related contamination in surface water, mine pool water, and waste rock material in the Nelson Tunnel/Commodore Waste Rock Site. Water quality monitoring at the Site and surrounding area has been ongoing since the late 1990's. The RI Report used environmental data gathered from investigations conducted since the late 1990's to describe the nature and extent of contamination. These investigations consistently identified what is now the Nelson Tunnel/Commodore Waste Rock Site as the major contributor of metal loads to the watershed (EPA, 2005, Kimball 2006, CDPHE 2020).

Some of the pre-NPL listing data was collected between 10 and 15 years prior to the RI. By 2008, several Site characteristics had changed since the RI data was collected, including Nelson Tunnel discharge volume and configuration of the Commodore Waste Rock pile (under a Removal Action conducted in 2008 and 2009). Data collection was not conducted on a regular basis prior to Site listing. Sampling locations varied by year, and many locations identified in a 2003 Sampling and Analysis Plan (SAP) (WCRC, 2003) were not regularly sampled. The historic data was used to inform the development of a sampling and analysis plan for the RI. During the RI development in 2010 and 2011, environmental data collection and analysis was performed for several locations and different media, including surface water in the Willow Creek watershed and Rio Grande, mine pool water, Commodore Waste Rock pile, and the road base material for County Road (CR)-503 and particulate air sampling along CR-503. Human health and ecological risk assessments were also performed.

All available data was screened to retain information that was the most comprehensive and representative of recent Site conditions. Also considered was the appropriateness of certain data for use in risk assessment or for describing the nature and extent of contamination.

With few exceptions, the 2010 data were used for both site characterization and for risk assessment. The April 2011 data were also used to describe site characteristics. In addition, some historic water quality and flow data were retained for the following reasons:

- To describe water quality conditions in the Mine workings (Nelson Tunnel). No data was collected from the subsurface during 2010 or 2011.
- To demonstrate temporal concentration trends near the Commodore Waste Rock pile to examine the effects of a recently completed removal action
- To determine whether the 2010 and 2011 surface water quality data at certain critical locations are representative of typical conditions. These include the Nelson Tunnel portal, confluence of East and West Willow Creeks, and locations in the Rio Grande where compliance with Applicable, Relevant or Appropriate Requirements (ARARs) is assessed.

An RI Addendum was developed in 2019 to supplement findings from the 2011 RI Report. Since the completion of the RI Report, a significant amount of water quality data was collected from Nelson Tunnel and the water quality monitoring stations in West Willow Creek, Willow Creek and the Rio Grande. In addition, multiple studies and other data collection events relevant to the Nelson Tunnel RI have occurred since the original RI was published. The 2019 RI Addendum incorporated new information and updated RI conclusions. The Focused Feasibility Study (FFS) for the Nelson Tunnel/Commodore Waste Rock NPL Site was completed in September 2020 (EPA, 2020). The FFS identified and evaluated remedial alternatives to reduce the likelihood of a sudden and large release of mine-impacted water from the Site to the environment. The remedial alternatives were identified and evaluated for an Interim Action. A comprehensive remedial action for the Site will be evaluated in the future.

The FFS followed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Feasibility Study process (EPA, 1988). Traditionally, a CERCLA Feasibility Study 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 identified focused alternatives to meet the remedial objective, thus, a full range of alternatives was not evaluated, and subsequent screening process was not performed. Each of the remedial alternatives identified were 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 compared retained alternatives using these nine NCP criteria as the measure.

2.3 Community Participation

The EPA has been involved with the Creede and Mineral County communities since the late 1990's when CDMG began investigating the area. Meetings have involved the EPA, the state and local departments, and the Headwaters Alliance (formerly known as the Willow Creek Reclamation Committee or WCRC). With the NPL designation in September 2008, the EPA was able to perform a much more detailed characterization of the nature and extent of mine-impacted water contamination through the RI/FS process.

An initial Community Involvement Plan (CIP) was completed in May 2009. The EPA and CDPHE conducted community interviews between March and May 2008 to inform the preparation of the CIP. The CIP includes a description of the site background, history of community involvement at the Site (including major community concerns), community involvement objectives, and a list of affected and interested stakeholders. The community interviews form the foundation for developing the appropriate information to be disseminated to the public and for determining what actions are necessary to address the public's concerns.

Interviews for the updated Community Involvement Plan were conducted between May and August 2017, and additional interviews were conducted in summer 2018 to determine outreach needs associated with the Time Critical Removal Action that occurred between 2018 and 2020 (EPA, 2019c).

The CIP revision was completed in July 2019. The CIP supports communication between Creede and Mineral County communities with the EPA, CDPHE and the U.S. Forest Service (USFS) and encourages community involvement in Site activities. Active public involvement is crucial to the success of any public project. The agencies' community involvement activities at the Site are designed to:

- inform the public of the nature of the environmental issues associated with the Site
- involve the public in evaluating the responses under consideration to remedy these issues
- involve the public in the decision-making processes that will affect them
- inform the public of the progress being made to implement the remedy

The WCRC/Headwaters Alliance has been directly involved with the Site since the EPA began assessment. The stakeholder group regularly provides information and feedback to the EPA, CDPHE and USFS. The EPA and the other agencies also provide routine updates to town, county and administration officials. To inform the community and respond to questions about the Proposed Plan for the Nelson Tunnel, the EPA hosted a virtual public meeting September 29, 2020. The EPA, CDPHE, USFS and the Headwaters Alliance held a separate virtual meeting on October 15, 2020, to address comments made by members of the Headwaters Alliance as well as citizens and local officials. The meeting concluded with the Headwaters Alliance generally voicing support for the preferred alternative. A summary of the comments received during the Proposed Plan public comment period is provided in the Responsiveness Summary in Section 3.

2.4 Scope and Role of Response Action

The scope and role of the planned Interim Action is to improve the underground workings in Nelson Tunnel and Commodore 5 level to allow for inspection and maintenance, and to control the flow from the Nelson Tunnel, reducing the likelihood of a sudden and large release from Nelson Tunnel. The remedy includes construction of an adit that intersects the Nelson Tunnel, bypassing the Nelson Tunnel Portal Pool, and installation of a bulkhead to control flow from the Nelson Tunnel. In addition, a flow-control structure will be installed in the Commodore 5 level to control unexpected discharge but still allow access to the rehabilitated mine workings.

The selected action will protect human health and the environment by reducing the likelihood of a sudden, large release of contaminated mine pool water from the impoundments in the Nelson Tunnel that would further contaminate Willow Creek and downstream environments. This will also reduce the likelihood of a sudden, large release coincident with obstructions in the concrete flume through the Town of Creede that could result in the banks of that channel overtopping and flooding of the local area. Additionally, the physical safety of individuals recreating on West Willow Creek or the upper section of Willow Creek could be impacted in a high flow event.

The Interim Action addressing OU2 is not intended as the final remedy for the Site. Though not intended to improve the quality of the water discharged from Nelson Tunnel, some incremental improvement may nevertheless result. The EPA continues to evaluate and explore alternatives to improve water quality for a final remedy.

2.5 Site Characteristics

This section includes a description of the conceptual site model (CSM**)** on which the investigations, risk assessment, and response actions are based. A CSM is used to organize and communicate information about site characteristics and potential exposure routes; it reflects the best interpretation of available information about the Site at any point in time. **Figure 6** presents the CSM developed during the RI. The major characteristics of the Nelson Tunnel, observed conditions, and the nature and extent of contamination are summarized below. More detailed information is available on the EPA Nelson Tunnel/Commodore Waste Rock – Creede, CO website.

2.5.1 General Site Description

The Nelson Tunnel is a primary feature within the Creede Mining District. The tunnel 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. 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 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, 4** and **5**). Volumes of water stored behind collapses and in each of these pools are conservatively estimated to be 1.2 MG, 1.4 MG and 19.5 MG, respectively. The Nelson portal has discharged an average of approximately 375 gpm (data from 2012 through 2017) and has previously been determined to be 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 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 RI 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 below are based on a May 24, 2016, site visit. Areas observed included the 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**. Conditions in the 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 below in the observations from the site visit.

- 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 the 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 2018-2020.
- 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 McClure Crosscut near Daylight Corner was stabilized with rock bolts and mesh in 2018.
- 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 the 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, and a new, larger flume with instrumentation was installed in the Nelson Tunnel in 2020.
- 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 dripping 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, but the ladders appeared structurally unsound.
- North of the Commodore Shaft, the ground became blockier and weaker. A significant roof fall caused a two- to three-feet-deep mine pool 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 and No Name Winze in 2020.
- Between the No Name Winze and Del Monte Raise was a section of poor ground with heavy clay alteration. The clay was supported by several generations of wood piles and steel rail. During the TCRA the clay was mined out and supported with steel sets backfilled with mine foam.
- 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 2007 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 the 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.

2.5.2 Site Climate

Temperatures in Creede range from an average low of 6º Fahrenheit (F) in December to an average high of 78º F in July. The annual average temperature is 40.8º F. At the Site, temperatures are expected to be slightly cooler due to the increased elevation (WCC, 2006). Average annual precipitation at Creede is 13.5 inches; however, precipitation can vary from 8.5 to 19.7 inches. Wettest months are August and September, and the driest months are December and January. Average annual snowfall is 47 inches (WCRC, 2006).

2.5.3 Surface Water Hydrology

The Site lies on West Willow Creek in the Middle Section of the Willow Creek watershed. Only the small segment of West Willow Creek that receives drainage water from Nelson Tunnel and abuts the Commodore Waste Rock pile is included in the Site. The Willow Creek watershed has been divided into four distinct sections, Upper, Middle, Creede, and Lower Sections. The Upper Section starts at the ridge tops and contains the top-most sections of East and West Willow Creeks. Narrow canyons and a steep stream gradient characterize the Middle Section, which contains the Creede Mining District and confluence of East and West Willow Creeks. Through the Creede Section, Willow Creek flows through the Town of Creede, located at the canyon mouth. The Lower Section contains the gently sloping alluvial floodplain of Willow Creek before its confluence with the Rio Grande (EPA, 2005).

West Willow Creek above Nelson Tunnel receives snowmelt from numerous high peaks surrounding Creede. Nelson Tunnel discharge and Deerhorn Creek are the largest tributaries to West Willow Creek. Willow Creek is formed by the confluence of West Willow and East Willow Creek, approximately half a mile below the Site. Windy Gulch joins Willow Creek and flows through Creede in a masonry flume constructed in 1950 by the US Army Corps of Engineers for flood control (EPA, 2005). The masonry flume discharges into a braided floodplain below Creede. An irrigation diversion to Wason Ranch is in the lower third of the floodplain. Measurements made for the Wason diversion (made in 2009 and 2010) ranged from 4 to 21 cubic feet per second (cfs) while flows measured from 2013 to 2016 averaged 6.95 cfs. The Willow Creek watershed drains 39.8 square miles (MFG, 1999) before joining with the Rio Grande in two main channels below the Wason diversion.

Flows within the Willow Creek watershed are monitored at several stations. Prior to 2010, stream monitoring was primarily conducted on an annual or biannual basis by volunteers from the WCRC. Flumes are not installed in most monitoring locations, so flow is measured using area-velocity method, portable flume, or volumetric method (WCRC, 2004a). Monitoring from 2010 through 2017 was conducted by the EPA. Discharge on West Willow Creek was measured using Flow Tracker® flow meters, portable cutthroat flumes, or Parshall flumes during the April, May, August and November sampling events.

The high flow season occurs in spring, primarily in May and June, dominated by snowmelt from high-mountain peaks. Low flows occur throughout the fall and winter months. Based on available flow data from 1995 – 2017, flows in Willow Creek at the confluence with the Rio Grande (the sum of measurements at monitoring stations W-I and W-J) ranged from 7 to 160 cfs. For 2017, in particular, the seasonal discharge for these locations ranged from 73 cfs in late spring to approximately 8 cfs in late fall. Flows in West Willow Creek just below the confluence with the Nelson Tunnel discharge (station WW-F) ranged from 1.5 to 70 cfs for data collected between 1995 and 2010. Upstream discharge data (station WW-G) from 2017 ranged from 43 cfs in the spring to 4.1 cfs in the late fall.

The Rio Grande originates in the San Juan Mountains west of Mineral County. Limited flow data is available at the confluence with Willow Creek. The United States Geological Survey (USGS) maintains the closest downstream gauging station, located below Wagon Wheel Gap approximately five miles downstream from Willow Creek (USGS Gauge # 08217500). Median monthly flows vary seasonally and range from 100 to 1,870 cfs. Lowest flows occur in January with a minimum of 130 cfs measured between 1952 and 2000 (CDPHE, 2010). High flow is correlated with snowmelt, reaching a peak in June of more than 3,380 cfs during the period 1952 to 2000. Multiple tributary streams outside the Willow Creek watershed enter the Rio Grande before Wagon Wheel Gap.

2.5.4 Geology

2.5.4.1 REGIONAL GEOLOGY AND MINERALIZATION

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.
>
> The Creede caldera, an eight-mile-wide collapse feature formed by eruption of the Snowshoe Mountain Tuff, was the final eruption within the central San Juan Mountains resulting in widespread ash flow sheeting. Following eruption of the Creede caldera, resurging magma within the caldera boundary led to a set of north trending distentional fractures just north of the caldera's margin. This distentional fracturing formed what is now referred to as the Creede Graben and is composed of four major fault systems: Alpha-Corsair; Bulldog Mountain; Amethyst; Solomon-Holy Moses. Mineralization within the Creede District appears to have taken place close to the surface and along recently active distentional faults formed by intrusion of magma (Steven and Eaton, 1975).

2.5.4.2 COMMODORE MINE COMPLEX

The Commodore Mine complex (Mine) includes several separate mines, mostly shafts that sunk workings along the Amethyst Vein system and were eventually all joined through the Nelson Tunnel and Commodore 5 level. **Figure 2** provides a plan-view of the Nelson and Commodore 5 levels, intersecting shafts, drifts (horizontal tunnels driven from the Nelson or Commodore 5) and mineralized faults. Most shafts developed 12 or more levels along a nearly 1,400-foot vertical section of the Amethyst Vein. Nearly three continuous miles of the Amethyst Vein were worked by various mines.

The lowest entry into the Mine complex is the Nelson Tunnel. Approximately 50 feet above the Nelson Tunnel is the Commodore 5 level. Additional exploration work was conducted below the Nelson Tunnel level at the Bachelor, Commodore and Berkshire Shafts. Exploratory drifts were driven along the Amethyst Vein around 350 feet below the Nelson Tunnel; however, exploration indicated unprofitable sulphide ore (Graves, 2006). The Mine worked the Amethyst Fault system, including mineralized veins, varying from less than inches to more than 15 feet in width, that strike N 20º W and dip southwest between 55º and 80º. The Amethyst Fault is the eastern complement to the Bulldog Fault with both bounding one of the inner keystone blocks of the Creede Graben.

2.5.5 Hydrogeology

2.5.5.1 MINE WORKING HYDROLOGY

Historical observations and discharge measurements of water flow within Mine workings provide a well-documented account of hydrologic conditions in existence during mining. In the early 1890's water was encountered within 200 feet of the surface as shafts were sunk along the Amethyst Vein.

Undifferentiated volcanic tuff bedrock is essentially impermeable except along fractures and faults. As shafts were driven deeper, the amount of water needing to be pumped and the costs associated with dewatering increased substantially. During development of the Nelson Tunnel, historic accounts indicate that large quantities of water were encountered near the base of the Last Chance and Amethyst Shafts. Exploratory work conducted from the Berkshire Shaft below the Nelson Tunnel from 1917-1920 encountered discharge from the drifts at nearly 1,300 gpm. Documents filed in water court by Mine owners indicated up to an 8,500 gpm discharge from the Nelson Tunnel working face near the Amethyst Shaft. A subsequent report by Hodges (1902) indicated discharge from the Nelson Tunnel portal at approximately 3,000 gpm.

During operation and pumping of the Bulldog Mine, located west of the Site, discharge from the Nelson Tunnel was less than 45 gpm. In the early 1990s, discharge from the Nelson portal averaged below 20 gpm but steadily rose to around 300 gpm in 1999, after closure of the Bulldog Mine. A sudden increase in portal flow from 300 gpm to well over 400 gpm was observed between November 1999 and December 2000, when flow subsided to approximately 250 gpm.

A flume at the Nelson Tunnel portal was reconfigured in 2003, and again in 2009, to allow for more accurate flow measurements. Periodic discharge measurements between 2002 and 2009 indicated stabilization of the flow, with fluctuations between 200 gpm and 300 gpm. However, the 2010 data indicated variable discharge for that year, ranging from 269 gpm to 380 gpm. Flume readings from 2010-2017 ranged between 293 and 485 gpm with an average of 355 gpm. The reported relationship between pumping at the Bulldog Mine and diminished discharge at the Nelson Tunnel portal suggests an indirect hydraulic connection exists between the Bulldog and Amethyst Faults. Several faults and numerous extension fractures are inferred to connect these two north-south trending faults.

In addition to groundwater entering the Mine workings via faults and fractures in the undifferentiated ash flow tuff bedrock, a limited amount of surface water is suspected or known to be entering Mine shafts at various locations. This water enters lower Mine workings ultimately discharging from the Nelson Tunnel, but only accounts for a very minor portion of the discharge observed at the Nelson Tunnel portal.

While a majority of this surface water discharges through the collapsed Nelson Tunnel portal, a small amount, averaging less than 10 gpm, is discharged from the Commodore 5 level portal. This discreet flow originates as seepage entering the Commodore 5 level between the portal and Daylight Winze as well as between Daylight Winze and the Peak Drift. The discharge flows south from the portal, across the waste rock, and connects with the Nelson Tunnel discharge just downstream of the Nelson portal flume.

Monitoring points have been established to characterize hydrologic and water quality conditions within the Mine. Due to collapses and unsafe access, monitoring locations were limited to areas where the Nelson Tunnel is accessible from the Commodore 5 level. Limited flow measurements conducted at the Nelson Tunnel portal, Nelson Tunnel at Bachelor Shaft and Nelson Tunnel near the No Name Winze indicate that, on average, between 80% and 90% of Nelson Tunnel portal discharge originates upstream of the No Name Winze. This observation is supported by the lack of additional discreet inflows reported between the portal and No Name Winze.

Water level data collected since 2002 indicate a series of collapses in the Nelson Tunnel resulting in formation of three Mine pools including:

- The Nelson Tunnel Portal Pool extends from the portal almost to the Bachelor Shaft
- The Lower Mine Pool extends from a collapse just upstream of the Bachelor Shaft to just past the No Name Winze
- The Upper Mine Pool appears to extend from the Hospital Decline through the Berkshire Shaft and OH-Amethyst junction to within 500 feet of the No Name Winze

Additional collapses may be present within major Mine pools, but do not appear to affect water levels. The collapse sequence from the Nelson Tunnel portal to the Bachelor Shaft is unknown; however, discussions with former mine employees indicate a complex pattern of poor rock conditions resulting in the possibility of numerous collapses along that portion of the Mine. Mine pool water elevations and flows at both Nelson Tunnel portal and Bachelor Shaft fluctuate. Because only limited data was collected, discerning distinct correlations is difficult.

Some fluctuations in Mine pool elevation may result from new collapses impounding additional water or from blowout of previous collapses. High water marks, noted by iron staining, indicate some Mine pool elevations 8 to 10 feet higher than currently observed. High flows at the Nelson Tunnel portal in 2000 may have resulted from blowout of a large impoundment within the Mine. Since installation of continuous logging pressure transducers within the Upper Mine Pool, a seasonal mine pool fluctuation pattern has been observed. Water level rises consistently in late spring with occasional spikes over the summer, followed by a steady decline until the next spring.

2.5.5.2 SOURCES OF RECHARGE AND AGE OF MINE POOL WATER

Since the completion of the RI, additional studies and investigations focused on the hydrology of the mine workings have been completed. The following provides a summary of each, presented chronologically.

2.5.5.2.1 Geological Model of the Nelson Tunnel Mine Drainage by Craig Byington

Studies by Craig Byington of Millennium Geosciences were conducted in 2011 and 2012 to construct a geological model of the Nelson Tunnel mine drainage. Mr. Byington is a geologist with extensive experience with the Creede Mining District. His studies included examining historical evidence of water flow in the mine district, review of recent water quality data, review of isotopic and tracer studies completed by Dr. Mark Williams at the University of Colorado Institute of Arctic and Alpine Research, as well as observations and the collection of geologic and geochemical data. Report conclusions regarding the source of waters from Nelson Tunnel are summarized below (Byington, 2012):

Historically the vast majority of the water encountered in the Nelson Tunnel and along all other workings following the Amethyst fault system came from the hanging wall within a short distance of the Amethyst fault. There are no records indicating water coming from the OH or P veins nor was any evidence found during this study suggesting that significant amounts of water could penetrate the OH or P vein fractures. During advance of the various headings, {miners working in Nelson Tunnel} often encountered an initial high flow rate of water (reportedly as much as 5,000 to over 8,000 gpm). After this extreme flow rate “bled off,” the water typically upwelled into the lowest level of workings (i.e. the Nelson Tunnel). Very little water is currently entering into the

Commodore 5 level from the overlying workings, and the Nelson Tunnel was filled with water and ferrihydrite in all exposures so that the inflow of sub-level water could not be determined.

Although there certainly must be a very significant component of meteoric recharge in the Nelson Tunnel waters, less than a few gallons per minute are currently accounted for elsewhere in the mine workings. This "missing" meteoric input could represent a significant amount of the Nelson Tunnel total flow. If these waters could be captured and re-directed before they become contaminated, then the size of the acid mine drainage outflow problem could be significantly reduced. The model presented in the Byington report, and supported by various lines of evidence, envisions downward percolating meteoric recharge water through the Happy Thought workings, in particular the open and vertically continuous stopes, and into the hanging wall fracture system of the Amethyst fault.

In addition, deep upwelling Nelson Tunnel recharge waters may be entering the Amethyst fault system via a 700-foot-long (230 meter) transtensional segment where the strike of the fault has inflected toward a more-likely-to-be "open" orientation. The fluids following this strike-related conduit may or may not make it to the Nelson Tunnel level at that point, and they may or may not have an ancient isotopic signature (most likely not, in Byington's opinion). Abundant anecdotal and circumstantial evidence presented in the Byington report documented that a very significant inflow, well beyond what is coming from the Nelson portal currently, was encountered during some 1917-1920 exploration/development work. The input points for this flow occur in the north faces of the headings driven from the Commodore shaft and, more likely, from the north faces of the headings driven under the Happy Thought stopes from the Berkshire shaft. In Mr. Byington's opinion, water flowing from the north face of the heading driven at approximately 200 feet below the Nelson Tunnel and advanced from the Berkshire shaft to well under the Happy Thought stopes will account for most of the water coming into the upper "mine pool."

No evidence was found to support the hypothesis that warm waters were encountered during the historical work anywhere in any of the mine workings, nor is there evidence that warm springs existed historically along the surface trace of the Amethyst fault system prior to or during mining. This does not preclude the possibility of warm water up-flows, but it recognizes that there is no historical analog for the warm (19-21 °C) spring waters currently hypothesized to be entering the Nelson Tunnel. The highest temperature measured is about 5° C above what, according to the Byington's calculations, would be expected in a standard geothermal gradient. If geochemical or bio-geochemical exothermic reactions or an above-standard geothermal gradient (i.e. a still-cooling volcanic field) are contributing to the temperature difference, then there may not be any unexpectedly elevated temperatures.

No analogue for juvenile magmatic waters which would be low in pH (i.e. 4.4 as per CDMG/WCRC, 2003) and exhibit a strong oxidizing character is known anywhere else in the San Juan Volcanic Field. Haba, et al (1985) calculated that the mineralizing waters at Creede were near a pH of 5.4 which "is nearly neutral pH at 250 °C." They calculate that the magmatic waters were very saline with a range of 4-12 percent by weight and had a total sulfur concentration of 0.018-0.30 molal. No evidence was found to support an upwelling "spring" with waters that geochemically resemble the initial waters envisioned by Haba, et al. The proposition that carbon and hydrogen isotopic analysis documents extremely old waters is questionable when the inorganic carbon input from the abundant carbonates in the district has not been factored into the equation.

There is hard evidence and anecdotal testimony that the water flow rate from the Nelson Tunnel is seasonal or at least appears to approximately vacillate on an annual basis. After development mining on the Nelson Tunnel and Commodore 5 level ceased early in the twentieth century, the flow equilibrated somewhat to reportedly around the current Nelson Tunnel output. Evidence is presented in the Byington report that the internal reservoirs, both large and small, tend to normalize the flow rate downstream to the Nelson Tunnel portal. Given connected reservoirs with water-flow constrictions (roof-fall dams) and ferrihydrite terraces throughout the Nelson Tunnel, the greatest fluctuations in water level should occur where the water inflow is the greatest. Evidence was presented documenting that the greatest fluctuations in water level occurred near the Del Monte shaft, which is directly below the Last Chance workings, and the Berkshire shaft. Evidence is presented that a very unusual water inflow was encountered by the Humphreys Tunnel Company in an area north of the Berkshire shaft during advance in the Nelson Tunnel. Specifically, an extraordinary flow was reportedly encountered where the Nelson Tunnel conspicuously jogs into the footwall.

2.5.5.2.2 Source Water Investigation Report of the Nelson Tunnel Mine Drainage

Hydrogeologic investigation of the sources and pathways of water contributing to acid mine drainage discharge were conducted by Colorado University's Institute of Arctic and Alpine Research from 2009 through 2013. The investigation included review of historic information, collection of geochemical and physical data from samples of mine waters at various locations, as well as samples from surface waters, springs, domestic wells and precipitation collectors in the West Willow Creek watershed. Isotopic analyses for tritium, deuterium, stable water isotopes, and dissolved inorganic carbon were used to provide information on the source of mine pool water. Tritium isotopes indicated that the Berkshire, Nelson and Bulldog mine water has an apparent age >50 years compared to samples from watershed areas (streams, seeps, springs, domestic wells) that contained measurable tritium, suggesting that these waters are primarily modern in origin. Radiocarbon 14C isotopes from dissolved inorganic carbon indicate that Nelson Tunnel and Bulldog mine water has an apparent age > 5,000 years. Results from the isotopic analysis provided the basis for a conceptual model for the Creede Mining District (Williams, 2014):

1. Water was recharged to the groundwater system at high elevations.
2. That water could not pass through the low-permeability northern caldera wall at the Equity fault.
3. This barrier forced water down to a depth of about 1-2 kilometers, where it reached a subsurface barrier below the Bulldog and Amethyst faults.
4. Water then flowed towards the Rio Grande until it reached a similar barrier at the southern caldera wall. Some groundwater flows through the caldera wall in what is probably a highly preferential flow path and some groundwater moves upward into a network of variable permeability fractures associated with the intragraben area between the Amethyst and Bulldog graben faults, with long residence times and circulation depths sufficient to generate consistently warm (~20 °C) discharge.
5. Prior to mining, the potentiometric surface within the intragraben area was higher than the Nelson Tunnel portal elevation due to the high recharge area elevation. The sub-Nelson mine workings were excavated into a water-bearing zone within the intragraben area and below the pre-mining potentiometric surface.
6. Water within this intragraben area is interconnected, and perturbations of the water level at any point in the area will affect water levels throughout the intragraben area.

7. These results indicate a large regional extent of mineralization associated with the graben fault system and suggest that degraded groundwater quality may exist beyond the extent of the mine environment.

2.5.6 Ecology

The major habitats affected by the Site consist of West Willow Creek, Willow Creek and the Rio Grande. The Site lies on West Willow Creek in the middle section of the Willow Creek watershed, which is divided into four sections, namely the upper, middle, Creede, and lower sections as described in the RI (USEPA, 2011). The portion of West Willow Creek where the tunnel discharges is confined by narrow canyons and a steep gradient. The lower portion of Willow Creek above the confluence with the Rio Grande River is a gently sloping alluvial floodplain (EPA, 2005 as cited in EPA, 2011).

The EPA completed an '*Aquatic Resources Assessment of the Willow Creek Watershed*' in 2005 to analyze the ecological and hydrological conditions of the watershed's surface water, groundwater, wetlands, and riparian habitat (EPA, 2005). The EPA (2005) identified more than 200 species of amphibians, reptiles, birds and mammals known to occur in Mineral County and about 35 other species that are likely to occur in the county. Mammals known to occur in the watershed include elk, mule deer, moose, beaver and others. United States Fish and Wildlife Service (USFWS) (2010) also lists several species of conservation concern in Mineral County. A complete list of species is provided in the Screening-level Ecological Risk Assessment (SLERA) (EPA, 2010) and contains two mammal species, three fish species, one insect species and two bird species.

West Willow Creek from upstream of Nelson portal and the confluence with East Willow Creek is characterized as a high-gradient stream with optimal habitat. Most of the stream upstream of Nelson portal has good epifaunal substrate and cover with limited sediment deposition, excellent vegetative protection and a healthy riparian zone. West Willow Creek goes through a canyon as it approaches the Commodore and Nelson portals. Waterfalls are prevalent through much of this reach. Upstream areas of the creek show optimal, unimpaired habitat.

West Willow Creek is affected by past human activities including channelization. Vegetation is mostly absent from the stream banks. A portion of the streambed downstream of Nelson portal is lined with rocks embedded in concrete which results in poor aquatic habitat; riparian vegetation is absent. The Commodore Waste Rock pile is prevalent on the east side of the stream bank just downstream of Nelson portal. Shoring structures are present by the edge of the stream.

Habitat is poor and no riparian zone exists upstream of the confluence with East Willow Creek. This section of West Willow Creek is channelized, with boulders placed along the banks for erosion control. Much of the stream also runs through a canyon. The stream is further impacted by CR-503. Habitat in this stretch is poor and much of the stream has experienced recent disturbances. Just upstream of the confluence with East Willow Creek, West Willow Creek consists of shallow, fast-moving water without any deep pools. This reach lacks vegetative protection or a riparian zone. The banks are stabilized by large rocks and boulders.

From the confluence of East and West Willow Creek to below the Town of Creede, Willow Creek shows poor fish habitat because vegetative protection is missing, and the riparian zone is absent. Willow Creek runs through the Town of Creede as a straight, concrete-lined channel lacking fish habitat and benthic invertebrates. The stream flows through a floodplain before it reaches the Rio Grande. Although this section of Willow Creek was not fully investigated for habitat quality, general observations show that the habitat is better than that found further upstream. The riparian zone is more established, and epifaunal substrate appears more suitable for colonization by benthic invertebrates.

2.5.7 Disturbed Areas

The Nelson Tunnel is an underground structure with the only surface disturbance in the areas immediately surrounding the Nelson portal (now collapsed) and the Commodore 5 level portal. The Nelson and Commodore 5 level portals discharge directly into West Willow Creek. The creek downstream of the discharge point is affected by past human activities including channelization as described in Section 2.5.6. Vegetation is mostly absent from the stream banks and a portion of the streambed downstream of Nelson portal is lined with rocks embedded in concrete. The Commodore Waste Rock pile begins at the Nelson Tunnel portal and extends downstream for approximately 0.1 miles.

2.5.8 Nature and Extent of Contamination

2.5.8.1 SITE CONCEPTUAL MODEL

A site conceptual model was developed for the entire Nelson Tunnel/Commodore Waste Rock pile site (OU 1 and OU 2) (**Figure 6**). The West Willow Creek pathway presented in the conceptual model reflects the discharge from Nelson Tunnel. The primary release mechanisms due to the discharge are surface water and acid rock drainage releases and indicate potentially complete pathways for surface water ingestion for all all-terrain vehicle (ATV) riders and rock hunters. Results from isotopic tracer studies performed during and after the RI show that the waters in the mine are largely not directly connected to surface waters or to the shallow groundwater (springs, seeps). Instead, this water in the tunnel appears to have a residence time on the order of hundreds to thousands of years, and tracer results suggest that this water is entering the tunnel in the slow-moving, quasi-stagnant Upper Mine Pool, likely resulting from the intersection of the tunnel with a system of watershed-wide faults (Williams, 2014).

2.5.8.2 SURFACE WATER QUALITY

Available data on levels of mining-related contaminants in the Willow Creek watershed indicate that several metals are present at elevated concentrations, including arsenic, cadmium, copper, lead, manganese and zinc (ATSDR, 2009). Regulatory criteria for Segment 4 of the Rio Grande, downstream of the Site, identify numeric standards for physical parameters, dissolved metals, and non-metallic inorganic contaminants. Metals concentrations are regulated based on hardness and can be calculated using metal-specific equations yielding Table Value Standards (TVS). TVS are set by the CDPHE Water Quality Control Commission. Based on historic and recent data, cadmium and zinc almost always exceed the chronic TVS for the Rio Grande.

Average hardness in the Rio Grande is approximately 36 milligrams per liter (mg/L) (CDPHE, Total Maximum Daily Load (TMDL) Assessment, 2010). The corresponding TVS for chronic cadmium and zinc exposure are 0.20 µg/L and 52 µg/L, respectively (CDPHE, 2009). No other regulated chemicals are noted to exceed TVS values in Segment 4 of the Rio Grande (CDPHE, 2010). The Human Health Risk Assessment (d) presented in the RI Report identified no additional chemicals posing risks above a level of concern based on incidental ingestion of surface water. The

Baseline Ecological Risk Assessment (BERA) identified several chemicals in water other than cadmium and zinc that may pose risks to ecological receptors above a level of concern. Among these are lead, manganese, copper, beryllium and others. However, risks to ecological receptors are most frequently driven by cadmium and zinc. Therefore, the chemicals used to describe the nature and extent of contamination in site water are cadmium and zinc.

Since publishing the RI in 2011, the EPA has collected surface water samples from West Willow Creek, East Willow Creek, Willow Creek and the Rio Grande to assess the impact of discharge from Nelson Tunnel. Typically, sampling has occurred four times a year. Samples have been analyzed by the EPA Region 8 Laboratory in Golden, Colorado. Surface water sampling locations are shown on **Figure 7** (EPA, 2019a).

The State of Colorado Department of Public Health and Environment Water Quality Control Commission (WQCC) regulates water quality and publishes water quality standards (WQS) specific to streams and stream segments in the state. The stream segments that correspond to the Site surface water sampling locations shown on **Figure 7** include:

- Rio Grande Segment 2, which is the river segment immediately upstream of the confluence with Willow Creek
- Rio Grande Segment 4a, which is the river segment immediately downstream of the confluence with Willow Creek
- Rio Grande Segment 7, which includes West Willow Creek and Willow Creek.

Water quality standards are applied based on the use classification. The applicable classifications for the three segments are listed in **Table 1**.

Table 1 Stream Segment Classifications

Stream Segment	Classifications
Willow Creek, West Willow Creek (Rio Grande Segment 7)	Aquatic Life Cold Stream Tier 2 Recreation Existing Primary Agriculture
Rio Grande Segment 2 (Upstream of Willow Creek)	Aquatic Life Cold Stream Tier 1 Recreation Existing Primary Water Supply Agriculture
Rio Grande Segment 4a (Downstream of Willow Creek)	Aquatic Life Cold Stream Tier 1 Recreation Existing Primary Water Supply Agriculture

Segment 4a of the Rio Grande is on Colorado's 303(d) list of impaired waters for lead and Segment 7 is on the 303(d) list for copper, cadmium, lead and zinc (CDPHE, 2018).

The following summarizes the comparison of cadmium, copper, lead, manganese and zinc concentrations to TVS:

- Cadmium: Concentrations exceed TVS in all samples collected in West Willow and Willow Creeks, including samples collected upstream of Nelson Tunnel. In the Rio Grande, 91% of samples collected downstream of the confluence with Willow Creek exceeded TVS, while none of the samples collected upstream of that confluence exceeded TVS.
- Copper: During high flow, concentrations exceed TVS about 40% of the time upstream and downstream of the Nelson Tunnel inflow in West Willow Creek and in Willow Creek. During low flow, none of the samples collected upstream of Nelson Tunnel exceeded TVS, while slightly more exceeded TVS in West Willow Creek than Willow Creek (23% and 18%). In the Rio Grande, none of the samples exceeded TVS.
- Lead: Concentrations exceeded TVS in all samples collected in West Willow and Willow Creeks, including samples collected upstream of Nelson Tunnel. In the Rio Grande, during high flow, none of the lead concentrations downstream of the confluence with Willow Creek exceeded TVS, while 19% during low flow exceeded TVS. None of the samples collected upstream of that confluence exceeded TVS.
- Manganese: Manganese concentration were below the TVS in all Willow, West Willow and Rio Grande measurements during high flow. The TVS is exceeded in 55% of the low flow samples collected in West Willow Creek and 12% of the low flow samples collected in Willow Creek. All the exceedances in Willow Creek occurred at location WSN. In the Rio Grande, one sample out of 26 exceeded the TVS downstream of the Willow Creek confluence and, based on the concentration, is likely due to an error.
- Zinc: Concentrations exceed TVS in all samples collected in West Willow and Willow Creeks, including samples collected upstream of Nelson Tunnel. In the Rio Grande, TVS during high and low flow was exceeded in 78% and 92% of the samples collected, respectively. None of the samples collected upstream of Willow Creek exceeded TVS.

The Nelson Tunnel portal discharge is the largest known point source of cadmium and zinc load to West Willow Creek, Willow Creek and Segment 4 of the Rio Grande. **Table 2** shows the high, low and average concentrations of metals for the Nelson Tunnel Discharge (WW-NT on **Figure 7**) from 2010 through 2016 in comparison to the 2019 WQCC Aquatic Life Standards for West Willow Creek and Willow Creek (Rio Grande Segment 7).

Table 2 Metals Concentrations - Nelson Tunnel Discharge (2010-2016)

	Dissolved Concentration in µg/L			**CO WQCC Aquatic Life Standards**	
Analyte	**High**	**Low**	**Average**	**Acute (cold)**	**Chronic**
Hardness	680	371	496	496	496
Al	4670	238	1135	NA	NA
Cd	998	9.51	210	9*	5*
Cu	1760	2.02	283	67*	45*
Fe**	857	104	290	NA	1000
Mn	19300	1550	14077	5090*	2812*
Pb	1980	67.3	911	350*	14*
Zn	64300	40900	49846	686*	520*

* TVS based on average Hardness 2010-2016
** Fe undetected (MDL >1000 µg/L) for several samples

In periods of the year when low flows are observed (August to mid-May), the Nelson Tunnel contributes approximately 11-48% and 22-78% of the highest load of cadmium and zinc, respectively, measured in Willow Creek. During high-runoff periods (mid-May to July), the Nelson Tunnel contributes between 19-39% and 30-55% of cadmium and zinc loads, respectively. Therefore, the Nelson Tunnel is not always the primary source of zinc and cadmium load in Willow Creek or the Rio Grande.

Additional cadmium and zinc load are introduced to Willow Creek, primarily along the floodplain below Creede. However, additional metal load has also been observed entering West Willow Creek between stations WW-E through WW-A (**Figure 7**). Under most flow conditions, the sum of these contributions exceeds the metals load introduced by the Nelson Tunnel portal discharge.

The following summarizes the information on the cadmium, copper, lead and zinc load contributions to Willow Creek and the Rio Grande, modifying the characterization of surface water impacts from Nelson Tunnel discharge:

- Cadmium: On average, 59% of the cadmium load exiting Willow Creek can be attributed to Nelson Tunnel. In the Rio Grande, the average load above Willow Creek is about 10% of the load below Willow Creek.
- Copper: The average copper load from Nelson Tunnel is 119% and 66% of the average load exiting Willow Creek during high and low flow, respectively. Copper is relatively pH sensitive and it is likely that some of the load from Nelson Tunnel precipitates as the pH

rises downstream of Nelson Tunnel. In the Rio Grande, loads measured at RG-2 average 66% of the copper load below Willow Creek. Note that copper does not exceed the TVS in the Rio Grande.

- Lead: The average lead load from Nelson Tunnel is 147% and 416% of the average load exiting Willow Creek during high and low flow, respectively. Lead is pH sensitive and it is apparent that some of the load from Nelson Tunnel precipitates as the pH rises downstream of Nelson Tunnel. In the Rio Grande, loads measured at RG-2 average less than 10% of the lead load below Willow Creek.
- Manganese: The average manganese load from Nelson Tunnel is 125% and 198% of the average load exiting Willow Creek during high and low flow, respectively. In the Rio Grande, loads measured at RG-2 average 66% of the manganese load at RG-4, below the confluence with Willow Creek.
- Zinc: The average zinc load from Nelson Tunnel is 56% and 78% of the average load exiting Willow Creek during high and low flow, respectively. In the Rio Grande, loads measured at RG-2 average less than 5% of the zinc load below the confluence with Willow Creek.

Additional sampling and data evaluation were conducted after the RI and the results were reported in the RI Addendum. Conclusions reported based on the additional sampling include:

- Based on evaluation of the autosampler data collected downstream of the Commodore Waste Rock pile, it is likely that significant rain events cause precipitated metals to become suspended, increasing the load within the stream. The CWRP is likely a major source.
- Diel sampling performed in 2016 and 2017 indicated that cadmium, manganese and zinc exhibit distinct diel variation, with the minimum concentrations occurring mid-day and the maximum concentrations occurring before sunrise and after sunset. Zinc exhibited the greatest variation: on average the dissolved zinc concentration was nearly four times greater before sunrise than late in the afternoon. Diel variation was not apparent in the concentrations of copper, iron and lead.
- Evaluation of sediment data collected from the Rio Grande monitoring stations suggest that discharge from Willow Creek has increased cadmium and lead concentrations to a level above EPA screening values. Zinc concentrations in sediment also indicate an increase downstream of Willow Creek, but to a level that does not exceed the screening values. Concentrations of copper in sediment were similar upstream and downstream of Willow Creek.
- Pore water samples were collected from the Rio Grande monitoring stations and concentrations of metals in pore water were compared to TVS. None of the lead or copper pore water samples exhibited concentrations above TVS. Cadmium concentrations exceeded TVS in 25% of samples collected at RG-2 and 25% of samples downstream of Willow Creek. Zinc concentrations exceeded TVS in 25% of samples.
- Bioassessment of macroinvertebrate samples collected at the Rio Grande surface water monitoring stations using Multi-Metric Index (MMI) scoring was completed from 2014-2017. All the MMI scores are above the threshold for attainment, indicating the aquatic communities at the Rio Grande monitoring stations are not impaired.

2.5.8.3 MINE POOL WATER

Water at the Nelson Tunnel portal and throughout the length of submerged Mine workings has a low pH, relatively high concentration of dissolved metals and minimal alkalinity. Cadmium and zinc concentrations fluctuate throughout the Nelson Tunnel but generally vary in a similar way. Concentration data for cadmium and zinc from the back of the Mine workings to the portal is described below:

- Zinc concentrations measured in the three sampling locations furthest from the portal (Park Regent Shaft, Decline and Berkshire Shaft) are similar at approximately 45,000 µg/L. Water at this location has a relatively low cadmium concentration with the lowest at the Park Regent Shaft in the rear of the tunnel. Unlike the samples collected at the Decline and Berkshire, the Park Regent samples represent surface infiltration inflows and not mine pool water.
- Between the Berkshire Shaft and No Name Winze, cadmium and zinc concentrations increase despite relatively clean surface inflows from the Amethyst 3 Shaft. Although not measured, the clean inflows occur at a low flow rate relative to flow in the mine pool. Therefore, any dilution effect is expected to be minor.
- A steep decrease in zinc and cadmium concentrations was observed between the No Name Winze and Commodore Shaft. There are no obvious sources of clean water inflow in this region of the tunnel. Below the Commodore Shaft, a steady increase in cadmium concentration was observed all the way to the portal. In the case of zinc, the concentration of zinc decreases between the No Name Winze and Lower Mine Pool.

2.5.8.4 COMMODORE WASTE ROCK PILE (OU1)

The Commodore Waste Rock pile is comprised of mine wastes from the Commodore and Nelson Tunnel workings, deposited between 1890 and 1960. The pile contains approximately 200,000 cubic yards (CY) of barren and mineralized rock containing metals such as lead, cadmium, copper and zinc (EPA, 2008). The minerals found in the waste rock include metallic sulfides, which are dominated by pyrite. A TCRA memorandum was issued in 2008 calling for stabilization of waste rock material at the Site. In accordance with the removal action, the pile has been reworked to reduce erosion and uncontrolled releases into Willow Creek during flooding or high runoff periods (EPA, 2008).

2.5.8.5 GROUNDWATER QUALITY

Groundwater in host rock or alluvium within the NPL Site boundaries was not evaluated as part of the RI due to the lack of groundwater data and lack of groundwater use in the NPL boundary of the Site. The leaching of metals from waste rock by infiltrating precipitation is addressed via the surface water. In addition, water flowing in the Nelson Tunnel and discharging from the portal is being evaluated separately from confined groundwater pathways. Flows in the Nelson Tunnel appear to originate primarily from upwelling groundwater in veins and fractures of the surrounding host rock. Some additional flows are believed to be coming from precipitation seeping through fractures and the mine workings above the Nelson.

The likelihood of groundwater use in and near the residential and commercial areas of Creede was assessed as a part of the RI. The assessment consisted of a review of a private water well survey (Kirkham, 2003) and contact with the Colorado State Engineer's office to determine if any new wells had been permitted since 2003. Based on the work done by Kirkham and Colorado State

Engineer's records (Naugle, 2011), as of 2003, no permitted groundwater wells existed in the developed portion of Creede. Creede provides municipal water sourced from wells proximal to the Rio Grande.

2.5.8.6 SURFACE SEDIMENT QUALITY

Contamination present in sediment in Willow Creek was not evaluated as part of the RI. Sampling to characterize the extent of contamination related to the Commodore Waste Rock Pile in 2010 did not include sediment because none was present within the boundaries of the study area. The metals loading to Willow Creek from the Nelson Tunnel discharge, Commodore Waste Rock and other upstream sources has contributed to the reported concentrations of metals in sediment at downstream locations in Willow Creek and in the Rio Grande. The specific contribution of sediment contaminants and sediment quality related to discharge within the Nelson Tunnel NPL boundary has not been evaluated. This contribution would be evaluated following the interim action remedy to develop the final remedy for the Site.

Sediment samples were collected from each of the four surface water monitoring stations in the Rio Grande from 2012 through 2017. From 2014-2017, pore water samples were also collected at these locations. Samples were collected once per year, in August or early September, and are noted in the 2019 RI Addendum (EPA, 2019a). Evaluation of sediment data collected from the Rio Grande monitoring stations suggests that discharge from Willow Creek has increased cadmium and lead concentrations to a level above EPA screening values. Zinc concentrations in sediment also indicate an increase downstream of Willow Creek but to a level that does not exceed the screening values. Concentrations of copper in sediment were similar upstream and downstream of Willow Creek.

2.6 Current and Potential Future Land and Resource Uses

2.6.1 Land Uses

<u>Current and Potential Future Land and Resource Uses</u>

Most of the property within the Nelson Tunnel Superfund Site is currently owned by the Commodore Mining Company and the Del Monte Mining Company. A parcel containing the collapsed Nelson Tunnel portal is on USFS-managed land. Previously, the above-ground and underground areas of the Site were used for hard rock mining as discussed in the Site Background and History in Section 2.1 and Section 2.2. Currently, the remediated Commodore Waste Rock pile and areas adjacent to the Commodore 5 level portal are being used as staging areas for EPA removal and remedial action work including underground stabilization, characterization and investigation projects and treatability studies. Some of the area within the Nelson Tunnel NPL boundary includes historical mining structures—in particular, there are some smaller structures upgradient of the Commodore Waste Rock pile (OU1). Structures adjacent to the Site include the Commodore structures above the Commodore 5 level portal and the large Ore House and Tram House. These off-site structures are the gateway to the historic mining Bachelor Loop roadway (CR 503) and essential to the local tourist economy (EPA, 2019b).

Since mining operations ceased, the above ground historical mining structures have deteriorated. Residents have raised concerns about the need to stabilize and preserve the structures for public safety and to maintain this unique example of local mining heritage. Several of the Commodore structures may pose a safety risk if portions of the structures collapse. A collapse could affect the

EPA's staging area for construction work next to the Commodore 5 level portal or the Bachelor Loop roadway, which serves as a tourist attraction and access to both public land and private residences. Interest in preserving the historic structures has been expressed to the EPA by the property owner and community members. To support the EPA's cleanup access and local planning, the EPA conducted a reuse situation assessment that identified reuse goals and considerations for the stabilization, preservation and potential reuse of the Commodore structures. Since the EPA does not plan on impacting any of these structures for the interim action, other entities will need to collaborate on the best way to stabilize and preserve these structures. Again, these structures are regarded as beyond the scope of the interim action, and as such, a cultural resource survey is not required.

The assumption in this IROD is that tourism will remain the predominant future land use for both public property (i.e., USFS-managed lands) and private property. There is interest in mining at the Amethyst 5 portal, but this area is outside the scope of this IROD. The EPA will coordinate closely with local entities regarding the interim action to avoid or minimize impacts on tourism activities along the Bachelor Loop roadway as much as is practicable. If interim remedial action construction activities are expected to impact road accessibility, interruptions will be minimized, and signage and advance notice will be provided to the community.

2.6.2 Surface Water Uses

The Site is located adjacent to West Willow Creek, a tributary to Rio Grande River. Willow Creek is not designated for water supply. This use classification is not likely to change in the future. The Town of Creede uses two tributary wells along the Rio Grande for its municipal water supply (including drinking water). These wells are located upstream of the confluence of the Rio Grande with Willow Creek. Creede does not directly divert water from the Rio Grande, but its adjacent wells pull water out of the alluvial aquifer around the river. Downstream of Creede the Rio Grande is used for agricultural, industrial, domestic and municipal water either via wells or river diversions. Where it is used for municipal purposes in the US, some level of treatment is typically needed to meet drinking water standards. Where it is used for domestic supply, treatment may or may not be carried out.

The CDPHE Water Quality Control Commission (WQCC) regulates water quality and publishes water quality standards (WQS) specific to streams and stream segments in the state. The stream segments that correspond to the Site surface water sampling locations include:

- Rio Grande Segment 2, which is the river segment immediately upstream of the confluence with Willow Creek
- Rio Grande Segment 4a, which is the river segment immediately downstream of the confluence with Willow Creek
- Rio Grande Segment 7, which includes West Willow Creek and Willow Creek

Water quality standards are applied based on the use classification (**Table 1**).

2.6.3 Groundwater Uses

The likelihood of groundwater use in and near the residential and commercial areas of Creede was assessed as a part of the RI. The assessment consisted of a review of a 2003 private water well survey and contact with the Colorado State Engineer's office to determine if any new wells had been permitted since 2003.

Based on the 2003 survey and Colorado State Engineer's records, no permitted groundwater wells exist in the developed portion of Creede. Creede provides municipal water sourced from wells proximal to the Rio Grande. As described in Section 2.5.8.5, there are no known groundwater wells or documented groundwater use within the Site boundaries.

2.7 Summary of Site Risks

A Baseline Human Health Risk Assessment (HHRA) was completed as part of the RI. The Site boundary for the HHRA was limited to the Nelson Tunnel, which drains directly into West Willow Creek, and the Commodore Waste Rock near the Nelson Tunnel portal. Risk to ATV riders from exposure to dust on CR-503 was also evaluated. The risk assessment results therefore reflect risks due to the combined sources and do not segregate risks from Nelson Tunnel or its discharge.

A Baseline Ecological Risk Assessment (BERA) was performed on the aquatic habitats potentially affected by the Site. The BERA was prepared after a Draft Screening-Level Ecological Risk Assessment (SLERA) (EPA, 2010) identified the potential for ecological risks above a level of concern.

2.7.1 Summary of Human Health Risk Assessment

2.7.1.1 CHEMICALS OF CONCERN

Chemicals of potential concern (COPCs) are chemicals which exist in the environment at concentration levels that might be of potential health concern to humans and which are or might be derived, at least in part, from Site-related sources. Soil COPCs from Commodore Waste Rock and from CR-503 (which could be traveled on by ATV riders traversing near and/or directly through the Site) were selected based on comparison of the maximum detected concentration for each chemical to Site-specific Risk-Based Concentrations (RBCs). If the maximum detected concentration does not exceed the RBC, it may be concluded that the chemical does not pose a significant risk to humans, including maximally exposed individuals. Risk-based concentrations were calculated for Rock hunter populations. Waste rock soil COPCs include arsenic, cadmium, chromium, lead and manganese. CR-503 COPCs include arsenic, chromium, lead and manganese. Willow Creek surface water COPCs include arsenic, chromium and lead.

2.7.1.2 EXPOSURE ASSESSMENT

Exposure is quantified by determining exposure point concentrations (EPCs) and conservative receptor-specific exposure parameters and then calculating intakes. Receptors selected for the HHRA include rock hunters who could be exposed to soil, dust and surface water, and ATV riders who could be exposed to soil/dust when riding on CR-503. Exposure routes for the rock hunter included incidental ingestion of soil/rock, incidental surface water ingestion while wading or otherwise engaging in activities along West Willow Creek, and inhalation of contaminated windborne particulates. Exposure routes for ATV riders included incidental ingestion of soil from CR-503 and inhalation of particulates from road base materials mobilized into the air by wind and vehicle traffic.

Subsequent data collected in 2017 and reported in the 2019 RI Addendum was evaluated and it was determined that risks to both adult and child ATV riders meet the EPA's risk criteria and are below the EPA's acceptable risk levels. Significant long-term direct ingestion of water from the Nelson Tunnel discharge, West Willow Creek or Willow Creek is unlikely and is not considered an exposure pathway. Absorption through the skin and other incidental contact exposures are not considered significant exposure pathways.

2.7.2 Summary of Ecological Risk Assessment

A BERA was performed on the aquatic habitats potentially affected by the Site. The BERA was prepared after a Draft SLERA (EPA, 2010a) identified the potential for ecological risks above a level of concern. The following is a summary of the BERA. The major habitats affected by the Site consist of West Willow Creek, Willow Creek and the Rio Grande.

2.7.2.1 EXPOSURE ASSESSMENT

The Conceptual Site Model (CSM) developed for the screening level assessment was re-evaluated to identify exposure pathways and receptors both on- and off-Site.

The receptor groups of concern were benthic invertebrates, water column invertebrates, fish, aquatic insectivorous birds, piscivorous birds, omnivorous birds, and herbivorous mammals. Exposure routes included direct exposures in sediment and surface water by aquatic receptors (invertebrates and fish), and ingestion of contaminated surface water and food items (such as aquatic insects, plants and fish) by wildlife feeding in Willow Creek and the Rio Grande.

2.7.2.2 COMPARE COPEC ECOLOGICAL EFFECTS ASSESSMENT

The following Contaminants of Potential Environmental Concern (COPECs) were identified as risk drivers for each receptor community:

- Benthic invertebrate community–cadmium, lead and zinc
- Water column invertebrate community–cadmium, lead, zinc and copper (Beryllium, iron, selenium, strontium and vanadium were also identified as risk drivers for the exposure unit (EU) located at the Nelson Tunnel discharge before its confluence with West Willow Creek)
- Fish–cadmium, lead and zinc (Manganese, beryllium, iron, selenium, strontium and vanadium were also COPECs for the EU located at the Nelson Tunnel discharge before its confluence with West Willow Creek)
- Aquatic insectivorous birds (American Dipper)–cadmium, lead, copper, zinc
- Omnivorous birds (Mallard)–cadmium, copper, lead and zinc
- Piscivorous birds (Belted Kingfisher)–cadmium and zinc
- Herbivorous mammals (muskrat)–cadmium, lead and zinc

The community-level receptors consisted of aquatic invertebrates (water column-dwelling and sediment-dwelling) and fish. The wildlife receptors, and their exposure routes, were as follows:

- *Insectivores* (represented by the American dipper) were assumed to eat aquatic invertebrates which accumulated COPECs from surface water. They also ingested COPECs by drinking surface water.
- *Herbivores* (represented by the muskrat) were assumed to eat aquatic plants which accumulated COPECs from surface water. They also ingested COPECs by drinking surface water.

- *Piscivores* (represented by the belted kingfisher) were assumed to eat fish which accumulated COPECs from surface water. They also ingested COPECs by drinking surface water.
- *Omnivores* (represented by the mallard duck) were assumed to eat 100% aquatic invertebrates (spring), or 50% aquatic invertebrates and 50% aquatic plants (fall), which accumulated COPECs from surface water. They also ingested COPECs by drinking surface water.

2.7.2.3 OVERALL RISK ASSESSMENT CONCLUSIONS AND BASIS FOR RESPONSE ACTION

The 2011 BERA for the Site concluded that the weight of evidence indicates ecological risks above a level of concern for water, aquatic invertebrates, trout and aquatic birds that eat insects in the Rio Grande River downstream of Willow Creek. However, a sediment survey of the Rio Grande River below the confluence with Willow Creek indicates only mild mine-water-related impacts based on a model for assessing populations in creeks and rivers. In addition, 2012 fish toxicity testing showed no significant acute toxicity occurred to young rainbow trout exposed to water samples collected downstream of the confluence with Willow Creek.

After the BERA was completed, toxicity testing was conducted in 2012 using waters collected from Willow Creek and the Rio Grande downstream of Willow Creek to evaluate aquatic toxicity of metals contamination associated with historical mining activities. The following conclusions were reached:

- In Willow Creek, serial dilution toxicity tests showed that poorly diluted surface water from this creek was acutely toxic to juvenile rainbow trout under the conditions that prevailed in April 2012
- Rio Grande surface water toxicity test showed that no significant acute toxicity occurred to juvenile rainbow trout exposed to water samples collected downstream of the confluence with Willow Creek

Study of samples collected at the Rio Grande surface water monitoring stations from 2014-2017 indicated that aquatic communities were not impaired.

2.8 Remedial Action Objective

The Remedial Action Objective (RAO) is to reduce the likelihood of a sudden and large release of the mine-impacted water in the event of a blockage failure within the Nelson Tunnel (OU2 of the Nelson Tunnel/Commodore Waste Rock Site). Such a release would result in human and ecological exposure to contaminated water and sediments discharged to surface water, groundwater, and stream and riverbed substrates. An additional consideration of the IROD is to develop a near-term remedy that provides long-term protection against a sudden and large release while not precluding other work that may be needed for other overall remedies. Water quality remediation goals are not being defined in this IROD because addressing surface water quality is not the focus of this Interim Action.

2.9 Development and Screening of Alternatives

2.9.1 Identification and Screening of 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.

2.9.2 Description of Alternatives

2.9.2.1 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. Re-grading 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 sudden and large release from the mine.
2. Extensive rehabilitation of the Commodore 5 level and some associated drifts during the 2018-2020 TCRA. The rehabilitation work provides for medium-term (at least 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 feet inby of the Commodore 5 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 reduce the likelihood of a buildup of pressure against the blockage that creates the Upper Mine Pool. Pressure relief is provided when the 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 the Upper Mine Pool Blockage. This is an important aspect of the TCRA rehabilitation work because if further collapses in the Commodore 5 level eliminate the means for water to bypass the 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 the Upper Mine Pool Blockage, which could result in a sudden, large 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.

2.9.2.2 ALTERNATIVE 2: SELECTIVE REHABILITATION OF MINE WORKINGS AND PERIODIC INSPECTIONS & MONITORING

This alternative is similar to Alternative 1 in that no action is performed to reduce the likelihood of a sudden, large releases from Nelson Tunnel or through the Commodore 5 level. Therefore, Alternative 2 does not meet the RAO, but was 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**) as part of the 2018-2020 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 the Commodore 5 level to provide pressure relief for the Upper Mine Pool, as described in Alternative 1.

2.9.2.3 ALTERNATIVE 3: CLEAR NELSON TUNNEL PORTAL POOL, TUNNEL REHABILITATION, INSTALL BULKHEAD IN NELSON TUNNEL AND FLOW-CONTROL STRUCTURE IN THE 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 outby of the Nelson-Wooster junction, and installation of a permanent flow-control structure in the Commodore 5 level. As part of this alternative, the tunnel outby of the bulkhead would be rehabilitated for long-term stability. This alternative would provide protection against a sudden, large release from Nelson Tunnel and from the 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 outby 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 hydrostatic head pressure will be determined after further study and consultation with the 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 a bulkhead is needed there 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. Re-grading 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 collapsed portal. 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 RD 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 slowed 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 (**Figure 8**). 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 to reduce the likelihood of a sudden, large release. The structure would include a manway, 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 for treatment since the pumped water would not settle out and filter through the portal collapse. Hence, provisions for a modular, temporary water treatment system 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 system would treat a portion of the flow (up to approximately 200 gpm) and be operated to maintain existing water quality. Treatment sludge could be disposed of off-site. Sludge disposal options would be evaluated during Remedial Design.

2.9.2.4 ALTERNATIVE 4: DRIVE NEW ADIT TO INTERSECT NELSON TUNNEL, TUNNEL REHABILITATION, INSTALL BULKHEAD IN NELSON TUNNEL AND FLOW-CONTROL STRUCTURE IN THE 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 9 and 10**). 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. Like 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 a sudden, large release from Nelson Tunnel and from the 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 9**). Based on survey data, the estimated invert elevation of the new adit would be 9182 feet above mean sea level. Realigment 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 10, 11 and 12**. 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 grade.

Based on available geologic mapping of the Nelson Tunnel (**Figure 8**), 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 the 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 to reduce the likelihood of a sudden, large release. The structure would include a manway, which would allow continued access to and ventilation of the inby mine workings.

Material conditions, logistics, and disposal volumes of materials and wastes generated from the bypass adit excavation would necessitate disposal outside of the mine or consideration of beneficial re-use options. Thousands of cubic yards of inert, "country rock" will be excavated and could be staged and re-purposed off Site by the USFS. The USFS works with the local Mineral County road and bridge department and has a need for this type of material. If this option is not available, the Commodore Waste Rock pile would be modified to incorporate the inert rock to the extent practicable while not comingling the material with the contaminated waste that currently is capped within the pile. Other waste streams generated during construction of the bypass adit could include heavily mineralized material, sludge already within the mine, wood and timber debris, clay gauge and byproduct from the water treatment system, which may either be consolidated within the mine workings or disposed of appropriately off-Site. During Remedial Design a Waste Management Plan will be developed identifying the storage and disposal options for the waste streams to be generated during the Interim Action. Estimates of each waste stream will be further evaluated for potential sequencing and storage or disposal of the materials either within the mine workings or off Site.

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 system 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 of off-site. Sludge disposal options would be evaluated during Remedial Design.

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 Tunnel. 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. Specific State of Colorado regulations to which this waiver would apply can be found in Sections 2.10 and 2.12.1.4. In Alternative 4, however, the time over which water would need to be managed would be shorter in duration as treatment 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 outby of the Bypass Adit and out the portal. These flows are expected to be minor.

2.9.2.5 ALTERNATIVE 5: DEWATERING OF STORED MINE POOL WATER, REHABILITATION 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. Like 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 RD phase. It is anticipated that water treatment would be needed throughout the construction period.

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. Significant off-site disposal may be necessary. As with Alternative 3, water will likely be pumped from a sump outby 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 system, 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 system and space requirements, it is assumed that the system would need to be located south of the Town of Creede. A new pipeline would be installed along Willow Creek to deliver flow to the system. The system 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. Depending on the anticipated volume of generation, treatment sludge would be disposed of off-site.

2.10 Summary of Comparative Analysis of Alternatives

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 3**. For each of the criteria, the alternative judged as the most favorable based on comparative analysis is listed as high ranking in **Table 3** 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.

Table 3 Alternative Comparison Summary

Evaluation Criterion	Alternative				Notes About Rankings
	1	3	4	5	
Overall Protection of Human Health and the Environment	○	⊕	⊕	●	Alternatives 3 and 4 are the most effective source control alternatives and 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 fully meeting surface water quality standards.
Long-Term Effectiveness	○	⊕	⊕	●	Alternatives 3 and 4 will meet the RAO by installing bulkheads and other flow control devices; whereas Alternative 5 will remove existing blockages but is not expected to provide long-term protection from sudden, large releases.
Reduction of Toxicity, Mobility and Volume through Treatment	○	○	○	○	The RAO of this Interim Action does not include long-term measures to improve surface water quality.
Short-Term Effectiveness	○	⊕	⊕	●	The schedule for completing construction is approximately two years for both Alternatives 3 and 4.
Implementability	⊕	●	⊕	○	Alternative 4, which includes constructing a bypass adit to avoid unstable portions of Nelson Tunnel, is considered easier to implement than Alternative 3.
Cost	⊕	●	●	○	Cost for Alternatives 3 and 4 are similar. In comparison, the cost for Alternative 5 is nearly 3 times greater than estimated costs for Alternatives 3 and 4.
State Acceptance	○	●	⊕	○	The State of Colorado concurs with the selection of Alternative 4 as the Preferred Alternative.
Community Acceptance	○	●	⊕	●	Most community members preferred alternative #4.

○ Low Ranking ● Moderate Ranking ⊕ High Ranking

2.10.1 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 reduce the likelihood of a sudden, large 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 reduce the likelihood of a sudden, large release should future collapses occur in the tunnel or workings that drain into it.

2.10.2 Compliance with Applicable or Relevant and Appropriate Requirements

It is anticipated that all the alternatives can be in compliance with Applicable or Relevant and Appropriate Requirements (ARARs). Alternatives 3, 4 and 5 would increase water flow from the Nelson Tunnel during construction, requiring treatment. Each of these alternatives would require an interim measures waiver to allow treated water to be discharged without fully meeting surface water quality standards.

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 the applicable or relevant and appropriate requirements of Federal and State environmental statutes or provides a basis for invoking a waiver.

A discussion of specific ARARs for the IROD is presented below. Chemical-specific, location-specific, and action-specific ARARs are identified in **Tables 4, 5 and 6**, respectively. The tables provide citations and a description of the citation.

2.10.2.1 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 include selected standards, criteria and guidelines that are typically considered ARARs for remedial actions conducted under CERCLA. **Table 4** summarizes the chemical-specific ARARs.

2.10.2.2 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. **Table 5** summarizes the location-specific ARARs.

2.10.2.3 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 is the National Pollutant Discharge Elimination System discharge regulations. Action-specific requirements do not, by themselves, determine the remedial alternative; rather, they indicate how a selected remedial alternative must be achieved. **Table 6** summarizes the action-specific ARARs.

Table 4 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. The CERCLA interim measures waiver will be invoked for this ARAR, as described in section 2.12.1.4 of the IROD.	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. The CERCLA interim measures waiver will be invoked for this ARAR, as described in section 2.12.1.4 of the IROD.	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 5 Location-Specific ARARs

FEDERAL LOCATION SPECIFIC REQUIREMENTS			
Location	**Requirements**	**Prerequisite**	**Citation**
Creede National Historic District	This statute and implementing regulations require federal agencies to consider the effect of this response action upon any district, site, building, structure, or object that is included or eligible for the National Register of Historic Places.	The Site is slated to become part of the Creede National Historic District.	National Historic Preservation Act, 16 U.S.C. § 470, 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.	Actions that may negatively impact the migratory birds and their habitat.	Migratory Bird Treaty Act, 16 U.S.C. § 703 *et seq.*, 50 CFR Part 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.	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
Realignment of West Willow Creek for installation of bypass adit portal platform	Clean Water Act Section 404 regulates the discharge of dredge or fill material into waters of the United States. Substantive requirements of a dredge and fill permit apply.	Discharge of dredge or fill material into West Willow Creek, a water of the United States.	Clean Water Act, 33 U.S.C. § 404 *et seq.*; 40 CFR. Parts 230, 231

Table 5 Location-Specific ARARs (cont'd)

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

Table 5 Location-Specific ARARs (cont'd)

STATE LOCATION SPECIFIC REQUIREMENTS			
Location	**Requirements**	**Prerequisite**	**Citation**
Areas where bulkhead, flow-control structure and other engineered features constructed	Requires environmental covenants (ECs) or notices 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	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] An EC or RN will be required for any 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 5 Location-Specific ARARs (cont'd)

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, S-WA-1 (p.49); S-CR-1 (p.57)

Table 6 Action-Specific ARARs

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
Discharging water from the water treatment system 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. The CERCLA interim measures waiver will be invoked for this ARAR, as described in section 2.12.1.4 of the IROD.	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. The CERCLA interim measures waiver will be invoked for this ARAR, as described in section 2.12.1.4 of the IROD.	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

Table 6 Action-Specific ARARs (cont'd)

STATE ACTION SPECIFIC REQUIREMENTS			
Action	**Requirements**	**Prerequisite**	**Citation**
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 Rule1 3.1.5(5), (10), (11)
Drilling for the bypass adit and other above-ground construction activities.	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)

[1] Pursuant to the Solid Wastes Disposal Sites and Facilities Act, C.R.S. § 30-20-102(4), mining operations, including reclamation activities, with approved reclamation plans under a Colorado Mined Land Reclamation Board (MLRB) permit may dispose of solid wastes generated by such operations within the permitted area without obtaining a Certificate of Designation. CDPHE interprets this provision to exempt CERCLA response actions similar to mined land reclamation activities described in the MLRB's Regulations, 2 C.C.R. 407-1 Rule 3 (Reclamation Performance Standards), from Colorado's regulations pertaining to solid waste disposal.

2.10.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refer 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 reducing the long-term threat of a sudden and large release from the Nelson Tunnel and Commodore 5 level. 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 the Nelson Tunnel and Commodore 5 level that regulate flow. The mine discharge also remains a source under Alternative 5, but Alternative 5 does not allow for regulation of flow, and future collapses could lead to increased likelihood of a sudden, large 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. Conversely, elimination of the mine pools would decrease mine water residence time, which may be responsible for a significant portion of the metal loading.

2.10.4 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.

2.10.5 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 the 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 three years and design and coordination may require a substantial amount of time. Siting of the treatment system 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 sited on the Commodore Waste Rock pile, due to the duration and design flow of the treatment system and space requirements, it is assumed that the system for Alternative 5 would need to be located south of the Town of Creede. Property agreements will likely be required along with a pipeline to convey the water from the mine workings to a treatment system south of Creede. Acquisition or lease of property for the treatment system will also be required.

Working with the existing 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 timeline required for selecting a water treatment technology and siting of the system. It will also require coordination with additional parties including the Colorado Division of Water Resources, the Town of Creede, US Forest Service and private parties.

Alternative 1 is not effective at reducing the short-term threat of a sudden, large release. Alternatives 3 and 4 are comparable in reducing the short-term threat of a sudden, large 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 a sudden, large 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, large 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.

2.10.6 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. Disposal of contaminated material from the Nelson Tunnel will likely be challenging and costly.

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. Much of the rock mined out from the bypass adit construction would likely be inert and could be used as construction material.

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 system. The pipeline to convey water to the system would need to cross many properties with different owners. Acquisition or lease of property upon which to construct and operate the system 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 Alternatives 3 and 4. Additional flow is not anticipated to be significantly larger than the typical 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 does not impact existing water rights.

2.10.7 Cost

A summary of the alternative costs is provided in **Table 7**.

Table 7 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 the Nelson Portal Pool, Tunnel Rehabilitation, Install Bulkhead in Nelson Tunnel and Flow-Control Structure in the 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 the 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

Details on the estimated cost of each alternative are provided in **Appendix A.**

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, the EPA estimates 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.

2.10.8 State Acceptance

For the Nelson Tunnel/Commodore Waste Rock Superfund Site, the EPA, as lead agency, has coordinated all Site activities with the CDPHE throughout this project. CDPHE, as the support agency, has participated in the development of, and has commented on the alternatives presented in, the proposed plan and the IROD. State comments and EPA responses on those documents are not included in the Responsiveness Summary. The EPA, as a partner to the CDPHE, acknowledged the State's concerns and comments through revisions to those documents.

CDPHE expressed its support and concurs with the EPA's decision to select Alternative 4 to address the risks to the citizens of Creede, Colorado, and downstream communities. The EPA agrees with the CDPHE regarding coordination with the Town of Creede to begin the process of implementing ICs where appropriate.

2.11 Principal Threat Wastes

The NCP establishes an expectation that the EPA will use treatment to address principal threats posed by a site wherever practical. The principal threat concept is applied to the characterization of "source material" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure. The EPA has defined principal threat wastes as those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. Source materials do not generally include groundwater, surface water, or residuals resulting from treatment of site materials.

No principal threat waste has been identified at the Nelson Tunnel/Commodore Waste Rock Superfund Site. The sources of contamination are mineralized materials within the geologic formation and mine waste located within the mine or immediately outside of the mine surface openings. The source material contains metal contaminants that are not considered highly toxic in the current form. Mineralized materials within the geologic formation and mine wastes located within the mine workings are contained and not highly mobile. Mine waste located outside the mine openings is somewhat mobile due to wind and water erosion; however, waste materials within the Commodore Waste Rock have been removed from the West Willow Creek flow path and re-graded to reduce fluvial mobilization. Run-on controls reduce erosion further. The mine waste can be reliably contained through a combination of engineering controls and administrative controls including containment, treatment, land-use restrictions and natural processes. Therefore, the mine waste is not considered principal threat waste. Discharges of water from the Nelson Tunnel and residuals from potential treatment of the mine discharges are not considered source material and are therefore not considered principal threat waste.

2.12 Selected Interim Remedy

The selected remedy for this IROD is Alternative 4, Drive New Adit to Intersect Nelson Tunnel, Tunnel Rehabilitation, Install Bulkhead and Flow-Control Structure. This alternative is recommended because it will meet the RAO more effectively than the other alternatives.

Because the selected remedy will require more than one construction season to implement, it will likely be completed in phases. Construction of a bypass adit that intersects Nelson Tunnel and bypasses the Nelson Tunnel Portal Pool will be constructed during the first phase. During the next construction phase, the bulkhead in Nelson Tunnel will be installed. In the final phase, an accessible flow-control structure in the Commodore 5 level will be installed.

Based on the information currently available, the EPA, as lead agency, and support agencies CDPHE and USFS, believe the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria.

The EPA and CDPHE expect the selected remedy to meet the statutory requirements of CERCLA 121(b) to the extent practicable for an interim action. This Interim Action is protective of human health and the environment with respect to the remedial action objective and is cost effective. Action-specific surface water quality standards for this limited scope action will be waived. Subsequent actions are planned to fully address the threats posed by mine-impacted water discharging from the Nelson Tunnel. Because this is an Interim Action, review of this Site and of this remedy will be ongoing as the EPA, CDPHE and USFS continue to develop final remedial alternatives for the Site.

2.12.1 Description of the Interim Remedial Components

The plan for Alternative 4 will include a new adit to be driven parallel to and south of the Nelson Tunnel to bypass the Nelson Portal Pool (**Figures 10 and 11**). Nelson Tunnel will be rehabilitated from the bypass connection to the bulkhead location. This will be a short distance because the bypass will intersect the Nelson Tunnel just below the planned bulkhead location. A shorter bypass will be riskier since the extent of the collapses are not known. A flow-through bulkhead will be installed in the Nelson Tunnel and a flow-control structure will be installed in the Commodore 5 level. This alternative will provide protection against a sudden, large release from the Nelson Tunnel and from Commodore 5 level, meeting the RAO. The construction duration is estimated to be two years.

2.12.1.1 INITIAL SITE SETUP

The first step of this alternative will 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 will 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 new bypass adit portal will be located south of the Nelson portal and will be headed at an elevation two feet below the Nelson portal along West Willow Creek (**Figure 9**). Based on survey data, the estimated invert elevation of the new adit will be 9,182 feet above mean sea level. Re-grading of West Willow Creek near the Commodore Waste Rock pile and installation of a bridge will 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 10, 11 and 12**. Access will be from the existing turn-off and access road that was used during the OU2 waste rock pile grading. The northern part of this existing road has a 25% grade. The bridge will likely match this grade and connect to a platform constructed at the bypass adit portal.

2.12.1.2 BYPASS ADIT CONSTRUCTION AND NELSON TUNNEL REHABILITATION

Based on available geologic mapping of the Nelson Tunnel (**Figure 8**), 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 will be performed in the face of the bypass adit as a precaution against encountering a permeable rock conduit for inflow from the Nelson Portal Pool. If inflows are encountered, pre-excavation grouting will be performed. Prior work (Emmons and Larson,

1923) indicates that some areas of running ground may be encountered during construction of the bypass adit. These areas may require additional ground support measures to be considered.

During construction of the bypass adit, the Nelson Portal will continue to be drained by gravity. Only just before connecting into the Nelson from the bypass adit will the Nelson Portal Pool be reduced by pumping from the Lower Mine Pool or from an outby cofferdam. The possibility of dewatering the Nelson Portal Pool via horizontal or directional drilling will also be investigated during the remedial design phase. Pumping rates will be incrementally increased, and water treated to avoid exacerbating the existing water quality in West Willow Creek during construction. After completion of the new adit, Nelson Tunnel discharge will be diverted to the new adit by gravity flow, eliminating the operation and maintenance costs of pumps. A diversion wall (thin bulkhead) will direct all flow into the new bypass adit. Some groundwater, including recharge from the ground above the Nelson, could still seep into the Nelson Tunnel outby of the bypass adit connection and discharge through the collapsed Nelson portal. These flows are expected to be minor.

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 will include strict site access control, secure storage and 24-hour guard. It will also likely require road closure or traffic control (or both) of the adjacent county road at certain times during blasting. Blasting for the bypass adit will be designed to limit vibrations in the Nelson Tunnel. Due to the close proximity of the new adit to the existing collapsed portal, blasting will need to be controlled to ensure that ground movement does not cause failure of the existing portal collapse. Blasting engineers will design and simulate the blasting to mitigate the potential for blast-induced forces that could cause failure of the collapse material and to determine if other specific control measures are required.

2.12.1.3 NELSON TUNNEL BULKHEAD AND THE COMMODORE 5 LEVEL FLOW-CONTROL STRUCTURE

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 will likely have few fractures and be relatively impermeable. The depth of rock cover at this location is enough for bulkhead design requirements. The bulkhead will be a concrete plug, grouted radially to reduce seepage. The plug will have a stainless-steel pipe with a valve to allow water through. The intent will be to allow all normal flow through and not to impound water beyond the depth of the pipe. The valve and pipe will 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 adjusted.

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

After bulkhead installation in the Nelson Tunnel, the final requirement for Alternative 4 will 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 will 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 will provide a means to control and regulate flows to reduce the likelihood of a sudden and large release. The structure will include a manway, which will allow continued access to and ventilation of the deeper mine workings for maintenance and inspection.

2.12.1.4 WATER TREATMENT AND WASTE DISPOSAL

This alternative requires diversion of a portion of Nelson Tunnel flows through the Commodore 5 level during construction. While an interim measures waiver will apply to the temporary Commodore 5 level discharges, those discharges will be treated to ensure water quality is not further degraded from existing conditions in West Willow Creek. Regulations that this waiver will apply to can be found in the ARARs tables of Section 2.10 and include: the Colorado Surface Water Quality Classifications and Numeric Standards (5 CCR 1002-36, pursuant to C.R.S. §§ 25-8-203 and 204); the Colorado Basic Standards and Methodologies for Surface Water (5 CCR 1002-31, pursuant to C.R.S. § 25-8-101 *et seq.*); the Colorado Discharge Permit Regulations (5 CCR 1002-61 pursuant to C.R.S. § 25-8-501); and the Colorado Effluent Limitations (5 CCR 1002-62, pursuant to C.R.S. § 25-8-205). Provisions for a modular, temporary water treatment system located on the Commodore Waste Rock pile to provide supplementary treatment maintaining 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 evaluated during Remedial Design. It is assumed that the system will treat a portion of the flow (up to approximately 200 gpm) and be operated to maintain existing water quality in West Willow Creek.

Other wastes generated by the interim action include heavily mineralized ore, muck within the mine, wood and timber debris, clay gauge and byproduct from the water treatment system. To meet the MLRB-Regulations ARARs, acid-forming or toxic-producing mine waste will be handled and disposed of in a manner that will control unsightliness and protect the surface and groundwater drainage system from pollution. Inert country rock excavated during bypass adit construction constitutes environmental media and is not considered solid waste. As such, it can be used as construction material. This material could be staged and re-purposed off-Site by USFS and utilized by the Mineral County road and bridge department. Alternatively, the Commodore Waste Rock pile could incorporate inert country rock so long as it does not comingle with the mine waste beneath the existing cap.

A Waste Management Plan will be developed during Remedial Design identifying the storage and/or disposal options for the waste streams generated during the interim remedial action. Estimates of each waste stream will be further evaluated for potential sequencing and storage or disposal of the waste materials either within the mine workings or off site. Water treatment sludge will be disposed of off-site as specified in the Waste Management Plan.

2.12.1.5 INSTITUTIONAL AND LAND USE CONTROLS

ICs are defined as “non-engineered instruments that help minimize the potential for exposure to contamination and/or protect the integrity of a response action” in the *Institutional Controls: A*

Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites (EPA, 2012). ICs are a subset of land use controls (LUCs). LUCs include engineering and physical barriers, such as fences and signs, as well as ICs. Final ICs will be selected in the final record of decision; however, the NCP recommends that ICs should be used to supplement engineering controls during all phases of cleanup.

The EPA and the State of Colorado will work together to implement ICs necessary to protect the integrity of the interim remedial actions taken in this IROD. ICs could include governmental or proprietary controls on land use as provided by the Colorado Environmental Covenants Statute, C.R.S. §§ 25-15-317 *et seq*. (EC Statute), enforcement tools that limit certain activities, and informational devices to provide information or notification to local communities, recreational users and other interested persons, as appropriate.

The EC Statute has been identified as an applicable requirement for the engineered components of the interim remedial action. In the event Mineral County does not enact an ordinance pursuant to C.R.S. § 25-15-320, the EPA, in coordination with the State, will evaluate the use of restrictive notices to establish use restrictions prohibiting activities that may interfere with engineered components of the interim remedy.

2.12.2 Summary of the Estimated Interim Remedy Costs

The cost estimates comparisons shown in **Table 6** are generally based upon recent experience with similar work, adjusted for inflation, escalation and professional judgment. The following points summarize the estimated Interim Remedy Costs:

- Alternative 1 has zero costs for Capital and 30-year O&M net present value
- Estimated costs for Alternative 3 are as follows:
  - Capital Cost = $13,313,000
  - 30-year O&M[1] = $1,776,000
  - **Total Cost = $15,089,000**
  - 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 enters the Nelson Tunnel construction area.
- Estimated costs for Alternative 4 are as follows:
  - Capital Cost = $10,318,000
  - 30-year O&M[2] = $1,411,000
  - **Total Cost = $11,729,000**
  - 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

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[1] O&M costs include yearly inspections and annual costs to maintain rehabilitation of the adits. Cost is calculated as the present worth cost, which is the total cost of an alternative over time in terms of today's dollars.

- Estimated costs for Alternative 5 are as follows:
  - Capital Cost = $55,237,000
  - 30-year O&M[2] = $2,822,000
  - **Total Cost = $58,059,000**
- Completion of the TCRA to rehabilitate the Commodore 5 level is reflected in the estimated costs
- Cost differences between alternatives reflect the length of adit that would require maintenance

Appendix A presents the detailed cost estimates for these alternatives.

2.13 Statutory Determinations

The interim remedial action selected for implementation at the Nelson Tunnel/Commodore Waste Rock site is consistent with CERCLA and, to the extent practicable, the National Contingency Plan. The selected interim remedy is protective of human health and the environment, will comply with ARARs or appropriate waivers, and is cost-effective. In addition, the selected remedy utilizes permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable. The interim remedy will include driving a new bypass adit to intersect the Nelson Tunnel, Nelson Tunnel rehabilitation, and the installation of a bulkhead in Nelson Tunnel and a flow-control structure in the Commodore 5 level.

2.13.1 The Selected Remedy is Protective of Human Health and the Environment

The selected interim remedy will adequately protect human health and the environment by reducing the likelihood of a sudden and large release of the mine-impacted water impounded within the Nelson Tunnel and associated workings. The selected remedy will reduce environmental risk to protective ARARs levels.

Implementation of the selected remedy will not pose any unacceptable short-term risks or cause cross-media impacts.

2.13.2 The Selected Remedy Complies with ARARs

It is expected that all components of the remedial action can be performed in accordance with the ARARs shown on **Tables 4 through 6** including odor, dust and noise control, mining reclamation, weed control, wildlife protection, and cultural and natural resource protection. The ability to comply with key ARARs is described below.

2.13.2.1 COLORADO SURFACE WATER REGULATIONS

Colorado Water Quality Standards (WQS) will be the primary trigger for determining if additional remedial action is required. During the interim remedial action, the EPA will invoke an interim-measures ARARs Waiver, which ensures the interim remedy is consistent with the final remedy. Current water quality conditions in West Willow Creek will not be degraded during remedial construction. The EPA is invoking an interim measures waiver for this interim remedy as the project currently does not have the capacity to install a full-scale active water treatment system. The EPA and CDPHE's intentions are to not further degrade water quality during interim action. EPA contractors will treat water to a point where the water quality remains the same and will not worsen.

Colorado Discharge Permit System (CDPS) regulations will be applicable to discharges from a temporary water treatment system during the interim remedial action. A permit is not needed for on-site remedial actions, but the substantive requirements of a permit, including discharge criteria, would be established cooperatively between the EPA and CDPHE. The State develops discharge requirements to support existing WQS attainment. For this interim remedy, the EPA and CDPHE are invoking an interim measures waiver as the project currently does not have the capacity to install a full-scale active water treatment system currently. The EPA and CDPHE's intentions are to not further degrade water quality during interim action. EPA contractors will treat water to a point where the water quality will not worsen and the discharge effluent concentrations from the temporary water treatment system will reflect this intention.

2.13.2.2 SECTION 404 OF THE CLEAN WATER ACT

Section 404 of the Clean Water Act (CWA) and regulations promulgated under the CWA prohibit dredge and fill activities that adversely affect waters of the United States if a practicable alternative that has less adverse effect exists. This ARAR applies to the realignment of West Willow Creek, which is necessary to build the bypass adit platform for the selected remedy.

2.13.2.3 COLORADO ENVIRONMENTAL COVENANTS ACT

Either a county-enacted ordinance or restrictive notice will be implemented to protect engineered components of the remedy. This will satisfy the Colorado Environmental Covenants Act.

2.13.2.4 NATIONAL HISTORIC PRESERVATION ACT

The EPA conducted a reuse situation assessment in 2019 that identified reuse goals and considerations for the stabilization, preservation, and potential reuse of the Commodore historical mining structures that are located within and around the Site. The EPA does not anticipate the interim remedy will impact any of these structures; therefore, a cultural resource survey was not conducted. The Site is projected to become a part of the Creede National Historic District. As more information becomes available, the EPA will continue to evaluate and mitigate potential impacts to the Site's historical structures, as required by the National Historic Preservation Act.

2.13.3 The Selected Remedy is Cost Effective

In the EPA's judgment, the selected remedy is cost-effective because costs are proportional to its overall effectiveness. This determination was made by evaluating the long-term effectiveness and permanence of reducing the likelihood of a sudden, large release of impounded mine water through installation of flow-control structures in the Nelson Tunnel and the Commodore 5 level and the short-term effectiveness of the remedy components. Selecting a phased approach for interim action that starts with lower-cost alternatives and only progresses to water treatment as a potential final remedy, a remedy with long-term O&M obligations, ensures that the minimum costs will be incurred by the EPA and the State to achieve long-term effectiveness.

The source control alternatives would reduce contaminant mobilization and the impacts of the Site to West Willow Creek and downstream receptors; however, the effectiveness of the flow-control structures in meeting ARARs and cleanup goals is uncertain. The selected remedial components require little O&M, and the overall costs are relatively low. Implementation of the remedial components would reduce the scale of a water treatment system, and thus water treatment costs, should that be needed to meet future ARARs and cleanup goals. Therefore, it was determined that these components are cost effective methods of meeting the RAO.

2.13.4 The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to The Maximum Extent Practicable

The selected remedy primarily consists of permanent solutions to reduce the risk of a sudden, large release of impounded mine water, thus reducing contaminant mobility, the volume of contaminated water emanating from the mine, and impacts to downstream waters. The selected remedial components are expected to require little maintenance with the result of permanently controlling the flow of water from the Nelson Tunnel.

If water treatment is required to meet an interim-measures ARARs waiver, a temporary active treatment system will be utilized during construction. The size and scope of this treatment system would be evaluated during the Remedial Design phase.

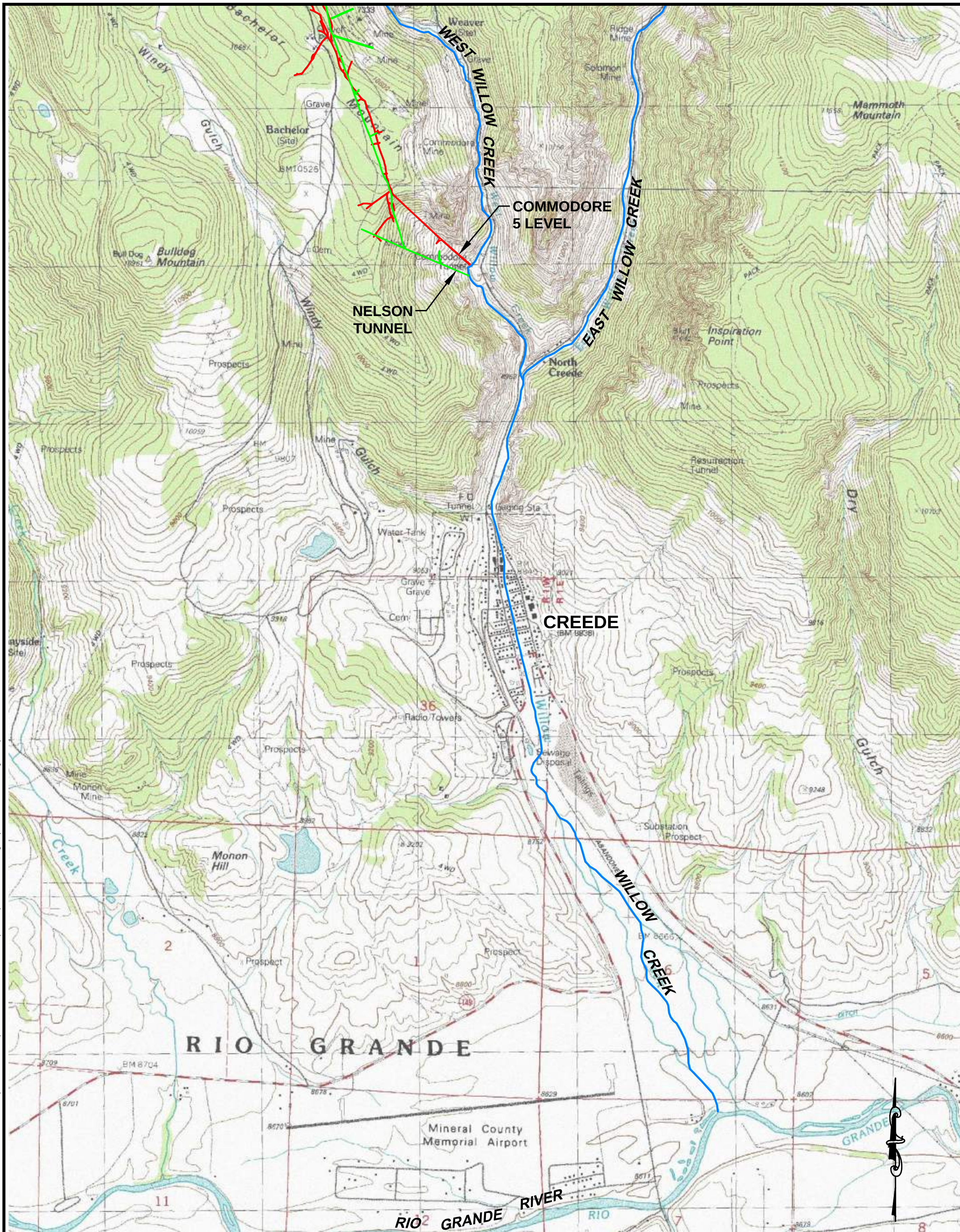
2.13.5 Five-Year Reviews of the Selected Remedy Are Required

The interim remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure; therefore, five-year reviews are required to ensure that the remedial action being implemented protects human health and the environment. The first review will be conducted within five years after initiation of the remedial action.

2.14 Documentation of No Significant Changes

The EPA reviewed all written and verbal comments submitted during the public comment period and it was determined that no significant changes to the remedy as described in the Proposed Plan were necessary or appropriate.

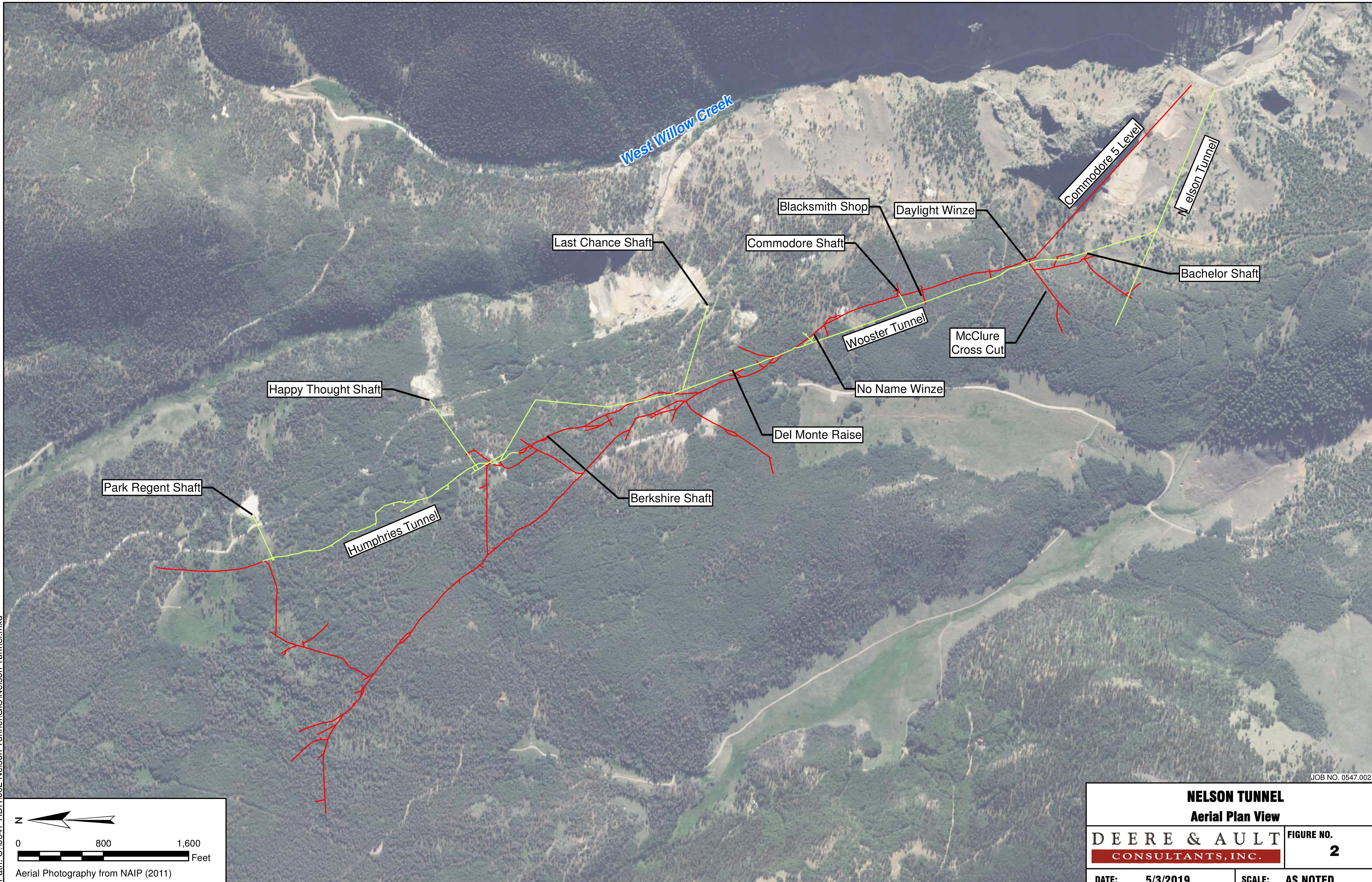
FIGURES



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

DEERE & AULT CONSULTANTS, INC.

NELSON TUNNEL VICINITY MAP		FIGURE NO. 1
JOB NO. 0547.002.00	SCALE: None	



Path: U:\0547 HDR\002 Nelson Tunnel\GIS\Nelson Tunnel.mxd

JOB NO. 0547.002.00

NELSON TUNNEL

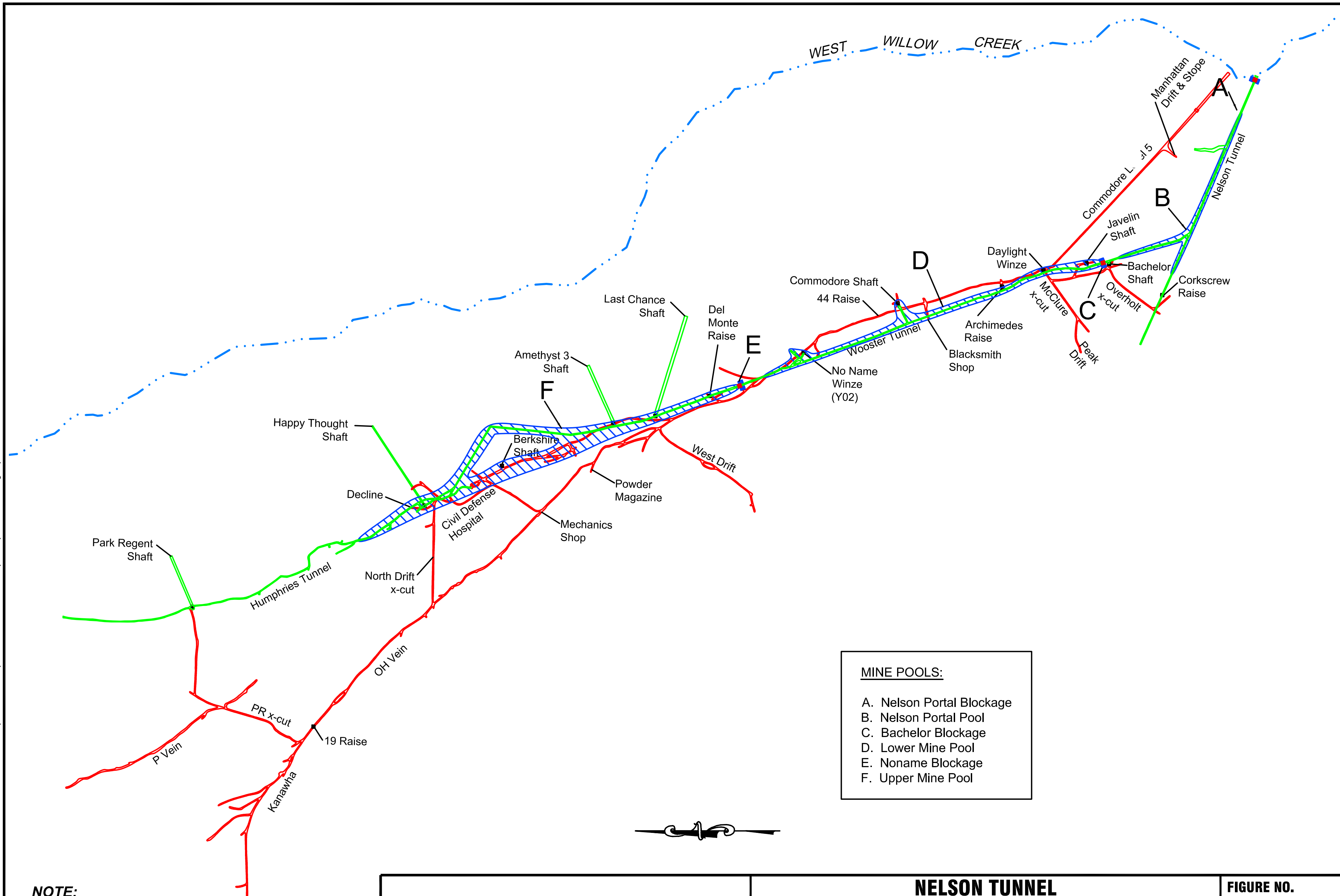
Aerial Plan View

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 2

DATE: 5/3/2019

SCALE: AS NOTED



NOTE:

MINE MAP BY CDRMS

DEERE & AULT CONSULTANTS, INC.

NELSON TUNNEL

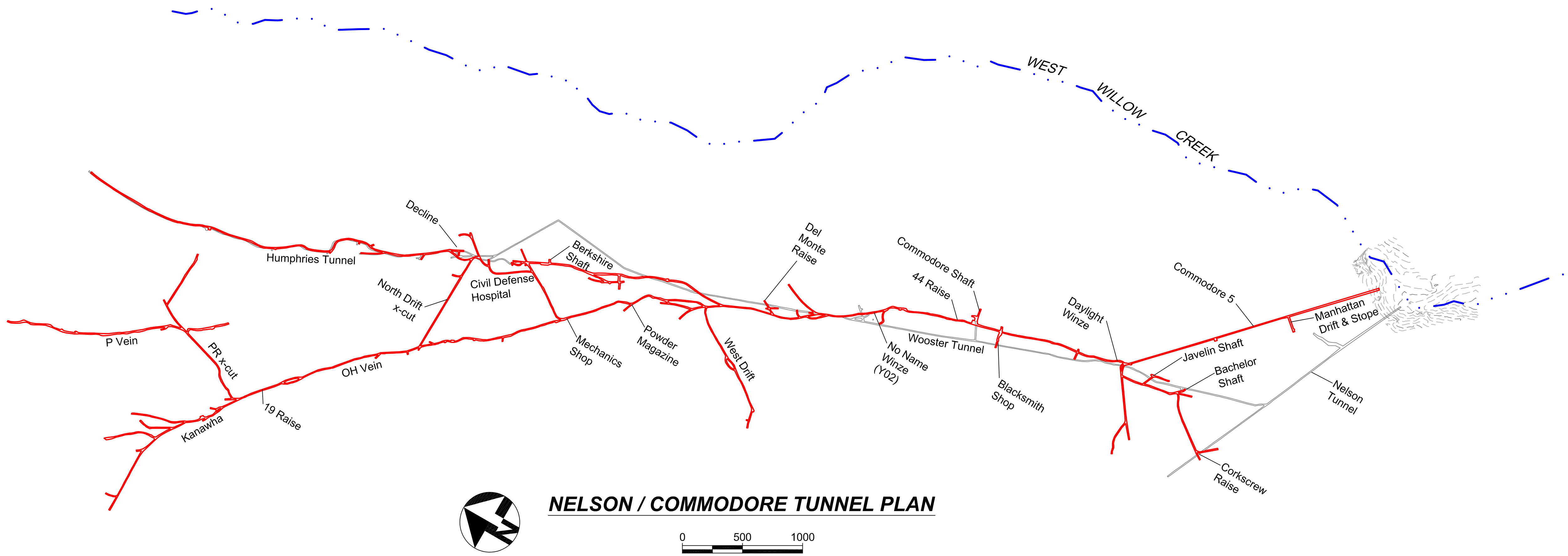
MINE POOL LOCATIONS

JOB NO.	**0547.002.00**	**SCALE:**	**None**

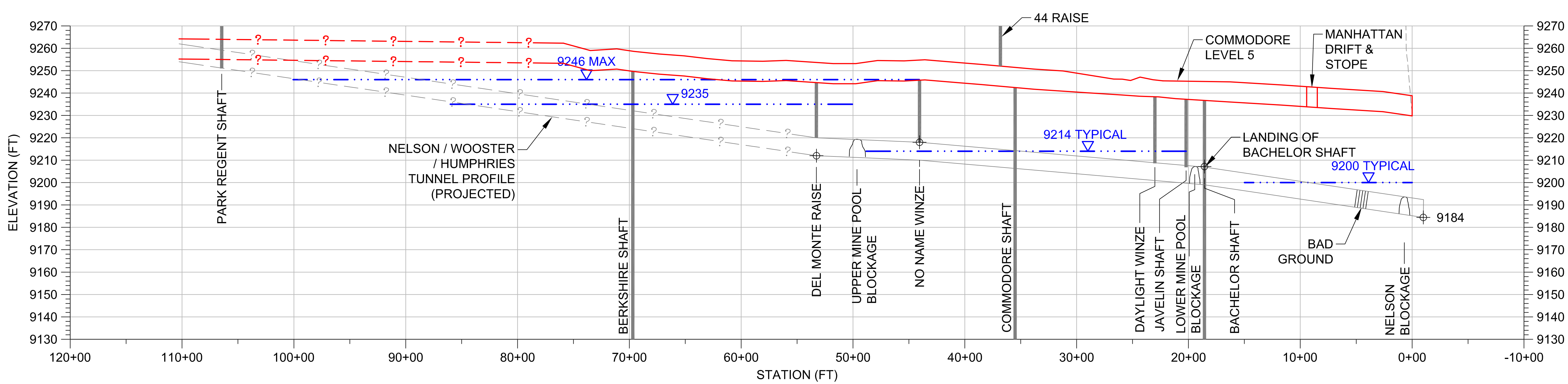
FIGURE NO.

3

Friday, May 3, 2019 4:44:34 PM DRAWING: U:\0547 HDR\002 Nelson Tunnel\CAD\DAC Drawings\Nelson Mine Pool Locations.DWG



NELSON / COMMODORE TUNNEL PLAN



NELSON / COMMODORE TUNNEL PROFILE

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

JOB NO. 0547.002.00

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.

NELSON TUNNEL

PLAN AND PROFILE OF UNDERGROUND WORKINGS

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 4

DATE: MAY 2019

SCALE: AS NOTED

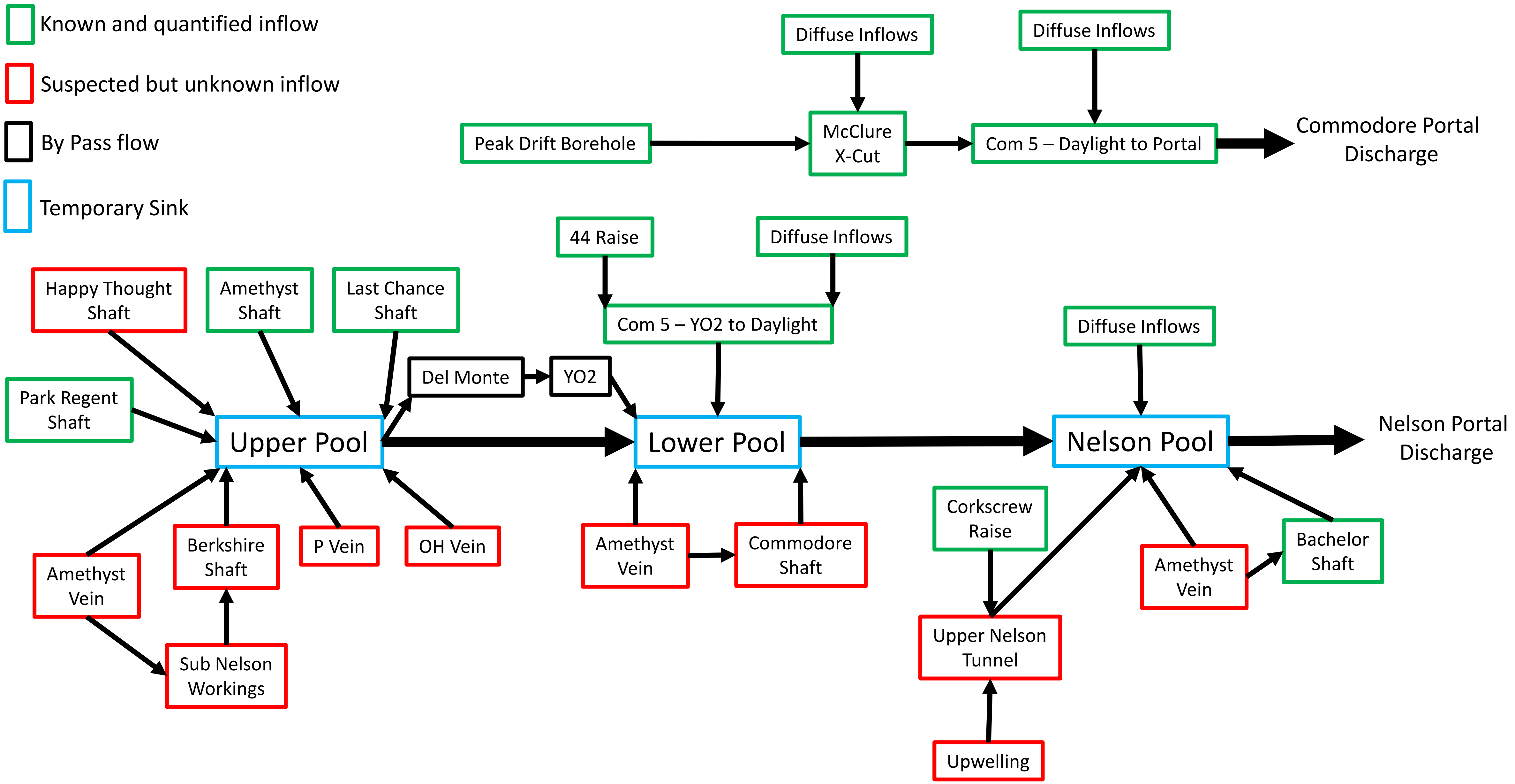
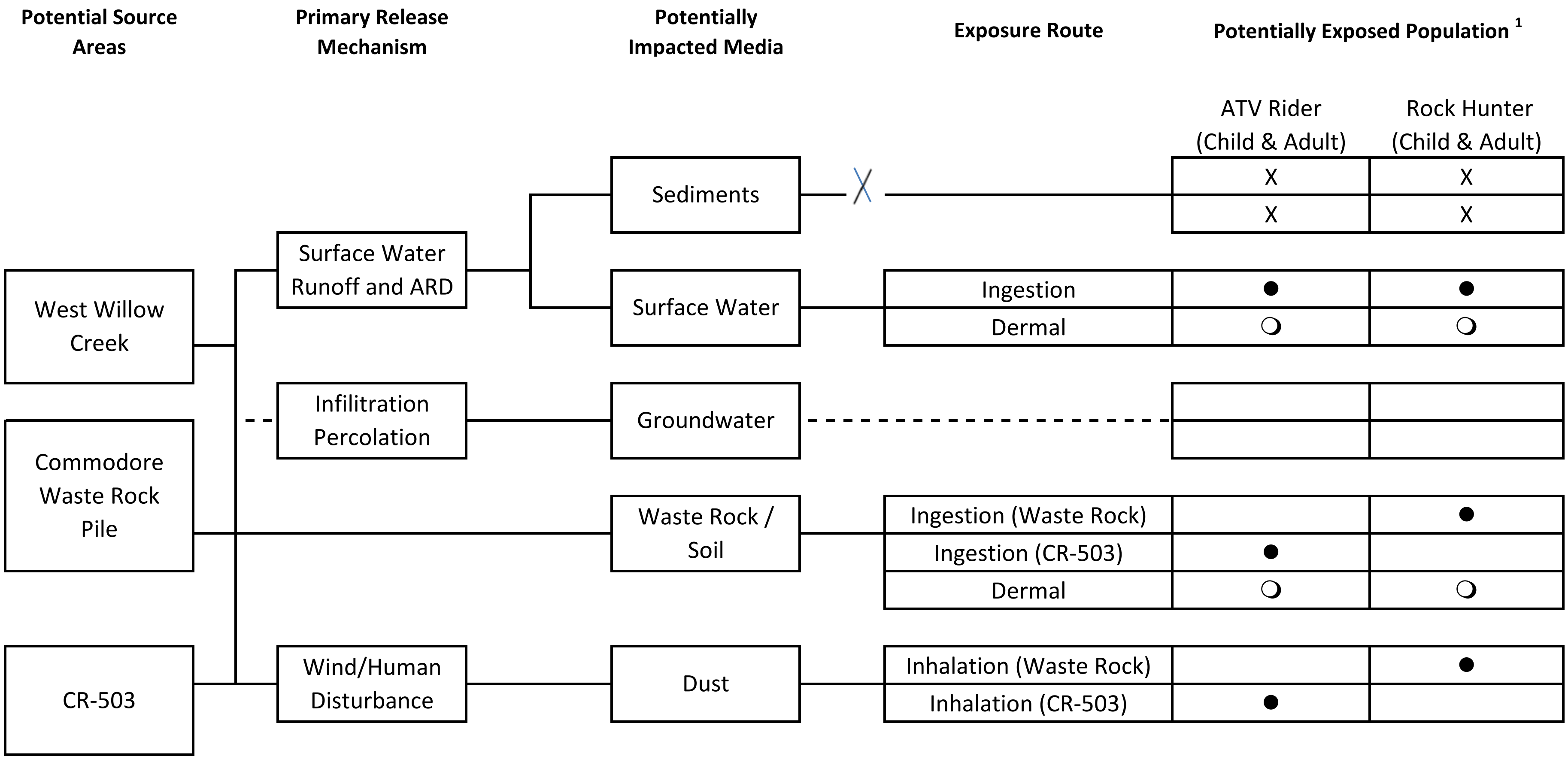


Figure 5. Site Conceptual Groundwater Flow Model for Nelson Tunnel/Commodore Waste Rock Pile

Figure 6. Site Conceptual Exposure Model for Human Receptors
Nelson Tunnel/Commodore Waste Rock Pile



[1] Child receptors are assumed to be mainly older children/adolescents (ages 6 - 12 yeards old)

●	Potentially complete pathway, quantitiave evaluation.
❍	Potentailly complete pathway but judged to be minor, qualitative evaluation.
X	Pathway not complete, no evauation required (no sediment present).
- - - - - - - - - -	Pathway not included in scope of investigation.

ARD Acid Rock Drainage

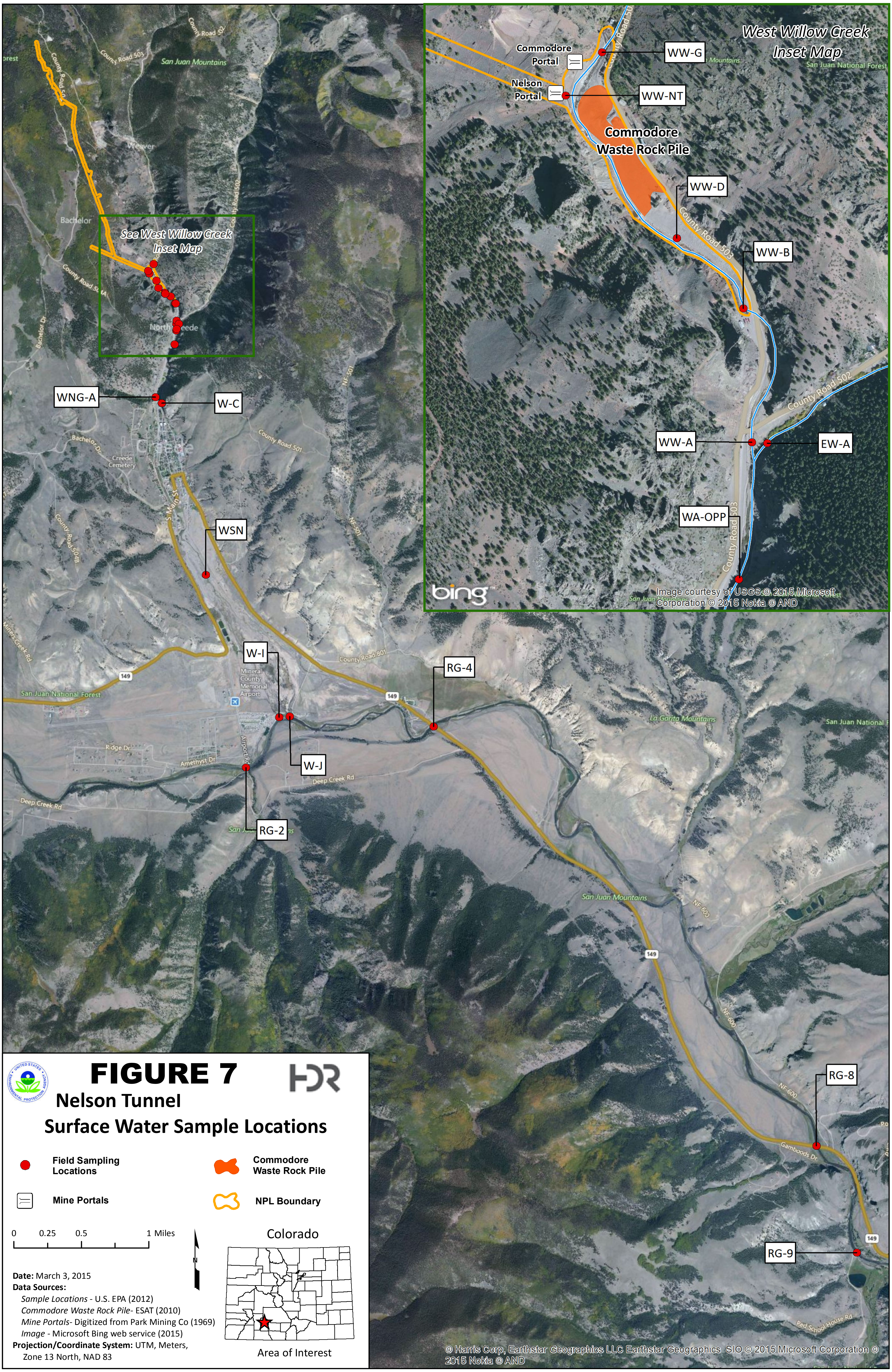
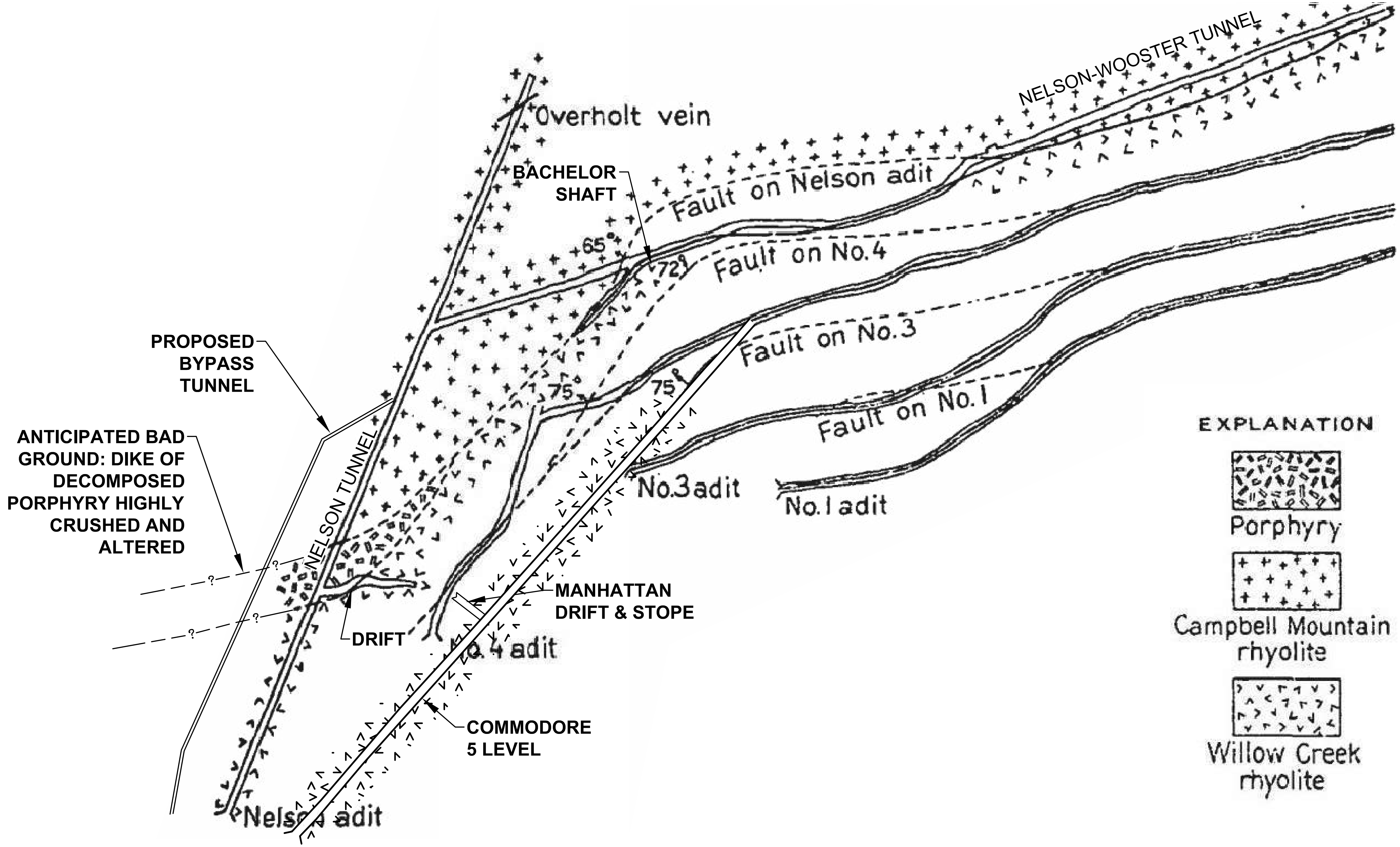


FIGURE 7
Nelson Tunnel
Surface Water Sample Locations
Field Sampling Locations
Commodore Waste Rock Pile
Mine Portals
NPL Boundary
0 0.25 0.5 1 Miles
Colorado
Area of Interest
Date: March 3, 2015
Data Sources:
Sample Locations - U.S. EPA (2012)
Commodore Waste Rock Pile- ESAT (2010)
Mine Portals- Digitized from Park Mining Co (1969)
Image - Microsoft Bing web service (2015)
Projection/Coordinate System: UTM, Meters, Zone 13 North, NAD 83
West Willow Creek Inset Map
Commodore Portal
Nelson Portal
Commodore Waste Rock Pile
WW-G
WW-NT
WW-D
WW-B
WW-A
EW-A
WA-OPP
County Road 503
County Road 502
Image courtesy of USGS © 2015 Microsoft Corporation © 2015 Nokia © AND
See West Willow Creek Inset Map
WNG-A
W-C
WSN
W-I
W-J
RG-2
RG-4
RG-8
RG-9
Creede
San Juan Mountains
La Garita Mountains
San Juan National Forest
County Road 505
County Road 501
County Road 801
Deep Creek Rd
Gamboods Dr
149
© Harris Corp, Earthstar Geographics LLC Earthstar Geographics SIO © 2015 Microsoft Corporation © 2015 Nokia © AND



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

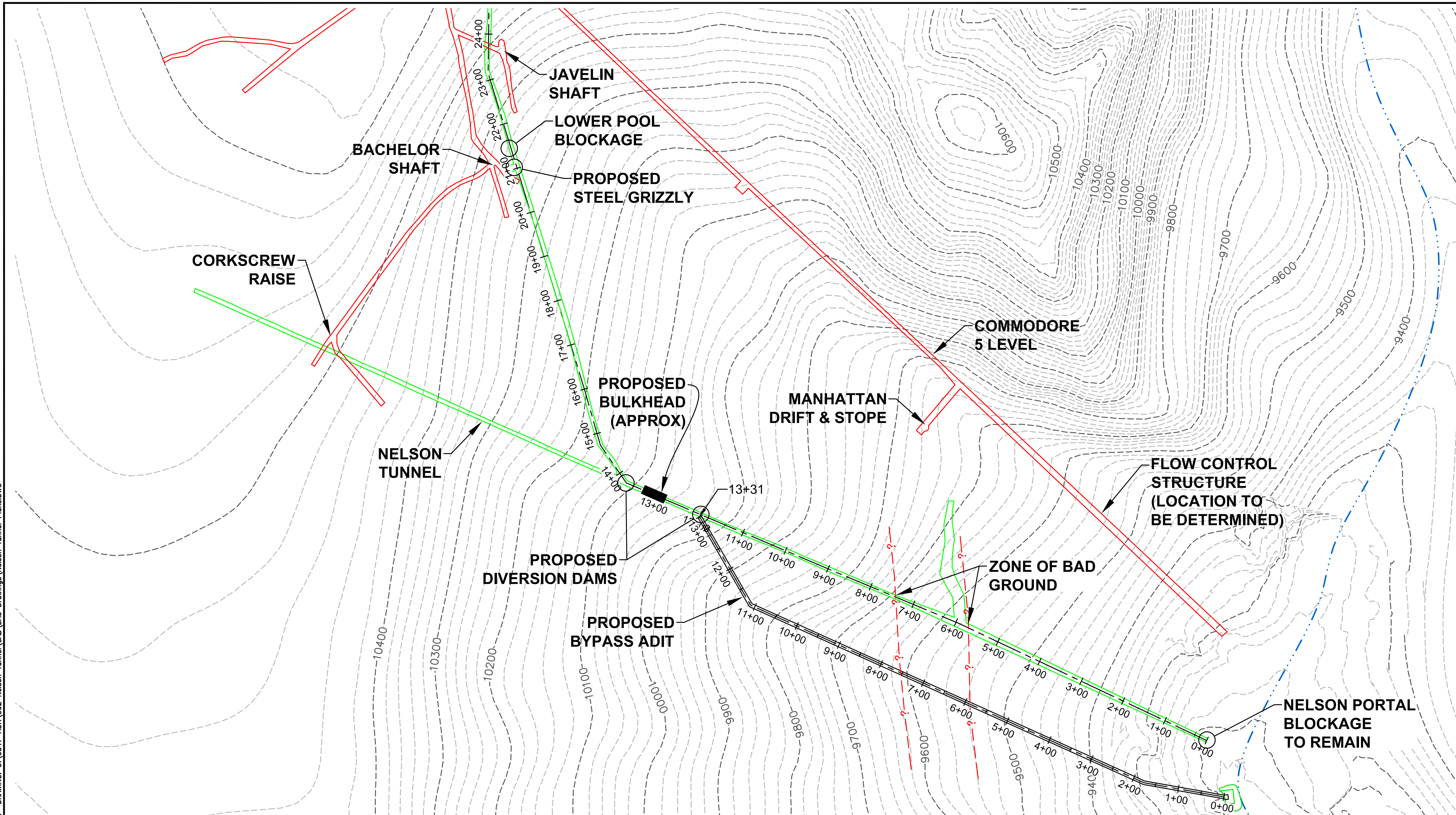
0 150 300
SCALE IN FEET

JOB NO. 0547.002.00

NELSON TUNNEL GEOLOGIC MAP			
DEERE & AULT CONSULTANTS, INC.		FIGURE NO. 8	
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

Friday, January 31, 2020 9:04:58 AM DRAWING: U:\0547 HDR\002 Nelson Tunnel\CAD\DAC Drawings\Nelson Tunnel Plans.DWG



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

NELSON TUNNEL

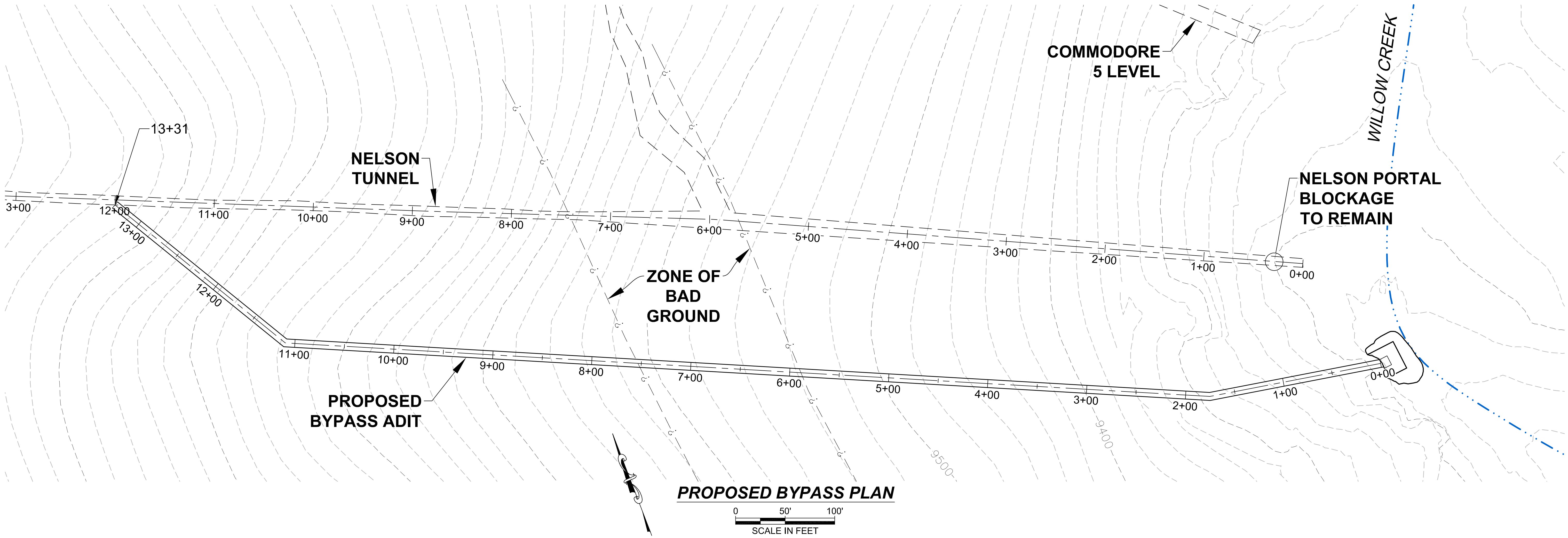
PROPOSED REMEDIAL PLAN - ALTERNATIVE 4

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 9

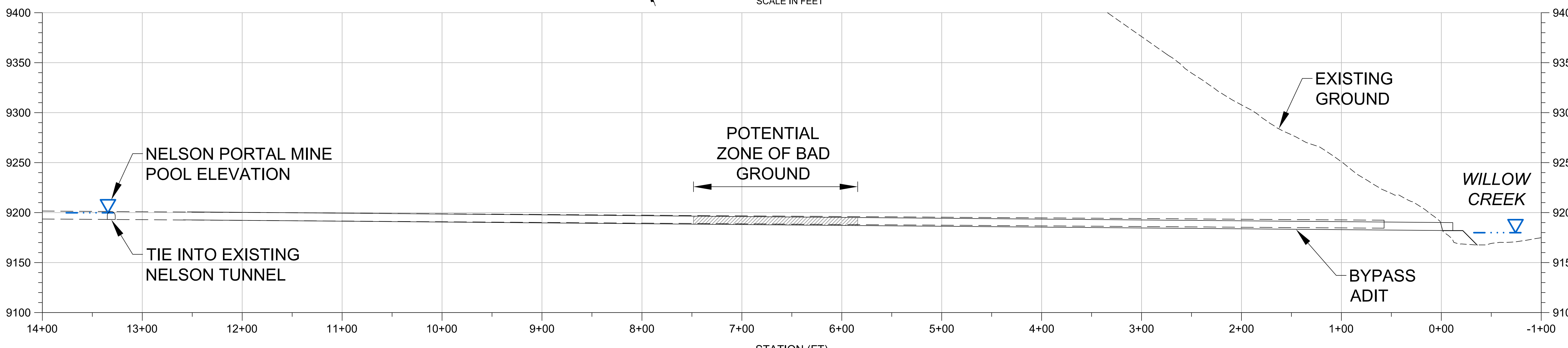
DATE: MAY 2019

SCALE: AS NOTED



PROPOSED BYPASS PLAN

0 50' 100'
SCALE IN FEET



PROPOSED BYPASS PROFILE

0 50' 100'
SCALE IN FEET

JOB NO. 0547.002.00

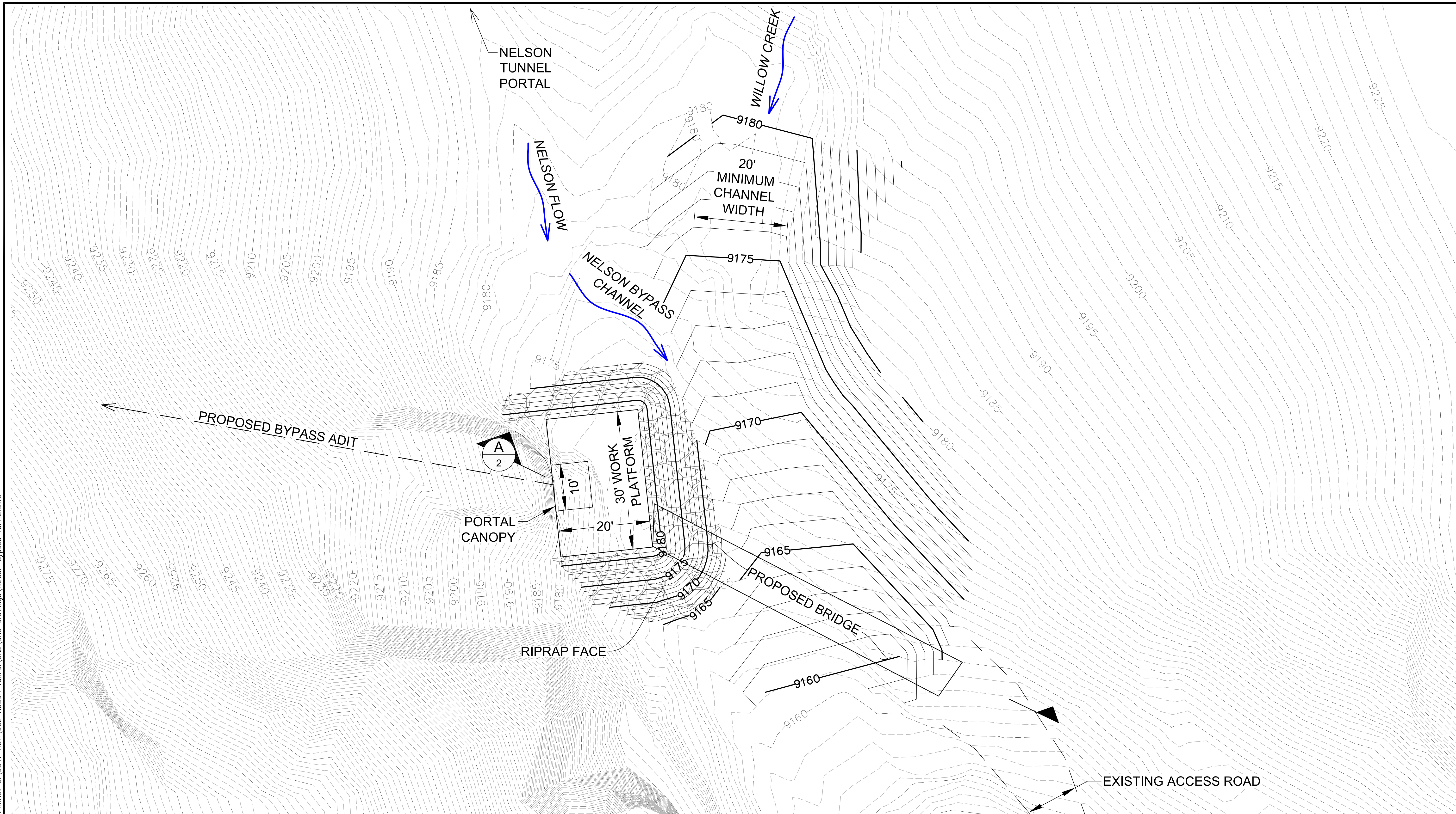
NELSON TUNNEL

ALTERNATIVE 4 - PROPOSED BYPASS ADIT PLAN & PROFILE

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. **10**

DATE: **MAY 2019** | SCALE: **AS NOTED**



JOB NO. 0547.002.00

DRAFT

NELSON TUNNEL

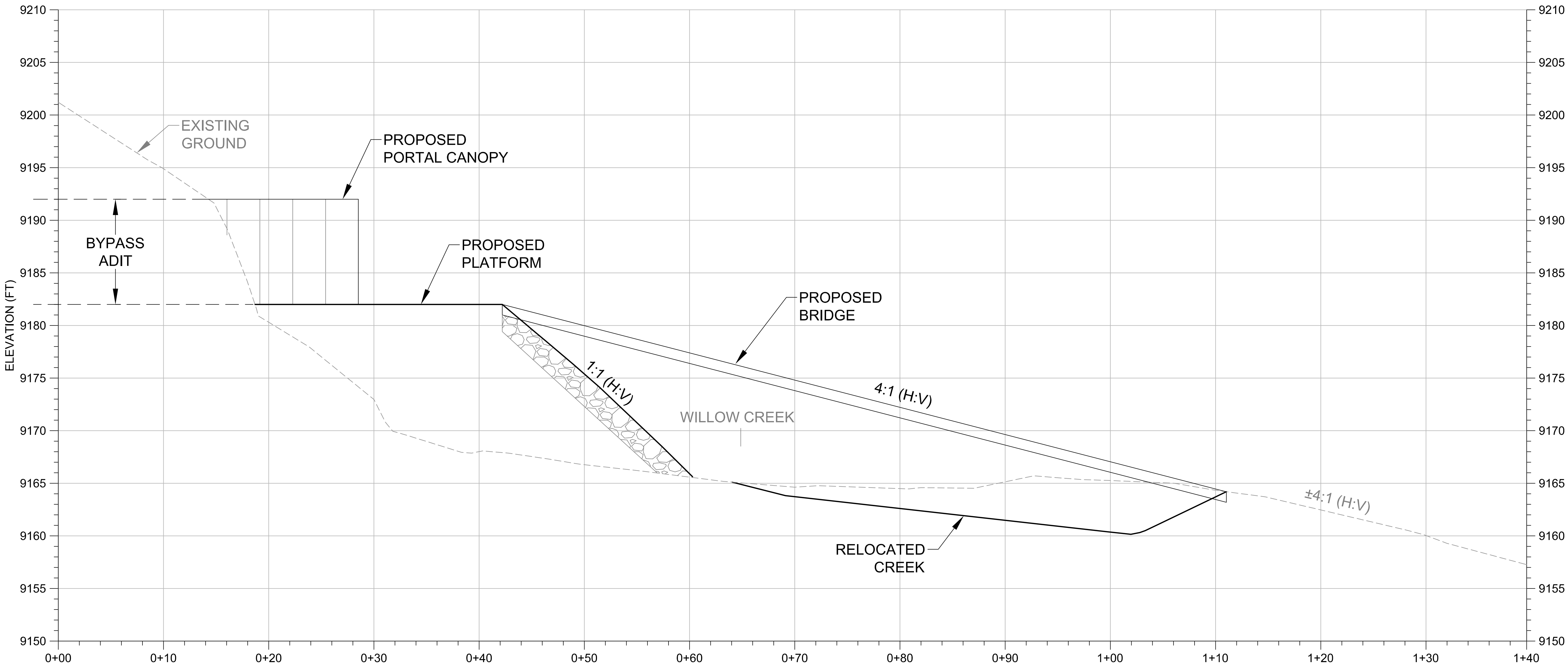
ALTERNATIVE 4 - BYPASS ADIT GRADING PLAN

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 11

DATE: MAY 2019

SCALE: AS NOTED



A
1
BRIDGE CROSS SECTION

0 5 10
SCALE IN FEET

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

JOB NO. 0547.002.00

DRAFT

NELSON TUNNEL

ALTERNATIVE 4 - BRIDGE CROSS SECTION

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 12

DATE: MAY 2019

SCALE: AS NOTED

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3 Responsiveness Summary

NELSON TUNNEL SUPERFUND SITE INTERIM REMEDIAL ACTION

PROPOSED PLAN – RESPONSIVENESS SUMMARY

Introduction

Overview

On September 15, 2020, the EPA released the Interim Action Proposed Plan for the Nelson Tunnel/Commodore Waste Rock Superfund Site. The EPA's preferred alternative in the proposed plan is Alternative 4, described as "Drive a new adit to intersect Nelson Tunnel, tunnel rehabilitation, install a bulkhead in Nelson Tunnel and flow-control structure in the Commodore 5 Level." This option consists of two main components including: installation of a new mine opening and installation of flow-control structures on the Nelson Tunnel and Commodore 5 levels.

The EPA conducted a 30-day public comment period from September 29 to October 30, 2020. The EPA received written and oral comments during the comment period in which oral comments were provided during a virtual proposed plan public meeting on September 29, 2020. The comments received had various common categories addressing elements of the selected interim remedy and have been summarized in accordance with these categories grouped to provide overall responses. Comments received during the public comment period indicate that residents and local elected officials generally support **Alternative 4**. Most comments received from the community indicate that Alternative 4 is the most effective to protect public health and the environment. Comments from the community also reflect the importance that the remedy be implemented in a timely way.

Background on Community Involvement

Since the EPA sought a National Priorities Listing (NPL) for the site in 2008, the EPA has been actively engaged in the community. Meetings with the community have involved the EPA, the State and the Headwaters Alliance (formally the Willow Creek Reclamation Committee [WCRC]). The Site was added to the National Priorities list in September 2008 following a 2005 flood event that washed out a portion of the adjacent Commodore Waste Rock pile. With the NPL designation in September 2008, the EPA was able to perform much more detailed characterization of the nature and extent of mine-impacted water contamination through the Remedial Investigation/Feasibility Study (RI/FS) process.

Initial Community Involvement Plan (CIP) interviews and documentation were completed between March and May 2008. The CIP was completed in May 2009, and a revision was completed in July 2019. The CIP supports communication between the Creede and Mineral County communities with the EPA, Colorado Department of Public Health and Environment (CDPHE) and the U.S. Forest Service (USFS) and encourages community involvement in Site activities. Active public involvement is crucial to the success of any public project. The agencies' community involvement activities at the site are designed to:

- Inform the public of the nature of the environmental issues associated with the site
- Involve the public in evaluating the responses under consideration to remedy these issues
- Involve the public in the decision-making processes that will affect them
- Inform the public of the progress being made to implement the remedy

The agencies conducted community interviews and, based on these interviews, prepared the Community Involvement Plan, which includes a description of the site background, history of community involvement at the site (including major community concerns), community involvement objectives, and a list of affected and interested stakeholders. The community interviews form the foundation for developing the appropriate information to be disseminated to the public and for determining what actions are necessary to address the public's concerns. Interviews for the updated Community Involvement Plan were conducted between May and August 2017, and additional interviews were conducted in summer 2018, to determine outreach needs associated with a Time Critical Removal Action that occurred between 2018 and 2020 (EPA, 2019c).

Periodic meetings are advertised in the local paper as well as the Headwaters Alliance website and are attended by community members, the EPA, State and local health department representatives, town and county representatives, and congressional representatives. Those meetings provide updates on:

- Sampling and analysis status
- Flow monitoring activities
- Rehabilitation and cleanup status
- Time-Critical Removal Action(s) (TCRA)

In 2008, CIP interviewees expressed the following issues and concerns about the Site:

- Stabilization of the Commodore Waste Rock pile before there is a catastrophic event that could wash more waste rock through the Town of Creede
- Cleaning up the water to a quality that could support fish habitat
- Maintaining the quality of the Town's drinking water (Even though it comes from deep wells near the Rio Grande River, there were concerns)
- Protection of the existing water right of the Nelson Tunnel discharge
- Preserving the historical structures located on Site

The EPA and CDPHE have developed the following list of objectives for community involvement and communication with Creede, Colorado, and surrounding areas:

- Develop a proactive approach to sharing information and involving the public in discussions, including an explanation of events and risks
- Clearly define site plans, schedules, responsibilities, costs, and the relationship between the different agencies and communicate this to the public
- Comply with the requirements under Superfund law (CERCLA/SARA)

The WCRC/Headwaters Alliance has served as a key local stakeholder for the Site since the EPA began investigating. Stakeholders provide information and feedback to the EPA, CDPHE and USFS, and the other agencies; they also provide routine updates to town, county and administration officials. In addition to the Proposed Plan public meeting held on September 29, 2020, the EPA, CDPHE, USFS and the Headwaters Alliance held a separate, virtual meeting on October 15 to address comments made by members of the Headwaters Alliance as well as citizens and local officials. The meeting concluded with the Headwaters Alliance generally voicing support for the preferred alternative.

The EPA has established a local information repository at the Creede Town Hall Meeting Room, 2223 N. Main Street, Creede, Colorado. Site records are also available at the EPA Superfund Records Center, 1595 Wynkoop Street, Denver, Colorado, and at the Colorado Department of Public Health and Environment, 4300 Cherry Creek Drive South, Denver, Colorado. To request copies of administrative record documents, call: 303-312-7273 or 800-227-8917 ext. 312-7273 (toll free Region 8 only).

1. Summary and Response to Comments and Questions Received During the Public Comment Period

During the public comment period, including during the public meeting, the EPA received eight general comments supporting the EPA's preferred alternative outlined in the proposed plan and several comments and questions regarding the Interim Remedial Action funding, schedule, development of the final Site remedy and potential impacts to the community. An official transcript of the September 29 public meeting is available on the EPA's web site under site documents. Below are responses to questions and comments received during the public comment period.

1.1. The EPA received a question on how the Remedy would be funded, what the current budget situation is for the Site, and how the Interim Remedial Action will be paid for:

EPA Response: Future settlement funds or other funding obtained by the EPA will be used to:

- Complete work on segment 6 of the Commodore 5 Time Critical Removal Action
- Fund interim remedial design and interim remedial action
- Contribute to additional investigations and studies to complete final feasibility study and final remedial action for surface water draining from the Nelson Tunnel

The EPA has partially funded the Commodore 5 removal action and intends to fund future response actions through various sources, including the following:

- Funds obtained from Site enforcement actions
- Federal appropriations from the Hazardous Substance Superfund
- Ten percent remedial action cost share from the State of Colorado
- Funding provided through current and future Interagency Agreement(s) entered into between the EPA and the United States Forest Service to support response work at the Site

Long-term operation and maintenance of the final remedy will be funded in accordance with Superfund law (CERCLA and the NCP). The EPA is currently waiting on settlement funding to continue work at the Site—no other funding is anticipated to be available for 2021.

1.2. The EPA received questions about the timeline for the construction of the Interim Remedial Action as well as what the next steps will be for the Site:

EPA Response: The EPA and the Agencies will issue a responsiveness summary to document responses to all public comments received (anticipated winter 2020-2021). The EPA and the Agencies hope to issue an interim record of decision (I-ROD) in early 2021. After the decision document is signed and funding is received, the EPA will begin designing an interim remedial design. The design process is expected to take about two years and will involve consultation with EPA Headquarters and additional community input. Construction of the interim remedial action is expected to take one to two years and would not begin until additional remedial action funding is secured from the EPA Headquarters. (This could take several years due to the Site's rank in priority among other sites nationally.) A construction contract for the EPA's interim remedial action would be competitively bid. All activities are funding-dependent and may take longer due to unforeseen obstacles.

1.3. The EPA was asked how connected and/or vital the installation of a flow-through bulkhead is to identifying and implementing a final remedy, as well as what the objectives are of the Final Remedial Action?

EPA response: It is difficult to know what a final remedy might look like until the EPA, the State of Colorado and USFS conduct additional investigation and treatability studies. Mitigating and reducing the likelihood of a sudden and large release from the Nelson Tunnel is our highest priority—and this is an efficient way for the EPA to begin work on the Nelson Tunnel/Commodore Waste Rock Site. The preferred alternative for an interim remedy will be consistent with the final remedy and will assist in phasing construction on the Site.

Key objectives in determining a final remedy will be to evaluate the water quality of discharge from Nelson Tunnel and improve surface water conditions. Future studies will help determine the extent to which water quality improvements are possible.

1.4. The EPA was asked if there are any Treatability Studies planned at this time to evaluate potential options for the final remedy:

EPA response: The EPA, CDPHE, CDRMS and USFS are considering several studies to improve the site conceptual model for understanding the pathways of contamination. Currently a 3-D model is being constructed to better understand the location, orientation, and dimensions of geologic features (faults, formations, etc.) and mining structures (adits, shafts, stopes, etc.). The Bachelor Shaft Pump Test has been planned and tentatively scheduled for 2021. Plans for additional studies are being formulated and are dependent on funding as well as the completion of the Commodore 5 level rehabilitation. Generally, the focus of future studies will be to improve the understanding of the sources, volumes and locations of groundwater entering the mine system and the chemistry of the groundwater sources.

In a related comment, one community member referenced that "the 2011 Remedial Investigation (RI) states that surface water is a very minor portion of the Nelson discharge, but I believe all efforts should be made to eliminate surface water inflow."

EPA response: Following the 2011 Remedial Investigation, studies were conducted by the University of Colorado and other mine experts which had different opinions on the origin of the water in Nelson Tunnel. Rehabilitation of Commodore 5 level will allow additional studies to be conducted to further evaluate the source of the water. We agree that if surface water infiltration is significantly contributing to the Nelson Tunnel flow, and an area of significant infiltration can be located, efforts to address the infiltration should be made.

1.5. There were also questions regarding the impacts of blasting activities to the local tourism and historic structures within and adjacent to the Site. One citizen noted that the public road along West Willow Creek is a very popular tourist route during the summer and asked how blasting would be scheduled in Alternative 4 to not adversely affect tourism and Creede's economy. Another community member asked whether the preferred alternative would impact the historic structures such as the ore house and crib wall that are located close to the Nelson Tunnel.

EPA response: During blasting and at the beginning of the bypass adit operation, we anticipate a few days of shutdown—potentially of the entire road. There may also be additional shutdowns when materials are being delivered to the Site. The frequency of the road shutdown could be limited to once or twice per day for around an hour at a time. All shutdowns would be coordinated with the community well in advance. Blasting for the preferred alternative would be highly concentrated and is not expected to impact areas near the Nelson Tunnel. The EPA has been working collaboratively with the owner of the nearby historical structures and State historic preservation experts regarding the stability of these aging structures. The historic preservation experts recently toured the area and determined that some of these structures are at risk of collapsing from weather elements within the next year or so and need stabilization. The Colorado Division of Reclamation, Mining and Safety, with assistance from the EPA, CDPHE and USFS are currently exploring the possibility of a jointly-funded assessment by a structural engineer. The goal would be to have a preliminary assessment completed within the next year or so. The EPA would not be able to fund actual stabilization work.

Another community member asked whether the blasting proposed in Alternative 4 could cause failure of one of the blockages and a sudden massive wastewater discharge; they asked about the results of modeling and whether a study of potential ground shaking should be completed prior to deciding to proceed with Alternative 4, to avoid another Gold King disaster.

EPA response: One of the key tasks in the investigation/design phase will be to design a blasting and monitoring program that will not impact Nelson Tunnel and the blockages impounding the mine pools. The blast design will be done by engineers who specialize in blasting around sensitive structures. During construction, the contractor's blasting plan will be carefully reviewed for compliance with the design, and engineering oversight will be provided to enforce the blasting requirements. Instrumentation will be installed to monitor the individual blasts.

1.6. A community member who is not supportive of the preferred alternative: "I understand the urgency of this issue due to a possible spill in the community. I do not think a slow leak into the rivers & streams as opposed to a large burst is the answer here! I do not agree with this plan at all! I believe you need some [sic] up with {a} better option! We need filters or buffers or to barrel it up & send it to water treatment facilities. Those are 3 different ideas. Do not do this! There are other options!"

EPA response: The EPA Region 8 has developed the focused feasibility study over the past several years to evaluate options to reduce the likelihood of a sudden, large release, and we have vetted these options with the community of Creede, local officials, Mineral County, the State of Colorado, the USFS, and the EPA headquarters as well as industry professionals and local mining companies. The proposed alternative (flow-through bulkhead) is the most cost-effective and efficient method that will meet our remedial action objective. This is an interim remedy, or early EPA cleanup action, and water quality will be evaluated during a final remedial action by the EPA and supporting agencies. The EPA, CDPHE and USFS are researching options for source controls or alternative water treatment to use in conjunction with the flow-control structures. Alternative #4 does not preclude the availability of water treatment options in the future and, in fact, aides in the treatment process by providing a single collection point for water to be conveyed to a treatment system. Treatment options including the use of filters, buffers and containerizing effluent waste will be considered through studies that are currently in the planning stages and the final site-wide feasibility study.

1.7. The EPA was asked during the public meeting if there are any long-term plans to reduce and/or eliminate the zinc and cadmium levels specifically?

EPA response: The final remedy may address the contaminants of concern of zinc and cadmium. This interim remedy is just addressing reducing the likelihood of a large and sudden release. We don't know yet if this flow-through bulkhead will have any impact on surface water quality, so we're going to have to evaluate that. We would measure the concentrations before a bulkhead was put in and afterward, but most likely this won't really affect water quality as the sources or rate of the acid mine water generation would not be impacted by this interim remedy. We will need to have a final remedy and many different alternatives in place, so this will be investigated with a site-wide Feasibility Study to address the surface water impacts of the Nelson Tunnel draining adit. In addition, the interim remedy would be part of any permanent solution, whether that solution ends up being long-term flow and treatment, or whether it ends up being a series of bulkheads sealing up the mountain. The idea is that this interim remedy would address the current problem of large releases, while also becoming part of whatever the future remedy might be. It will not limit the possible alternatives for the final remedy.

2. Summary and Response to Public Technical Comments, Concerns and Questions

The EPA received several technical comments and questions during the response period including questions about the lifespan of the repairs that have been made under the Time Critical Removal Action described in Alternative #2. Questions about impacts to the neighboring Bulldog Mine and its potential to resume mining were also asked; as well as the potential impacts to the adjacent West Willow Creek fish population and flow path if a sudden and large release event were to occur. Most of the technical questions, however, asked for further clarification as to why Alternative #5, to rehabilitate the entire Nelson Tunnel while simultaneously treating the full amount of impounded water, was not selected as the preferred alternative.

2.1. The EPA was asked about the estimated lifetime of the repairs to the tunnels currently being made as part of the Time Critical Removal Action. An additional comment was made about concern of the longevity of the Commodore remedy using steel in a wet and acid environment. "If expected lifetime is 10 years or so, will money for the flow-through bulkhead and auxiliary tunnel in the Nelson {be available} to build and maintain if it is not awarded in a timely manner? Would the plan include an emergency re-repair of the Commodore?"

EPA response: The lifespan of the repairs made under the Time Critical Removal Action is estimated to last decades. The work was done to be as permanent as possible, so all support is considered long term, not temporary. Based on observations of steel support installed in the Commodore 5 during previous periods of production (1976 or older), the environment does not appear to be very corrosive to steel. Only at the Archimedes Raise was significant corrosion apparent, hence additional steel sets were required at that location. Additional alternatives, such as coating the steel, could be implemented if deemed necessary following periodic inspections and maintenance. While difficult to predict precisely, the design life of the Commodore 5 rehabilitation should be well in excess of 10 years. Some maintenance will be required, but a major re-rehabilitation is unlikely.

A similar question was asked during the public meeting about the anticipated lifespan of the Alternative 4 bulkhead:

EPA response: The design life of the bulkhead and flow-control structure would be a very long period, essentially, as permanent as things could really be. It would be designed with ample capacity and to be able to resist any kind of dissolution, so essentially as permanent as possible. If the bulkhead shows signs of distress at some point in the future, a bulkhead extension could be added. That would provide an indefinite design life. During design, the water chemistry, concrete mix and piping material can be evaluated to predict a possible service life before an extension might be needed. Some maintenance will be required, but a major rehabilitation or replacement is unlikely.

2.2. The EPA was asked if it "anticipates the return of mining by Rio Grande Silver (RGS) to the Bulldog Mine and, if so, how the de-watering of the Nelson Tunnel by RGS would aid/augment/complicate the construction of a flow-through bulkhead."

EPA response: The EPA and CDPHE are in communication with Rio Grande Silver/Hecla on how to coordinate and proceed if the Bulldog Mine re-opens. If the Bulldog Mine were to de-water, historically it has been shown that the flows out of the Nelson Tunnel would reduce as well. This could be advantageous to plan construction of the flow-through bulkhead in the Nelson Tunnel during this time.

This question was echoed by another resident, "the presentation talked about a de-watering plan which is very good and well thought out. I would like to mention that in the event mining operations resumed at the Bull Dog Mine and de-waters down to the 9,000-foot level, flows from the Nelson Tunnel almost entirely stop. There is a source of infiltration at the end of the Nelson Tunnel that water analysis indicates is from the surface instead of the regional ground water in the mine pool. This source is very seasonal and seems to be unaffected by the cone of depression created by pumping in the Bulldog. If there is ever a remote possibility negotiation between EPA/DOJ and Rio Grande Silver can produce a favorable outcome, then de-watering could be accomplished with little or no cost to the project."

EPA response: If de-watering the Bulldog Mine reduces flows from the Nelson Tunnel, that would reduce the de-watering and treatment costs for the preferred alternative. During design, the team will review a variety of treatment options, which can include the suggested system.

2.3. The EPA was asked if it "was aware that downstream reaches {of Willow Creek} can accommodate the estimated 900 cubic feet per second volume of a sudden, large

release of water. Meaning the North Creede levee, flume and soon the lower Willow Creek floodplain will be designed to handle a 1200 cubic feet per second flow. Given that the downstream reaches have been/or will be engineered to handle this flow volume, does the EPA still feel the flow-through bulkhead is necessary?"

EPA response: Yes, the EPA is aware of the hydrologic reports estimating storm volumes, channel and structure capacities, and the planned improvements. A sudden, large release could endanger recreational visitors and could endanger the environment in Willow Creek and downstream in the Rio Grande. The amount of rock and debris that could be deposited downstream during a release would have the potential to restrict flow capacities in these areas as well. The EPA undertook the Interim Measure Focused Feasibility Study (FFS) to evaluate solutions to reduce the likelihood of potential damage to the environment and downstream stakeholders. Based on the FFS, installation of a flow-through bulkhead is the best solution.

2.4. The EPA was asked "regarding the potential of a fish kill in the Rio Grande from the sudden release of a large volume of water from the Nelson Tunnel – does the EPA have an estimate of the possible "loading ," which is the product of contaminant concentration multiplied by the rate of flow, to the Rio Grande in this scenario?"

EPA response: The EPA has not estimated the loading to Rio Grande that could result from a sudden, large release from the Nelson Tunnel. The loading would be dependent on the volume released, the chemistry of the water as it exits Nelson Tunnel, and the degree to which the water chemistry changes before it exits Willow Creek and flows into the Rio Grande.

2.5. The EPA was asked "what kind of data collection will EPA be doing on Willow Creek during the construction process?"

EPA response: The EPA and the Colorado Division of Reclamation, Mining and Safety have installed and monitored pressure transducer data loggers within the mine for over a decade and have a useful data to track water elevation or flow rate changes that could occur during and after construction. Willow Creek monitoring may look similar to a recent, nearby project at Standard Mine in Gunnison County where the EPA contractor performed twice-daily monitoring of the adjacent surface water quality parameters (pH, conductivity, ORP, temperature, turbidity, oil/grease, etc.) to track if any changes were occurring. Surface water sampling during high and low flow conditions, along with redundant sampling events, were conducted to set baseline parameters for the water chemistry (especially metals). If any changes were recorded during the daily monitoring of the field parameters that were outside of the baseline range that had been established prior to construction, the contractor was ready to collect samples and send to the EPA laboratory for analysis.

2.6. The EPA was asked if CDPHE is still going to continue with the Bachelor Shaft pump test investigative study that had been scheduled for summer 2020 but was delayed due to COVID-19?

EPA response: The EPA, CDPHE, CDRMS and USFS are planning on conducting the Bachelor Shaft Pump Test in 2021 in conjunction with rehabilitation of Segment 6 of the Commodore 5 level Time-Critical Removal Action. Funding may delay the timeframes for both projects.

2.7. There were several questions asked regarding water treatment options that were considered and the interim treatment that was proposed while construction is being performed.

2.7.1. The EPA was asked "if a temporary treatment plant must be built in Alternatives 3 and 4, couldn't it be economically used to treat the de-watered wastewater from the pools as well? Even if only 40 gallons per minute were dewatered and treated, it would take only 384 days to dewater the entire 22.1 million gallons in the mine pools."

EPA response: There are several technical challenges to de-watering that need to be considered:

- A continuous flow is moving through the mine system (350-400 gpm) some or all of which would need to be diverted to a treatment plant or around blockages. To draw down the mine pool would require treating that rate and then an additional amount.
- Treating more than the base flow through the system would require the installation of pumps deep within the mine.
- Safe removal of blockages and mine rehabilitation would be a major challenge with the amount of flow entering the mine and the unknown underground conditions
- It is estimated that some of the blockage waste will need to be disposed of outside the mine. Logistically moving the material will be difficult, and finding a suitable disposal option could be challenging, given the volume of materials.
- Treatment of water will also generate solid waste that will require disposal. The volume and duration of treatment is estimated to require more room than is available near the Nelson Portal.

2.7.2. During the public meeting, a clarification was requested regarding the estimated rate of flow for the treatment system during construction. Slide 73 of the presentation described a flow of approximately 36 gpm out of the estimated total 360 gpm to be treated in order to not exacerbate the amount of contamination discharging into West Willow Creek during construction.

EPA response: The idea of treatment during construction is to not make the water quality worse in West Willow Creek and downstream. The EPA created a conceptual idea of how much we would need to treat during construction to prevent worsening the creek's water quality. The treatment plan flow rate, proposed at 36 gpm, is conceptual at this point, but the idea is to make sure we are not making the water quality worse in West Willow Creek while we are constructing the bulkhead over those two seasons.

2.7.3. The EPA was asked during the public meeting, "Why is there no treatment contemplated for releases that will occur under the preferred alternative?"

EPA response: Yes, there is a water treatment system that is contemplated to not exacerbate any releases into West Willow Creek. The plan is that during construction of the interim remedial action there would be no degradation of the water in West Willow Creek. This is something to read more about in the Focused Feasibility Study. The EPA is invoking what is called an "interim-measures ARARs waiver." ARARs are regulations that we must abide by during this interim remedy. An interim-measures waiver requires the interim remedy to be consistent with the final remedy, we cannot exacerbate conditions in West Willow Creek. But we are invoking that for this interim remedy because we do not have the ability to do a full active water treatment system at this time. We plan to address the surface water quality in our final remedy. To be clear, our intentions are not to worsen water quality when we do our interim action, so we will treat water to a point where the water quality remains the same as it currently is and will not worsen. After construction the temporary water treatment plant would be removed, and discharge conditions would return to current conditions.

2.7.4. The EPA was asked during the public meeting, "If you can treat it {referencing the mine water discharge} to remain the same, can it be treated to be better?"

EPA response: Yes, but you would need a very large, active water treatment system to do that, which would be an alternative that would be evaluated in the final Feasibility Study. Treating the full discharge of mine water is possible, but there's a very complicated process to get there. We would like to evaluate this and other alternatives such as source control and passive water treatment in the final Feasibility Study to try to address the surface water quality issues. This interim remedial action lends itself to a whole range of potential final remedies, so one of those potentials is to build an active water treatment system and actually improve the zinc and cadmium levels in West Willow Creek, but in order to do that you really need a flow-control structure at the head of that incoming water to regulate that flow and to have consistent flow going into the water treatment system. Without that you are potentially putting in danger any infrastructure that you may have downstream. For example, if one did build a water treatment plant right at the portal and, perhaps suddenly, those non-engineered structures give way, it could blow out your whole water treatment facility. So, this flow-through bulkhead idea lends itself to a whole range of final remedy options, including water treatment.

2.7.5. A question was asked by a citizen regarding water treatment following construction of the bulkhead, "If water needs to be released via the flow through in the bulkhead, how is the contamination (after?) dealt with?"

EPA response: Water treatment following construction is not planned, and the mine water discharge would likely return to baseline flow and water quality conditions prior to the interim remedial action. Releases through the flow-through bulkhead would be kept to current rates by keeping the valve open or, in the case of a surge, throttling down the valve to keep flows at current rates. Again, during the construction phase only, we plan to treat water to a point where the water quality remains at least the same and does not worsen.

2.8. The EPA was asked if "radioactivity has been tested in the mine workings? If so, what are the results? If not, why not?"

EPA response: Radioactivity has not been recently investigated since it is not typically a high hazard in Colorado hard rock mines in this region. There is a 1959 US Geological Survey report that investigated radioactivity in the San Juan Mountain region and, more specifically, the Creede Mining District. It reported background radiation in the Amethyst Vein ranged from 0.04-0.05 mrems/hr in Commodore 3 to 0.01-0.04 mrems/hr in Amethyst Level 5 (USGS, 1959[1]). The National Regulatory Commission public dose limits (10 CFR part 20) is 2.0 mrems/hr (NRC, 2018[2]).

2.9. Comments were conveyed to the EPA from a Creede resident who provided historic information from previous mine rehabilitation efforts and recommendations for the construction of the bypass adit. "I would strongly encourage some judicious core drilling prior to final consideration of placement for the new portal. This could be done efficiently from a couple locations in the Commodore 5 tunnel. Core drilling from above the mine pool would mitigate concerns about uncontrolled releases of impounded water. From verbal accounts of miners working in the Nelson Tunnel, one of which had the contract to re-timber the tunnel in the 1960's, there was reportedly about 400 feet of heavy ground that had been problematic from the first days of construction. Some local miners referred to it as Porphyry but most likely it is more accurately a Gouge material. It would be unrealistic to assume ground control could be accomplished with rock bolts, wire and shotcrete in this area. Core drilling could help identify alternate routes that would minimize or eliminate the need to tunnel through the heavy ground and significantly reduce unnecessary cost associated with more extensive ground control measures."

EPA response: A geotechnical site investigation will be carried out prior to the design. This could include core drilling from Commodore 5, but this would likely be limited since each run would be approximately 400 to 600 feet. The primary planned coring and probe drilling would start from a

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[1]n, U. S. Govt. Print. Off., 1958, p. 407.

[2] US-NRC, 10 CFR Part 20.1301 - *Radiation Dose Limits for Individual Members of the Public;* 56 FR 23398, May 21,1991

platform at the proposed bypass adit portal location and along the proposed adit alignment. Probe drilling in advance of the bypass adit construction would provide geotechnical data ahead while also monitoring for any impounded water that may be encountered within fractured sections along the adit alignment. Depending on its size, depth, and access, some coring could potentially be carried out from the existing opening above the proposed bypass.

The EPA is familiar with the zone of bad ground in the Nelson Tunnel. Determining if it exists in the bypass and how long it is will be a focus of the geotechnical investigation. If such a zone is encountered, it will be included in the design. Potential ground support options may include spiling, steel sets with lagging, and shotcrete with lattice girders.

2.10. The Creede resident continued, “The presentation spoke of temporary impoundment of water behind the plug. Since there has been some experimentation with allowing a mined area to fill with water and change the oxidation of pyritic materials, thus affecting acid generation and dissolved metals, it might be advantageous to have that option if it didn’t make the cost of installing the plug outrageously expensive. Since the Commodore 5 tunnel is 56’ higher than the Nelson Tunnel portal there could only ever be a maximum of about 22 psi of water pressure behind the plug. While the volume of contaminated water would be a big number the maximum pressure would be manageable.”

EPA response: While the bulkhead could be used to back up water to a certain elevation such as the Commodore 5 level, flooding the Nelson could destabilize the remaining support and the blockages. It is also very probable that the natural water elevation is higher than the Commodore 5 level, hence water would still have to be released. Bulkheading the Nelson and Commodore to flood the mine workings and reducing acid generation is a potential future option for the final remedy, and this alternative would allow that.

2.11. An official representing the Mineral County Office of Emergency Management questioned whether outside consultation with community involvement groups as well as experienced miners, including those that have previously worked in the region, was performed during the Focused Feasibility Study phase.

EPA response: In November 2019, the agencies had a meeting with Headwaters Alliance and presented on mining bulkheads in mountain environments. This preferred alternative is a conceptual design, so the next step would be to memorialize this decision in the Interim Record of Decision or IROD, and then we would go to the next phase, which would be an Interim Remedial Design. Throughout that Remedial Design process is when these design particulars would be worked out, and the EPA is committed to engaging the community prior to finalizing the design. Milestone stages including a preliminary (30 percent) design, intermediate (60 percent) design, and then, of course, pre-final and final designs would present opportunities for informal input. These could be performed during scheduled Headwaters Alliance meetings or Pre-Remedial Design input sessions.

The final design would be formally presented at an EPA public meeting, and public input would be welcomed.

A recent project to reference is Standard Mine, which is located just north of Creede near Crested Butte, Colorado, and had a similar remedial action plan. At that site, the EPA installed a bypass adit in the lowest level of the Standard Mine starting in 2015 and finishing in 2017. It was a 500-foot-long bypass adit that intersected the original adit as you saw in the photos. The original adit was then rehabilitated for about 200 feet, and the EPA installed a bulkhead. The idea for that bypass adit actually came from experienced miners who were contracted to perform the work. They looked at the degraded conditions of the original adit and asked, “maybe we could go around everything?” The idea for the interim remedial action Proposed Plan was really spawned from looking at other options besides just going straight at the problem and, instead, going around it.

We have spoken with various local miners before and, in fact, had one on our team to help us with one of the costs of these alternatives. He has been around for many decades working different mines, and he did a very thorough review of what we're proposing here. Going back to the presentation and showing areas of the Commodore 5 level, you may recall there was the area within the drift on the Commodore 5 that had collapsed that they drove a bypass around through the more-stable footwall. So, much as we'd love to say this is such a brilliant concept that's new, modern and awesome, it is a common standard process.

2.12. The EPA was asked during the public meeting, “If the stability of the blockages that impound water is relatively unknown, how certain is the stability of a bulkhead, or more precisely, the stability of the geology/hydrology of the tunnels once water is stacked behind the bulkhead?”

EPA response: As part of any bulkhead design you do geotechnical evaluation of where that bulkhead is located, which allows you to confirm the stability of the geology. With respect to the hydrology, I think the plan for the bulkhead at this point is to allow it to be flow-through, so there really shouldn't be a situation where water is stacked significantly behind that bulkhead for an extended period. The bulkhead would be designed in such a way that if the ultimate solution were to be to seal up the mountain, that could be a possibility, but it is too early to evaluate that. The concept could be part of whatever the final solution may be. During design we will evaluate where to locate the bulkhead and will be able to specify materials with known strength factors like concrete, steel, and the quality of the rock around the bulkhead. With respect to the collapses that currently exist in Nelson Tunnel, we don’t know exactly what these are made of or what their long-term stability is. So that's a total unknown compared to an engineered bulkhead.

2.13. The remaining technical questions and comments pertain to the decision to not select Alternative #5 as the preferred alternative. The main components of Alternative #5 are described as the following, “De-watering of Stored Mine Pool Water, Rehabilitation and Removal of Blockages throughout the entire Nelson Tunnel.”

2.13.1. The EPA received the following comment and question, "On page 44 of the Focused Feasibility Study for Flow Control, it states: '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.' This seems counter-intuitive, as removing 22 MG of contaminated water would logically improve water quality and reduce outflow of contaminated water from the mines in the long term."

EPA response: In a historic mine that is discharging at a continuous rate of 350 gallons per minute, water degradation is caused by exposure to oxygen in the air and sulfide minerals, most commonly iron pyrite. The combination of water, air and iron pyrite results in a chemical process that acidifies the water, dissolves heavy metals, and lowers water quality. This statement points to the possibility that removing the reservoir of water could increase the availability of oxygen to the flowing water, decreasing water quality. In addition, removing the water reservoirs would lower the water surface in the mine, perhaps increasing the amount of water flowing from the surrounding groundwater into the mine.

2.13.2. The EPA received the following comment, "Alternative 5 would seem to accomplish goals and significantly reduce costs for the Final Remedial Action. The bulkhead and flow-control structure could be part of the Final Remedial Action, and thus the long-term protection lacking in Alt. 5 could be provided in the final Action." Another citizen echoed this comment stating, "The community needs to strive for 'Alternative #5'. It seems that fixing this ongoing issue once-and-for-all is the best solution. Yes, it is the more expensive solution, but having to come back and do more work, over time, could be the most-costly solution. Alternative #5 also meets the RAO listed."

EPA response: The major drawbacks for Alternative #5 are:

- Future collapses inby of the Upper Mine Pool could create new mine pools, posing the same threat we are facing currently. In addition, there may currently be collapses impounding water further inby that have not been discovered. In that case, Alternative 5 would not meet the goal of the Interim Remedial Action.
- A continuous flow is moving through the mine system (350-400 gpm) some or all of which would need to be diverted to a treatment plant or around blockages.
- Safe removal of blockages and mine rehabilitation would be a major challenge with the amount of flow entering the mine and the unknown underground conditions.
- To safely remove the blockages, all water behind them would have to be pumped out and the area kept relatively dry (similar to removing a dam). A mine pool pumping test conducted in 2007 showed that due to partial collapses, existing mine connections into the mine pools would likely not be sufficient for pumping.

- It is estimated that most of the blockage waste will need to be disposed of outside the mine. Logistically moving the material will be difficult, and finding a suitable disposal option could be challenging, given the large volume of materials.
- Treatment of water will also generate solid waste that will require disposal. The volume and duration of treatment is estimated to require more room than is available near the Nelson Portal
- The costs of Alternative 5 are much higher due to more de-watering, debris removal and rehabilitation required.

2.13.3. The EPA received the following comment and question, "in Alternative 5, 36 months are estimated to de-water, due to difficulties expected in the Upper Mine Pool. Couldn't a small shaft be drilled to accomplish de-watering without major delay?"

EPA response: The estimated construction time for Alternative 5 is based on the time to remove blockages and rehabilitate as well as time to dewater. Horizontal drilling to drain the mine pools has been evaluated and may be a viable de-watering option. Further evaluation will be completed during the design.

2.13.4. The EPA received the following question, "In Alternative 5, if the larger treatment plant is required, could the pipeline to the treatment plant be sited on the shoulder of the existing concrete channel for Willow Creek, thus eliminating property acquisition issues?"

EPA response: A study of land ownership requirements was not completed for the Focused Feasibility Study, but a review of the County GIS mapping indicates that not all of Willow Creek is on public land. To build across non-public lands often requires easements and consent for access, which can be resource intensive.

3. <u>Summary and Response to Comments, Concerns and Questions on the Nelson Tunnel Water Rights</u>

The EPA received several comments and questions regarding the water rights diversion that currently exists at the collapsed Nelson Tunnel portal. This outlet has a confluence with West Willow Creek approximately 80 feet southeast of the Nelson Tunnel portal Parshall flume which, until recently, had measured the flow rates. A more accurate Parshall flume was installed in 2019 within the Nelson Tunnel at the Bachelor Shaft location and collects continuous flow data that is distributed to the water rights stakeholders.

3.1. Preferred Alternative 4 includes relocating the Nelson Tunnel discharge through the newly constructed bypass adit. The EPA received two questions about whether the Town's water rights for Nelson Tunnel will be protected?

EPA response: The preferred alternative in the proposed plan contemplates a future discharge point within 200 feet from the existing Nelson Tunnel portal flume. This proposed change would not impact water supply and while additional water rights evaluations will be conducted during remedial design, the EPA's preliminary investigations indicate that such a move would not injure any water rights. We have updated our current water rights evaluation technical memorandum and have shared with all stakeholders. The EPA and our supporting agencies do not want to adversely impact the Town of Creede's water right with the proposed interim remedy and will continue to work with the Town of Creede to make sure we will not cause such impacts.

The EPA and the USFS have coordinated with the Town of Creede Public Works to continue with the augmentation process using 0.50 cubic feet per second (cfs), or 224 gpm, as the consistent flow from the Nelson Tunnel. The EPA will send the Town of Creede Public Works the flow data that they gather from their meter quarterly. If the flow drops below the consistent 0.50 cfs, the water rights will need to be addressed accordingly.

3.2. The EPA was asked by the Town of Creede Public Works during the public meeting, "Are there plans to replace the flume or the weir that is presently outside the Nelson Tunnel? Creede is using this for flow totals and its augmentation plan."

EPA response: The agencies have spoken with the Department of Water Resources and decided that we will be sharing data that will be collected on a quarterly basis from the Nelson Tunnel flume that is currently installed at the Bachelor Shaft. The decision to replace the flume outside of the Nelson portal is on hold at this time since there is an existing inside flume that is continuously collecting hourly flow data which is being reported to the Water Resource Division. Given that we have good data (which is probably more accurate than what is being, or what could be, collected at the portal) about 1,300 feet inside the Nelson Tunnel, it is not currently a priority to replace the flume. The USFS's concern, as the land manager at the portal, is that the surface disturbance that would be required to remove the current flume and set a new flume or weir in place may be sufficient to disturb the blockage at Nelson portal. USFS would feel more comfortable in having that discussion about replacing the external flume once the interim remedy to control unintended releases is in place.

Conclusion

In summary, the local community of Creede, Colorado, including local officials and representatives of local stakeholder groups, indicate support for the EPA's Preferred Alternative #4. CDPHE, CDRMS and the USFS also support this preferred alternative for the interim action.

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Appendix A: Alternative Cost Detail

TABLE A-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	6.4%	$ 10,700	Based on RS Means (2017 - 2019)
Total Estimated Alternative Cost		**$ 229,716**	

TABLE A-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	$229,716
Annual O&M Cost	$10,000
Annual Labor Cost	$40,000
Future Capital Costs	
	None anticipated

Discount Rate	1.50%

Year	O&M COSTS			CAPITAL COSTS	Subtotal Year end	Present Value
	Project Cost	O&M	Labor		Cost	Cost
0	$229,716	--	--		$229,716	$229,716
1		$10,000	$40,000		$50,000	$49,261
2		$10,000	$40,000		$50,000	$48,533
3		$10,000	$40,000		$50,000	$47,816
4		$10,000	$40,000		$50,000	$47,109
5		$10,000	$40,000		$50,000	$46,413
6		$10,000	$40,000		$50,000	$45,727
7		$10,000	$40,000		$50,000	$45,051
8		$10,000	$40,000		$50,000	$44,386
9		$10,000	$40,000		$50,000	$43,730
10		$10,000	$40,000		$50,000	$43,083
11		$10,000	$40,000		$50,000	$42,447
12		$10,000	$40,000		$50,000	$41,819
13		$10,000	$40,000		$50,000	$41,201
14		$10,000	$40,000		$50,000	$40,592
15		$10,000	$40,000		$50,000	$39,993
16		$10,000	$40,000		$50,000	$39,402
17		$10,000	$40,000		$50,000	$38,819
18		$10,000	$40,000		$50,000	$38,246
19		$10,000	$40,000		$50,000	$37,680
20		$10,000	$40,000		$50,000	$37,124
21		$10,000	$40,000		$50,000	$36,575
22		$10,000	$40,000		$50,000	$36,034
23		$10,000	$40,000		$50,000	$35,502
24		$10,000	$40,000		$50,000	$34,977
25		$10,000	$40,000		$50,000	$34,460
26		$10,000	$40,000		$50,000	$33,951
27		$10,000	$40,000		$50,000	$33,449
28		$10,000	$40,000		$50,000	$32,955
29		$10,000	$40,000		$50,000	$32,468
30		$10,000	$40,000		$50,000	$31,988

TOTAL*= $1,430,508

*Note: Total is in 2019 dollars.

TABLE A-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	6.4%			$ 595,806	Based on RS Means (2017 - 2019)
Total Estimated Alternative Cost				**$ 12,791,201**	

TABLE A-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	$12,791,201
Annual O&M Cost	$15,000
Annual Labor Cost	$50,000
Future Capital Costs	
	None anticipated

Discount Rate	1.50%

Year	O&M COSTS Project Cost	O&M	Labor	CAPITAL COSTS	Subtotal Year end Cost	Present Value Cost
0	$12,791,201	--	--		$12,791,201	$12,791,201
1		$15,000	$50,000		$65,000	$64,039
2		$15,000	$50,000		$65,000	$63,093
3		$15,000	$50,000		$65,000	$62,161
4		$15,000	$50,000		$65,000	$61,242
5		$15,000	$50,000		$65,000	$60,337
6		$15,000	$50,000		$65,000	$59,445
7		$15,000	$50,000		$65,000	$58,567
8		$15,000	$50,000		$65,000	$57,701
9		$15,000	$50,000		$65,000	$56,848
10		$15,000	$50,000		$65,000	$56,008
11		$15,000	$50,000		$65,000	$55,181
12		$15,000	$50,000		$65,000	$54,365
13		$15,000	$50,000		$65,000	$53,562
14		$15,000	$50,000		$65,000	$52,770
15		$15,000	$50,000		$65,000	$51,990
16		$15,000	$50,000		$65,000	$51,222
17		$15,000	$50,000		$65,000	$50,465
18		$15,000	$50,000		$65,000	$49,719
19		$15,000	$50,000		$65,000	$48,984
20		$15,000	$50,000		$65,000	$48,261
21		$15,000	$50,000		$65,000	$47,547
22		$15,000	$50,000		$65,000	$46,845
23		$15,000	$50,000		$65,000	$46,152
24		$15,000	$50,000		$65,000	$45,470
25		$15,000	$50,000		$65,000	$44,798
26		$15,000	$50,000		$65,000	$44,136
27		$15,000	$50,000		$65,000	$43,484
28		$15,000	$50,000		$65,000	$42,841
29		$15,000	$50,000		$65,000	$42,208
30		$15,000	$50,000		$65,000	$41,585

TOTAL*= $14,310,646

Note: Total is in 2019 dollars.

TABLE A-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	6.4%			$ 461,790	Based on RS Means (2017 - 2019)
Total Estimated Alternative Cost				**$ 9,914,054**	

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

PRESENT DAY COSTS (2019 Dollars)	
Total Project Costs	$9,914,054
Annual O&M Cost	$10,000
Annual Labor Cost	$40,000
Future Capital Costs	
	None anticipated

Discount Rate	1.50%

Year	O&M COSTS			CAPITAL COSTS	Subtotal Year end Cost	Present Value Cost
	Project Cost	O&M	Labor			
0	$9,914,054	--	--		$9,914,054	$9,914,054
1		$10,000	$40,000		$50,000	$49,261
2		$10,000	$40,000		$50,000	$48,533
3		$10,000	$40,000		$50,000	$47,816
4		$10,000	$40,000		$50,000	$47,109
5		$10,000	$40,000		$50,000	$46,413
6		$10,000	$40,000		$50,000	$45,727
7		$10,000	$40,000		$50,000	$45,051
8		$10,000	$40,000		$50,000	$44,386
9		$10,000	$40,000		$50,000	$43,730
10		$10,000	$40,000		$50,000	$43,083
11		$10,000	$40,000		$50,000	$42,447
12		$10,000	$40,000		$50,000	$41,819
13		$10,000	$40,000		$50,000	$41,201
14		$10,000	$40,000		$50,000	$40,592
15		$10,000	$40,000		$50,000	$39,993
16		$10,000	$40,000		$50,000	$39,402
17		$10,000	$40,000		$50,000	$38,819
18		$10,000	$40,000		$50,000	$38,246
19		$10,000	$40,000		$50,000	$37,680
20		$10,000	$40,000		$50,000	$37,124
21		$10,000	$40,000		$50,000	$36,575
22		$10,000	$40,000		$50,000	$36,034
23		$10,000	$40,000		$50,000	$35,502
24		$10,000	$40,000		$50,000	$34,977
25		$10,000	$40,000		$50,000	$34,460
26		$10,000	$40,000		$50,000	$33,951
27		$10,000	$40,000		$50,000	$33,449
28		$10,000	$40,000		$50,000	$32,955
29		$10,000	$40,000		$50,000	$32,468
30		$10,000	$40,000		$50,000	$31,988

TOTAL*= $11,114,846

Note: Total is in 2019 dollars.

TABLE A-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	6.4%			$ 2,421,360	Based on RS Means (2017 - 2019)
Total Estimated Alternative Cost				**$ 53,118,585**	

TABLE A-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	$53,118,585
Annual O&M Cost	$20,000
Annual Labor Cost	$80,000
Future Capital Costs	
	None anticipated

Discount Rate	1.50%

Year	O&M COSTS			CAPITAL COSTS	Subtotal Year end Cost	Present Value Cost
	Project Cost	O&M	Labor			
0	$53,118,585	--	--		$53,118,585	$53,118,585
1		$20,000	$80,000		$100,000	$98,522
2		$20,000	$80,000		$100,000	$97,066
3		$20,000	$80,000		$100,000	$95,632
4		$20,000	$80,000		$100,000	$94,218
5		$20,000	$80,000		$100,000	$92,826
6		$20,000	$80,000		$100,000	$91,454
7		$20,000	$80,000		$100,000	$90,103
8		$20,000	$80,000		$100,000	$88,771
9		$20,000	$80,000		$100,000	$87,459
10		$20,000	$80,000		$100,000	$86,167
11		$20,000	$80,000		$100,000	$84,893
12		$20,000	$80,000		$100,000	$83,639
13		$20,000	$80,000		$100,000	$82,403
14		$20,000	$80,000		$100,000	$81,185
15		$20,000	$80,000		$100,000	$79,985
16		$20,000	$80,000		$100,000	$78,803
17		$20,000	$80,000		$100,000	$77,639
18		$20,000	$80,000		$100,000	$76,491
19		$20,000	$80,000		$100,000	$75,361
20		$20,000	$80,000		$100,000	$74,247
21		$20,000	$80,000		$100,000	$73,150
22		$20,000	$80,000		$100,000	$72,069
23		$20,000	$80,000		$100,000	$71,004
24		$20,000	$80,000		$100,000	$69,954
25		$20,000	$80,000		$100,000	$68,921
26		$20,000	$80,000		$100,000	$67,902
27		$20,000	$80,000		$100,000	$66,899
28		$20,000	$80,000		$100,000	$65,910
29		$20,000	$80,000		$100,000	$64,936
30		$20,000	$80,000		$100,000	$63,976

TOTAL= $55,520,169

Note: Total is in 2019 dollars.