COLORADO
Department of Public Health & Environment

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RE: Nelson Tunnel Superfund Site Treatability Study – Series 1 – Bachelor Shaft Pump Test

1.0 Introduction

EPA, CDPHE, and CDRMS have been studying the mechanics of groundwater flow at the Nelson Tunnel Superfund Site since 1999. One of the conceptual models developed since that time suggests that water entering the Nelson Tunnel is dominated by old groundwater upwelling into sub Nelson workings and possibly the Nelson Tunnel itself. This older groundwater is thought to increase its dissolved mineral content as it resides within and flows through the mine workings of the Nelson Tunnel. To inform the conceptual model, a series of treatability studies have been envisioned to assist in the understanding of the site's source water and provide data on the chemistry of that water.

The first in a series of potential treatability studies is the Bachelor Shaft pump test. This study is the obvious first candidate in the series because it is the simplest to conduct. The objective of this study is to provide insight into hydraulic communication between internal mine features such as the Bachelor Shaft and the Nelson Tunnel, confirm the age of water in the Bachelor Shaft and assess water quality over the duration of the study. The proposed activities for executing the study are detailed in Section 4.0. The proposed water monitoring schedule is detailed in Section 5.0.

It is anticipated that this study will be conducted during the Nelson Tunnel Time Critical Removal Action (TCRA) segments 5b and 6. The purpose of this letter is to provide a summary of the study and seek support from EPA. The primary parties involved in conducting this study are CDPHE, CDRMS, EPA and USFS.

2.0 Background

The Nelson Tunnel Superfund Site is located in the San Juan Mountains in south-central Colorado, and lies one mile north of the town of Creede in Mineral County. Approximately 350 gallons per minute (gpm) of acid mine drainage (AMD) discharges from the Nelson Tunnel into West Willow Creek. West Willow Creek flows into Willow Creek and finally into the Rio Grande River approximately five miles from the Nelson Tunnel.

The surface structure and underground workings of the Nelson Tunnel have deteriorated over time creating blockages that have caused the formation of three mine pools. These mine pools include:

- The Nelson Tunnel Portal Pool which extends from the portal to the Bachelor Shaft and contains approximately 1.2 million gallons of AMD.
- The Lower Mine Pool extends from the Bachelor Shaft to No Name Winze and contains approximately 1.4 million gallons of AMD.

- The Upper Mine Pool extends from the No Name blockage to just beyond the decline and contains approximately 19.4 million gallons of AMD.

The Commodore 5 Level Portal is located approximately 50 ft above and offset to the east of the collapsed Nelson Tunnel Portal. The Commodore 5 Level underground workings are currently being rehabilitated through a TCRA. The Commodore 5 Level provides access to a number of vertical connections to the Nelson Tunnel and its mine pools. The Commodore 5 Level has been used to access the Nelson Tunnel to conduct numerous studies, including:

- 2003 Underground Report: Interim Underground Report: December 2002 to December 2003; Colorado Division of Minerals and Geology, Willow Creek Reclamation Committee; December 31, 2003 – Covers initial investigations for many sections of the Nelson Tunnel and established elevation controls, mine pool blockages and sampling locations.
- Dewatering Report: Nelson Tunnel Dewatering Pilot Project; Jeff Graves, Colorado Division of Reclamation, Mining and Safety; 2007 – Study involving pumping of the Upper Mine Pool into dry sections of the overlying Commodore 5 Level which had been temporarily bulkheaded to impound water during the test.
- Byington Report: Characterization of Water Conduits Related to the Nelson Tunnel Mine Drainage, Creede, Colorado; C. Byington – Millennium Geoscience; August 2012.
- CU Report: Source Water Investigation Report – Isotopic and Geochemical Approaches to Characterizing Water Movement Through Abandoned Mine Workings in the Nelson-Wooster-Humphrey Tunnel, Creede, Colorado; R. Cowie, M. Williams, A. Krupicka – University of Colorado, Boulder Institute of Arctic and Alpine Research; July 19, 2014.

These studies have resulted in the creation of a site conceptual hydrological model including the evaluation of mine pool volumes mentioned above. Results from the following studies highlights critical components of the conceptual model. The CU Report confirmed a high rate of conductivity between the mine pools and determined water quality and age is consistent through each of the three pools. This study also states that meteoric infiltration from levels above the Commodore 5 Level contributes a small fraction to the total mine discharge. The Byington Report supports the theory that the majority of water infiltration is upwelling from below the Nelson Tunnel. This study recommends further investigations to advance the hydrologic conceptual site model, in particular the quality of sub-Nelson water.

3.0 The Bachelor Shaft

The Bachelor Shaft can be accessed from the Commodore 5 Level via the McClure/Overholt Cross Cut that connects to the Commodore 5 Level near Daylight Winze. New ladders and platforms have been installed as part of the TCRA and provide safe access to the Bachelor Shaft. The Bachelor Shaft is approximately 8 feet across and extends approximately 122ft below the Nelson Tunnel, making it one of only three shafts that are known to have been driven below the Nelson Tunnel. All known sub-Nelson Tunnel shafts are shown in Figure 1 below.

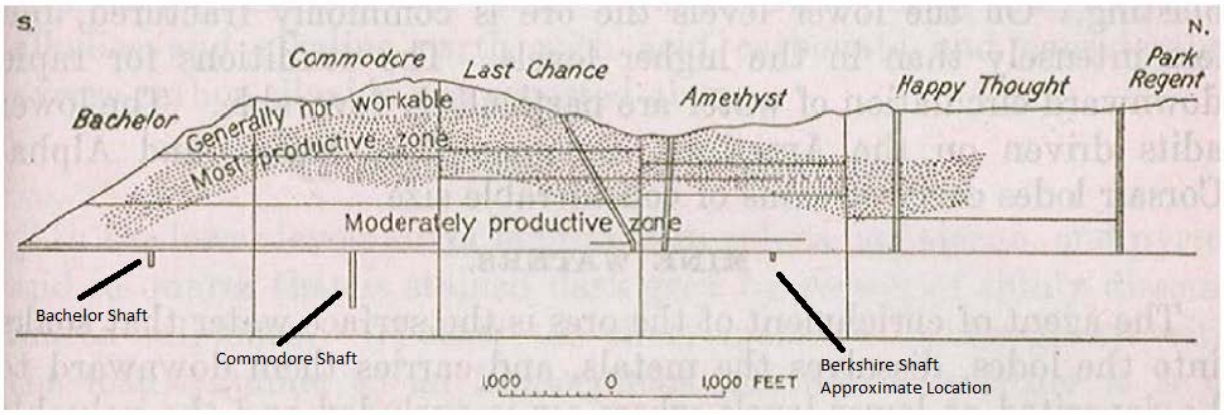

Figure 1 - Profile View of Mine Workings (Emmons and Larson, 1923)

Water is flowing from the crest of the Bachelor Shaft collar at approximately 1-5 gpm and draining into the Nelson Tunnel. The Bachelor Shaft was sampled during the 2003 and 2014 investigations listed above, and in both cases, the water quality was significantly different than most other parts of the Nelson Tunnel. In preparation for the Bachelor Shaft pump test, water was once again sampled in 2019 to evaluate water quality. These sampling efforts have confirmed the presence of cleaner water than that observed in the Nelson Tunnel discharge. Water quality summary results are presented in Table 1 below.

Location	Date	pH	Cadmium (µg/L)	Lead (µg/L)	Zinc (µg/L)
WQ Standard – Low Flow - 2021		6.5-9.0	Chronic Std = 27.4	Chronic Std = 102	Chronic Std = 9360
Bachelor Shaft (0ft)	May 2019	6.52	3.98	3.58	3550
Bachelor Shaft (20ft)	May 2019	7.12	3.0	4.84	3400
Bachelor Shaft (15ft)	2014	6.82	7.01	15	4180
Nelson Tunnel	2014	4.58	110	733	53200
Bachelor Shaft (0ft)	2003	5.97	1.8	10.6	2124
Nelson Tunnel	2003	4.50	138.5	756.1	74580

Table 1 – Bachelor Shaft and Nelson Tunnel water quality vs chronic low flow standards effective through 2021.

Table 1 presents water quality data from the Bachelor Shaft, Nelson Tunnel and CDPHE low flow water quality standards for West Willow Creek. This table highlights the difference in water quality between the Bachelor Shaft and the Nelson Tunnel discharges. This table also shows that water from the Bachelor Shaft attains low flow water quality standards for West Willow Creek. This attainment of standards is critical to the study moving forward as water from the Bachelor Shaft will not have to be treated when pumped and discharged to West Willow Creek as part of this study.

Pursuant to CERCLA 42 USC § 9621(e) "No Federal, State or local permit shall be required for the portion of any removal action or remedial action conducted entirely on-site…" The Term "on-site" means the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action. In Lieu of complying with requirements to obtain permits, licenses or any form of administrative permission, EPA must comply with the substantive portions of Regulations 36: Classifications and Numeric Standards for Rio Grande Basin. More specifically, site specific low flow standards (August 1 – March 31) effective through 12/31/2021 for Rio Grande Segment 7 – West Willow Creek. These standards are presented in Table 1. As expressed in Table 1, the Bachelor Shaft water quality complies with these standards.

Furthermore, CDPHE Water Quality Control Division has been notified and is aware of the planned study.

4.0 Bachelor Shaft Pump Test

As previously mentioned, objective of this study is to provide insight into hydraulic communication between the Bachelor Shaft and the Nelson Tunnel, further confirm the age of water in the Bachelor Shaft and assess water quality over the duration of the test. Hydraulic communication between the Bachelor Shaft and the Nelson Tunnel will be evaluated through water level monitoring of all three Nelson Tunnel mine pools, the Bachelor Shaft and Nelson Tunnel discharge during the test. Samples will be collected for isotope analysis to confirm the age of the water and additional samples will be collected to assess potential changes in water quality at the beginning and end of the study.

The duration of the study is anticipated to include 1-3 days of 12 hour pumping periods. However, this will be dependent on the recharge rate of water entering the Bachelor Shaft. If the recharge into the Bachelor Shaft is too small to maintain a constant 12 hour pumping rate, then the study will be terminated after all samples are collected. If recharge is continuous, the Bachelor Shaft will be drawn down as much as possible within the 12 hour window, then allowed to recharge for the following 12 hours. A flow meter with a cumulative volume counter will facilitate pump adjustment in pursuit of a desired flow rate. Water pumped from the Bachelor Shaft will be discharged from the Commodore 5 Level. Water will be pumped and piped to Daylight Corner, where it can openly flow and exit the mine through the Commodore 5 Level. If discharge from the Bachelor Shaft study impedes TCRA work or exceeds the capacity of the existing drainage ditch, then the discharge will be piped to the Commodore 5 Level portal. The discharge rate is not anticipated to exceed 60gpm. Pictures attached to this document show the location and condition of the Commodore 5 Level drainage ditch. It is anticipated that minor ditch maintenance will be required before and during the test.

A preliminary cost estimate provided by HRD Inc. is attached for this document for reference.

4.1 Study Termination

It should be noted that the intent of the study is to evaluate hydraulic communication between the Bachelor Shaft and the Nelson Tunnel. This study is not designed to significantly cause water level fluctuations within the mine pools or provoke a drastic change in water quality.

To ensure the treatability study does not create a fluid hazard by significantly altering the stability of mine workings, blockages and mine pools, a mine pool elevation threshold has been predetermined. This threshold primarily focuses on ensuring integrity of the blockages responsible for creating the Portal, Lower and Upper mine pools within the Nelson Tunnel.

Furthermore, the treatability is not intended to exacerbate water quality. Water quality data from the Bachelor Shaft expresses substantive attainment of water quality standards identified in Regulation 36. Water quality parameters indicative of significant water chemistry change will be recorded twice daily to ensure discharge is still in substantive attainment.

4.1.1 Fluid Hazard Study Termination

The study will be terminated if the Portal, Lower or Upper Pools express a significant increase or decrease in pool elevation. This scenario is extremely unlikely, however, observed fluctuations in mine pools have the potential to cause instability in mine pool blockages and will therefore be minimized to the extent practicable. This will be accomplished by daily monitoring of the Portal, Lower and Upper mine pool elevations and comparing elevations collected during the study to the range of conditions observed prior to the study. This will be executed daily when pumping from the Bachelor Shaft.

The study will be terminated if any mine pool expresses a greater than 10% increase or decrease in water level compared to the normal range encountered during the TCRA from November to May 2019.

4.1.2 Water Quality Study Termination

The study will be terminated if physical water quality indicators, pH, electrical conductivity (EC), color and air quality, express a change indicative of possible unattainment of substantive standards or create an unsafe working environment. The likelihood of significant water quality fluctuations is unclear. In pursuit of

water quality standard attainment identified in Regulation 36, physical water quality indicators will be collected twice daily. Termination of the study will be required if any indicator threshold presented below is exceeded:

- pH – after two days of pumping (5 data points, one pre-pumping and 4 during pumping observations) if the rolling average pH exceeds the range of 6.5-9.0, then the test will be terminated. This is the allowable pH range identified in Regulation 36.

- EC – after two days of pumping (5 data points, one pre-pumping and 4 during pumping observations) if EC increases by greater than 50% compared to the average of the 5 data points, then the test will be terminated. Generally, an increase in EC indicates an increase in dissolved solids. This has the potential to indicate an increase in mineral content and negative impact on water quality.

- Color – if the color of the water being discharged as a result of the treatability study is orange or indicates a negative impact to water quality, then the test will be terminated.

- Air Quality – a generator will be required to supply power to the pump. Air quality will be monitored within all working areas of the mine. If air quality degrades to a point of concern, then the generator will be turned off and the test will be terminated.

4.2 Study Initiation

As part of the study initiation, the following activities will be conducted prior to pumping to ensure conditions are suitable and instruments are installed to record measurements. These activities include:

- Test if ventilation is required for power equipment during the study. If additional ventilation is required, then install ventilation and other necessary utilities within the Bachelor Shaft area to enable use of either a diesel-over-hydraulic or electric submersible pump. Notification of intended activities will be communicated to all personnel throughout the mine.
- Ensure the Nelson Tunnel flume is accurately measuring flow.
- Ensure Nelson Tunnel flume data loggers are functioning as intended.
- Ensure lower and upper mine pool data loggers are functioning as intended.
- Install a staff gauge in the Nelson Tunnel portal pool.
- Determine the normal range of mine pool elevations during the November to May 2019 TCRA. Evaluate the study termination 10% increase or decrease thresholds and compare daily mine pool elevations to thresholds during the study.
- Construct and install slotted casing to house the submersible pump within the Bachelor Shaft. Casing length and pump depth may be limited by timbers within the Bachelor Shaft at depth.
- Prior to the dewatering the Bachelor Shaft, samples will be collected and multi-parameter probe will be used to collect baseline water quality parameters within the Bachelor Shaft. The same sampling will be conducted at the end of the test.

5.0 Bachelor Shaft Pump Test Monitoring Plan

Water quality monitoring for the Bachelor Shaft pump test shall be conducted to achieve two primary objectives. One is to inform the conceptual model. The second is to monitor Bachelor Shaft discharge to evaluate attainment of water quality standards.

Water monitoring to inform the conceptual model includes all the substantive Regulation 36 monitoring outlined in Table 4 as well as isotope sample collection to assess potential variation in Bachelor Shaft water age from the beginning to the end of the study. Table 3 outlines the isotopic analysis. Previous

isotope analysis from the CU Report suggested that the Nelson Tunnel mine water has an apparent age of > 5,000 years.

Parameter	Frequency	Comment
Tritium	At beginning and end of study	Samples collected at start and end of pumping.
Stable Water Isotopes (oxygen-18 and deuterium)	At beginning and end of study	Samples collected at start and end of pumping.
Dissolved Inorganic Carbon	At beginning and end of study	Samples collected at start and end of pumping.
Dissolved Organic Carbon	At beginning and end of study	Samples collected at start and end of pumping.

Table 3 – Isotope analytical suite

As previously mentioned, water quality monitoring from the Bachelor Shaft indicates cleaner water then that discharging from the Nelson Tunnel. Comparison of Regulation 36 standards against May 2019 analytical results confirm that water from the Bachelor Shaft attain low flow (August 1 – March 31) site specific standards for West Willow Creek. Because of the attainment, water treatment is not required to conduct this study during the low flow period. However, to assess continued attainment of these standards the monitoring presented in Table 3 will be conducted.

Parameter	Frequency	Comment
Physical Water Quality Parameters	Twice a day	pH and EC observations will be used to inform water quality termination thresholds identified in Section 4.1.2.
Dissolved Metals	At beginning and end of study	Samples collected at start and end of pumping.
Total Metals	At beginning and end of study	Samples collected at start and end of pumping.

Table 4 – Samples collected for Regulation 36 evaluation

All samples collected will be collected under the approved START EPA contractor QAPP.

6.0 Conclusion

The Bachelor Shaft pump test treatability study is designed to provide information to better understand the water conveyance mechanics at the Nelson Tunnel Superfund Site. The site team believes that a better understanding on the hydraulic setting will lend itself to more informed decision making with regard to a final site remedy.

The Colorado Department of Reclamation, Mining and Safety will be the project leader. All on-site decision making will be approved by Jeff Graves.

If there are any questions or concerns that require clarification, then please contact Ross Davis or Jeff Graves.

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