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November 30, 2011
VIA E-MAIL AND HAND DELIVERY

Mr. Daron Haddock
Utah Division of Oil, Gas and Mining
1594 West North Temple
Salt Lake City, Utah 84116

RE: Revised Probable Hydrologic Consequences Determination ("PHC"), Genwal Resources, Inc., Crandall Canyon Mine, C/015/0032; Task ID # 3712

Dear Daron:

Enclosed on behalf of Genwal Resources, Inc., are four copies of the revised PHC, Chapter 7, Appendix 7-15, and new Appendix 7-66. This revised PHC is submitted pursuant to Genwal's Hydrologic Study Work Plan accepted by the Division in response to Division Order 10-A for the Crandall Canyon Mine Permit No. C/015/0032. Also enclosed is form C-1 and C-2 executed by David W. Hibbs, President of Genwal Resources, Inc.

We appreciate your consideration in this matter.

Very truly yours,

Denise A. Dragoo

DD:jmc
cc: David Hibbs (via e-mail)
Dave Shaver (via e-mail)
Erik Petersen (via e-mail)

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APPLICATION FOR COAL PERMIT PROCESSING

Permit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐

Permittee: Genwal Resources, Inc.
Mine: Crandall Canyon Mine
Permit Number: 015/032
Title: Response to Division Order DO-10-A
Description, Include reason for application and timing required to implement:

Instructions: If you answer yes to any of the first eight questions, this application may require Public Notice publication.

☐ Yes ☒ No 1. Change in the size of the Permit Area? Acres: _____ Disturbed Area: _____ ☐ increase ☐ decrease.
☒ Yes ☐ No 2. Is the application submitted as a result of a Division Order? DO# 10-A
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☐ Yes ☒ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes ☒ No 6. Does the application require or include public notice publication?
☐ Yes ☒ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☐ Yes ☒ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: _____
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☐ Yes ☒ No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☐ Yes ☒ No 15. Does the application require or include soil removal, storage or placement?
☐ Yes ☒ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☐ Yes ☒ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☐ Yes ☒ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☐ Yes ☒ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☐ Yes ☒ No 21. Have reclamation costs for bonding been provided?
☐ Yes ☒ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?
☐ Yes ☒ No 24. Does the application include confidential information and is it clearly marked and separated in the plan?

Please attach three (3) review copies of the application. If the mine is on or adjacent to Forest Service land please submit four (4) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

Print Name	Position	Date	Signature (Right-click above choose certify then have notary sign below)
David W. Hibbs	President	11/30/11	David Hibbs

Subscribed and sworn to before me this 30th day of November, 2011

Notary Public: Linda Kerns, state of Utah.

My commission Expires: 03-27-13
Commission Number: 578211
Address: 345 N. 700 E
City: Price, State: Ut Zip: 84501

} ss:

LINDA KERNS
NOTARY PUBLIC • STATE of UTAH
COMMISSION # 578211
COMM. EXP. 03-27-2013

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Form DOGM- C1 (Revised December 10, 2007)

APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

Permittee: Genwal Resources, Inc.
Mine: Crandall Canyon Mine
Title: Response to Division Order DO-10-A
Permit Number: 015/032

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Chapter 7, Appendix 7-15, Probable Hydrologic Consequences Determination
☒ Add	☐ Replace	☐ Remove	Chapter 7, Appendix 7-66
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Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.

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Form DOGM - C2 (Revised December 10, 2007)

APPENDIX 7-15

PROBABLE HYDROLOGIC

CONSEQUENCES DETERMINATION

R645-301-728 Probable Hydrologic Consequences Determination

This document has been prepared in accordance with requirements of the State of Utah R645 Coal Mining Rules. The format follows the regulations R645-301-718.100 through R645-301-728.400. This Probable Hydrologic Consequences evaluation of the coal mining and reclamation operations has been prepared by Genwal Resources, Inc. to provide a description of the potential impacts of the mining operation on the hydrologic systems and the means to prevent or mitigate those identified impacts.

R645-301-728.100 Determination

This determination section presents a brief summary of the surface water, groundwater, and geologic resource descriptions of the permit area and the South Crandall Lease area and the U-68082 lease mod area and a description of the possible impacts of the coal mine on the hydrologic resources.

The geologic and hydrologic data and their associated appendices are contained in Chapter 6 and Chapter 7, respectively. The potential sources of contamination to the hydrologic resources in the area of the mine were identified through site visits, knowledge of the working operations of the mine and discussions with Genwal Resources personnel. These potential contamination sources and impacts include:

Water Quantity
- Interception of groundwater and surface water
- Water consumption within the mine
- Seepage from mine sumps
- Pumping from Crandall Creek

Water Quality
- Additional sediment contribution
- Fugitive dust
- Oil and grease
- Mine water discharge
- Acid-toxic materials
- Flooding or Streamflow Alteration

Each of these potential sources of contamination or impact and their associated mitigating measures or circumstances are discussed in the following sections.

Water Quantity Impacts

Possible impacts to the surface and groundwater systems from the mining operation could affect the quantity of water in the mine area. Interception, consumption, and seepage of surface or groundwater are possible mechanisms which could affect the water systems.

Interception.

A limited potential exists for interception of groundwater or surface water due to subsidence which may affect the perched aquifers (springs and seeps), and stream flows in Crandall Canyon, Blind Canyon, Horse Creek, the upper headwaters of the Indian Creek drainage (Upper Joes Valley), and the streams and springs of the South Crandall Lease area and the U-68082 lease mod area. The potential for hydrologic impacts may result from creating subsurface interconnections from the more permeable zones in the strata as a result of mine subsidence. This can be expressed by the potential interrelated occurrences of intercepted groundwater flow in the overlying perched aquifers, the interruption or lessening of flow to springs, or the interception of surface water flow from ephemeral streams.

Groundwater Interception.

Typically, groundwater interception and translocation of that water is the primary mechanism by which the groundwater system may be impacted. As indicated in Section 7.24.1 of this permit, the regional groundwater system, located in the Blackhawk-Starpoint aquifer at the Crandall Canyon Mine, is below the Hiawatha Coal in all but the western portion of the mine.

Monitoring of in-mine and surface wells indicate that the potentiometric surface of the regional Blackhawk-Star Point aquifer in the mine area lies approximately 50 to 60 feet below the top of the Star Point Sandstone over most of the mine. In the westernmost portion of the mine, near the Joes Valley Fault system, the potentiometric surface of the Star Point Sandstone is at or slightly above the elevation of the floor of the mine. In these areas, minor amounts of groundwater weep from the floor of the mine. In the remainder of the mining areas, because mining is being conducted in the Hiawatha seam of the Blackhawk Formation, which overlies the Starpoint Sandstone, dewatering of the Blackhawk-Starpoint aquifer by the Crandall Canyon Mine is not possible.

Historically, the springs within the permit area which are monitored on a quarterly basis, in the perched aquifer of the Blackhawk Formation above the mine, have not been affected by operating the Crandall Canyon Mine. ~~Because of the tightness of the joints and the presence of aquicludes, significant mine in-flows from the overlying strata have not occurred and nor are they anticipated.~~ Locally, modest amounts of groundwater have been intercepted during mining operations at the Crandall Canyon Mine. Prior to 1996, discharge from the Crandall Canyon Mine was minimal or did not occur. As mining occurred in the northwest portion of the mine in Sections 26 and 35, T15S, R6E, appreciable groundwater inflows were encountered. Most of this groundwater entered the mine workings from fracture zones in the mine roof. This groundwater discharge appeared to be associated with release of groundwater from storage in fractured paleochannel systems overlying the Hiawatha coal seam. The fracture systems from which the groundwater emanated are likely associated with synthetic faulting related to the Joes Valley Fault system. The Joes Valley Fault system, which extends considerable distances to both the north and south, is present immediately west of mined areas.

The amount of groundwater flowing into the mine from Sections 26 and 35, T15S, R6E, together with groundwater originating from less significant sources located elsewhere in the mine, exceeded the amount of groundwater utilized in underground mining processes. Consequently, it became necessary to discharge the excess groundwater from the Crandall

Canyon Mine. The mine water was pumped from underground sumps to the surface and then discharged into Crandall Canyon Creek at monitoring point UPDES 002. The northwest portion of the Crandall Canyon Mine was sealed after mining in that area was complete. However, drainage of groundwater from the sealed northwest portion of the mine continued. Groundwater discharge from the Crandall Canyon Mine was essentially continuous throughout the remaining period of active mining.

In August 2007, a tragic mine collapse event occurred at the Crandall Canyon Mine. As a consequence of this event, the Crandall Canyon Mine was subsequently closed and sealed. Accordingly, as the mine pumps were removed, it was no longer possible to pump groundwater from the Crandall Canyon Mine workings and discharge from the mine ceased during September 2007.

Beginning in January 2008, groundwater began to discharge from the Crandall Canyon Mine portals via gravity drainage. It should be noted that, based on the geometry of the Crandall Canyon Mine workings (with the lowest elevation regions occurring in the southern part of the mine), large portions of the mine workings likely remain free of mine water.

A reconnaissance of field information and data available from the old Huntington #4 permit indicates that Little Bear Spring located in T16S-R7E-Sec9 (see Plates 7-12, 7-13, and 7-14) emanates from the Panther (lowest member) of the Star Point Formation. Previous drilling within the mine area has shown that the three members of the Starpoint Sandstone are vertically isolated from one another. The Spring Canyon member is located within the upper 100 feet of the Starpoint Sandstone. This member has been found to contain water in some areas of the mine. The Storrs member was isolated from the Spring Canyon member by interbedded shale and siltstone. It did not appear to contain any appreciable water. The Panther member was found to be about 36 feet thick at a depth of 315 to 351 feet. Flow from this bed varied from about 2.1-7.0 gallons per minute. Although Little Bear spring emanates out of the Panther member, age dating showed the water to be of recent age (<50 years old). Age dating of water from the Starpoint Sandstone shows it to be of an age greater than 10,000 years old. It appears that Little Bear Spring emanates from a fault zone which may be serving as a conduit for diversion of recent water intercepted in some of the larger drainages in the area. It is doubtful that mining activities would have any affect on flow from Little Bear Spring due to the large age difference between the water encountered underground and the water flowing out of Little Bear Spring.

Meetings with the Castle Valley Special Service District officials and their representatives, as well as the other water user districts of the area, were held on 10 June 1993. The concern of the Castle Valley Special Service District regarding diminution and mitigation of the Little Bear Spring flow that could result from future mining were discussed. Given the elevations of the Starpoint potentiometric surface, in relation to that of the Hiawatha Coal Seam, it was shown that the present and future mine workings would not interfere with the Starpoint aquifer.

Little Bear Spring is a developed spring that provides municipal water to nearby municipalities. It emanates from a fracture system in the Panther Member of the Star Point Sandstone that trends in an approximate northeast-southwest direction.

Because of its importance as a municipal water supply source and its proximity to proposed mining areas, Little Bear Spring has been extensively studied. Several hydrologic studies have been performed since 1977 to investigate the recharge source for Little Bear Spring (Forest Service Project File). These studies have agreed that the spring flow is supported by a fault/fracture system. Since Little Bear Spring lies more than 300 feet below the level of the mineable coal seams and past mining encountered the fault/fracture system without significant inflow of water, there is general consensus among the Castle Valley Special Service District (CVSSD), mine operators, scientific community, and the regulatory agencies that adverse effects to the spring are unlikely.

Several studies have been done that suggest a northerly component of flow feeding Little Bear Spring. These studies include:

- Vaughn Hansen Associated, *Water Quality and Hydrologic Study in Vicinity of Huntington Creek Mine No. 4 and Little Bear Spring*, Prepared for Swisher Coal Company, August1977.
- Hydro-Sciences, Inc., *Ground Water Hydrology in the Vicinity of the Huntington No. 4 Mine,* Prepared for ARCO Coal Company, December 19, 1980.
- Beaver Creek Coal Company, *Huntington Canyon No. 4 Mining and Reclamation Plan,* Prepared for UDOGM, 1983.
- Utah Geological and Mineral Survey, *Effects of Coal Mining at Huntington Canyon No. 4 Mine on Little Bear Spring, Emery County,* Prepared for Castle Valley Special Services District, Job No. 84-005, January 21, 1984.
- Vaughn Hansen Associated, *Hydrologic Conditions in Huntington Canyon No. 4 Mine,* 1984.

These referenced studies are available for review at the Division's Public Information Center.

Other studies indicate that the Little Bear Spring may possibly be fed by a fault/fracture system which intercepts surface water in Mill Fork Canyon southwest of the South Crandall Lease area. These scientific investigations include an investigation of the Little Bear Spring groundwater system and the groundwater systems encountered in the Crandall Canyon Mine (Appendix 7-52), a solute and isotopic investigation of groundwater from Little Bear Spring and the Star Point Sandstone and Blackhawk Formation groundwater systems the Crandall Canyon Mine (Appendix 7-53), an investigation of the hydraulic conductivity of the Star Point Sandstone in the vicinity of the Crandall Canyon Mine (Appendix 7-54), an investigation of the alluvial groundwater system in Mill Fork Canyon with implications for recharge to Little Bear Spring (Appendix 7-55), an investigation of the potential for Little Bear Spring recharge in Mill Fork Canyon (Appendix 7-56), and a fluorescent dye-tracing study that conclusively demonstrates the hydraulic connection between the stream/alluvial groundwater system in Mill Fork Canyon and Little Bear Spring (Appendix 7-57). Sunrise Engineering also performed a series of investigations using a proprietary geophysical technique that demonstrated a hydraulic connection between Little Bear Spring and the surface drainage in Mill Fork Canyon. These investigations are included as Appendix 7-59, Appendix 7-60, Appendix 7-61, and Appendix 7-62.

These studies, taken as a whole, have indicated that Little Bear Spring is possibly recharged through surface water and alluvial groundwater losses in Mill Fork Canyon, located well beyond the boundary of the South Crandall Lease area, approximately 1.5 miles southwest of the spring. The

basis for this assumption is discussed briefly below. The reader is referred to the above mentioned appendices for a more rigorous discussion of the recharge of Little Bear Spring.

The assumption that Little Bear Spring may possibly be recharged from surface-water and alluvial groundwater losses in Mill Fork Canyon is based on several findings. These include:

1) the finding that, from a water budged standpoint, there is sufficient water available in Mill Fork Canyon to account for the recharge to Little Bear Spring and any surface water drainage that leaves the Mill Fork drainage and flows into Huntington Creek,

2) the finding that there is a chemical and isotopic match (or a plausible chemical evolutionary pathway) between surface waters and alluvial groundwaters in Mill Fork Canyon and groundwater at Little Bear Spring, and

3) the finding that there is a demonstrated hydraulic connection between Mill Fork Canyon and Little Bear Spring and the hydraulic gradient and flow volume through the connection is sufficient to provide Mill Fork water to the spring.

These findings are discussed below.

An investigation was performed in 2001 to determine the quantity of water available in Mill Fork Canyon to recharge Little Bear Spring (Appendix 7-56). It is the finding of this investigation that there is an excess of approximately 300 gpm in the Mill Fork drainage that is available for recharge to the spring. Indeed, it is difficult to explain the loss of approximately 300 gpm from the drainage basin without taking the recharge to Little Bear Spring into account. This finding is based on a comparative analysis of baseflow in the Crandall Creek drainage, which is very similar in geology, topography, aspect, and elevation to the Mill Fork Creek drainage. The baseflow in Crandall Canyon Creek during most years is approximately 300 gpm greater than that in Mill Fork.

Another investigation examined the capacity of the alluvial groundwater system in Mill Fork Canyon to transmit sufficient groundwater to sustain the baseflow of Little Bear Creek during periods when there is not surface flow in the Mill Fork drainage (Appendix 7-55). This investigation was based on a quantitative determination of the flow of groundwater migrating through the alluvial groundwater system above the spring recharge location compared to that flowing through the alluvial deposits below the spring recharge location in Mill Fork Canyon. It is the conclusion of this investigation that there is appreciably more groundwater flowing through the alluvial deposits above the spring recharge location as compared to that flowing in the alluvial deposits below the spring recharge location (approximately 300 gpm more).

Investigations regarding the solute and isotopic compositions of groundwater at Little Bear Spring and other shallow groundwater systems in the vicinity have been performed. These investigations have also examined the solute and isotopic compositions of Star Point Sandstone groundwater systems encountered in the Crandall Canyon Mine. These studies are included as Appendix 7-52 and Appendix 7-53. It is the findings of these investigations that groundwater discharging from Little Bear Spring is modern in origin (<50 years old), while groundwater from deep Star Point Sandstone groundwater systems in the Crandall Canyon Mine have a mean groundwater age of many thousands of years. Shallow Groundwater systems (that provide baseflow

to upper Mill Fork Creek) are modern in origin. The solute composition of groundwater in Little Bear Spring and that of surface water and shallow alluvial groundwater in Mill Fork Canyon are similar.

The fact that the discharge in Little Bear Spring shows rapid seasonal variations in discharge rate suggests that the recharge is related to a shallow recharge source that is closely tied to seasonal recharge. The ancient groundwater systems encountered in the Star Point Sandstone in area coal mines do not exhibit seasonal variability.

Finally, in order to explore the assumption that Little Bear Spring may possibly be recharged from Mill Fork Canyon, a fluorescent dye tracing study was performed in 2001 (Appendix 7-57). In this investigation, fluorescent dye was placed in the upper Mill Fork drainage immediately above the spring recharge location. A positive dye recovery occurred at Little Bear Spring within 40 days of the dye placement. Thus, a hydraulic connection between the alluvial system in upper Mill Fork Canyon was positively confirmed.

The elevation of the spring recharge location in upper Mill Fork Canyon is approximately 7710 to 7790 feet, while the elevation of Little Bear Spring is approximately 7475 feet. Thus, there is a substantial hydraulic gradient between the possible Mill Fork recharge location and Little Bear Spring. It is important to note that the possible recharge location for Little Bear Spring in Mill Fork Canyon is outside the boundaries of the South Crandall Lease area. Likewise, the groundwater flowpath connecting Mill Fork Canyon and Little Bear Spring is outside of the area of potential coal mining by Genwal Resources.

While the flow mechanisms conveying water to Little Bear Spring are not completely understood, additional hydrologic studies performed since the Mill Fork EA was written have indicated that adverse impacts to the spring are not expected due to the vertical separation between the coal seams and flow. (Forest Service, BLM Joint Decision Notice/Finding of No Significant Impact, Coal Lease Application UTU-78953)

In conclusion, because mining occurs above the Panther Member of the Star Point Formation, the source of water of the Little Bear Spring; because the mine is relatively dry; and because age dating has shown that the water sampled underground from the Starpoint Sandstone and from Little Bear Springs are not the same age (: there is little, if any chance, that current or proposed future mine workings of the Crandall Canyon Mine could affect the Little Bear Spring. Operation of the mine should not adversely impact the Star Point aquifer or Little Bear Spring.

Mitigation for potential disruption to the Little Bear Spring will be accomplished though the construction of a water treatment plant which will provide replacement water for the spring. Construction of this water treatment plant will be done under the provisions of a water replacement agreement between Genwal Resources, Inc. and the Castle Valley Special Service District who maintain culinary water rights to Little Bear springs. A copy of this water replacement agreement is included in Appendix 7-51. With construction of this water treatment plant an uninterrupted supply of culinary water will be assured irrespectively of whether mining can be conclusively shown to have affected Little Bear Spring. This is in compliance with special stipulation #17 of federal lease UTU-78953 (see Appendix 1-13).

Spring and Seep Interception.

There is a potential for impact to overlying seeps and springs through interception of the perched aquifers as a result of subsidence. Seeps and springs throughout the mine area and the South Crandall Lease area and the U-68082 lease mod area have been identified through intensive field and aerial surveys. These survey results are presented in Chapter 7, Section 7.24.1, associated appendices, and are shown on Plate 7-12. Water rights have also been researched and are provided in Chapter 7, Table 7-6.

Genwal is currently monitoring the water flow rates and quality of representative springs and seeps as indicated in section 7.31 within and adjacent to the current mine permit area (including LBA No. 9 and the South Crandall Lease area). The springs which are monitored cover both the proposed aerial extent of the mine and also are located within each of the major lithologic units from the Blackhawk (above the regional aquifer) to the North Horn Formation (which caps the highest portions of the top of East Mountain).

As stated in Section 7.24.1, the water emitting from seeps and springs which overlie the coal seam originates from perched aquifers. These perched aquifers appear to have no direct communication with the Star Point Sandstone, or with the mine. Isotopic sampling has shown the chemistry of these springs to be substantially different than water from underground sources or the Starpoint Sandstone. These springs do not appear to have any vertical communication with the Blackhawk or Star Point Sandstone formations even when subsidence has occurred. This is due to the extensive interbedded shale in the intervening strata. Also, during the drilling conducted for the LBA No. 9 only one hole, DH-7, intercepted any groundwater. These data indicate that a significant zone of non-saturated, low-permeability strata (aquitard or aquiclude) are present between the Star Point Sandstone and the overlying perched aquifers.

~~Natural groundwater inflow to the Crandall Canyon Mine is limited. Inflows~~ During the period of active mining, inflows into the Crandall Canyon Mine were usually modest in magnitude and of short duration ~~to be of short and limited duration~~. Most of the natural inflows are from mined-out areas of the longwall. Less frequently, natural inflows occur from bolt holes in the roof and from very limited sections at the face. As mining occurred in the northwest portion of the mine in Sections 26 and 35, T15S, R6E, appreciable groundwater inflows were encountered. Most of this groundwater entered the mine workings from fracture zones in the mine roof. This groundwater discharge appeared to be associated with release of groundwater from storage in fractured paleochannel systems overlying the Hiawatha coal seam. The fracture systems from which the groundwater emanated are likely associated with synthetic faulting related to the Joes Valley Fault system.

Genwal has an operational monitoring plan which includes monitoring surface flows from Crandall, Blind Canyon and Indian Creeks using flumes and continuous recorders. In addition, Genwal has committed to monitor Horse Canyon at station H-1 on a quarterly basis. Genwal is currently monitoring ~~14~~24 springs on a quarterly basis across their potential area of influence (see Chapter 7 for additional details).

Prior to about 1996, due to the dryness of the mine, water from Crandall Creek had been pumped into the mine to provide dust control water and water for the mining equipment. A water

supply well provideds shower water for the bathhouse. This well (MW-1) is no longer operative in the now closed Crandall Canyon Mine. Based on the 1992 mine water records, approximately 6.9 million gallons of water were used in the mining operation. Of this volume, it is estimated that approximately 6.2 million gallons of water were pumped into the mine from either the water supply well MW-1 or from Crandall Creek. These volumes indicate that the water collected from natural inflow underground was approximately 700,000 gallons, which is about 10 percent of the 1992 water usage. This amounts to a 1.3 gpm inflow rate. Much of the natural inflow water is used in the mining operation. Discharge from the mine had occurred only 3 times prior to 1990. Beginning in January 1996, relatively continuous discharge of mine water began to occur. A plot of Crandall Canyon Mine discharge as monitored at UPDES 002 is presented in Figure PHC-1. It is apparent in Figure PHC-1 that mine-water discharge rates increased gradually from 1996 to 2001. Discharge from the mine peaked during the period from 2001 through 2004, with discharges commonly exceeding 1,000 gpm. After 2004, discharge data from the mine show a gradual decreasing trend. During the first three quarters of 2010, the reported discharge has averaged about 500 gpm.

In the event that a subsidence fracture did reach the surface or intercept one of the overlying perched aquifers, it is likely that the affect would be temporary in nature. As indicated in Appendix 7-41, the clays within the Blackhawk Formation have a tendency to swell when exposed to water. Therefore, if the fracturing from subsidence did intersect a saturated, perched aquifer and conveyed water, the clays within the formation would swell and seal the fracture. This self-healing condition has been identified within the headwaters of the Huntington Creek drainage (DeGraff, 1978) and at other mines in the area.

An alternative water source plan has been developed in the event any water rights or springs/seeps impacted in a long-term manner by the mining operation or reclamation activities. This plan is detailed in Chapter 7, Section 7.27.

The Division of Oil, Gas and Mining has requested that this PHC be revised with respect to:

1. The magnitude and potential source of the groundwater inflows currently occurring at the Crandall Canyon Mine

2. The nature of the groundwater system currently being intercepted in the mine

3. The potential impacts of intercepting groundwater in the mine including the potential for impact to State appropriated water rights, and

4. The potential impacts to the Crandall Creek stream channel resulting from sustained discharge, including potential impacts to stream channel morphology and aquatic habitat.

In conjunction with this request, a written work plan was prepared that outlined the specific work tasks that would be performed in conjunction with the Division's request. The work plan was subsequently approved by the Division, and the work tasks were accomplished during 2011. Petersen Hydrologic, LLC was commissioned to perform the requested hydrologic investigations.

The following sections of this PHC describe the methods and results of the individual work tasks

as outlined in the approved work plan.

2011 Investigative Tasks

- Monitoring of supplemental Spring and Seep locations

During the 2011 field season, Petersen Hydrologic performed a field investigation of selected springs and seeps in the permit and surrounding areas. The purpose of this investigation was to collect supplemental discharge and water quality data from springs in the study area to which baseline hydrologic data could be compared. The purpose of this analysis was to determine whether there has been any measureable interception or diversion of groundwater resources into the subsurface as a result of mining operations at the Crandall Canyon Mine. For this investigation, hydrologic monitoring was performed by Petersen Hydrologic at 36 spring locations distributed over the study area during the 4th quarter of 2011 (an additional spring site was monitoring during July 2011 and a general observation of conditions in the Joes Valley alluvium was performed during October 2011). Additionally, as part of the routine quarterly water monitoring activities at the Crandall Canyon Mine, an additional 12 monitoring sites in and adjacent to the study area were monitored during the 4th quarter of 2011. Additionally, laboratory water quality analysis for four additional springs was performed as part of this investigation. These springs include SP1-3, SP1-19, SP1-24, SP1-22, which are part of the approved monitoring plan, but for which laboratory water chemistry analysis is not generally performed. The results of the laboratory water quality measurements will be submitted electronically to the Division's on-line hydrology database together with the other 4th quarter 2011 monitoring information when the results from the analytical laboratory become available.

Additionally, as part of their water monitoring activities at the adjacent Deer Creek Mine, PacifiCorp previously performed monitoring at 10 spring sites situated near the Crandall Canyon Mine permit area (See Appendix 7-66, Figure 1 and Table 1). Monitoring information collected by PacifiCorp (including discharge and field water quality data) was obtained for these sites from the Division's publically available on-line hydrology database. Information from the Deer Creek Mine monitoring activities for the 4th quarter 2010 was utilized for this investigation (which was the most recent 4th quarter monitoring data available).

A summary of the comparison between the 2011 monitoring data and the historic monitoring data previously provided to the Division (Work Plan Table 1) for the comparison is presented in Appendix 7-66, Table 1. From the data presented in Appendix 7-66, Table 1 it is apparent that groundwater discharge rates measured during 4th quarter of 2011(and during 2010 for the PacifiCorp monitoring) generally equal or exceed those measured during the period of baseline monitoring (in some instances by a considerable amount). There is no indication that groundwater discharge rates from springs in any portion of the study area have been adversely impacted by mining operations at the Crandall Canyon Mine. Similarly, there is no indication that appreciable changes to water quality have occurred relative to conditions observed during the baseline monitoring activities (with the possible exception of some marginally elevated specific conductance values at a few monitoring sites). What this suggests is that the groundwater systems that support springs and seeps and provides baseflow to streams in the mine permit and surrounding area are apparently not in good hydraulic communication with the groundwater systems which have previously been intercepted in the Crandall Canyon Mine

workings.

- Monitoring of Surface Water

As part of this investigation, surface water flow rates and stream water quality from the mine permit area have been measured in the Indian Creek drainage, Horse Canyon drainage, Blind Canyon drainage, Shingle Canyon drainage, Crandall Canyon drainage, Little Bear Canyon drainage, the Section 4 Creek drainage, and the Section 5 Creek drainage. These surface water drainages together drain essentially the entirety of the land surface in the Crandall Canyon Mine permit area.

The results of regular quarterly monitoring activities on streams are reported to the Division quarterly through the Division's on-line coal water quality database. The results of previous years' surface water monitoring activities have been summarized in annual reports of water monitoring at the Crandall Canyon Mine. These reports include graphs of discharge rates and important water quality parameters for each stream monitoring site. An analysis of the current year's surface-water monitoring data together with data from previous years is provided.

To date, other than the effects of the permitted discharge of mine water to Crandall Creek, no detrimental impacts to water quantity or water quality in streams that could be attributed to mining and reclamation activities at the Crandall Canyon Mine have been identified.

- Hydrogeologic field investigation

During the 2011 field season, the land surface overlying mining areas were traversed and geologic and hydrogeologic conditions were observed. The locations of identified features of potential hydrogeologic significance are shown in Appendix 7-66, Figure 1.

The land surface area overlying the synthetic faulting encountered in the underground mine workings (in Section 35 and in the southern portion of Section 26, T15S, R6E) was traversed and inspected. Lineaments were observed in this area on high-resolution aerial imagery. However, the presence of a relatively thick soil mantle in the area and the unusually dense vegetative cover present during the 2011 field season made field identification of these structures difficult. As a result of these factors, together with the fact that these faults apparently have only relatively small offsets, positive identification of the surface traces of these faults in the field was not made during the 2011 field investigation (i.e. the previously mapped fault locations have not been changed). It was notable that when the fault area was surveyed, groundwater discharge was observed at several springs and seeps in the area. The presence of the springs and seeps in the area suggests that the land surface overlying the synthetic fault system is a groundwater discharge area and not an area where recharge to fractures would potentially be occurring. The fact that these springs (numbers 20, 21, 22, 23, and 25) discharge along the approximate trend of the westernmost of the mapped synthetic faults suggests the possibility that the discharge mechanisms for these springs could be associated with a damaged zone associated with the fault.

The surface trace of the Joes Valley Fault system was observed in several locations. It is readily apparent that groundwater discharge along the surface expression of the fault trace is not significant. While there are a few springs that discharge along the length of the Joes Valley

Fault zone within the study area, the discharges from these few springs are generally meager (See Work Plan Table 1). These observations suggest that groundwater discharge as upwelling from the Joes Valley Fault along the steep, fault-related escarpment is either not appreciable or does not occur. It should be noted that appreciable groundwater discharge does occur in Joes Valley west of the East Mountain escarpment. Earthfax Engineering previously performed an isotopic investigation of groundwaters discharging from selected springs in Joes Valley. The results of their investigation demonstrated that each of these springs (SP1-1A, SP1-47, SP1-42A, and SP1-37A) had elevated tritium concentrations ranging from 19.2 to 38.2 TU (See Mayo and Associates, 1997). These elevated tritium contents clearly indicate that recharge to these springs occurred within the past approximately 50 years. In contrast, tritium and radiocarbon analysis on the Joes Valley Fault water intercepted underground contained no tritium and had old radiocarbon ages.

The land surface overlying the Blackhawk Formation sandstone channel scour that was encountered in the underground Crandall Canyon Mine working was inspected as part of this investigation (primarily in Sections 25 and 26, T15S, R6E, and also the southern portions of Sections 23 and 24, T15S, R6E). Where encountered underground, the southern extent of the channel scour area is situated along the northern margins of the mined area. No unusual or hydrogeologically significant features were observed at the land surface in these regions, although a few springs with appreciable groundwater discharge were identified (Refer to springs 26, and 29-33 in Appendix 7-66, Table 1). The significance of the presence of these springs is that it indicates that these areas are groundwater discharge locations. Accordingly, there is no indication that large quantities of groundwater are being diverted from these areas into the subsurface. Because of the thickness of the overburden in these areas, the lower Blackhawk Formation scour is not exposed at the surface in the study area. Where the lower Blackhawk Formation is exposed in Horse Canyon east of the study area, no unusual hydrogeologic characteristics were observed.

Other than the considerable and spatially extensive erosion of near-surface soils and colluvium along the steeper slopes below the ridge line of East Mountain, no particularly anomalous geologic or hydrologic conditions were observed during the 2011 field geologic inventory.

- Analysis of historic discharge data from Crandall Creek

Prior to the temporary cessation of mining in 2007, flow measurements were generally performed using an in-line totalizing flow meter and are believed to be accurate. From the time that gravity discharge from the mine portal commenced in early 2008 until October 2011, various methods were utilized to measure the mine-water discharge rates. Several factors complicated the performance of the mine water discharge flow measurements subsequent to the commencement of gravity discharge (including the necessity of correcting flow meter readings

for the rate of pumped water recirculation associated with the water treatment facility). Accordingly, the flow measurements performed during this time period are considered less accurate than those measured prior to September 2007. Commencing in October 2011, an improved flow metering system was installed and flow measurements being performed currently are believed to be accurate.

The mine water discharge rates measured at the Crandall Canyon Mine are graphed in Appendix 7-66, Figure 2. Also included in Appendix 7-66 is a plot of the 6-month running average for the mine discharge (Figure 3). The 6-month running average plot is useful for analyzing long-term trends. The running average data analysis technique typically results in a smoothed data plot which simplifies the identification of long-term trends while minimizing the noise and clutter of short-term data anomalies (such as potential measurement errors). The period during which there was no discharge from the mine during late 2007 was omitted from the running average flow rate calculation. A bar graph summarizing the average yearly mine water discharge rates are presented in Appendix 7-66, Figure 4.

It is apparent from Appendix 7-66, Figures 2, 3, and 4, that after peaking in the early 2000s, the mine discharge rate plot indicates a downward trend beginning around 2004. This trend is more readily discernable in the 6-month running average plot for mine discharge shown in Figure 3. Additionally, the yearly-average mine discharge rates plotted in Figure 4 show an obvious generally declining trend, and do not correlate with recent climatic trends (i.e. extremely wet years in 2005 and 2011). It is notable from Figure 4 that the average yearly discharge rate for 2011 (first 6 months) is less than half the average rate for 2001, demonstrating the declining trend in mine water discharge rates. The observed declines are likely the result of two main factors. These include 1) with a decrease in the mining rate or a cessation of mining activities, the potential for the underground interception and exposure of water-bearing features in the subsurface is minimized or ceases, and 2) over time it is common for discharge rates from intercepted underground water-bearing features in the Wasatch Plateau coal district to decline as the contained water is gradually drained from storage.

It has been observed by Genwal Resources personnel that recent increases in the mine discharge rate seem to correlate with the passage of weather fronts or the onset of cold weather. It is important to note that these flow rate changes occur even in the absence of any associated precipitation. This suggests the likelihood that the temporary increases in mine water discharge rate may be associated with barometric pressure effects acting on the underground mine pool. There is no indication that the occasionally observed increases in flow are in tied to any potential nearly immediate infiltration of precipitation waters into the underground mine workings.

- Crandall Creek stream channel morphology field investigation

During November 2011, a field investigation of the stream channel morphology in Crandall Creek was performed. The purpose of this investigation is to characterize the physical properties of the stream channel to assist in determining whether the addition of mine discharge water to creek could have detrimental impacts to the stream channel. Measurements were performed at 13 stations on the creek between the mine water discharge location and the confluence with Huntington Creek. The stream channel morphology evaluation points are shown in Appendix 7-

66, Figure 1.

At each creek station, measurements of the channel geomorphology were made. These measurements were made using a field laser transit, a tape measure, and a stream wading rod. The widths of the surveyed cross sections at each location were made of sufficient length such that the inner channel, bank full level, and flood plains were included in the measured sections.

It should be noted that where the water was deep in ponded areas associated with beaver dams, and the substrate consisted of relatively uniform fine-grained sediments (which could not reasonably be waded), the water depths in the ponds was approximated. Also, in some locations where the hillside rises precipitously above the lateral extents of the highest flood plain level, the slope of the adjacent hillside was estimated.

At each station, the measured section included the inner channel geometry (width and depth), the bank full channel geometry, and the geometry of any associated flood plains. These measurements are presented herein graphically as a series of cross-section profiles that are presented in Appendix 7-66, Attachment 1. These cross-sections were generated electronically using SigmaPlot™ version 9.01 scientific graphing software.

In most locations, the stable inner channel, which was accommodating the entirety of the stream flow at the time of the stream survey in November 2011, is well vegetated and does not appear to be easily erodible. The abundant presence of cobbles and boulders in the stream bed and stream banks minimizes the potential for appreciable erosion during increased flow events. In many locations, the stream bed is stabilized by the presence of deposited carbonates.

It was noteworthy that there were many beaver ponds in the surveyed portion of Crandall Creek. The presence of these beaver ponds has resulted in a stepped stream channel geometry, with areas of impounded, quiescent water behind the beaver dams in which fine-grained sediments are deposited. The intervening reaches between the ponds have steeper stream gradients and swifter water currents. As expected, little fine-grained material is present in the steeper gradient reaches of the stream.

It is evident in the discharge record for Crandall Creek that peak seasonal flows exceeding 6,000 gpm are common. The potential for erosion in the stream channel during these high-flow periods likely exceeds the erosion potential associated with baseflow conditions, which, although persistent for longer periods of time, are an order of magnitude lower in flow rate.

It is of significance to this investigation to note that the existing Crandall Canyon stream channel has accommodated the addition of mine discharge flows near to or exceeding the current mine water discharge rate for at least 10 years (see Appendix 7-66, Figures 2 and 3). In its current state, the stream channel appears to be in a fairly stable condition. Given the general downward trajectory of the mine water discharge rate in recent years, it follows that the potential impact associated with the inclusion of mine water should generally decrease rather than increase over time.

It should be noted here that in some locations, slumpage of the soils and colluvium situated on the steep hillsides adjacent to the active stream channel has occurred. However, inspection of

the Crandall Creek stream channel in locations above the mine discharge location shows similar mass movement occurrences throughout the upper reaches of the Crandall Creek drainage. This phenomenon is likely largely attributable to entrenchment and downcutting of stream channels into their associated unconsolidated sediments – a phenomenon that is currently being observed regionally throughout the Wasatch Plateau and adjacent regions of Utah.

- State appropriated water rights inventory

As part of this investigation, an inventory of State appropriated water rights in the study area was performed. Specific water rights have been filed with the Utah Division of Water Rights on some specific springs and stream reaches in the Crandall Canyon Mine permit and surrounding areas (see Table 7-22 and Plate 7-14).

State appropriated water rights for springs in and near the study area include 93-1176 (SP1-3), 93-1404 (SP2-9), 93-1403 (SP2-14), 93-624 (SP2-23), 93-1406 (SP2-24), 93-1410 (SP1-26), and 93-1409 (probably SP-58). Each of these springs was inspected and monitored as part of the 2011 field investigation (with the exception of SP2-14). Based on comparisons with baseline water quantity and water quality data, there is no indication that there have been impacts to water quantity or water quality in these springs.

As part of this investigation, an inventory of State appropriated water rights on streams in and around the study area was also performed. Each of the major stream drainages was visited and inspected as part of the 2011 field investigation. Based on an analysis of water monitoring data for the surface water drainages in the study and surrounding areas, there is no indication that water quantity or water quality has been impacted at these drainages.

- Whole effluent toxicity (WET) testing

Whole effluent toxicity testing was performed during the 2011 field season as required. The results of the whole effluent toxicity testing will be provided to the Division as required.

- Macro invertebrate studies

Macro invertebrate field studies were performed in 2011 during the early and late season time periods as required. The laboratory and analytical components of these investigations are currently in progress. The results of the macro invertebrate studies will be provided to the Division as required.

Conclusions

The magnitude and potential source of the groundwater inflows currently occurring at the Crandall Canyon Mine;

The nature of the groundwater system currently being intercepted in the mine

While the storage volume of the source(s) of water contributing to the Crandall Canyon Mine discharge is unknown, it is readily apparent that the rate of discharge is gradually declining (See Appendix 7-66, Figures 2, 3, and 4). Additionally, there is no correlation evident between mine water discharge rates and climatic variability. During mining operations, seasonal variability in discharge rates from water sources intercepted underground were not observed. These observations support the conclusion that at least some of the source(s) of the mine inflow waters are not in good hydraulic communication with appreciable recharge sources (i.e., the groundwater is primarily being removed from storage). These considerations also suggest that the observed declining trend in the mine water discharge rate may continue into the future.

Mayo and Associates, LC (1997), and Mayo et al. (2003) have previously conducted a series of investigations regarding groundwater systems in the Crandall Canyon Mine and surrounding mines in the Wasatch Plateau coal district.

Mayo and Associates (1997) concluded that 1) the groundwater in the Joes Valley Fault system within the Crandall Canyon Mine is thousands of years old, with no component of modern water, 2) the fault system groundwater has a stable isotopic affinity for other groundwaters encountered within the mine, suggesting that the recharge source for the fault waters is different from the recharge source for modern, shallow groundwaters and surface waters, 3) no expression of groundwater discharge from the fault system into springs and creeks at the surface in the vicinity of the Genwal lease area was identified, suggesting that groundwater discharge to the surface is either minimal or non-existent, and 4) groundwaters are upwelling from beneath the mine along the fault system, and do not appear to be under great confining pressure.

Mayo et al. (2003) concluded that damage-zone groundwater at the Crandall Canyon Mine is compartmentalized and does not readily recharge adjacent aquifer-quality rock. They indicate that water issuing from a fractured sandstone channel in the mine roof, located 100 meters from the Joes Valley Fault, contained 0.95 TU, indicating hydraulic communication with surface water. This water (5th West fault) had a ^{14}C age of approximately 3,000 to 4,000 years (Mayo and Associates, 1997), indicating a mixed source. Mayo and others (2003) further concluded that elsewhere, water in the roof channel sandstone, located near the fault, had 0 TU and older ^{14}C ages. Water issuing from the mining face, located ~ 60 meters from the fault, had 0 TU and had a ^{14}C age of 2,500 years. Additionally, modern water in the damage zone did not impact the deeper Star Point Sandstone where a sample from a well located ~ 60 meters from the fault contained 0 TU and had a ^{14}C age of 5,000 years.

Water sampled in a sandstone channel in the mine roof in the southwest portion of the mine (8th East roof drips), where longwall mining occurred from about 1999 to 2004, contained 0 TU and had a mean radiocarbon age of approximately 14,000 years (Mayo and Associates, 1997).

While much is known about the groundwater systems encountered in the Crandall Canyon Mine, a determination of precisely where the water in the various systems is ultimately recharged is

probably not possible. However, potential source(s) include:

- Drainage of old, perched groundwater from fractured Blackhawk Formation paleochannels in the mine roof into the mine openings
- Upwelling of old Star Point Sandstone groundwater through fractures in the mine floor in the westernmost portion of the mine
- Discharge of old groundwater leaking from the Joes Valley Fault into the westernmost portion of the mine
- Drainage of groundwater with a mixed origin (with components of both old and modern water) from other sources.

All of these sources have in varying degrees contributed groundwater to the Crandall Canyon Mine workings in the past.

However, it is important to stress that the results of our 2011 investigation of groundwater and surface-water resources overlying and adjacent to the Crandall Canyon Mine workings *do not* indicate that quantifiable decreases in rates of discharge from groundwater systems that support springs and seeps and provide baseflow to streams in the area have occurred.

The potential impacts of intercepting groundwater in the mine including the potential for impact to State appropriated water rights

During the 2011 field season, Petersen Hydrologic, LLC conducted an inventory of selected springs and seeps in the region overlying areas where groundwater inflows into the Crandall Canyon Mine were observed. The details of this investigation are provided in Appendix 7-66. The purpose of this investigation was to determine whether shallow groundwater systems that support springs and seeps at the surface are a potential source of the water intercepted in the underground mine workings. The findings of this investigation indicate that after more than 14 years of inflow of groundwater into the Crandall Canyon Mine, no quantifiable impacts have occurred to spring or stream flow rates. This conclusion is based on 1) the results of the performance of the rigorous Division approved hydrologic monitoring plan for springs and streams (which show no impacts), and 2) the results of the 2011 supplemental monitoring of more than 36 different spring and seep locations, which showed no discernable impacts to water quantity or quality when compared to baseline, pre-mining hydrologic conditions. Accordingly, as the magnitude of the groundwater inflows is declining over time (Appendix 7-66, Figures 2, 3, and 4), there seems to be little basis to conclude that future impacts would be likely.

An analysis of the groundwater and surface-water resources associated with the specifically delineated State appropriated water rights indicates that no detrimental impacts to flow rates have occurred at these sources. Similarly, there is no indication that any regional or systematic impacts to water resources has occurred.

Potential impacts to the Crandall Creek stream channel resulting from sustained discharge,

including potential impacts to stream channel morphology and aquatic habitat

A stream morphology survey was conducted on Crandall Creek below the mine discharge location in November 2011. This information includes channel widths and depths, the character of the materials in the bed and bank deposits, and measured stream gradients. This information was gathered to assist in the determination of whether erosion would be anticipated at varying creek discharge rates. However, based on the geometry and non-erosion prone materials present in the relatively stable inner stream channel, and the fact that the flow from the mine has been gradually decreasing over time, it seems probable that ongoing discharge of water in the stream under baseflow conditions similar to those existing currently, will not result in significant erosional changes to the stream channel morphology.

Information regarding the aquatic habitat in Crandall Creek has been collected and is currently being analyzed. This information will be provided to the Division when it is completed.

Surface Water Interception.

The possible surface water interception impacts may affect stream flows in Crandall Canyon, Blind Canyon, Horse Creek, the headwaters of Indian Creek, and drainages in the South Crandall Lease area and in the U-68082 lease mod area. These impacts would likely be the result of subsidence fractures intersecting the ground surface. If these fractures occur within or across a surface drainage channel, then a potential is created for the surface flow within the drainage to be temporarily intercepted. For the drainages within and adjacent to the Crandall Canyon Mine, all sections of the streams that are perennial will be protected from subsidence by limiting retreat mining activities within the area of the stream buffer zones as discussed in Section 5.25 of this permit.

The potential for significant water loss for these drainages is minimal. This conclusion is based on the existing hydrologic and geologic information presented in Section 7.24 and Appendices 7-2 and 7-23 and past mining experience within the Huntington Creek drainage. In addition, the streams in the majority of the surface area which overlies the current or proposed mine workings are ephemeral. However, due to the concerns raised by the U.S. Forest Service, regarding their uncertainty in supporting this conclusion, Genwal Resources Inc. has initiated extensive studies of within Blind and portion of Crandall Canyon to determine if mining through these drainages have an adverse affect on the surface or groundwater resources within the drainage. Until the results of these studies are determined, Genwal will continue to protect those portions of the streams that have been proven to be perennial.

It is important to note that the geologic units located in the formations stratigraphically above the Blackhawk Formation and the Hiawatha coal seam at the Crandall Canyon mine are hydrologically isolated from the contiguous area. East Mountain is bounded on the north by the South (Left) Fork of Huntington Creek; on the west by Upper Joes Valley; on the south by Cottonwood Canyon; and on the east by Huntington Canyon. Data show that the regional aquifer is located below the Hiawatha Coal. Field data indicate that Blind Canyon is ephemeral and that Horse Canyon is perennial only in that area where it intersects or is below the regional aquifer. Based on the baseline data (Appendix 7-58), it is apparent that all of the surface-water drainages in the South

Crandall Lease area are likely ephemeral or intermittent in nature. The drainages in the U-68082 lease mod area are all ephemeral or intermittent.

The perennial portion of Crandall Canyon extends above the regional aquifer. This occurs because the perched Price River and North Horn Formation cover a broader area of this watershed and because Crandall Canyon has a larger drainage area (and thus, more potential for recharge and increased runoff) than the other two canyons.

Consumption.

The consumption of water by the mining operation is a combination of moisture added to the mined coal through the mining process and that which is extracted with the coal as well as evaporation due to ventilation of the mine workings. It is estimated that mining extraction and the mining process utilize approximately 200 gpm during the two 8-hour mining shifts per day. The volume of water extracted by ventilation is estimated to be approximately 50 gpm.

Seepage from Mine Sumps.

Underground sumps are utilized to store water pumped underground or collected from groundwater inflows until the water is used as mine process water. During the period that water is stored in these sumps it is probable for some seepage to occur to the underlying formation (Spring Canyon member). For the Crandall Canyon Mine, the potential volume of such seepage is expected to be quite low because of the presence of a fine grained mudstone strata underlying the Hiawatha seam within the Blackhawk Formation. This layer limits the downward movement of seepage to a very slow rate.

Pumping from Crandall Creek.

Due to the past need for supplemental water underground, there is also potential for decreased surface flows in Crandall Canyon due to pumping from Crandall Creek. Surface water availability could only be impacted by excessive pumping of water from Crandall Creek for the operation. This is not expected to occur since Genwal has committed to not pump from Crandall Creek at a rate that will dewater the stream. (Chapter 7, Section 7.24.2). (Genwal will have determined the baseline water flow which needs to remain within Crandall Creek to sustain the existing flora and fauna by August 31, 1995).

Water Quality Impacts.

The quality of the surface and groundwater in the mine area may potentially be affected by increased sediment loading, dust from the operations, mine water discharges, hydrocarbons used in the mining operations, and seepage losses from within the mine. The following sections discuss these potential impacts and mitigating measures.

With the installation of the main diversion culvert during the expansion of the mine yard facility area it is possible that additional sedimentation could occur. Genwal will install a pair of silt fences downstream in Crandall Canyon to collect any suspended material that may occur as a result

of the installation of the 18" drain pipe bedded in drain rock or the 72" culvert. The silt fences will be checked periodically and cleaned out as needed to maintain maximum efficiency.

Once the culvert is in place and operable, the creek will be diverted through the culvert thus bypassing the disturbed area and minimizing the potential for runoff from the disturbed area accidentally flowing directly into the creek. The sediment pond may experience an increase in sediment loading during the construction process and until the construction has been completed. This would be a short term effect. The sediment pond will also be enlarged during the construction process to accommodate the increase in disturbed area. The net result will be that the pond will be better suited to handle runoff from the disturbed area once it has been reconstructed and enlarged. Drainage from the Forest Service parking area will now report directly to the sediment pond. All drainage from the disturbed area will report directly to the sediment pond and the potential for drainage to bypass the sediment pond and flow into the creek untreated will be virtually eliminated.

Flow in Crandall Creek will be temporarily (during the remainder of the life of the mine) diverted through the 72" culvert. However, when reclamation occurs, the channel will be replaced exactly in the same location as it existed prior to the culvert placement. Genwal will lay a geotextile over the existing channel to preserve the channel morphology prior to installation of the drain rock and 18" drain pipe. The drain rock and drain pipe will serve to allow any drainage from the channel bed or adjacent seepage from colluvial materials to flow downstream. Then, the 72" diversion pipe will be placed over this drain. The drain will preserve the integrity of the fill, thus minimizing the potential for problems from settling of the 72" pipe and ensuring the successful operation of the bypass culvert.

Increased Sediment Loading.

As discussed in Section 7.24.2, the permit area is drained by ephemeral, intermittent, and perennial watersheds. These watersheds are steep (with average slopes 50 percent) and well vegetated (with vegetative cover also often exceeding 50 percent). The primary potential for impact to surface water is in the form of increased sedimentation from the operations.

Sediment yield will naturally increase (on a temporary basis during construction and revegetation) from areas disturbed for the operation. A runoff control plan, required by the Division of Oil, Gas, and Mining, provides for the containment or treatment of all runoff and sediment produced from the disturbed areas. Based on this plan, described in Chapter 7, Section 7.42.22, the majority of the disturbed area runoff is directed to the sediment pond. The designed sediment storage for the pond is 1.02 acre feet, including 0.084 acre feet from disturbed areas and 0.018 acre feet from undisturbed and reclaimed areas, over a 10 year period. Storm runoff was determined to be 1.98 acre feet. The pond is designed with a total storage volume of 3.27 acre feet, which allows for complete containment of sediment.

There are 7 small areas (ASCA 2, 5, 6, 7, 8, 9, & 10) which do not drain to the sediment pond, as shown on Plate 7-5, and described in Chapter 7, Section 7.42.21. Sediment yield from these areas is minimized through the use of sediment traps, straw bale dikes, silt fences, and vegetation as described in Section 7.42.21. Sediment yield from the facility and the disturbed areas is minimized through the installation and maintenance of the above described controls.

A secondary potential source may exist due to subsidence creating surface irregularities which would be more susceptible to erosion. Calculations presented in Appendices 7-27 to 7-40 indicate a very small potential for increased sedimentation reaching a perennial stream. A study has been conducted by Genwal and the U.S. Forest Service in Blind Canyon to measure the amount of subsidence, erosion, and the associated sediment yield which may be produced as a result of current mining operations. (Refer to Appendices 7-38 and 7-39).

Fugitive dust.

The potential impacts of fugitive dust from the Crandall Canyon Mine include reduced air quality in the facilities area and a small decrease in the surface water quality of Crandall Creek. The air quality degradation result from particulate emissions from the paved road and pad, reclamation activities, and from coal loading operations. The water quality degradation and sediment loading increase would result from the settlement of dust within the waters of Crandall Creek. Placement of the stream within the culvert under the expanded mine yard will serve to minimize the possibility of coal dust settling in Crandall Creek.

These impacts are mitigated by sweeping the paved access roads and portions of the pad, water sprays in the coal handling process, and contemporaneous reclamation. These actions minimize the dust production from the facilities area.

Oil and grease.

The use of oil, grease, and flammable hydrocarbon-based products in the mine facilities area creates the possibility of contamination within and adjacent to the facilities area. Contamination could result from spillage of these products during maintenance of the mine equipment, accidental spillage during filling of fuel tanks, or leakage from equipment during operations. Such contamination could impact the soils, groundwater, and possibly surface waters downstream of the facility.

The impacts from spillage during maintenance activities and during filling of tanks will be mitigated by the implementation of the SPCC plan. Additionally, the runoff from all areas of the site where equipment will be operating is drained to the sedimentation pond. The pond is equipped with an oil and grease skimmer to prevent the release of hydrocarbons.

Mine water discharge.

A potential impact to water quality would be from mine water discharges. ~~Currently there is~~ Prior to early 1996 there was no appreciable discharge from the Crandall Canyon Mine. ~~However, when the underground sumps are full and mining consumption is minimal, such as during a longwall move or vacation, discharges may occur.~~ Prior to 1990, there were only three discharges from the mine and these discharges were of a limited nature in both duration and quantity. The mine has an UPDES discharge permit.

From early 1996 until the mine was sealed in September 2007, mine water was routinely discharged from the Crandall Canyon Mine to Crandall Canyon Creek. The quality of the mine discharge water was good, and almost always met the requirements of the UPDES discharge

permit. Information on water quality and water discharge rates from the Crandall Canyon Mine (and also from all other monitoring sites) has been submitted quarterly to the Utah Division of Oil, Gas and Mining and is available for inspection at http://ogm.utah.gov/coal/edi/wqdb.htm (UDOGM, 2011). The total dissolved solids (TDS) concentrations of mine discharge waters are plotted in Figure PHC-2. It is apparent in Figure PHC-2 that the TDS concentrations of mine discharge waters prior to the cessation of pumping in 2007 were (with a single anomalous exception in 2004) less than about 625 mg/L (see monitoring site UPDES 002, UDOGM, 2011). Total iron concentrations in the mine discharge water during this period were almost always substantially less than the UPDES discharge permit limit of 1 mg/L.

Beginning in January 2008, after a period of several months with no discharge subsequent to the cessation of pumping of mine discharge water, groundwater began to discharge from the Crandall Canyon Mine portals via gravity drainage. It should be noted that, based on the geometry of the Crandall Canyon Mine workings (with the lowest elevation regions occurring in the southern part of the mine), large portions of the mine workings likely remain free of mine water.

The TDS concentrations of the mine discharge waters that initially flowed from the Crandall Canyon Mine portals in early 2008 were somewhat elevated relative to that pumped prior to the mine's closure (see Figure PHC-2 and monitoring data for site UPDES 002 in the UDOGM online coal hydrology database, 2011). The elevated TDS concentrations were likely attributable to the initial flushing and dissolution of soluble minerals or other materials present in portions of the mine that had not previously been inundated with water. TDS concentrations of the mine water subsequent to its first discharge from the mine portals lowered precipitously during the first several months of discharge (Figure PHC-2). After a period of approximately 30 months, TDS concentrations in mine discharge waters had completely returned to the levels observed prior to the mine collapse event and the subsequent cessation of pumping of mine water in 2007.

Since gravity discharge from the Crandall Canyon Mine commenced in early 2008, total iron concentrations in the mine discharge waters have been elevated relative to the total iron concentrations of mine waters discharging prior to mine closure (See Figures PHC-2 and PHC-3; UDOGM, 2011). The likely source of increased total iron concentrations in the mine discharge water is the oxidation of sulfide minerals (such as pyrite) that have come into contact with oxygenated water in the newly flooded portions of the Crandall Canyon Mine.

It is apparent from the data plotted in Figure PHC-4 that total iron concentrations in the Crandall Canyon Mine discharge water peaked at a concentration of 8.03 mg/L in October 2009. It is apparent in Figure PHC-4 that since that time, total iron concentrations in the pre-treatment mine discharge water have been declining gradually. During the fourth quarter of 2010, total iron concentrations in the mine pre-treatment water were 2.81, 3.19, and 3.29 mg/L in October, November, and December, respectively, averaging 3.1 mg/L. Thus, the fourth quarter 2010 average total iron concentration in mine discharge water (untreated) represents a decrease of more than 60% relative to the October 2009 peak concentration over this approximately 12 to 14 month period.

In response to the increased total iron concentrations in the Crandall Canyon Mine discharge water, Genwal Resources, Inc. has constructed and operates a treatment facility that removes iron from the water prior to its discharge into Crandall Canyon Creek. Details of the treatment facility are provided in Appendix 7-65. Subsequent to the installation and successful operation of the treatment facility, total iron concentrations in the mine discharge water (UPDES 002) are now routinely in compliance with the 1 mg/L discharge limit established in the UPDES discharge permit (See Figure PHC-4; UDOGM, 2011).

A well oxygenated surface stream with near-neutral pH will rarely contain more than a few micrograms per liter of dissolved iron (Hem, 1985). Dissolved iron species in such streams are readily precipitated as solid precipitates (commonly iron hydroxides) which will settle to the bottom of the stream bed or may be incorporated as co-precipitates with other mineral precipitation processes. Accordingly, because elevated dissolved iron concentrations are not likely to persist in the well-oxygenated creek, the potential for significantly impacting iron concentrations in Huntington Creek into which Crandall Canyon Creek flows (more than a mile below the mine water discharge point) is considered minimal. Concentrations of total iron in Crandall Creek water above the mine water discharge point (at UPF-1), and immediately below the mine water discharge point (at LOF-1) are shown on Figure PHC-5.

Prior to the installation and operation of the iron treatment facility, some discoloration of the Crandall Canyon Creek stream substrate near and below the mine-water discharge point was observed. The discoloration of the creek likely resulted from the presence of iron hydroxide precipitates.

Whole effluent toxicity (WET) testing of Crandall Canyon Mine discharge water has occurred routinely subsequent to the onset of gravity discharge from the mine portals. The mine discharge water has routinely passed the WET tests during this period, indicating a lack of toxicity of the mine discharge water. WET testing of the chemically treated mine discharge water has been performed subsequent to the operation of the mine's iron treatment facility (second and third quarters of 2010). The second quarter 2010 treated mine discharge water successfully passed the WET testing (the laboratory WET testing procedure for the third quarter mine discharge sample is currently in progress has not yet been completed). The fact that the treated mine discharge water passes the WET testing indicates a lack of toxicity.

The aquatic habitat of Crandall Canyon Creek has also been evaluated previously by JBR Environmental Consultants, Inc. In a report entitled *Crandall Canyon Mine Macroinvertebrate Study September 2009*, JBR evaluated the aquatic habitat by sampling the creek's benthic macroinvertibrates and assessed the resultant data to determine whether or not the mine discharge is affecting Crandall Creek's aquatic community. JBR found that overall, while both the upper and lower monitoring sites continue to support a variety of macroinvertebrates, the Crandall Creek macroinvertebrate community downstream of the mine's discharge was negatively impacted relative to the sampling site upstream of the mine discharge. However, they considered attributing the degradation directly to iron in Genwal's mine water discharge to be problematic. It should also be noted that this represents a potential impact that occurred prior to the onset of chemical mine-water treatment. Genwal Resources, Inc. has committed to performing ongoing routine monitoring of the macroinvertebrate community in

Crandall Canyon Creek in the future. The future sampling will provide additional data, which will be used to assess continued impact or recovery as the mine discharge water is now treated.

Subsequent to the construction and operation of the iron-treatment facility for the Crandall Canyon Mine discharge, the treated mine discharge water is currently being discharged in compliance with all relevant regulations and guidelines. Impacts to the hydrologic balance resulting from the discharge of mine water are being minimized. To summarize current mine water discharge conditions:

1) The iron treatment facility (which uses both chemical and physical treatment processes) is successfully reducing total iron concentrations in the mine discharge water to levels in compliance with the UPDES permit (continuously for the last 10 months).
2) Aluminum concentrations in the treated mine discharge water are in compliance with the UPDES permit stipulations.
3) The use of polyacrylamide chemicals in the iron treatment facility at the Crandall Canyon Mine is in compliance with relevant NSF 60 standards for drinking water treatment chemicals.
4) Whole effluent toxicity testing of the treated mine discharge water indicates a lack of toxicity.
5) All applicable regulations and guidelines for the mine water discharge are currently and consistently being met, demonstrating the capability of Genwal Resources, Inc. to remain in compliance with the stipulations of the mine water discharge permit.

While the precise length of time during which elevated iron concentrations will persist in the untreated Crandall Canyon Mine discharge is difficult to determine with certainty, it is considered very likely that iron concentrations will gradually decline over time. This is because the system is reactant-limited. Crandall Canyon Mine waters that were pumped to the surface prior to the closure and sealing of the mine were consistently low in iron content (Figure PHC-3; UDOGM, 2011). These waters flowed over the mine floor and were held in underground sumps prior to being discharged to the surface via pumping. Subsequent to the mine closure and the cessation of mine water pumping, groundwaters within the mine likely came into contact with portions of the mine that had not previously been inundated with water prior to reaching the surface. This may include areas where coal debris resulting from the mine collapse event was emplaced in mine entries. Over time, the sulfide minerals exposed in the newly flooded portions of the mine will either 1) become depleted due to removal of the iron by oxidation processes (i.e. become consumed and flushed from the system as iron and sulfate in the mine discharge water), or 2) become non-reactive as the necessary chemical reactants facilitating the sulfide mineral oxidation processes become unavailable (i.e. depletion of dissolved oxygen levels in the mine water for example). Because there is not an unlimited supply of exposed and available sulfide mineral in the newly flooded portions of the mine, it can be stated with confidence that the discharge of iron from sulfide mineral oxidation <u>cannot</u> continue in perpetuity.

It should also be noted that, while damage occurred to pillars in some portions of the mine in conjunction with the August 2007 mine collapse event, such damage likely did not occur over widespread portions of the mine. In their July 2008 report of the August 2007 mine

collapse incident, the Mine Safety and Health Administration (MSHA) provide a delineation of the likely spatial extent of collapse damage in the mine. This report includes a delineation of the approximate extent of "extensively damaged pillars" as well as a delineation of the approximate extent of "damaged pillars" (see Figure 33 on page 61 of the MSHA report). It is significant to note that the total acreage of "damaged" and "extensively damaged" pillars is on the general order of the size of one of the typical longwall panels in the Crandall Canyon Mine adjacent to the collapsed area.

Inasmuch as more than three years have transpired since the tragic August 2007 mine collapse event (and the performance of any underground mining activities in the area), it seems unlikely that seismic activity in the mine area of significant magnitude to rubbleize currently intact coal and expose appreciable amounts of sulfide minerals to oxygenated mine water will occur in the future.

Based on these considerations and the recent trends in total iron concentrations observed in the mine discharge water, together with previous experiences at the Crandall Canyon Mine and other coal mining operations in the Wasatch Plateau, it seems reasonable to conclude that the elevated iron concentrations in the Crandall Canyon Mine discharge water likely will not persist more than about 10 years.

The quantity of water in Crandall Creek increases substantially when Crandall Canyon Mine discharge waters are discharged into the creek. Typically, during mid-summer and low-flow conditions, the amount of water in the creek more than doubles as a consequence of the inclusion of the mine discharge water (UDOGM, 2011). The additional modest quantity of flow in the creek, particularly during the low-flow season, is likely beneficial to aquatic habitat rather than being detrimental to the overall aquatic habitat.

In order to further evaluate and characterize the potential effects of the Crandall Canyon Mine discharge water on Crandall Canyon Creek, extensive monitoring of mine discharge rates and mine discharge water chemical compositions will be carried out. The proposed monitoring plan for the Crandall Canyon Mine discharge water (prior to any treatments) is presented below:

Water monitoring protocols for Crandall Canyon Mine discharge water (untreated mine discharge)		
Parameter	**Reported as**	**Frequency**
Field Parameters		
Mine discharge	gpm	Daily
Temperature	°C	Monthly
pH	S.U.	Monthly
Specific conductance	µS/cm	Monthly
Dissolved oxygen	mg/L	Monthly
Ferrous Iron (field)	mg/L	Monthly
Laboratory analyses		

Calcium (dissolved)	mg/L	Monthly
Magnesium (dissolved)	mg/L	Monthly
Sodium (dissolved)	mg/L	Monthly
Potassium (dissolved)	mg/L	Monthly
Bicarbonate	mg/L as CaCO3	Monthly
Carbonate	mg/L as CaCO3	Monthly
Sulfate	mg/L	Monthly
Chloride	mg/L	Monthly
Aluminum (total)	mg/L	Monthly
Aluminum (dissolved)	mg/L	Monthly
Iron (total)	mg/L	Monthly
Iron (dissolved)	mg/L	Monthly
Manganese (total)	mg/L	Monthly
Silica	mg/L	Monthly
TDS	mg/L	Monthly
TSS	mg/L	Monthly
Alkalinity (total)	mg/L as CaCO3	Monthly
Hot acidity (by SM 2310B 4(a))	mg/L	Monthly

The water monitoring data for the untreated mine discharge water outlined above will be submitted to the Division monthly. The water chemistry and measurement data will be submitted electronically using the Division's water monitoring database EDI system. Mine-water discharge rate data will be provided in a spreadsheet format or other format acceptable to the Division. The monitoring of the untreated mine discharge water will be conducted for the life of the permit or until the Division deems it no longer necessary.

The monitoring data will be used to detect and characterize any potential changes in the quantity or quality of Crandall Canyon Mine discharge water. This may be accomplished by evaluating changes or significant trends in individual monitored parameters over time (i.e. comparing previous chemical compositions or discharge rates with current chemical compositions or discharge rates). This information may then be used to determine whether adverse impacts to the quality or quantity of the receiving water (Crandall Canyon Creek) are occurring or are likely to occur. The monitoring data may also be used in future geochemical evaluations of the hydrogeochemical regime in the Crandall Canyon Mine.

Acid-toxic materials.

As discussed in Section 5.28.30, waste rock is not normally produced during mining operations. When incidental quantities of rock are encountered, the rock is left in the mine and will not be removed in the future; thus, the strata which overlie and underlie the Hiawatha seam are not expected to cause any negative effects or create acid-forming potential. ~~Additionally, the mine is currently considered to be a "dry mine" and the minimal volume of water that is encountered underground does not exhibit any acid or toxic characteristics.~~ All waters encountered have had a near neutral to slightly alkaline chemistry. Laboratory data have shown that no materials are present within the coal, underburden, overburden, etc. which are of an acid or toxic nature.

Further, handling plans have been implemented for earth, refuse, and acid-toxic forming materials (if encountered), which, if needed, will prevent or control discharge of pollutants to the hydrologic system (Section 7.31.3). This will be accomplished using the best technology currently available.

However, to further characterize the acid-forming potential of strata immediately above and below the Hiawatha seam, the applicant has collected roof-, floor-rock, and coal samples from locations within the current mine workings. Analytical results from these sets of samples, Appendix 6-2, indicate that acid and toxic forming materials are not present within the overburden or underburden.

Flooding or Streamflow Alteration.

The potential for flooding is minimized by the design and installation of adequately sized diversions, sediment pond and velocity control structures as described in Chapter 7, Section 7.40. All diversions are sized for a 25 year - 24 hour storm event. Ditches, culverts and sediment pond are designed for a 10 year - 24 hour storm event. Ditches, culverts and sediment pond are designed for a 10 year - 24 hour storm event.

Crandall Creek will be culverted for a distance of about 1,100 feet through the expanded mine yard area. While a minimal short term impact will occur as the culvert is being installed, the long term affect will be to reduce the potential for sediment to flow from the disturbed area into the creek. It will also reduce the potential for flow within Crandall Creek to impinge upon the sediment pond embankment due to their close proximity. The slopes of the sediment pond will be 2:1 on the outslope. The toe of the sediment pond has been fortified with an additional 2 feet of 12.5 inch D-50 rip-rap for protection and stabilization. The culvert outlet downstream from the pond will minimize the potential for impact from running water to damage the sediment pond embankment. An analysis of the Crandall Creek flow and pond protection measures indicates that these measures are adequate for a return period in excess of 10,000 years (Section 7.42.22). A slope stability analysis has also been performed on the pond embankment, indicating it meets the required slope-stability safety factors (Chapter 7, Table 7-7).

R645-301-728.200 Basis for Determination

The PHC Determination for this operation is based on baseline hydrologic, geologic, and other information gathered specifically for this site and the surrounding area by the permittee. This includes information from the South Crandall Lease area and from the U-68082 lease mod area. Additionally, regional information has been provided through various published reports as noted in the plan.

Specific groundwater information is provided in Section 7.24.1 and Appendices 7-16, 7-17, 7-18, 7-19, 7-21, 7-24, 7-40, 7-41, 7-43, 7-46, 7-47, and 7-48 of Chapter 7. Surface water data is presented in Section 7.24.2 and Appendices 7-14, 7-23, 7-25, 7-26, 7-27 through 7-39, 7-43, 7-44, 7-45, and 7-48 of Chapter 7. Geologic information is provided in Chapter 6 and Section 7.24.3, while climatic information is provided in Section 7.24.4.

R645-301-728.300 Findings

7.28.310

Chapter 7, Sections 7.24.1 and 7.24.2, indicate the potential for adverse impacts to the hydrologic balance to be minimal in both the existing permit area and in the South Crandall Lease area, and in the U-68082 lease mod area. The basis for this determination is through extensive studies, past and on-going groundwater and surface water monitoring, past history, and performance of the on-going operation, and various protection plans for operations and reclamation. A summary of potential impacts is provided in Table 1 of this PHC.

7.28.320

Waste rock is produced in limited quantities on a very infrequent basis during mining operations. When incidental quantities of rock are encountered, the rock is left in the mine and will not be removed in the future. These conditions, coupled with the fact that the waste rock does not have acid or toxic characteristics indicate that little potential exists for any impacts from toxic- or acid-forming materials.

Further, handling plans have been implemented for earth, refuse, and acid-toxic forming materials, which, if needed, will prevent or control discharge of pollutants to the hydrologic system (Section 7.31.1). This will be accomplished using the best technology currently available.

7.28.330

The following are expected impacts from the coal mining and reclamation operation:

7.28.331

Sediment yield does naturally increase on a temporary basis from areas disturbed for the operation. However, the majority of the disturbed area runoff is directed to the sediment pond. The pond is designed with a total storage volume of 0.98 acre feet, which allows for complete containment of sediment. The 7 small areas which do not drain to the sediment pond, as shown on Plate 7-5, are treated through the use of sediment traps, straw bale dikes, silt fences, and vegetation.

Genwal, in cooperation with the U.S. Forest Service, is conducting detailed sedimentation and erosion studies in the Blind Canyon watershed to determine the exact impact of mining and subsidence. To date, negative impacts to intermittent and perennial streams by sediment loading and increased turbidity has not been observed in the permit area.

7.28.332

Water quality parameters, including acidity, total suspended solids and total dissolved solids, are not expected to be impacted by the mining or reclamation operations. This determination is based on information provided in Chapter 7, Sections 7.24.1 and 7.24.2, and by results of the on-going water monitoring program detailed in Section 7.31.2.

It is unlikely that groundwater quality or quantity will be affected by the underground mining operation (as discussed in Section 7.24.1 and associated appendices, and Section 7.28.100). There exists a potential for impacts to the surface water. However, these potential impacts are expected to be minimal for the following reasons:

(1) Sediment controls are in place and maintained to minimize sediment loading to drainages;

(2) All discharges from the sediment pond (or mine) are conducted in accordance with requirements of a U.P.D.E.S. Permit; Where elevated total iron concentrations (above UPDES discharge permit limits) in mine discharge waters may occur, the water will be treated to remove excess iron prior to discharge to receiving waters;

(3) Historical data from this site (which is summarized in the Annual Report and Appendices 7-16, 7-17, 7-18, 7-19, 7-21, 7-24, 7-40, 7-41, 7-43, 7-46, 7-47, and 7-48) show no indication of mine related impacts on the hydrology of the area, other than the permitted discharges of mine water to Crandall Creek regulated under the mine's UPDES permit;

(4) The water monitoring program will continue to be followed as described in Chapter 7, Section 7.31.2. Results will continue to be analyzed and any problem areas noted will be corrected to prevent further impacts to the hydrology. ~~As requested by the Division, recent water monitoring data (through the third quarter of 2010)~~

728.333

The potential for flooding of the surface facilities is minimized by the design and installation of adequately sized diversions, sediment pond and velocity control structures as described in Chapter 7, Section 7.40.

728.334

The Crandall Canyon Mine is expected to have little impact on groundwater. ~~As mentioned earlier, the mine does not appear to have any hydrologic connection to surface water above the mine nor any connection to groundwater in the Star Point Sandstone below.~~

Monitoring of in-mine and surface monitoring wells drilled within and adjacent to the Crandall Canyon Mine and completed in the regional Blackhawk-Starpoint aquifer indicate the potentiometric surface of this aquifer generally lies 50 to 60 feet below the top of the Star Point Formation in all but the westernmost portion of the mine. Thus, mining of the Hiawatha Coal Seam at the base of the Blackhawk Formation, overlying the Star Point Formation, will not intersect and drain any water from the regional aquifer. Nor would water from underground mining enter the Star

Point Sandstone due to the relatively impermeable shale zone that lies between the Hiawatha seam and the sandstone below.

There may be some potential for impact to seeps and springs through subsidence. Genwal is currently monitoring the water flow rates and quality of the water rights associated with seeps and springs within and adjacent to the current mine permit area. No evidence of impacts has been identified; however, an alternative water source plan has been developed in the event any water rights or springs/seeps are adversely affected by the mining operation or reclamation activities.

At the request of the Division, an analysis of water-monitoring data at the Crandall Canyon Mine through the third quarter of 2010 has been performed. All related water-monitoring information has been submitted electronically to the Division's on-line hydrology database located at http://ogm.utah.gov/coal/edi/wqdb.htm.

As part of the requested analysis of water-monitoring data, graphs of discharge, specific conductance, and pH are provided together with plots of the Palmer Hydrologic Drought Index (PHDI) for Crandall Canyon Mine monitoring sites in PHC-Attachment 1. The PHDI is a monthly parameter that is generated by the National Climatic Data Center (NCDC) that indicates the severity of wet or dry spells. The PHDI is useful in evaluating spring or stream discharge data to determine whether variability in spring or stream discharge rates is related to climatic variability or attributable other factors.

Based on the analysis of all monitoring information performed in this investigation, it is concluded that, other than the permitted discharge of mine discharge water to Crandall Creek, which is regulated under a UPDES discharge permit, there are no indications of adverse impacts to water quality or water quantity that could be attributed to mining-related activities. It is apparent that effects of both seasonal and climatic variability influence conditions at monitored springs and streams in the mine area. Other than the permitted discharge of mine water to Crandall Creek with likely temporarily increased total iron concentrations as discussed previously, there is no indication that the events associated with the August 2007 mine collapse event have had any perceptible or quantifiable impacts on water quality or water quantity in surrounding streams or springs. Similarly, no perceptible or quantifiable impacts to water quality or water quantity in streams or springs overlying mine areas that could be attributed to the current discharge of mine water from the Crandall Canyon Mine portals have been identified.

Similar comprehensive analyses of water-monitoring data from the Crandall Canyon Mine have previously been provided yearly in annual reports of water monitoring activities submitted to the Division. An analysis of all monitoring data collected during 2010 will be provided to the Division with the submittal of the 2010 annual report of water monitoring activities.

The groundwater system that supports discharge at Little Bear Spring will not be subsided. As discussed above, the groundwater discharging from the spring is NOT derived from a regional Star Point aquifer. Rather, it is recharged from surface-water and alluvial groundwater losses in Mill Fork Canyon outside of the permit area. The significant fracture in the Star Point Sandstone from which the spring discharges serves primarily as a conduit for the conveyance of the Mill Fork water to the spring. Groundwater in the Star Point Sandstone that is not within the fracture system does not contribute appreciable quantities of groundwater to the spring. For these reasons, the potential

for impacts to Little Bear Spring resulting from mining operations in Genwal's permit area is considered extremely unlikely.

Impacts to the surface water quality and quantity are minimized through the installation and maintenance of surface runoff and sediment control structures, and a commitment (Section 7.24.2) to not pump from Crandall Creek at a rate that will cause the in-stream flow to decrease below the minimum required rate.

In addition, groundwater and surface water quantity and quality are monitored on a quarterly basis to determine seasonal flow conditions for the permit and adjacent areas. Further, handling plans have been implemented for earth, refuse, and acid-toxic forming materials, which will prevent or control discharge of pollutants to the hydrologic system. Implementation of these plans will be accomplished using the best technology currently available.

Based on the above, there is some potential for the operation to have an impact on the groundwater and surface water resources of the area; however, the impacts are expected to be minimal due to natural geologic and hydrologic conditions, and the implementation of control and protection systems. Therefore, the "Probable Hydrologic Consequences" of this operation are expected to be minimal, if not negligible.

7.28.335

Additional information will be provided if deemed necessary by the Division.

R645-301-728.340 N/A

This is an underground operation.

R645-301-728-400 **Updated PHC**

This document is provided as an up-dated PHC for the permit renewal in accordance with the State of Utah R645-Coal Mining Rules.

TABLE 1
POTENTIAL HYDROLOGIC IMPACTS

POTENTIAL IMPACT	POTENTIAL EFFECT	POTENTIAL MAGNITUDE OF IMPACT	PROBABILITY OF OCCURRENCE	MITIGATION MEASURES
Leaching of acid or toxic forming materials	Degradation of surface and groundwater quality	Low (no such materials present)	Low	Monitoring materials handled by approved methods
Groundwater Availability	Decrease in spring flow due to subsidence	Low to moderate depending on location	Low (No history of impact)	Monitoring
Groundwater Availability	Interception of groundwater by mine workings	Low	Low (on-going)	Monitoring
Groundwater Availability	Removal of water with coal	Low	Moderate (on-going)	Monitoring
Groundwater Quality	Decrease in quality due to hydrocarbons	Low	Low	SPCC Plan, monitoring inspections and maintenance
Sediment Yield	Increase in TSS	Moderate	Low	Sediment pond, diversions, sediment control, monitoring
Flooding	Damage to downstream area	Low	Low	Sediment ponds, diversions, and monitoring
Streamflow Alteration	Damage to streams due to subsidence	Low	Low	Protection of perennial streams, monitoring
Surface Water Quality	Decrease in quality due to hydrocarbons	Low	Low	SPCC plan, inspections, monitoring, maintenance
Surface Water Quality	Increase in TSS due to coal fines and dust	Low	Low	Sweeping of access road and pads, misting of coal
Surface Water Quality	Increase in iron concentrations in Crandall Canyon Creek as a result of mine water discharge	Moderate	Low (mine discharge is being treated)	Monitoring, Mine discharge is being treated
Surface Water Quantity	Decrease in flow in Crandall Creek below mine	Moderate	Low	Monitoring, maintaining baseflow
Surface Water Quantity	Increase in flow rates in Crandall Creek below the mine discharge	Low potential for negative impact; additional water of acceptable quality would likely benefit the overall aquatic habitat	Moderate	Monitoring, mine discharge is being treated

Appendix 7-66

Appendix 7-66 Table 1 Results of supplemental monitoring activities at the Crandall Canyon Mine permit and surrounding areas.

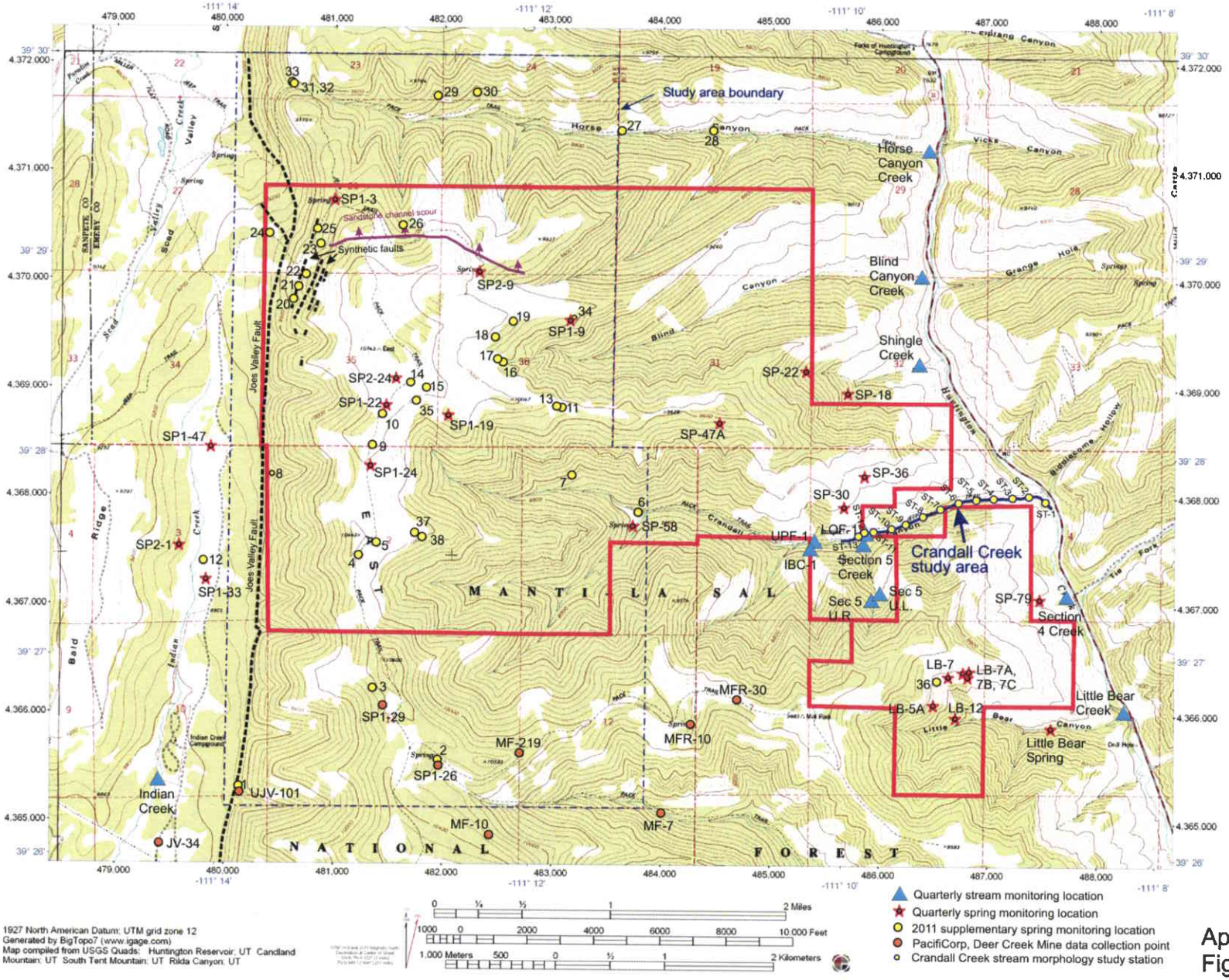
Spring	Date	UTM, NAD 27		Temp (°C)	pH	Cond. (µS/cm)	Flow (gpm)	Associated baseline Spring (Plate 7-12 and Work Plan Table 1)*	Geologic Formation	4th Quarter baseflow range (gpm)	Temp range (°C)	pH range	Cond. Range (µS/cm)
Petersen Hydrologic 4th Quarter 2011 supplemental monitoring site													
1	21-Oct-11	480146	4365296	6.7	7.77	545	2.02	UJV-101	Blackhawk	Seep to <0.3	5.9 to 9	7.18 to 7.34	467 to 581
2	4-Oct-11	481958	4365559	4.1	7.76	424	6.98	SP1-26	North Horn	0.5 to 2	4 to 7	7.78 to 8.82	282 to 340
3	4-Oct-11	481358	4366235	5.4	7.85	486	0.03	SP1-29	North Horn	dry to seep	2 to 5	7.55 to 7.98	315 to 694
4	4-Oct-11	481224	4367450	9.6	8.44	350	<0.05	SP2-26	North Horn	dry to 0.05	4 to 11	7.57 to 8.16	297 to 446
5	4-Oct-11	481386	4367567	8.5	8.29	359	0.13	SP2-34a	North Horn	Dry	4 to 6	7.8 to 8.04	221 to 327
6	26-Oct-11	483774	4367868	4.1	7.80	941	0.61	SP-52	Blackhawk	Dry to 1	6 to 12	7.99 to 8.6	337 to 602
7	26-Oct-11	483160	4368188	13.6	7.88	684	<0.1	SP-55	Blackhawk	Dry to 10	4 to 5.5	7.36 to 7.97	314 to 530
8	21-Oct-11	480430	4368198	4.3	7.78	480	2.04	SP1-53	Castlegate	seep to 3	1 to 7.5	7.65 to 8.35	198 to 402
9	4-Oct-11	481341	4368462	9.6	8.18	389	0.22	SP1-23	North Horn	Dry to 0.25	4 to 5	7.57 to 8.22	297 to 369
10	4-Oct-11	481431	4368765	7.0	8.13	343	1.42	SP1-23	North Horn	Dry to 0.25	4 to 5	7.57 to 8.22	297 to 369
11	3-Oct-11	483083	4368829	6.3	7.74	388	0.55	SP1-15	North Horn	Dry to <<1	2.2 to 6	7.4 to 8.19	251 to 380
12	4-Oct-11	479809	4367371	Locally, alluvium is everywhere saturated				NA	Joes Valley Alluvium	---	---	---	---
13	3-Oct-11	483041	4368839	8.1	7.56	399	<0.25	SP1-12	North Horn	Dry to seep	3 to 5	7.37 to 8.09	320 to 350
14	4-Oct-11	481698	4369050	6.6	7.98	401	0.70	SP1-21b	North Horn	Dry to 3	4 to 5	7.36 to 8.62	236 to 335
15	4-Oct-11	481809	4369054	8.2	8.36	350	0.64	SP1-21a	North Horn	Dry to 2	4 to 6	728 to 8.26	174 to 305
16	3-Oct-11	482529	4369250	8.6	7.65	464	0.97	SP1-10a	Price River	0.5 to 2	3 to 7	7.91 to 8.42	259 to 458
17	3-Oct-11	482488	4369273	8.8	7.68	455	0.28	No nearby spring identified	Price River	---	---	---	---
18	3-Oct-11	482462	4369465	8.1	7.80	376	0.34	No nearby spring identified	Price River	---	---	---	---
19	3-Oct-11	482630	4369616	6.6	7.87	260	0.19	SP1-8	North Horn	Dry to seep	3 to 11	7.22 to 8.05	197 to 420
20	17-Oct-11	480623	4369813	---	---	---	<0.25	SP1-49	Price River	dry to seep	3 to 5	7.45 to 8.23	288 to 385
21	17-Oct-11	480668	4369932	5.3	7.67	433	0.38	SP1-48a	Price River	Dry	4 to 5	7.29 to 8.13	310 to 383
22	17-Oct-11	480734	4370046	4.1	7.77	412	0.61	SP1-48	Price River	seep to <<1	2 to 4.1	7.71 to 8.01	312 to 380
23	17-Oct-11	480875	4370317	4.0	7.93	331	1.23	SP1-2a	Price River	seep to 5	1 to 7	7.8 to 8.68	202 to 320
24	20-Jul-11	480391	4370417	14.2	7.54	440	<0.05	SP1-2	Price River	Dry	0 to 9	7.61 to 8.05	214 to 517
25	17-Oct-11	480842	4370453	4.3	7.82	377	1.51	SP1-2B	Price River	Dry	3	7.56	219
26	17-Oct-11	481625	4370492	3.1	7.86	343	1.55	SP2-23	Price River	Dry to 0.5	2 to 5	8.42 to 8.84	290 to 305
27	31-Oct-11	483614	4371382	8.7	7.88	773	<0.05	SP6-15B	Blackhawk	Seep to <0.25	5.5 to 6	7.87 to 8.46	270 to 701
28	31-Oct-11	484451	4371396	8.7	8.53	705	0.61	No nearby spring identified	Blackhawk	---	---	---	---
29	31-Oct-11	481927	4371709	5.3	8.60	295	6.28	SP6-13	Blackhawk	2	2 to 3	8.14 to 8.38	260 to 391
30	31-Oct-11	482290	4371734	7.5	7.85	471	2.95	No nearby spring identified	Blackhawk	---	---	---	---
31	17-Oct-11	480613	4371806	5.5	7.77	339	7.19	SP6-3	Price River	<0.25 to 5	2 to 6	7.27 to 8.39	211 to 490
32	17-Oct-11	480608	4371811	6.8	7.76	337	0.59	SP6-3A	Price River	Seep to 2	4 to 6	7.68 to 8.6	322 to 359
33	17-Oct-11	480600	4371823	7.1	7.79	339	0.48	SP6-3A	Price River	Seep to 2	4 to 6	7.68 to 8.6	322 to 359
34	3-Oct-11	481192	4369641	6.8	7.69	331	0.51	No nearby spring identified	North Horn	---	---	---	---
35	4-Oct-11	481744	4368892	9.1	8.63	418	1.06	SP1-25	North Horn	0.5 to 2	2 to 7	7.76 to 8.34	130 to 490
36	25-Oct-11	486532	4366345	8.8	7.87	560	1.33	LB-5	Blackhawk	Seep	---	---	---
37	4-Oct-11	481739	4367655	---	---	---	Dry	SP2-35	Price River	<<1 to 0.5	3 to 6	7.72 to 8.21	249 to 443
38	4-Oct-11	481819	4367614	---	---	---	Dry	SP2-36	Price River	Dry	3 to 15	8.1	389
PacifoCorp, 4th Quarter 2010 Deer Creek Mine, selected monitoring sites													
JV-34	20-Oct-10	---	---	8.2	8.29	537	2.0	UJV-72	Joes Valley Alluvium	Seep to 0.5	8	7.72 to 8.22	435 to 491
MF-7	19-Oct-10	---	---	4.7	8.30	517	23.1	MF-7	Blackhawk	10 to 20	4 to 6	7.78 to 7.79	460 to 504
MF-10	12-Oct-10	---	---	3.0	8.06	330	4.9	MF-10	North Horn	0.25 to 10	2.5 to 5	7.95 to 8.4	309 to 356
MF-219	14-Oct-10	---	---	5.1	7.78	426	4.9	SP2-43A	North Horn	0.5 to 1	5 to 8	7.86 to 8.58	353 to 435

Appendix 7-66 Table 2 Crandall Creek morphology study data.

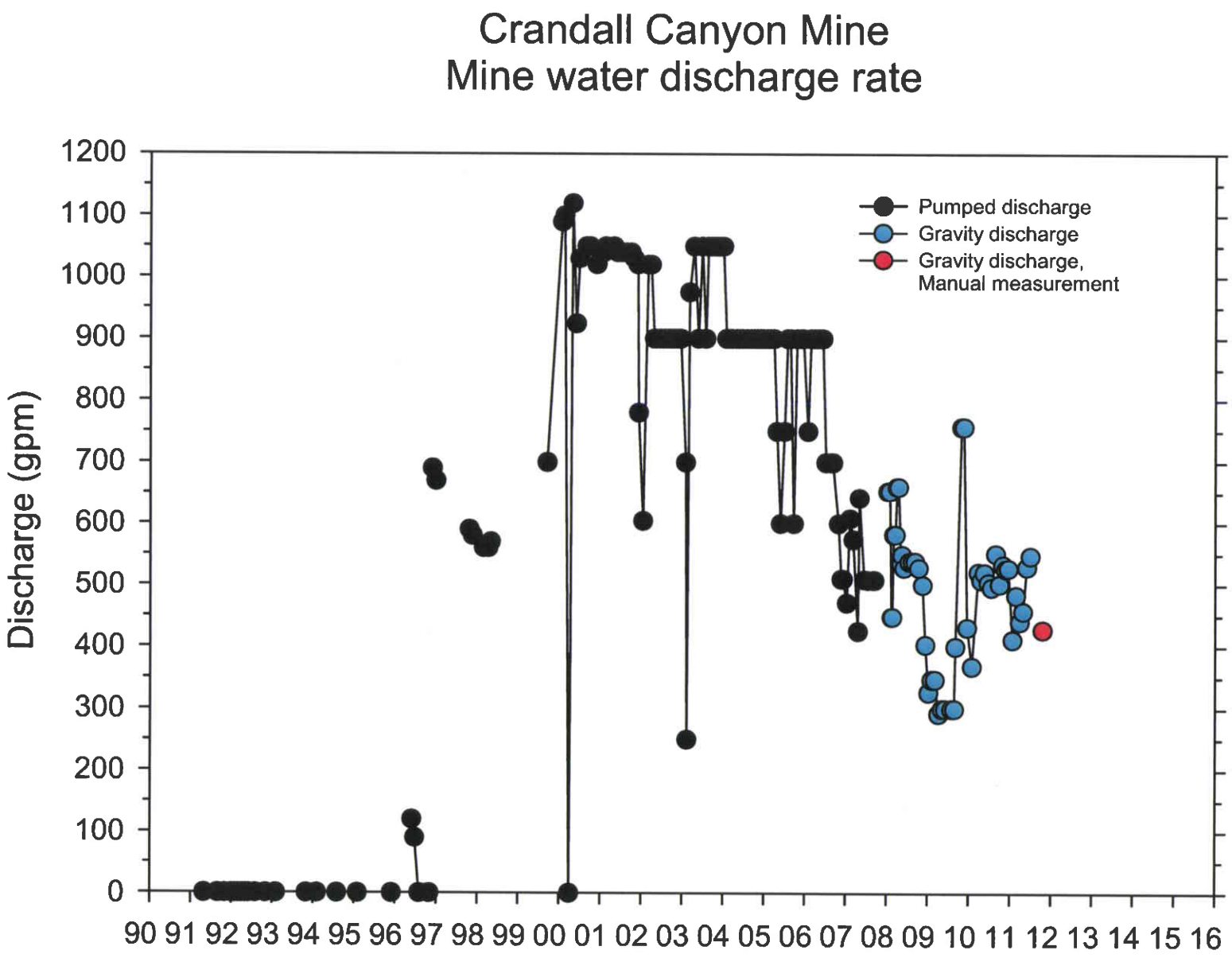
Station	Location (UTM, NAD 27)		Stream gradient	Streamflow conditions	Stream substrate composition	Streambank composition
ST-1	487499	4368045	0.045	Swift stream flow over boulders, cobbles, and gravels	Boulders and cobbles in stream channel substrate, few fines, stabilized with carbonate precip.	Non-stratified cobbles, boulders, soil, colluvium, well vegetated; Star Point Sandstone bedrock exposed in hillsides just above; well vegetated
ST-2	487349	4368028	0.017	Series of beaver dams above and below; Moderately swift flowing stream over gravels and cobbles between beaver ponds.	Fine-grained silty and clayey sediments on channel bottom; Gravels and cobbles in channel bottom above pond area stabilized with carbonate precip.	Non-stratified cobbles, boulders, soil, colluvium, well vegetated
ST-3	487206	4368033	0.050	Swift stream current, flowing over bedrock, boulders, and cobbles	Stream substrate is situated on or immediately above Star Point Sandstone bedrock; Boulders and cobbles in channel bottom stabilized with carbonate precip.	Non-stratified cobbles, rocks, colluvium, well vegetated, slumping of hillside below highway
ST-4	487049	4368014	0.038	Swift stream current, flowing over bedrock, boulders, and cobbles	Star Point Sandtone bedrock with some boulders stabilized with carbonate precip and also some loose gravels.	Non-stratified colluvium, bedrock, boulders, well vegetated
ST-5	486894	4367995	<0.005	Bever pond; low energy quiescent water; there are a series of beaver ponds above	Beaver pond bottom is filled with silt and clayey sediments	Star Point Sandstone bedrock exposed in hillside just above stream channel, non-stratified colluvium, boulders in other streambank areas; Well vegetated
ST-6	486730	4367971	0.038	Moderately swift stream current; situated between beaver ponds above and below	Boulders and cobbles in stream channel substrate, overlying Star Point Sandstone bedrock, boulders stabilized with carbonate precip.	Non-stratified colluvium, boulders, cobbles, soils, well vegetated
ST-7	486560	4367902	0.008	Slow to moderate current velocity, flowing over loose cobbles and boulders	Bedrock in stream channel substrate, some gravels and cobbles which are loose, minor carbonate precip.	Non-stratified colluvium, soils, boulders, cobbles in streambanks, well vegetated
ST-8	486407	4367833	<0.005	This is a large beaver dam and pond (75 feet across), very slow current, just above large beaver dam; more big beaver ponds above	Pond behind dam is filled with silty and clayey fine-grained sediments, carbonate precip. at beaver dam	Non-straified colluvium, gravels, boulders, cobbles, and soil; well vegetated
ST-9	486249	4367779	0.037	Swift stream current in area between two beaver ponds about 120 feet apart;	Silty materials in quiescent portions of the stream channel, apprecaible carbonate depositions along dams, stream substrate is mostly loose material	Non-stratified cobbles, boulders, soil, colluvium, well vegetated; Star Point Sandstone bedrock exposed in hillsides just above; well vegetated
ST-10	486114	4367718	<0.005	Situated in medium sized beaver pond; Low velocity current, quiescent flow conditions	Silty, soft, fine-grained sediments on the floor of the pond; Star Point Sandstone bedrock exposed on south side of channel	Bedrock on south side; non-stratified colluvium, soil, boulders, and cobbles on north side; well vegetated
ST-11	485939	4367694	<0.005	Upper end of beaver pond, very slow stream velocity	Fine-grained silty sediments on bottom of pool	Non-stratified boulders and cobbles in stream banks; some very large boulders in stream channel and banks; well vegetated
ST-12	485863	4367691	0.073	Situated just below first beaver pond below mine discharge location; swift current on cobbles and boulders	Cobbles and boulders in stream substrate	Non-stratified colluvium, boulders, soils, cobbles; some erosion of adjacent hillside above active channel; well vegetated
ST-13	485824	4367663	<0.005	Slow to moderate stream current velocity; situated just below mine discharge location above beaver pond just below	Loose cobbles, gravels, and silt; some FeOH deposition in creek	Eroded, non-stratified colluvium, boulders, soil, and cobbles on south side; large rip-rap boulders on north streambank

Spring	Date	UTM, NAD 27		Temp (°C)	pH	Cond. (µS/cm)	Flow (gpm)	Spring (Plate 7-12 and Work Plan Table 1)*	Geologic Formation	4th Quarter baseflow range (gpm)	Temp range (°C)	pH range	Cond. Range (µS/cm)
MFR-10	14-Oct-10	---	---	7.6	8.16	470	4.2	SP2-44B	North Horn	Seep	4 to 6	7.49 to 8.02	449 to 507
MFR-30	12-Oct-10	---	---	---	---	---	Dry	SP5-4	Price River	Seep	3	7.99	400
SP1-26	12-Oct-10	---	---	7.3	8.46	371	5.5	SP1-26	North Horn	0.5 to 2	4 to 7	7.78 to 8.82	282 to 340
SP1-29	12-Oct-10	---	---	7.1	8.18	451	0.11	SP1-29	North Horn	dry to seep	2 to 5	7.55 to 7.98	315 to 694
UJV-101	20-Oct-10	---	---	7.4	7.64	544	0.9	UJV-101	Blackhawk	Seep to <0.3	5.9 to 9	7.18 to 7.34	467 to 581
UJV-206	20-Oct-10	---	---	5.8	7.96	526	0.92	UJV-206	Price River	Seep to 0.5	5 to 8	7.18 to 7.32	462 to 491
Petersen Hydrologic 4th Quarter 2011, selected regular monitoring plan sites													
SP1-3	3-Oct-11	480985	4370720	4.9	7.95	301	0.41	---	Price River	---	---	---	---
SP2-9	3-Oct-11	482324	4370075	5.9	7.87	299	1.38	---	North Horn	---	---	---	---
SP1-9	3-Oct-11	483178	4369632	6.1	7.74	339	1.01	---	North Horn	---	---	---	---
SP-47A	3-Oct-11	484524	4368691	7.9	7.46	411	0.31	---	Price River	---	---	---	---
SP1-19	4-Oct-11	482048	4368746	7.1	7.92	483	3.78	---	North Horn	---	---	---	---
SP1-24	4-Oct-11	481326	4368281	10.4	8.12	454	0.12	---	North Horn	---	---	---	---
SP1-22	4-Oct-11	481487	4368819	6.6	8.16	343	1.14	---	North Horn	---	---	---	---
SP2-24	4-Oct-01	481615	4369040	4.4	8.19	382	2.44	---	North Horn	---	---	---	---
SP1-47	4-Oct-11	479877	4368437	8.9	8.25	562	28.0	---	Joes Valley Alluvium	---	---	---	---
SP2-1	4-Oct-11	479593	4367521	6.4	7.65	547	3.42	---	Joes Valley Alluvium	---	---	---	---
SP1-33	4-Oct-11	479827	4367211	5.8	7.61	567	3.07	---	Joes Valley Alluvium	---	---	---	---
SP-58	26-Oct-11	483733	4367731	5.7	7.6	863	31.5	---	Blackhawk	---	---	---	---

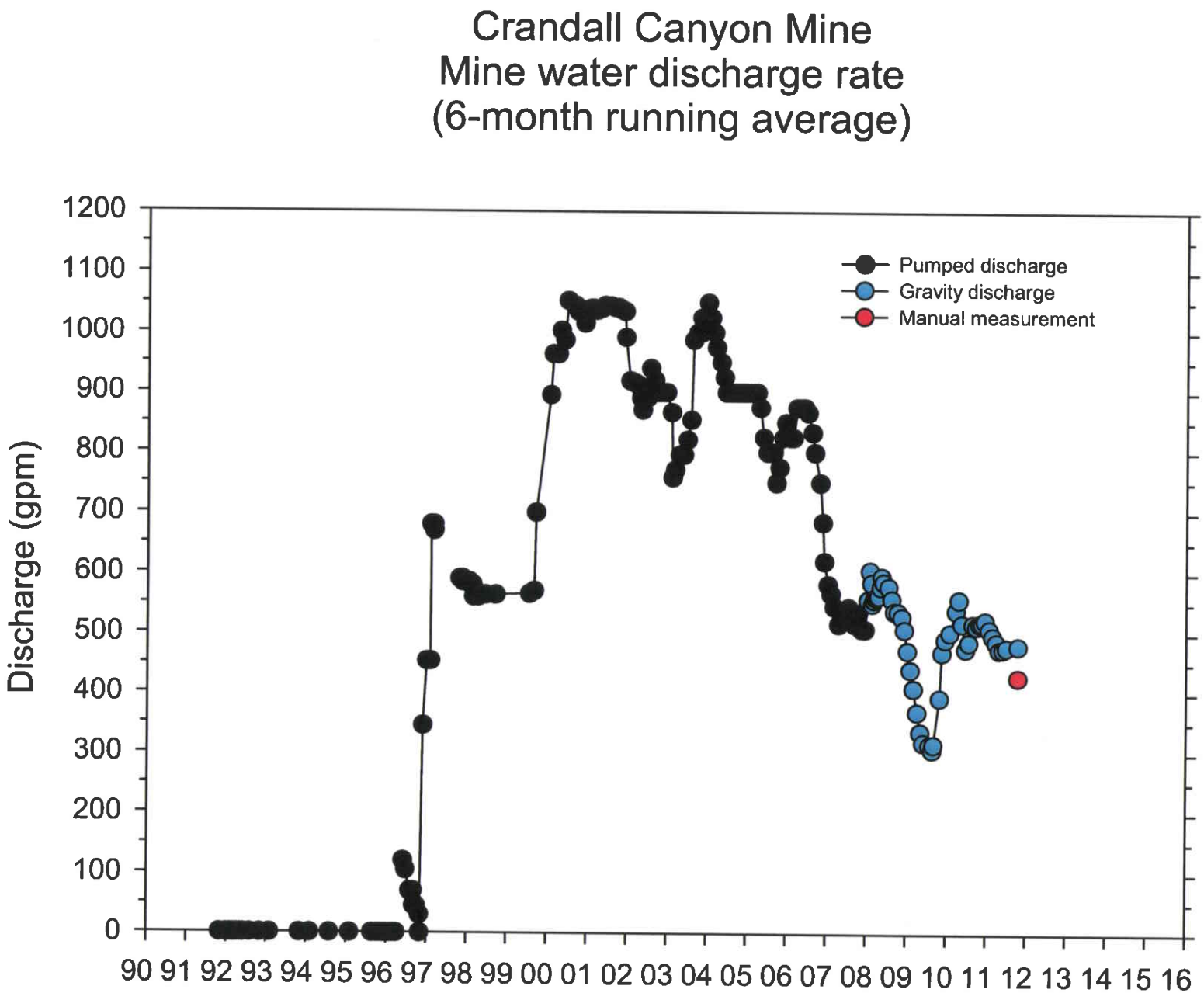
*Note: The "associated baseline spring" was determined by identifying the closest spring plotted on Plate 7-12 in the Crandall Canyon Mine MRP relative to the plotting location of the 2011 supplemental monitoring spring or seep. It should be noted that at the the time the initial baseline monitoring activities were performed, high resolution GPS was not available; consequently, there is likely some error in the plotting locations for the identified springs and seeps. Accordingly, while we have used our best judgment in correlating the springs, in some instances there is considerable distance between the "associated baseline spring" and the spring identified as part of this investigation. In a few instances, there was no spring plotted on Plate 7-12 near enough to the 2011 spring to determine an "associated baseline spring"



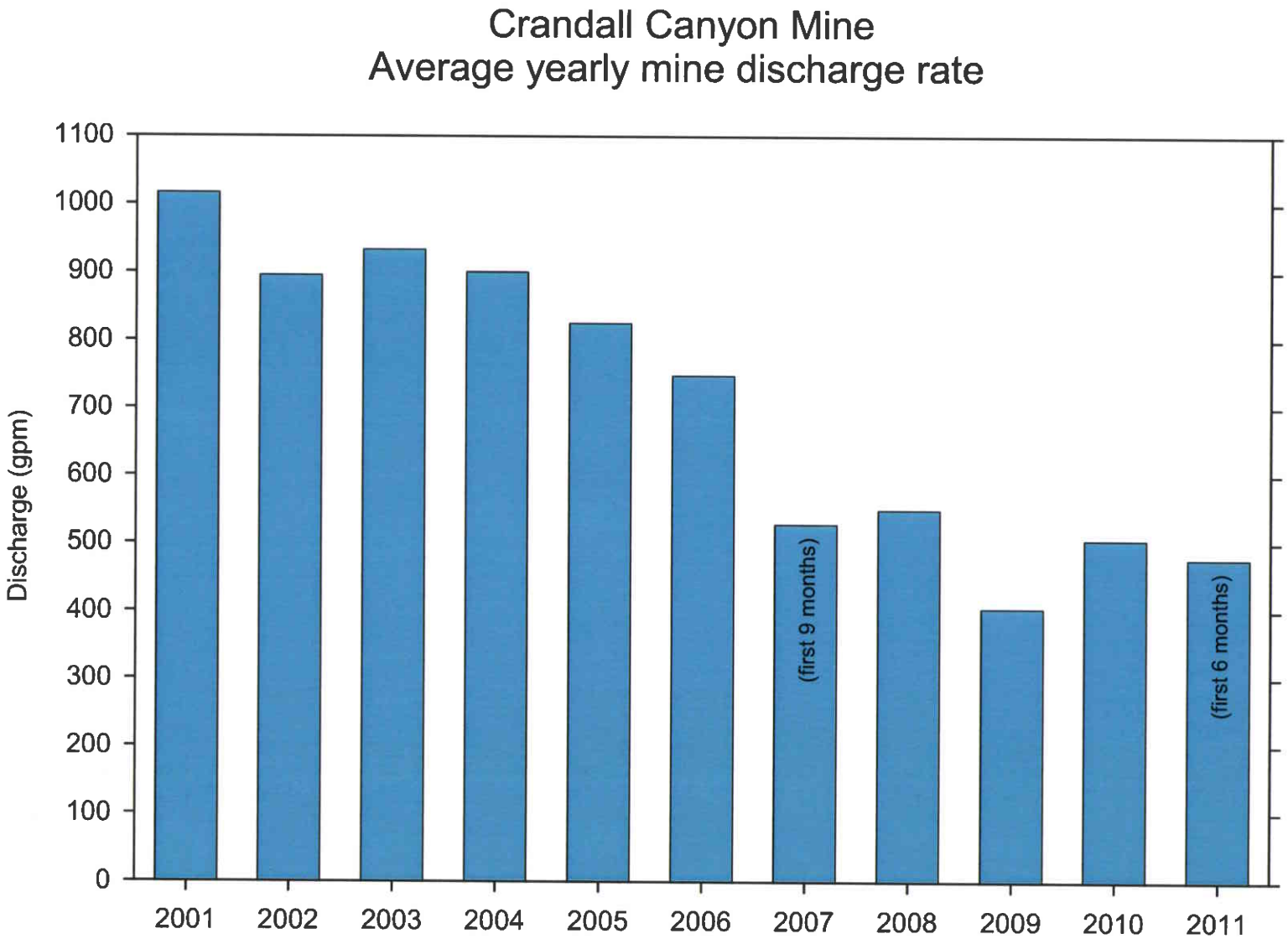
Appendix 7-66
Figure 1



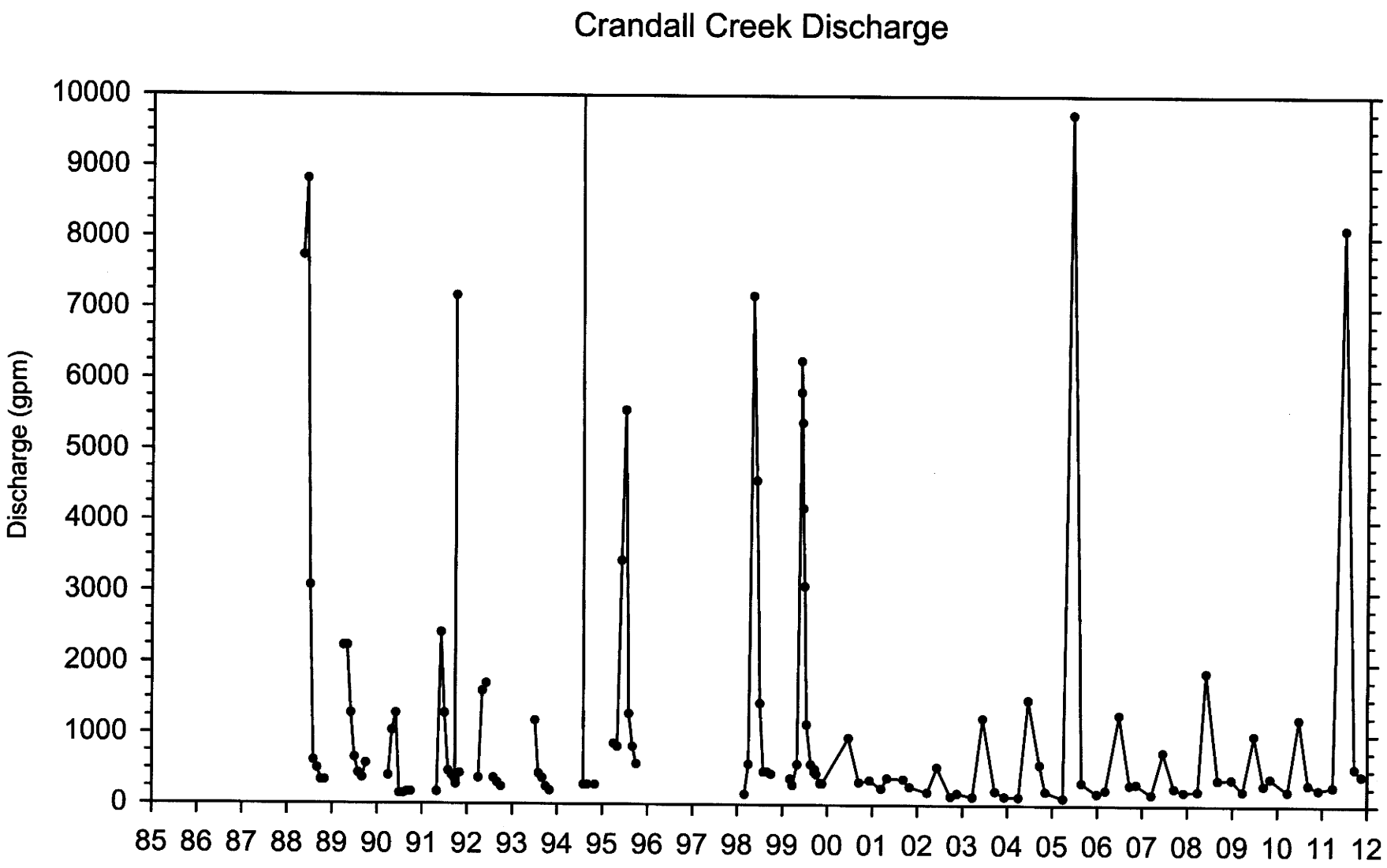
Appendix 7-66, Figure 4 Plot of Crandall Canyon Mine discharge rates.



Appendix 7-66, Figure 3 Plot of Crandall Canyon Mine discharge rates, 6-month running average.



Appendix 7-66 Figure 4 Average yearly mine water discharge rates for the Crandall Canyon Mine.



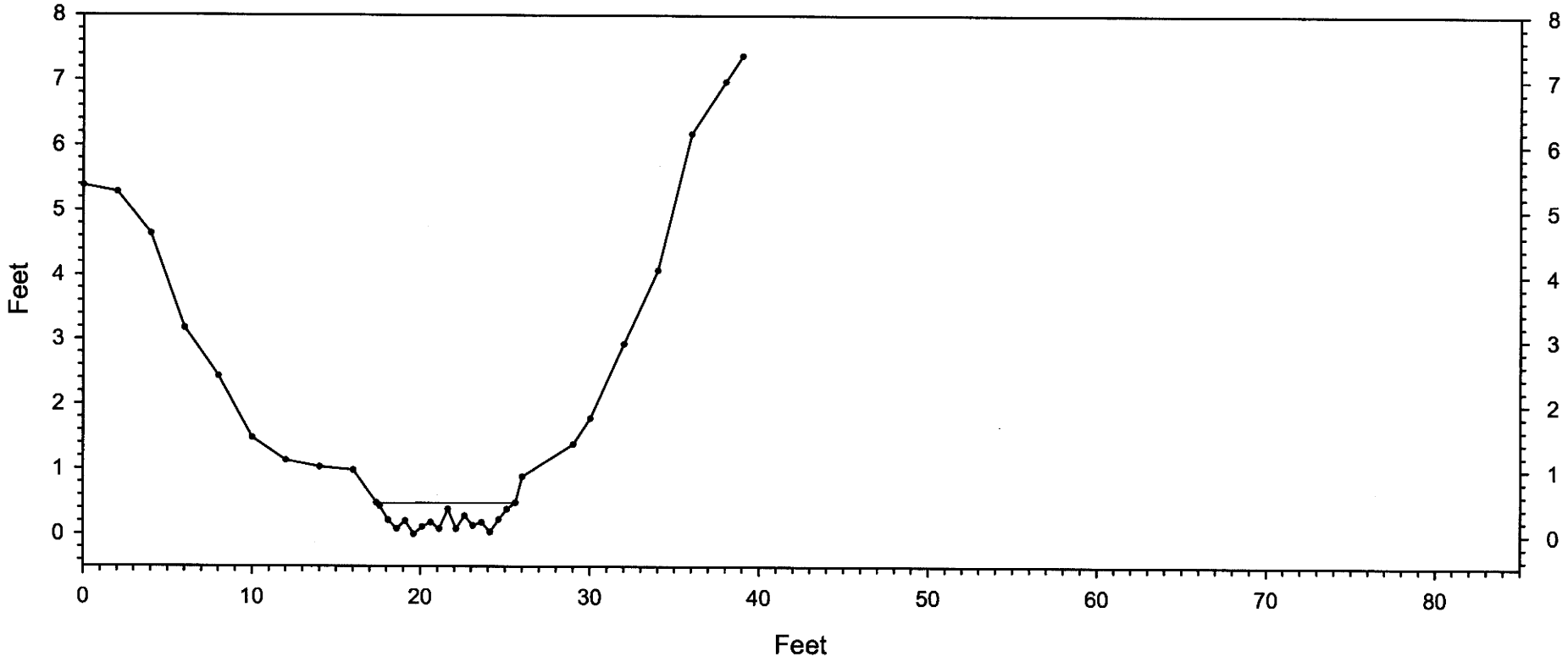
Appendix 7-66 Figure 5 Discharge hydrograph for Crandall Creek above the mine discharge location.

Appendix 7-66

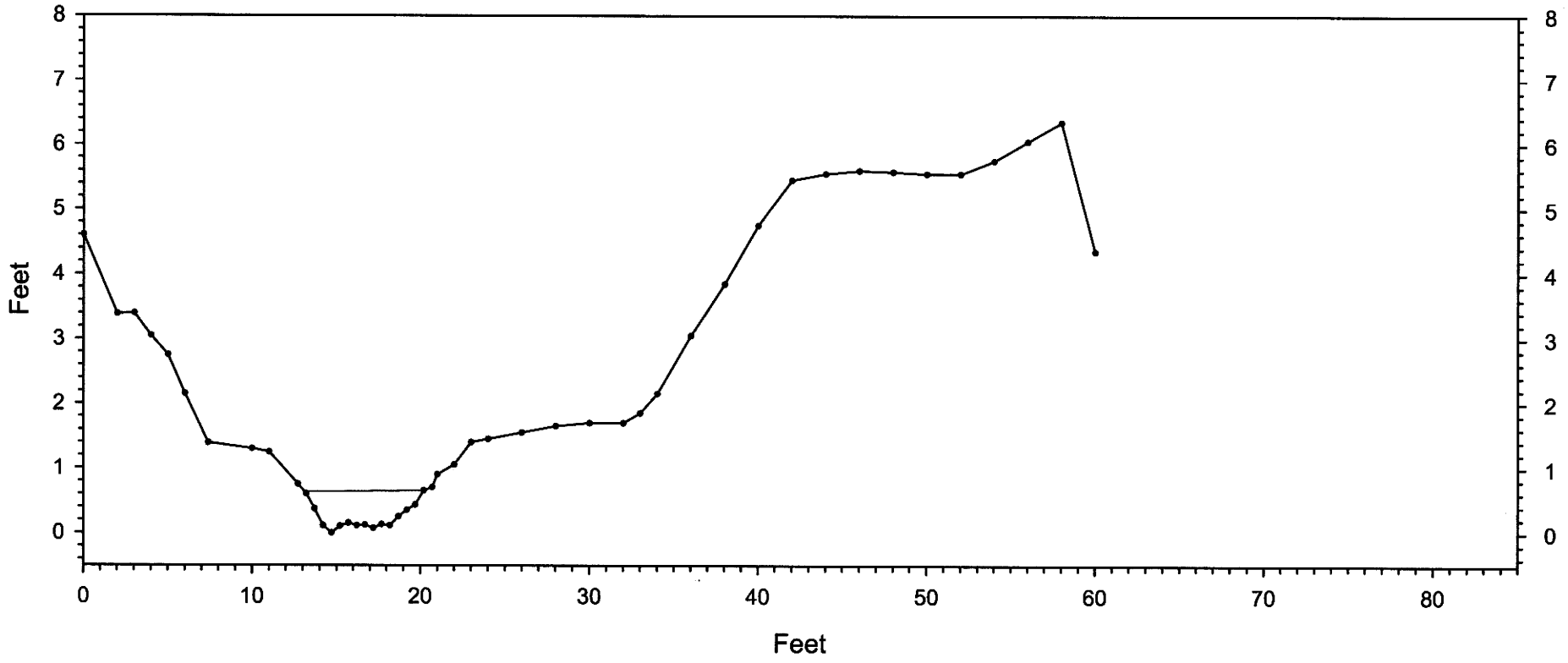
Attachment A

Crandall Creek
Stream Morphology Profiles

ST-1



ST-2



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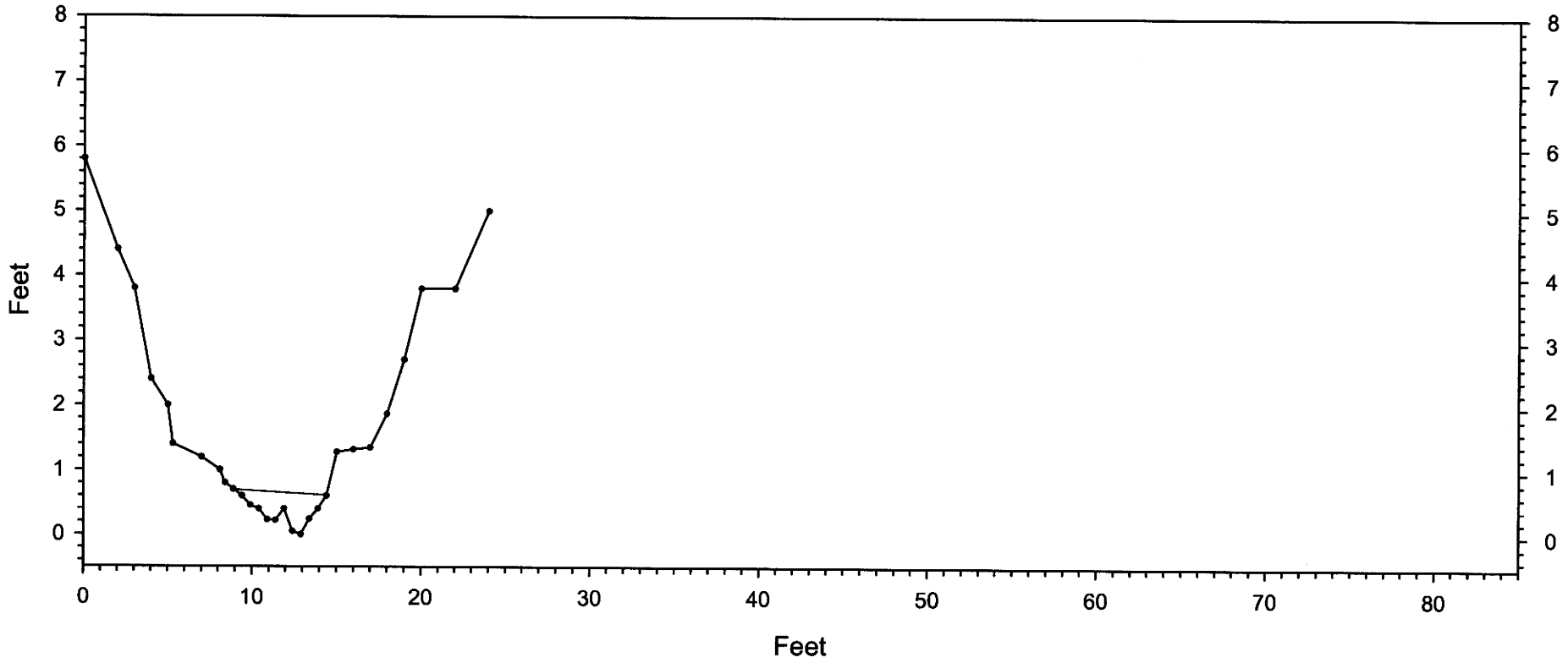

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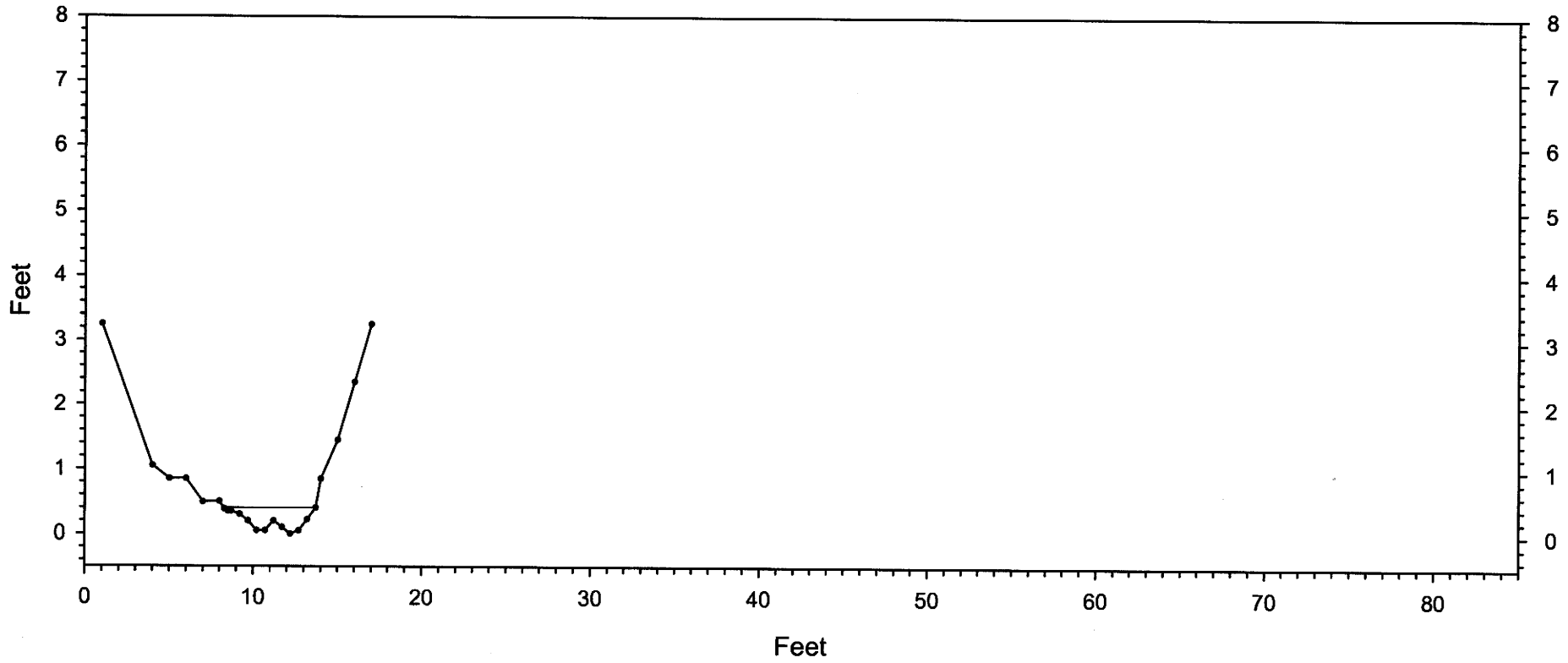

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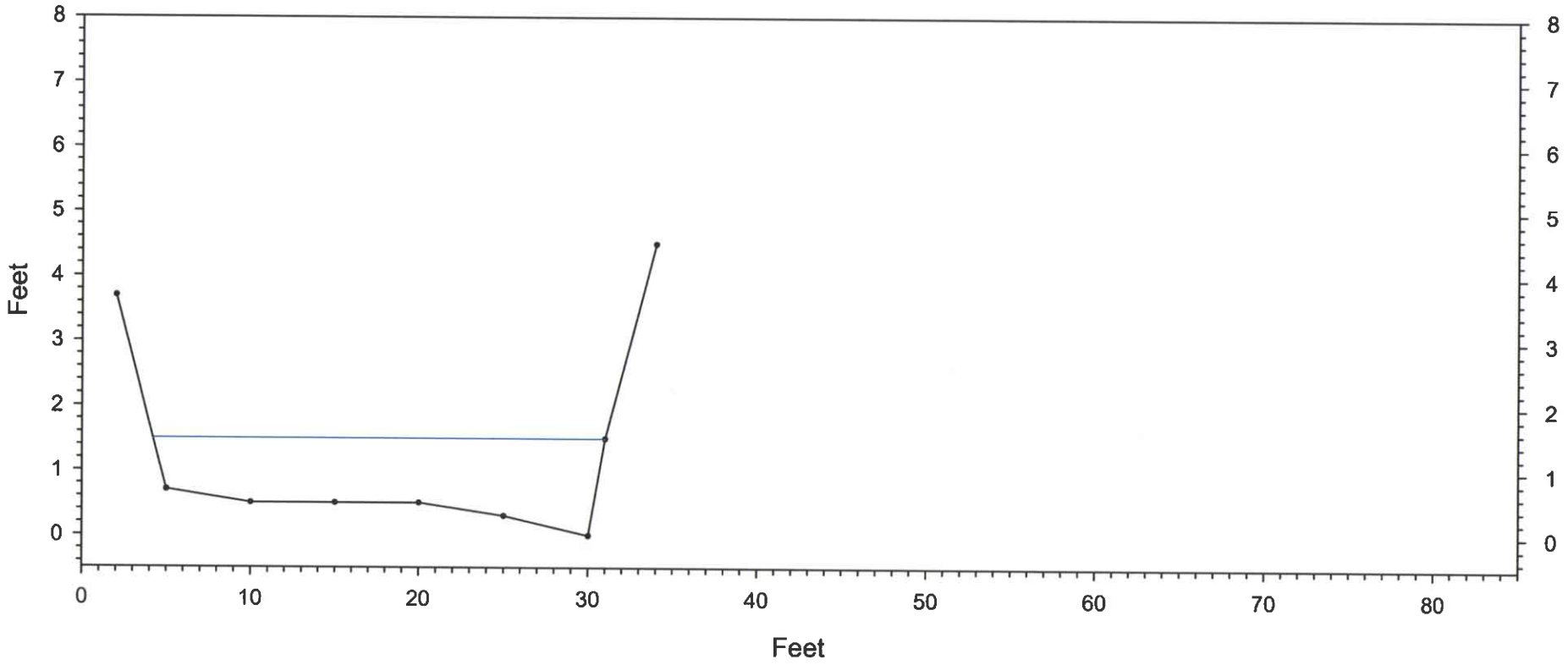
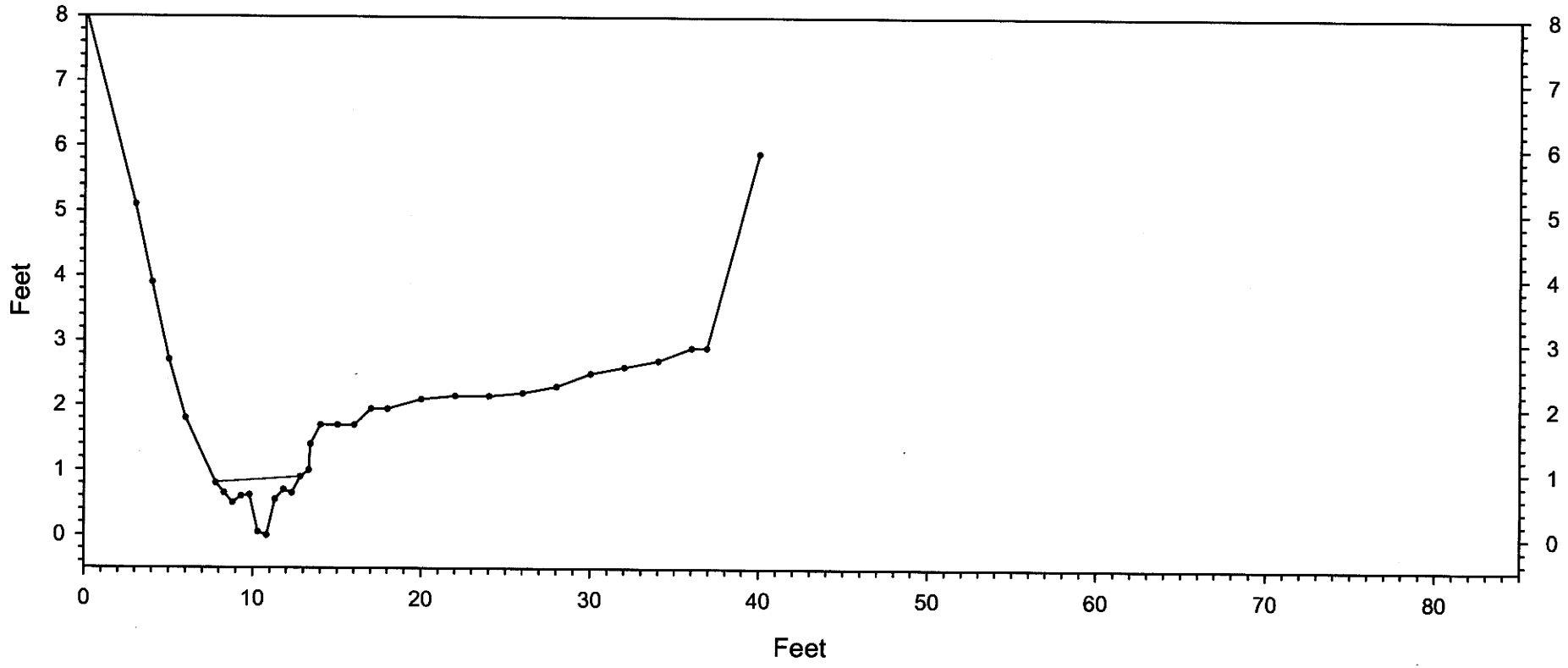


ST-6



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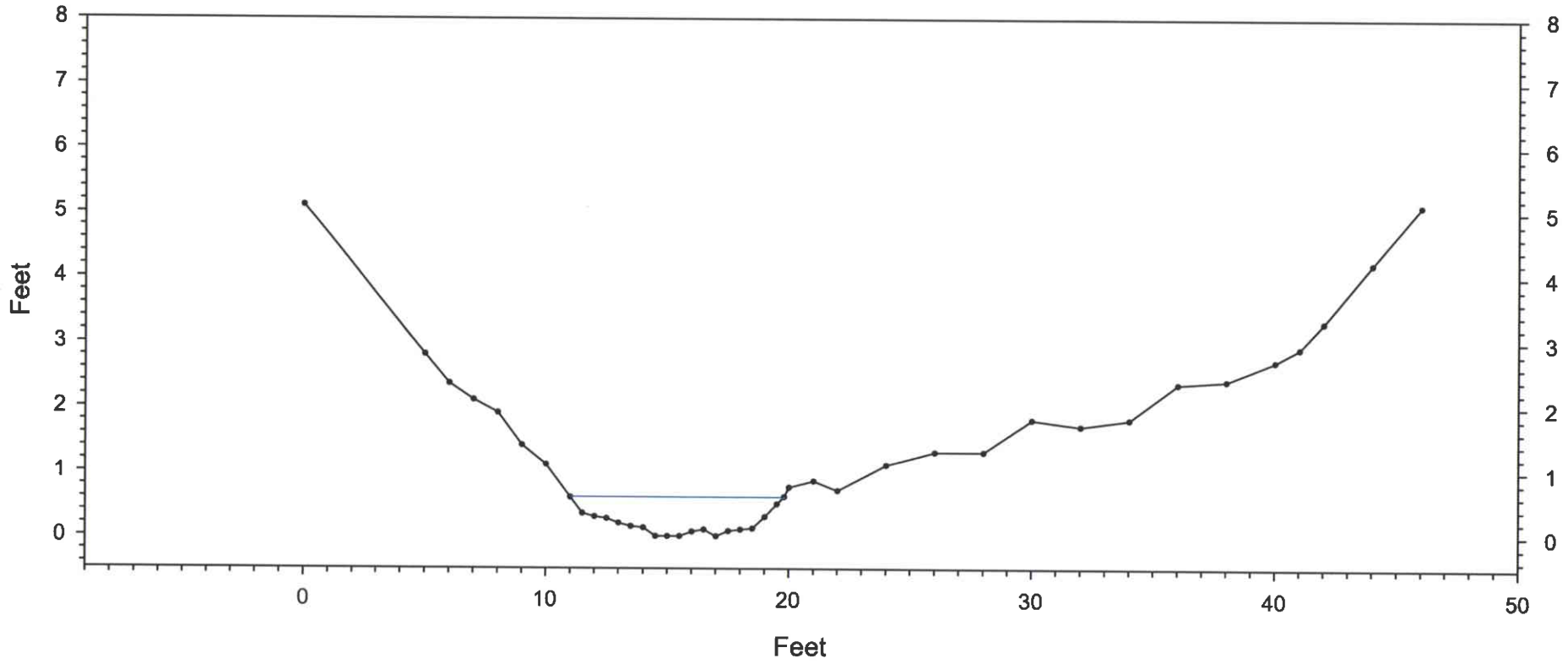
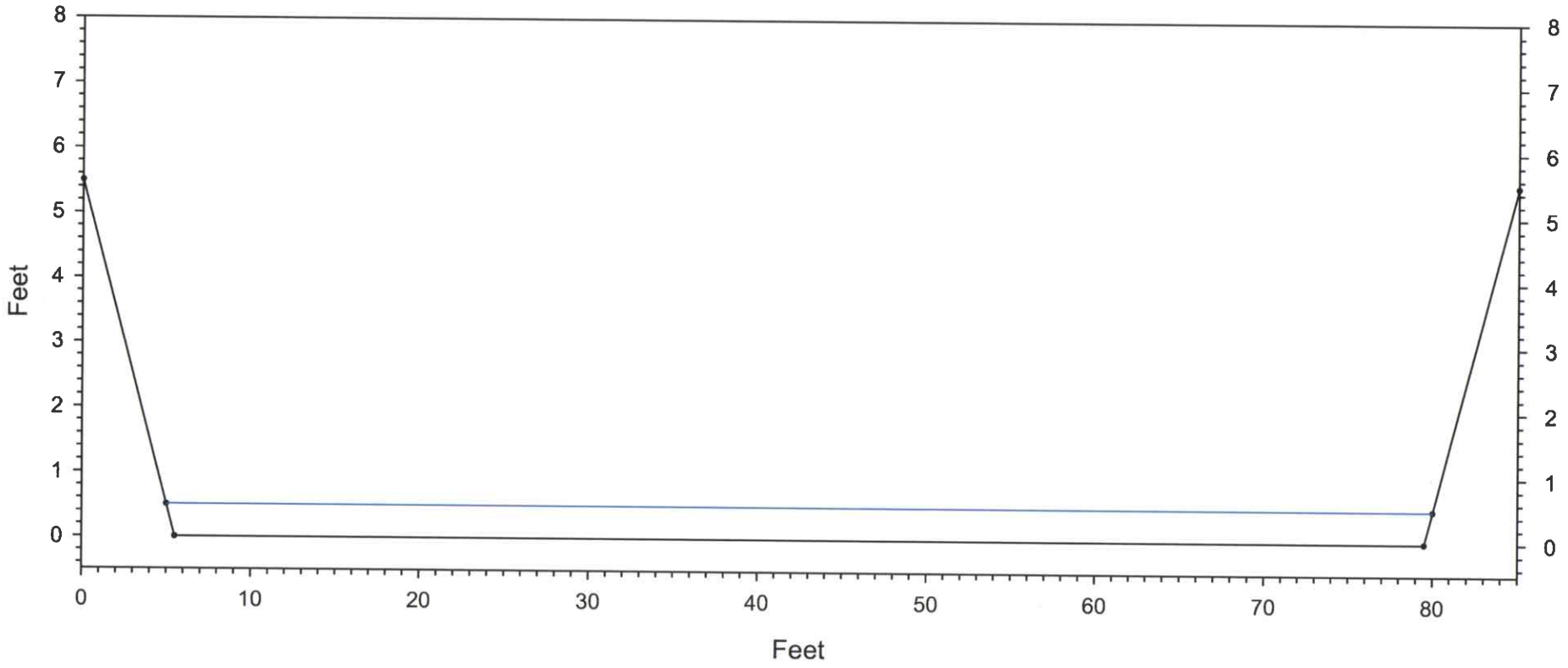
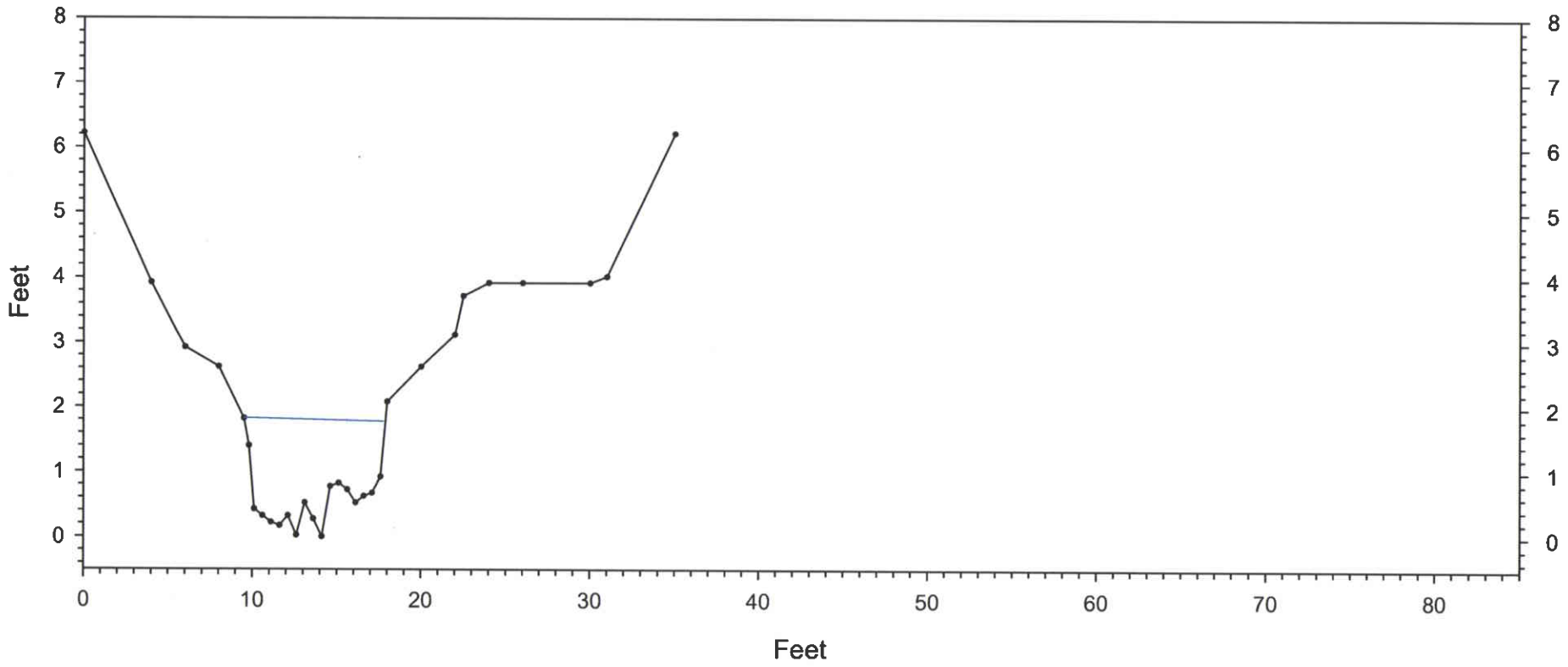


ST-8



ST-9



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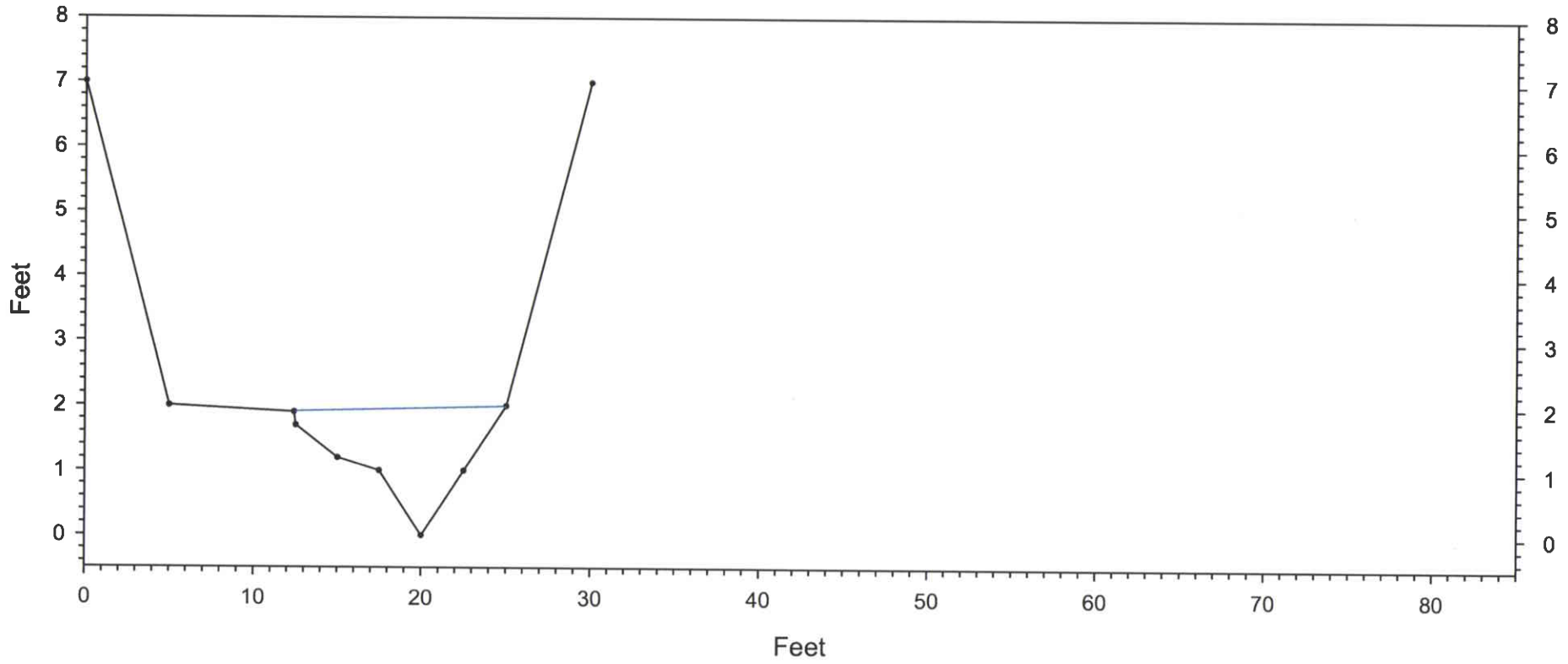
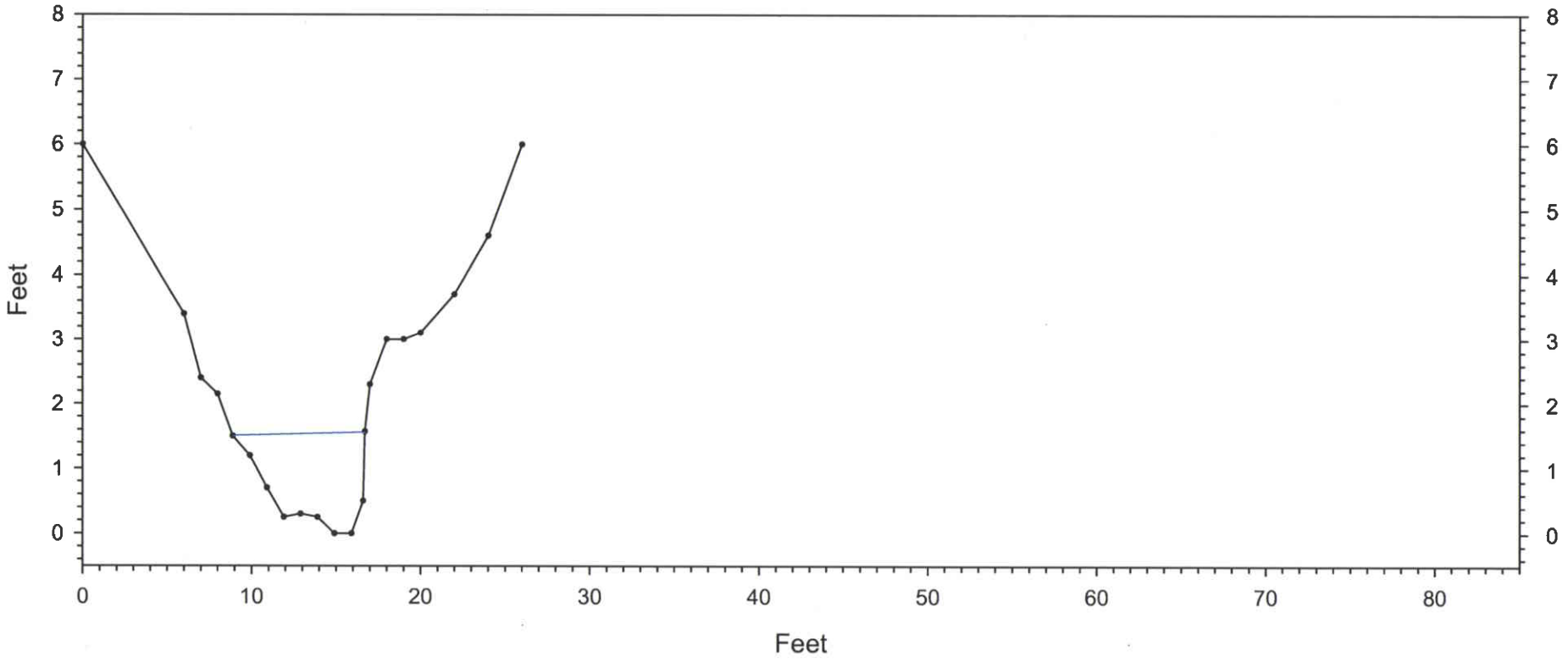
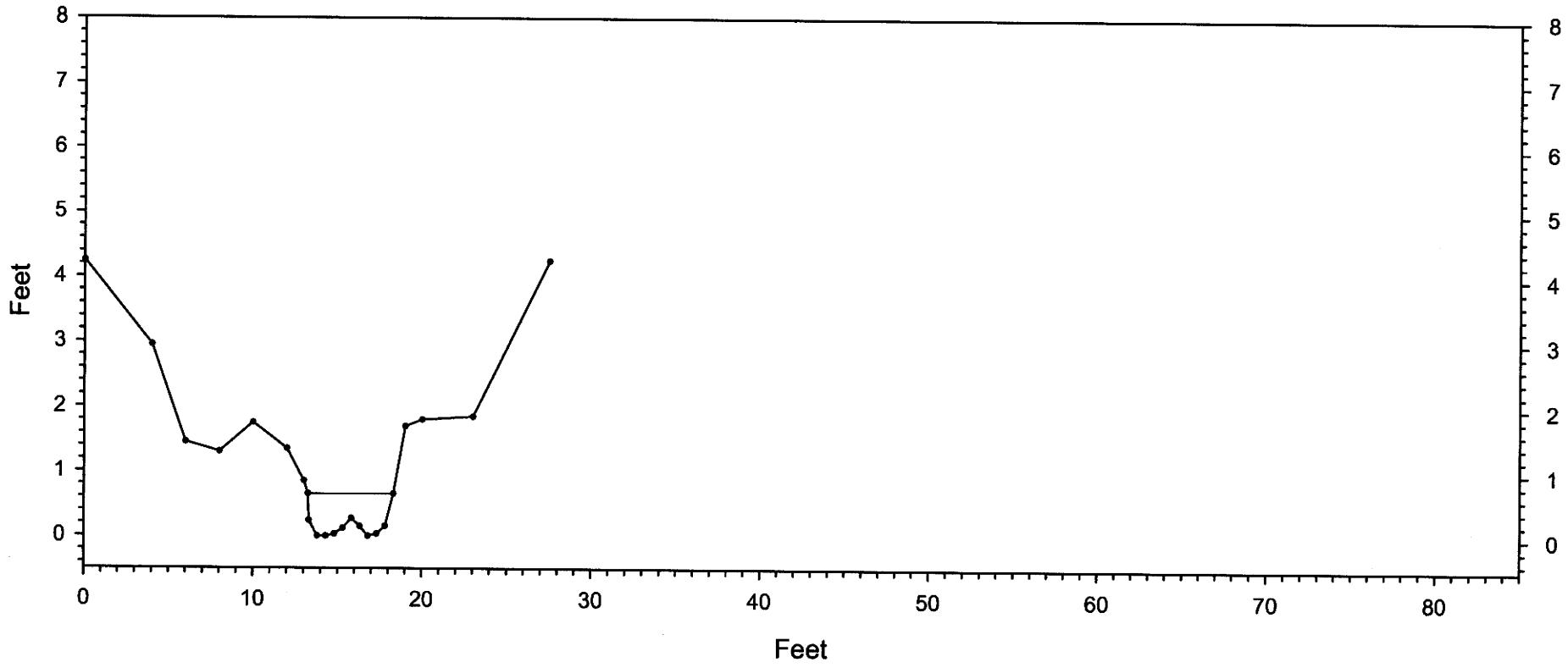
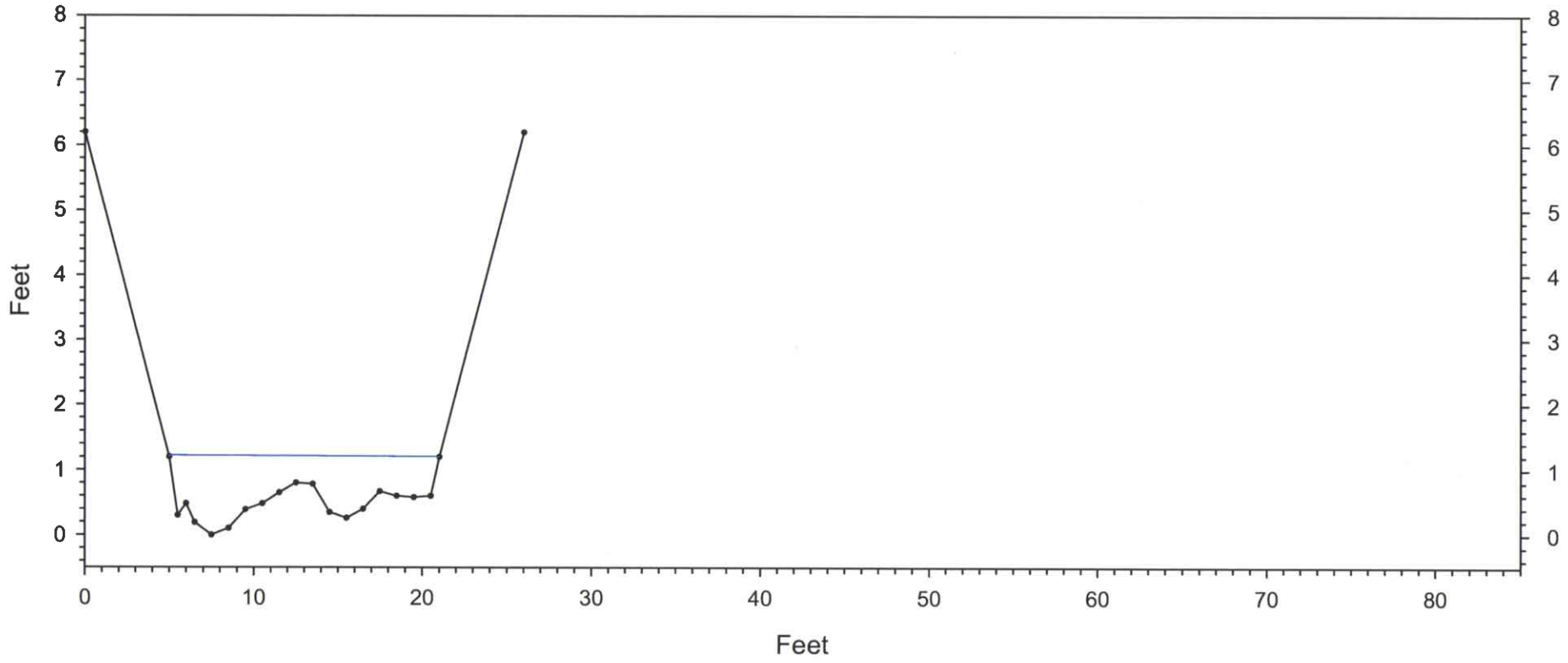


ST-11



ST-12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