U.S. Environmental Protection Agency

Third Five-Year Review Report for Silver Bow Creek/Butte Area Superfund Site

Volume 3: Butte Mine Flooding Operable Unit

June 2011

Final

REMEDIAL ACTION CONTRACT
FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME-CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR THREATENED RELEASE OF HAZARDOUS SUBSTANCES IN EPA REGION 8

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FINAL

Third Five-Year Review for the Silver Bow Creek/Butte Area NPL Site Butte, Montana

Volume 3: Butte Mine Flooding Operable Unit

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Acronyms

ACMC	Anaconda Copper Mining Company
AMD	acid mine drainage
amsl	above mean sea level
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirements
ARCO	Atlantic Richfield Company
ASARCO	American Smelting and Refining Company
BABCGWA	Butte Alluvial and Bedrock Controlled Groundwater Area
BMFOU	Butte Mine Flooding Operable Unit
BPSOU	Butte Priority Soils Operable Unit
BSBC	Butte/Silver Bow County
CD	consent decree
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System
CFR	Code of Federal Regulations
CGWA	Controlled Groundwater Area
CTEC	Citizens Technical Environmental Committee
CWL	critical water level
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resources
EE/CA	engineering estimate/cost analysis
EPA	U. S. Environmental Protection Agency
ESD	explanation of significant differences
FS	feasibility study
gpm	gallons per minute
HDS	high density sludge
HSB	Horseshoe Bend
IC	Institutional Control
LAO	Lower Area One
MBMG	Montana Bureau of Mines and Geology
MCL	maximum contaminant level
mg/L	milligrams per liter
MR	Montana Resources
mrem/yr	millirems per year
MSD	Metro Storm Drain
NPL	National Priorities List
O&M	operation and maintenance
OU	operable unit

pCi/L	picocuries per liter
PRP	potentially responsible party
RAO	remedial action objective
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RPM	Remedial Project Manager
SD	settling defendant
Site	Silver Bow Creek/Butte Area Superfund Site
TSS	total suspended solids
UAO	Unilateral Administrative Order
USGS	U.S. Geological Survey
WET	whole effluent toxicity
WSP	Warm Springs Ponds
WTP	water treatment plant
μg/L	micrograms per liter

Section 1 Introduction

The U.S. Environmental Protection Agency (EPA) Region 8 has conducted a five-year review of the response actions implemented at the Silver Bow Creek/Butte Area Superfund Site (Site), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Information System (CERCLIS) ID: MTD980502777 in Silver Bow and Deer Lodge counties, Montana. This review covers activities conducted from January 2005 through December 2009. This section of the report focuses on Butte Mine Flooding Operable Unit (BMFOU) 03; separate volumes have been prepared that focus on the other Silver Bow Creek/Butte Area Site Operable Units (OUs). This is the third five-year review for the Site; however, this is the second five-year review for the BMFOU. This volume documents the results of the review. The purpose of the five-year review is to determine whether the remedies in place at the BMFOU are protective of human health and the environment. The methods, findings, and conclusions of the reviews are documented in five-year review reports. In addition, five-year review reports identify deficiencies found during the review, if any, and recommendations to address them. The BMFOU is one of seven OUs comprising the Site.

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Section 2
Site Chronology

Table 2-1 presents important site events and relevant dates for the BMFOU. The identified events are selective, not comprehensive.

Table 2-1
Chronology of Site Events

Event	Operable Unit	Date
Placer gold discovered in Silver Bow Creek.	All	1864
Large scale underground mining in Butte.	03/08	1875 - 1955
Major smelting period in Butte.	03/08	1879 - 1900
Open pit mining at Berkeley Pit.	03	1955 - 1982
Anaconda Copper Mining Company (ACMC) merged with the Atlantic Richfield Company (ARCO) with a full assumption of liability.	All	1977
Discovery of mining-related contamination along Silver Bow Creek between Butte and Warm Springs, Montana.	01	September 1, 1979
Mining at the Berkeley Pit ceases; the underground dewatering pumps in the Kelley mine are shut off. Underground workings and Berkeley Pit begin flooding with groundwater.	03	1982
Hazard Ranking System Package Completed.	All	December 1, 1982
Silver Bow Creek Site proposed to the National Priorities List (NPL).	All	December 30, 1982
Mining at the Continental Pit ceases. Water from the Horseshoe Bend (HSB) seep is diverted into the Berkeley Pit.	03	1983
Silver Bow Creek Site (original portion) listed as Final on the NPL.	All	September 8, 1983
Mining resumes in Continental Pit by Montana Resources (MR). Operations include heap leaching of old Berkeley Pit waste rock.	03	1986
Silver Bow Creek (original portion) Phase I Remedial Investigation Final Report.	All	January 1987
Butte Area portion added to Silver Bow Creek Site by Federal Register Notice.	02	July 22,1987
Record of decision (ROD) for Butte Mine Flooding OU.	03	September 29, 1994
Remedial Action Start	03	September 3, 1996
HSB water is diverted away from the Berkeley Pit and pumped up to the Yankee Doodle Tailings Pond.	03	1996
MR ceases heap leaching and begins pumping Berkeley Pit water to the precipitation plant to extract copper from the water.	03	1998
1.3 million cubic yard landslide on the southeast highwall of the Berkeley Pit raises the water level 2.5 feet.	03	1998

Table 2-1
Chronology of Site Events

Event	Operable Unit	Date
Initial five-year review Silver Bow Creek/Butte Area Site with emphasis on Warm Springs Ponds (WSP) OUs.	04/12	March 23, 2000
MR ceases mining in Butte due to rising electricity costs. Horseshoe Bend water flows into the Pit, triggering planning and construction of the HSB water treatment plant (WTP).	03	2000
Explanation of significant differences for BMFOU.	03	March 2002
Consent decree (CD) for BMFOU.	03	August 14, 2002
Construction of HSB WTP.	03	2002-2003
MR resumes mining and the HSB WTP goes on line. Treated HSB water is recycled and used in mine operations.	03	2003
First HSB WTP performance test.	03	2003
MR resumes pumping Berkeley Pit water to the precipitation plant for copper extraction.	03	2004
Second five-year review for Silver Bow Creek/Butte Area Site, with emphasis on WSPOUs.	01, 03, 04, 07, & 12	September 2005
HSB WTP performance test.	03	November 2007
Third five-year review for Silver Bow Creek/Butte Area Site.	04/12, 01, 03, 07, 08	September 2010

Note: Chronology details from PITWATCH 2009

Section 3 Background

3.1 Location and Setting

The BMFOU is part of the Silver Bow Creek/Butte Area National Priorities List (NPL) site and is located in and near the cities of Butte and Walkerville, Montana (Figure 3−1). The remedy for the BMFOU addresses contaminated water in the Berkeley Pit, contaminated water in associated underground mine workings, and other contaminated inflow to Berkeley Pit and BMFOU. The primary objective of the remedy is to protect human health and the environment from actual and potential risks posed by contaminated bedrock aquifer and the rising contaminated waters within the BMFOU. The site lies beneath the cities of Butte and Walkerville, as well as beneath the permitted active mine area currently operated by Montana Resources (MR).

The boundaries of the OU are generally the Continental Divide to the east, Metro Storm Drain (MSD)/Silver Bow Creek to the south, Missoula Gulch to the west, the Yankee Doodle Tailings Pond, and upper Silver Bow Creek to the north (which flows directly into the Yankee Doodle Tailings Pond) (Figure 3-2). The OU is within the Butte mining district and covers about 23 square miles. As described in the consent decree (EPA 2002a), the site consists of: (a) the waters within the Berkeley Pit; (b) the underground mine workings hydraulically connected to the Berkeley Pit; (c) the alluvial aquifer near Berkeley Pit which drains into Berkeley Pit; (d) the bedrock aquifers, including the bedrock aquifer water in and near the Continental Pit, (e) other contributing sources of inflow to the Berkeley Pit/East Camp system, including surface runoff, leach pad, stormwater that enters the Berkeley Pit from the Butte Priority Soils Operable Unit (BPSOU), tailings slurry circuit overflows, and Horseshoe Bend (HSB) surface water flows; (f) the Travona/West Camp groundwater system, except if that groundwater discharge becomes part of the BPSOU response actions upon approval by EPA, in consultation with the state; and (g) the surface area designated for the potential development of a sludge repository.

As mentioned in item (f) above, the OU also originally includes the underground workings of the "West Camp" system, which are hydraulically separate from the Berkeley Pit/East Camp workings. The West Camp System is located in the southwest corner of the OU and includes the Travona, Emma, and Ophir mines and their associated underground workings. The East Camp and West Camp systems are separated by bulkheads installed in the late 1950s to reduce the amount of pumping necessary to dewater the mines. The West Camp is considered to be a separate hydrologic system. As is discussed further in Section 3.5, maintenance of the West Camp groundwater (through pump and treat) was shifted to the BPSOU (EPA 2006).

The Berkeley Pit is the major feature of the OU, and it is 1,780 feet deep, encompassing an area of 675 acres. The BMFOU also encompasses thousands of miles of underground mine workings. Groundwater in the East Camp system has been rising since the 1982 when mine dewatering pumping ceased. The volume of water in the Berkeley Pit as of January 4, 2010, was 39.7 billion gallons. The water level as of January 2010 was 5,286 feet above mean sea level (amsl).

Water in the Berkeley Pit, surrounding bedrock aquifer, and the shafts contains high levels of toxic metals and arsenic as a result of water levels rising in the mine workings, and from contaminated surface water inflows. The source of the contamination is acid mine drainage (AMD) which results from the oxidation of sulfide minerals (in the presence of oxygen) to form iron hydroxide, sulfate, and free hydrogen ions (acid).

The Outer Camp System includes the western and northern extent of mine workings that were once connected to the East Camp. The Outer Camp workings were hydraulically isolated long ago, and it is believed that water levels have returned to, or are near, pre-mining conditions.

As mentioned above, active mining continues near the BMFOU in the permit area by MR, primarily for copper and molybdenum. The active mining operations are discussed briefly here, because their milling process operations use site water which affects the water balance in the BMFOU. The reclamation of the active mining operations is addressed by an active hardrock mining permit; the BMFOU addresses certain water issues associated with the active mine. As is discussed in more detail later, MR's shutdown of mining operations in 2000 triggered the need to construct the HSB water treatment plant (WTP). Thus the mine operations are intricately linked with water issues at the BMFOU.

MR operates the Continental Pit to the east of the Berkeley Pit. Waste rock is placed on dumps to the south and east of the Continental Pit. The ore is milled and processed at the MR Concentrator located near the south rim of the Berkeley Pit. The milling process uses treated HSB water, water decanted from the tailings pond, imported fresh water from the Silver Lake pipeline, and excess water pumped from the Continental Pit area.

Tailings from the milling process at the MR Concentrator are pumped as slurry to the Yankee Doodle Tailings Pond. The tailings pond is a settling basin used to decant water from the tailings slurry. Decanted water in the pond is then pumped back to the concentrator for use in the milling operation. The tailings pond occupies an area of about 960 acres.

Currently, MR recovers dissolved copper in the Berkeley Pit water in the precipitation plant. The copper-rich water from the Berkeley Pit flows through concrete cells filled with scrap iron, where the copper is precipitated out of solution as nearly pure copper metal, and iron is dissolved in the water. This iron-rich water is then returned to the Berkeley Pit. MR currently cycles 13 million gallons per day (mgd) of Berkeley Pit water through the precipitation plant, and recovers about 400,000 pounds of copper per month. Because this is a closed-loop process where water is pumped from and returns to the pit, this process does not affect rising water levels.

3.2 Physical Characteristics

3.2.1 Surface Hydrology

Silver Bow Creek is the main stream drainage within the BMFOU. Originally the creek flowed from its origin in the mountains northeast of the tailings pond through the area presently altered by mining activities. Mining and other activities in the area have greatly changed the original channel alignment. Surface water flow above the tailings pond is intercepted by the tailings pond and used as makeup water in the milling process. From the tailings pond to the MR Concentrator, the original Silver Bow Creek channel no longer exists. Surface water in the active mining area is controlled by a series of ditches and ponds which convey runoff and mine process water to various locations, including the Berkeley Pit and concentrator area. From the MR Concentrator to the confluence with Blacktail Creek, the former creek channel has been reconfigured and is known as the MSD (the MSD is part of the BPSOU). Silver Bow Creek "officially" begins at the confluence of the MSD and Blacktail Creek, from which it receives the majority of its flow. From there, Silver Bow Creek flows west and then north, terminating at the Warm Springs Ponds (WSP).

3.2.2 Groundwater Hydrology

The principal geologic rock units within the BMFOU are the alluvium and the bedrock. The alluvium is a sedimentary deposit consisting of unconsolidated and discontinuous layers of sand, silt, clay, and gravel. The alluvium thickness ranges from 130 feet near the leach pads to 600 feet or more southeast of the Berkeley Pit. Underlying the alluvium is igneous bedrock consisting primarily of quartz monzonite. The upper 100 to 200 feet of the bedrock is weathered (oxidized and decomposed) to a clayey material interspersed with rock fragments.

The two main aquifers in the area are the bedrock, which underlies the entire OU, and the alluvium, which was deposited over the bedrock in valleys and drainages. Groundwater in the bedrock occurs in fractures, joints, and mine workings. Currently, groundwater levels in the surrounding bedrock aquifer are higher than the water level in the Berkeley Pit, resulting in radial flow of groundwater from the bedrock toward the Pit (Figure 3-3).

Groundwater in the alluvium flows south from the leach pads area and then west toward the Berkeley Pit. An alluvial groundwater divide exists approximately one mile south of the Berkeley Pit (in the vicinity of Continental Drive and the Butte/Silver Bow County [BSBC] shops). North of this divide, groundwater flows toward the Pit; south of the divide, groundwater flows to the MSD, where it is captured and sent to the Butte Treatment Lagoons system for treatment (under the BPSOU remedy).

The Berkeley Pit is filling with water originating from the surrounding bedrock and alluvial aquifers and also from surface inflows. The water accumulating in the Berkeley Pit and in the bedrock aquifer is acidic from the formation of acid mine drainage and contains high concentrations of metals. Presently, because the water level in the Berkeley Pit is the lowest groundwater elevation in the bedrock system – all bedrock groundwater in the area flows toward the Berkeley Pit. Therefore, contaminated mine water is contained and prevented from migrating off site. However, if water levels were to continue to rise uncontrolled, the hydraulic gradient could change and contaminated water could begin to flow out of the East and West Camps into the surrounding alluvial groundwater and eventually to Silver Bow Creek. To prevent this from occurring, EPA and the state determined that the water levels in the OU must not rise above the critical water level (CWL) elevations (East Camp - 5,410 feet amsl, West Camp - 5,435 feet amsl [U.S. Geological Survey (USGS) datum], as described in the 1994 BMFOU Record of Decision (ROD) (EPA 1994).

3.3 Land and Resource Use

Flooded mine workings underlie the urban areas of Butte and Walkerville, Montana, as well as the active mine area operated by MR. Land use is mixed as would be expected in any urban area, with a mixture of residential, industrial, and commercial uses. The Berkeley Pit, Continental Pit, Yankee Doodle Tailings Pond, and other portions of the active mine area lie to the east and north of the urban areas. Mining in the Continental Pit and copper extraction from the Berkeley Pit water are industrial uses constituting ongoing mineral resource recovery, primarily copper and molybdenum.

3.4 History of Contamination and Initial Response

In July 1955, the Anaconda Copper Mining Company (ACMC) began open pit mining in the Berkeley Pit. In 1963, the Weed Concentrator (now known as the MR Concentrator) became operational. Ore from the Berkeley Pit was processed at this facility, and concentrates were transported to Anaconda, Montana for smelting.

To allow underground and later open pit mining in the Butte area, groundwater was lowered by pumping. In later years, the pumping system was located in the Kelley Mine shaft, just west of the Berkeley Pit. In 1982, pumping was discontinued, and mining was discontinued in the Berkeley Pit in 1983. As a result, the artificially lowered groundwater level in the area has been rising toward its pre-mining level in the underground mines and the Berkeley Pit.

Since July 1986, open pit mining has been conducted in the Continental Pit, located east of the Berkeley Pit. Ore from this pit is transported to the MR Concentrator for milling and processing. The concentrates are shipped off site to various locations throughout the world for smelting and refining.

During the course of the Silver Bow Creek remedial investigation/feasibility study (RI/FS), the importance of Butte as a source of the contamination of Silver Bow Creek was formally recognized. Preliminary results from the Silver Bow Creek RI/FS indicated that sources upstream of the MSD were partly responsible for the contamination observed in the creek. The site was expanded to include the Butte area and the formal name was changed to the Silver Bow Creek/Butte Area Site in July 1987 (52 Fed. Reg. 1987).

Early EPA technical evaluations of the Berkeley Pit and West Camp workings indicated that it would be necessary to control the rate of Berkeley Pit filling to prevent future impacts to the alluvial aquifer and Silver Bow Creek. The evaluations further demonstrated the need to treat the Berkeley Pit water prior to discharge to Silver Bow Creek.

3.5 Regulatory History Summary

The BMFOU is part of the Butte Area portion of the Site. EPA is the lead agency and Montana Department of Environmental Quality (DEQ) is the support agency.

A removal action was implemented in the West Camp Area to control potential impacts of rising mine waters. The purpose of the removal action was to prevent flooding of basements and discharge of contaminated groundwater to Silver Bow Creek. An Action Memorandum describing EPA's cleanup plan was issued by EPA in July 1989. This action was implemented by responsible parties under EPA oversight.

The PRPs were required to convey water pumped from the Travona shaft to the Butte Metro Sewage Treatment Plant for treatment and discharge to Silver Bow Creek. This action also established a preliminary CWL for the West Camp and required the PRPs to maintain the water level elevation within the West Camp System below 5,435 feet (USGS datum) (EPA 1994).

A Unilateral Administrative Order (UAO) (Docket No. CERCLA-VIII-89-18) was issued to the non-consenting PRPs (New Butte Mining Inc. and Tzarina-Travona Mining Corp.) to install the pipeline which carried Travona shaft water to the Butte Metro Sewage Treatment Plant. The non-consenting PRPs complied with this order.

EPA completed the RI/FS work plan for the BMFOU in April 1990 (CDM 1990). A CWL of 5,410 feet (USGS datum) for the East Camp/Berkeley Pit System was established, and the PRPs were required to maintain the water level in the East Camp/Berkeley Pit System below this level. The RI/FS was conducted from July 1990 through January 1994. Site investigations, results, and remedial alternative development and evaluation are presented in the remedial investigation (RI) report (Canonie 1994a) and the feasibility study (FS) report (Canonie 1994b). After issuance of a proposed plan and receipt of public comments, EPA issued a ROD for the BMFOU in September 1994 (EPA 1994).

A UAO (Docket No. CERCLA-VIII-96-19) was issued to ARCO, Montana Resources Inc., American Smelting and Refining Company (ASARCO), and Dennis Washington in 1996 to implement the remedial design/remedial action activities associated with the ROD. The requirements of the ROD were modified in a March 2002 explanation of significant differences (ESD) (EPA 2002b).

A CD was signed between Atlantic Richfield, the MR related entities, the United States, and the State of Montana in June 2002 and entered in federal district court in August 2002. This CD supersedes all previous AOCs and UAOs issued for this OU.

Per the ROD and CD, the cessation in mining operations at MR in 2000 (due to economic factors) triggered construction of the HSB WTP to treat the HSB seep so that it does not contribute to the infilling of the Berkeley Pit. The CD parties complied with these requirements and constructed a treatment plant. The HSB WTP came online in 2003. Treated water from the HSB WTP is currently used in the tailings circuit of the active mining operations and is not discharged to Silver Bow Creek. The ROD and CD also require monitoring of Berkeley Pit water levels so that the HSB WTP will begin treating Berkeley Pit water when the CWL is approached. That monitoring continues.

The 2002 CD and ESD note that alternate treatment methods for management of the West Camp water (i.e., the Travona Shaft Water) could be investigated, including addressing the water as part of the BPSOU. Since that time, the West Camp water has been successfully routed and treated in the BPSOU Butte Treatment Lagoons system (where BPSOU alluvial groundwater undergoes lime treatment). According to the BPSOU ROD, the West Camp groundwater will be routed to the BPSOU hydraulic control channel at Lower Area One (LAO) for treatment through the treatment facility (EPA 2006).

3.6 Basis for Taking Action

The BMFOU is located in the upstream portion of the Site and, thus, a release of contamination from this OU would cause further detrimental impacts to surface water and groundwater in downstream OUs. Remediation in the BMFOU is a priority because of the rate of flooding (currently 5 mgd) and extremely high toxicity to aquatic life of the water contained in the bedrock system and the potential downstream impacts and risks to human health and the environment which would be caused by the release of the contaminated waters. Remedial actions undertaken in the BMFOU will complement future actions in the other Site OUs. Significant cleanup actions have already been initiated for other OUs at this Site to improve water quality in Silver Bow Creek and the Clark Fork River. The action described in the ROD, the 2002 CD and the 2002 ESD will ensure that contamination in the BMFOU will not contribute to the degradation of Silver Bow Creek or the Clark Fork River.

The CWLs have been established by EPA to contain the contaminated water in the Berkeley Pit and West Camp Systems. If either CWL is exceeded, there is the potential for the present hydraulic gradient to change, which could potentially result in the flow of contaminated groundwater in the alluvial aquifer towards Silver Bow Creek. This could result in the potential exposure of aquatic life to contaminants.

Section 4
Remedial Actions

Summaries of the remedial actions selected, their implementation, and operations and maintenance (O&M) activities for the BMFOU are presented below.

4.1 Remedy Selection

The overall remedial action objective (RAO) established for the BMFOU in the 1994 ROD is:

- To prevent human and aquatic exposure to contaminated groundwater and surface water.

This overall objective will be met through implementation of the selected remedy in the 1994 ROD, as amended by the 2002 ESD (EPA 1994 and EPA 2002b):

- All surface water from the HSB area is intercepted and treated using a high density lime precipitation treatment system. This treated water is either recycled back into the MR mining operations or discharged into Silver Bow Creek.[1]

- The water level in the Berkeley Pit system is kept below the CWL (5,410 feet) through pumping, treatment as described above, and discharge to Silver Bow Creek (or used for some other beneficial uses).

- The BMFOU monitoring plan tracks the elevations and quality of water inflows into the Berkeley Pit and West Camp Systems against the CWL for both the Pit and the West Camp. This information is updated annually and used in models of the Berkeley Pit and West Camp to provide EPA and DEQ with a projected date at which the CWLs will be met. The effectiveness of this monitoring plan is reviewed every 3 years by both EPA and DEQ.

- Produce a focused FS 24 months before mine closure or before the Berkeley Pit reaches the CWL. At that time, EPA will evaluate all existing and emerging technologies to provide EPA with information to select a final treatment technology for the Berkeley Pit water before discharge of this water into Silver Bow Creek. This treatment technology will treat the Berkeley Pit water to the State of Montana and other pertinent water quality standards.[2]

- Institute a long-term, comprehensive monitoring program.

- Implement an institutional control (IC) program to restrict use of contaminated groundwater using land and water use restrictions, along with access controls.

[1] Discharge to Silver Bow Creek has not yet occurred. To date, all water treated at the HSB WTP has been recycled back into the MR mining operations.
[2] This requirement was changed in the 2002 ESD.

- Create and implement a public education program to inform the public on the progress of the Mine Flooding project.

An ESD (EPA 2002b) modifies the selected remedy ROD in the following ways:

- It adds more stringent contaminant requirements for the water discharge from the treatment plant. The cadmium standard was the most important standard made more stringent by the ESD because of a post-ROD change in water quality standards by the State of Montana.
- It acknowledges DEQ's primary responsibility for operations and reclamation of the active mine area and the Yankee Doodle Tailings Pond and EPA's responsibility for the sludge repository operations.
- It acknowledges EPA's prior decision to send West Camp contaminated water into the BPSOU as long as it can be handled effectively there.
- It notes that a full FS level examination of different treatment options for the mine flooding water is no longer required.
- It allows stormwater from uptown Butte to be diverted to the Berkeley Pit and sludge from the HSB WTP to go to Berkeley Pit.

The above summary describes only the major actions required in the selected remedy. A complete description of all the remedy requirements is contained in the ROD and the ESD.

4.2 Remedy Implementation

On April 15, 1996, the PRPs instituted the inflow control program by capturing and integrating the HSB discharge into the mining process at the MR Mine. However, a hiatus in MR mining operation from July 2000 to September 2003 triggered construction of a WTP for the HSB discharge. The HSB WTP was completed and came online in 2003. Importantly, treated HSB water is not discharged to Silver Bow Creek at this time, and will not discharge into Silver Bow Creek until mining operations cease or CWL within the Berkeley Pit System is reached. The treated HSB water is utilized in the MR mining operations.

Treatment of West Camp waters at Butte Metro Sewage WTP terminated in 2002 in favor of treatment in the BPSOU Butte Treatment Lagoons along with other BPSOU groundwater. This decision was incorporated in to the 2006 BPSOU ROD.

In the 2002 ESD, the requirement to conduct a focused FS to determine the best treatment technology was changed instead to evaluate if the existing HSB WTP can treat the combined HSB and Berkeley Pit flows. This evaluation must be completed four years before reaching the CWL. The current estimate for reaching the critical water level is in 2022, thus this evaluation should occur in 2018 if current projections are accurate. Any necessary upgrades to the WTP must be completed two years before the CWL.

The BMFOU Monitoring Plan has been implemented. EPA provides funding to DEQ through a cooperative agreement so that DEQ can contract with the Montana Bureau of Mines and Geology (MBMG) for monitoring support services. MBMG takes monthly water levels and water quality data are collected periodically (Table 6-4) which is reported as outlined in the 2002 CD. Results of the ongoing monitoring are presented in Section 6.

A ban on domestic use of the BMFOU aquifer was issued by the Department of Natural Resources Conservation (DNRC) and is currently in effect (DNRC 2009). Implementation of ICs for the BMFOU was evaluated for this five-year review. The results of this evaluation are presented in Section 6 as part of the data review.

4.3 System Operations and Maintenance

This section summarizes issues and costs related to the O&M of the HSB WTP. The HSB WTP is the primary remedy component with an ongoing O&M component (implementation of ICs and ongoing groundwater monitoring are portions of the remedy, but these programs are administrative in nature and are evaluated differently). Therefore, the O&M for the BMFOU remedy presented in this five-year review will be limited to the HSB WTP. In subsequent five-year reviews, O&M of other portions of the remedy for the BMFOU will be discussed as they are completed.

4.3.1 General System Operations

The HSB WTP is a two-stage high density sludge (HDS) lime precipitation water treatment system consisting of two primary treatment units and five ancillary process systems. The primary treatment units include first and second stage pH adjustment reactors and first and second stage clarifiers. The four ancillary processes include the influent control system, effluent control system, lime feed system and the polymer feed system.

The treatment facility is fully automated with remote alarm indication. The major treatment components of the WTP such as lime feed, influent pumps, effluent pumps, aeration blowers, polymer feed pumps and clarification stages have completely redundant systems to eliminate downtime due to equipment failure. Major tanks in the WTP process were constructed of concrete to provide longevity. The WTP is also equipped with an automated effluent control loop. If effluent exceeds the acceptable pH range, this system will automatically send water back to Berkeley Pit rather than discharge to Silver Bow Creek.

The WTP was designed with operational flexibility provided by variable frequency drives on influent, effluent, and sludge pumps that can vary influent rates to the plant. This “turn-down” capacity also reduces power consumption at lower flows to the WTP.

4.3.2 Summary of O&M Events

The following provides a brief summary of some of the significant O&M activities and plant modifications that have taken place between the period 2003 and 2009.

Table 4-1
Maintenance Activities and Plant Modifications

Year	Description
2003-2006	1. Reactor pH probes were relocated upwell of the reactors to minimize probe fouling and improve operator access.
	2. Lime slaker control programming was modified to provide continuous operation of the slaker and consistent lime slurry tank level control.
	3. Operation of the reactor air blowers was discontinued since suitable water quality for use in the mine process was achieved without blower air, and no significant change in lime consumption was observed.
	4. Operational experience has shown the necessity to perform annual clean-out of the reactor/clarifiers to manually remove the scale build up.
	5. The addition of scale inhibitors to the clarifier overflow to protect the pipelines and effluent pumps became necessary.
	6. Annual overhaul of the clarifier sludge pumps was determined to be a necessary routine maintenance activity.
	7. Both influent and effluent pumps were pulled for inspection, and minor repairs were made to the effluent pumps.
	8. There were no mechanical failures of the major equipment components of the WTP during this time period.
2007	1. Both reactor/clarifiers were taken down, one at a time, for routine cleaning, de-scaling and inspection.
	2. Both clarifier sludge pumps were changed out for overhaul.
	3. Both effluent pumps were also overhauled.
2008	1. Water flows through the WTP were switched to operate as single stage alkalization in parallel through the reactor/clarifier units.
	2. A side stream test was performed to evaluate the potential of adding a scale inhibitor to the reactor sludge in an attempt to reduce the scaling that occurs in the reactor/clarifiers.
2009	1. Both reactor/clarifiers were taken down, one at a time, for routine cleaning, de-scaling and inspection.
	2. A plant trial to evaluate the addition of a scale inhibitor to the reactors, in an attempt to reduce the scaling tendency in the reactor/clarifiers was undertaken.
	3. Both stage one and stage two clarifier sludge pumps were replaced and sent for repair.

Since the last reporting period, continued operations of the treatment plant have resulted in improved O&M activities with a more focused preventative maintenance program. Annual maintenance activities now include overhauling both clarifier sludge pumps and effluent pumps. The reactors and clarifiers are also taken down one at a time on an annual basis for routine cleaning, de-scaling and inspection. When this occurs, all flow is treated in a single stage treatment train using the other operating reactor and clarifier.

In addition, the treatment plant operations have been optimized since the last reporting period. Major changes to plant operations include adding an anti-scalant to the second stage clarifier overflow to minimize effluent pipeline scaling from gypsum. In addition, operation of the reactor blowers have been discontinued since suitable water quality for use in the mine process was achieved without blower air and no significant change in lime consumption was observed. Finally, current testing is underway to evaluate the addition of a scale inhibitor to the reactor sludge in an attempt to reduce the scaling that occurs in the reactors and clarifiers.

Table 4-2 shows a summary of the treatment flows and reagent additions during the period of 2003 through 2009.

Table 4-2
Water Treatment Flow and Reagent Use Summary

Year	Volume Treated (1)	Sludge Discharge (2)	Lime Grit Discharge (2)	Lime Usage	Polymer Flocculant Usage	Scale Inhibitor Usage
	(MG)	(MG)	(MG)	(tons)	(pounds)	(gallons)
2003	114.19	NR	NR	646	NR	
2004	536.87	26.07	7.91	4,115	NR	1,550
2005	1,184.41	51.08	5.07	9,117	NR	2,445
2006	1,642.74	110.80	18.89	14,952	24,825	1,945
2007	1,788.80	68.02	8.70	13,603	23,475	4,581
2008	1,787.03	81.78	15.05	14,775	19,842	5,754
2009	1,852.11	120.29	8.99	14,636	25,350	6,528

NR = Not Reported
MG = million gallons
(1) Effluent discharged to MR mining operations
(2) Discharge to Berkeley Pit

4.3.3 Estimated Annual O&M Costs

Because the operation of the HSB WTP is part of an active mining operation, MR prefers not to disclose the O&M costs of its operation. Further, as the WTP is being operated to treat water to be suitable for use in the mine circuit, the costs would not reflect eventual costs to treat the water to discharge standards.

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Section 5
Progress Since Last Review

This section discusses the performance of the remedy implementation to date at the BMFOU.

5.1 Evaluation of Butte Mine Flooding OU

Implementation of the remedy is not complete at the BMFOU. The following bullets list the major work completed since the last review.

- Monitoring of ground water levels and chemistry (and adjustments as necessary).
- Conducting a second performance test of the HSB WTP in 2007.
- Operation of the HSB WTP. Even though the HSB WTP is not currently operated to meet surface water discharge standards, the continued operation of the WTP will aid in the design improvements and operation of the treatment plant once it must start discharging to Silver Bow Creek.
- Ongoing public education and outreach, particularly through the periodic publication of the PITWATCH fact sheet.
- Official implementation of the controlled groundwater area (CGWA) ("well ban") in conjunction with the BPSOU (the Butte Alluvial and Bedrock Controlled Groundwater Area – BABCGWA) in 2009 (DNRC 2009).
- Annual updating of the Berkeley Pit filling model to project the date of the critical water level.

5.2 Previous Statement on Protectiveness

No previous statements on protectiveness were made in the 2005 five-year review report for BMFOU because the remedy has not been fully implemented.

5.3 Status of Previous Recommendations and Follow-Up Actions

Table 5-1 lists the issues and recommended follow up actions from the previous five-year review report and summarizes the outcome. The specific reports and data reviewed are summarized in Section 6.

Table 5-1
Actions Taken Since the Last Five-Year Review

Issues from Previous Review	Recommendations/ Follow-Up Actions	Party Responsible	Milestone Date	Action Taken and Outcome	Date of Action
The HSB WTP did not meet the final cadmium performance criterion, which is required when discharge to Silver Bow Creek occurs.	Atlantic Richfield and MR to conduct additional performance testing. If the testing shows that the final cadmium standard cannot be met at the HSB WTP without further modification, Atlantic Richfield and MR will explore potential additional treatment solutions or perform a protectiveness analysis to determine if the discharge is protective of Silver Bow Creek despite inability to meet the cadmium standard.	Atlantic Richfield	Complete	Conducted performance test and determined optimum pH of second stage reactor/ clarifier to be 11.2, which met discharge limit. Performance testing will continue.	September 30, 2008

Section 6
Five-Year Review Evaluation

The five-year review team was lead by Roger Hoogerheide, an EPA Remedial Project Manager (RPM), and included EPA and state of Montana project managers of the OUs covered in the review, and technical staff from EPA's contractor, CDM, with expertise in areas of environmental engineering, hydrogeology, geochemistry, chemical engineering, risk assessment, and community involvement.

The review was initiated in October 2009 and included the following components:

- Community involvement
- Community interviews
- Document review
- Data review
- Institutional controls review
- Site inspection

The schedule for review extended through September 2010.

6.1 Community Involvement and Notification

Display ads were placed in the local papers (the Montana Standard and the Butte Weekly). The first ad announced the start of the five-year review process and ran in the Butte Weekly and the Montana Standard on September 30, 2009.

The agencies participated in three public meetings hosted by the Citizens Technical Environmental Committee (CTEC) regarding the five-year review process. The meetings were held on November 17, 2009, February 24, 2010, and March 3, 2010.

These advertisements and details of the public meetings are summarized in the community involvement and interviews memorandum included in Appendix A of Volume 1 of this five-year review report.

EPA released a draft of the five-year review report for public review and comment from December 12, 2010 through January 31, 2011. A public meeting was held on January 11, 2011. Comments received on the BMFOU are included in Appendix B.

6.2 Local Interviews

Interviews were conducted from January through March 2010 with several groups of people which included members of the general public, site neighbors, members of special interest groups such as the Citizen Action Group and Technical Action

Committees, representatives of local government, and oversight personnel with direct knowledge of the project. Advertisements were placed in newspapers and postcards were mailed to many citizens in the area. The final list of interviewees included 94 individuals. Considering the interview questions were fairly broad in nature and were not specific to any particular OU, the responses have been summarized separately in the community involvement and interviews memorandum (Volume 1, Appendix A).

6.3 Document Review

In preparing this five-year review, the following documents were reviewed:

- Horseshoe Bend Water Treatment Plant Draft Performance Test Report. Prepared by Atlantic Richfield Company, Montana Resources, and North American Water Systems. September 2008.
- Atlantic Richfield Company, HSBWTP, Operation and Maintenance Annual Summary Reports, March 23, 2010.
- Atlantic Richfield Company, Final Horseshoe Bend Water Treatment Facility Construction Summary Report, March 19, 2010.
- Letter from Mr. Ted Duaime to Mr. Daryl Reed and Ms. Sara Sparks regarding the updated results of the MBMG Berkeley Pit filling model. Dated April 19, 2010 (note: the date 2009 is incorrect on the letter – it should be 2010).
- Record of Decision, Butte Mine Flooding Operable Unit, Silver Bow Creek Butte Area NPL Site, Butte, Montana. U.S. Environmental Protection Agency. September 29, 1994.
- Explanation of Significant Differences for the Butte Mine flooding Operable Unit, Silver Bow Creek/Butte Area NPL Site, Butte, Montana. U.S. Environmental Protection Agency. March 2002.
- EPA Comprehensive Five-Year Review Guidance, 2001.
- PITWATCH. 2009. Informational public newsletter by the Berkeley Pit Public Education Committee. Summer 2009 edition. Website: www.pitwatch.org
- Review Draft, Water Level Monitoring and Water Quality Sampling, 2008 Consent Decree Update. Butte, Montana 1982-2008. Butte Mine Flooding Operable Unit. MBMG Open File Report 589. September 2009.
- Summary Report 2009. Butte Mine Flooding Operable Unit. Prepared by MBMG. February 20, 2010.

- Consent Decree for the Butte Mine Flooding Site. CIVIL ACTION NO. 02-35-BU-SHE. U.S. Environmental Protection Agency, Montana Office. Lodged March 25, 2002. Entered August 14, 2002.

- Final Order, Butte Alluvial and Bedrock Controlled Ground Water Area No. 76G-30043832. Filed by DNRC October 30, 2009. http://www.dnrc.mt.gov/wrd/water_rts/cgwa/butte/final_order.pdf

Applicable or relevant and appropriate requirements (ARARs) were reviewed to determine whether any changes to the ARARs have occurred since the signing of RODS or ESDs that could impact the protectiveness of the remedy of the site. The results of this review are summarized in the attached ARARs technical memorandum, and are discussed in Section 7.0, under Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

6.4 Data Review

6.4.1 Water Level and Water Quality Monitoring

Long term monitoring of the Berkeley Pit and all ancillary mine shafts and monitoring wells is ongoing as required in the BMFOU CD. The monitoring program consists of 63 monitoring wells, 11 mine shafts, and four surface water sites, as well as the Berkeley and Continental Pits. Figures 6-1, 6-2, and 6-3 show the locations of the West Camp and Outer Camp wells, East Camp Bedrock Wells, and East Camp Alluvial Wells. The MBMG provides monthly and annual summary reports to the agencies. The annual summary reports present ongoing series of monitoring data and trends; data from some of the monitoring locations date back to 1983 when the site was first listed. Data through the end of 2009 are included in this five-year review.

The 1994 ROD, as amended, established the preliminary critical water levels for the East Camp and West Camp bedrock systems established in the 1989 and 1990 AOCs. In the West Camp bedrock system, the maximum water level cannot exceed an elevation of 5,435 feet amsl (USGS datum) at well BMF96-1D (near the Travona mine). In the East Camp bedrock system (which includes the Berkeley Pit and hydraulically connected mine workings), the maximum water level cannot exceed an elevation of 5,410 feet amsl (USGS datum) at any of the eight compliance points listed below:

- Anselmo

- Granite Mountain

- Kelley

- Pilot Butte

- Belmont Well #2

- Bedrock Well A
- Bedrock Well C
- Bedrock Well G

In addition to these compliance points, the East Camp bedrock system must be maintained at a level lower than the West Camp water levels.

Alluvial wells overlying the East Camp bedrock aquifer are also monitored. The East Camp alluvial system includes the alluvial aquifer within the active mine area and a portion of the alluvial aquifer outside of the active mine area to the south. The alluvial groundwater divide between BMFOU and the BPSOU is included in this monitoring. Water levels and water quality vary throughout the alluvial system. Areas closer to mining operations exhibit elevated metal concentrations (e.g., leaching from waste dumps and historic tailings impoundments). Areas outside of mining operations reflect more regional water quality and hydrology.

6.4.2 Water Level Trends

In general, the monitoring well groups associated with the four BMFOU aquifer "systems" can be summarized as follows:

1. East Camp Alluvial Wells – water levels vary by locations, but generally are affected by precipitation trends, local irrigation, and water management practices at the active mine.

2. East Camp Bedrock System – water levels in the bedrock system continue to increase. The Berkeley Pit is the lowest point in the East Camp System, and groundwater flows in a radial pattern toward the Berkeley Pit. Current modeling estimates the critical water level of 5,410 feet will be reached in 2022 in the Anselmo mine. Water will be pumped and treated out of the Berkeley Pit in perpetuity to maintain the Berkeley Pit below the critical water level, and to maintain it as a regional groundwater sink.

3. West Camp Bedrock System – water levels in the West Camp bedrock are maintained below the CWL of 5,435 feet by pumping water out of well WCP near the Travona mine. The water is routed to the Butte Treatment Lagoons (in the BPSOU) for treatment.

4. Outer Camp wells – water levels in the Outer Camp tend to follow seasonal (small-scale fluctuations) and long-term fluctuations (multi-year fluctuations) based on precipitation.

Some representative hydrographs of different monitoring wells are shown for illustrative purposes; however, this data presentation is not intended to be comprehensive.

East Camp Alluvial Wells

Figure 6-4 shows water-level elevations for alluvial wells LP-14, AMC-8, and BMF05-3. These wells are reflective of the general alluvial system within the active mine area.

The GS-series wells are three pairs of nested wells, a shallow, and a deep well within the alluvial aquifer. Figure 6-5 is a hydrograph showing the water level for wells GS-41S and GS-41D. Rises in water levels from spring snowmelt and summer precipitation followed by water-level declines in the fall and winter are noticeable on these graphs.

East Camp Bedrock Wells

Table 6-1 shows the water level data for the East Camp Bedrock compliance wells as of October 2009 (Duaime 2010).

Table 6-1
East Camp Bedrock Water Levels – October 2009

Compliance Point	Monthly Water Level (ft)	Depth Below CWL (ft)
Anselmo Mine	5,307.71	102.29
Granite Mountain Mine	5,298.91	111.09
Pilot Butte Mine	5,309.06	100.94
Kelley Mine	5,295.12	114.88
Belmont Well #2	5,294.68	115.32
Well A	5,298.05	111.95
Well C	5,296.82	113.18
Well G	5,307.91	102.09
Berkeley Pit	5,283.87	126.13

For the past several years, the compliance point with the highest water level has varied between the Anselmo Mine, the Pilot Butte Mine, and bedrock well G. This would be expected, as these sites are the farthest monitoring points on the west, north, and east sides of the East Camp bedrock system. Currently, water levels are the highest at the Pilot Butte Mine, with the water level 100.94 feet below the CWL. Figure 6-6 is a hydrograph showing water-level elevations for bedrock wells A, C, and G. (Duaime 2010).

The Berkeley Pit filling rate is decreasing with time and as the water level rises (Figure 6-7). For example, the 1988 filling rate was estimated to be 7.6 mgd; the Berkeley Pit is currently estimated to be filling at a rate of 2.6 mgd (PITWATCH 2009). In December 1993, the elevation of the water in the Berkeley Pit was 5,062.67 feet (USGS datum) and was increasing by about 2 feet per month. The rate of increase has further slowed so that in 2009 the increase was about 0.5 feet per month (an increase of 6 feet during 2009 (MBMG 2010)).

All water levels in compliance wells are below the CWL. It is currently projected that the CWL of 5,410 feet (USGS datum) for the East Camp/Berkeley Pit System will be reached in the Anselmo Mine around the year 2022 (Duaime 2010).

West Camp Bedrock Wells

Figure 6-8 shows the water level elevations in the West Camp system along with the pumping rates since 2005. With the exception of a brief period of time in 2007 where the pumping rate was decreased to 100 gallons per minute (gpm) for a period of 2 weeks, the water level is generally maintained at 10 to 15 feet below the CWL. The pumping rate over the five-year review period varied from 60 gpm to 305 gpm, and averaged approximately 180 gpm.

Outer Camp System

There are no compliance points associated with this system. Figure 6-9 shows the water levels in the Marget Ann mine shaft as an example of the Outer Camp trends.

6.4.3 Groundwater Quality

Groundwater throughout the BMFOU is sampled for water quality and these data and trends are tracked and reported by the MBMG in their annual reports. However, a technical impracticability waiver was established for the BMFOU in 1994.

The focus of the BMFOU selected remedy is on containment of the contaminated water; there are no water quality standards to be met in the affected BMFOU aquifers. The variability in water chemistry among different wells throughout the OU is most relevant for planning water treatment activities and for tracking the extent of contamination. Therefore, in an effort to simplify the evaluation of the selected remedy, the groundwater quality data will not be presented in this five-year review. Water quality data from the BMFOU groundwater monitoring program are publically available in the State of Montana's Groundwater Information Center.

6.4.4 Horseshoe Bend Water Treatment Plant

The primary RAO, as stated within the ROD, is to prevent human and aquatic exposure to contaminated groundwater and surface water. The HSB WTP is intended to meet the RAOs for the BMFOU through the treatment of the HSB water, and (eventually) Continental Pit water and Berkeley Pit Water.

The treatment plant currently treats HSB water and discharges the treated effluent as makeup water to MR's mining operations. Consequently, the treatment plant does not normally need to operate at the same conditions (pH targets, effluent turbidity targets, etc.) as it would if the water required discharge to Silver Bow Creek. Therefore, in order to evaluate and confirm the plant is capable of meeting discharge limits into Silver Bow Creek, a second performance test was conducted in 2007. The performance test involved treatment of only HSB water and not water from Berkeley Pit. The plant was operated at the design flow of 3,200 gpm over a 72-hour period.

This section presents a review of the performance test results and a discussion of issues that need to be considered in preparation for eventual discharge to Silver Bow Creek. According to the most recent Berkeley Pit filling model results, the key review of the treatment plant adequacy will occur by December 2018 and any upgrades to the plan will need to be completed by December 2020 (MBMG 2010).

A review of the performance test data resulted in the following major conclusions:

1. All effluent performance limits, except pH, were met during the test.

2. The pH of the second stage reactor needed to be increased to 11.2 in order to meet the cadmium effluent limit of 0.8 micrograms per liter (µg/L).

3. The high pH requirement for meeting the cadmium limit was the primary reason that the effluent pH limit could not be met (there is no current means to lower the pH). Atlantic Richfield believes that natural aeration and absorption of carbon dioxide in the downstream effluent lagoon may lower the pH below 9.5. However, this and other methods, require further investigation.

4. The plant generally achieved low turbidity in the effluent. However, effluent turbidity spikes did occur during the test. Operating logs indicate that the turbidity spikes were mostly a result of polymer flocculant equipment problems as well as disturbance in the clarifier from a significant rain event that occurred during the test.

5. All of the radionuclide analyses that could be analyzed were below standards. However, the performance standard is based on beta/photon emitters, which is a dose rather than a concentration. Consequently, in order to meet the beta/photon limit, 179 different radionuclides would need to be analyzed. The practicality of this method needs to be re-evaluated.

6. Analysis of the effluent water shows that the concentration of calcium sulfate (gypsum) is above the solubility limit (i.e., supersaturated).

Based on these results, the following were identified as issues that need to be considered for successful, long term treatment of Berkeley Pit water prior to discharging into Silver Bow Creek:

Gypsum. Performance test results show that the treatment plant effluent has calcium concentrations of about 960 milligrams per liter (mg/L) and sulfate concentrations of approximately 2,650 mg/L. At these levels, calcium sulfate (gypsum) is supersaturated by a factor of about 2. Gypsum is known to remain supersaturated for long periods of time (up to 24 hours), but will eventually reach equilibrium with the water and precipitate from solution. Either way, this could create issues for discharge to Silver Bow Creek. If the gypsum precipitates before reaching Silver Bow Creek, the effluent total suspended solids (TSS) will increase, and potentially exceed the TSS discharge standard of 20 mg/L. In addition, the precipitation of gypsum is likely to cause pipeline scaling and potential accumulation of solids within the piping system. If gypsum remains in solution long enough to reach Silver Bow Creek, the sulfate concentration in Silver Bow Creek will increase significantly, especially under low flow conditions. Due to the higher acidity (requiring a higher lime dose for treatment) and higher sulfate concentrations in Berkeley Pit water, these issues may be more significant when treating water from Berkeley Pit.

Cadmium. The discharge limit for cadmium is 0.8 μg/L. This standard was met in the treatment facility by raising the pH to 11.2 in the second stage reactor and removing the resultant cadmium hydroxide precipitates in the second stage clarifier. In order to meet the cadmium standard on a continuous basis, it will be important to maintain the proper, minimum pH and achieve excellent removal of TSS in the second clarifier. This is because the effluent limit for cadmium corresponds to a TSS concentration of only 1 μg/L. In other words, if all of the cadmium were present in the treated water as cadmium hydroxide particulate, then it only takes approximately 1 μg/L of TSS (as cadmium hydroxide) to exceed the cadmium effluent standard. As a result, the effluent turbidity will need to be maintained at low levels and monitored closely in order to meet the cadmium standard on a consistent and reliable basis.

Effluent pH. As discussed previously, the pH of the treated effluent is estimated to be about 11.2, which exceeds the pH standard of between 6.5 and 9.5. Because the pH scale is logarithmic, a pH of 11.2 is 1.7 orders of magnitude or 50 times more alkaline than a pH of 9.5; achieving this pH decrease should not be considered trivial. In order to lower the pH below 9.5, the addition of an acid will be necessary. This may come in the form of adding a mineral acid, such as sulfuric or hydrochloric acid, or from carbon dioxide gas. As indicated by Atlantic Richfield, addition of carbon dioxide may occur naturally through aeration and adsorption from the atmosphere. If carbon dioxide is used, then precipitation of calcium carbonate will occur, potentially causing some of the same issues of pipeline scaling and solids accumulation that gypsum presents, as described above.

Treatment of Berkeley Pit Water. The performance test did not evaluate the treatability of Berkeley Pit water. The Berkeley Pit water contains higher concentrations of metals and sulfate. Ultimately, while this water should be treatable in the HSB WTP, it will require larger dosages of lime than HSB water. Consequently, the gypsum scaling and discharge issues described above will potentially be more significant than current operations using only HSB water.

Whole Effluent Toxicity (WET) Testing. In addition to meeting ARAR discharge standards, the BMFOU CD also requires WET testing to be performed annually on the treated effluent:

> *The toxic effect of the effluent collected at the Controlled Discharge to Silver Bow Creek shall be measured annually using procedures consistent with the requirements of 40 CFR Part 122. The test species for the WET Testing shall be* Ceriodaphma Dubia *and* Pimephales Promelas *(fathead minnow). As determined by the WET*

testing there shall be no acute toxicity in the effluent discharged by the HSB Water Treatment Plant or HSB Water Treatment Plant Upgrade and no chronic toxicity in Silver Bow Creek caused by the discharges from the aforementioned treatment plant following complete mixing of the effluent stream and Silver Bow Creek flows.

While performance testing indicates the HSB WTP should be able to meet the discharge standards for heavy metals, it is not yet known if other substances remaining in the treated water (such as the high levels of calcium and sulfate, or other ions) are harmful to aquatic life. The WET testing should be performed well in advance of any anticipated discharge to Silver Bow Creek so that it is known whether or not additional water treatment processes are necessary.

Use of Scale Inhibitors. Scale inhibitors are being added to the treated effluent to control gypsum scaling issues before pumping this water back to MR mining operations for reuse. In addition, studies are currently underway to evaluate the addition of scale inhibitors to the sludge recirculation lines within the treatment system to help minimize scaling issues within the reactors and clarifiers. While this is acceptable for discharge back to the mining operations, the use of scale inhibitors within the treatment system may be problematic when trying to precipitate metals from solution and achieve very low metal standards for discharge to Silver Bow Creek. This is because scale inhibitors generally prevent or delay the precipitation of minerals (including metal hydroxides) from solution. As a result, if scale inhibitors are required to minimize maintenance of equipment and pipelines, then its use will need to be evaluated further before discharge to Silver Bow Creek occurs.

Maintenance. Atlantic Richfield has identified several preventative maintenance items that need to be conducted on an annual basis. One of these items includes shutting down each reactor/clarifier system one at a time for cleaning. During cleaning of one system, all of the flow is routed through the other reactor/clarifier treatment system and treated in a single stage system. This appears to be an effective approach for maintaining the required makeup flows to the mining operations, while performing equipment maintenance. However, if this practice is considered for use during discharge to Silver Bow Creek, additional testing will be required to ensure that standards can be met using a single treatment train.

6.4.5 Water Fowl Mitigation

A water fowl mitigation plan was developed because of potential impacts to the birds if they use the Pit waters. Hundreds of waterfowl land on the surface of the Berkeley Pit during migration seasons and most fly off unharmed. MR personnel use various devices to haze birds off the water surface, such as noise from rifles and shotguns. In addition, devices that emit predator sounds are located at the lake surface to discourage birds from landing. MR personnel observe the Berkeley Pit hourly during the day, and once every 4 hours at night during spring and fall bird migrations. They cut back to 5 or 6 observations per day during non-migratory seasons or when the Pit is frozen.

MR personnel also go out on the Pit surface in a boat twice a month to survey the water perimeter for dead waterfowl. Mortalities are recorded and the U.S. Fish and Wildlife Service are notified; they decide whether or not an autopsy is necessary. The boat can also be used to haze or rescue waterfowl that have ignored other warnings or are in distress. These birds are captured and released to fresh water in the upper part of the drainage above the Yankee Doodle Tailings Pond, or taken to a veterinarian.

Table 6-2 shows the number of observed birds and mortalities over time since 2006. During this time, 28,939 birds were observed, and 94 fatalities reported. According to the summer 2009 issue of PITWATCH, 37 birds, including ducks, geese, and one swan, were found dead at the Berkeley Pit after a weekend of fog in October 2007. In this case, the mitigation actions failed to haze the birds from the Pit, although it is believed the weather must have been a factor. All involved continue to keep incidents to a minimum.

Table 6-2
Birds Observed and Bird Fatalities Recorded at the Berkeley Pit (2006-2009)

	2006		2007		2008		2009		Totals	
Month	Birds Observed	Fatalities	Birds Observed	Fatalities	Birds Observed	Fatalities	Birds Observed	Fatalities	Total Observed	Total Fatalities
January	0	0	0	0	0	0	0	0	0	0
February	1	0	21	0	0	0	0	0	22	0
March	616	11	1,021	0	1,071	3	780	0	3,488	14
April	2,869	2	1,308	0	2,966	17	4,439	7	11,582	26
May	556	0	1,378	0	1,770	0	1,824	0	5,528	0
June	10	1	18	0	23	0	0	0	51	1
July	1	0	8	0	0	0	3	0	12	0
August	484	0	1,421	0	181	0	137	0	2,223	0
September	113	0	1,828	0	181	0	6	0	2,128	0
October	238	0	1,172	0	170	0	492	0	2,072	0
November	111	16	1,454	37	54	0	52	0	1,671	53
December	0	0	2	0	123	0	37	0	162	0
Totals	**4,999**	**30**	**9,631**	**37**	**6,539**	**20**	**7,770**	**7**	**28,939**	**94**

6.5 Review of Institutional Controls

6.5.1 Land and Water Use Restrictions

Restrictions on land and water use at the BMFOU include enacting measures to prevent:

- interference with or adverse affects to the implementation, integrity, or protectiveness of the remedy;
- the use of groundwater for drinking;
- the use of any portion of the BMFOU owned by the settling defendants (SDs) for residential habitation;
- interference with or destroying monitoring wells or equipment; and
- interference with or destroying any treatment facility.

A DNRC-designated CGWA (the BABCGWA) was implemented in October 2009 that restricts well drilling and groundwater use in areas overlying both the contaminated bedrock aquifer of the BMFOU and the contaminated alluvial groundwater of the BPSOU. This CGWA (See Figure 6-10), among other things, gives the county and EPA another tool to restrict the public's access to contaminated groundwater and thereby prevent human exposure and the spreading of contaminated water to the environment. The BSBC water quality district has implemented a monitoring and enforcement program for this IC. To date, the IC is working.

The ROD and CD do not prohibit mining operations from taking place. Metal extraction processes continue at the BMFOU.

6.5.2 Institutional Controls Review

Information obtained from the CD, from county records, and through interviews with the following individuals form the basis of the discussion of IC implementation at the BMFOU.

- Daryl Reed. DEQ. December 22, 2009.
- Ted Duaime. Montana Bureau of Mines and Geology (MBMG). December 22, 2009.
- Sara Sparks. EPA RPM. January 2010.

The implementation of ICs for the BMFOU is discussed below and a summary is provided in Table 6-3.

Table 6-3
Implementation and Effectiveness of Institutional Controls at the Butte Mine Flooding Operable Unit

	Institutional Control and Instrument (as identified in the controlling documents)	Instrument Implementation and Use	Effectiveness of the IC in Supporting the Remedy
Controlling Document	ROD (1994) and ESD (2002)		
Responsible Entity	Atlantic Richfield and other SDs		
Land and Water Use Restrictions	For property owned or controlled by the SDs, the CD states that they will restrict land use to avoid interference with or adverse affects to the implementation, integrity, or protectiveness of the remedy. These restrictions include using groundwater for potable domestic use, using any portion of the BMFOU for residential habitation, interfering with or destroying monitoring wells or equipment, and interfering with or destroying any treatment facility.	CD implements this IC for the SD owned or controlled property.	This IC is implemented and effective; no issues noted.
	For property <u>not</u> owned by the SDs, the CD states that the SDs will seek agreements from property owners to meet the land use restriction stated above. The only identified needs are for the protection of monitoring wells and infrastructure related to mine shafts.	The SDs do not have written agreements with private (i.e., third party) property owners to restrict land use. However, any incidents of wellhead damages have been addressed by the SDs.	This IC is implemented and effective.
	SDs will cooperate with the county to adopt a CGWA.	A DNRC-designated CGWA was implemented in October 2009 that restricts well drilling and groundwater use in areas overlying the contaminated bedrock aquifer of the BMFOU. This CGWA, among other things, gives the county another tool to restrict the public's access to contaminated groundwater and thereby prevent human exposure and the spreading of contaminated water to the environment.	This IC is implemented and effective.
	SDs will cooperate with EPA and DEQ if additional land/water use restrictions are needed in the form of state or local laws, regulations, ordinances, or other governmental controls.	Additional land/water use restrictions have not been identified.	Not applicable to date and unknown if this IC will be applicable in the future.

Atlantic Richfield and the SDs have strict access control on BMFOU land outside the City of Butte in the industrial area near the Berkeley Pit. For this portion of the OU, therefore, land use restrictions are in place by virtue of the SDs' ability to physically restrict access by the general public. This has been effective in preventing the use of contaminated groundwater, preventing residential habitation, and preventing anyone from destroying or interfering with monitoring wells, equipment, or treatment facilities in this area of the OU.

The CD states that the SDs are to seek agreements from the property owners (i.e., third parties) to restrict land use to avoid interference with or adverse affects to the implementation, integrity, or protectiveness of the remedy for the area of the OU lying within the city of Butte. The primary concern for these properties is the potential damage that may occur to the monitoring wellheads. The access agreements for these properties (described above) are only for monitoring and maintenance activities and do not restrict land uses, such as using an area to drive or park vehicles. Third-party well head protection issues have been effectively addressed.

Despite not having written land use agreements with third party private land owners, interference with the monitoring wellheads has been minimal and deliberate destruction has not occurred to any of the wellheads or any other monitoring station infrastructure, such as mine shafts (Duaime 2009). There have been several incidences where wellheads were accidentally damaged by vehicles, but they were readily repaired and groundwater monitoring continued without disruption. There have been no acts of intentional vandalism.

6.5.3 Effectiveness

The ICs implemented for the BMFOU continue to effectively protect the remedy. The only situation identified where an IC may not be considered completely implemented and effective is where a wellhead is on private property (i.e., non-SD owned property), because it is not absolutely protected from damage by the public. A representative of the MBMG indicated that there have been incidences where a wellhead was accidentally damaged and then repaired. In these cases there were no adverse effects to the well and groundwater monitoring continued uninterrupted.

6.6 Site Inspection

6.6.1 Montana Resources Property and Horseshoe Bend Water Treatment Plant

EPA and DEQ project managers and their contractors attended a site inspection and tour of the HSB WTP on October 6, 2009. Site photos can be found in Appendix A. During this tour, the plant operators and members of MR and Atlantic Richfield management discussed the day-to-day operations of the WTP. No issues were found with respect to plant operations. The HSB WTP is currently treating HSB water to be used in the mining operations and the water is not discharged to Silver Bow Creek. Therefore, the plant is optimized for meeting the needs of the mining operations and is operating only as necessary to meet those needs.

The BMFOU within the active mining area (which includes the Berkeley Pit) is fenced and has security gates to prevent trespass.

6.6.2 Monitoring Wells

On November 24, 2009, EPA and DEQ project managers accompanied Ted Duaime of the MBMG for a site tour and inspection of 78 monitoring wells for the BMFOU. The status and inspection findings that concern the security and integrity of these wells are summarized in Appendix A.

Section 7
Technical Assessment

A technical assessment of the remedy for the BMFOU is performed as part of the five-year review process. This technical assessment, focusing on answers to three unique questions, is presented in this section of the five-year review.

7.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

Remedial Action Performance

Yes, the remedy is functioning as intended by the decision documents. The overall remedy as defined by the decision documents on the BMFOU is ongoing. As in the 2005 five-year review, the HSB WTP is sending the effluent to the MR mining operations and not discharging into Silver Bow Creek at this time. Preliminarily, the HSB WTP is functioning well for its current use, and the initial performance test results indicate it can function as intended. As noted earlier, additional testing (such as the effluent WET testing) and evaluation when the CWL is approached will further define and refine the performance.

Long term monitoring of the Berkeley Pit and all ancillary mine shafts and monitoring wells is ongoing. As discussed in Section 6, the latest modeling indicates the CWL in the East Camp will not be reached until 2022 (Anselmo Mine). Water levels indicate that the Berkeley Pit remains the groundwater sink for East Camp bedrock groundwater.

Water levels in the West Camp bedrock system are maintained below the CWL by pumping groundwater to the Butte Treatment Lagoons facility for the BPSOU. Water levels have typically remained about 10 to 15 feet below the CWL.

System Operations/O&M

The influent water for the 2007 Performance Test consisted only of HSB water, as water from the Berkeley Pit is not yet required to be pumped and treated in the plant. The results of this test indicated that all final discharge limits could be met except for effluent pH. In order to meet the cadmium limit, the pH in the final treatment stage needed to be raised to 11.2. Consequently, the effluent pH did not drop to below the discharge standard of 9.5 through natural aeration. Methods for lowering the pH of the effluent to below the discharge standard of 9.5 have been evaluated on a conceptual level, but will require a more formal analysis before final discharge to Silver Bow Creek is necessary.

The results of the performance test also determined a need to revisit the applicability of the final performance standard for beta/photon emitters, which is expressed as a dose of 4 millirem per year (mrem/yr). There are approximately 179 radionuclides that need to be analyzed in order to calculate the actual beta/photon emitter dose, bringing into question the practicality of the laboratory procedures needed to meet the beta/photon standard.

The results of this performance test are presented below and summarized in Table 7−1.

Table 7-1
Performance Test Results Compared to Final Standards

Parameter	Final Standard Avg. Monthly	Final Standard Daily Max.	11/18/2007	11/19/2007	11/20/2007	Exceed Final Std?	11/19/2007 (MBMG Sample)[3]
Arsenic (mg/L)	≤ 0.010	≤ 0.010	< 0.0017	< 0.0017	< 0.0017	No	0.0041
Cadmium (mg/L)	≤ 0.0008	≤ 0.005	0.0006	0.0006	0.0005	No	< 0.0005
Copper (mg/L) [1]	≤ 0.0305	≤ 0.0516	0.0059	0.0046	0.0045	No	0.0105
Iron (mg/L)	≤ 1.000	≤ 1.500	< 0.070	0.088	<0.070	No	0.065
Lead (mg/L) [1]	≤ 0.015	≤ 0.015	< 0.0002	< 0.0002	< 0.0002	No	< 0.002
Mercury (mg/L)	≤ 0.00091	≤ 0.0017	0.0001	0.0001	0.0001	No	N/A
Zinc (mg/L)	≤ 0.388	≤ 0.388	< 0.077	< 0.077	< 0.077	No	0.0372
pH (S.U.)	6.5 - 9.5	6.5 - 9.5	>10	>10	>10	Yes	>10
TSS (mg/L)	≤ 20	≤ 30	9	<3.5	<3.5	No	
Hardness (mg/L as $CaCO_3$)	N/A	N/A	>400	>400	>400	N/A	>400
Uranium (mg/L)	≤ 0.030	≤ 0.030	0.00003	0.00002	< 0.00001	No	< 0.0005
Comb. Radium 226/228 (pCi/L)	≤ 5 pCi/L	≤ 5 pCi/L	< 1.2	< 1.2	< 1.2	No	
Gross Alpha Particle (pCi/L)	≤ 15 pCi/L	≤ 15 pCi/L	14.8	1.1	< 1.0	No	
Beta/photon emitters [2] (mrem/yr)	≤ 4 mrem/yr	≤ 4 mrem/yr	See Gross Beta and footnotes[2]	See Gross Beta and footnotes[2]	See Gross Beta and footnotes[2]	See Gross Beta and footnotes[2]	
Gross Beta [2] (pCi/L)		50 pCi/L Screening Level[2]	12	12	10.3	Below Screening Level[2]	

Notes:

1. The standards for cadmium, copper, lead, and zinc are hardness dependent and these limitations are based on the DEQ-7 numeric standard using a maximum allowable hardness of 400 mg/L. Hardness shall be measured in the discharge and limitations adjusted for those samples where a hardness less than 400 mg/L is measured.

2. Comparison of analytical results to Beta/photon emitters Final Standard not possible with the analytical data collected. The EPA recommended methodology of comparison of Gross Beta, less potassium-40, to a 50 picocuries per liter (pCi/L) screening level was instead used for comparison. For simplicity, the potassium-40 concentration was not calculated from the potassium concentration that was measured and was therefore assumed to be zero in this calculation. This provides an even greater level of conservatism in comparison to the screening level.

Opportunities for Optimization
Based on the results of the most recent performance test and plant operations and maintenance activities, there are several areas where optimization is needed: They include: 1) effluent pH adjustment (when discharge to Silver Bow Creek is necessary), 2) equipment and pipeline scaling from gypsum and 3) equipment corrosion issues. Each of these issues is undergoing various levels of engineering evaluation and testing to determine the best long term course of action.

Early Indicators of Potential Issues
There are no indications of potential equipment problems or operational problems that would put the protectiveness of the HSB WTP at risk. However, it is unknown whether discharge of treated water saturated with gypsum will adversely affect aquatic life in Silver Bow Creek. It is also possible that delayed precipitation of gypsum could cause exceedances of the TSS discharge standard. This issue will require further evaluation before discharge occurs.

Implementation of Institutional Controls and Other Measures
Based on the information obtained from a review of the site documentation in the administrative record and from interviews with the site RPM and other stakeholders, the ICs implemented for the BMFOU continue to effectively protect the remedy and the public. Publications such as the PITWATCH, inform the public as to progress on the BMFOU. The current DNRC order prohibits use of the BMFOU aquifer for domestic use. Enforcement and monitoring of this prohibition is important.

7.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of Remedy Selection Still Valid?

Yes. The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid.

Changes in Standards and TBCs
The most significant change to the ARARs was the lowering of the State of Montana human health standard for arsenic to 10 µg/L, consistent with the 2006 federal maximum contaminant level (MCL) (Circular DEQ-7, published in 2008). However, the BMFOU ESD anticipated this change in the federal MCL and the effluent level for arsenic is set in the CD at the 10 µg/L; thus no change is required. The performance test results indicate that the arsenic standard was met.

Changes in Exposure Pathways

No changes in physical conditions of the BMFOU or in land use that would affect the protectiveness of the remedy were identified. Potential exposure pathways to contaminated groundwater or surface water have not changed since the ROD and no additional receptors have been identified in this review. Governmental and enforcement controls restricting the use of contaminated groundwater for drinking water should protect human health if implemented carefully. The newly-designated CGWA is expected to strengthen to ability of the County and EPA to protect the public and environment from coming into contact with contaminated groundwater.

Changes in Toxicity and Other Contaminant Characteristics

Some changes in risk estimates would occur if the risk calculations were re-done using current guidance and practice. However, the results would likely be similar to results from the baseline risk assessments, i.e., future risks from contaminated BMFOU groundwater would still be high. Since the remedy is not directly based on risk-based remediation goals, the protectiveness of the remedy would not change.

Changes in Risk Assessment Methods

No information gathered during the risk assessment review calls into question the protectiveness of the remedy for the BMFOU.

Expected Progress Towards Meeting RAOs

The overriding RAO at the BMFOU is to prevent human and aquatic exposure to contaminated groundwater and surface water. This RAO is being met for the West Camp system through pumping and treatment of the groundwater. This RAO is currently being met for the East Camp system, and plans are in place to pump and treat this groundwater as well; however, current modeling indicates the triggers for these actions are not expected to occur until 2018.

7.3 Question C: Has Any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

No. There has been no information gathered during this five-year review that calls into question the protectiveness of the remedy for the BMFOU.

Section 8
Issues

Based on information collected during preparation of this five-year review report, the following issues were identified and summarized in Table 8-1.

Table 8-1
BMFOU Issues Summary

Issue No.	Issue	Affects Current Protectiveness? (Y/N)	Affects Future Protectiveness? (Y/N)
1	The HSB WTP did not meet the final pH effluent standard. Effluent is currently recycled to the MR mining operations and does not discharge to Silver Bow Creek.	No	Yes
2	Supersaturation of gypsum in the treated effluent causes a high potential for gypsum scaling throughout the WTP and in the effluent pipeline to Silver Bow Creek. Delayed precipitation of gypsum may also cause exceedances of the TSS discharge standard. Effluent from the WTP is currently recycled to MR mining operations.	No	Yes
3	Stringent pH and effluent turbidity control will be required for the WTP to reliably meet the cadmium discharge standard. Effluent from the WTP is currently recycled to MR mining operations.	No	Yes
4	The performance test did not include treatment of Berkeley Pit water, which has significantly higher concentrations of metals and sulfate than HSB water.	No	Yes
5	Use of scale inhibitors to control gypsum scaling issues in the treatment system may affect metals removal in the treatment plant. Effluent from the WTP is currently recycled to MR mining operations.	No	Yes
6	WET testing has not yet been performed on the HSB WTP effluent. Effluent from the WTP is currently recycled to MR mining operations. Should the effluent fail the WET testing, additional treatment processes may be necessary.	No	Yes.
7	The beta-photon procedure used to evaluate the concentration of radio- nuclides in the treatment plant effluent is not practical, given the need to analyze 179 different radionuclides.	No	No

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Section 9
Recommendations and Follow-Up Actions

Table 9-1 identifies recommendations and follow-up actions for issues identified in Section 8.

Table 9-1
Recommendations and Follow-up Actions

Issue No.	Recommendation and Follow-Up Action	Party Responsible	Oversight Agency	Milestone Date
1	Conduct an additional performance test to investigate solutions to exceedance of the final pH standard prior to the next five-year review.	Atlantic Richfield and MR	EPA/DEQ	December 31, 2014
2	Conduct an additional performance test to investigate solutions to gypsum supersaturation issues prior to the next five-year review.	Atlantic Richfield and MR	EPA/DEQ	December 31, 2014
3	Conduct an additional performance test to investigate solutions to ensure reliable cadmium compliance prior to the next five-year review.	Atlantic Richfield and MR	EPA/DEQ	December 31, 2014
4	Conduct an additional performance test to treat Berkeley Pit water prior to the next five-year review.	Atlantic Richfield and MR	EPA/DEQ	December 31, 2014
5	Conduct an additional performance test to investigate the effect of scale inhibitors on metals removal prior to the next five-year review.	Atlantic Richfield and MR	EPA/DEQ	December 31, 2014
6	Perform WET testing on representative effluent prior to the next five-year review.	Atlantic Richfield and MR	EPA/DEQ	December 31, 2014
7	Determine a more practical approach to analyzing radionuclides to determine compliance with the beta-photon emitter discharge criteria.	EPA, DEQ, Atlantic Richfield, and MR	EPA/DEQ	December 31, 2014

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Section 10
Protectiveness Statements

The remedy at BMFOU is expected to be protective of human health and the environment upon completion, and in the interim, exposure pathways that could cause unacceptable risk are being controlled by water treatment, routing water for re-mining use, land use access controls, and an IC preventing groundwater use. In order to be protective in the long term, water quality issues in the treated effluent will have to be resolved before discharge to Silver Bow Creek becomes necessary.

West Camp water treatment has been formally transferred to the BPSOU.

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Section 11
Next Review

The next five-year review for the BMFOU is required by September 30, 2015.

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Section 12
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Figures

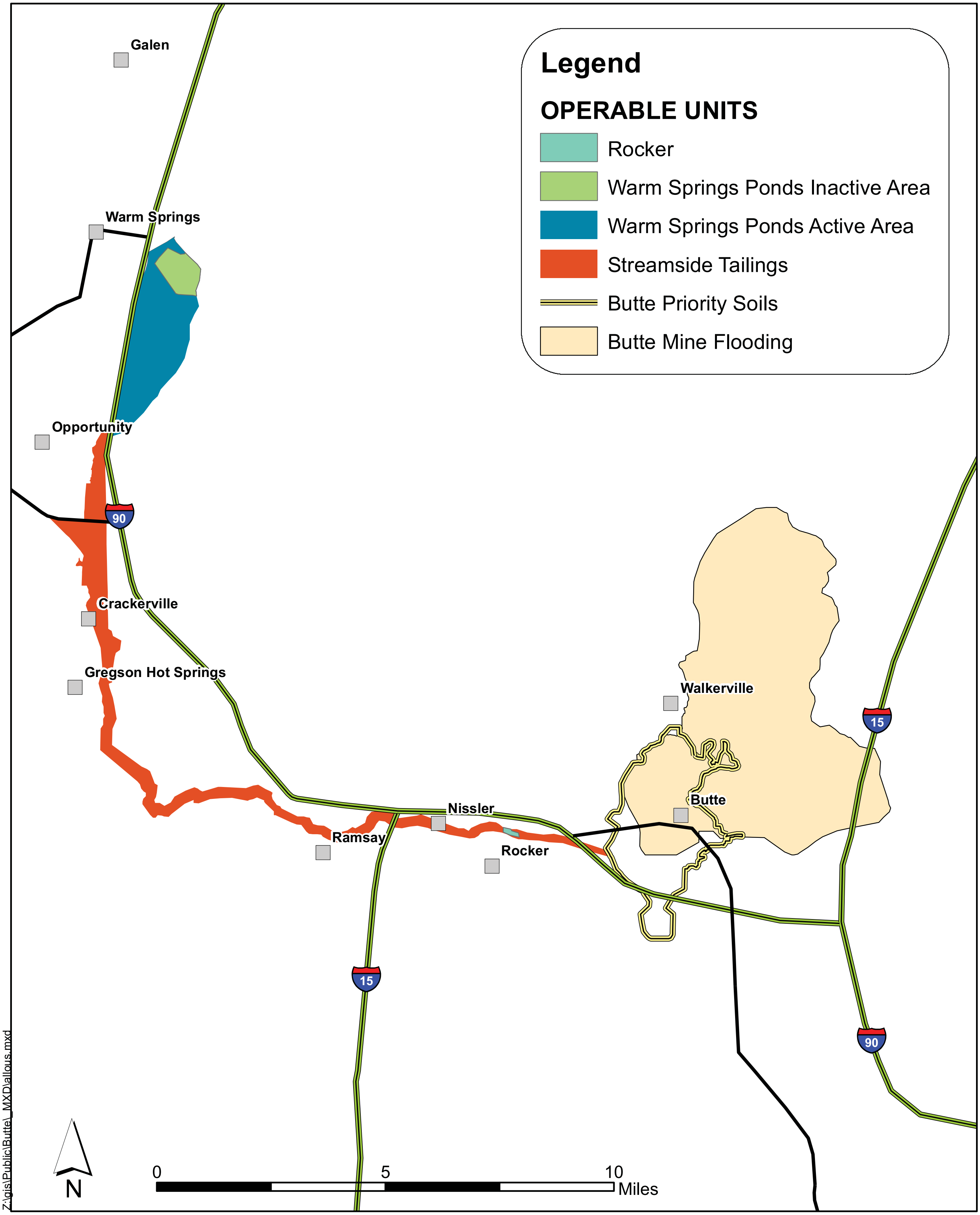

Figure 3-1 Operable Units in the Silver Bow Creek/Butte Area Site

Figure 3-2. Major Site Features
Butte Mine Flooding Operable Unit
Butte, Montana

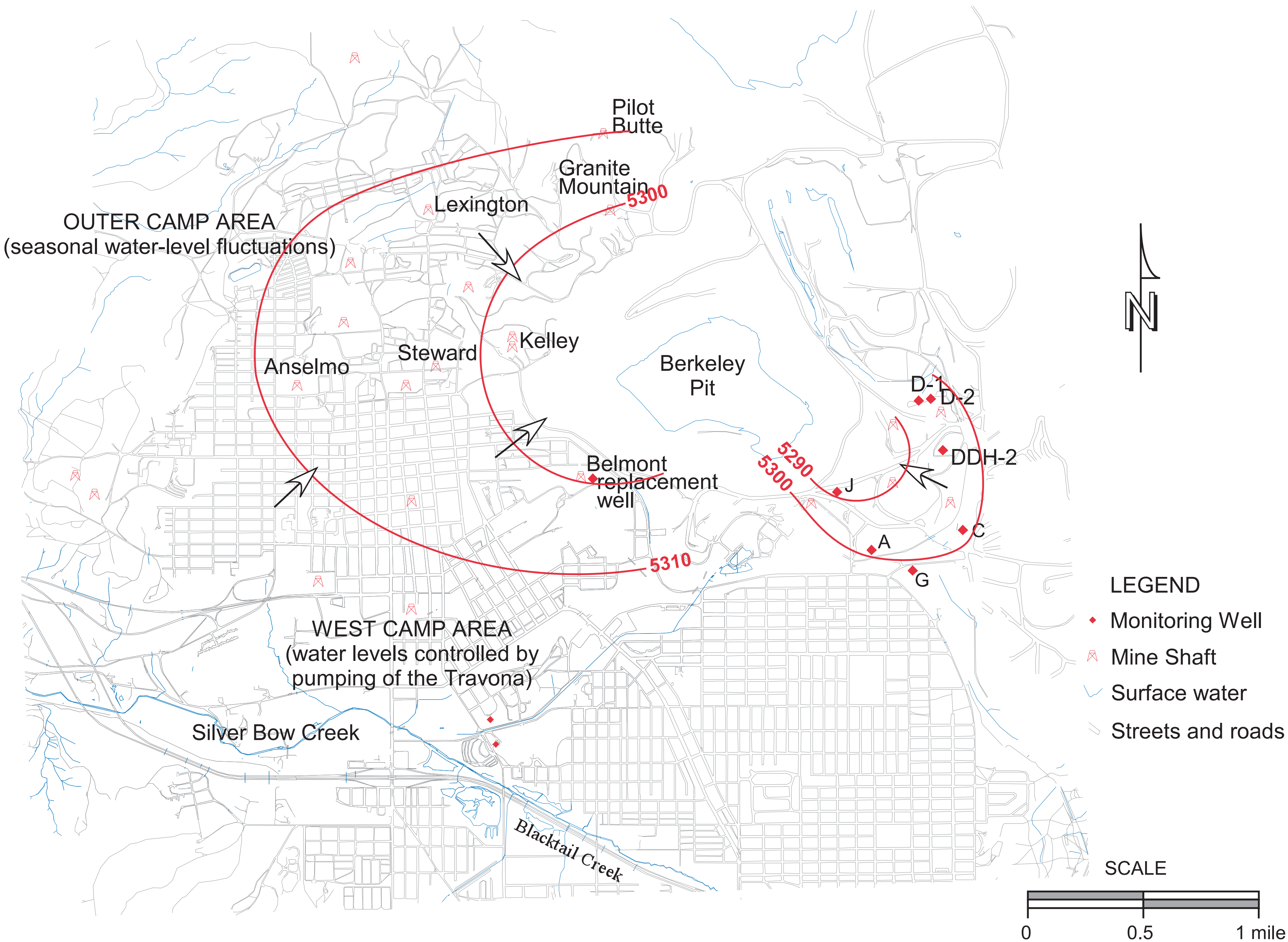

Figure 3-3. Potentiometric map for the East Camp bedrock aquifer, December of 2009; arrows indicate direction of ground-water flow (contour interval is 10 feet).

Butte Mine Flooding

Figure 6-1
Monitoring Well Locations
West Camp - Outer Camp
May 11, 2010

Legend

Monitoring sites

West Camp - Outer Camp

West Camp - Outer Camp (surface site)

0 400 800 1,200 1,600 2,000
Feet

Butte Mine Flooding

Figure 6-2
Monitoring Well Locations
East Camp - Bedrock
May 11, 2010

Legend

Monitoring sites

East Camp - Bedrock

East Camp - Bedrock (surface site)

0 400 800 1,200 1,600 2,000 Feet

Butte Mine Flooding

Figure 6-3
Monitoring Well Locations
East Camp - Alluvial
May 11, 2010

Legend

Monitoring sites

East Camp - Alluvial

N

0 400 800 1,200 1,600 2,000 Feet

Figure 6-4
Water Level Elevations of Alluvial Wells LP-14, AMC-8, and BMF05-3
Silver Bow Creek/Butte Area NPL Site, Five-Year Review, 2010

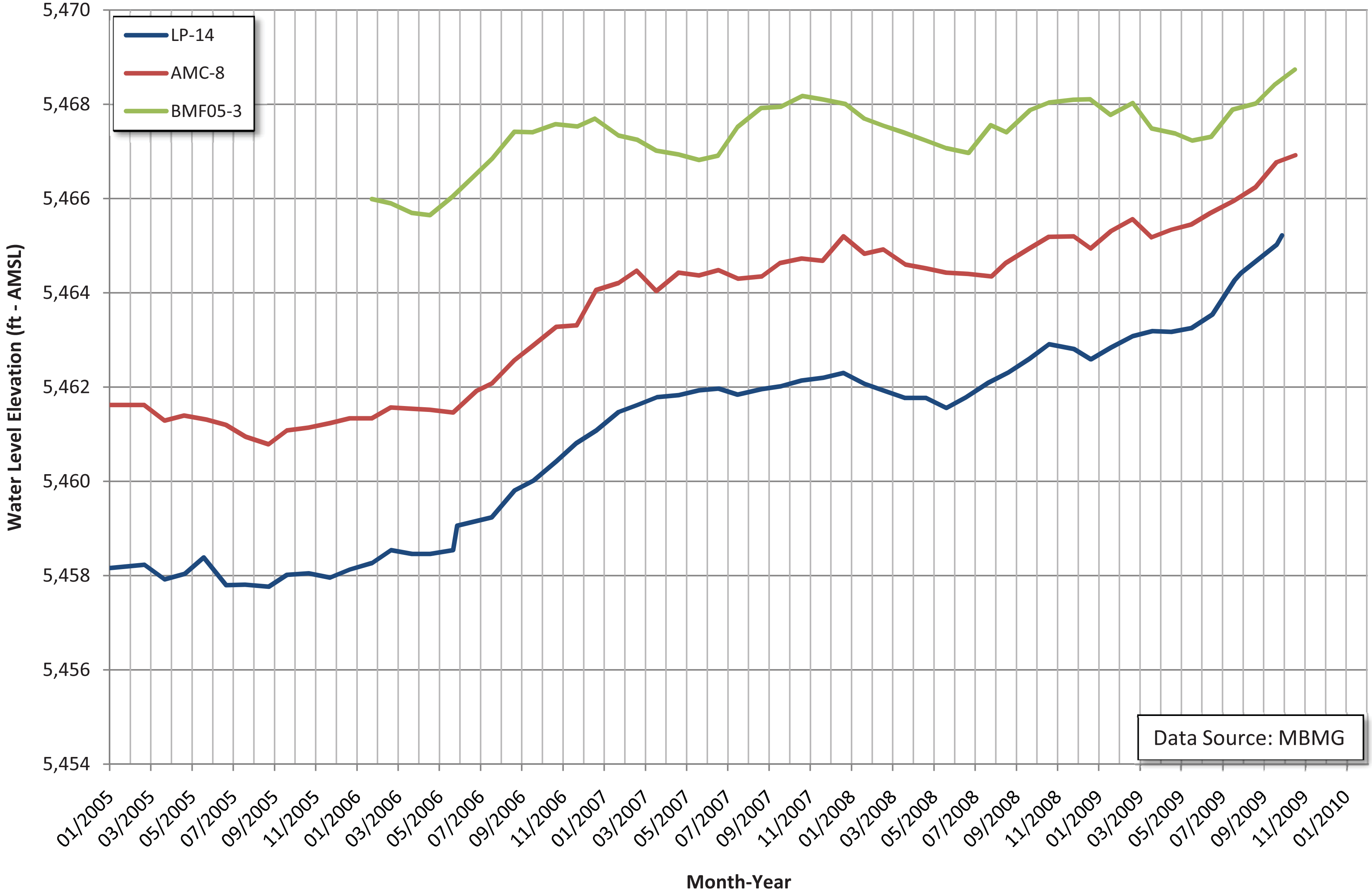

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Figure 6-5
Water Level Elevations of Alluvial Wells GS-41S and GS-41D
Silver Bow Creek/Butte Area NPL Site, Five-Year Review, 2010

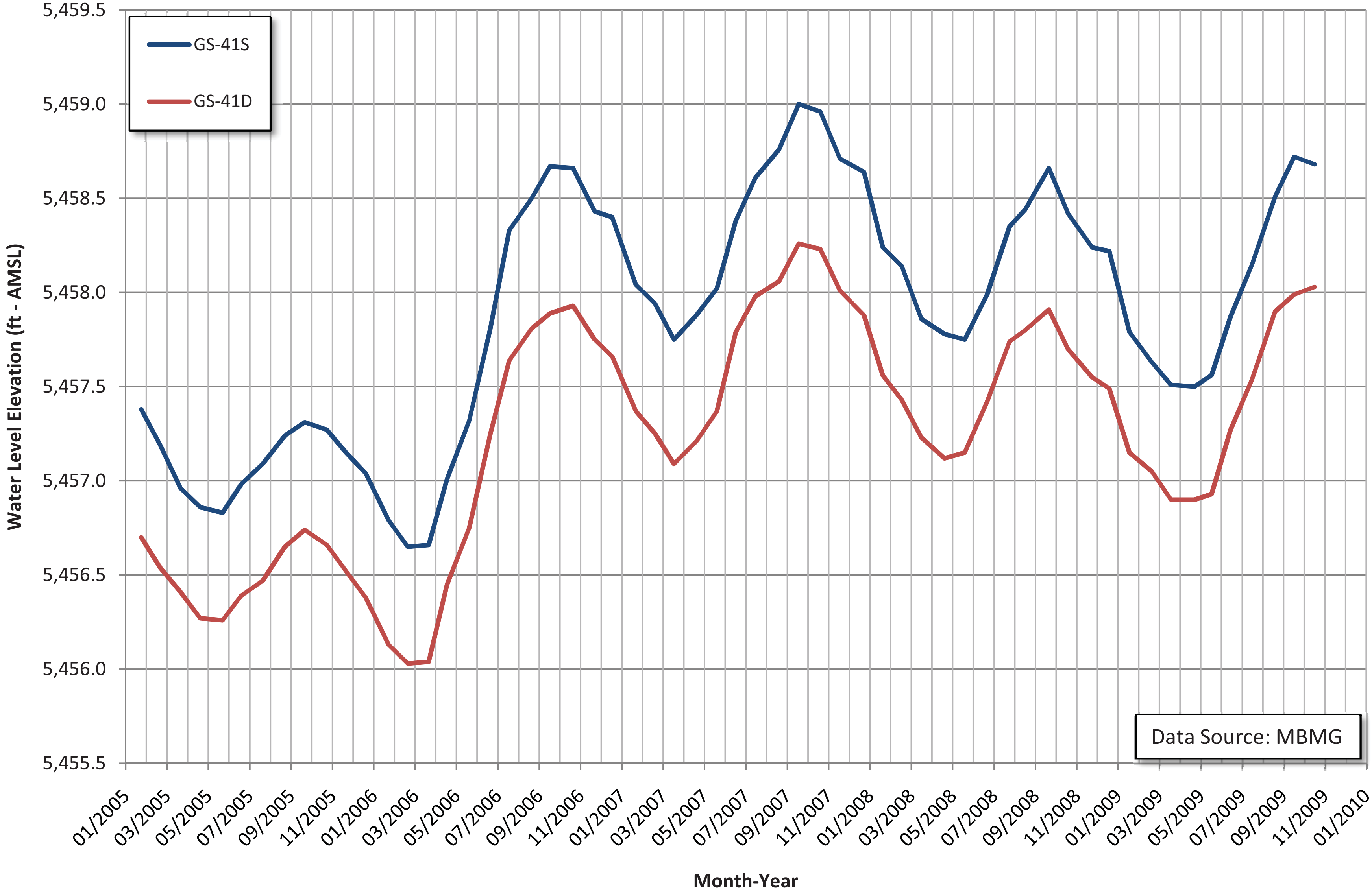

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Figure 6-6
Water Level Elevations of Bedrock Well A, Well C, and Well G
Silver Bow Creek/Butte Area NPL Site, Five-Year Review, 2010

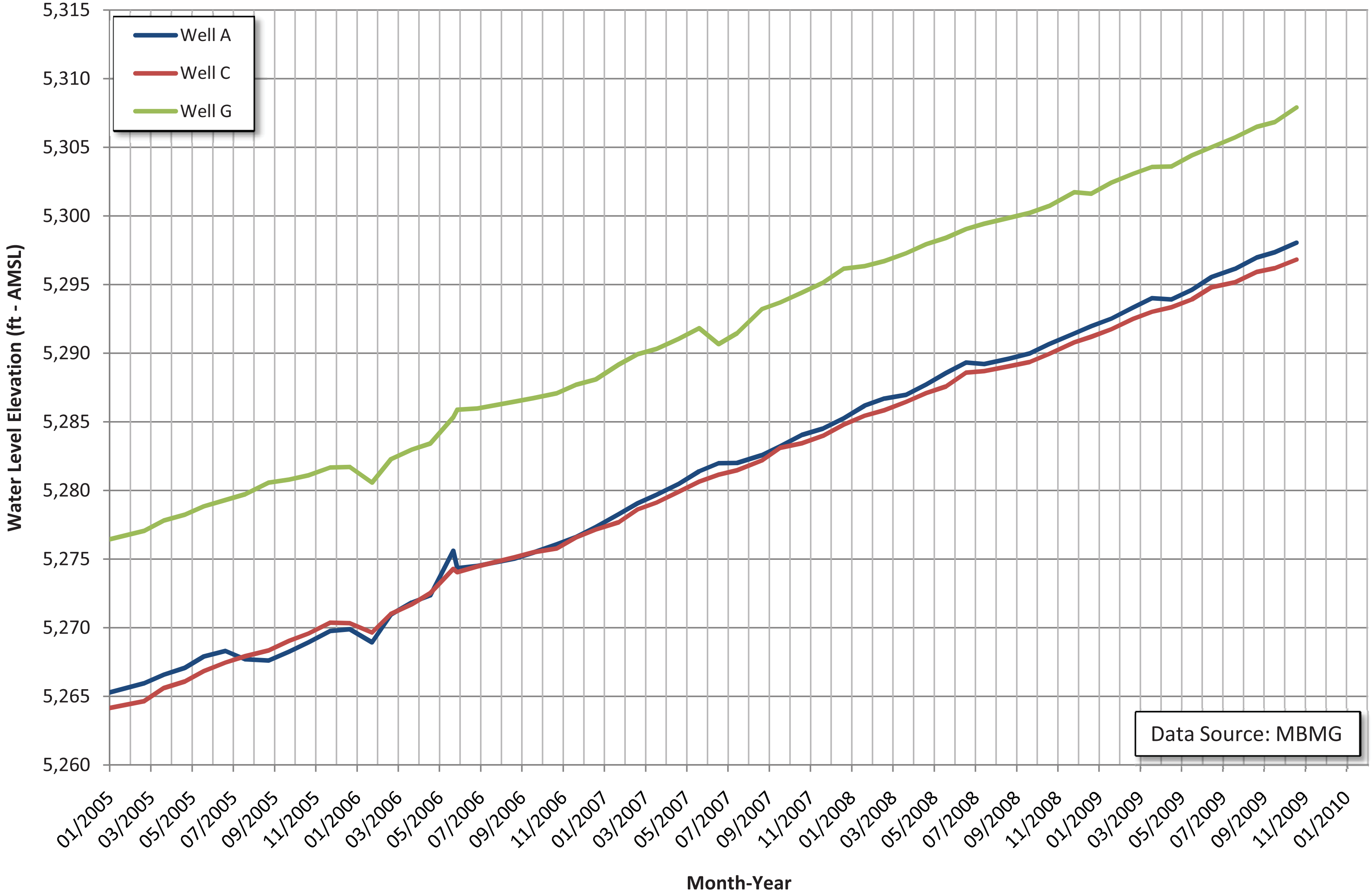

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Figure 6-7
Water Level Elevation at the Berkeley Pit and Anselmo Mine
Silver Bow Creek/Butte Area NPL Site, Five-Year Review, 2010

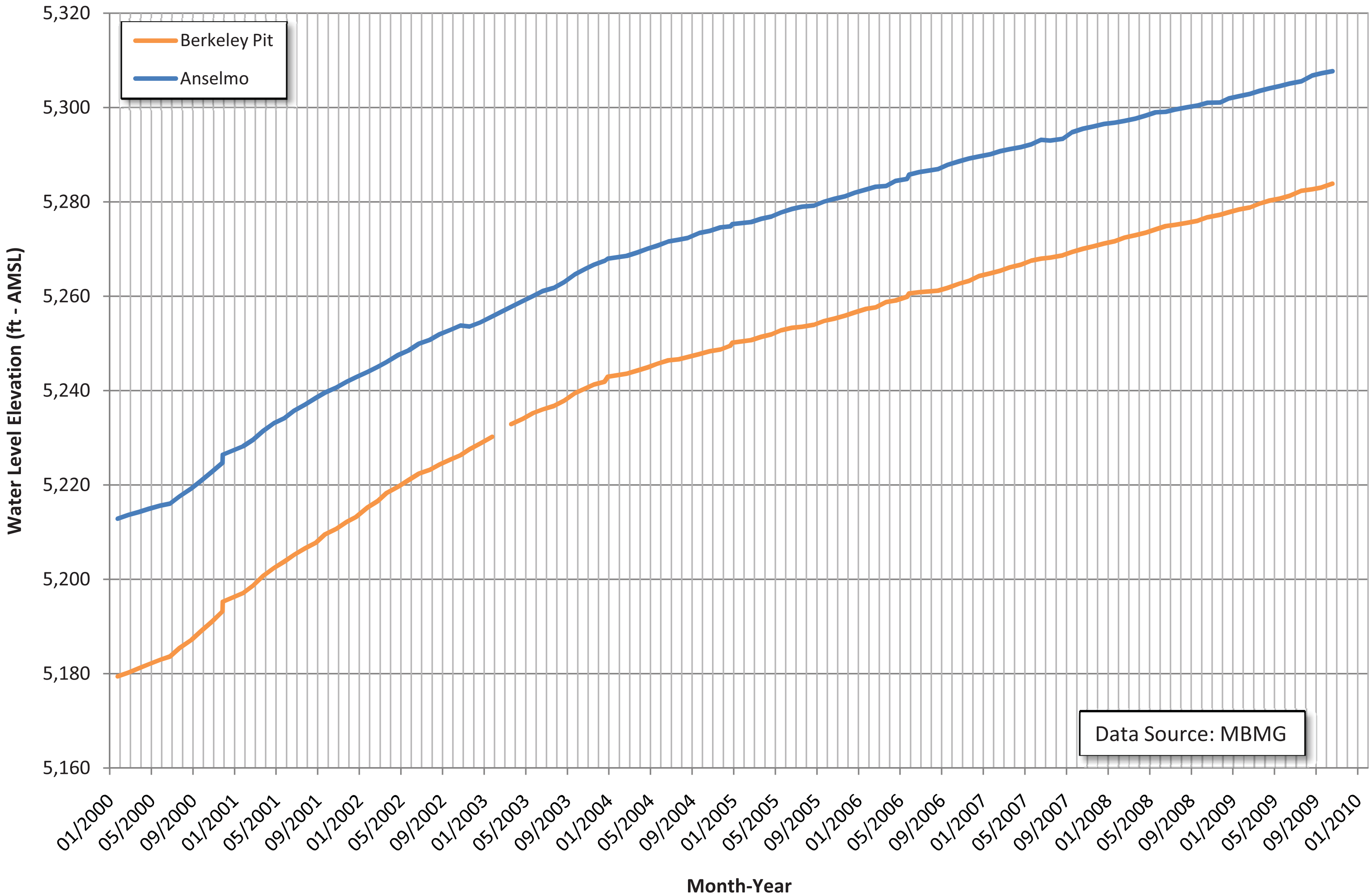

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Figure 6-8
Water Level Elevation of West Camp Bedrock Well BMF96-1D and West Camp Pumping Rate
Silver Bow Creek/Butte Area NPL Site, Five-Year Review, 2010

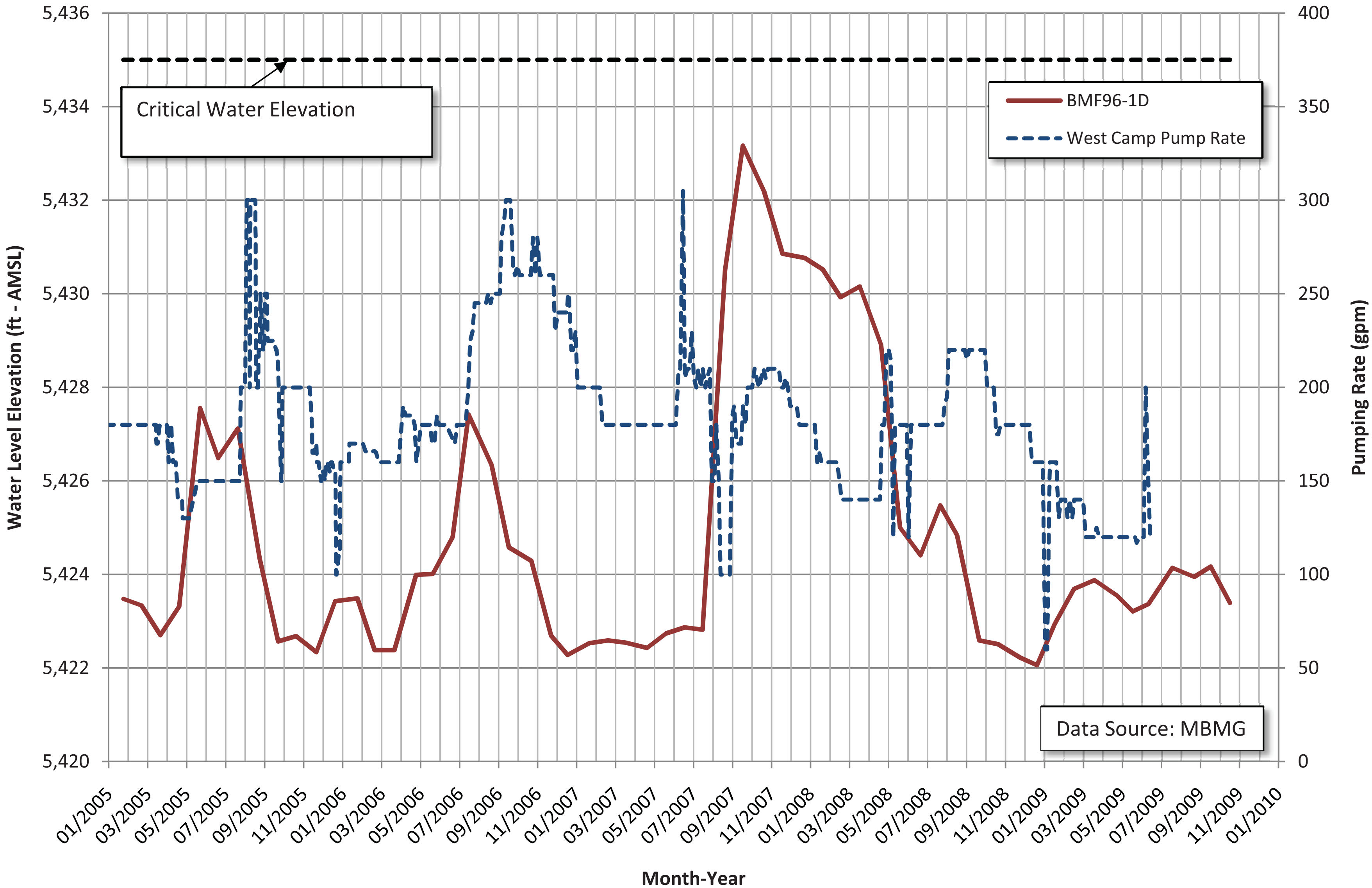

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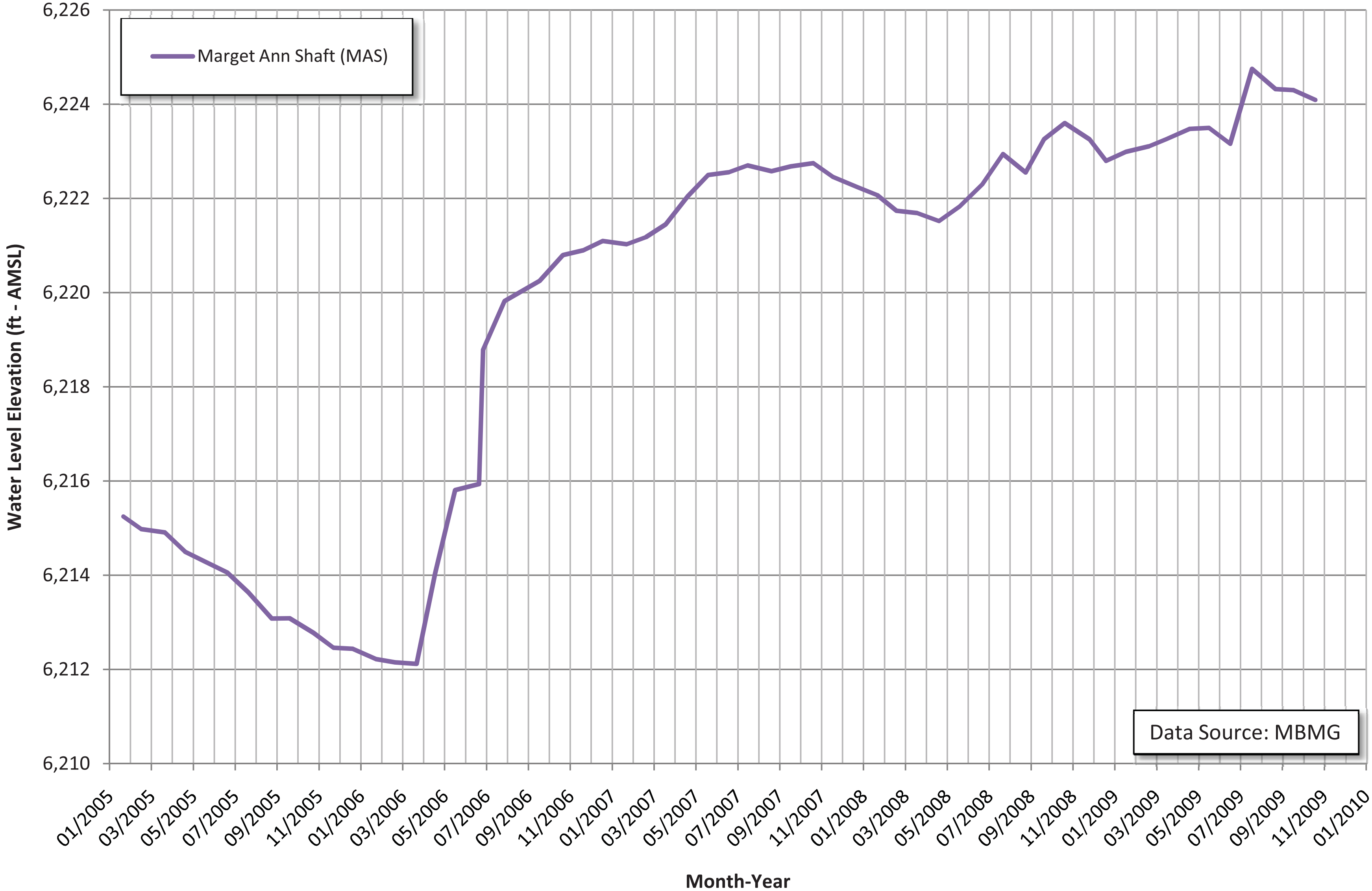
Figure 6-9
Water Level Elevation of Outer Camp Marget Ann Shaft
Silver Bow Creek/Butte Area NPL Site, Five-Year Review, 2010



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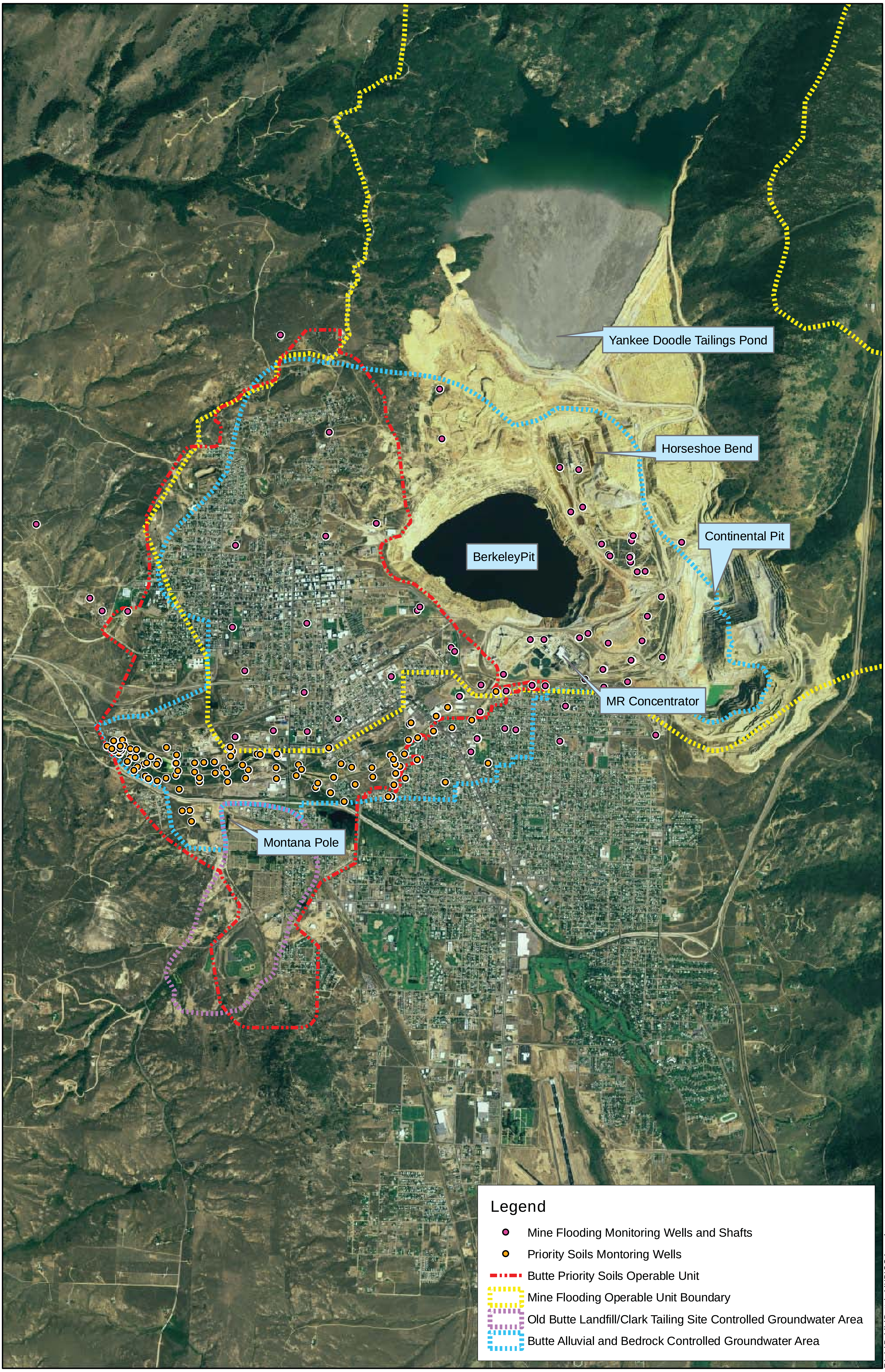

Figure **6-10. Controlled Groundwater Areas**
Silver Bow Creek/Butte **Area Site**

Appendix A

Site Inspection Photographs and Monitoring Well Inspections

Part 1: Tour of Horseshoe Bend Water Treatment Plant, October 6, 2009

Photo 1. Horseshoe Bend WTP effluent discharge pipeline

Photo 2. WTP control room. Pat Cunneen discusses plant operations.

Part 1: Tour of Horseshoe Bend Water Treatment Plant, October 6, 2009

Photo 3. Lime slaking equipment.

Photo 4. Drained reactor tank, baffle visible (drained for maintenance)

Photo 5. Clarifier with rakes visible (drained for maintenance).

Photo 6. Scale build-up along lip of clarifier overflow.

Photo 7. Large block of scale removed from vessel wall, note thickness.

Photo 8. Flow into first stage reactor tank.

Photo 9. Looking across clarifier.

Part 2: Tour BMFOU Monitoring Wells and Mine Shafts, November 24, 2009

Photo 10. Orphan Boy mine shaft cover and monitoring well.

Photo 11. Lexington mine.

Part 2: Tour BMFOU Monitoring Wells and Mine Shafts, November 24, 2009

Photo 12. West Camp Pump Station

Photo 13. West Camp Pumping Well

Part 2: Tour BMFOU Monitoring Wells and Mine Shafts, November 24, 2009

Photo 14. Emma Shaft cover

Photo 15. Well LP-2 (leach pad area alluvial well)

Part 2: Tour BMFOU Monitoring Wells and Mine Shafts, November 24, 2009

Photo 16. Seeps along alluvial face of Berkeley Pit (MR concentrator in background)

Photo 17. Berkeley Pit and northwest bedrock highwall.

Photo 18. Pilot Butte shaft.

Photo 19. Pilot Butte building interior with vandalism.

Part 2: Tour BMFOU Monitoring Wells and Mine Shafts, November 24, 2009

Photo 20. Horseshoe Bend weir.

Photo 21. Horseshoe Bend staff gauge.

Inspection Summary of BMFOU Monitoring Wells

Site Name	Monitoring Status	Water Quality Frequency	Comments
Anselmo	on-going	Annual	OK
Belmont #2	on-going	Not sampled	OK
Granite Mountain	on-going	Not sampled	OK, If continue to sample need to replace stolen metal protecting shaft
Kelley	on-going	Annual	OK
Lexington	on-going	Not sampled	OK
Pilot Butte	on-going	Not sampled	OK, Last standing wooden frame
Steward	on-going	Annual	OK
Berkeley Pit	on-going	2x/year at 3 depths	OK
Continental Pit	in-active	2x per year	N/A
HSB weir new	on-going	Monthly	OK, iron deposits on stream gauge
Orphan Boy	on-going	Semi-Annual	OK
Orphan Girl	in-active	Semi-Annual	N/A
Marget Ann	on-going	Every 2 years, 2011	OK
S-4	on-going	Not sampled	OK
Green seep	on-going	Semi-Annual	OK, cannot put weir in place because of trespass issues
Tech Well #1	on-going	Every 2 years, 2011	OK
Well-A	on-going	Semi-Annual	OK
Well-B	on-going	Semi-Annual	OK
Well-C	on-going	Semi-Annual	OK, Farthest east monitoring well
Well-D1	on-going	Annual	OK, new casing installed a few years ago
Well-D2	on-going	Annual	OK
Well-E	on-going	Every 2 years 2011	OK
Well-F	on-going	Every 2 years 2011	OK
Well-G	on-going	Annual	OK
Well-J	on-going	Annual	OK
DDH-1	plugged	Not sampled	MR damaged well a couple of years ago. MBMG requests to officially abandon
DDH-2	on-going	Not sampled	OK
DDH-8	on-going	Not sampled	OK
LP-01	on-going	Not sampled	OK
LP-02	on-going	Not sampled	OK
LP-04	on-going	Not sampled	OK
LP-05	on-going	Not sampled	OK
LP-06	on-going, dry	Not sampled	MBMG requests to officially abandon because of proximity to mining operations
LP-07	on-going, dry	Not sampled	OK
LP-08	on-going	Annual	OK
LP-09	on-going	Annual or Semi-Annual	OK
LP-10	on-going	Semi-Annual	OK
LP-12	on-going	Semi-Annual	OK
LP-13	on-going	Semi-Annual	OK
LP-14	on-going	Semi-Annual	OK
LP-15	on-going	Semi-Annual	OK
LP-16	on-going	Semi-Annual	OK
LP-17	on-going	Annual	OK
MR-97-01	on-going	Not sampled	OK
MR-97-02	on-going	Not sampled	OK
MR-97-03	on-going	Not sampled	OK
MR-97-04	on-going	Not sampled	OK

Inspection Summary of BMFOU Monitoring Wells

Site Name	Monitoring Status	Water Quality Frequency	Comments
AMC-05	on-going	Annual	OK
AMC-06	on-going	Semi-Annual	OK, flush mount because in parking lot
AMC-08	on-going	Semi-Annual	OK
AMW- 08	on-going	Not sampled	OK
AMC-10	on-going, dry	Semi-Annual	OK
AMC-12	on-going	Annual	OK
AMC-13	on-going	Not sampled	OK but not locked. Use thumb screws to open
AMC-15	on-going	Every 2 years, 2011	OK
AMW-22	on-going	Not sampled	OK
GS-41D	on-going	Annual	OK
GS-41S	on-going	Annual	OK
GS-44D	on-going	Annual	OK
GS-44S	on-going	Annual	OK
GS-46D	on-going	Annual	OK
GS-46S	on-going	Annual	OK
Belmont #1	on-going	Not sampled	OK
Chester Steele	on-going	Annual	OK
Hebgen	on-going	Not sampled	OK, well used for irrigation
Parrott Park	on-going	Annual	OK
Emma	on-going	Annual	OK, unsecured safety sampling location
Ophir	on-going	Annual	OK
Travona	on-going	Annual	Gate recently locked with someone else's lock and MBMG has to cut lock to gain access
BMF-96-01D	on-going	Not sampled	OK
BMF-96-01S	on-going	Not sampled	OK
BMF-96-02	on-going	Not sampled	OK
BMF-96-03	on-going	Not sampled	OK
BMF-96-04	on-going	Annual	OK
BMF05-01	on-going	Semi-Annual	OK, material laydown area
BMF05-02	on-going	Semi Annual	OK, some frost heaving detected
BMF05-03	on-going	Semi-Annual	OK
BMF05-04	on-going	Semi-Annual	OK

Responsiveness Summary – Butte Mine Flooding Operable Unit

The responsiveness summary includes comments received on the draft BMFOU five-year review report (Volume 3) during the December 12, 2010 through January 31, 2011 comment period. The comments are shown as received but were edited to include only those comments pertaining to the BMFOU. EPA responses are included in italicized text.

Comments from Atlantic Richfield:

BUTTE MINE FLOODING OPERABLE UNIT

AR agrees that the Horseshoe Bend water treatment plant's ability to meet the final pH standard, the cadmium standard and the other performance requirements associated with potential future discharge of treated water to SBC identified in EPA's five-year review issues 1, 2, 3, 4 and 7 are legitimate issues.

- *EPA Response: Comment noted and the final text continues to contain these recommendations.*

However, the scope of work for the site already contemplates a thorough technology review well before any discharges to SBC occur. These and other issues should be considered as part of that review rather than by completing additional performance testing now.

- *EPA Response: The issues identified in the five year review are of sufficient importance that they should be highlighted in the five year review recommendations. EPA would like to be sure the requirements of the existing Mine Flooding Consent Decree work plan are followed, and the necessary testing and engineering work needed to meet standards once a discharge from the Horse Shoe Bend Treatment Plant goes to Silver Bow Creek is done in a timely and complete manner. EPA, in consultation with DEQ, will work with the Mine Flooding Settling Defendants to ensure this is done.*

Specific Comments

1. Issue 5 - Use of scale inhibitors to control gypsum scaling issues in the treatment system may have an effect on metals removal in the treatment plant: Use of scale inhibitors within the treatment process is a temporary operational test and is not currently being proposed as a sustainable option. Should use of the scale inhibitors prove to be successful, and should they be proposed in the future, impacts to other treatment goals would be evaluated.

- *EPA Response: EPA acknowledges AR's response to this issue and is very interested in how the Mine Flooding Settlings Defendants plan to address the gypsum scaling issue.*

2. Issue 6 - The beta-photon procedure used to evaluate the concentration of radio- nuclides in the treatment plant effluent is not practical, given the need to analyze 179 different radionuclides: AR agrees with EPA's general conclusion regarding the beta-photon emitter performance standard within the Consent Decree (CD). Based upon the rationale provided in the Performance Test Report, the beta-photon emitter performance standard should be removed from the performance standard requirements of the CD.

- *EPA Response: EPA acknowledges the comment, and will work with DEQ and the Mine Flooding Settling Defendants to address this issue appropriately.*

Comments from CTEC:

16. Specific remedial action objectives included in the Butte Mine Flooding Operable Unit (BMFOU) ROD include "Implementing a comprehensive monitoring program to verify the protectiveness of the CWLs." The final review should include an evaluation of the critical water level (CWL) and whether the assumptions used in calculating the CWL are still correct.

- *EPA Response: The MBMG conducts the comprehensive groundwater monitoring program for the BMFOU. As part of the monitoring, the MBMG annually updates the Berkeley Pit infilling model (which involves verifying that the CWL is protective and valid,) and also estimates the time at which the CWL will be reached. Current estimates are that the CWL of 5,410 feet will be reached in 2022 in the Anselmo mine. There are multiple bedrock wells surrounding the Berkeley Pit that are considered compliance wells. This adds another layer of certainty that the Berkeley Pit water itself will be kept below the CWL of 5,410 and that the annual updates are valid.*

Comments from the January 11, 2011 Public Meeting Transcript:

Mr. Penhaligen – page 36, lines 18-20, 24-25, and page 37 lines 5-6:
"…but why are we waiting for the water to get to the critical stage in the Berkeley Pit to start that type of pumping and treating? …Why are we waiting to get to that critical level? Because critical means critical. ...Isn't the Berkeley Pit getting higher?"

- *EPA Response: The critical water level is a level set at an elevation that the Pit water can never exceed. By pumping and treating the water at that level, you ensure that the bedrock aquifer contaminated water will not be released into other aquifers, and that bedrock groundwater always flows downhill towards the Pit, not away from the Pit. Making the critical water level lower would not further the protectiveness of the remedy.*