Quality Assurance Project Plan

Overview

Phase 1 of Bunker Hill Mining Corp's Water Management Program will include extensive site characterization[1] to update and inform understanding of the mine's hydrology and hydrogeology. Phase 1 will also include engineering and construction of systems that are specifically designed to improve water quality of mine effluent. This will occur by improving water flow, arresting acidification in upper levels of the mine and maintaining a relatively high pH as water flows down to the 9 level and out of the Kellogg Tunnel. The program will monitor and measure impacts of system improvements and inform Phase 2 activities.

The Quality Assurance Project Plan for Bunker Hill's Phase 1 Water Monitoring program relates specifically to the site characterization activities that will occur from September 2020 through February 2021[2]. This QAPP describes the roles and mechanisms through which oversight on implementation of procedures and protocols will occur. Many of these procedures and protocols are designed to ensure data integrity, statistically valid analyses and scientifically robust insights into the mine's complex hydrology and hydrogeology. Quality Assurance / Quality Control (QA/QC) oversight will be applied to water sample collection, water flow measurements, field parameter measurements, calibration of instruments and statistical validity of data collected by the program (both field measurements and lab testing). We refer to this set of activities throughout this document as the Phase 1 Water Monitoring Program.

Quality System Components

Section A – Responsibility for QA/QC

Bunker Hill has contracted an environmental engineering professional, Klepfer Mining Services (KMS), to design its water monitoring program and to provide certain elements of QA/QC. KMS is experienced in water sampling and testing program design, execution and management, having successfully designed water management programs for Kensington Mine in Alaska, Montanore Mine in Libby, MT for Hecla, and various other Hecla mine sites, including the Lucky Friday Mine. KMS has expertise that directly relates to:

- Idaho Department of Environmental Quality procedures, protocols and requirements
- Idaho Water Quality Standards
- EPA CERCLA procedures, protocols and requirements

Members of the Water Management Team at Bunker Hill will also check data quality at different points.

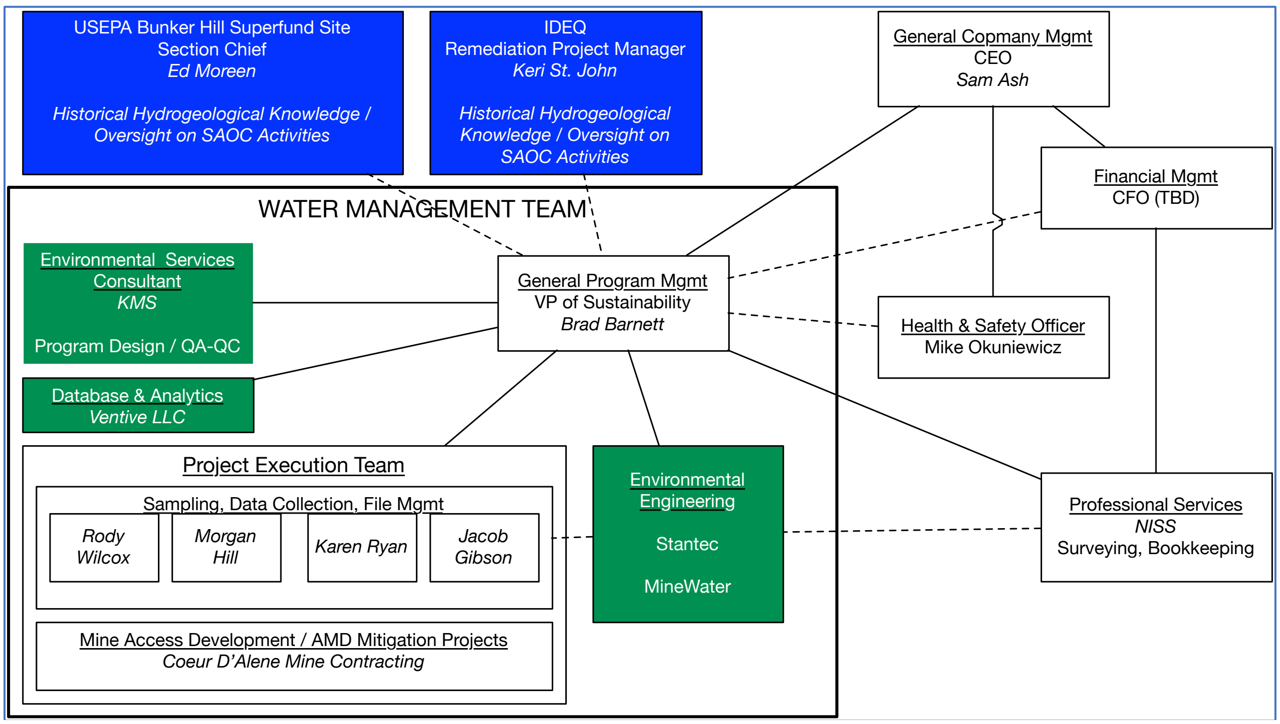
[1] Water will be sampled and tested in and around Bunker Hill Mine, including sections of the South Fork of the Coeur D'Alene River and the top portion of the mine pool. Phase 1 site characterization will not include flooded workings from the 11 level through the 27 level of Bunker Hill Mine.
[2] NOTE: Water management and water monitoring activities will continue in some form as long as BHMC is active at Bunker Hill Mine. Funding has not yet been secured for future phases of activity. For that reason, this document only discusses activities for which current funding exists.

Section B – Organizational Hierarchy

The environmental consultant responsible for QA/QC of Bunker Hill's Phase 1 water monitoring activities, KMS, reports to the Vice President of Sustainability as shown in Figure 1, below.

The environmental consultant will not have direct management responsibility for the Water Management Team, but will review works product, analyze the statistical validity of all data produced by the Water Management Team's activities, including lab results, and will observe and document whether the procedures and protocols are strictly observed.

Figure 1. Bunker Hill Organizational Structure (Phase 1 Water Management)



The Vice President of Sustainability manages the Water Management Team, which will be collecting all data in the field, completing all field parameter data forms and submitting water samples to the laboratory for testing.

Section C – Documentation of QA/QC Procedures

Bunker Hill has developed a detailed monitoring plan for the project (Water Monitoring and Analysis Plan). In this plan, it describes locations, schedules, sampling procedures, calibration, field parameter collection procedures, documentation, data management, and quality assurance and quality control (QA/QC). QA/QC for the project covers field data forms, data entry, and lab results. Trained individuals from an experienced environmental consulting firm (KMS) will complete the QA/QC process. A separate individual will QA/QC data than the person that collected and/or uploaded data into the database. The specific procedures for QA/QC are included in the BHMC Water Monitoring & Analysis Plan ("Water Monitoring Plan"). This includes the use of blanks and duplicates as a check on the laboratory technique consistency, reliability and reproducibility. It also includes calibration check of instruments prior to use in the field, regular reviews of completed forms and database contents but multiple team members.

Section D – Process for Assessing, Documenting, Correcting in QA/QC

Under the QA/QC section of the Water Monitoring Plan, all corrections or changes to data that has been recorded in any form is documented with the use of a Data QA/QC Form. If laboratory reruns are requested due to anomalous results, or any other perceived data or testing quality problems, those are also documented using the same form (all forms being used in the Water Monitoring Program are included in section 6 of the Water Monitoring Plan. If any particular error occurs multiple times, adjustments will be made to the plan to minimize or eliminate the errors.

While QA/QC procedures are a described in section 4 of the Water Monitoring Plan, in general, no authorization is required to make corrections when errors are found. Corrections will be requested and documented using the Data QA/QC Form. Team members will be encouraged to make changes to data once it is confirmed that an error does in fact exist. Periodic checks of the database contents will ensure that errors that have been identified have also been corrected.

In general, members of the BHMC Water Management Team are responsible for review of completed forms for errors and omissions. The VP of Sustainability and the Environmental Service Consultant will review the contents of the database, cross-reference against completed forms and request of the Database Consultant to make any necessary corrections to erroneous data.

Project Definition and Background

<u>Background</u>
A review of historical studies and datasets from 1983 through 2019 indicate a relatively consistent pattern of environmental challenges that includes high levels of acidity of water that flows into and through sulphide ore bodies in the Bunker Hill Mine. This constitutes an environmental challenge in and of itself. Because acid forms and flows through areas of veins and ore bodies with high levels of metal content, a significant concentration of metals is dissolved into and mobilized by some of the water flows within the mine.

Throughout the history of environmental study of Bunker Hill Mine, several flow paths have consistently registered as the major conduits of dissolved metals while others have consistently maintained lower concentrations of dissolved metals and lower degrees of acidity. Streams that maintain the highest water flow upon entering the 9 level, generally have lower metals content and lower acidity (higher pH). Once entering the 9 level of the mine, relatively good quality water[3] eventually mixes at different points with relatively bad quality water and significant volumes of sludge are created. Eventually, waters find their way to the Kellogg Tunnel, the single discharge point of the mine[4], and flow to the Central Treatment Plant that is operated and maintained by the EPA.

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[3] Relatively good water equates in this context to higher pH and lower metals content while relatively bad quality water equates to the converse of the previous statement.
[4] Located on the 9 level of Bunker Hill Mine.

Throughout most of the periods of commercial production at Bunker Hill, the points of good and bad water confluence were cleared of sludge to allow operations to run smoothly and in some cases, the streams where separated and not allowed to mix in the first place in order to prevent sludge from forming. As mine production decreased, then became intermittent to some extent and then ceased, the frequency of sludge-clearing in these points of confluence correspondingly decreased. Over this time period, the systems for transporting, storing and using water also fell into disrepair and generally stopped serving their productive purposes.

The amount of sludge present in the East Drift of the 9 level represents one observable difference in the mine’s current hydrology versus the state described and measured in various environmental studies conducted over period of 1983 through 2000. In most other ways, however, the hydrodynamics and hydrogeology of the mine appear to be substantially similar now to twenty and forty years ago. Preliminary field testing seems to bear this out.

<u>Sampling Locations in Phase 1</u>

There are 29 locations in the Phase 1 program. Twenty of these are located within the Bunker Hill Mine. Nine of the locations are surface water monitoring locations.

Underground Water Monitoring Map – 5 Level

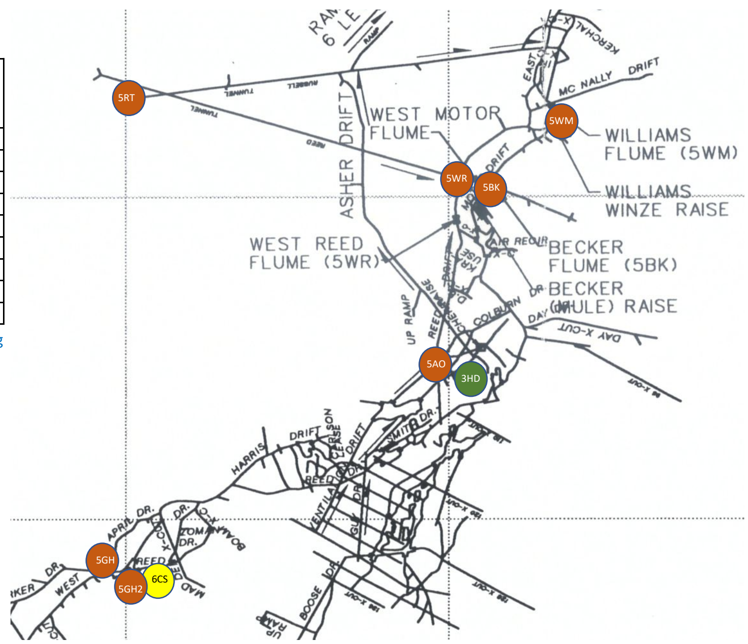
S#	Location ID	Location Name	Mine Level
1	3HD	Homestake Drift	3
2	**5RT**	**Reed Tunnel Pumphouse**	**5**
3	5WM	Williams Flume	5
4	5WR	West Reed Flume	5
5	5BK	Becker Flume	5
6	**5GH**	**Greenhouse 1 - April Drift**	**5**
7	**5GH2**	**Greenhouse 2 - Reed Drift**	**5**
8	**5AO**	**Asher Ore Chute**	**5**
9	**6CS**	**Crusher Station**	**6**

Blue indicates site that has been added to the historical EPA sampling

3-Level in green

5-Level in orange

6-Level in yellow



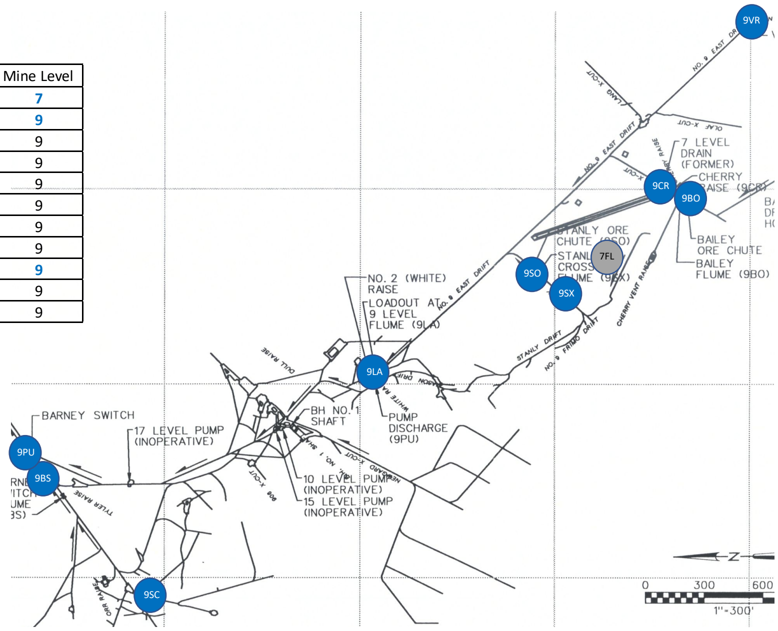
Underground Water Monitoring Map – 9 Level

S#	Location ID	Location Name	Mine Level
10	7FL	Flood Drifts	7
11	9VR	Van Raise	9
12	9BO	Bailey Ore Chute	9
13	9CR	Cherry Raise	9
14	9SX	Stanly Crosscut	9
15	9SO	Stanly Ore Chute	9
16	9LA	Loadout Area (East Drift)	9
17	9PU	Mine Pool Discharge	9
18	9SC	South Chance	9
19	9BS	Barney Switch	9
20	9KT	Kellogg Tunnel	9

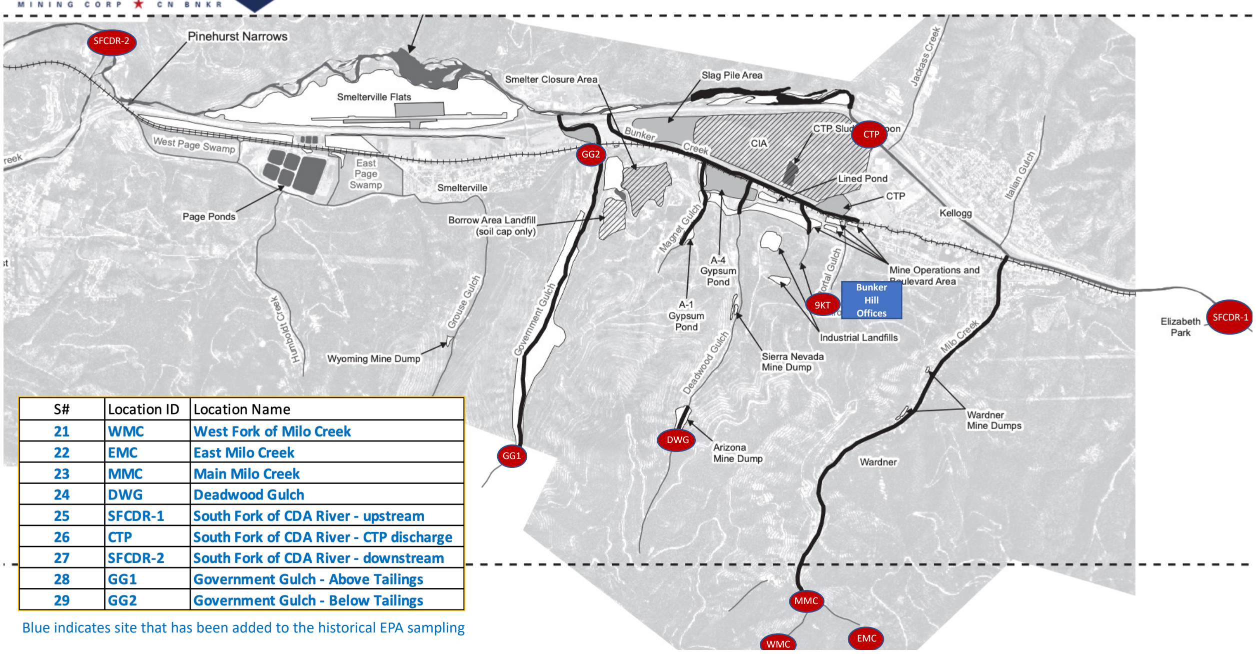
Blue indicates site that has been added to the historical EPA sampling

7-Level in gray

9-Level in blue



Surface Water Monitoring Map



S#	Location ID	Location Name
21	WMC	West Fork of Milo Creek
22	EMC	East Milo Creek
23	MMC	Main Milo Creek
24	DWG	Deadwood Gulch
25	SFCDR-1	South Fork of CDA River - upstream
26	CTP	South Fork of CDA River - CTP discharge
27	SFCDR-2	South Fork of CDA River - downstream
28	GG1	Government Gulch - Above Tailings
29	GG2	Government Gulch - Below Tailings

Blue indicates site that has been added to the historical EPA sampling

Project Definition

The major focuses of the Water Monitoring Program are to:

1. Collect new data from the same monitoring locations as past efforts[5] to maximize the use of historical data;

[5] In particular, Phase 1 will use the CH2M/EPA work from 1998 and 1999 that informed the Conceptual Site Model published in 2000.

2. Add new monitoring locations into the sampling program to expand the opportunity to better model the water system of the mine;
3. Collect samples and take measurements on a regular recurring basis in a consistent manner designed by an experienced environmental professional[6];
4. Establish a current baseline of water quality and environmental conditions in and around the mine prior to the initiation of projects designed to improve water quality of the mine's effluent;
5. Once data passes QA/QC analysis, begin the process of updating the Conceptual Site Model[7] with current water quality and water flow data;
6. Determine areas of dynamism within the water system between (1) the last major in-mine data collection effort (in 1999) and the present and (2) different monitoring periods in Phase 1;
7. Modify the monitoring program to better understand the significance of the differences and/or the rate of change of significant differences between any periods of analysis;
8. As projects designed to improve water quality are completed, analyze the observable impacts of the projects;
9. Use impact analysis from the Phase 1 projects to inform the development of a Phase 2 Water Management Project Plan, with the goal of maximizing the financial efficiency of available budget for water quality improvement from February 2021 onward;
10. Begin gathering data for an eventual IPDES Water Discharge Permit application.

The outcome of this re-initiation of water monitoring in the mine is uncertain. BHMC's Phase 1 budgeting and conceptual planning has been based on extensive in-mine reconnaissance and testing of field parameters. Bunker Hill Mine is a large mine, however, and because over 100 years of underground development it has not been possible to visit all of the workings above the mine pool. It is also not possible at this point in time to define exactly what proportion of the existing mine workings remain inaccessible.

As water monitoring occurs in Phase 1, a number of different activities will occur that can inform the development of a Conceptual Site Model and improve understanding of where and why gaps may exist within the model. These activities include surveying, LIDAR scanning of the workings above the mine pool (to the degree they are accessible from any number of different directions) and 3-dimensional modeling of the mine (including known workings, lithography, stratigraphy, faulting and other information). The product of this work is expected to dovetail with both historical and Phase 1 water monitoring data to inform further CSM development and Phase 2 budgeting. Much of Phase 2 budgeting will be shaped by the impacts generated by and knowledge gained in Phase 1.

Data Quality Objectives (DQOs)

The overarching objective of Phase1 is to develop an understanding that is comprehensive enough and accurate enough to begin a process of improvement in water quality discharged by the mine that continues until no measurable negative externalities are generated by the mine in the future.

[6] This is planned to occur on a monthly basis for water sample collection and full suite laboratory testing and twice per month for field parameters and flow measurements. Funding only exists at present for Phase 1 activities. For this reason, the QAPP does not contemplate long-term project function. Water management and environmental management will be integral elements of BHMC's business model as long as it is active at Bunker Hill.

[7] The Conceptual Site Model being reference is the document published by EPA and produced largely by CH2M in 2000.

The Problem

Bunker Hill Mine produces water with low pH. This, in turn, dissolves and mobilizes high concentrations of metals. BHMC has a water management team led by the VP of Sustainability who are focused on the study of this set of problem and to begin solving them. The team has a total budget of approximately $1 million to do two things by February 2021: (1) begin study of the Bunker Hill hydrogeological system and (2) begin improvements in water quality.

Goal of the Study

The goal of the study is to develop an information system at Bunker Hill Mine where BHMC management can analyze data about the Bunker Hill hydrogeological system on an ongoing and regular basis in such a way that highly targeted AMD mitigation projects can be designed and implemented. The projects must satisfy two main criteria (1) improve water quality in Bunker Hill Mine to reduce water treatment costs, (2) provide insights into the cost/benefit relationship for and efficacy of a range of future water management projects in and around Bunker Hill Mine.

In order to achieve these results, BHMC believes that a well-developed and accurate Conceptual Site Model (CSM) is essential. Information system design is intended to improve the initial CSM work conducted by Dr. John Riley and the EPA. The challenge BHMC faces is to meet this objective rapidly and effectively within the limits of narrow budgetary confines.

BHMC believes the key questions to answer for further development of the CSM and that stakeholders seek to answer with new environmental data are:

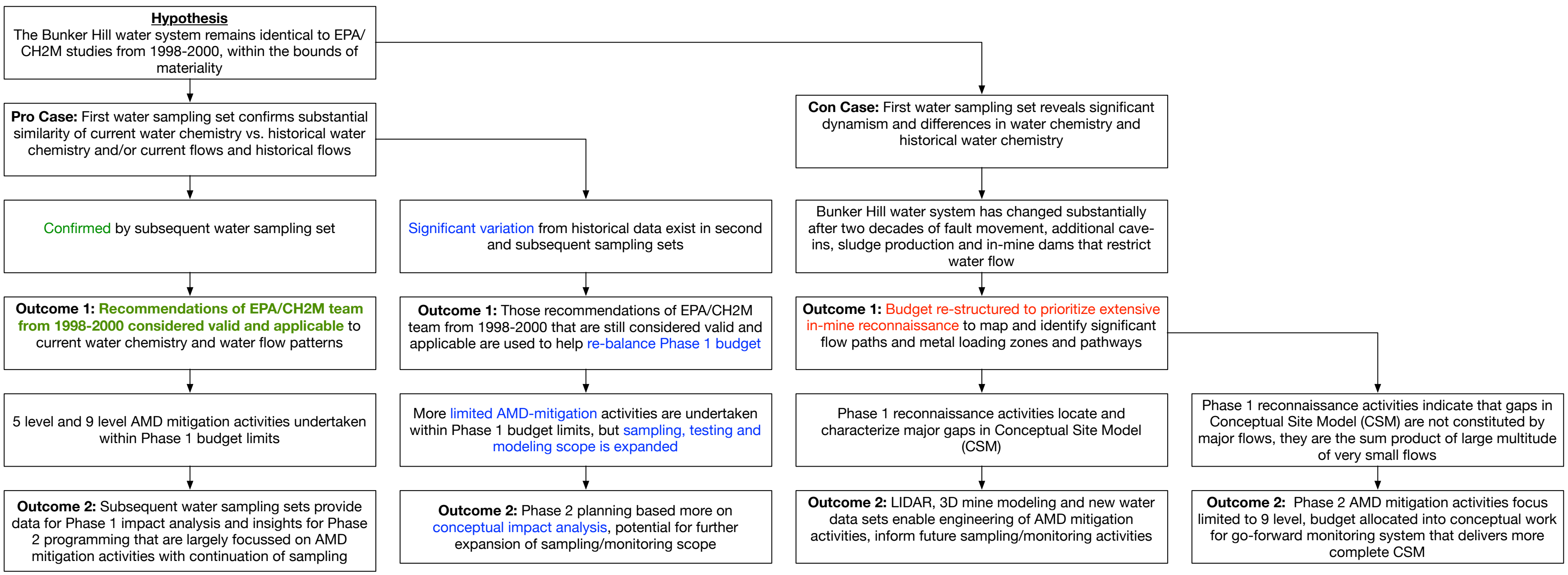
- Where is the most intense acid generated within the mine? And in what quantities?
- Where within the mine are the highest concentration of dissolved metals?
- How and where does water with very high metal concentrations move within the mine?
- What are the highest volume flow paths of water within the mine?
- What are the flow rates of the major water flows in the mine?
- What are the flow rates for all the identifiable tributaries of the major water flows in the mine?
- What are the metal loads of all major water flows and major tributaries?
- Where do the largest amounts of metal loading occur, and in what quantities?
- Where does relatively good water mix with relative bad water in the mine?
    - What are the relative flow rates and volumes in these areas?
- On a case by case basis, what would the investment requirement be to prevent mixing of good and bad water streams?
- How do these all of these elements, metrics and dynamics change at different points in the year?
- For the water chemistry in the areas of the mine where the highest concentrations of dissolved metals occur, what is the most efficient treatment system? And how much would that cost?
- For the water chemistry in the areas of the mine where the largest amount of metal loading occurs, what is the most efficient treatment system? And how much would that cost?
- For the water chemistry in the areas with the cleanest water in the mine, what would the most efficient treatment system be? And how much would that cost?

- Once AMD mitigation projects are underway that will could change hydrogeological dynamics:
    - Is there any observable change in specific areas of the mine and also at the Kellogg Tunnel effluent in:
        - Water flow
        - pH
        - Metal concentrations
        - Metal loads
    - To what degree is pooling (restrictions on water flow within the mine) correlated with:
        - Low pH
        - High metal concentrations
        - High metal loads
    - What elements remain inside that mine that prevent water flow?
        - What is the best way to remove them?
- How many areas of the mine are inaccessible that generate significant water flows?
    - What are the pH and dissolved metals concentrations of these flows?
    - How do these areas compare to other areas of the mine that are targeted for AMD mitigation projects?
- How do surface water flows correlate with different in-mine water flows when we incorporate a range of different lags?
    - Which surface flows and in-mine flows correlate most robustly?
    - How does seasonality impact these correlation(s)?
    - Does seasonality impact the lag periods that most closely correlate the flows?
- How do surface water flows correlate with different in-mine water quality metrics when we incorporate a range of different lags?
    - Which surface flows and in-mine water quality metrics correlate most robustly?
    - How does seasonality impact these correlation(s)?
    - Does seasonality impact the lag periods that most closely correlate the flows?
- What are the relationships between surface environmental factors like precipitation, barometric pressure and temperature and in-mine factors at different locations within the mine such as water flow rates, acidity, metal loads and dissolved metal concentrations?

There are, of course, many other questions that one could seek to answer, but BHMC believes these to be the most important to our universe of stakeholders. As BHMC seeks the answers to these questions, there are a number of different outcome scenarios we see as possible within some reasonable bound of probability.

These are presented in Figure 2, below.

Figure 2. Phase 1 Decision Tree

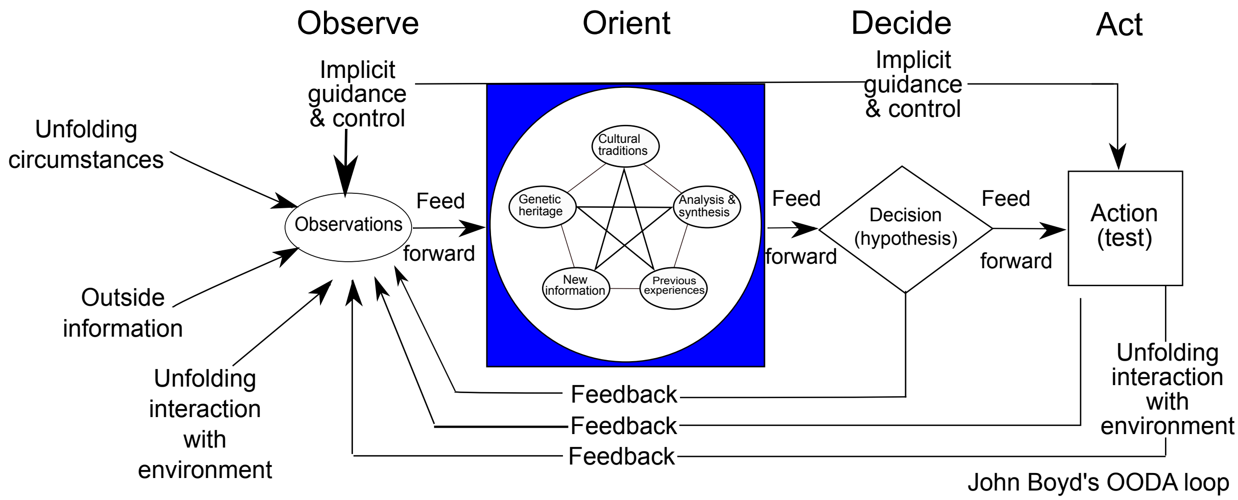


Much of Phase 1 and all anticipated future activity will be iterative and self-informing. By the nature of that type of process, it will involve a degree of dynamism. To that end, pathways in the decision-making process will exist in-between and outside of the decision tree presented in Figure 2. BHMC sees the four pathways presented in Figure 2 as the most likely based on our current observations and evolving understanding.

As part of the iterative and self-informing process, if information is collected at any point that significantly alters understanding, it will necessarily change the decision tree. As a consequence, this will be altered and updated. Because the natural environment is ever-changing and because activity within the mine will impact the ecosystem, its hydrology and Bunk Hill hydrogeology – the Conceptual Site Model will always behave like a living breathing organism.

In this way the CSM behaves like a military OODA loop:

Figure 3. Col. John Boyd's OODA Loop



In the context of Bunker Hill Mine and its CSM, however, elements in the military's 5-point Orient process like cultural traditions and genetic heritage would be replaced with water quantity data, water quality data and other environmental data that we collect in BHMC monitoring and testing, trusted open source publishers and collaborative stakeholders such as the EPA.

Information Inputs

In order to best answer the questions listed above within the bounds of available budget, BHMC will collect monthly water samples from 29 locations. Twenty locations are inside Bunker Hill Mine, nine are surface locations.

Because a significant time gap exists in the historical environmental data available to BHMC and the present, BHMC plans to test a wide range of metrics. These are presented in section 3.4 of the Water Monitoring & Analysis Plan. An ISO-accredited laboratory will be selected that has deep experience testing with EPA method 200.7 and 200.8.

BHMC will also collect field parameter data on a bi-weekly basis. This is much less costly to collect, record and analyze but it may provide greater insight into the water quantity and water quality dynamics of the water system. Field parameters include pH, electrical conductivity, dissolved oxygen, turbidity, total dissolved solids, water temperature, ambient temperature and water flow. The procedures for field data collection and the instruments that will be used are described in the Water Monitoring and Analysis Plan.

Open source information will be gathered from SNOTEL Idaho (precipitation data), NOAA National Weather Service, available METAR and Radar weather datasets (local weather and pressure data) and USGS (water flow data for the South Fork of the Coeur D'Alene River).

Third-party historical information has been supplied by the EPA, including but not limited to the following studies:

- AMD Mitigations Evaluation – Bunker Hill Mine Water Presumptive Remedy (July 28, 1999)

- Bunker Hill Mine Flood-Stanly Ore Body In-Mine Reconnaissance Report (September 1999)
- Field Reconnaissance of Inflow/Recharge Mechanisms, AMD Generation Mitigations, Bunker Hill Mine Water Management Project (November 15, 1999)
- Acid Mine Drainage – Bunker Hill Mine Water Conceptual Model (July 28, 1999)
- Supplement No. 1B – Bunker Hill Mine Conceptual Model 1998/9 (February 1, 2000)

The information supplied by the EPA to BHMC to aid understanding of the water system of Bunker Hill and to help manage the water system has been invaluable orienting and educating BHMC management and staff. This has accelerated the learning process of BHMC by several years.

Boundaries of the Study

Phase 1 of this study began in September of 2020 and will extend until the end of February 2021. The study will occur in and around Bunker Hill Mine (above the mine pool on level 11). Surface study locations the lie outside of the mine include: Milo Creek (east fork, west form and main fork), Government Gulch, Deadwood Creek and the South Fork of the Coeur D'Alene River.

The characteristics of interest in Phase 1 are broadly water quantity characterization and water quality characterization. This is detailed in the Water Monitoring and Analysis Plan.

Analytic Approach

Data will be analyzed a number of ways that will, in all likelihood, grow in nature and complexity as the dataset expands over time, space and potentially also in metrics.

Phase 1 will examine current data and historical data within an interactive database with a range of functions, including but not limited to:

- Any variable versus any other variable, or any single variable individually
  - Trendlines/time series, including the following functionality:
    - Adjustable date range (single point in time, quarterly/seasonal averages over a start and end custom date range, averages over custom period)
    - Toggle on/off any sample location (can include only one location or up to 29 locations)
    - Toggle on/off any metal
  - Scatterplot
    - Every data point within a customizable date range
    - Toggle on/off any sample location
    - Toggle on/off any variable (toggling on displays both the total metal and dissolved metal for any single metal)
    - Scatterplot of each data point with a date range
    - quarterly averages
- Idaho Stream Water Quality Standards vs. Dissolved Metals
  - Comparison of any monitoring location for each numerical standard at any given point in time of the entire dataset versus SWQS discharge limits at location's lab-tested level of hardness
- Scatter plots
  - Site location comparison for each constituent compared to stream background data (Elizabeth Park/ SFCDR-1)

- Individual scatter plots for any of the major analytes
  - Customize by toggling on/off monitoring locations
  - Adjustable date ranges (single points in time, quarterly/seasonal averages over a start and end custom date range, averages over custom period
- Time series comparisons for key relationships:
  - Customize by toggling on/off monitoring locations (can include a single location or any chosen amount of locations in one time series, up to all 29 locations)
  - Adjustable date range (single point in time, quarterly/seasonal averages over a start and end custom date range, averages over custom period)
  - Key relationships:
    - Hardness of water samples and pH
    - pH & dissolved zinc concentration
    - Water flow & pH
    - Water flow and Zn load
    - Water flow and dissolved zinc concentration
    - pH & EC
    - Water flow and EC
    - EC & dissolved zinc concentration
    - EC and Zn load
    - Zinc load & pH
    - pH & dissolved Mn concentration
    - Water flow and Mn load
    - Water flow and dissolved Mn concentration
    - EC & dissolved Mn concentration
    - EC and Mn load
    - Mn load & pH
    - pH & dissolved Cd concentration
    - Water flow and Cd load
    - Water flow and dissolved Cd concentration
    - EC & dissolved Cd concentration
    - EC and Cd load
    - Cd load & pH
    - pH & dissolved Pb concentration
    - Water flow and Pb load
    - Water flow and dissolved Pb concentration
    - EC & dissolved Pb concentration
    - EC and Pb load
    - Pb load & pH
    - Precipitation & water flow
      - Including various lags
- Correlation matrix of key variables:
  - Any single monitoring location, generate correlations for key variables
  - Adjustable date ranges (single point in time, quarterly/seasonal averages over a start and end custom date range, averages over custom period)
  - Key Variables:
    - Hardness
    - Water flow (gpm)
    - pH
    - EC (mS/cm)
    - Turbidity (NTUs)
    - TSS (ppt)
    - TDS (ppt)
    - Dissolved oxygen (mg/l)
    - Total Zn (µg/l)
    - Dissolved Zn (µg/l)
    - Total Cd (µg/l)

- Dissolved Cd (µg/l)
- Total Fe (µg/l)
- Dissolved Fe (µg/l)
- Total Pb (µg/l)
- Dissolved Pb (µg/l)
- Total Mn (µg/l)
- Ambient temperature at monitoring location
- Relative humidity at monitoring location
- Outside Temperature (degrees C and F)
- Monthly Precipitation (cm and inches)
- Precipitation 3-month total (cm and inches)
- Barometric pressure

    - Season/quarterly totals (3-month totals)
    - 1-month lag
    - 2-month lag
    - 3-month lag
- Box and whisker plots
    - Any single variable
    - Any location
    - Any time range in the data series
- Spatial plotting of data points on level maps
    - User can select a single data points or time period averages
    - User can select a single metric or up to 50 metrics
    - User can select on monitoring location or as many as all of the locations on that map

These different analytics will help BHMC better understand the relationships relevant to water quantities and water quality, including potential causality and impacts of any AMD mitigation activities.

Data will also be used to update and expand the mass balance analysis presented in historical studies supplied by the EPA. In areas where gaps are determined to exist, Phase 1 activities will include investigation and inventory exercise that identifies all tributaries of the major water flows on the 9 level. These will be measured in terms of both volume of water flow and also water quality in terms of the field parameters BHMC is capturing. Minor flows on the 9 levels will also be inventoried and characterized in the same way. This will create an update to the mass balance map and may also either expend or alter the monitoring locations include in Phase 1 or subsequent phases (contingent upon future funding)

Data from current sampling events will be compared to the same locations from historical data to determine how much dynamism exists. Twelve of the planned 29 locations of the Phase 1 program were included in the historical monitoring program. Historical studies drew specific conclusions about how to mitigate AMD within Bunker Hill Mine. These conclusions and/or recommendations were based on data collected from 1983 through 1999.

To the extent that these conclusions are specific to monitoring locations within the mine, the current data set will be compared to the historical data set for that location to determine how applicable the historical recommendations might be. If there are substantial differences are germane to the specific recommendations that were made, BHMC will undertake technical evaluation of whether:

a) A modification of the recommended solution is likely to be effective, or
b) If an entirely new solution would be most effective, or
c) If this location no longer presents the same type of challenge or the same magnitude of challenge (or both)
    a. As a consequence, this location would continue to be monitored but no immediate intervention would be planned

Some recommendations are specific to levels of the mine or areas of levels of the mine (e.g. the east side of the 9 level or east side of the 5 level). Some recommendations are specific to flow paths within the mine that transport high volumes of water or high concentrations of dissolved metals or large metals loads. In each of these cases, BHMC will use the general logic described in the case of one single monitoring locations described in the previous paragraph but would apply it to these different cases on a case by case basis.

To the degree that specific historical recommendations appear to be applicable to current water quality or water quantity dynamics, BHMC will evaluate whether new technological options could improve the efficiency of the activity. After this step, high level cost estimates will be generated for different interventions. Activities will be greenlighted on the basis of the fit in three main criteria:

a) Areas where there is substantial concurrence between the historical data set and the current ones
b) Areas where the historical study team(s) ranked challenges as significant contributors to AMD, and
c) Areas where the intervention can be completed within the budgetary limits of Phase 1 and the time limits of Phase 1

In new areas that were not included in the historical dataset but where BHMC observes significant challenges of a nature similar to those described in historical studies, time and effort will be spent developing interventions/solutions for the location/area of the mine/flow path on a conceptual level. This will be advanced as additional sampling events continue to demonstrate that a challenge exist in that area. Any area where the specific challenge seems to be intermittent or varies significantly in the degree of negative impact from sampling event to sampling event, then it will be deprioritized over areas that are both more constant and also more significant contributors to AMD.

In areas where AMD mitigations activities are undertaken in Phase 1, data will be analyzed to determine if any part of the water system that is connected with the area of impact of the intervention demonstrates observable change. If all the parts of the system connected with the area of the intervention experience a change that is similar in nature, then some level of causality may be attributed to the intervention. To the degree that some part of the connected system demonstrate change, and some do not, more investigation will take place to determine:

a) Why the inconsistency is occurring
b) Whether causality can in some measure be attributed or either not immediately, or not at all

In cases where the change is evaluated to be a positive one, then a decision must be made as to whether it is sufficient in the present form or whether it can or should be modified to amplify the positive effects (and when those modifications should take place). The answer to that question will be impacted by both time and budgetary limitations. It will also be impacted by the other inventions that have been identified and how the relative cost-benefit relationships of different options compare. Some assignment of confidence and/or probability will have to be made of achieving future cost-benefit relationships for interventions that have yet to take place. This will involve technical personnel, the Water Management Team and the BHMC management team. In general, interventions with the best cost-benefit relationships that can be accomplished within short periods, will be the most highly prioritized.

If for any reason the changes to the water system attributable to any invention are evaluated to be negative impacts, then an evaluation must be undertaken as to whether the intervention can be modified so that positive impacts result instead of negative ones. If for any reason the negative impacts are of such a nature that they cannot be modified or eliminated, then the lowest cost method of undoing the intervention will be undertaken on the condition that that process will not create negative impacts either. We view this potentiality as highly unlikely given that substantial forethought will be applied to the design of the intervention in the first place and BHMC will use proven technologies and designs.

BHMC will seek to create a deliberate balance between action (AMD mitigation activities/interventions) and building understanding both in the immediate term and, we anticipate, through the long-term. The Bunker Hill water system is complex enough that constructing a full, highly accurate and predictive CSM could take a large amount of resources and a large amount of time to achieve. We believe the challenges to the water quality and water quantity being discharge by the mine have been substantially well-defined and well-documented in historical studies, that significant improvements in both water quality and water quantity of the discharge can be achieved in the short-term if proper emphasis and budget is given to action. Achievement of these improvements will increase investor confidence in Bunker Hill and thereby increase the likelihood of future funding being available to further improve understanding and continue to take measured action.

Performance / Acceptance Criteria

Evaluation of data quality and also the QA/QC processes for evaluating acceptability of data is described in some detail in section 4 of the Water Monitoring & Analysis Plan.

Project Organization and Responsibilities of the Researcher

Sampling activities will be conducted by two or three 2-person teams, depending on the availability of personnel. Two-person teams are the minimum unit for safety reasons. This is also necessary in order to transport the volume of sampling bottles and all field parameter instruments to the locations that are difficult to reach within in the mine, while also meeting the objective of sampling all 29 monitoring locations in the same day.

The org chart presented in section B of this document describes the personnel involved in the Phase 1 Water Management program. The personnel who will be involved in sample collection and measurement of field parameters are those included in the “Water Management Team” box and the VP of Sustainability.

Sampling activities are divided into four groups:

- Wardner – this includes 10 locations:
    - Homestake Drift West (3 level)
    - Reed Pumphouse (4 level)
    - Greenhouse – April Drift (5 level)
    - Greenhouse – Reed Drift (5 level)
    - Asher Ore Chute (5 level)
    - Williams Raise (5 level)
    - Becker Raise (5 level)
    - West Reed Drift (5 level)
    - East Milo Creek (surface)
    - Main Milo Creek (surface)
- Mid-mine – this includes 3 locations:
    - Crusher Station (6 level)
    - Flood Drifts (7 level)
    - South Chance (9 level)
- 9 level – this includes 8 locations:
    - Van Raise
    - Cherry Raise
    - Bailey Ore Chute
    - Stanly Ore Chute
    - Stanly Crosscut
    - 9 Level Load Out
    - Mine Pool Discharge

- Barney Switch
- Surface – this includes 8 locations:
  - Kellogg Tunnel
  - West Milo Creek
  - Deadwood Gulch
  - Government Gulch – Above Tailings
  - Government Gulch – Below Tailings
  - SFCDR – Elizabeth Park
  - Central Treatment Plant Discharge Port
  - SFCDR – Pine Creek

In general, one of the three team will be assigned to either Wardner, Mid-Mine or 9-Level locations. The group that completes sampling first will be responsible for conducting Surface location sampling, field testing and flow measurements.

If sufficient time in the day does not exist for the Surface locations to be sampled and tested within the same day by one team, these locations will be broken into two subgroups and split among two of the sampling teams. The team that finishes in-mine sampling first in this case will be responsible for the three locations on the South Fork of the Coeur D'Alene River and the two Government Gulch locations. The second team will be responsible for Deadwood Gulch, West Milo Creek and the Kellogg Tunnel.

If sufficient time does not exist to record flow rate measurements for the Surface sites, these will be measured and recorded the following day.

Field parameters will be tested using the following instruments:

- Hanna Waterproof Combo meter – pH, electrical conductivity, total dissolved solids
- Hanna HI98193 meter – dissolved oxygen, biological oxygen demand meter
- Hach FH950 flow meter and Rickly 4-ft wading rod – flow measurements
- Oakton T-100 turbidity meter
- Extech FLIR hygro-thermometer psychrometer – ambient temperature and relative humidity

Field parameter data will be recorded in an electronic form recorded on smartphones and/or tablets that uploads data directly into the Bunker Hill AMD Monitoring Database in the cloud. Data will be analyzed for QA/QC purposes. If the data is determined to be statistically valid, the data will be used for analysis and recommendations. A hard copy of these forms will be kept on file in the Bunker Hill Mine office. Refer to Appendix 1 for the current copy of the form.

Once all field data is measured and recorded and all applicable fields of the sampling form have been filled, the form will be submitted by the Field Technician/Sampler and the data will upload to the cloud in PDF and Excel files. PDF versions of completed forms will be printed and filed.

Once all water sample bottles have been filled and returned to the Bunker Hill Office, they will be photographed as a completed batch. Chain of Custody documents will be completed by the team of Field Technicians. Bottles will be sealed with a sticker from the lab and the entire sample batch will be delivered to the laboratory by one or more of Bunker Hill's Field

Technicians[8]. Signed copies of the completed Chain of Custody forms will be kept on file at the Bunker Hill office after the lab and in electronic scanned form in the cloud.

All forms and analyses are expected to change over time as the team reports observations from the field and as analysis is conducted on the data. This may, in turn, create different or additional activities and responsibilities for the Water Management Team members and sample collections teams.

Project Description, Documentation and Reporting

Section A – Literature Search

The following studies were provided to Bunker Hill by EPA Bunker Hill Superfund Site Project Manager, Ed Moreen:

- Analysis of AMD Sludge Disposal in Hanna Stope
- AMD Mitigation Evaluation – Bunker Hill Mine Water Presumptive Remedy
- Supplement No. 1B – Bunker Hill Mine Conceptual Model
- Bunker Hill Mine Flood-Stanly Ore Body In-Mine Reconnaissance Report
- Acid Mine Drainage – Bunker Hill Mine Water Conceptual Model
- Field Reconnaissance of Inflow-Recharge Mechanisms, AMD Generation Mitigations, Bunker Hill Mine Water Management Project
- Bunker Hill Mine Water Management Remedial Investigation / Feasibility Study (April 2001)

These studies formed the substantive basis upon which in-mine assessments were conducted over the period of May 2020 through August 2020 that informed Water Management Phase 1 program design, including the Water Monitoring Program. These studies were published at different points over the period of 1999 through 2001. To the knowledge of the Bunker Hill team, no recent update to these studies has been conducted up to the point of initiation of Phase 1.

EPA also shared monthly reports on the quality of the effluent discharged from the Kellogg Tunnel and effluent discharged from the Central Treatment Plant over the course of 2019. This data will also be inputted into the database and used in analyses. In particular this will increase the dataset for Kellogg Tunnel effluent substantially, given the 20-year gap information that generally exists between EPA/CH2M and Phase 1 activities, this is a very valuable contribution.

The Bunker Hill Water Management Team also studied:

- Hydrogeology of an Underground Lead-Zinc Mine: Water Flow and Quality Characteristics (John Riley, Daniel Erikson, Dale Ralston, Roy Williams, University of Idaho Press, 1984)

Section B – Non-Quality Constraints on Use of Historical Information

No known limitations exist on the use of or inclusion of any of the historical information in any analysis and subsequent analysis, reporting and communications of results.

[8] This QAPP uses the example of SVL Analytical as the service provider. In the event that other labs are used, arrangements with courier services will be made such that all short hold time limitations can be met.

Section C – Use of Existing/Historical Data in the Project

Historical data will be compared to information collected in Phase 1 and beyond in four main ways:

- Correlations of relationships of the entire range of metrics in historical data versus new data to indicate potential areas of dynamism within the water system, which may provide opportunities to study the system in ways that are not yet incorporated into the program;
- Time series analyses in monthly periods and seasonal periods for all common and locations metrics that examines trends in data;
- Spatial analysis of similarity or differences in flows rates, pH and various forms of metals loading of water flows;
- Impact analysis for Phase 1 Water Management Program activities designed to improve water quality.

Section D – Procedures for Determining the Quality of Existing Data

As noted above, there have been numerous monitoring events at the project, over the period of 1983 through 1999. Documentation of the methods, procedures, and any QA/QC is not available other than communications with the field reconnaissance team member and project manager of the studies conducted in 1998 and 1999 (Bill Hudson, ex-Bunker Hill & CH2M and Jim Stefanoff, CH2M/Jacobs, respectively).

A statistical analysis will be completed on the historical data set. This will identify any outliers or anomalous data. It may not be possible to determine if these particular data points are truly erroneous, but an attempt will be made to communicate with members of past study team to gather all information that is available.

For this reason, all historic data will be preserved until additional data is collected by Bunker Hill for a long enough period to assess seasonal variability. Once sufficient data has been collected, statistical analyses of outliners and anomalous data can be identified. Data that is identified as being anomalous will have an identifier added to it in the BHMC Water Management Database that allows for analyses to be run that either eliminate anomalies or that include anomalies (depending upon what the database user wishes for whatever reason).

Much of the historic data was collected by EPA contractor, CH2M, is expected to have had QA/QC procedures in place. For data obtained from the water treatment plant, it is also assumed to have a monitoring and QAPP plans.

Section E – Reduction/Validation Procedures for Existing Data

Historical data exist for portions of the time period between 1983 and 1999. These are a collection of data points for a broad set of metrics that apply with varying levels of completeness at different points in time for different monitoring locations within Bunker Hill Mine. The current monitoring program has been designed to be substantially similar to the historical program of study and analysis of the water system at Bunker Hill

Historical data will be reviewed to determine if any data entry errors occurred in studies that were eventually published by the EPA. BHMC will also seek comment from the EPA and any parties EPA feels would be relevant to the conversation that can comment on the accuracy of any parts or specific data points included in the historical data set.

Section F – Plans for Review of the Project During Operation

The QAPP will be reviewed by the Environmental Consultant and the VP of Exploration every two months to determine whether changes and/or additions will best achieve the objective of the Phase 1 program (or any subsequent Phases, subject to availability of funding).

7. Reconciliation with Data Quality Objectives

The primary objective for the project, at this stage, is to accurately characterize water quality, water quantity and loading of water in and around Bunker Hill Mine associated with the project so that:

- Phase 1 activities can be programmed
- The impact of Phase 1 activities can be measured
- A CSM can be update and improved
- Design of Phase 2 activities will be effective

As the project advances, Bunker Hill will evaluate all the technical elements of water quantity, quality, treatment, and other parameters important for permitting or other decisions that are made that may influence treatment and discharges.