# Midnite Mine Superfund Site

# 100~~90~~ Percent Design

# Appendix G – Groundwater Controls

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| | |
|---|---|
| AGCS | Alluvial Groundwater Control System |
| ASTM | American Society for Testing and Materials |
| BMP | Best Management Practice |
| BODR | Basis of Design Report |
| CD | Consent Decree |
| Cm/s | Centimeters per Second |
| GCL | Geocomposite Clay Liner |
| gpm | gallons per minute |
| GSR | Green and Sustainable Remediation |
| EPA | U.S. Environmental Protection Agency |
| ft | Feet |
| HDPE | High-density Polyethylene |
| NEH | National Engineering Handbook |
| NRCS | Natural Resources Conservation Service |
| O&M | Operations and Maintenance |
| PCP | Pollution Control Pond |
| psi | pounds per square inch |
| RA | Remedial Action |
| RAO | Remedial Action Objective |
| RD | Remedial Design |
| Site | Midnite Mine Superfund Site |
| SB | soil bentonite |
| SLCB | slag-cement bentonite |
| SOW | Statement of Work |
| SWMP | Stormwater Management Plan |
| SWPPP | Stormwater Pollution Protection Plan |
| Tribe | Spokane Tribe of Indians |
| USBR | U.S. Bureau of Reclamation |
| USCOE | U.S. Army Corps of Engineers |
| WTP | Water Treatment Plant |

# G1.0 INTRODUCTION

This appendix to the *Midnite Mine Superfund Site Basis of Design Report* (BODR) presents the detailed design information of the groundwater controls for intercepting and collecting contaminated alluvial groundwater at the Midnite Mine Superfund Site (the Site). Contaminated alluvial groundwater has been identified in the Western, Central, and Far East Seep Drainages and an interim water management systems, consisting of shallow wells and pump back systems, have been installed in these three drainages to capture this groundwater. As part of the *Consent Decree Statement of Work* (CD SOW; EPA, 2011), a more robust Alluvial Groundwater Collection System (AGCS),alluvial groundwater collection system, consisting of a groundwater collection trench and a downgradient, low-permeability barrier will be installed in each of these drainages as part of the early stages of the Final Remedial Action (RA).

AGCSsGroundwater controls will be installed in the Western, Central, and Far East Seep Drainages at the locations shown in Section 7 of the Drawings. Based upon comments received from EPA and the Tribe, the locations of the AGCSsgroundwater systems in the Western Drainage and Central Drainage have been moved downstream from the locations previously shown in the Midnite Mine 60 Percent - Basis of Design Report (60% BODR, MWH, 2013). The groundwater controls are intended to intercept groundwater in the impacted shallow aquifer consisting of the shallow alluvium, residual soils, and underlying extremely -weathered bedrock, then convey the groundwater for treatment at the Site water treatment plant (WTP). This design is based upon information from recent geotechnical investigations intended to provide site-specific subsurface information at each of the proposed AGCS locations, as well as from previous investigations of subsurface conditions in these drainages. A summary of the recent AGCS geotechnical investigations is included as Attachment G-4 to this appendix. The AGCS geotechnical investigations consisted of test hole drilling and sampling, as well as seismic refraction surveys at each of the proposed AGCS locations. The previous investigations are summarized in the *Draft data summary report from investigation of the alluvial aquifer south of the Midnite Mine* (SMI, 1997), the *Remedial Action Work Plan - Interim Mechanisms* (Tetra Tech, 2010a) and the *Storage Ponds Investigation Report* (MWH, 2012). These investigationsdocuments indicate subsurface conditions at the proposedthe geologic materials underlying the locations where interception trench locations trenches are proposed consist of alluvium overlying extremely weathered bedrock (i.e., the residual soil) that grade to less-weathered bedrock with depth. The alluvium and residual soils are generally relatively fine-grained with moderate permeability.

Groundwater controls proposed for each of these drainages will consist of an extraction trench installed immediately upslope of a low-permeability barrier wall. The extraction trench will be excavated through the alluvium, residual soils and extremely ~~-~~weathered paralithic bedrock to the point of hydraulic excavator refusal in competent bedrock. In the Far East Seep Drainage, the results of the seismic refraction survey performed along the AGCS alignment suggest that competent (Attachment G-4), unexcavatable bedrock may be deep in some areas. Although there is uncertainty associated with interpretation of excavatability from seismic refraction surveys, the point of excavator refusal may not be reached at a practical depth over parts of the AGCS. Large hydraulic excavator equipment with the ability to excavate to depths of 40 feet or more will be used to construct the AGCS. If areas along the proposed AGCS alignment are encountered where competent (unexcavatable) bedrock is deeper than the maximum reach of the excavator (assumed to be at least 40 feet), alternatives will be assessed for deepening the AGCS or modifying the location. Any location modification will be made in consultation with EPA.

~~ downgradient of the Mine Area. ~~The low-permeability barrier wall also will be installed~~, also~~ to depths corresponding to excavator refusal in competent bedrock (or alternatives assessed as discussed above) immediately downgradient of the extraction trench to increase capture efficiency. If post-construction performance monitoring indicates significant bypass of alluvial groundwater either around, or under the low-permeability barrier wall, consideration will be given to permeation grouting of the barrier wall/bedrock contact as well as the bedrock underlying and adjacent to the barrier wall.

After excavation of waste piles, placement of these wastes in Pits 3 and 4, followed by capping of these upgradient areas, it is expected that the alluvial groundwater quality downgradient from these RA activity will gradually improve, and the Groundwater Controls described in this appendix will not be necessary. Once the groundwater quality in the alluvial groundwater system~~systems~~ has improved to the point where they no longer exceed the maximum concentrations listed in Table 2-4 of the CD SOW, and after approval from EPA, the Groundwater Control systems will be abandoned. Abandonment shall include removal of all, or parts of, the collection systems and barrier walls as needed to return the flow regime in each drainage to a more natural state.

This remainder of this appendix contains the following information:

- Demonstration that the design will attain the Groundwater Control Performance Standards identified in the Consent Decree (CD.).
- Design calculations, assumptions, and parameters such as estimates of alluvial groundwater flow rates to be intercepted and conveyed to the WTP.
- Proposed locations of the groundwater controls.
- Sequencing for construction of the groundwater controls.
- Configurations, design details, and methods to be used during the construction of the: 1) groundwater barrier wall, 2) groundwater extraction trench, and 3) groundwater collection and conveyance systems.
- Materials management strategies, anticipated limits of excavations, and erosion and surface water controls.
- Instrumentation for monitoring of the performance of the Groundwater Controls.
- Green and Sustainable Remediation (GSR) considerations.

# G2.0 PERFORMANCE STANDARDS

The Performance Standards presented herein are defined in the SOW, and were developed to define attainment of the Remedial Action Objectives (RAOs) of the Selected Remedy. The Performance Standardsperformance standards include both general and specific standards applicable to the Selected Remedy work elements and associated work components. All of the Performance Standards for the Midnite Mine RA, as well as a summary of where or how they are addressed in the Remedial Design (RD),, are summarized on Table 4-6 of the BODR. The general and specific Performance Standards related to Groundwater Controls are listed below.

## Table G-1 – Performance Standards Applicable to Groundwater Controls

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| Performance Standard No. in CD SOW | Performance Standard | Comments |
|---|---|---|
| **2.3 General Standards Applicable to All Work Elements and Components of Work - Groundwater Controls** | | |
| 2.3.15 E. | Removals and other excavations conducted as part of the construction activities shall be performed in a manner that allows for proper drainage from the excavated area. Drainage from Work Areas that may have come into contact with contaminants shall be captured and conveyed to the water treatment plant for treatment. No drainage from Work Areas that may have come into contact with contaminants shall be allowed to infiltrate or discharge to natural drainages where water treatment collection and conveyance controls are not in place and operating. | Surface flows in the drainages are either ephemeral or intermittent, and construction will be scheduled during summer or early autumn to avoid impacting surface flows to the extent possible. Site preparation work will involve an open excavation perpendicular to the stream channels to a depth of at least two feet below the channel thalweg. Any shallow groundwater of surface flow intercepted in this excavation will be pumped to the Pollution Control Pond (PCP), from where it will be transferred to the WTP. |
| 2.3.15 H. | To the extent practicable, construction activities shall be conducted in a manner that does not result in the re-contamination of areas already remediated or contamination of areas that were previously uncontaminated. Any such re-contaminated or newly contaminated areas shall be addressed by the Settling Defendants in a manner that is subject to the review and approval of EPA. | Construction of Groundwater Controls will occur during Phase 1 of RA construction activities and will be completed prior to sediment cleanup in drainages, thus avoiding recontamination of remediated areas. To the maximum extent possible, spoils from trench excavations will be hauled to the top of the South Waste Rock Pile along existing roads to avoid potential for contamination of previously uncontaminated areas. |
| 2.3.18 | Best Management Practices (BMPs) shall be used as specified below during all construction activities to minimize the transport of disturbed material by water, wind erosion or vehicles. The Settling Defendants shall develop a catalog of BMPs that shall be used at the Site and shall identify the primary activities requiring those BMPs. The BMP catalog shall be comprehensive and is subject to the review and approval of EPA. The minimum BMPs that must be contained in the BMP catalog are presented below. The Settling Defendants shall include these BMPs in the BMP catalog along with additional BMPs that may be necessary to complete the Work. A Storm Water Management Plan (SWMP) shall be prepared which contains the BMP catalog and identifies BMPs and specific sediment control measures to be employed before, during, and after construction. | In accordance with the Master SWMP in Appendix O, a Construciton Stormwater Polution Protection Plan (SWPPP) will be prepared for this work and will include specific BMPs for sediment and stormwater control before, during, and after construction. |

**Table G-1 – Performance Standards Applicable to Groundwater Controls**

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| Performance Standard No. in CD SOW | Performance Standard | Comments |
|---|---|---|
| **2.4 Standards Applicable to Groundwater Control Work Components** | | |
| 2.4.3.3.2 I. | Contaminated groundwater in the alluvium and weathered bedrock that exceeds concentrations listed in Table 4-4 or which may result in concentrations in surface water downgradient greater than the concentrations listed in Table 4-3 shall be intercepted and collected. | Groundwater in the alluvium in the Western, Central, and Far Eastern Drainages has been identified as exceeding concentrations listed in Tables 4-3 and 4-4 and will be intercepted and collected as shown in the Section 7 Drawings. |
| 2.4.3.3.2 J. | This groundwater collection system shall be sited in locations to be determined during RD and shall consist of an interception trench excavated to competent bedrock, a designed drain backfill, a low permeability barrier on the down-gradient side of the drain backfill, and a collection sump and pump back system or other system approved by EPA. | The locations of the groundwater collection systems in the Western, Central, and Far Eastern Drainages are shown on Drawing 7-1 (in Volume II). ~~The locations were selected to lie within the existing fenced mine area in order to limit the offsite footprint of the RA construction while maximizing the amount of impacted alluvial groundwater collected.~~ |
| 2.4.3.3.2 K. | All water collected in the groundwater collection system shall be conveyed to the WTP for treatment. | Initially, water collected in the groundwater collection system will be conveyed to the WTP via the PCP. Once the PCP is decommissioned (in Phase 3), groundwater will be conveyed directly to the WTP Equalization Pond. |
| 2.4.3.3.2 L. | The groundwater collection system shall be constructed as early as practicable during the Work to provide effective capture of contaminated groundwater during up gradient construction and to accelerate the recovery of Blue Creek surface water and sediment quality. | The groundwater collection system will be constructed during Phase 1 of the RA construction. |
| 2.4.3.3.2 M. | The groundwater collection system shall continue to be operated until otherwise approved by EPA. | The groundwater collection systems have been designed for long-term operation, with maintenance systems including drain pipe cleanouts and easily ~~-~~accessible pump risers, to enhance long-term operation included in the designs. |

## G3.0 ENGINEERING DESIGN DRAWINGS

The engineering design drawings are contained in Volume II of the BODR. The drawings related to Groundwater Controls include:

| Sheet Number | Description |
|---|---|
| 7-1 | Location of Alluvial Groundwater Controls |
| 7-2 | Western and Central Drainage Detailed Plan View |
| 7-3 | Western Drainage Section A |
| 7-4 | Western Drainage Section B |
| 7-5 | Western Drainage Section C |
| 7-6 | Central Drainage Section D |
| 7-7 | Central Drainage Barrier Wall |
| 7-8 | Central Drainage Extraction Trench |
| 7-9 | Far East Seep Drainage Detailed Plan View |
| 7-10 | Far East Seep Drainage Section G |
| 7-11 | Far East Seep Drainage -Sections H and I |
| 7-12 | Groundwater Collection System Details |

## G4.0 LOCATION OF GROUNDWATER CONTROLS

Groundwater in the alluvium in the Western, Central, and Far East Seep Drainages has been identified as exceeding concentrations listed in Tables 4-3 and 4-4 of the BODR. As discussed above, alluvial pump back systems have been installed in these drainages as part of interim improvements to the water management system (Tetra Tech, 2010b). The AGCSs~~groundwater controls~~ described in this appendix will replace those systems and will be located farther downstream in the Western, Central, and Far East Seep Drainages as shown on Drawings 7-1, 7-2, and 7-9 (in Volume II).

Based upon comments received from EPA and the Tribe, the locations of the AGCSs~~groundwater systems~~ in the Western Drainage and Central Drainage have been moved downstream approximately 350 feet downstream and 710 feet respectively from the locations shown in the 60% BODR (MWH, 2013) in order to increase capture of potentially impacted alluvial groundwater in these downgradient areas. The location of the AGCS~~Groundwater Control System~~ in the Far East Seep Drainage has not been moved~~ due to topographic constraints in this drainage that preclude downstream relocation of this feature~~.

## G5.0 CONSTRUCTION SEQUENCING

Installation of groundwater controls will occur during Phase 1 of construction and will be completed prior to sediment cleanup in the drainages, thus avoiding recontamination of remediated areas. Construction will be scheduled such that it occurs during summer or early autumn to avoid impacting ephemeral/intermittent surface flows that occur in the drainages to the extent possible.

The sequence for construction of the groundwater collection systems within each of the drainages will be as follows:

1) BMP installations for sediment and stormwater controls immediately prior to commencement of construction.

2) Excavation of a level working platform in preparation for Extraction Trench and Barrier Wall construction. This excavation will be roughly perpendicular to the stream channel and will be excavated to a depth of approximately two feet below the stream channel thalweg or other lowest point in the existing ground surface along the valley cross section. It is anticipated that this level working platform will be approximately 30-feet wide and will extend into either valley wall until practical excavator refusal is reached. Ripping and/or blasting will not be performed as part of this work. Upon completion of the working platform excavation, a layer of stabilizing fill will be placed as needed to provide a stable working surface for construction equipment and to contain trench slurry.

3) Construction of the extraction trench will be completed as shown on Drawings 7-5, 7-8, and 7-11.

4) Dewatering pumps will be installed in the extraction trenches and temporary conveyance pipelines will be constructed to the existing PCP.

5) Commence with dewatering of the alluvial/shallow bedrock system.

6) Construction of the low-permeability barrier wall downgradient of the extraction trench as shown on Drawings 7-4, 7-7, and 7-11.

7) Backfill and grade working platform excavation in order to restore original grade in work area.

8) Install monitoring wells in each of the drainages to evaluate performance of the groundwater controls.

9) Install post-construction BMPs and revegetate disturbed areas in accordance with the Revegetation Plan contained in Appendix D (Attachment D-12).area of disturbance using an approved native seed mix.

10) Performance monitoring of the completed AGCSsalluvial groundwater collection system will be performed as described in Section G9.0. If post-construction performance indicates significant bypass of alluvial groundwater either around, or under the low-permeability barrier wall, an investigation into the nature of the groundwater bypass will be performed and appropriate corrective measures will be implemented. The precise design of any corrective measures that might be required (e.g. permeation or jet grouting of the barrier wall/bedrock contact, permeation grouting of high-permeability bedrock underlying or adjacent to the barrier wall) cannot be defined at this time, and as such, the extent of these possible design changes are not shown on the drawings.

## G6.0 MATERIALS MANAGEMENT

Construction of the working platform will consist of excavating a level surface perpendicular to the stream channel at an elevation approximately two feet below the stream channel thalweg or other lowest point in the existing ground surface along the valley cross section. As discussed above, it is anticipated that this level working platform will be approximately 30-feet wide and will generally extend into either valley wall until practical excavator refusal is reached. As discussed in Section 1.0, seismic refraction survey results in the Far East Seep Drainage suggest that competent unexcavatable bedrock may be deep in some areas. Although there is some uncertainty associated with interpretation of excavatability from seismic refraction surveys, interpretations suggest excavator refusal may not be reached at a practical depth. The limits of excavatable rock shown on Sheet 7-11 are based on the seismic refraction results. These results suggest that excavations of more than 60 vertical feet and over 100 feet horizontally into the valley walls could be required to tie the working platform into unexcavatable bedrock in the Far East Seep Drainage. As a practical construction consideration, the sections shown on Sheet 7-11 limit excavations into the valley walls for working platform construction to a maximum depth of 30 feet. The working platform would then be benched at approximately 30 feet above the valley floor as shown on Section H on Sheet 7-11 in order to provide additional area for barrier wall construction. If these, or other conditions arise during construction that present construction difficulties that cannot be addressed in this proposed manner, other alternatives may be assessed including modifications to the proposed construction method or relocation of the alignment. Any modifications to the location or proposed methods of construction will be made in consultation with EPA.

Any shallow groundwater or surface flow intercepted at the working platform level will be pumped to the PCP and then transferred to the WTP. Shallow groundwater that will be removed during the installation of the extraction trenches and barrier walls is discussed in Section G7.0.

If spoils from site preparation excavations meet soil cleanup criteria, they will be stockpiled upgradient from the excavations and used for backfilling and final surface restoration. Spoils will not be stockpiled in the stream channels or other natural drainage pathways. If site preparation spoils do not meet soil cleanup criteria, they will be hauled to Pit 4 and incorporated into the mine waste backfill. Spoils from the extraction trench and barrier wall excavations will be hauled to a stockpile location on the South Waste Rock Pile and incorporated into the Pit 4 mine waste backfill.

# G7.0 EXTRACTION TRENCHES

Groundwater extraction trenches will be constructed in each of the drainages as shown on Drawings 7-5, 7-8, and 7-11. Construction will consist of trench excavation, installation of an in-trench dewatering system, backfilling with high-permeability backfill, installing trench cover, and final surface restoration. Each of these components is described in more detail in the following subsections.

## G7.1 Extraction Trench Excavation

Extraction trenches will be excavated from the working platform through the underlying alluvium and weathered bedrock materials to a depth where practical excavator refusal is reached, or in the case of the Far East Seep Drainage, to the limits of the working platform in the valley bottom as shown on Section I and Sheet 7-11.. Ripping, blasting, drop-chisel excavation, or other methods of rock excavation that are likely to disturb the underlying formation and induce fracturing will not be performed as part of this work. The excavations will be continued into either valley wall as shown on the Drawings to the point where the working platform contact with the valley wall is reached. For design purposes the depth of excavator refusal was estimated based upon the results of seismic surveys and drill hole information obtained from recent AGCS geotechnical investigations (see Attachment G-4). Additional information was also obtained from summary reports fromperformed as part of a previous investigation of alluvial aquifers south of the Midnite Mine (SMI, 1997) and from seismic refraction surveys and test hole drilling summarized in the *Storage Ponds Investigation Report* (MWH, 2012). Additional site-specific stratigraphic and geotechnical information at the proposed groundwater collection system locations is the focus of an investigation that is currently ongoing and based on the approved work plan entitled *Alluvial Groundwater Collection System Geotechnical Investigation Work Plan, Revision 1* (MWH, 2014). The data collected during the current investigation will be used to update the final groundwater collections system designs and as a guide for construction.

Although it is anticipated that extraction trenches will be excavated using biodegradablebio-degradable polymer slurry to support trench walls during construction, it is also possible that trench boxes or other shoring methods may be used.

## G7.2 Dewatering System

Flow rates expected in the extraction trenches were estimated and summarized in Attachment G-1 to this Appendix. These flow rates were estimated using data from the recent AGCS geotechnical investigation summarized in Attachment G-4 as well as previous investigations. These previous investigations are summarized in the *Remedial Action Work Plan - Interim Mechanisms (*Tetra Tech, 2010a) and the *Storage Ponds Investigation Report* (MWH, 2012).

These investigations found the alluvium in the drainages generally consists of silty or clayey sand with gravel, silty clay, and sand overlying decomposed quartz monzonite (Western and Central Drainages) or weathered/decomposed phyllite (Far Eastern Drainage). The decomposed quartz monzonite in the Western and Central Drainages generally is soil-like (residual soil), dense to very dense clayey sand, clayey sand with gravel, and sand with gravel that gradually transitioned to less weathered rock with depth. The decomposed phyllite in the Far East Drainage also is generally soil-like at shallow depths and classified as very dense silty sand, clayey sand, and sandy gravel with clay, and also gradually transitions with depth to less weathered rock.

The hydraulic conductivity of the alluvial and shallow bedrock system in the drainages was estimated using pumping test and slug test data from previous investigations (Tetra Tech, 2010a) to be 18 and 40 ft/day in the Western Drainage and 0.7 to 1.8 ft/day in the Central Drainage. Although no estimates were provided for the Far Eastern Drainage, they are assumed to be similar to the Western and Central Drainages (Tetra Tech, 2010a).

Based upon the~~se~~ hydraulic properties of the alluvium/shallow bedrock, and the extraction trench geometries shown on Drawings 7-5, 7-8, and 7-11~~10~~, the estimated inflow rates to the extraction trenches ranged from approximately 0.1~~2~~ gpm to 7~~32~~ gpm under typical dry-season, base flow ~~high groundwater~~ conditions (similar to~~during wet periods, but will be significantly less during the majority of the year, including~~ when this construction is planned to occur) and from approximately 1 to 13 gpm during wet periods (refer to Attachment G-1). These flow estimates are consistent with flows measured ~~, but conservative when compared to, downstream flow measurements~~ at surface water monitoring stations WDAC and SW-12 in the Western and Central Drainages, respectively.~~.~~ These two stations are located downstream of the proposed collection systems in the Western and Central Drainages at points where shallow bedrock forces alluvial groundwater flow to the surface. Discharge~~Flows~~ at these stations have been monitored continuously since 2010, and the resulting measurements are~~have been~~ summarized in~~and included as~~ Attachment G-2 for comparison to these estimated (calculated) flows to the AGCSs~~groundwater extraction trenches~~ in the Western and Central Drainages. Based upon both the groundwater flow estimates presented in Attachment G-1, and the current flow measurements summarized in Attachment G-2, it is assumed that in-flows to the AGCSs~~alluvial groundwater controls~~ may range from 1 to 15~~10~~ gpm depending on the time of year.

Groundwater will be collected in slotted drain pipe installed near the bottom of the trench as shown on Drawings 7-5, 7-8, and 7-11~~10~~. A vertical pump riser will be connected to the drain pipe near the low-point of the extraction trench. Groundwater will be extracted from the trenches by pumping intermittently via submersible pumps and discharge pipes installed in each of the pump risers. Initially, groundwater from the extraction trenches will be conveyed to the PCP, and from there it will be conveyed to the storage ponds and WTP. Once the PCP is decommissioned (in Phase 3), groundwater will be conveyed directly to the WTP Equalization Pond.

The AGCSs~~groundwater controls~~ shall continue to operate until otherwise approved by EPA. As such, the extraction trenches have been designed for long-term operation, with maintenance systems including drain pipe cleanouts and easily ~~-~~accessible pump risers to enhance long-term operation included in the designs as shown on the Drawings.

## G7.3 Extraction Trench Backfilling

The extraction trenches will be backfilled from the trench bottom to the elevation of the level working platform with drain sand. The drain sand will be placed using a tremmie pipe (or using similar method that will avoid trapping of trench slurry and other foreign materials within the backfill material) from the bottom of each trench upward. The drain sand will be selected such that it has sufficiently high permeability to provide efficient drainage, yet still provide filter compatibility with the finer alluvial sediments that have been encountered. MaterialIt is anticipated that material meeting the gradational requirements for fine concrete aggregate (ASTM C33 or equivalent) will meet these requirements. This material will be sourced from an off-site supplier of concrete aggregate. The gradational characteristics of ASTM C33 fine aggregate are summarized in Table G-2.

**Table G-2 – Drain Sand Gradation Specification**

| Particle Size | | Coarse Range | Fine Range |
|---|---|---|---|
| | | Max | Max |
| Sieve Size | Size Opening [mm] | %Pass | %Pass |
| 3/8 inch | 9.5 | 100 | 100 |
| No.4 | 4.75 | 95 | 100 |
| No.8 | 2.36 | 80 | 100 |
| No. 16 | 1.18 | 50 | 85 |
| No. 30 | 0.6 | 25 | 60 |
| No. 50 | 0.3 | 5 | 30 |
| No. 100 | 0.15 | 0 | 10 |
| No. 200 | 0.075 | 0 | 5 |

Material with this specification has been tested ~~extensively~~ and used extensively by the ~~U.S.~~ Natural Resources Conservation Service (NRCS) and others (USBR and USCOE) to provide filter-compatible backfill material for groundwater collection trenches excavated into fine-grained materials. The proposed ASTM C33 drain sand material was evaluated using procedures detailed in Part 633 of the National Engineering Handbook (NEH), Chapter 26 for evaluating sand and gravel materials in trench drains and has been found compatible with the site soils. The results of this evaluation are included as Attachment G-3.

Slots in the drain pipe described in the previous section also must be sized to be compatible with the selected backfill sand and prevent migration of sand into the dewatering system piping and pumps. Slot sizing calculations were also performed using NEH Chapter 26 guidelines, and are included in Attachment G-3. These calculations indicate that drain pipe with a 0.6 mm (No. 30) slot width will prevent migration of finer sand particles into the pipe.

In addition to gradational requirements, the drain sand backfill will not contain carbonates or other materials that may adversely react with the alluvial groundwater.

## G7.4 Final Grading and Surface Restoration

Upon completion of the dewatering system and trench backfill, the top of the extraction trench will be covered with a geocomposite clay liner (GCL) as shown on the Drawings to minimize the infiltration of surface water into the dewatering system. This GCL infiltration barrier will be covered with a minimum of 2 feet of compacted soil, the ground surface in the work area restored to its original contours, and areas of disturbance revegetated with native seed mix in accordance with project requirements.

# G8.0 BARRIER WALLS

Low-permeability barrier walls will be constructed immediately downgradient of the extraction trenches, as shown on Drawings 7-2, 7-3, 7-6, 7-9, and 7-10, in order to increase the capture efficiency of the AGCSs.Groundwater Controls. Construction will consist of trench excavation and backfilling with low-permeability fill, installing trench cover, and final surface restoration. Each of these components is described in more detail in the following subsections.

## G8.1 Barrier Wall Excavation

The barrier wall will be excavated from the working platform through the underlying alluvium and weathered bedrock materials to a depth where practical excavator refusal is reached, or in areas where deep bedrock is encountered, as discussed in Section G1.0. Due to the likelihood that unexcavatable competent bedrock may occur at depths greater than 40 feet below the ground surface in the Far East Seep Drainage, it is anticipated that a multi-level working platform will be required for barrier wall construction at this location as shown on Section H of Drawing 7-11. The multi-level working platform is needed order to limit the amount of disturbance due to working platform excavation to a reasonable amount, and to accommodate barrier wall construction on the steep valley walls.

. Ripping, blasting, drop-chisel excavation, or other methods of rock excavation that are likely to disturb the underlying formation and induce fracturing will not be performed as part of this work. The excavations will be continued into either valley wall as shown on the Drawings 7-4, 7-7, and 7-11 to the point where the working platform contact with the valley wall is reached. For design purposes the depth of excavator refusal was estimated based upon the results of seismic surveys performed as part of a previous investigation of alluvial aquifers south of the Midnite Mine (SMI, 1997) and from seismic refraction surveys and test hole drilling summarized in the *Storage Ponds Investigation Report* (MWH, 2012). Additional site-specific stratigraphic and geotechnical information at the proposed groundwater collection system locations is the focus of a current investigation that is currently ongoing (MWH, 2014). New data gathered during this investigation will be used to update the final groundwater collections system designs and as a guide for construction.

Although it is anticipated that the barrier walls will be constructed as slag-cement bentonite (SLCB) slurry walls, it is possible that other methods (such as soil mixing) may be used. The SLCB will both provide trench support and serve as the final low-permeability backfill. Typical

SLCB walls have moderate strength (typically 10 to 50 psi) and can achieve permeabilities of $5 \times 10^{-7}$ cm/s ($3 \times 10^{-4}$ ft/day) or less. Similar performance criteria are achievable with other methods such as soil mixing. Due to the restricted nature of the barrier wall sites, a more conventional soil-bentonite (SB) slurry wall method of construction is not considered a preferred option due to the need to haul excavation spoils to a remote mixing area (most likely on the South Waste Rock Pile). Once at the mixing area, mixing the spoils with bentonite and/or other additives, and back-hauling the treated spoils to the barrier wall sites for use as backfill would be required for construction of an SB wall.

Excavation spoils from the SLCB trench will be transported to a stockpile location on the top of the South Waste Rock Pile where they will be allowed to harden, and will then be incorporated into the Pit 4 mine waste backfill.

### G8.2 Final Grading and Surface Restoration

Upon completion of the barrier wall, the wall will be allowed to harden to the point where it will not be damaged by backfilling and then covered with a minimum of 2 feet of soil to prevent damage due to desiccation or erosion. The ground surface in the work area will then be restored to its original contours, and areas of disturbance revegetated ~~with native seed mix~~ in accordance with the Revegetation Plan contained in Appendix D (Attachment D-12).~~project requirements.~~

## G9.0 PERFORMANCE MONITORING

A series of monitoring wells will be installed upgradient and downgradient of the AGCSs~~Groundwater Controls~~ in each of the drainages to provide data needed to evaluate of the performance of the groundwater controls after construction. These proposed wells will be located as close as practical to the lowest points in the valley cross section, where alluvial groundwater will tend to be concentrated, as shown on Drawings 7-2 and 7-9.

- In the Western Drainage, two upgradient wells and two downgradient wells will be drilled in the valley bottoms adjacent to the AGCS.~~groundwater controls.~~ Only one upgradient well is proposed for the Central Drainage as the numerous existing shallow wells upgradient of the groundwater control (e.g. PBC-01, PBC-02, and PBC-03) can be used to provide the necessary data in this area.

Likewise, only one upgradient well is proposed in the Far Eastern Drainage as the existing well MWED-05 will be used to provide additional upgradient water level information. In addition, a monitoring well will be placed within drain sand backfill near the low point of the trench, as shown on Drawings 7-5, 7-8, and 7-11 to allow for monitoring of water levels within the backfill.

Data from these wells will be used to evaluate the effectiveness of the AGCSs~~alluvial groundwater controls~~ in controlling downgradient migration of impacted S~~s~~ite waters (see Table Q2-A-4 of the *Site-Wide Monitoring Quality Assurance Project Plan*, located in BODR Appendix Q2).~~.~~ If performance monitoring indicates significant bypass of alluvial groundwater either around, or under the low-permeability barrier wall (which is always a possibility, regardless of the depth of barrier excavation), consideration will be given to permeation grouting of the barrier wall/bedrock contact as well as the bedrock underlying and adjacent to the barrier wall.

# G10.0 GREEN AND SUSTAINABLE REMEDIATION CONSIDERATIONS

~~Below are the~~ GSR considerations for the~~Appendix G –~~ Groundwater Controls included~~. GSR considerations were evaluated for~~: 1) Constructions Materials (characteristics and manufacturing considerations), 2) Construction Methods, and 3) Low Impact/Sustainability measures undertaken during construction.

## G10.1 Construction Material Considerations

Piping in the groundwater extraction trenches will consist of HDPE. The use of HDPE as the pipeline material was in part selected for its GSR attributes. HDPE is less costly to transport and will require fewer truckloads over other pipe materials (e.g., metallic) because it weighs significantly less and smaller diameter pipes can be nested within larger pipes during transport.~~.~~ HDPE fused joints are less likely to leak than any other connection resulting in a more sustainable solution (lower~~with less~~ likelihood of future repairs or contamination of surrounding materials).~~any material recontamination.~~ When installed permanently, HDPE yields a longer life expectancy because it does not rust or scour and is highly resistant to mineral tuberculation. HDPE also has a high chemical resistance yielding a superior piping material for this application with respect to environmental reliability as well as longevity of the material of construction.

## G10.2 Construction Methods

The selection of extraction trenches coupled with downgradient low-permeability barrier walls in the three drainages at the Site provides significant long-term sustainable benefits over drilling individual extraction wells along each alignment. The use of individual extraction wells to capture this groundwater would require significantly more infrastructure, sustained energy consumption, and O&M efforts. This was considered during the feasibility study for the Site (EPA, 2005), and as a result, extraction trenches coupled with downgradient low-permeability barrier walls are explicitly stated in the consent decree statement of work.

It is anticipated that the barrier walls will be constructed as ~~slag-cement bentonite (~~SLCB~~)~~ slurry walls, although similar performance criteria are achievable with other methods of low-permeability barrier walls (e.g., soil-bentonite slurry wall). The use of a more conventional soil-bentonite slurry wall was not considered a preferred option due to the required hauling of excavated spoils to a remote mixing area. These spoils then would be mixed with bentonite and/or other additives and the resulting treated spoils hauled back to the barrier wall~~Barrier Wall~~ site for backfilling. The SLCB construction method selected has significantly less material handling requirements and therefore would utilize less machine time and emit less greenhouse gases during implementation.

Ripping, blasting, drop-chisel excavation, or other methods of rock excavation would require significantly more energy consumption for equipment. The selected construction methods are simple, will result in facilities that will meet the performance objectives for removal of contaminated groundwater, and will have a lower impact on the surrounding ecosystem because the more intensive excavation methods are not necessary for this project.

### G10.3 Low Impact Development/Sustainability

Phasing of the installation of the groundwater controls system to occur prior to the sediment cleanup in the drainages provides less environmental/habitat impact as it avoids recontamination of previously remediated areas of the Site. Additionally, scheduling the construction of the groundwater controls system during the summer or early autumn (i.e., post spring runoff) minimizes the impact on the ephemeral/intermittent surface flow that occurs in the drainages.

After the RA is completed, an approved, native seed mix will be used for revegetation of the area. This native seed mix will provide habitat for the area wildlife.

## G11.0 REFERENCES

MWH Americas, Inc. (MWH), 2012. Midnite Mine Superfund Site, Storage Ponds Investigation Report - Revision 0, Prepared for Dawn Mining Company LLC, Newmont USA Ltd, March 22.

MWH Americas, Inc. (MWH), 2013. Midnite Mine Superfund Site 60% Design Basis of Design Report. Prepared for Dawn Mining Company LLC, and Newmont USA Limited. December 16.

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# Attachment G-1

# Calculation Brief – Extraction Trench Flow Estimates

# *ATTACHMENT G-1*

# *MIDNITE MINE REMEDIAL ACTION*
# *CALCULATION BRIEF FOR*
# *EXTRACTION TRENCH FLOW ESTIMATES*

| Revisioning | | | | | |
|---|---|---|---|---|---|
| **Rev.** | **Date** | **Description** | **By** | **Checked** | **Date** |
| *0* | *05-Nov-12* | *Initial Version* | *Tom Kelley* | *VKD* | *18-Nov-12* |
| *1* | *03-Dec-12* | *60% Design Submittal* | *Tom Kelley* | | |
| *2* | *24-Jul-14* | *90% Design Submittal* | *Tom Kelley* | *VKD* | |
| *3* | *15-Jul-15* | *100% Design Submittal* | *Tom Kelley* | *VKD* | *30-June-15* |

**Location and Format**

*Electronic copies of these calculations are located in the project files system at:*

*\\usftc2s01\Projects\Newmont\Midnite Mine_2011\6.0 Studies & Reports\6.2 Technical\Groundwater Controls\90% BODR*

*The following calculations were generated using the following software:*

*Excel*

# 1.0 BACKGROUND

This calculation briefmemorandum presents estimates of the range of groundwater flow rates that may be intercepted by the Alluvial Groundwater Control Systems (AGCSs)systems at the Midnite Mine Superfund Site (the Site). The AGCSsgroundwater Control systems are intended to intercept impacted groundwater in the alluvial/shallow bedrock aquifers in the Western, Central and Far East Seep Drainages. The proposed Groundwater Control systems will be located near the southern perimeter of the fenced Mine Area and will consist of extraction trenches excavated roughly perpendicular to the valley bottom in each of the drainages. Based upon comments received from EPA and the Tribe, the locations of the Groundwater Control systems in the Western Drainage and Central Drainage werehave been moved downstream approximately 350 feet downstream and 710 feet respectively from the locations shown in the Midnite Mine 60 Percent - Basis of Design Report (60% BODR, MWH, 2013) in order to increase capture of potentially impacted alluvial groundwater flowing from the upgradient area of the Site. The location of the AGCSGroundwater Control System in the Far East Seep Drainage has not been moved., due to topographic constraints in this drainage that preclude moving the Groundwater Control System further downstream. A low-permeability barrier wall will be constructed immediately downgradient of each of the extraction trenches in order to enhance collection efficiency. Details of the proposed AGCSsGroundwater Control systems for each of the three drainages are shown in Section 7 of the Drawings (MWH, 20154a).

The subsurface stratigraphy shown in Section 7 of the Drawings and used to update this calculation brief is based upon the results of the alluvial groundwater collection system geotechnical investigation (MWH, 2015b in Attachment G-4) that was completed in the fall of 2014 after the 90% Basis of Design Report had been finalized. Flow rates to the extraction trenches were estimated based upon the extraction trench geometries shown in Section 7 of the Drawings (MWH, 20154a) and data from previous investigations, as well as, the recent geotechnical investigation (MWH, 2015b).

The. These previous investigations (i.e., prior to the most recent 2014 work) are summarized in the *Remedial Action Work Plan - Interim Mechanisms (*Tetra Tech, 2010a) and the *Storage Ponds Investigation Report* (MWH, 2012). These investigations found the alluvium in the drainages generally consists of silty or clayey sand with gravel, silty clay, and sand overlying decomposed quartz monzonite (Western and Central Drainages) or weathered/decomposed phyllite (Far Eastern Drainage). The decomposed quartz monzonite in the Western and Central Drainages generally is soil-like (residual soil), dense to very dense clayey sand, clayey sand with gravel, and sand with gravel that gradually transitions to less -weathered rock with depth. The decomposed phyllite in the Far East Drainage also is generally soil-like at shallow depths and classified as very dense silty sand, clayey sand, and sandy gravel with clay, and again gradually transitions with depth to less-weathered rock. The 2014 geotechnical investigations generally confirmed these observations.

The proposed extraction trenches and barrier walls will be excavated through the alluvium and decomposed bedrock layers, and into less-weathered bedrock to the point where hydraulic excavator refusal is reached, or to a maximum depth achievable by the excavation equipment is reached, whichever is less. Depths to excavator refusal and other subsurface. Additional site-specific stratigraphic and geotechnical information shown on the drawings relied heavily on the geotechnicalat the proposed groundwater collection system locations is the focus of an investigation that was completed in 2014 specifically to obtainis currently ongoing (MWH, 2014b) and this information for will be used to update the final design of the AGCSs. In the westerly portion of the Far East Seep Drainage, the estimated depths to unexcavatable hard rock were very deep,groundwater collections system designs (as necessary) and a maximum excavation depth of 40 feet was assumed for the excavation equipment in the design drawings (see Sheet 7-11).as a guide for construction.

Hydraulic conductivity data from previous investigations are summarized in the *Remedial Action Work Plan - Interim Mechanisms (*Tetra Tech, 2010a). These data included hydraulic conductivity measurements from pumping tests and slug tests performed in the Western and Central Drainages and other alluvial areas at the site (SMI, 1997 and URS, 2002). Based on this testing, the hydraulic conductivity of the alluvial and shallow bedrock system in the drainages was estimated to be 18 and 40 ft/./day in the Western Drainage and 0.7 to 1.8 ft/./day in the Central Drainage. Hydraulic conductivity of alluvial materials in the Far Eastern Drainage waswere assumed to be similar to the Western and Central Drainages. This data was used in the design of alluvial pumpback wells systems that were constructed as part of interim water management system (Tetra Tech, 2010b). The *Storage Pond Investigation Report* (MWH, 2012) provides a summary of recent data from alluvial groundwater wells, including depths to alluvial groundwater in the vicinity of the extraction trenches that are summarized in Table 1.

**Table 1. Hydraulic Conductivity and Average Depth to Alluvial Groundwater**

| Location | Range of Hydraulic Conductivity (ft/day) | Average Depth to Groundwater |
|---|---|---|
| Western Drainage | 18 to 40 | 7 feet |
| Central Drainage | 0.7 to 1.8 | 8 feet |
| Far Eastern Drainage | 5 to 20 (assumed) | 16 feet(1) |

Note: (1) The minimum depth to groundwater reported for the Far Eastern Seep Drainage was obtained from a single shallow well (MWED-05), which is also used for pumping as part of interim alluvial groundwater control mechanisms at the Site. During dry parts of the year, static water levels are often below the bottom of the well screen in (deeper than 25 feet) and pumping typically only occurs from this well during wet parts of the year. Static water level readings have typically ranged from 16.4 feet to greater than 25 feet in the Far Eastern Seep Drainage.

# 2.0 DESCRIPTION OF ANALYSES

## 2.1 ONE-DIMENSIONAL (1-D) FLOW IN ALLUVIAL SYSTEM

The maximum flow that may potentially report to the AGCSsGroundwater Control systems can be estimated based upon the flow in the alluvial system. Flow through in the alluvial groundwater system in vicinity of each of the AGCSsGroundwater Control System was calculated by assuming the alluvial system was prismatic, with a constant slope and uniform geometry in the downslope direction. In this case, the flow in the alluvial system can be calculated using the one-dimensional form of Darcy's law (Freeze and Cherry, 1979):

$$Q = -0.005194 * K * i * A$$

Where:

Q = Flow to the Extraction Trench (gpm)

*i* = the hydraulic gradient of the unconfined alluvial aquifer (equal to the channel bed slope in each drainage)).

K = Hydraulic Conductivity (ft/day)
A = Cross-sectional area of the alluvial system below the high groundwater tablelevel, measured normal to the direction of flow ($ft^2$).

The geometric parameters at each AGCSGroundwater Control System are summarized in Table 2. The cross-sectional areas shown in Table 2 were calculated based upon the depth at which groundwater was first encountered during drilling for the 2014 geotechnical investigation (the assumed normal flow condition). Cross-sectional areas under wet periods also were estimated assuming groundwater elevations 3levels approximately six feet higher thanabove the highest levels measured during the 2014 geotechnical investigationlevels in each of the drainages in order to provide conservative estimates of what inflows might be during very wet periods.

**Table 2. Extraction Trench Geometries**

| Location | A ($ft^2$) (Normal Flow Conditions)Assumed High Groundwater Level (ft. bgs) | A ($ft^2$) (Assumed Wet Periods) | *Valley Bottom Slope (i)* |
|---|---|---|---|
| Western Drainage | 5322 | 1,067515 | 0.06079 |
| Central Drainage | 1,3062 | 1,8303,406 | 0.11083 |
| Far Eastern Seep Drainage | 1310 | 93512 | 0.30170 |

The results of the analyses of alluvial flows are summarized in Table 4 in Section 3.0.

## 2.2 CALCULATION OF TWO-DIMENSIONAL (2-D)DIMENSIONAL FLOW TO TRENCH DRAIN

The rate of groundwater flow to the extraction trenches were also estimated using a closed-form solution for steady-state flow to a drain in an unconfined aquifer based upon the Dupuit-Forcheimer approximation for various assumed lengths of influence zones (McWhorter and Sunada, 1977). This solution assumes all flow toward the extraction trench is driven by the drawdown created by the extraction trench and does not account for the slope of the alluvial drainage (see following sketch). As such, it is likely that this solution will underestimate flows to the extraction trench at larger assumed influence zones and steeper bed slopes in the valley bottoms.

This two-dimensional closed-form solution is summarized below:

$$Q = 0.005194*B*K/2L\ (h_s^2 - h_d^2)$$

Where:

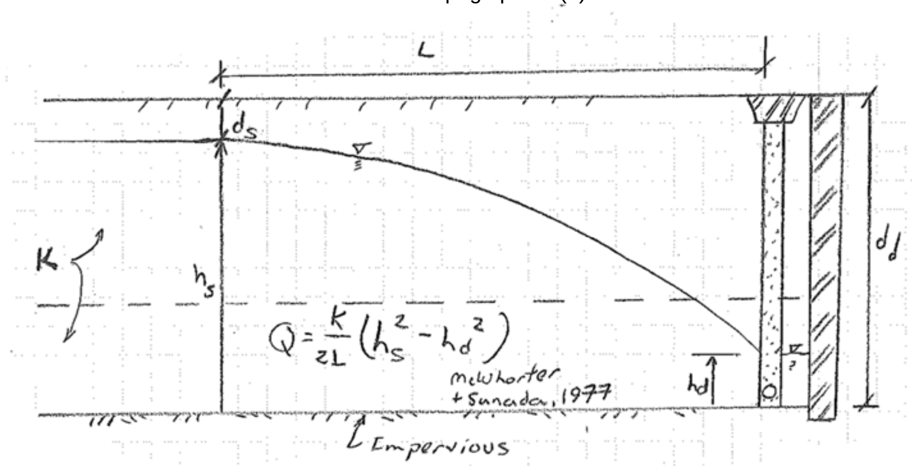
Q = Flow to the Extraction Trench (gpm)
K = Hydraulic Conductivity (ft/./day)
$h_s$ = Hydraulic head in the alluvial system in areas beyond the zone of influence of the extraction trench, defined in terms of the bottom of the extraction trench (ft): ($h_s = d_d - d_s$)
$d_d$ = depth of the extraction trench (ft)

$d_s$ = depth to alluvial groundwater alluvial in areas beyond the zone of influence of the extraction trench (ft)

$h_d$ = Hydraulic head within the extraction trench (ft)

L = Length of zone of influence of the extraction trench (ft)

B = Trench Width in the out-of page plane (ft)




It is assumed that the extraction trenches will be dewatered using submersible pumps that are pumped intermittently, but that the average head within the extraction trench, $h_d$, will be approximately 3.5 feet.

In order to account for elevated alluvial groundwater levels that may occur during prolonged wet periods, and provide conservative (higher) estimates of potential inflow, the depth to alluvial groundwater, $d_s$, in areas beyond the zone of influence of the extraction trench was assumed to be 2 feet in the Western and Central Drainages, and 10 feet in the Far East Seep Drainage.

The average depth of each extraction trench was calculated based upon the cross sectional area and length of each extraction trench as shown on the drawings as follows:

$$D_{avg} = A_{xsec}/B$$

Where:

$D_{avg}$ = the average depth of the extraction trench below the groundwater static groundwater surfaceworking platform (ft).)

$A_{xsec}$ = Cross Sectional Area of extraction trench below the static groundwater surface ($ft^2$)

B = as defined above.

And $d_d$–, the average depth of the extraction trench below the finished ground surface was calculated as:

$$d_d = D_{avg} + d_s \text{ (ft).)}$$

A summary of geometric parameters for the proposed extraction trenches under normal flow and assumed wet period conditions are included as Table 3.

**Table 3. Extraction Trench Geometries**

| Location | $A_{xsec}$ (ft$^2$) | B (ft.) | $h_s$~~$D_{avg}$~~ (ft.) | $h_d$~~$d_d$~~ |
|---|---|---|---|---|
| **Normal Flow Conditions** | | | | |
| ~~Western Drainage~~ | ~~532~~ | ~~167~~ | ~~3.2~~ | ~~0~~ |
| ~~Central Drainage~~ | ~~1,306~~ | ~~158~~ | ~~8.3~~ | ~~0~~ |
| ~~Far Eastern Seep Drainage~~ | ~~13~~ | ~~18~~ | ~~0.7~~ | ~~0~~ |
| **Assumed Wet Period Conditions** | | | | |
| Western Drainage | 1,067~~515~~ | 18~~5~~9 | ~~9.~~5.6 | 0~~11.5~~ |
| Central Drainage | 1,830~~3,406~~ | 181~~242~~ | 10~~14~~.1 | 0~~16.1~~ |
| Far Eastern Seep Drainage | 93~~1454~~ | 33~~114~~ | 2~~12~~.8 | 0~~14.8~~ |

The results of the analyses of two~~2~~-dimensional flow to trench drains in the three drainages are summarized in Table 5 through Table 7 in Section 3.0.

## 3.0 RESULTS

Estimated flows (Q) to each of the extraction trenches were calculated using the parameters and assumptions listed above for a range of 1) hydraulic conductivities 2) groundwater levels, and 3~~2~~) influence zones (i.e., 40, 60, 80 and 100 feet), ~~Ls,~~ that reasonably could be expected in each trench. The results are summarized below for extraction trenches installed in each of the Midnite Mine drainages using 1-D (Table 4) and 2-D flow calculations.

**Table 4. Summary of 1-D Flow CalculationsFlows in Alluvial Systems**

| Location | Estimated Alluvial Flow (gpm) | |
|---|---|---|
| | Normal Flow ConditionsK = 18 ft./day | 11.2 |
| | K = 18 ft/day | 3 |
| | K = 40 ft/./day | 724.9 |
| | Assumed Wet Period Conditions | |
| | K = 18 ft/day | 6 |
| Western Drainage | K = 40 ft/day | 13 |
| | Normal Flow Conditions | |
| **Central Drainage** | K = 0.7 ft/day | 0.5 |
| | K = 1.8 ft/day | 1.3 |
| | Assumed Wet Period Conditions | |
| Central Drainage | K = 0.7 ft/./day | 1.0.7 |
| | K = 1.8 ft/./day | 1.92.6 |
| | Normal Flow ConditionsK = 5 ft./day | 3.0 |
| | K = 520 ft/./day | 012.1 |
| | K = 20 ft/day | 0.4 |
| | Assumed Wet Period Conditions | |
| | K = 5 ft/day | 1 |
| Far East Seep Drainage | K = 20 ft/day | 3 |

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**Table 5. Summary of 2-D Flow CalculationsEstimated Flows - 2D Solution for Western Drainage Extraction Trench**

| Range of Hydraulic Conductivities (ft./day) | Flow to Drain(Q - gpm) | | | |
|---|---|---|---|---|
| | (L = 40 ft.)) | (L = 60 ft.)) | (L = 80 ft.)) | (L = 100 ft.)) |
| Normal Flow Conditions | | | | |
| 18 | 2.0 | 1.3 | 1.0 | 0.8 |
| 40 | 4.4 | 2.9 | 2.2 | 1.8 |
| Assumed Wet Period Conditions | | | | |
| 18 | 715 | 510 | 47 | 36 |
| 40 | 1632 | 1022 | 816 | 613 |

**Table 6. Summary of 2-D Flow CalculationsEstimated Flows - 2D Solution for Central Drainage Extraction Trench**

| Range of Hydraulic Conductivities (ft./day) | Flow to Drain(Q - gpm) | | | |
|---|---|---|---|---|
| | (L = 40 ft.)) | (L = 60 ft.)) | (L = 80 ft.)) | (L = 100 ft.)) |
| Normal Flow Conditions | | | | |
| 0.7 | 0.52 | 0.31 | 0.21 | 0.21 |
| 1.8 | 1.3 | 0.8 | 0.6 | 0.5 |
| Assumed Wet Period Conditions | | | | |
| 0.7 | 0.8 | 0.6 | 0.4 | 0.3 |
| 1.8 | 2.25 | 1.4 | 1.13 | 0.92 |

Merged Cells

**Table 7. Summary of 2-D Flow CalculationsEstimated Flows - 2D Solution for Far East Seep Drainage Extraction Trench**

| Range of Hydraulic Conductivity (ft./day) | Flow to Drain(Q - gpm) | | | |
|---|---|---|---|---|
| | (L = 40 ft.)) | (L = 60 ft.)) | (L = 80 ft.)) | (L = 100 ft.)) |
| Normal Flow Conditions | | | | |
| 5 | 0 | 0 | 0 | 0 |
| 20 | 0.01 | 0.01 | 0.01 | 0 |
| Assumed Wet Period Conditions | | | | |
| 5 | 0.09 | 0.06 | 0.0 | 0.0 |
| 205 | 0.3.4 | 0.2.3 | 0.2 | 0.1.2 |
| 20 | 1.6 | 1.1 | .8 | .6 |

The results from both approaches used for estimating flows to the alluvial groundwater collection systems provide relatively similar results for each of the three drainages. The Western and Central Drainages where the saturated thickness of alluvium is greatest. However in the Far East Seep Drainage, the two-dimensional flow analyses predictedpredicts much lower flows in the Far East Seep Drainage, , most likely due to the two-dimensional solution ignoring the contribution to the hydraulic gradient of the very-steeply sloped valleydrainage bottom. in the Far East Seep Drainage. Based upon these results, the flow intercepted by each extraction trench is expected to range from 0.1 to 7 gpm under normal flowunder seasonal high groundwater conditions, but could range from 10.2 to 1332 gpm during very wet periods.

## 4.0 REFERENCES


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URS, 2002. Draft- Phase I Hydrologic Modeling for Midnite Mine RI/FS, Prepared for EPA Region 10, August.

# Attachment G-2

# Alluvial Flow Measurements

# Attachment G-3

# Calculation Brief – Extraction Trench Filter Compatibility Calculations

# Attachment G-4

# Geotechnical Investigation Report, Alluvial Groundwater Collection, Midnite Mine