COLORADO DIVISION OF RECLAMATION, MINING AND SAFETY
1313 Sherman Street, Room 215, Denver, Colorado 80203 ph(303) 866-3567

REQUEST FOR TECHNICAL REVISION (TR) COVER SHEET

File No.: M- 1980-110 Site Name: Henderson Development

County Adams TR# *(DRMS Use only)*

Permittee: E-470 Public Highway Authority

Operator (If Other than Permittee):

Permittee Representative: Derek Slack

Please provide a brief description of the proposed revision:

This technical revision consists of a modification for installation of a passive drainage sytem to transport ground water around the site. This is further described in the attachments.

As defined by the Minerals Rules, a Technical Revision (TR) is: “a change in the permit or application which does not have more than a minor effect upon the approved or proposed Reclamation or Environmental Protection Plan.” The Division is charged with determining if the revision as submitted meets this definition. If the Division determines that the proposed revision is beyond the scope of a TR, the Division may require the submittal of a permit amendment to make the required or desired changes to the permit.

The request for a TR is not considered “filed for review” until the appropriate fee is received by the Division (as listed below by permit type). Please submit the appropriate fee with your request to expedite the review process. After the TR is submitted with the appropriate fee, the Division will determine if it is approvable within 30 days. If the Division requires additional information to approve a TR, you will be notified of specific deficiencies that will need to be addressed. If at the end of the 30 day review period there are still outstanding deficiencies, the Division must deny the TR unless the permittee requests additional time, in writing, to provide the required information.

There is no pre-defined format for the submittal of a TR; however, it is up to the permittee to provide sufficient information to the Division to approve the TR request, including updated mining and reclamation plan maps that accurately depict the changes proposed in the requested TR.

Required Fees for Technical Revision by Permit Type - Please mark the correct fee and submit it with your request for a Technical Revision.

Permit Type	**Required TR Fee**	**Submitted** (mark only one)
110c, 111, 112 construction materials, and 112 quarries	$216	☑
112 hard rock (not DMO)	$175	☐
110d, 112d(1, 2 or 3)	$1006	☐

Technical Revision
M-1980-110
Henderson Development (Sandy Acres)

This Technical revision is for the installation of a passive drainage system to transport ground water around the site.

The pit backfill was completed in July 2016. Water was first noted on the south end of the site in 2019. Water now covers a majority of the backfilled site. E-470 hired BBA Water Consultants and they determined that the ponded water is from ground water not from surface runoff. A series of test wells were installed to gather data on the ground water in the area. BBA has analyzed the data and developed a phased approach to eliminate ground water from ponding on the site. A passive drainage system will be used which consists of digging a trench and installing perforated pipe and rock. The initial installation of approximately 1,000 feet will be completed and the water levels monitored. If the system works to lower water levels it may then be extended in order to eliminate ground water ponding on the site. Once the system is completed as-built drawings will be submitted.

The attached report from BBA provides more detail on the analysis and the recommendations.

January 2022

MEMORANDUM

BBA Water Consultants, Inc.

To: Derek Slack, P.E. and Neil Thomson, P.E.
E-470 Public Highway Authority (E-470)

From: Timothy A. Crawford

Subject: E-470 – Sandy Acres Pit – Ponding Water Mitigation Efforts

Job: 9607.00

Date: October 21, 2021

This memorandum presents information to assist E-470 with mitigating the current ponding water issues at the E-470 Sandy Acres Pit. We understand that the ponding water issues need to be addressed before closing the mining permit for the pit. Based on conversation with E-470, the investigation of mitigation options has been discussed in a stepwise manner to allow for confirmation of options, approaches and efficacy of potential solutions before designing and installing a full system to address the issues.

General Background

The Sandy Acres Pit is currently a backfilled, inactive, unlined gravel pit located on one of E-470's properties near Henderson, Colorado. The former gravel pit was permitted by the Colorado Division of Reclamation, Mining and Safety (DRMS) as the "Henderson Development" under Permit No. M-1980-110. DRMS approved Amendment No. 6, AM-06 on September 3, 2014 and Technical Revision No. 3 on May 12, 2015, allowing E-470 to backfill the Sandy Acres Pit with washed fines from a neighboring gravel pit. The approved backfilling was completed on July 1, 2016.

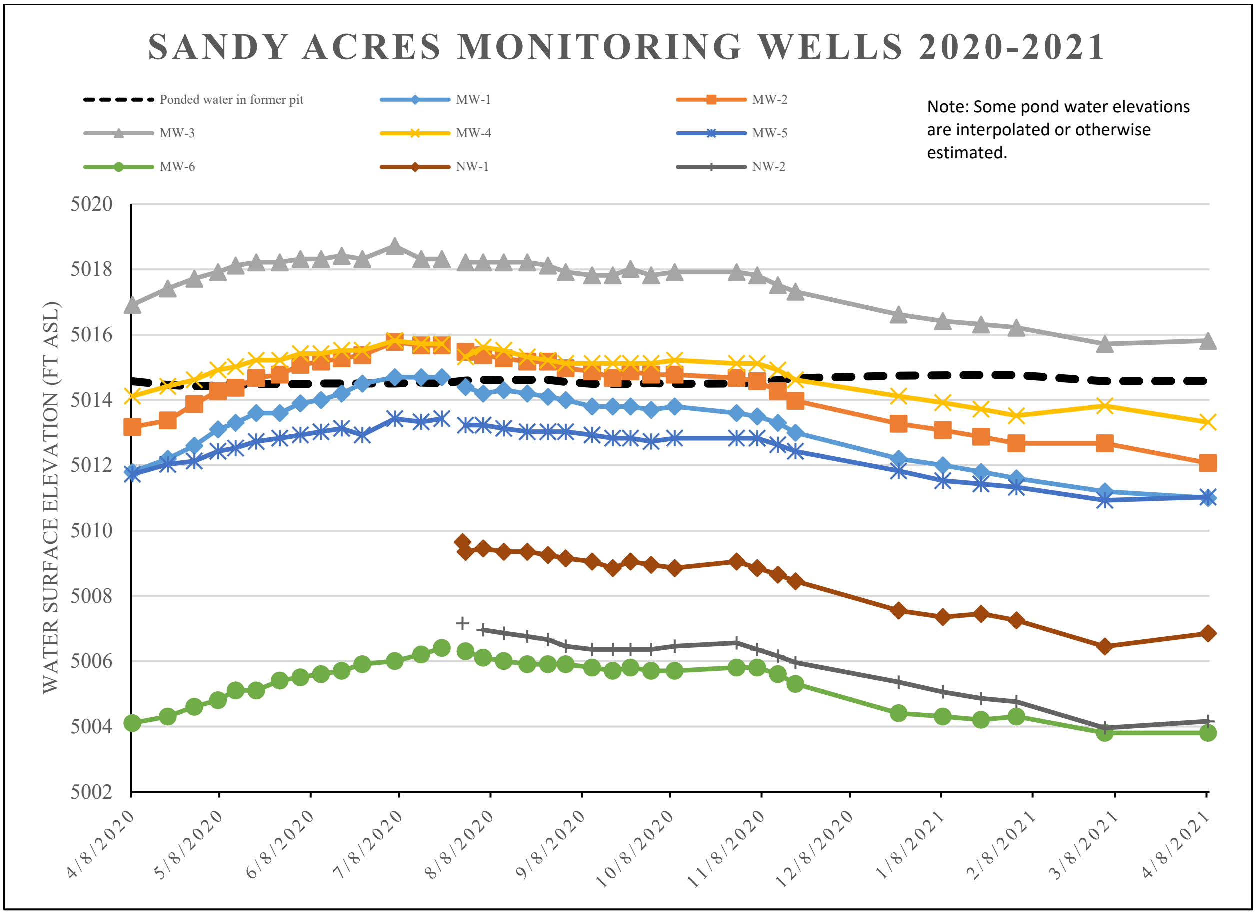
During a 2019 site inspection, DRMS staff noted ponding water at the base of the (backfilled) pit at the southern end of the site. Representatives from E-470 and BBA Water Consultants, Inc. (BBA) visited the site and confirmed the presence of the observed ponded water in the Sandy Acres Pit.

We understand that E-470 is seeking to close the mining permit for the Sandy Acres Pit and that the ponding water issue must be resolved before the permit can be closed.

Geologic and Hydrogeologic Background

The Sandy Acres Pit was constructed into and mined the South Platte Alluvium which, based on the available geologic mapping, is quaternary alluvial material that consists of sand, gravel, silt and clay with deposits potentially as thick as 60 feet. Test drilling efforts completed to investigate the ground water system as it relates to ponding water issues indicate that the alluvium at the Sandy Acres Pit ranges in depth from 32 to 45 feet and consists of gravels, sand, silt and clay, generally consistent with the mapped geology. The test drilling efforts included the installation of monitoring wells, located as presented in Figure 1, which indicate the alluvium is saturated. Water level data has been collected from the wells since installation. The water level data collected in 2020 and 2021 indicate that water levels around the pit fluctuate with a general gradient from south to north with the highest ground water elevations consistently measured in the MW-3 well (southernmost well) and the lowest ground water elevations consistently measured in the MW-6 well (northernmost well).

A comparison of water level elevations, as presented below, indicates that ground water is a contributing source of inflow to the pit. In areas and at times where / when the ground water around the pit is at a higher elevation than the standing water in the pit, the ground water system is discharging to the pit. Data suggests that inflow to the pit occurs along the southern and eastern portions of the pit and may occur year-round near the MW-3 location, for portions of the year around the MW-2 and MW-4 locations and for a brief portion of the year near the MW-1 location. We note that the water level data period of record available to review is limited to 1 year. While we would expect similar conditions to the data below, future ground water conditions will be a factor of local steam flow and precipitation.



The fill material in the pit may exacerbate the interaction between ground water and the pit due to the lower permeability of the fill material by forcing ground water to mound upgradient from the pit resulting in artificially higher ground water elevations.

The monitoring well data suggest that the ground water elevation is below the elevation of the standing water in the pit in the northwestern portions of the pit around the NW-1, NW-2 and MW-6 locations.

Figure 2 presents 3 perimeter zones around the Sandy Acres Pit representing reaches of the pit perimeter that have differing pit inflow conditions. In "Zone A", the water level data indicate that ground water inflow to the pit occurs year-round. In "Zone B", the water level data indicate that water level conditions vary and ground water inflow to the pit occurs at some times of the year. In “Zone C”, the water level data indicate that no ground water inflow occurs at any time of the year.

It is conceptualized that ground water inflow occurs around the edge of the pit with the inflow being perched on top of the fill material in the pit and flowing to the north.

Potential Pit Inflow

The ground water in the general vicinity of the Sandy Acres Pit has been identified as one potential source for the standing water in the pit indicating that the ground water is discharging to the pit at some rate.

A simplified Darcy calculation with Dupuit assumptions designed to calculate inflows to a linear feature, such as a drainage ditch or the perimeter of a pit, indicates that inflows to the pit may be as high as approximately 1,600 gallons per minute (gpm) in the middle of the summer when water levels are at their highest in the aquifer around the pit. During the early spring months, when water levels around the pit are deeper and there is less interaction with the ground water system, inflows to the pit may only be on the order of 200 gpm. This estimation of inflow is sensitive to the inputs which have been assumed based on the best information available, but can vary significantly. These estimates should be considered rough planning estimates of potential ground water inflow to the pit.

A second method to estimate pit inflow is a simplified water balance approach focusing on potential evaporation and infiltration, which indicates a potential pit inflow of approximately 700 gpm.

These basic investigations indicate that ground water inflow to the pit may be as high 700 to 1,600 gpm at certain times of the year. We would expect for inflows to vary throughout the year and from year to year based on water level conditions in the alluvial aquifer surrounding the pit.

We also understand that there are storm drain outlets that discharge to the pit and also directly contribute to ponding water in the pit when flowing.

Options

As mentioned above, we understand that E-470 is seeking to remedy the ponding water conditions in the Sandy Acres Pit as part of the closure of the DRMS permit for the pit. There are several conceptual options that can be implemented at the Sandy Acres Pit to remedy the ponding water conditions although we understand E-470 is interested in passive solutions. The conceptual options available to E-470 include:

- An active dewatering system either in or adjacent to the pit,
- The installation of additional fill to an elevation above the elevation of the neighboring ground water system,

- Sealing of all or portions of the interior of the pit walls (such as by using a compacted clay liner),

- A slurry wall system around the exterior of the pit, and / or

- A passive drainage system (French drain system) in or adjacent to the pit.

These options could be implemented individually or in tandem and each have inherent advantages and disadvantages. As mentioned above, we understand that E-470 is most interested in a passive system, specifically a passive drainage system, as it should provide a remedy that can be installed and allow the pit to be closed without significant cost or ongoing operating and maintenance requirements.

Generalized Passive Drainage System Conceptual Design

A passive drainage system will include a lateral trench(es) that intercept(s) ground water before it enters the pit or collect(s) standing water in the pit and convey(s) that water to a discharge point. More specifically, a passive drainage system will include:

- Excavated trenches that intercept the ground water system,

- Conducting layers to allow the system to communicate with the ground water system and screen fine grained material from drainage water entering the system,

- Collector pipes to efficiently convey drainage water,

- Geotextile fabric to minimize system sedimentation, and

- Outlet structures.

For the Sandy Acres Pit, E-470 can consider either a perimeter trench or a trench(es) inside the pit to collect and convey water.

<u>Perimeter Trench Vs. Interior Trench Considerations</u>

The benefit of a perimeter trench is that the trench would intercept ground water before it enters the pit and contributes to the standing water. This option may have a better potential to remedy the ponding water conditions to the DRMS' satisfaction if the ground water is discharging along the edges of the pit and becoming perched on the fill material.

An interior trench system could reduce the total linear length of trench required; however, water would still need to flow into the pit and then to the collection system before being captured and conveyed by the system. An interior system could successfully move water and lower the water level of standing water in the pit, but may not fully address the ponding water issue as desired to achieve closure of the permit for the pit. An interior system would provide for efficient conveyance of captured water by utilizing the apparent low permeability of the fill material in the pit.

Surface drainage into the pit can be captured and directed to either trench system to effectively convey and discharge surface drainage contributions to the pit along with any captured ground water.

Once outside contributions to the pit are controlled, direct precipitation to the pit should not be a concern as any precipitation will be consumed though natural evapotranspiration.

Due to the greater potential for success, we recommend a perimeter trench design of the Sandy Acres Pit.

Trench Underdrain System Conceptual Design

The trenching for an underdrain system at the Sandy Acres Pit will be at least 24-inches wide, will be excavated to establish a positive grade in the trench and allow for the installation of perforated pipe. A perimeter trench will be constructed to interact with productive alluvial material outside the fill material in the pit and to maintain a slope of approximately 0.2% across the system. In the southern portions of the pit, the trench and piping will be shallow (2 to 3 feet), but in the northern portions of the pit, the recommended trench and piping may be up to 6 to 8 feet deep. The elevations of the pit and the neighboring ground water do not allow for a system that would meet a recommended system slope of 0.5% but should accommodate the minimum recommended slope of 0.2%.

The trench will be backfilled with gravel material as bedding material before perforated pipe is installed. Additional gravel will be backfilled around and on top of the pipe to the ground surface. There should be a minimum of 6 inches of gravel beneath the perforated pipe. We recommend 8-inch PVC perforated pipe with a slot size of 0.05 inches (50-slot) for installation, but high-density polyethylene pipe (HDPE) can also be considered. The PVC pipe or HDPE pipe will provide for corrosion resistance in the system in case of aggressive ground water quality. The 8-inch diameter pipe is recommended to provide capacity and to minimize sedimentation issues within the system since the system will have horizontal pipe over 500 feet in length. A geofabric textile material will also be installed around the gravel to minimize fine grained material from entering the system. A generalized cross section of the trench construction has been presented in Figure 3.

The perforated pipe installed within the conducting layer of the trench will collect water from the trench layer and help convey it more efficiently to the system's outlet(s). The perforated pipe will provide for a safety factor in this essential portion of the drainage system.

A passive drainage system typically discharges to the surface at a location away from its collection areas. Due to the closed surface drainage condition of the Sandy Acres Pit, surface discharge is not feasible without pumping or substantial infrastructure modifications. Accordingly, a sump structure should be constructed into the productive alluvial material on the downgradient end of the pit (northern end near MW-6) to help discharge any captured inflow that is conveyed to the northern end of the pit.

The drainage system should include cleanouts to allow for future maintenance in case of silting of the pipe.

The trench will act as a collector trench wherever the elevation of the trench is lower than the elevation of the neighboring ground water system. Anywhere the trench is located above the ground water elevation, it will act to convey the captured water as well as discharge the captured water into unsaturated alluvium beneath those reaches of the trench.

Sandy Acres Passive Drainage System Conceptual Design

The most important design component for a passive dewatering system at the Sandy Acres Pit is the trench system installed to capture and convey the ground water inflow. We recommend a perimeter trench encircling the entire pit. As mentioned above, reaches of the trench that are below the elevation of the neighboring ground water will capture ground water and any reaches that are above the elevation of the neighboring ground water will convey and discharge captured ground water. The entire length of the trenching will need to be outside, but within approximately 5 to 10 feet, of the fill material of the pit and in contact with the native alluvial material around the pit to allow for communication with the ground water system.

For the Sandy Acres Pit, the trench should be at least 24-inches wide, but could be wider if available equipment does not allow for such a narrow width.

The trench will be constructed to depths necessary to maintain positive grade through the system. Required trenching depths may range up to 6 to 8 feet in some areas. A final trench design including trench and pipe elevations can be finalized based on the findings the initial investigation described below.

The proposed Sandy Acres Pit dewatering system will utilize the trench system to discharge captured water to unsaturated alluvial material generally present along the northern perimeter of the pit. While the ultimate trench system is anticipated to have sufficient capacity to discharge captured water to the alluvium along its length, the system should also include a sump to help discharge water as a safety factor. The system should include an over excavated and gravel backfilled sump at the northern end of the pit that is connected to receive flow from the perimeter trenching. This sump feature should be approximately 20 feet by 20 feet in size and excavated to at least 10 feet of depth into the native gravel material.

The existing storm drain should be plumbed into the perimeter trench such that the drainage system captures the flow from the storm drain before it enters the pit and contributes to ponding water conditions in the pit.

Initial Steps for System Installation and Efficacy Testing

A stepwise approach to the installation of the underdrain system can be implemented to generally confirm the feasibility and efficacy of a passive underdrain system. By installing portions of the system, the ability for the individual aspects of the system (and potential feasibility of a complete system) can be tested.

We recommend starting a trench on the east side of the pit near the middle of the “Zone B” perimeter reach (the “pilot hole” location just north of MW-2). Initial trenching should start with a shallow, open, investigative trench constructed to approximately 3 feet in depth with the intention of observing shallow ground water conditions at the edge of the pit. If the initial trenching is dry to 3 feet, the trenching should be extended upgradient (to the south) until ground water inflow is encountered and continued to the south to induce ground water inflow to be captured by the trench. A minimum 300 feet of additional trenching upgradient should be planned for and additional trenching may be necessary based on ground water conditions. If the initial trenching is saturated at 3 feet, the trenching should be extended down gradient (to the north) to provide for conveyance and discharge of captured inflow. The trenching would then be expanded based on field observations. Initial trenching of up to 500 to 1000 feet may be required. The recommended location of the initial trenching (both the pilot hole and the general trench area) has been presented in Figure 2.

Feasibility of a perimeter trench design will be based on:

- The ability of the trench to encounter and capture ground water inflow. In areas, the trenching should be able to encounter and collect ground water and saturated conditions should be observed in the shallow subsurface around the southern portions of the proposed initial trenching.

- The ability of the trench to convey captured inflow. Flow should be observed in the trenching from the south to the north.

- The capacity of the trench to discharge captured inflow. If saturated conditions are encountered and flow to the north can be induced in the trench, as expected, then the captured inflow will either collect in the northern portions of the trench or infiltrate into the subsurface evidenced by reduced trench flow to the north and even a dry northern terminus of the trench. If water accumulates in the northern end of the trench, the trench should be extended to the north or it is simply an indication that a sump structure may be a more integral part of the outlet works of the underdrain system.

Ongoing Water Level Monitoring

Water level measurements should continue to be collected in the existing monitoring wells before, during and after the installation of any drainage system to investigate the impact of the system on the ground water elevations around the pit. The full drainage system should effectively lower ground water elevations to the south and east of the pit and increase ground water elevations to the north and west of the pit as it essentially redirects water around the pit fill.

If the proposed initial trenching is successful, we would expect to see slightly higher elevations in the MW-2, MW-1 and NW-2 wells.

Recommendations

- E-470 should further investigate the feasibility and efficacy of a passive drainage system by excavating an initial length of trench where indicated to confirm that:
    - An excavated trench will communicate with ground water,
    - The trench will effectively convey water to the north,

- The captured ground water can be discharged into unsaturated material.

- It is recommended that BBA be onsite for portions of the initial excavation to observe ground water inflow, conveyance and discharge and to provide guidance for the expansion of the trenching for the initial investigation.

- If ground water is captured and conveyed in the initial trenching, the trench flow should be gaged to confirm inflow expectations.

- Continue the collection and review of water level measurements in the existing monitoring wells.

- Review operation of initial trenching and consider potential additional trenching expansion and sump testing.

Figure 1
E-470
Sandy Acres Pit
Monitoring Well Locations

Date: 6/29/2021 | Job No. 9607.00

Legend

Monitoring Holes (Name, Permit No.)

Sandy Acres Pit Former High Water Line

Aerial Photo Date: 8/3/2019 NAIP-USDA
Data Source: CDSS, CDOT, USGS, BLM

Overview Map

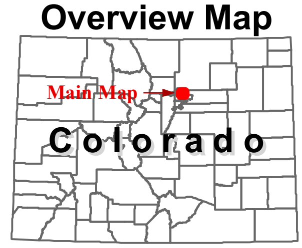


Figure 2
E-470
Sandy Acres Pit
Ground Water Inflow

Date: 9/27/2021 | Job No. 9607.00
Aerial Photo Date: 8/3/2019 NAIP-USDA
Data Source: CDSS, CDOT, USGS, BLM

Legend

- Pilot Hole
- Monitoring Holes (Name, Permit No.)
- Proposed Initial Trenching

Pond Zone Reach

- Zone C
- Zone B
- Zone A
- Former Pond High Water Line

Overview Map

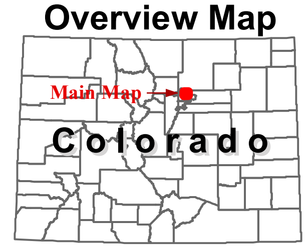


Figure 3
E-470
Sandy Acres Pit
Cross Section of Proposed Trench Construction