Re: Sunnyside Gold Corporation
Evaluation of the Success of Its Bulkheading and Remedial Activities

Dear Ms. Bidwell:

Thank you again for providing me the opportunity to present at the recent Annual San Juan Mining and Reclamation Conference in Creede, CO. Since the conference, I have been able to obtain and analyze new data from 2018 that further verifies the fact that SGC’s bulkheading and remedial activities in the Silverton Caldera were successful and reduced metals loading in the Animas River. A brief summary of the analysis and findings is set forth in this letter.

1.0 INTRODUCTION

The Paper SGC Mining and Reclamation Activities and Metals Loading in the Animas River concluded that “it is incontrovertible that the actions of SGC have substantially reduced acid rock drainage and metals loading in the Animas from what would have otherwise been the case.” A copy of the Paper is attached as Attachment A, and an abridged version can be found in the July 2018 issue of the Engineering & Mining Journal. Following the receipt of new data from 2018, additional examination was undertaken into the reduction in acid rock drainage resulting from SGC’s remedial activities, including the installation of engineered concrete bulkheads, after May 1996 (“Bulkheading and Remediation”).

2.0 METHODOLOGY

More than 22 years (1996-present) of recorded flows and Zinc concentrations at sampling point A-72 were compiled and analyzed. Zinc concentrations have historically been utilized to analyze water quality in the Animas River because the properties of Zinc make it an ideal indicator of overall metals loading. A-72 is a long-established monitoring point on the Animas River below the confluences of Cement and Mineral Creeks with comprehensive historical data. Using this extensive A-72 data from multiple sources, the standard residuals for Zinc at A-72 over time were derived and are depicted on Figure 1.

The headwaters of the Animas river are subject to seasonal fluctuations of flow due to varying climatic factors. When comparing varying concentrations of dissolved metals in surface waters, standard practice is to adjust the concentrations for the variation in streamflow. When the data set consists of samples collected at many different streamflows, some, or perhaps all, of the variation in concentration could be the...
result of variation of streamflows and not to changes in upstream loading. By computing a regression equation relating streamflow to concentration, the effect of streamflow on concentration can be accounted for. The combined flow and concentration data at A-72 indicate that higher concentrations are measured during the rising limb of the stream hydrograph.

To use traditional statistical methods, which are based on assuming normally distributed data, the flow and concentration data at A-72 need to be transformed to account for the log-normal distribution of the data. The applied transformation consisted of taking the natural logarithm of the flow and concentration data. The transformed data can then be evaluated using linear regression analysis.

The baseline water quality period is defined as data collected from September 5, 1991 to May 22, 1996. Separate regression equations were calculated for those samples on the rising limb of the stream hydrograph and those not on it. The regression equation relating the zinc concentration at A-72 to flow during the baseline period is:

\[
\ln(Zn_{A-72}) = 8.30 - 0.462\ln(\text{flow}) + 0.697\text{Rise}
\]

Where rise = 1 if on the rising limb of the hydrograph and 0 otherwise

and

\[ Zn_{A-72} = e^{[\ln(Zn_{A-72})]} \]

To remove the effects of flow and rise on the analysis, the value predicted from the regression equation is subtracted from the natural logarithm of the measured zinc concentration to create a residual. The residual is the distance the observed value deviates from the regression line. The residual contains the variation due to all variables other than flow and rise. The residual is then standardized by dividing by the standard error of the regression. In this way, the magnitude and importance of the residual can be judged. The equation is:

\[
\text{StR} = (\ln[Zn_{A-7s \text{Actual}}] - \ln[Zn_{A-72\text{Pred}}]) / \text{StdE}
\]

To evaluate the trends in the data, a running average of length 10 was calculated. Values that descend below the center line indicate samples where the actual value is less than would be expected based on the baseline relationship and values extending above the line indicate samples where the actual value is greater than would be expected if the conditions were similar to those during the baseline period. The regression analysis simply compares the characteristics of one set of data with another. There is no time variable in the analysis other than the selection of data groupings.

### 3.0 BACKGROUND.

The Silverton Caldera is highly mineralized, and acid rock drainage and poor water quality were prevalent long before the advent of mining. The Caldera hosted hundreds of mines and dozens of mills between the early 1870’s and 1985, which contributes to acid rock drainage and poor water quality in the area.

SGC was formed and acquired the Sunnyside Mine in 1985 and mined it from 1986 until 1991 using modern techniques and under modern environmental regulations. SGC closed the Sunnyside Mine in 1991. With
the objective of improving water quality and habitats in the Animas River, SGC and the State of Colorado agreed on a comprehensive watershed approach in which SGC would install engineered bulkheads to eliminate mine drainage from the Sunnyside Mine workings and complete numerous other reclamation projects in the region.

The success of the approach was evaluated by the State of Colorado utilizing the regression equation previously discussed to set a target for Zinc concentrations at A-72 (the “Target”). There were two independent aspects to Colorado’s Plan to achieve the Target: 1) SGC’s Bulkheading and Remediation; and 2) the running of a water treatment plant at Gladstone. Each separate aspect was designed to address a portion of the metals loading and improve water quality.

4.0 RESULTS OF THE ANALYSIS

Review of the plot in Figure 1 indicates that the standard residual changes in response to specific anthropomorphic changes to the watershed. The results are discussed below.

June 1996 – August 2001 - Water Treatment Alone Does Not Achieve Target. SGC commenced the Bulkheading and Remediation in the summer of 1996.¹ The most critical component of the endeavor was the construction of American Tunnel Bulkhead #1, which isolated the interior workings of the Sunnyside Mine. The successful isolation of the interior workings was demonstrated in May 2001, when water behind Bulkhead #1 reached confirmed equilibrium. In August 2001, American Tunnel Bulkhead #2 was completed to isolate water inflows from a fracture zone not on SGC’s property. Active remediation of mine and process waste was ongoing during this period and any reduction of load resulting from these activities would not yet be evident. A water treatment plant was run at Gladstone from June 1996 until August 2001. During this period, Colorado’s Target was not met on a regular basis (Figure 1). This demonstrates that one independent aspect of Colorado’s Plan – in this case water treatment – was not enough to result in Colorado’s Target being consistently achieved.

August 2001 – August 2004 - Bulkheading/Remediation and Water Treatment Jointly Achieve Target. A water treatment plant continued to be run at Gladstone from August 2001 until August 2004 and the reduction in load from the remediation activates was evident in the concentration trends. During this period, the Target was met (Figure 1). This conclusively demonstrates the success of SGC’s Bulkheading and Remediation and that the Target would be met when both aspects – Bulkheading and Remediation plus water treatment – of Colorado’s Plan were in place.

August 2004 – August 2015 - Bulkheading/Remediation Alone Does Not Achieve Target. Subsequent to an unrelated independent third party, Gold King Mines Corporation, ceasing to run the water treatment plant at Gladstone in August 2004, there was a statistically significant upward trend in Zinc concentrations at A-72 (Figure 1). Commencing in 2005, Colorado’s Target was no longer being achieved (Figure 1).

¹The Projects undertaken by SGC are set forth in Attachment B. The engineered concrete bulkheads are described in the Report The Engineered Concrete Bulkheads Installed by SGC attached as Attachment C.
While SGC’s Bulkheading and Remediation continued to be successful and improve water quality, the second aspect of Colorado’s Plan had been compromised, which resulted in the Target generally not being achieved between August 2004 and August 2015. It is interesting to note that even with the negation of the second aspect of Colorado’s Plan, SGC’s Bulkheading and Remediation was so successful in improving water quality that the Target was met at times during this period. Absent the Gold King Blowout, it is possible that the Target could have been achieved more often over time as natural groundwater equilibrium evolved.

**The Gold King Blowout.** On August 5, 2015, EPA released millions of gallons of mine impacted water, which resulted in a spike in Zinc concentrations at A-72. It should be noted that the standard residuals running average methodology causes the impact of the Blowout to be reflected on Figure 1 both before and after August 5, 2015 (Figure 1). Additionally, this sudden release of pressure resulted in significant alteration of the groundwater flow regime within the mountain.

**February 2016 – Present - Bulkheading/Remediation and Water Treatment Presently Jointly Achieve Target.** EPA commenced running a water treatment plant at Gladstone in October of 2015, and the plant was running effectively, but at substantially less than full capacity, by February 2016. Even running the plant at a fraction of its capacity resulted in a statistically significant downward trend in Zinc concentrations at A-72, and the Target being achieved commencing June 2017 (Figure 1). This again demonstrates the success of SGC’s Bulkheading and Remediation in improving water quality. While the Blowout resulted in significant alteration of the groundwater flow regime, the data indicates that Colorado’s Target would be met consistently going forward if EPA were to elect to run the water treatment plant at full capacity.

**Conclusion.** The analysis of Zinc loading at A-72 from 1996 through the present conclusively demonstrates that SGC’s Bulkheading and Remediation was successful and improved water quality by substantially reducing acid rock drainage and metals loading in the Animas River. Whenever both aspects of Colorado’s Plan were in place prior to the Gold King Blowout, Colorado’s Target was met. Each aspect of Colorado’s Plan, (1) SGC’s Bulkheading and Remediation and (2) the running of a water treatment plant at Gladstone, played a key role in the Target being achieved and the improvement of water quality. Although the Gold King Blowout significantly altered the existing groundwater flow regime, Colorado’s Target is being met today, as a combined result of SGC’s Bulkheading and Remediation and EPA running its treatment plant at a fraction of capacity.

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2 A letter dated April 13, 2018 from Pioneer Technical Services, Inc. addressing the capacity of the EPA water treatment plant is attached as Attachment D.
I hope that this information is useful to you. Please do not hesitate to contact me with any questions that you may have.

Thank you.

Yours truly,

Knight Piésold and Co.

[Signature]

Steven L. Lange
Senior Geochemist

Attachments:

- Figure 1: Animas River Zinc Levels
- Attachment A: SGC Mining and Reclamation Activities and Metals Loading in the Animas River
  Steven Lange, M.S., Senior Project Manager, Knight Piésold Consulting
  January 2018
- Attachment B: SGC Bulkheading and Remedial Activities
- Attachment C: The Engineered Concrete Bulkheads Installed by SGC
  February 2018
- Attachment D: Letter from Joel L. Gerhart, Pioneer Technical Services, Inc.
  To Larry Perino, Sunnyside Gold Corporation
  April 13, 2018
Figure 1
to
August 24, 2018 Letter to MSI
Figure 1: Animas Zinc Levels
Running Average Data
A-72 South of Silverton, CO

- (Ln(Zn_{A72})-(Ln(Zn_{pred}))/Standard Error
- Exceeds Target
- Meets Target

Bulkheading and Remediation + Water Treatment
= Water Quality Target MET

Water Treatment Only

Bulkheading and Remediation Only

Colorado Zinc Target

Standard Residual Zinc Levels


American Tunnel Bulkhead #2 Closed
Third Party Stock Water Treatment
Gold King Blowout
EPA Water Treatment Plant Running Effectively
Updated February 7, 2019
Attachment A
to
August 24, 2018 Letter to MSI
SGC Mining and Reclamation Activities and Metals Loading in the Animas River

by

Steven Lange, M.S., Senior Project Manager, Knight Piésold Consulting

January 2018
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EXECUTIVE SUMMARY

Metals loading adversely impacts the Animas River in the area around Silverton, San Juan County, Colorado. (Church, et al., 2007). The metals of concern include iron, aluminum, cadmium, copper, lead, zinc, arsenic, and nickel. (U.S. Geological Survey, 2007 at 7). The metals loading in the Animas River is due to acid rock drainage. (Yager and Bove, 2007). Acid rock drainage refers to acidic water that is created when sulfide minerals are exposed to air and water to produce sulphuric acid. The acidic water can dissolve area minerals and then deposit metals in rivers like the Animas. (von Guerard, et al., 2007). Metals loading in the Animas River has limited aquatic life, including the trout fishery downstream from Silverton. (Butler, et al., 2001). Sunnyside Gold Corporation (SGC) was formed and acquired the Sunnyside Mine in 1985 and mined it from 1986 until 1991 under modern environmental regulations and using modern mining techniques. Since 1985, SGC has engaged in more than 30 years of reclamation and remediation in the Silverton Caldera. This Paper analyzes the geologic setting and historic mining that have caused the metals loading in the Animas River as well as the effect of SGC’s mining and extensive reclamation activities. It is the conclusion of this Paper that it is incontrovertible that the actions of SGC have substantially reduced acid rock drainage and metals loading in the Animas from what would have otherwise been the case.

GEOLOGIC SETTING

The Sunnyside Mine is located approximately 8 miles north of Silverton, in the Eureka mining district, San Juan County, Colorado (Degraff, 2007, Figure 4). The Eureka mining district is in the northern portion of the Silverton Caldera, which is part of the San Juan Volcanic complex which was active during the mid-Tertiary (25 to 35 million years ago). The area is naturally mineralized, has been for millions of years, and forms part of the Upper Animas River basin.

San Juan Caldera: The area includes the drainage basins of three main tributaries: Mineral Creek, Cement Creek, and the Animas River. Elevations range from 9,305 feet at Silverton to more than 13,800 feet in the surrounding mountains.
A large volume of literature has been generated on the geology and mineralization of the Silverton area. Aspects of the geology are discussed by Lipman (1976), Lipman, et al. (1978), Luedke and Burbank (1987), Plouff and Rakiser (1972), Steven (1975), and Steven and Lipman (1976). Ore deposits and mineralization have been discussed by Prosser (1910), Bejnar (1957), Burbank (1940), Burbank and Luedke (1968), Casadevall and Ohmoto (1977), Fisher, et al. (1973), Grauch, et al. (1985) and others. The following summary on the regional geologic history follows the narrative discussed in Yager and Bove (2007).

The first major episode of caldera-formation associated with eruptions in the project area occurred around 28.2 Ma with the San Juan-Uncompahgre caldera complex. Eruptions associated with these structures accounted for over 1,000 km³ of volcanic materials. Around 27.6 Ma, the smaller Silverton caldera developed within the older San Juan caldera. Total volume of erupted Silverton caldera materials was approximately 50 to 100 km³. Around 26 Ma, numerous silica-rich intrusions, dikes, and stocks formed along the concentric fracture zone surrounding the Silverton caldera. Intrusions continued to occur until around 11 Ma in parts of the caldera structure. These intrusions were likely the heat sources for the mineralizing events that deposited the minerals and altered the surrounding rocks. Alteration of host rock occurred contemporaneously with these intrusions, as well as throughout much of the Miocene, with hydrothermal alteration by upwelling fluids. Secondary alteration through this time led to emplacement of many of the minerals mined in the region since the late 1800s.

The major structural feature in the area is the northeast-trending Eureka Grabben. An intricate system of radial fractures and faults, including the Ross Basin and Bonita faults, formed around the San Juan Caldera and provided the pathway for mineralizing solutions and locations for deposition on the vein deposits.

The widespread propylitic alteration in the area has affected many cubic miles of volcanic rocks throughout the Eureka district and beyond (Burbank 1960). Pyrite is ubiquitous in the propylitized rocks which forms 0.1 to 2.0 weight percent of the rock mass (Casadevall and Ohmoto, 1977). It is estimated that 100’s of million tons of pyrite is present in the rocks in the vicinity.

Through the remainder of the Tertiary to the Holocene, several processes, both geologic and climatic, were paramount in the formation of the San Juan Mountain’s rich mining history. Through much of the remainder of the Tertiary, extensive erosion resulted in the development of the canyons present in the San Juan Mountains today (Lee, 1917). The progression of erosion and canyon cutting was associated with regional uplift that was a consequence of regional tectonic events from the late Tertiary through the Pliocene. The uplifted region was prone to greater runoff from more frequent winter precipitation patterns, that, with higher gradients due to the uplift, led to the development of the deep mountain canyons and valleys present today in the San Juan Mountains (Smith and Bailey, 1968; Steven, et al., 1995). These erosional processes were key in exposing the large areas of mineralized bedrock, veins, dikes, sills, and intrusions that led to extensive mining in the region.

Natural weathering of altered and mineralized rock can be an important source of metals and acidity to surface and ground water. Weathering of the altered rock in the Upper Animas basin over the last million years provided a natural source of metals and acidity to the basin waters long before mining began. Historically, parts of Cement and Mineral Creeks were always acidic, contained
high metals loads, and likely did not support any aquatic life other than species of algae that can tolerate a pH < 4. (Church, et al., 2007). Franklin Rhonda, a topographer with the 1874 Hayden Survey who worked in the Silverton area “described the water in both Cement and Mineral Creeks as iron sulfate waters that were undrinkable.” (U.S. Geological Survey, 2007 at 4). “Pre-mining geochemical conditions in Cement Creek were not very different than they are today.” A “viable macroinvertebrate community probably did not exist in either Mineral Creek upstream from the confluence with South Fork Mineral Creek or in Cement Creek prior to mining.” (U.S. Geological Survey, 2007 at 9).

The area has been naturally discharging heavy metals for literally thousands and thousands of years. “A several-thousand year history of acidic drainage is recorded in many of the surficial deposits, where iron-rich ground water derived from pyrite weathering has infiltrated these deposits and cemented them with oxides of iron, forming what is referred to as ferricrete. These recent geologic events have exposed mineral deposits to surface weathering prior to mining.” (Degraff, 2007).

Before the first miner arrived, there was massive natural metals loading in the Animas River, which limited aquatic life, including trout populations downstream from Silverton. (Besser and Brumbaugh, 2007).

**HISTORIC MINING**

As early as the 1700’s, Spanish explorers discovered placer gold in Arrastra Creek, a tributary of the Upper Animas River. Serious mineral exploration began in the early 1870’s, following discovery of placer gold by the U.S. Army’s Baker reconnaissance team. (USGS Fact Sheet, 2007). In the 1870’s, the Upper Animas watershed became a prime location of mining activity for gold, silver, lead and copper. The area contains over 1,500 mines.¹ (USGS Fact Sheet, 1999). In addition, the area was home to over 50 separate mill sites, 8 distinct smelters, and 35 different aerial trams. (Jones, 2007, at 76)

¹ One of these historic mines was the Gold King, where, in August 2015, an EPA contractor breached an earthen plug and caused the release of over 3 million gallons of water. The released waters eroded a historic waste rock pile, washing material into Cement Creek. According to EPA, the amount of metals loading to the Animas River from the Spill was small when compared with ongoing metals loading from natural and other historic sources in the area and the impacts of the Spill on wildlife were minimal. (US EPA, 2017, Fate and Transport Report Executive Summary).
Mineral processing in the Animas River watershed were typical of those practiced throughout the West in the 19th and 20th centuries. Beginning in 1872, vein deposits were mined underground by small crews who selectively mined high-grade ore. Ore was hand-sorted and sent to smelters by mule pack train and later by wagon. Waste rock was discarded in open mine stopes or on mine-waste dumps outside the portal where the hand sorting was done. As more efficient methods of mining and milling were developed and rail transport became available, increasingly larger amounts of lower grade ore were mined and processed and additional metals recovered. For example, before 1917, the available mineral processing methods could not recover zinc so it was discarded with the other tailings. After 1917, zinc was recovered from the ore. Waste rock was disposed of in waste dumps outside the mine portal, and mill wastes were deposited into the nearest stream course. An estimated 8.6 million short tons of mill waste, about 47.5 percent of the total ore produced, was discharged directly into surface streams between 1872 and 1935. (Jones, 2007, at 80; USGS Fact Sheet, 2007).

With the arrival of mining in the upper Animas 140 years ago, drainage from mine adits, discharges of tailings to water ways, and the weathering of waste rock added to the naturally high metal and acid loads in the Animas River and its tributaries. These discharges continued long after the mines were no longer active. The total quantity of tailings generated from 1873 until 1964 is enormous. “The total amount of tailings created in the watershed in 125 years of mining is on the order of 16-18 million tons if one extrapolates from the figures from 1873 to 1964. Of this about 12 million tons is reasonably accounted for, mostly in the Mayflower Mill impounds [where impounding began in 1935].” (Nash, Undated). The majority of the remaining 4 to 6 million tons were likely directly discharged to surface drainages.
Even when tailings were impounded rather than expelled directly to area streams, significant discharges took place. In 1947, the sand wall on the Mayflower Tailing Impoundment #1 collapsed and a large quantity of waste and tailings spilled into Boulder Creek and then the Animas River. (Jones, 2007). In 1975, the main Mayflower tailings impoundment washed out, resulting in the discharge of 100,000 short tons of tailings and waste into Boulder Gulch and the Animas River. Considerable cleanup was required and Standard Metals, the owner of the property at the time, received a $40,000 fine for the incident which was the largest environmental fine in Colorado’s history. (Mayflower PRP Report, 2013). In 1978, Lake Emma broke through into the 2580 Stope on Sunnyside Mine level C and flooded the mine, stripping timbers from the main shaft, crushing equipment and filling tunnels with mud. At the Gladstone portal, an estimated 5 to 10 million gallons of water blew out the walls of the portal building. The Animas River turned black from the glacial mud and sediment well past Farmington, New Mexico. (Jones, 2007).

There was an extensive legacy of man-made, systematic, and cataclysmic discharges of metals and acidity to the upper Animas River basin prior to 1985. Before the 1970’s, there were no measurements of any of these discharge quantities, but they were clearly significant. Miners were not required to reclaim their sites until the 1970’s and most followed the acceptable practices of their time. This massive industrial mining and milling complex resulted in enormous amounts of metals loading in the Animas River, which further limited aquatic life, including trout populations downstream from Silverton. (Church, et al., 2007).

**SGC’S 5 YEARS OF MINING IN THE SILVERTON CALDERA**

SGC was formed in September of 1985 and acquired the Sunnyside Mine from Standard Metals on November 19, 1985. The Sunnyside Mine was discovered in 1873 by Ruben McNutt and
George Howard. (Bird, A.G., 1986 at 7) Standard Metals had operated the property since 1960, but by 1985 they were in bankruptcy. The mine was not commercially producing and was under a Cease and Desist Order for violations of its mining permit and two of its three water discharge permits. (NOV Ltr., Aug. 14, 1984; NOV Ltr., Oct. 23, 1984; NOV Ltr., Jan. 21, 1985; NOV Ltr., Oct. 25, 1985; NOV Ltr., Dec. 18, 1984). The third water discharge permit was under a notice of violation which, due to Standard’s neglect, matured into a Cease and Desist Order by December of 1985. (NOV, Dec. 12, 1985). Standard’s permit violations included: inadequate storm-water discharge control, lack of water treatment, unapproved disposal of pond sludge waste, a poorly constructed and inappropriately located waste rock dump, unapproved disposal of approximately 8,000 cubic yards of trash, failed revegetation, spring flow running through tailings ponds, and mining impacts in unpermitted areas including the Terry Tunnel and seven acres in the Sunnyside Basin, specifically the collapsed Lake Emma. (MLRD Inspection, July 10, 1985; MLRD Inspection, Aug. 28, 1985). Water permit violations included exceedances of cyanide, pH, zinc, total suspended solids, copper and lead discharge limits. (WQCD Ltr., Sept. 7, 1984; WQCD Ltr., Sept. 27, 1984; NOV Ltr., Oct. 23, 1984; NOV, Dec. 12, 1985).

The water treatment facilities at Gladstone were not operating and were in such a state of disrepair that SGC had to apply for bypass approval in order to remain in compliance while critical upgrades were completed. (SGC Ltr., Nov. 18, 1985; WQCD Ltr., Nov. 25, 1985). The Colorado Mined Land Reclamation Division’s (MLRD) July 10, 1985 inspection of Standard’s operation noted the following: evident that water quality above and below the site is poor; drainage control at AT (American Tunnel) is poor; water treatment not running; untreated water routed through ponds, then discharged to North Fork of Cement Creek; waste rock dump constructed with little engineering concern in a swampy area; sludge has been disposed at waste rock dump, trash improperly disposed. (MLRD Inspection, July 10, 1985). Standard Metals’ answer to these violations was to advise the regulatory agencies that Standard could not respond due to their bankruptcy filing and lack of resources. (SMC Ltr., Aug. 5, 1985).

SGC promptly brought all discharge permits into compliance, re-designed the mining operation, and completed a substantial mine permit amendment in cooperation with Colorado regulatory agencies. Specifically, SGC removed scrap iron, broken ore cars and locomotives, made drainage improvements, and constructed a new water treatment plant at Gladstone. The old dry hydrated lime feed system was replaced with a milk of quick lime and liquid flocculent system with an effluent pH control loop. The improvements resulted in a modern, efficient operation with greatly reduced environmental impacts. (SGC Ltr., April 6, 1988). As a result of SGC’s efforts, on February 29, 1988 the Colorado Mined Land Reclamation Division awarded SGC the 1987 Mined Land Reclamation Award in the classification “Most Improved Sites.” The Director wrote, “Our congratulations and appreciation for the outstanding job you have accomplished.” (MLRD, Feb. 29, 1988, Ltr. to Bergstrom).

At the time of Standard Metals’ bankruptcy filing, Standard’s reclamation bond was only $446,100. This bond was forfeited and, through litigation and bankruptcy, EPA recovered only $900,000 of additional insurance proceeds and some unwanted Standard Metals property that was conveyed to the BLM. The cost to reclaim the Sunnyside Mine and related facilities was in the millions. Standard Metals walked away from those costs. But for SGC’s presence in the basin, the Standard Metals bankruptcy would have fit the all too familiar pattern of other failed mines in the West. At the Sunnyside mine, SGC shouldered all of those costs.
SGC operated the Sunnyside Mine for only 5 years. During that time period, ore from the mine was hauled to the Mayflower Mill for processing. All tailings were retained in the upper level of Mayflower Impoundment No. 4, well clear of any groundwater infiltration or surface path to the Animas River. SGC’s activities were all regulated by the Federal and State governments and SGC’s activities were all permitted. The MLRD October 28, 1987 Inspection report of SGC’s operations noted, “The mining operation exhibited some vast improvements over the last two years. The Division would like to commend Frank Bergstrom (SGC Environmental Manager at the time) for his courteous, efficient and diligent manner with which he works with our office as well as in the field, as evidenced by the improvements noted, specifically at the Terry and American Tunnels.” (MLRD Inspection, Oct., 28, 1987).

**SGC treatment at Cement Creek**

From 1985 until 2003, SGC treated the entire American Tunnel discharge and stored the resulting sludge at the Mayflower Impoundments, even though not all of the discharge was generated from SGC property. In addition, from 1996 until 2003, SGC treated the entire flow of Cement Creek for nine months each year, removing thousands of pounds of metals from this Animas River tributary, again even though there were significant natural and third party sources of heavy metals to the Creek. This Cement Creek treatment addressed the total impact of upper Cement Creek to the Animas River, both natural and mining related. Based upon the NPDES Discharge Monitoring Reports provided to the State of Colorado, SGC’s treatment of Cement Creek between August of
1996 and December of 2002 removed over 326,000 pounds of metal from the Creek. Over this same time period, SGC’s treatment of water discharging from the American Tunnel prevented approximately 290,000 pounds of metals from entering the Creek. As a result, Cement Creek below the treatment plant had less metals loading than the Creek would have had under natural baseline conditions. SGC also operated a treatment plant at the Terry Tunnel from 1986 until SGC bulkheaded the Tunnel in 1996, removing thousands of additional pounds of potential contaminants. (NPDES Discharge Monitoring Reports (1996-2004)).

During the period of SGC’s operations, the “net” load that SGC removed from the Animas was tremendous. While SGC mined additional ore, all discharges generated were permitted, treated, or contained. Furthermore, SGC bulkheaded the entire mine upon closure. SGC operated the mine at a financial loss and the mine ultimately closed in 1991. (Bird, A.G., 1986 at 199). SGC’s five years of mining, which used modern techniques and was under the modern era of environmental regulation, substantially reduced metals loading in the Animas River from what would have otherwise been the case.

SGC’S 30 YEARS OF RECLAMATION AND REMEDIATION

SGC closed the Sunnyside Mine in 1991 and continued the remediation and reclamation activities it began in 1985 when it acquired the property. SGC’s mine permit included the notation from the Colorado DMG that “Indefinite mine drainage treatment is not acceptable as final reclamation. Please devise an alternate reclamation plan.” (MLRD Ltr., July 15, 1986). SGC and the State of Colorado agreed on a comprehensive watershed approach in which SGC would be released from obligations in exchange for installing engineered bulkheads to eliminate mine drainage from the Sunnyside Mine workings and completing numerous other reclamation projects in the region. Many of these reclamation projects were on ground never owned or operated by SGC. This agreement was memorialized in a Colorado District Court approved Consent Decree, endorsed by the Environmental Protection Agency, and approved by the Bureau of Land Management, with all regulators noting the benefit of the watershed approach to the environment. (SGC Consent Decree, 1996). SGC successfully completed all tasks called for by the Consent Decree and the Colorado Water Quality Division confirmed as much on February 26, 2003. “Each criterion in the termination assessment has been successfully accomplished. Therefore, the Division has concluded that there has been Successful Consent Decree Completion.” (WQCD, February 26, 2003, Letter to SGC). SGC’s primary reclamation activities are summarized below, with some “before and after” photos provided to illustrate the efficacy of the efforts undertaken.

a. Historic Mayflower Impoundment #1—SGC moved the impoundment toe back from Boulder Creek and the highway to minimize the potential for erosion and migration. SGC flattened the side slopes to increase stability and potential for re-vegetation, regraded to promote drainage, capped with subsoil, and seeded.
b. **Historic Mayflower Impoundment #2**—SGC moved the impoundment toe back from Boulder Creek to minimize erosion and migration potential. SGC flattened the side slopes to increase stability and the potential for re-vegetation, regraded the top to promote drainage, capped with subsoil, and seeded.
Mayflower Tailings pond 2, 1991

Mayflower Tailings pond 2, 1995
c. Historic Mayflower Impoundment #3—SGC regraded the top to promote drainage, capped with subsoil, and reseeded.

d. Mayflower Impoundment #4—SGC excavated and relocated approximately 80,000 tons of mostly historic mine waste and historic tails to Mayflower Impoundment #4, regraded the area, and re-seeded. SGC improved the intercept and diversion drains and placed a concrete diversion wall to divert groundwater to surface and around the tailings material. SGC also installed a lined toe ditch.

Mayflower Tailings ponds 3 and 4, 1992
Mayflower Tailings ponds 3 and 4, 1995

e. **Mayflower Mill Area**—SGC cleaned the site, contoured and seeded. SGC ultimately donated the Mill to the San Juan Historical Society along with $120,000 and nearby property. The mill is now on the National Register of Historic Sites and operated as a historical tour by the San Juan Historical Society.

f. **Eureka Tailings**—SGC removed 112,000 cubic yards of historic finely ground tailings, which are more geochemically active, from the banks and floodplain of the Animas River and its tributaries and relocated them to the Mayflower Impoundments. ([Vincent and Elliot, 2007 at 934](#)).

g. **American tunnel mine waste and tailings**—SGC removed 80,000 tons of mostly historic mine waste and tails.
h. Longfellow-Koehler Project—SGC opened a caved adit and removed 32,000 cubic yards of mine waste and pond sediments, consolidated other waste to reduce footprint, added neutralizing materials to the area, covered the area with overburden, seeded, and constructed surface water diversion to divert upland flow around the site.
Longfellow Mine, 1996.


i. Boulder Creek Tailings—SGC removed 5,700 cubic yards of tailings from the Boulder Creek and Animas River flood plain.
j. Pride of the West Tailings—SGC excavated 84,000 cubic yards of historic tailings and relocated 45,000 cubic yards to an on-site tailings impoundment and the remainder to the Mayflower Tailings Impoundment #4. SGC conducted a geotechnical study, installed a toe drain, and contoured to the slope. SGC capped the impoundment with overburden, fertilized, and seeded. SGC partially rebuilt and planted a wetland.

![Pride of the West, 1996](image1)

![Pride of the West, 1999](image2)
k. Lead Carbonate Tailings Impoundment Removal—SGC relocated 27,000 cubic yards of tailings to Mayflower Impoundment #4, regraded, neutralized, and reseeded the area.
1. Lime injection—SGC injected approximately 1.3 million pounds of hydrated lime into the interior workings of the Sunnyside Mine to increase alkalinity.

m. Gold Prince Mine Waste and Tailings—SGC installed two closure bulkheads, relocated historic tails and ash piles into lined containment within a consolidated waste pile that was relocated away from stream flows, covered removal areas with overburden, and seeded.

n. Ransom adit drainage—SGC opened the caved in adit, designed and installed a bulkhead to eliminate drainage, graded the portal area, and seeded.

o. Mayflower Hydraulic Controls—SGC designed and installed three interception structures to capture and transport stormwater and groundwater around Mayflower Impoundment #1 and the Mayflower Mill area to prevent contact and infiltration with tailings and waste rock.

p. Sunnyside Basin—SGC placed 240,000 cubic yards of clean fill to cover the Lake Emma subsidence area and to create positive drainage, contoured the area, and seeded.
q. American Tunnel portal—SGC removed surface facilities, constructed a diversion ditch, stabilized the bank of Cement Creek, re-contoured, and seeded.

r. Mogul adit and Koehler Tunnel Bulkheads—SGC funded the placement of bulkheads in the Mogul Adit and Koehler Tunnel.

s. Mayflower Passive Treatment Wall—SGC constructed a passive treatment wall for groundwater, leaving a wetland near the southwest corner of the historic lower deposits in Tailings Impoundment #4.

t. Power Plant Tailings—SGC picked up tailings previously reclaimed along the Animas River in the vicinity of the old Power Plant and consolidated these into TP4.

u. Bulkhead Installation—with oversight and approval of all relevant agencies, between 1992 and 2002, SGC installed a series of 9 engineered concrete bulkheads in the Sunnyside Mine, and the Terry and American Tunnels to isolate the mine workings from other workings in the area and to prevent water flow from the Sunnyside Mine workings into the Animas River. The bulkheads were always expected to return the local water table towards its natural, pre-mining level. (See SGC, August 24, 2015 Letter).

In recognition of this reclamation, the Colorado Division of Minerals and Geology gave SGC its Reclamation Award for the work completed at the Mayflower Mill and the Sunnyside Mine.
“Congratulations to you and your organization for a job well done.” (MLRB, 1995, Letter to Goodhard).

In addition to the work summarized above, SGC has voluntarily participated with the Animas River Stakeholders Group (ARSG) to evaluate and implement projects since 1994. Utilizing their own expertise as well as a number of State and Federal agencies, the group prioritized various contributing sources to the Upper Animas based on an analysis of factors such as the amount of each contaminant, physical attributes, accessibility to power, and proximity to streams, wetlands, and avalanche paths. Eventually, 400 sites were identified as priorities. Further analysis revealed that 67 of these historic mining sources accounted for 90 percent of the metals contamination from all mining sources. This comprehensive prioritization approach proved successful and led the Colorado Department of Public Health and Environment (CDPHE) to implement 27 realistic Total Maximum Daily Load standards based on partial remediation of the priority sites. ARSG implemented many of these projects utilizing 319 grants, and SGC expenditures and participation provided a portion of the in-kind match required under that program. SGC also provided a disposal area for one of the projects.

SGC and ARSG were successful in removing 70% of the copper and 50% of the zinc in Mineral Creek. (ARSG, May 2013, Animas Watershed Plan). The USGS analysis concluded that the “remediation project at sites 79-80 (Fig. 11) resulted in long-term reductions of the copper concentration and significant improvement in copper load in Mineral Creek (Fig. 14A). A similar reduction in zinc (and cadmium) concentrations is also evident (Fig. 14B).” (Church, S.E., Owen, J.R., et al., 2007). SGC’s 30 years of remediation and reclamation substantially reduced ongoing metals loading in the Animas River from what would have otherwise been the case.

**CONCLUSION**

Metals loading in the Animas River is the result of the geologic setting and more than a century of historic mining in the area. The Silverton Caldera is highly mineralized, and acid rock drainage and poor water quality in the area was always prevalent given the natural generation of significant quantities of heavy metals. There was also an extensive legacy of man-made, systematic, and cataclysmic discharges of metals and acidity to the Upper Animas River basin prior to 1985. It is incontrovertible that both SGC’s five years of mining between 1986 and 1991, which used modern techniques and was under the modern era of environmental regulation, and SGC’s 30 years of remediation and reclamation in the Silverton Caldera each substantially reduced metals loading in the Animas River from what would have otherwise been the case. But for the actions of SGC, metals levels in the Animas River, and the resulting impacts on aquatic life, including the trout fishery downstream of Silverton, would undoubtedly be more adverse.
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Author Biography

Steven L. Lange:

Steven Lange is the Director of the Geochemistry, Groundwater and Surface Water Group at Knight Piésold USA. He brings over 40 years of experience related to investigation, evaluation, and remediation of mining and industrial sites throughout the world. He has conducted baseline environmental studies, geochemical evaluations, ARD assessments, and geochemical modeling for feasibility, operational, closure, and remedial investigation studies at mine sites in the USA, Canada, Europe, South America and the Philippines. Mr Lange has been studying and evaluating mineral deposits in the San Juan Mountains of Colorado since 1976. Steven has several publications on site investigation and modeling and has a B.S. in geology and an MS in geochemistry from Kansas State University.
Attachment B

to

August 24, 2018 Letter to MSI
SGC Bulkheading and Remedial Activities

a. **Eureka Tailings**—SGC removed 112,000 cubic yards of historic finely ground tailings, which are more geochemically active, from the banks and floodplain of the Animas River and its tributaries and relocated them to the Mayflower Impoundments.

b. **American tunnel mine waste and tailings**—SGC removed 80,000 tons of mostly historic mine waste and tails.

c. **Longfellow-Koehler Project**—SGC opened a caved adit and removed 32,000 cubic yards of mine waste and pond sediments, consolidated other waste to reduce footprint, added neutralizing materials to the area, covered the area with overburden, seeded, and constructed surface water diversion to divert upland flow around the site.

d. **Boulder Creek Tailings**—SGC removed 5,700 cubic yards of tailings from the Boulder Creek and Animas River flood plain.

e. **Pride of the West Tailings**—SGC excavated 84,000 cubic yards of historic tailings and relocated 45,000 cubic yards to an on-site tailings impoundment and the remainder to the Mayflower Tailings Impoundment #4. SGC conducted a geotechnical study, installed a toe drain, and contoured to the slope. SGC capped the impoundment with overburden, fertilized, and seeded. SGC partially rebuilt and planted a wetland.

f. **Lime injection**—SGC injected approximately 1.3 million pounds of hydrated lime into the interior workings of the Sunnyside Mine to increase alkalinity.

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j. **Sunnyside Basin**—SGC placed 240,000 cubic yards of clean fill to cover the Lake Emma subsidence area and to create positive drainage, contoured the area, and seeded.

k. **American Tunnel portal**—SGC removed surface facilities, constructed a diversion ditch, stabilized the bank of Cement Creek, re-contoured, and seeded.

l. **Mogul adit and Koehler Tunnel Bulkheads**—SGC funded the placement of bulkheads in the Mogul Adit and Koehler Tunnel.
m. **Mayflower Passive Treatment Wall**—SGC constructed a passive treatment wall for groundwater, leaving a wetland near the southwest corner of the historic lower deposits in Tailings Impoundment #4.

n. **Power Plant Tailings**—SGC picked up tailings previously reclaimed along the Animas River in the vicinity of the old Power Plant and consolidated these into TP4.

o. **Bulkhead Installation**—with oversight and approval of all relevant agencies, SGC installed a series of engineered concrete bulkheads to isolate the Sunnyside mine workings from other workings in the area and to prevent water flow from the Sunnyside Mine workings into the Animas River. The bulkheads were always expected to return the local water table towards its natural, pre-mining level.
Attachment C

to

August 24, 2018 Letter to MSI
The Engineered Concrete Bulkheads Installed by SGC
I. EXECUTIVE SUMMARY

The installation of engineered bulkheads is often part of Best Management Practices for final mine closure. The engineered concrete bulkheads installed by SGC in the Bonita Peak area for purposes of environmental remediation are stable and performing as designed. As intended, and as approved by the State of Colorado and EPA, the bulkheads have isolated the interior workings of the Sunnyside Mine and caused the water table to return toward natural levels, resulting in the expected increase in flows from springs, seeps and adits. As recently recognized by multiple engineering experts, the engineered bulkheads are completely stable and there is no appreciable risk of catastrophic failure.

II. BULKHEADING OF MINES FOR ENVIRONMENTAL REMEDIATION

Placement of engineered bulkheads in draining mine adits for environmental remediation is a Best Management Practice for final mine closure. In the right geologic setting, this practice isolates mine drainage water from direct contact with surface waters, establishes an approximation of the pre-mining phreatic surface, and minimizes the oxygen available for chemical reaction. An added benefit of engineered bulkheads is the protection of surface waters from blowouts caused when flow blockages occur due to collapsed and unmaintained mine workings that may be suddenly released when internal pressure exceeds the structural capabilities of the blockage.

The reestablishment of the pre-mining phreatic surface allows waters to return to their pre-mining flow paths emerging as seeps and springs that existed prior to mining, rather than draining through exposed mine workings. The seeps and springs that are located away from surface flows most likely undergo metals reductions when oxygenated after surfacing and migrating towards surface flow paths, creating ferricrete deposits that exist naturally in mineral rich environments.

For a general discussion of the positive impacts of bulkheading, please see information contained at http://www.miningfacts.org/Environment/What-is-acid-rock-drainage/. Additionally, the Global Acid Rock Drainage (GARD) Guide discusses, at length, the benefits of the well-reasoned use of bulkheads. For example:

When decommissioning an underground mine, knowledge of the areas within the mine that are geochemically most reactive and knowledge of water ingress and discharge locations will enable design and implementation of a rational ARD management plan aimed at controlling the flow of water to minimize water quality deterioration. This process would involve construction of seals [bulkheads] and also perhaps reinforcing of some areas in advance of flooding to accommodate water flow. Use of seals and reinforcements is a good example of prevention and minimization by design. See http://www.gardguide.com/index.php?title=Chapter_6
Furthermore, as noted in the March 2016 Deere & Ault report commissioned by EPA:

Water impounding concrete bulkheads installed at strategic locations in draining and discharging underground mine workings have the potential to flood the workings and create a mine pool that will eventually establish a ground water system with water table and flow paths similar to the pre-mining system. Saturation of sulfide minerals in the flooded workings and country rock will create relatively anoxic conditions and limit the generation of ARD. Bulkhead installation eliminates rapid and continuous collection and discharge of ground water through open mine workings and minimizes direct discharge of ARD from mine portals….Bulkhead installation in mines that are determined to be good candidates has the potential to significantly reduce metal loading to receiving streams. (May18, 2015 DRMS report at 1-2).

Without question, in mines such as the Sunnyside Mine, bulkheads are a crucial component of safe and effective environmental remediation.

III. THE ENGINEERED BULKHEADS INSTALLED BY SGC

   A. Description of the Engineered Bulkheads.

Numerous engineered bulkheads have been installed in the Bonita Peak area specifically for the purpose of environmental remediation. SGC installed nine engineered bulkheads in connection with the closure of the Sunnyside Mine between January 1994 and November 2001. EPA has since recently installed a bulkhead at the Red and Bonita Mine.

Three of the SGC-installed engineered bulkheads were placed within the American Tunnel, the lowest drainage pathway from the interior workings of the Sunnyside Mine to surface. The most interior American Tunnel bulkhead (Bulkhead #1) was placed to isolate the interior mine workings from the surface. This bulkhead also isolates the SGC owned property from downstream portions of the American Tunnel owned by others. The next interior engineered bulkhead (Bulkhead #2) was placed down gradient of a water-bearing fracture zone to isolate the flows from this zone and return them to their natural path. The most near-surface engineered bulkhead (Bulkhead #3) is on BLM ground and was placed to capture water entering the American Tunnel from the near-surface fracture system.

Two of the SGC-installed engineered bulkheads were placed in the Terry Tunnel, the upper level main drainage pathway from the interior workings of the Sunnyside Mine to the surface. The interior engineered bulkhead was placed to isolate the interior mine workings from the surface. The near-surface bulkhead was placed to isolate any inflows to the tunnel downstream of the interior bulkhead.
Additionally, SGC installed four engineered bulkheads to isolate the interior workings of the Sunnyside Mine from the Brenneman and Mogul workings.

**B. Engineering and Installation of the Bulkheads.**

The engineered bulkheads installed by SGC were all designed by John F. Abel, Jr. PhD, a retired professor from the Colorado School of Mines. The engineered bulkheads were designed as reinforced concrete deep beam structures using American Concrete Institute Code Requirements. This same design was largely utilized by EPA for the Red and Bonita bulkhead. The SGC-installed bulkheads were designed for maximum possible head (surface elevation), using appropriate construction materials for the exposure conditions and the environment. Each of the SGC-installed engineered bulkheads was specifically designed to be stable for any predictable earthquake loading.

As part of the installation process, Dr. Abel did a pre-pour inspection on all bulkheads and was on-site during the majority of the concrete pours. Expert experienced underground miners conducted the installation. Colorado’s Division of Reclamation Mining and Safety (DRMS) also did a pre-pour inspection on each of the bulkheads. DRMS commented that the locations chosen were ideal for bulkhead installation.

**C. The 1996 Consent Decree**

SGC was formed and acquired the Sunnyside Mine in 1985 and mined it from 1986 until 1991 using modern techniques and under the modern era of environmental regulation. Due to state and regulatory approval, and approval from engineering experts, it was clear that the installation of engineered bulkheads was perfectly suited as a Best Management Practice for final closure of the Sunnyside Mine. It was recognized that the engineered bulkheads would return the water table toward natural levels, resulting in an expected flow increase from springs and seeps. A legal question arose as to the permitting of these resulting increased flows. As part of the resulting legal process, and aware that bulkheading would cause additional flows elsewhere, SGC and the State of Colorado entered into a comprehensive settlement agreement that took the form of a Court-approved Consent Decree. The installation of engineered bulkheads in the American and Terry Tunnels was required by the Consent Decree. In consideration of SGC’s installation of these bulkheads and related remediation activity, Colorado, acting under EPA vested authority, agreed not to sue or take any administrative action against SGC for future seeps or springs that might emerge or increase as a result of SGC’s activities. EPA had a significant role in the Consent Decree’s development and implementation. EPA encouraged the Consent Decree and applauded its results. EPA’s retained expert on the issue stated “Technically, the plan [utilized in the Consent Decree] makes sense and has merit, and I encourage its implementation without further, long-term discussion.” SGC completed all of the requirements of the Consent Decree, which included the installation of the engineered bulkheads in the American
and Terry Tunnels and, in 2003, the Court discharged SGC’s remedial obligations with respect to the Sunnyside Mine.

D. The Engineered Bulkheads are Stable and Performing as Designed

It is clear that the SGC-installed bulkheads are stable and performing as designed, and no further study is necessary to support this fact. Multiple experts have recently reviewed the bulkheads in the American Tunnel, which are considered the most critical. These experts, including experts retained by EPA, have concluded that the bulkheads were well-constructed, are working as designed, and that catastrophic failure leading to a large release of water is extremely unlikely.

For example, a 2016 Deere & Ault study commissioned by EPA concluded that “Shear failures in the bulkheads are highly unlikely . . . [and that] ...[s]tructural failures would be very unlikely.” The report specifically stated:

We have reviewed the design and as-built reports for all three American Tunnel bulkheads and generally concur with their stated capacities. . . .

Based on their design pressures, the American Tunnel Bulkheads are unlikely to fail in a catastrophic manner. If water pressures were higher than expected, the most likely consequence would be increased seepage past the bulkheads and through the rock mass.

Further, attached hereto as Exhibit A is a report recently prepared by Stephen Phillips of Phillips Mining Geotechnical & Grouting LLC. Mr. Phillips has extensive, worldwide experience with bulkheads and is a leading expert in the field. His report discusses in detail the design and construction of the American Tunnel Bulkheads and reaches the same conclusion as Deere & Ault: “It is my opinion that the design and construction of the bulkheads were carried out adequately and that a catastrophic disruptive shear failure leading to a large release of water is extremely unlikely.” Further, Mr. Phillips specifically concludes that, because the bulkheads were constructed to “potential head conditions”, further study on the likelihood of a catastrophic failure would be unnecessary and unwarranted.

IV. CONCLUSION

The engineered concrete bulkheads installed by SGC in the Bonita Peak area for purposes of environmental remediation are stable and performing as designed. As intended and designed, and as approved by the State of Colorado and EPA, the engineered bulkheads have isolated the interior workings of the Sunnyside Mine and have returned the water table toward natural levels. This has resulted in the expected increase in flows from springs and seeps which has, as anticipated, increased flows from unbulkheaded adits. There is no credible evidence to the contrary. The engineered bulkheads are completely stable, and, as recognized in the recent written
opinions of multiple experts, there is no appreciable risk of catastrophic failure. Any suggestion to the contrary would be baseless and irresponsible.
Exhibit A

To

The Engineered Concrete Bulkheads Installed by SGC
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THE AMERICAN TUNNEL BULKHEAD STABILITY
ANALYSIS AND REPORT.

1. INTRODUCTION

I have been asked to evaluate certain existing data (described herein) and offer an opinion as to the stability of the bulkheads in the American Tunnel, and specifically, the likelihood of a catastrophic bulkhead failure, as defined as an “in tunnel” disruptive shear or structural failure of the bulkhead leading to a large release of water.

The construction of the three bulkheads in the American Tunnel was a mitigation project completed as part of a “Consent Decree” involving Sunnyside Gold Corporation and the State of Colorado aimed at segregating the Sunnyside Mine workings from other workings in the area and minimizing the flow of mine-impacted water from the American Tunnel to Cement Creek. The purpose of these three bulkheads, together with other bulkheads built previously in interconnected mine workings, was to restore the post-mining hydrology as best as possible to that which existed prior to mining. The bulkheads were designed and located to prevent the movement of groundwater through the low resistance mined openings as was occurring prior to the bulkhead construction.

As well as minimizing the flow of water through existing mine workings, it was intended that impounding the water would significantly reduce the oxidation rate of sulfide minerals that were previously exposed to air in the abandoned stopes, drifts and tunnels. This process would minimize the eventual production of sulfuric acid and the metallic and sulfate ion contamination of the water draining from the American Tunnel.

This review is based mainly on annotated projections of the Sunnyside Mine, on a report and a letter report, both authored by Dr. John F. Abel Jr. entitled, “Bulkhead Design for the Sunnyside Mine” dated March 10, 1993 and, “American Tunnel Bulkheads #2 and #3”, dated January 15, 2001, respectively. The reports, drawings and other
miscellaneous data and exchanges were provided by Sunnyside Gold Corporation personnel, at least one of whom was active in the construction of the bulkheads.

The American Tunnel was originally driven (by others) 6,233 feet northeastward from the portal as a deep level exploratory and potential development access for the Gold King Mine. The American Tunnel was never connected to the Gold King Mine workings about 850 feet above the Tunnel (see Attachment 1, showing the location of the American Tunnel relative to other mine workings in the area). Between 1960 and 1961, the tunnel was extended to the Sunnyside Mine workings to provide egress, ventilation, and ore haulage for that mine. The approximate portal elevation is 10,600 feet and the total length of the tunnel is approximately 10,450 feet (Reference 1).

The first of the three bulkheads to be constructed in the American Tunnel was Bulkhead Number 1 at elevation 10,668 feet. This bulkhead was placed near Sunnyside’s property boundary. The ground cover over the bulkhead at this location is about 2,130 feet and the hydrostatic head used in its design was 1,550 feet (670 psi). This bulkhead is 25 feet long and located 7,950 feet from the American Tunnel portal and about 500 feet downstream of two ore passes (likely to be at least partially plugged) that connect the American Tunnel to upper levels of the mine, and 2,486 feet downstream from a shaft station. There are no other mined connections to the upper levels of the mine between these two ore passes and the American Tunnel Portal.

From private communications (Reference 2), the water flow through the portion of the tunnel where Bulkhead Number 1 is located was relatively steady throughout the year at about 1,700 gpm. After completion of this bulkhead in 1996, the hydrostatic head buildup behind the bulkhead was monitored for 5 years until steady state was reached. At this time, the phreatic level in the mine had risen to elevation 11,666 feet, resulting in a hydrostatic head of 998 feet (432 psi) on the bulkhead. In 2002, the State of Colorado noted that “the mine tunnel seal in the American Tunnel, initially placed in 1996, has functioned and continues to function as designed while the mine pool has risen behind the plug to the point of physical equilibrium.”
The next bulkhead to be constructed was Bulkhead Number 2, some 5,950 feet downstream (closer to the American Tunnel Portal) from Bulkhead Number 1. The ground cover over the bulkhead at this location is 762 feet and the hydrostatic head used in its design was 640 feet (277 psi). This bulkhead is 10 feet long and was constructed to impound leakage, if any, through or passing around Bulkhead Number 1 together with any water that was produced over the 5,950 feet of tunnel between the two bulkheads. The majority of the total inflow of about 850 gpm of water that was impounded by Bulkhead Number 2 issued from a 200+ feet wide fractured/faulted zone that itself produced about 650 gpm.

Bulkhead Number 2 was completed at the end of August 2001 when the valve on the drainage pipe was closed. The last time the pressure on this bulkhead was recorded, 8.5 months after its completion, the hydrostatic head on it was 376 feet (163 psi) and leakage through or passing around the bulkhead was reported as being minimal. Based on the recorded build-up of head on this bulkhead with time and extrapolating the data, it is considered most unlikely that under the same conditions, the final steady state hydrostatic head exceeded 392 feet (170 psi).

Prior to the construction of Bulkhead Number 2, it was anticipated that some time after its completion and the buildup of hydrostatic head behind it, there might be an increase in flow in Cement Creek. The mechanism for this potential increase was water flow from the pressurized section of tunnel up to surface through the relatively permeable 200 feet wide fractured/fault zone located 1,000 to 1,200 feet upstream of Bulkhead Number 2. Not surprisingly, this flow increase was not observed because the final head on the bulkhead was insufficient to raise the phreatic head some 640 feet up to the ground surface.

The third bulkhead (Bulkhead Number 3) was constructed 1,625 feet downstream from Bulkhead Number 2 and is located 375 feet from the American Tunnel Portal. The ground cover over the bulkhead at this location is 160 feet and the hydrostatic head used in its
design was 773 feet (335 psi). This bulkhead is 11 feet long and was constructed to impound the water produced in the tunnel from “generalized increased joint permeability” in the rock between it and Bulkhead Number 2. From the available records, this produced water amounted to about 450 gpm.

Shortly after the completion of Bulkhead Number 3 in December 2002, the portal of the American Tunnel was backfilled around a pipe that was installed to drain any water finding its way into the 375 feet of tunnel between the bulkhead and the portal. Thus, there was only access to this bulkhead for a short period of time and no direct long-term monitoring or observation of its performance.

Sometime in 2003, the portal of the American Tunnel was reopened and additional grouting was carried out. The report on site reclamation activities for the period April 2003 to March 2004 records this as follows. “Reopening the American Tunnel and performing maintenance work (grouting) of the American Tunnel downstream of the No. 3 Bulkhead. Seepage from the remaining tunnel occurred after closure, as the water table in the mountain was re-established. The remaining tunnel provided a path for the near surface fracture system to drain to surface. Work on this project was not completed due to winter conditions.”

Currently, there are three engineered bulkheads in the American Tunnel between the Sunnyside Mine’s boundary and the American Tunnel Portal. The location of the American Tunnel bulkheads is shown in Attachment 2.

2. BULKHEAD STABILITY AND FAILURE DESIGN CONSIDERATIONS.

In most situations, the optimum shape for an underground bulkhead is one with parallel sides that conforms to the cross section of the existing excavation, as documented by Garrett and Campbell Pitt, Lancaster (References 3, 4 and 5) and more recently by Auld (Reference 6). In most drill and blast excavations, the surface of the exposed rock is very irregular and so it is not necessary to provide additional load transferring devices such as
tapers or hitches. A parallel-sided bulkhead requires the minimum of additional excavation and is usually the simplest type of bulkhead that satisfies the necessary design requirements for a bulkhead.

To help ensure the integrity of a bulkhead, maximize its effective life and protect public safety and the environment, a bulkhead design should incorporate the following features;

- **Optimize its location.** The long-term performance of any bulkhead depends greatly upon the choice of bulkhead location and should be constructed at the most appropriate site to achieve the desired performance. The optimum bulkhead location is one in which the conditions are stable, the surrounding rock is competent, has a low permeability, is preferably in an area of low seismic activity and is free from major geological features such as faults, shear zones, veins, etc. In addition, the bulkhead site should be remote from highly stressed areas and other mined openings. It is not always possible to find the perfect bulkhead site. However, an imperfect site may become acceptable by modifying the bulkhead configuration or the ground treatment around it, and/or employing higher factors of safety to accommodate the existing conditions.

- **Use appropriate factors of safety.** Bulkhead designs should be based on the “best available technology” and appropriate factors of safety that result in the most effective closure for the actual site conditions. In particular, it is important to ensure the following:
  - That the bulkhead structure itself can withstand the stresses applied to it under both normal operating conditions and those associated with potential seismic events.
  - That the stresses on the contact between concrete and rock are within the allowable limits for the weaker material, such that the bulkhead can safely generate the necessary shear resistance to withstand the applied hydrostatic head.
  - That the hydraulic gradient across the bulkhead is sufficiently low such that leakage around the bulkhead is minimal.

- **Use appropriate techniques and durable materials in the bulkhead construction.** Bulkheads that are used to impound water should be designed and constructed to
minimize leakage from the flooded mine through and around the bulkheads and be
resistant to chemical attack by any deleterious substances or aggressive water that is
impounded by it.

To achieve these objectives, particularly for a long-term mine closure, the design
approach adopted should incorporate appropriate factors of safety and use the most
suitable techniques and durable products that are in current use to minimize the potential
degradation of the bulkhead in the environment in which it has to function.

3. AMERICAN TUNNEL BULKHEADS.

3.1 Bulkhead Location

According to Dr. Abel’s reports, the bulkhead locations were chosen to maximize the
length of natural low resistance hydraulic flow paths (the mined openings) and to minimize
the potential for water leakage through the jointed rock adjacent to the bulkheads.

From the available information, it appears that there are no major geological features
present at or near any of the American Tunnel Bulkheads. The closest major feature
appears to be a fault that is located between Bulkhead Numbers 1 and 2, and that is
about 4,800 feet downstream from the former and 1,000 feet upstream of the latter
bulkhead.

The three bulkheads in the American Tunnel are all remote from the nearest mine
opening. The lowest level of the Gold King Mine is about 850 feet vertically above the
central section of the American Tunnel and any significant workings of the Sunnyside
Mine working are over 2,000 feet inby of Bulkhead Number 1 and several hundred feet
above.
According to the records, the three locations in the American Tunnel chosen as the sites for the bulkheads were generally dry, thus indicating that the rock at the three sites had relatively low permeability.

Based on the descriptions of the conditions at the three sites chosen for the American Tunnel bulkheads, the choice of the bulkhead sites was appropriate to achieve the desired performance and will not have adversely influenced their long-term performance.

3.2 Factors of Safety.

The three American Tunnel bulkheads were designed as parallel sided, reinforced concrete bulkheads. The choice of parallel-sided bulkheads was very appropriate for those to be constructed in the American Tunnel. Parallel-sided bulkheads achieve resistance to the applied wet end hydrostatic pressure through mechanical interlock with the rough excavation face of the surrounding rock and can be constructed with just plain or reinforced concrete. The plain concrete bulkhead must be long enough such that the bending stresses in the concrete at the downstream end of the bulkhead do not exceed the allowable flexural tensile strength of the concrete. The reinforced concrete bulkhead incorporates steel reinforcing bars placed close to the downstream end of the bulkhead to carry the flexural tensile stresses. In general, parallel sided, reinforced concrete bulkheads are shorter than parallel sided, plain concrete bulkheads unless the bulkhead length is dominated by other controlling factors.

Table 1 provides details of the design parameters for the three bulkheads and includes the various design Factors of Safety against structural failure and leakage given in the design documents. The concrete mix design chosen for the bulkheads had an unconfined compressive strength of 3,000 psi. The concrete strength controls the shear analyses because of the higher rock strength as determined from tests performed at the American Tunnel Bulkhead Number 1 site. At this site the rock strength ranged from 3.5 to 8 times the concrete strength.
The design factors of safety on the structural aspects of the bulkheads conform to the American Concrete Institute ACI Building Code Requirements for Reinforced Concrete ACI 318-89. This required the use of the appropriate strength reduction factors together with the requirement that intensifying factors be applied to the maximum dead or fluid load that is resisted by the reinforced concrete deep beam structure. The design for the critical deep beam flexural stresses is based upon either vertical or horizontal rebar (whichever span is the larger) but in practice these stresses are resisted by two-way (both horizontal and vertical) rebar reinforcement, thus essentially doubling these design factors of safety.

The design earthquake loading on the bulkheads is based on the sum of the mass of water that has line-of-sight path to the bulkhead and the mass of the bulkhead itself that are accelerated by 0.087g maximum credible horizontal earthquake component. The ACI earthquake design procedure for reinforced concrete structures was used to determine the actual structural requirements of the bulkheads to resist the earthquake loading. Subsequently, in 2014, the maximum potential earthquake acceleration for the regional setting of the Sunnyside Mine was upgraded. This area was designated by USGS as a zone with a Seismic Hazard of 2% probability of exceeding a peak ground acceleration of 14-20% g (0.14g to 0.2g) in a 50 year period (Reference 7).

Three “rings” of holes were specified in the design report to be drilled relatively equally spaced (about 6 feet apart) along the 25 feet length of Bulkhead Number1. Each “ring” was to consist of 7 holes, 3 in the back and 2 in each side with a spacing of about 5 feet between holes. No holes were specified to be drilled to the concrete/rock contact in the floor. Based on the grout hole requirement for other relatively short bulkheads installed in the Sunnyside Mine and designed by Dr. Able, it seemed likely that the American Tunnel Bulkheads Numbers 2 and 3 would have only one “ring” of 7 similarly spaced holes that intercepted the concrete/rock contact in the back and ribs in the center of the 10 and 11 feet long structures.
The order in which the holes were to be drilled and grouted was not specified, only that they were to be drilled to the concrete/rock contact and grouted. Grout mix designs were not mentioned, but cement was to be used. No cement type was specified. Grouting pressures for Bulkhead #1 could range between a minimum of 100 psi and a maximum of 500 psi whereas grouting pressures for the other two American Tunnel bulkheads were not specified (possibly between 100 and 200 psi, based on that quoted for other relatively short bulkheads installed in the Sunnyside Mine and designed by Dr. Abel).

Grouting was specified to continue until refusal at the selected grouting pressure, but not less than the minimum specified 100 psi. If grout acceptance continued after the injection of two bags of cement without reaching the minimum grout pressure, grouting was to be continued in a new hole. If grouting in any one hole was deemed unsatisfactory, it was to be redrilled and re-grouted one day later. The process of cycling through the holes on each bulkhead had to continue until grout pressure either built up to the minimum pressure, or grout leaked at the free bulkhead face.

At the completion of the grouting, the holes were to be filled with grout and abandoned.

Based on the grouting program that was specified and applied to just the concrete/rock contact and the grouting pressures that would be used, it was established that the bulkhead should be capable of withstanding a hydraulic gradient of 41 psi/ft with minimal leakage.
### Table 1. Design Factors of Safety on Structural and Leakage Aspects of the American Tunnel Bulkheads

<table>
<thead>
<tr>
<th>B’head</th>
<th>Design Length (feet)</th>
<th>Design Head (feet) [psi]</th>
<th>F.S.* Design Hydraulic Gradient</th>
<th>F.S. Critical Section Shear</th>
<th>F.S. Rock/Concrete Contact Shear</th>
<th>F.S. **</th>
<th>F.S. *** E’quake Outby (Inby)</th>
<th>F.S. Deep Beam Bend Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>25</td>
<td>1550 [670]</td>
<td>1.53</td>
<td>1.48</td>
<td>1.26</td>
<td>**</td>
<td>1.26 (***)</td>
<td>1.01</td>
</tr>
<tr>
<td>#2</td>
<td>10</td>
<td>640 [277]</td>
<td>1.48**</td>
<td>1.48</td>
<td>1.16</td>
<td>1.204 (1.12)</td>
<td>1.03</td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td>11</td>
<td>773 [335]</td>
<td>1.35</td>
<td>1.51</td>
<td>1.08</td>
<td>1.24</td>
<td>1.02</td>
<td></td>
</tr>
</tbody>
</table>

* Based on allowable hydraulic gradient of 41 psi/foot

** Arithmetic error, actual F.S. is 1.41.

*** Quoted F.S. based on earthquake acceleration 0.085g.

**** This value not given.

As noted in Dr. Abel’s reports, the ACI code requires the application of strength reduction factors for reinforced concrete in flexure resulting in an actual minimum factor of safety of 1.56 against flexure. In addition, the design for the deep beam flexural stresses is based upon either vertical or horizontal rebar (whichever span is the larger), but in practice these stresses in bulkheads are resisted by two-way (both horizontal and vertical) rebar reinforcement, thus essentially doubling these design factors of safety.

In the case of shear, these ACI required factors result in an actual minimum factor of safety against shear of 1.65. These built-in factors of safety are not reflected in the quoted factors of safety given in Table 1, thus effectively increasing the relatively low values quoted there for flexural and shear stresses.
These modifications to the factors of safety that provide actual factors of safety apply not only to the deep beam bending stresses, but also to earthquake loading. Under these conditions the latter factors of safety are acceptable even under the new, increased, maximum potential earthquake acceleration designated by USGS in 2014 for the regional setting of the Sunnyside Mine.

3.3 Appropriate Techniques and Durable Products.

As noted above, the American Tunnel Bulkheads should be designed and constructed using applicable methods and be resistant to chemical attack by the aggressive water that is impounded by them. To achieve this outcome, particularly for a long-term mine closure, the most appropriate techniques and available, durable products must be used to minimize the potential degradation of the bulkhead.

Preparation for bulkhead construction included the installation of a coffer dam and appropriately sized pipe to control any water flowing through the bulkhead site, removal of the track, ties and all the rock ballast, scaling loose rock down to solid, and washing the rock surface to remove dirt and debris.

The main component of the bulkheads, the concrete, was specified to consist of a mix using OPC Type V, sulfate resisting cement to withstand the chemical attack by the sulfate ion concentration of the impounded mine water as required by the ACI code for exposure of concrete to “moderate” sulfate concentrations from 500 ppm to 1,500 ppm. The sulfate ion concentration in the mine water was approximately 1,040 ppm (Simon HydroSearch 1992 Appendix D). In addition to using Type V cement, the concrete mix design specified a water:cement ratio of 0.45 by weight and the addition of fly ash pozzolan in the amount of 16 percent of the cement by weight. The fly ash decreases the permeability of the cast in place concrete and thus improves its resistance to chemical attack. These concrete mix components were specified to further improve the durability of the concrete and its sulfate resistance to be in accordance with the ACI code
requirements for concrete in contact with “very severe” (greater than 10,000 ppm) sulfate ion concentrations.

The design concrete mix proportions were 1:2.5:3.5 cement:sand:gravel, the gravel being well graded ¾ inch maximum coarse aggregate. The relatively large amount of sand in the mix was specified to increase the slump of the mix, thus improving pumpability and to facilitate the filling of the bulkhead forms and the ability of the concrete to readily flow under gravity through the rebar mats. The use of the ¾ inch maximum aggregate size was also specified to enhance pumpability and minimize segregation and honey combing, particularly between the rebar mat and the face of the bulkhead forms. The class and quality of the fly ash was not specified in the design report.

4. COMMENTS.

Based on the descriptions of the conditions at the three sites chosen for the American Tunnel bulkheads, it is considered that the choice of the bulkhead sites were appropriate to achieve the desired performance and will not have adversely influenced their long-term performance.

The choice of parallel-sided bulkheads was very appropriate for those to be constructed in the American Tunnel. The factors of safety on the structural aspects of the bulkheads are adequate. This conclusion is further emphasized by three other considerations that effectively increase some of the actual, in-situ factors of safety:

- Although the factors of safety on deep beam flexural stresses appear low, the calculations to ACI code contain some built-in safeguards and for these bulkheads is based upon either vertical or horizontal rebar (whichever span is the larger). However, in practice, in the design of these bulkheads, these stresses are resisted by two-way (both horizontal and vertical) rebar reinforcement, thus effectively doubling the factors of safety.
Based on the results of testing the concrete cylinders taken for each bulkhead, the average unconfined compressive strength of the concrete was at least 50% higher than that used in the design (Private communication, Reference 2).

The design hydrostatic head on at least Numbers 1 and 2 Bulkheads has not been achieved by a fairly significant margin (30 to 35% less) based on the available information.

The recommended preparation of the bulkhead sites prior to erecting the concrete forms and concreting was very thorough. The water flowing through the tunnel was controlled and piped through the construction area and the loose rock was scaled and rock surfaces that would be covered with concrete were cleaned.

The design report correctly requires that the concrete placement be one monolithic pour. The concrete mix used all the appropriate components and mix ratios to minimize its degradation by the acidic mine water that was to be impounded. Fly ash was used firstly to minimize the total quantity and rate of generation of the heat of hydration that is produced in the concrete and avoid the potentially detrimental thermal effects that may be produced during setting, and also minimize any thermal shrinkage. Secondly, the fly ash with the Type V cement comprises a durable cementitious paste that is resistant to the potentially acidic water retained behind the bulkheads. No thermal problems associated with the setting and curing of the concrete were reported. From private communications (Reference 2) it has been reported that Class F fly ash was appropriately used.

Even when the rock at a bulkhead site is very competent and has inherently low permeability, water will seep through any fractures or partings around the bulkhead as well as along the rock/concrete interface when the full hydrostatic head is applied. Thus, special precautions must be taken to minimize this occurrence. An integral part of the successful installation of an underground bulkhead for the impoundment of water is the grouting program that is performed around the bulkhead. This procedure is carried out
to ensure that intimate contact is achieved between concrete and rock for the uniform transfer of stress and that the resulting bulkhead will exhibit the minimum of leakage.

Although the design reports give sparse detail on the grouting around the bulkheads, additional information has been obtained from private communications (Reference 2). A total of 31 holes in the 3 rings were drilled and grouted at Bulkhead Number 1. Grouting pressures up to 270 to 290 psi were used, but only a little grout was injected. The single ring of holes at Bulkhead Number 2 consisted of 9 holes, as did the ring at Number 3 Bulkhead. Pressures up to 200 psi were used at both bulkheads. Not much grout was injected around Bulkhead Number 2, but some holes at Bulkhead Number 3 accepted grout and could not be pressured up initially and had to be re-drilled and re-injected later. Type V cement was used for the grouting as was appropriate from the perspective of durability.

The grouting performed on the American Tunnel bulkheads will have significantly reduced the leakage along the concrete/rock contact and through fractures in the rock adjacent to it. This is evidenced by the reported minimal leakage through and passed Bulkheads 1 and 2, even when what is believed would be the maximum head (or close to it) was being applied to these bulkheads.

From private communications (Reference 2) it has been determined that the pipes and fittings were suitably fabricated from stainless steel. Additionally, filling and sealing of the drainage pipes and the monitoring pipe (for Bulkhead Number 1) was carried out appropriately, using a pig to displace the water in the pipe ahead of it, and so allowing the pipe behind it to be completely filled with grout, without any possibility of water mixing with the grout. Thus, if a zero-bleed grout was used, complete filling and sealing of the pipe would have been achieved. If there was any doubt about this, the use of stainless steel for the pipe and flanges etc., adds an additional level of security.

Based on the foregoing review and comments, it is my opinion that the design and construction of the bulkheads were carried out adequately and that a catastrophic
disruptive shear or structural failure leading to a large release of water is extremely unlikely.

It is my understanding that an extensive study of the bulkheads in the American Tunnel has been proposed. Additional study would not impact my opinions as they relate to a potential catastrophic failure of the bulkheads as defined herein. My opinions are based upon the bulkhead design criteria as provided in the original design reports, which take into consideration the potential head conditions for each of the American Tunnel bulkheads. Under those accepted conditions (which, to my knowledge, have not been questioned), a catastrophic failure of the bulkheads is extremely unlikely and additional study would not be warranted.

Stephen Phillips
REFERENCES.


7. USGS (2014) Earthquake Hazard Program, Probabilistic Maps and Data – Western US.
ATTACHMENTS
Attachment 1

Map Showing the Surface Projection of Underground Mine Workings, Major Fault Zones and the Locations of Bulkheads (Red X's).
April 13, 2018

Larry Perino
Reclamation Manager
Sunnyside Gold Corporation
P.O. Box 177
Silverton, CO 81433

RE: Gladstone Interim Water Treatment Plant Operations Information

Dear Mr. Perino:

Pursuant to your inquiry, this letter summarizes Pioneer’s understanding of certain facts provided to Sunnyside Gold Corporation previously regarding the Gladstone Interim Water Treatment Plant (IWTP). Based on our review of the publicly available information for the site, it is Pioneer’s understanding of the following facts with respect to the IWTP:

1. The IWTP has been operated since October 2015.
2. The IWTP has a design operating range of 200-900 gallons per minute (gpm).¹
3. The IWTP has an actual capacity of ±1,800 gpm.²
4. “Design Operating Range” means: the range of flows for which the facility was designed to treat. “Actual capacity” means: the upper limit of flows that the facility can reliably treat.
5. Only the Gold King Mine discharge, with an average flow of ±600 gpm³, is currently being treated in the IWTP.

<table>
<thead>
<tr>
<th>Gladstone Interim Water Treatment Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Operating Range</td>
</tr>
<tr>
<td>Actual Capacity</td>
</tr>
<tr>
<td>Current Treatment (only from Gold King Mine)</td>
</tr>
</tbody>
</table>

6. Discharge from the American Tunnel portal is currently being routed around the IWTP and is not being treated.
7. For a very brief time in 2017, while EPA was working in the American Tunnel, flows from the American Tunnel were treated at the IWTP.

³ Memorandum to Mr. Elliot Petri, P.E. Weston Solutions, Inc., Red and Bonita Mine Bulkhead Closure Evaluation 2017 Update; D&A Job No. CG-0628.001.00. (Deere & Ault, 2017).
8. Discharges from the EPA-operated Red & Bonita Mine are not now and have never been treated at the IWTP, but the Red & Bonita is proximate to the IWTP and piping is in place between the Red & Bonita and the IWTP.

9. Flows from the American Tunnel and Red & Bonita portals are susceptible to being treated at the IWTP.

10. The IWTP has sufficient excess capacity (at least 300 gpm) and should have the ability to treat such additional discharges at a relatively small and incremental cost that would require relatively little work to implement.

Based on the capacity at the upper end of the design range of ±900 gpm and subtracting the ±600 gpm average flow from the Gold King, and considering the operational flexibility afforded in typical water treatment plant designs, the existing IWTP would have an available capacity of approximately ±300 gpm. The following table summarizes the volume of additional water that could have been treated at the IWTP from November 1, 2015 through March 31, 2018. The estimates are based on the published average flows for the Red & Bonita and the American Tunnel sources (Deere and Ault, 2017) and the estimated available design capacity of the IWTP. These estimates do not account for the short period of time when flows from the American Tunnel were treated at the IWTP.

<table>
<thead>
<tr>
<th></th>
<th>Red &amp; Bonita</th>
<th>American Tunnel</th>
<th>Unused IWTP Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Flow (gpm)</td>
<td>±300</td>
<td>±100</td>
<td>±300</td>
</tr>
<tr>
<td>Average Flow (Gallons Per Day)</td>
<td>432,000</td>
<td>144,000</td>
<td><strong>432,000</strong></td>
</tr>
<tr>
<td>Total Days</td>
<td>880</td>
<td>880</td>
<td>880</td>
</tr>
<tr>
<td>Total Flow (Gallons)</td>
<td>380,160,000</td>
<td>126,720,000</td>
<td><strong>380,160,000</strong></td>
</tr>
</tbody>
</table>

Thus, based on the upper design capacity and for relatively small incremental additional treatment costs and associated minor plant upgrades, the IWTP could have treated ±380 million gallons of water from the Red & Bonita and American Tunnel portals between November 1, 2015 and March 31, 2018. If the actual capacity rather than the upper design capacity were to be assumed and if the appropriate minor modifications and operational adjustments were implemented, it may have been feasible for the plant to treat the entirety of the combined flows from the Red & Bonita and American Tunnel portals (±506,880,000 gallons) during this period.

Contact me anytime if you have any questions regarding the above information.

Respectfully,

Joel L. Gerhart, P.E.
Vice President