



COLORADO OPERATIONS

Henderson Mine and Mill
P.O. Box 68
Empire, CO 80438
Phone (303) 569-3221

March 31, 2023

Via Email

Mr. Peter Hays
Division of Reclamation Mining and Safety
1313 Sherman St., Rm. 215
Denver, CO 80203

RE: Henderson Mine POC Well MNGW-1 Low pH Status Update - Fourth (4th) Adequacy Review, Climax Molybdenum, Henderson Mine, File no. M-1977-342

Dear Mr. Hays:

Climax Molybdenum Company (CMC) is submitting this response regarding the August 2, 2022, request that Henderson provide possible mitigation measures for No Name Gulch (NNG) along with the findings from the August 2022 sampling and field evaluations.

If you have any questions regarding this submittal, please contact me at (720) 942-3631.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Ben Bates'.

Ben Bates
Senior Environmental Engineer
Climax Molybdenum Company
Henderson Operations

Contents:

1. 2022 summer evaluation findings and discussion
2. Mitigation solutions
3. Figures

Attachments:

1. Wheeler mitigation solutions technical memo

cc (via email)

M. Hamarat, Climax
G. Niggeler, Climax

DRMS Response: The Operator shall commit to providing mitigation measures to be taken in the summer of 2023 along with their findings from the summer 2022 evaluations. The Operator has an on-going exceedance of a permit condition at a point-of-compliance (POC) well. The Operator rerouted the natural drainage of No Name Gulch around their facility to discharge near the point-of-compliance well. The routing of the drainage appears to be, in part, responsible for the exceedances. The Operator needs to mitigate the on-going exceedances at the POC or enforcement action may be taken by the Division.

Summer 2022 Evaluation:

In our July 26, 2022, submittal, Henderson indicated that additional data and evaluation were necessary to better understand the relationship between the POC at MNGW-1 and the natural drainage of No Name Gulch, and to determine potential mechanisms for the increase in frequency of pH exceedances at MNGW-1. In 2022, Henderson investigated factors such as hydrological conditions or the existence of an alkaline buffer supplied by surrounding rock and soil within the No Name Gulch watershed. Transect evaluations for pH along No Name Gulch resulted in a 1 s.u. difference between 2013 and 2017 measurements (figure 1) suggesting an outside control such as changes in hydrologic conditions or geochemical influences.

In the July 2022 memo, Henderson mentioned that the presence of manganocrete and/or ferricrete deposits were observed during past transect evaluations of No Name Gulch. During the August 2022 sampling event, Henderson confirmed the presence of ferricrete (figure 2) indicating the long-term existence of acid-rock drainage (ARD) conditions in No Name Gulch. Similar ferricrete deposits have been used as exploration guides and indicators of the geochemical baseline conditions prior to mining operations.

Altogether, the summer 2022 evaluations yielded results consistent with the interpretation that low pH conditions observed in No Name Gulch are naturally occurring and unrelated to Henderson mining operations. These evaluations showed that the likely cause of lower pH in No Name Gulch and MNGW-1 is naturally occurring acid-rock drainage causing depletion of the natural alkaline buffering in the gulch.

The pH results from the August 2022 evaluation fell between the 2013 and 2017 results (figure 3). To test hydrologic factors, Henderson calculated a theoretical volume of water required to increase the pH by the 1.0 s.u. observed between the 2013 and 2017 datasets. In all of the sampling transect analyses, a gradual increase in pH was recorded from the top of the drainage to the lowest sampling station. To further evaluate temporal and spatial changes in pH along No Name Gulch, Henderson evaluated various mixing scenarios. The objective of the analysis was to see if changes in pH in No Name Gulch can be explained by mixing of naturally occurring No Name Gulch water with a more neutral water source. Understanding the factors influencing pH changes in No Name Gulch is needed to evaluate mitigation alternatives. Henderson's initial analysis consisted of mixing calculations using a pH of 3.9 for No Name Gulch and a pH of 7.4 for a neutral water source (value based on pH measurements recorded in nearby Butler Gulch). The mixing analysis found that based on hydrogen ion concentrations alone, it would take a mix ratio of nine (9) parts of a higher pH water source to one (1) part No Name Gulch to achieve an increase to the pH of the mix water by 1.0 s.u.

Based on these results, Henderson does not believe that pH changes in No Name Gulch, either temporal or spatial, can be explained by mixing with a neutral water source. Instead, Henderson believes it is likely that pH changes in No Name Gulch are more dependent on geochemical factors such as the existence of an alkaline buffer capacity. In 2023, Henderson intends to expand the analysis of No Name Gulch pH changes to include geochemical analyses that will incorporate additional parameters, like alkalinity and total inorganic carbon. In August 2023, Henderson plans to collect additional geochemical samples from No Name Gulch. The analyte list for the sampling event will include another pH transect as well as total inorganic carbon, which is needed to better understand geochemical conditions in No Name Gulch. To this end, Henderson intends to conduct equilibrium speciation analyses, using a modeling program like PHREEQC. As noted above, Henderson strives to better understand the geochemistry in this natural system so that the potential positive and negative impacts of potential mitigation alternatives can be evaluated.

In addition, Henderson has done a thorough review of potential issues and site features to look for areas that would benefit from improvement. Earlier this year, Henderson completed a review of Colorado Division of Water Resources imaged records portal. Included in the database were records related to the drilling and installation of POC monitor well MNGW-1 in 1993. The well construction report is included in figure 4. There are several construction details (summarized below) that Henderson believes are not consistent with the currently accepted practices for effective groundwater monitoring. For example, the construction drawing presents an unusual design that appears to lack any type of substantive surface seal. Additionally, the well appears to have been constructed using a back-hoe with the excavation (i.e., annulus) back-filled with excavated material. Because of the enhanced potential for migration of surface water, such as from No Name Gulch, into the screen interval of MNGW-1, Henderson intends to replace MNGW-1 with a new monitor well that will be designed and constructed in accordance with current standards and best practices, including a surface seal. The primary objective of the replacement well is to ensure that monitoring samples are most representative of groundwater conditions with minimal surface water influences. Henderson has scheduled the replacement of MNGW-1 for the summer of 2023. The original MNGW-1 well will be abandoned. Sampling of the new well will then further inform the extent and scope of additional mitigation measures in 2024.

Mitigation Measures:

As explained above, Henderson has concluded that reductions in pH observed in Monitoring Well MNGW-1 are likely to be the result of natural acid-rock drainage in No Name Gulch; there is also a likelihood of there being some level of exhaustion of naturally occurring alkaline buffer in No Name Gulch, especially in the materials used to create the diversion ditch decades ago. Flows from No Name Gulch then influence the pH in MNGW-1. Based on this information, decreasing pH in the monitoring well is caused by ambient, natural conditions.

Nevertheless, to be responsive to DRMS's request, Henderson initiated a preliminary evaluation of potential mitigation measures in 2022. Attached is a technical memorandum provided by W.W. Wheeler & Associates, Inc. (Wheeler) detailing potential mitigation options. Henderson is exploring the feasibility of rerouting No Name Gulch or lining the existing channel to segregate it from the POC well. Concurrent with continued evaluations mentioned above to determine the appropriate mitigation option, Henderson will continue to work with Wheeler to progress design phases during the search for a feasible mitigation option.

Any mitigation option entails potential environmental impacts and presents logistical issues. An alternative that would entail the conveyance of water to West Fork Clear Creek that could have lower pH levels would require an assessment of associated impacts. Any mitigation measure would require a jurisdictional delineation in order to determine the application of Clean Water Act (CWA) Section 404 permitting. The removal or segregation of No Name Gulch from the POC location has implications for the conveyance of natural water to a wetland area. A jurisdictional delineation and wetland survey are scheduled for the spring of 2023. As noted above, Henderson plans to conduct another sampling transect in No Name Gulch in 2023. Additionally, based on the findings mentioned above, Henderson plans to replace POC monitor well MNGW-1 with a new monitor well that includes a surface seal. Henderson expects the information obtained from these activities will be used to refine the identification and evaluation of mitigation alternatives.

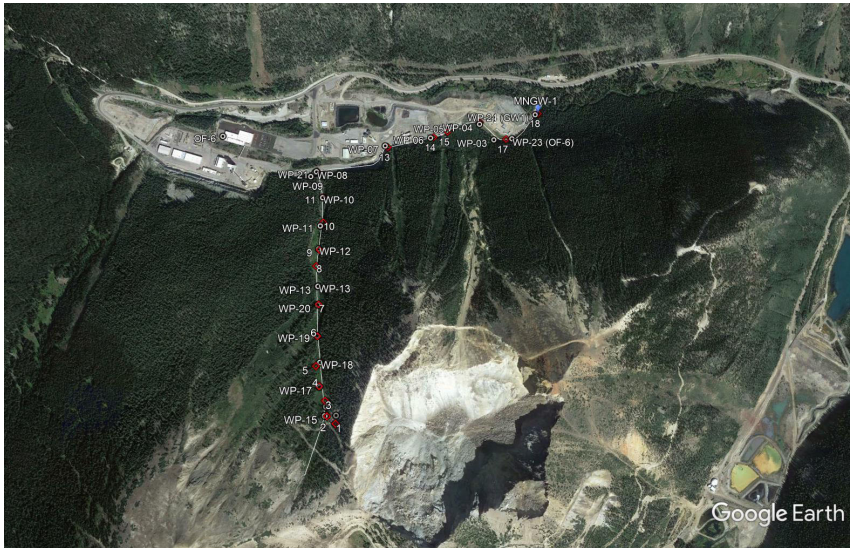
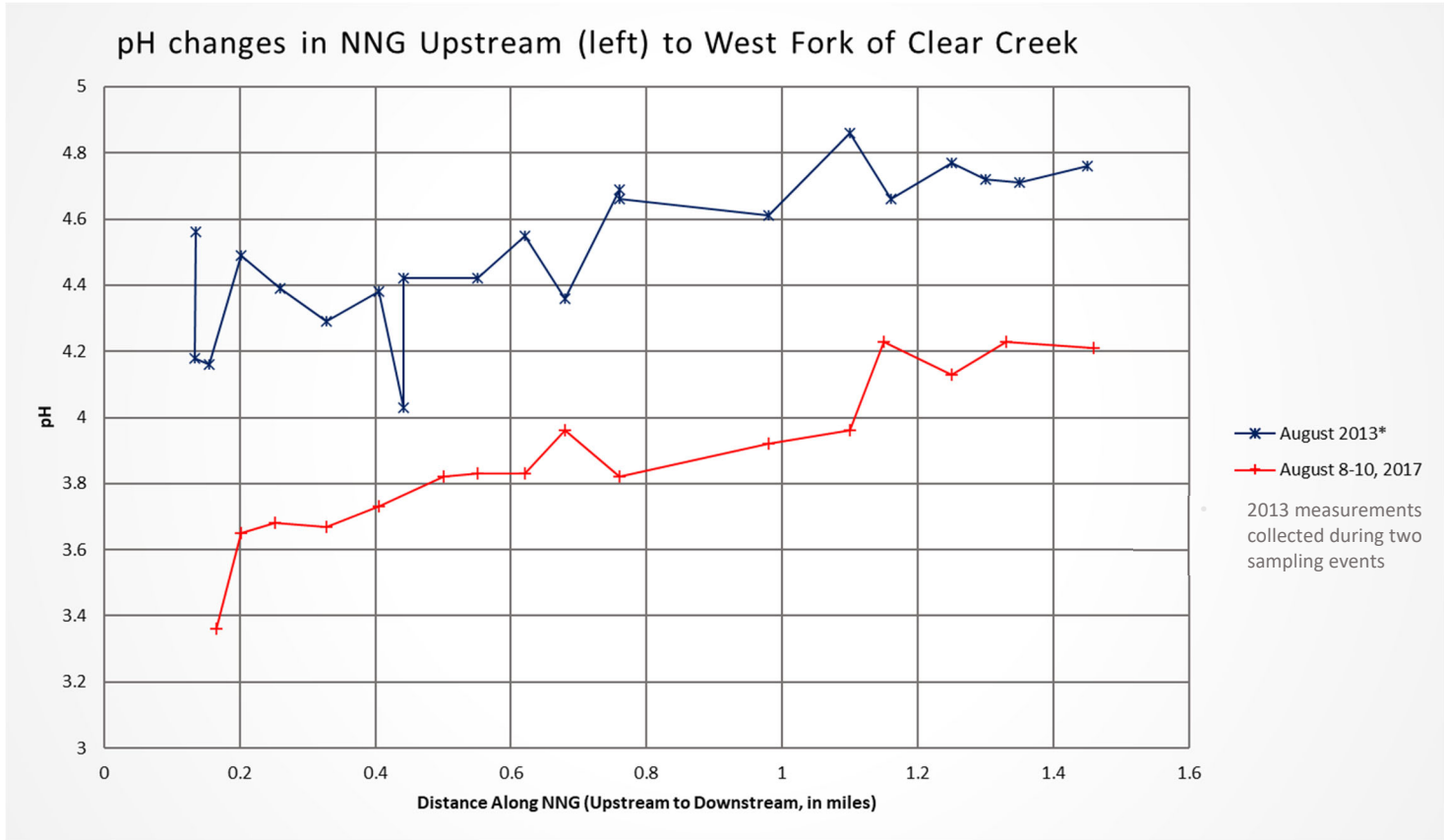


Figure 1



- *Top Left: Ferricrete sample from 2022 summer field survey*
- *Top Right: Ferricrete observed during 2013 summer field survey*
- *Bottom: Ferricrete documented during 2013 summer field survey*

Figure 2

pH changes in NNG Upstream (left) to West Fork of Clear Creek

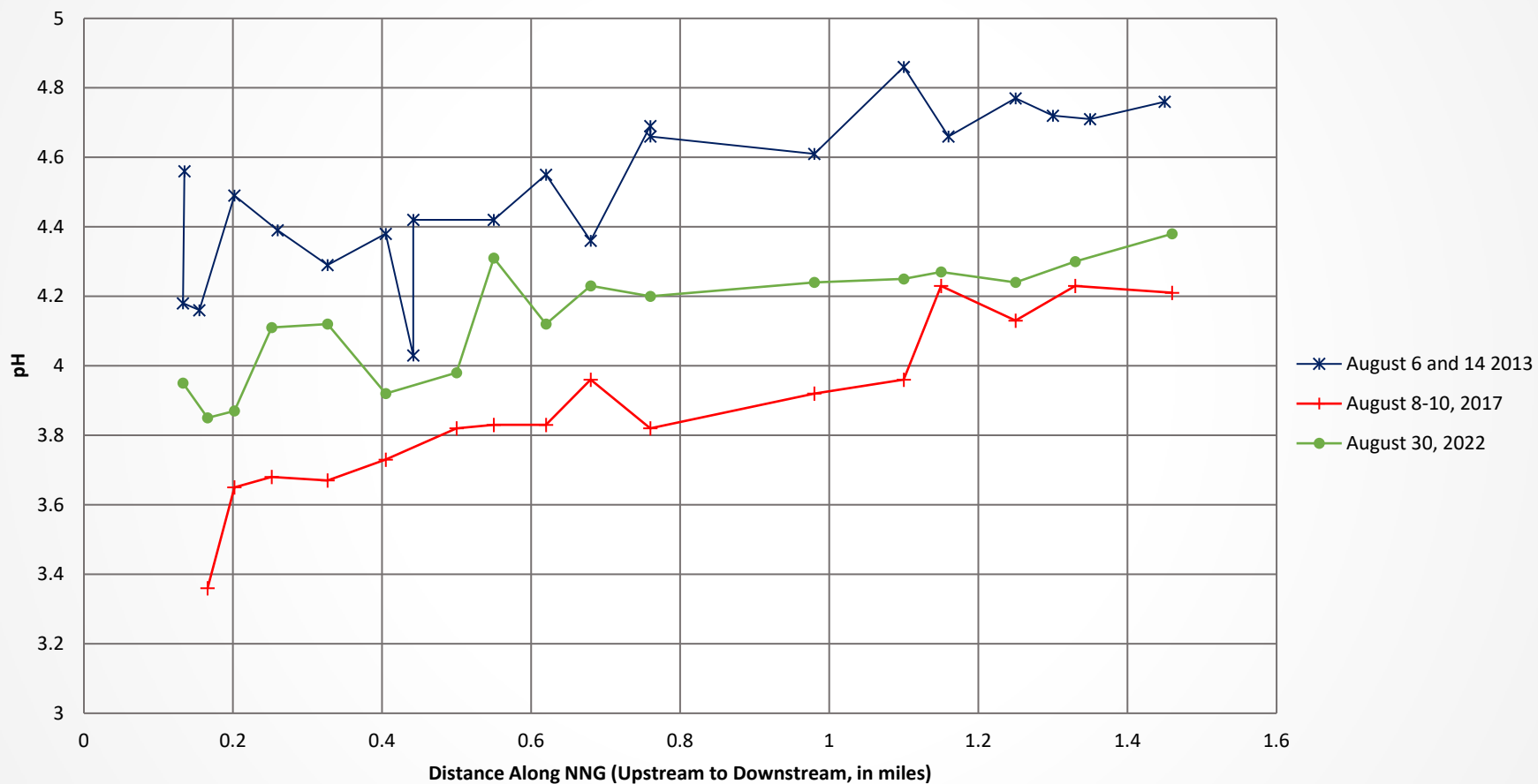


Figure 3

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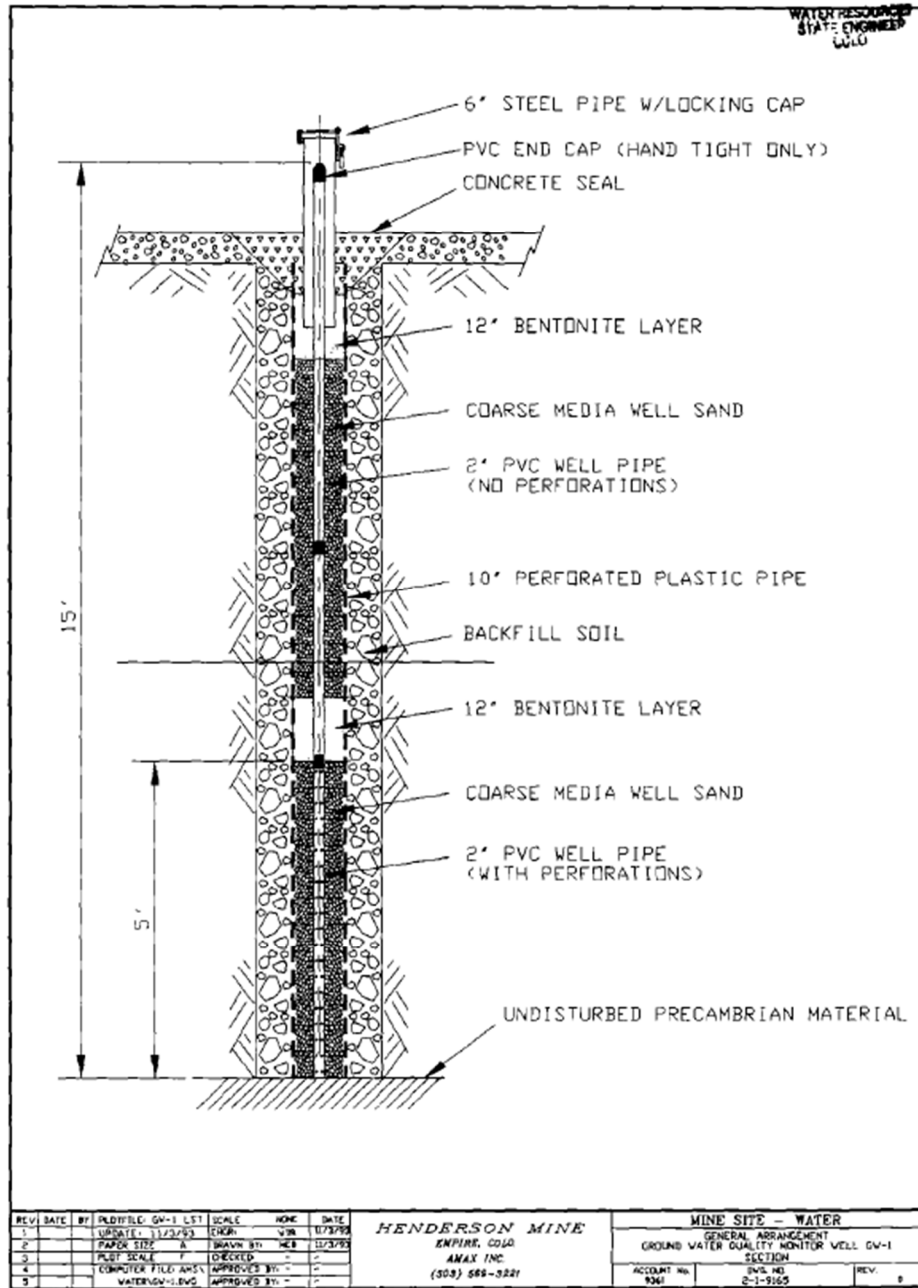


Figure 4



TECHNICAL MEMORANDUM

March 14, 2023

To: Mr. Ben Bates
Senior Environmental Engineer – Water Quality
Climax Molybdenum Company – Henderson Mine
Empire, Colorado

From: Trevor E. Mugele, P.E.
W. W. Wheeler & Associates, Inc.

Re: 1070.19.02 Henderson Mine - No Name Gulch
Groundwater Segregation Mitigation Options

W. W. Wheeler and Associates, Inc. (Wheeler) has been contracted by Henderson Mine (Henderson) to provide engineering services for the development of options for potential rerouting or lining of existing flow paths for the No Name Gulch at Henderson. No Name Gulch (NNG) is a drainage on the north face of Red Mountain, immediately south of Henderson facilities. Henderson currently diverts flow from the gulch around mine facilities to the confluence with the West Fork of Clear Creek (WFCC) immediately east of the development rock stockpile. The general existing layout of the area is shown on Figure 1.

This memorandum documents the mitigation options being considered by Henderson. Each option is summarized below:

Option 1A – Reroute No Name Gulch along a direct path to the West Fork of Clear Creek, similar to the assumed pre-mining impact path. A buried pipeline will convey rerouted flows through the Henderson site. This would be the shortest path but would require several utility crossings and impact to site access roads. The assumed pipeline size is 24-inch-diameter. The estimated reroute length is 800 feet.

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March 14, 2023
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Option 1B – Reroute No Name Gulch along the existing channel path to the east side of Henderson facilities to the West Fork of Clear Creek, similar to Option 1A but on a longer path which will cross fewer utility crossings. A buried pipeline will convey rerouted flows around Henderson Mine facilities. The assumed pipeline size is 24-inch-diameter. The estimated reroute length is 2500 feet.

Option 2A – Modify the No Name Gulch channel by construction of an impervious liner. Any necessary capacity or routing improvements to the channel would be made in conjunction with the installation of the liner. The estimated length of the modified channel is 3800 feet.

Option 2B – Modify the No Name Gulch channel by replacement with a buried pipeline along the existing path. The assumed pipeline size is 24-inch-diameter. The estimated pipe length is 3800 feet.

The four options are shown in plan view on Figure 2 at the end of this memorandum. The information provided in this memorandum is based in part on information provided by Henderson. Additional hydrologic and hydraulic calculations are required for final design and generation of civil construction drawings. The potential effect of any of the options described above on the water quality in the monitoring wells has not been estimated.

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