DRAFT
CR Kendall Mine Closure Environmental Impact Statement

Prepared for:

State of Montana
Department of Environmental Quality

September 2015

September 10, 2015

Dear Interested Party:

The Montana Department of Environmental Quality (DEQ) has completed a Draft Environmental Impact Statement (draft EIS) for a proposed amendment to Operating Permit No. 00122 issued to CR Kendall Corp. for the CR Kendall Mine. You can obtain an electronic version of the draft EIS on DEQ's web site at http://deq.mt.gov/eis.mcpx. There will be a 30-day public comment period for the CR Kendall Mine Closure draft EIS. DEQ will also hold a public meeting and accept public comments on September 30 from 6 to 8 P.M. at the Yogo Inn in Lewistown, Montana.

The CR Kendall Mine is an open pit mine in closure status located on the eastern flanks of the North Moccasin Mountains in Fergus County, Montana. DEQ issued CR Kendall's current Operating Permit No. 00122, covering about 1,040 acres, on September 14, 1984, under the Montana Metal Mine Reclamation Act (MMRA) (Section 82-4-301, *et seq*., Montana Code Annotated [MCA]). On July 25, 2012, DEQ received an application to amend Operating Permit No. 00122 (Amendment 007) from CR Kendall that contained an amended closure plan for final design of water management and treatment, final capping and reseeding of the former process pads, and long-term reclamation monitoring and maintenance. On March 9, 2015, DEQ determined that the company's application for Amendment 007 was complete and compliant and, pursuant to Section 82-4-337, MCA, issued a draft permit for the proposed closure.

Pursuant to Section 82-4-337(1)(f), MCA, issuance of the draft permit as a final permit is the proposed state action subject to the environmental review required by the Montana Environmental Policy Act (MEPA) (Section 75-1-201, *et seq*., MCA). Section 75-1-201(1)(iv), MCA, requires the preparation of an environmental impact statement (EIS) for state actions that may significantly affect the quality of the human environment. The EIS must include a detailed statement on the environmental impact of the proposed action, alternatives to the proposed action, and a no action alternative. Pursuant to this statute, the DEQ analyzed a No Action Alternative, a Proposed Action (the company's proposed amendment), the Process Pad Drainage Pretreatment Alternative, and the Process Pad Barrier Cover Alternative for the draft EIS.

ARM 17.4.617 requires DEQ to include in an EIS an identification of the agency's preferred alternative, if any, and the reasons for the preference. At this juncture, DEQ has identified the Process Pad Drainage Pretreatment Alternative as the preferred alternative. The draft EIS is not

a final decision. The preferred alternative could change in response to public comment on the draft EIS, new information, or new analysis that might be needed in preparing the final EIS.

Comments on the draft EIS may be submitted electronically using the DEQ Public Comment Portal at http://bit.ly/CRKendallPublicComment. Written comments, and any questions regarding the environmental review, may also be submitted to the following address:

Jen Lane
Department of Environmental Quality
P.O. Box 200901
Helena, MT 59601
406-444-4956

Comments on the draft EIS must be submitted to DEQ no later than October 9, 2015.

The DEQ will make reasonable accommodations for those with disabilities who wish to participate in the meeting. If you require an accommodation, please contact Lisa Peterson at 406-444-2929 or lpeterson@mt.gov.

I welcome and look forward to your participation.

Sincerely,

Tom Livers

Tom Livers
Director

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Summary

S.1 Introduction

This draft environmental impact statement (EIS) was prepared for the proposed closure of the CR Kendall Mine on the eastern flanks of the North Moccasin Mountains in Fergus County, Montana **(Figure 1-1)**. On July 25, 2012, the Department of Environmental Quality (DEQ) received an application to amend Operating Permit No. 00122 (Amendment 007) from CR Kendall that contained an amended closure plan for final design of water management and treatment, final capping and reseeding of the former process pads, and long-term reclamation monitoring and maintenance (Hydrometrics & CR Kendall Corp., 2012; CR Kendall, 2012). DEQ provided a deficiency letter to CR Kendall on September 21, 2012. CR Kendall responded to the deficiency review and DEQ issued a favorable compliance determination and a Draft Amendment 007 on March 9, 2015. The CR Kendall Mine closure activities described in the Amendment 007 Application comprise the Proposed Action.

DEQ is the lead agency and prepared this draft EIS to present the analysis of possible environmental consequences of four closure alternatives: the No Action Alternative, the Proposed Action, the Process Pad Drainage Pretreatment Alternative, and the Process Pad Barrier Cover Alternative. The two process pad alternatives include additional mitigation measures developed by DEQ.

S.2 Purpose and Need

CR Kendall conducted mining activity under Operating Permit 00122, which was originally issued to Triad Investments on September 14, 1984 and allowed mine development within a 119 acre permit area. The permit was subsequently amended several times, was acquired by Canyon Resources following a bankruptcy, and currently covers about 1,040 acres. The mine was permitted under the Montana Metal Mine Reclamation Act ([MMRA]; 82-4-301, *et seq.*, Montana Code Annotated [MCA]). Amendment 007 is a closure plan for the CR Kendall Mine and primarily focuses on water management and treatment. The amendment also addresses final capping of the former process pads, and long-term reclamation monitoring and maintenance.

The Montana Environmental Policy Act (MEPA) requires an environmental review of actions taken by the State of Montana that may significantly affect the quality of the human environment. This EIS was prepared to fulfill the MEPA requirements. The Director of DEQ will decide which alternative should be approved in a Record of Decision (ROD) based on the analysis in the final EIS. The final EIS will include comments received on the draft EIS and the agency's responses to those comments.

S.3 Issues of Concern

From the public involvement, two relevant issues were identified that should be addressed through the alternatives analysis process for the closure EIS—(1) the effects of the mine closure actions on surface water and groundwater quantity and quality; and (2) the effects of the mine closure actions on soils and reclamation. These issues will be evaluated in detail to address impacts to resources and to help determine reasonable alternatives for mine closure, including the Proposed Action. The specific components of the two relevant issues are:

Issue 1: Effects on quantity and quality of surface water and groundwater resources:

- Discharges from the mine to surface water and groundwater may exceed water quality standards for certain contaminants: arsenic, antimony, selenium, thallium, cyanide, and nitrate.
- Pumpback of contaminated groundwater and capture of surface water have reduced downgradient water quantity in four watersheds. Water management at the mine may continue to reduce downgradient water quantity.
- Pumping clean groundwater from water wells WW-6 and WW-7 may have reduced water quantity in downgradient wells.
- The mine facilities have intercepted natural drainages that channeled stormwater and snowmelt that no longer reach drainages below the mine.
- Water quantity in each drainage could need augmented by rerouting drainage channels and developing springs and other groundwater sources.
- Water and sediment from the mine may contribute arsenic to the Boy Scout pond downgradient of the permit boundary in South Fork Last Chance Creek.
- The underdrain in the process valley could be receiving impacted water.

Issue 2: Effects on soils and reclamation

- Reclamation efforts may have resulted in inadequate vegetation in some areas, erosion on steeper slopes, and excessive infiltration through the cover systems.
- Application of reverse osmosis (RO) brine on the leach pads may have caused elevated levels of salts and other potential contaminants possibly affecting the reclamation cover system and future revegetation.
- Insufficient and unsuitable on-site reclamation materials may limit reclamation cover system alternatives.

S.4 Alternatives Analyzed in Detail

Four alternatives are described and evaluated in detail in this draft EIS: the No Action Alternative; the Proposed Action (Application for Amendment 007); the Process Pad Drainage Pretreatment Alternative; and the Process Pad Barrier Cover Alternative. Brief summaries of the four alternatives are presented below. Detailed descriptions of the alternatives are provided in Chapter 2.

S.4.1 No Action Alternative

For this EIS, the 1989 Plan of Operations and 1995 Soils and Revegetation Plan along with the pumpback and water treatment plans are considered to be the No Action Alternative. The No Action Alternative reflects the current CR Kendall Mine operations under Operating Permit 00122, including six Amendments and 23 minor revisions up through Minor Revision 11-001. Most reclamation activities under the permit have been completed. Major disturbed areas have been reclaimed, including the Horseshoe Pit and Horseshoe Waste Rock Dump; Muleshoe Waste Rock Dump; Barnes-King Pit; Kendall Waste Rock Dump, and most of the Kendall and Muleshoe Pits. Minor Revision 11-001 was approved in 2011 and allowed CR Kendall to place a 17-inch layer of growth media directly over the basal layer on process pads 3 and 4 as an interim reclamation measure.

Under this alternative, CR Kendall would address the remaining reclamation items at the mine, including spreading the remaining stockpiled soil, completing some additional revegetation work, and providing long-term reclamation monitoring and maintenance.

Other mine facilities will be retained until water treatment is no longer needed, including pumps and piping; ponds 2B, 3B, 7, and 8; stormwater controls; water treatment and maintenance facilities; roads; power lines; and land application disposal (LAD) facilities.

S.4.2 Proposed Action

The Proposed Action is the proposed Closure Water Management Plan CR Kendall submitted in their Application for Amendment 007 to Operating Permit No. 00122. The Proposed Action primarily addresses the long-term water treatment of the process pad drainage and captured groundwater. The alternative would retain the installed vegetated soil cover authorized under Minor Revision 11-001 and outlines reclamation monitoring and maintenance activities. The main items different from the No Action Alternative are:

- The process pad drainage and all captured groundwater would be combined for treatment by filtering to remove particulate, treating with zeolite adsorption to remove thallium, and discharged to groundwater through the Kendall Pit. The option for LAD is retained as a contingency.

- No additional growth media (soil) would be placed on the regraded areas of the Kendall Pit with slopes less than 2:1 or the lower slopes in the Muleshoe Pit with poor vegetation establishment. No additional reseeding is planned.
- Most buildings would remain for private use after closure.

S.4.3 Process Pad Drainage Pretreatment Alternative

A separate piping system would collect the drainage water from process pads 3 and 4 for pretreatment prior to blending the drainage water with other mine waters. Arsenic is one of the contaminants in the process pad drainage water, and is projected to exceed groundwater standards even after the drainage water and captured groundwater are combined. The pretreatment system could remove arsenic and other contaminants, if necessary to comply with discharge criteria.

The likely pretreatment system would involve the oxidation and adsorption of arsenic onto an adsorbent compound (ferric chloride, iron filings, or other). The pretreatment process would most likely be developed specifically for the CR Kendall process pad drainage water to effectively remove arsenic. After pretreatment, the water would be combined with the other captured groundwater for thallium removal through the current method of zeolite adsorption. Treated water would be discharged to groundwater through the Kendall Pit.

New water treatment equipment would be required to pretreat the process pad drainage water. The annual average flow rate after installing the current process pads caps (2009 to 2014) ranged from 11.3 gallons per minute (gpm) to 20.5 gpm, with an average rate of 13.7 gpm.

The specific pretreatment technology chosen by CR Kendall to remove arsenic could generate a contaminated treatment media, or byproduct, that requires proper disposal. Because the specific technology has not been chosen or designed, the possible disposal options for the contaminated media could include: (1) shipping it back to the manufacturer when exhausted; (2) shipping it off-site for disposal; or (3) burying it on-site if confirmed as non-hazardous.

Similar to the No Action Alternative the remaining stockpiled soil, in excess of the quantity required to complete reclamation of facilities required for long term water treatment, would be placed on regraded slopes in the Kendall Pit and on the lower slopes in the Muleshoe Pit and the areas reseeded.

S.4.4 Process Pad Barrier Cover Alternative

The Process Pad Barrier Cover Alternative was developed to minimize the process pad drainage flows that require treatment. Adding a barrier liner to the process pads could effectively reduce drainage water flows. CR Kendall would select the effective cover materials to use; however, DEQ would have final review and approval. DEQ would

require the barrier liner be of HDPE or a similar product rather than a geosynthetic clay liner (GCL). The current 17 inches of soil would be temporarily removed and a geomembrane liner installed. The geomembrane liner would consist of a textured HDPE liner overlaid with a geocomposite drainage net. The salvaged soil would be replaced over the geomembrane liner and the process pads reseeded.

As with the Proposed Action, the process pad drainage and all captured groundwater would be combined for treatment by filtering to remove particulate, treating with zeolite adsorption to remove thallium, and discharged to groundwater through the Kendall Pit. The option for LAD is retained as a contingency.

Similar to the No Action Alternative and the Process Pad Drainage Pretreatment Alternative, the remaining stockpiled soil in excess of the quantity required to complete reclamation of facilities required for long term water treatment, would be used for reclamation.

S.5 Summary of Impacts

Table S-1 summarizes and compares the impacts of the four alternatives considered and evaluated in detail.

S.6 Preferred Alternative

The rules and regulations implementing MEPA (ARM 17.4.617) require agencies to indicate a preferred alternative in the draft EIS, if one has been identified. DEQ has identified the Process Pad Drainage Pretreatment Alternative as the preferred alternative for the reasons discussed below.

The Process Pad Drainage Pretreatment Alternative is the only alternative that ensures compliance with all groundwater standards for all water to be treated and discharged. This would be achieved through the development of an additional water treatment system to specifically remove arsenic from the process pad drainage. The system would be modified as necessary to include treatment for other elements, such as selenium, which may require treatment in the future to comply with groundwater discharge standards.

Mixing models developed for the Proposed Action predict the combined drainage water and captured groundwater would not meet groundwater standards for thallium and arsenic, but only treatment for thallium was proposed. CR Kendall assumed (1) either the natural background arsenic concentration in the Madison Limestone aquifer is also above the standard, or (2) dilution provided by mixing of the effluent from the treatment plant with groundwater moving through the aquifer would result in compliance with groundwater quality standards after mixing. CR Kendall has not collected data from the local Madison Limestone aquifer to document the validity of either assumption, which might allow for effluent limits higher than groundwater standards.

The Process Pad Barrier Cover Alternative is intended to reduce the rate of infiltration into, and drainage from, the process pads. Reduced flows from the process pads and combining this water with other captured groundwater may result in sufficient dilution of constituents, other than thallium, so that no other water treatment would be required to achieve standards. However, reclamation of process pads using barrier covers may not reduce seepage to levels where treatment is no longer required. It is also possible the total amounts of contaminants in the residual seepage may not decrease in proportion to the reduced flows. Therefore, the Process Pads Barrier Cover Alternative does not provide assurance that it would eliminate the need for additional water treatment steps in order to achieve compliance with groundwater discharge standards.

The Process Pad Drainage Pretreatment Alternative provides for better growth medium to support vegetation on the process pads compared to the Process Pad Barrier Cover Alternative. The existing 17 inch process pad soil cover overlies 6 inches of subsoil amended with bentonite and 12 inches of unamended subsoil. Plant roots are able to penetrate the entire soil profile, and thus should be more tolerant of drought. Plant roots may extend into the underlying spent ore. In contrast, the Process Pad Barrier Cover Alternative would restrict plant roots to the upper 17 inches of soil, resulting in the vegetation being more susceptible to drought. There would also be an increased potential for soil slumping along a saturated zone on top of the liner and increased potential for exposure and damage to the barrier cover from toppling of shallow-rooted trees. Additional impacts to soils and vegetation would be expected due to salvage, stockpiling, and replacement of the soil materials on the process pad barrier cover.

The Process Pad Drainage Pretreatment Alternative would result in some additional acres of revegetated land compared to the Proposed Action. CR Kendall would use the remaining stockpiled soil, other than the soil reserved for the eventual reclamation of roads and facilities, on the remaining areas of pit backfill that have not previously received soil.

TABLE S-1
COMPARISON OF CR KENDALL MINE CLOSURE EIS ALTERNATIVES

Alternative Component	No Action Alternative (Approved, Current Plan, or Already Completed)	Proposed Action	Process Pad Drainage Pretreatment Alternative	Process Pad Barrier Cover Alternative
Water				
Process Pad Drainage Water	Process pad drainage water is not actively treated but is collected in Pond 7 and land applied during growing season. Annual average flow rate after installing caps (2009 to 2014) ranged from 11.3 gpm to 20.5 gpm, with an average of 13.7 gpm.	Process pad drainage water would be captured, combined with other mine waters, filtered to remove particulate, treated by zeolite adsorption, and discharged to the Kendall Pit. LAD would be retained as contingency disposal during the growing season.	Process pad drainage water would be separately collected and piped to a pretreatment system (likely a specific media filtration system) primarily for the treatment and removal of arsenic. The treated water would be combined with the other mine water for zeolite adsorption treatment and discharged to groundwater through the Kendall Pit.	Same as Proposed Action.
Groundwater Capture and Pumpback Water Treatment	Groundwater that does not meet water quality standards is pumped back from South Fork Last Chance Creek (KVPB-5) and the Process Valley Underdrain (TMW-26) to the Process Valley Ponds 2B and 3B, then treated with zeolite adsorption before being discharged to groundwater through the Kendall Pit. Groundwater pumped back from Barnes-King Gulch (KVPB-2) and Little Dog Creek (KVPB-6) is land applied in the growing season. Otherwise, groundwater is stored in Ponds 7 and 8 for LAD during the growing season. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.	All captured groundwater would be combined with process pad drainage water in Ponds 7 and 8, filtered to remove particulate, and treated with zeolite adsorption before being discharged to groundwater through the Kendall Pit. LAD would be retained as contingency disposal during the growing season. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.	All captured groundwater would be combined with the pretreated pad drainage water, then treated by zeolite adsorption, and discharged to groundwater through the Kendall Pit. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.	Same as Proposed Action.
Disposal of Spent Zeolites	Disposal in leach pads until capped in 2012. Currently retained on site and stored in the truck shop.	Place into Pond 7. If zeolite generation is higher than anticipated, could transport off-site for disposal at a Class II or III landfill, or store in a purpose-built, on-site repository. All disposal methods would comply with Montana solid waste regulations.	Same as Proposed Action.	Same as Proposed Action.
Reclamation				
Process Pads Reclamation Design	Process pads were regraded to 3:1 slopes with 10 foot benches every 100 feet in 2004 (1989 Plan of Operations). A modified water-balance cover was installed in 2008 and 2012 consisting of 17 inches of growth media over 6 inches of subsoil basal layer material amended with 5 to 8 percent bentonite, over 12 inches of subsoil basal layer material (Minor Revision 11-001). Process pads were seeded in 2012.	Same as No Action.	Same as No Action.	Remove the upper 17 inches of growth media and vegetation from process pads 3 and 4 and install barrier cap (liner with drainage net). Replace the growth media on top of liner and revegetate.
Process Pads Underliner	Underliner would be perforated by drilling to the underdrain to eliminate water ponding (1989 Plan of Operations).	Maintain underliner integrity for drainage water discharge to Ponds 7 and 8.	Same as Proposed Action.	Same as Proposed Action.
Kendall and Muleshoe Pits	Rock stockpiles in the Kendall Pit were regraded in 2006 (Minor Revision 06-001). The placement of 8 to 10 inches of soil on regraded areas with less than 2:1 slopes and reseeding has not been completed. The lower slopes of the Muleshoe Pit were backfilled but not covered with soil and are poorly vegetated.	Same regrading (completed in 2006) in Kendall Pit but no additional soil placed on areas in Kendall or Muleshoe Pits.	Similar to No Action except soil from stockpile TS-13a would be placed on regraded slopes in the Kendall Pit and lower slopes in Muleshoe Pit and the areas reseeded.	Same as Process Pad Drainage Pretreatment.
Facilities	All buildings (including the WTP) will be removed at closure when reclamation is completed (1989 Plan of Operations). All ponds will be backfilled or graded to drain and the areas covered with soil and reseeded after water treatment is no longer required.	Most buildings will remain after closure for private use. After water treatment is no longer required, all ponds will be backfilled or graded to drain and the areas covered with soil and reseeded.	Same as Proposed Action	Same as Proposed Action.
Roads	All reclaimed except BLM right of way.	All roads retained until no longer needed for access for water treatment. After water treatment is no longer needed, all roads reclaimed except BLM right of way.	Same as Proposed Action	Same as Proposed Action

Purpose of and Need for Action

1.1 Introduction

This draft environmental impact statement (EIS) was prepared for the proposed closure of the CR Kendall Mine on the eastern flanks of the North Moccasin Mountains in Fergus County, Montana **(Figure 1-1)**. On July 25, 2012, the Department of Environmental Quality (DEQ) received an application to amend Operating Permit No. 00122 (Amendment 007) from CR Kendall that contained an amended closure plan for final design of water management and treatment, final capping and reseeding of the former process pads, and long-term reclamation monitoring and maintenance (Hydrometrics & CR Kendall Corp., 2012; CR Kendall, 2012). DEQ provided a deficiency letter to CR Kendall on September 21, 2012. CR Kendall responded to the deficiency review and DEQ issued a favorable compliance determination and a Draft Amendment 007 on March 9, 2015. The CR Kendall Mine closure activities described in the Amendment 007 Application comprise the Proposed Action.

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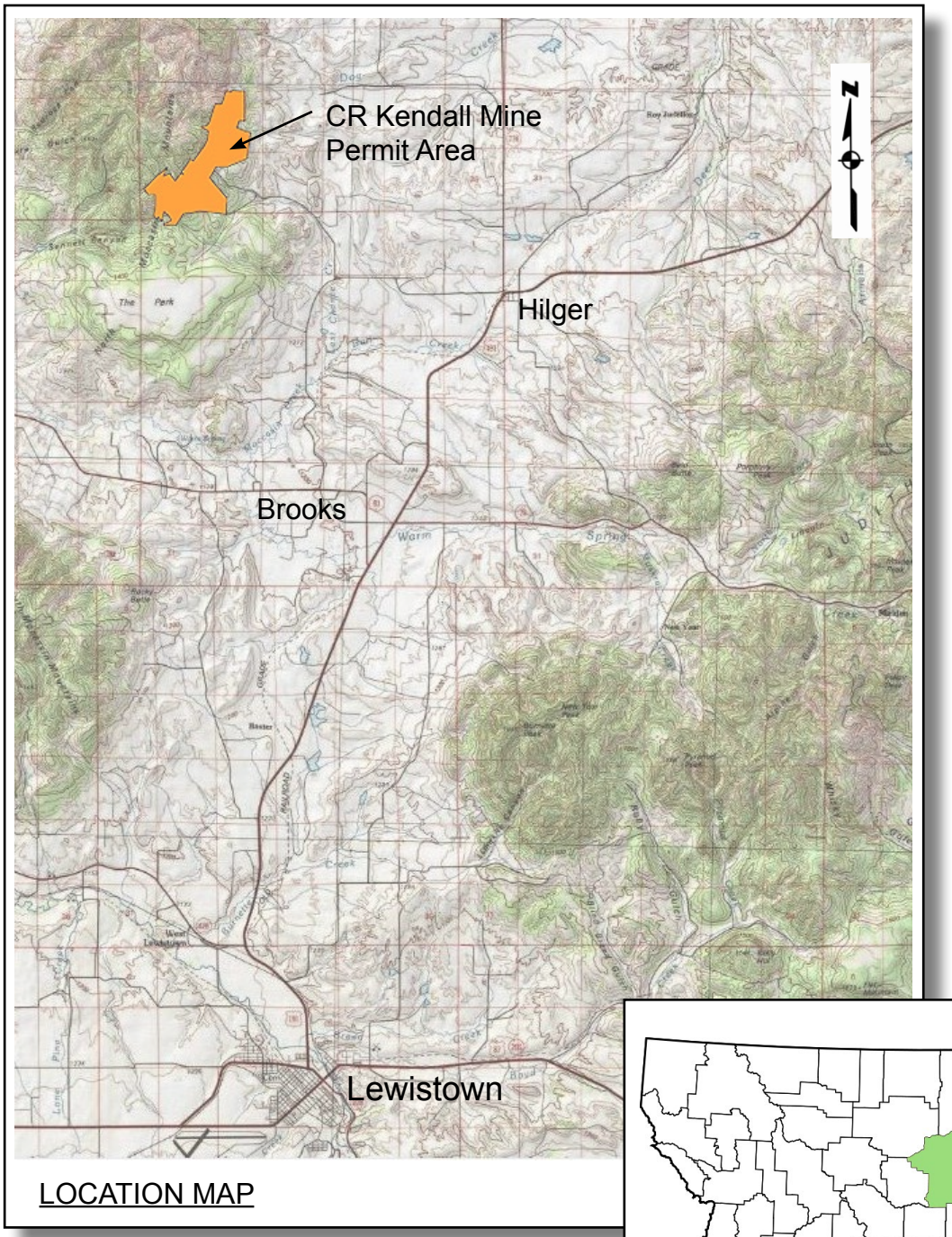
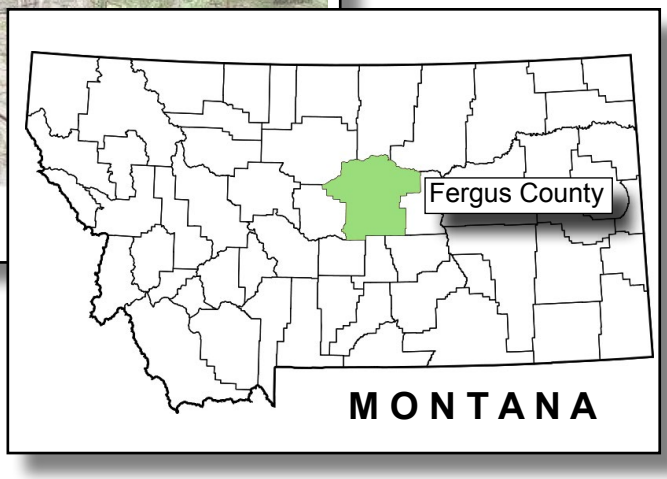
1.2 Purpose and Need

CR Kendall conducted mining activity under Operating Permit 00122, which was originally issued to Triad Investments on September 14, 1984 and allowed mine development within a 119 acre permit area. The permit was subsequently amended several times, was acquired by Canyon Resources following a bankruptcy, and currently covers about 1,040 acres. The mine was permitted under the Montana Metal Mine Reclamation Act ([MMRA]; 82-4-301, *et seq*., Montana Code Annotated [MCA]). Amendment 007 is a closure plan for the CR Kendall Mine and primarily focuses on water management and treatment. The amendment also addresses final capping of the former process pads, and long-term reclamation monitoring and maintenance.

The Montana Environmental Policy Act (MEPA) requires an environmental review of actions taken by the State of Montana that may significantly affect the quality of the human environment. This EIS was prepared to fulfill the MEPA requirements. The Director of DEQ will decide which alternative should be approved in a Record of Decision (ROD) based on the analysis in the final EIS. The final EIS will include comments received on the draft EIS and the agency's responses to those comments.





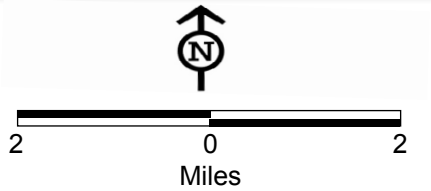


Figure 1-1
Project Location Map

1.3 Project Location and History

The CR Kendall Mine is in Fergus County, approximately 8 miles west of Hilger and 25 miles north of Lewistown, Montana **(Figure 1-1)**. Mining began in the area around the CR Kendall Mine in about 1880 and continued until 1942. Historical tailings from ore milling operations were deposited in Mason Canyon, Barnes-King Gulch, and Little Dog Creek, prior to CR Kendall's modern mining activities. The historical Kendall Mill discharged tailings into Mason Canyon. The Barnes-King Mill discharged tailings into Barnes-King Gulch and some tailings were transported as far as 2 miles downstream. The North Moccasin Syndicate Mill deposited tailings in the North Fork of Little Dog Creek.

The Horseshoe waste rock dump was constructed on top of North Moccasin Syndicate tailings after some tailings were removed and used for the process pad underliner material (CR Kendall, 1992). The majority of the North Moccasin Syndicate mill tailings are below and east of the CR Kendall Mine property boundary and behind a series of three earthen dams in Little Dog Creek.

Modern mining processes were initiated by Triad Investments, Inc. in 1981 under a Small Miner Exclusion for disturbance of less than 5 acres. In 1984 the company was issued Operating Permit #00122 with a permit area of 119 acres. The permit was later transferred to Greyhall Resources, who continued mining operations through 1986. Canyon Resources (CR) Corporation voluntarily took over the management of the site to prevent uncontrolled discharges of cyanide process solution during the bankruptcy of Greyhall Resources in 1987. CR Corporation took over sole management of the property in 1990 under the name of CR Kendall Corporation. Mining ceased in February 1995, and gold recovery continued through the fall of 1997. The gold recovery process involved cyanide heap leaching, gold precipitation on zinc filings, carbon recovery, and smelting.

The CR Kendall Mine operations disturbed approximately 448 acres of the 1,040 acre permit area (CR Kendall, 2014 Annual Report). Through December 31, 2014, approximately 395 acres have been reclaimed leaving approximately 53 acres unvegetated. The currently unvegetated acres include the mine office and shops, water treatment plant (WTP), main road and access roads, and approximately 8 acres in the Kendall and Muleshoe Pits where soil has not been replaced. The proposed Amendment 007 Water Management Closure Plan would continue to use approximately 45 acres for the WTP and associated facilities and for the access roads. A summary of the acres disturbed and reclaimed is in **Table 1-1**.

The major features at CR Kendall Mine include four mine pits (Horseshoe, Muleshoe, Barnes-King, and Kendall), three waste rock dumps (Horseshoe, Muleshoe, and Kendall), two process pads (3 and 4), various ore processing and/or water management facilities including process water ponds 2B, 3B, 7, and 8, and other disturbances. These

mine features are shown on **Figure 1-2**. All of the waste rock dumps and three of the four mine pits have been reclaimed in compliance with the approved reclamation plan. Approximately 8 acres of the Kendall Pit have regraded slopes but have not had soil replaced or been reseeded.

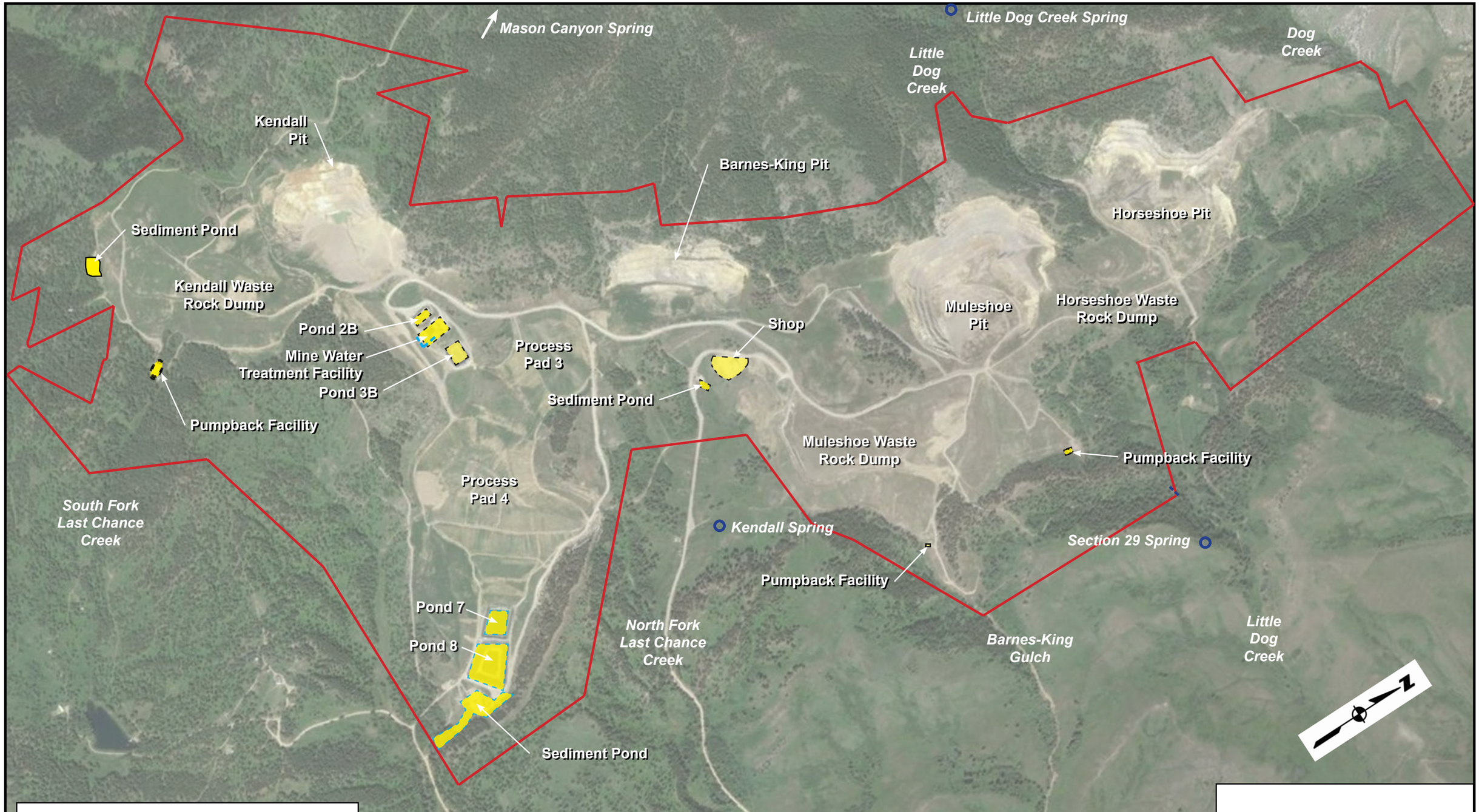
TABLE 1-1
DISTURBED AND RECLAIMED ACRES[1] FOR CR KENDALL MINE
(DECEMBER 2014)

Disturbance Type	Acres Disturbed	Acres Reclaimed
Mine Pits, Waste Rock Dumps, Soil Stockpiles, Associated Areas	353	345
Process Pads	50	50
WTP and Facilities	15	0
Main Roads (30-foot average width)	12	0
Access Roads (20-foot average width)	18	0
Totals	448	395

Note:
[1] Acreages are approximate.

In 2004, CR Kendall graded the process pads to their final reclamation slopes and, in 2006 and 2008, placed an 18-inch thick basal layer composed of crushed and screened Kootenai Formation rock obtained from an onsite quarry south of process pad 4. The 18 inch layer consisted of 12 inches of minus-6-inch material capped by 6 inches of minus-1.25-inch material amended with sodium bentonite at 5 to 8 percent by volume. This grading and placement of the basal layers was approved by DEQ recognizing that these layers would be a component of any closure plan approved for the process pads.

In July of 2011, CR Kendall submitted a request for a revision to its operating permit regarding final capping of process pads 3 and 4. CR Kendall sought authorization to place 17 inches of growth media directly over the basal layer as the final capping of the process pads. CR Kendall expressed a concern that if a soil cap was not placed on the process pads, the bentonite-amended basal layer could significantly erode due to continued exposure to precipitation events. DEQ could only approve placement of the 17 inches of growth media on the basal layer as an interim measure because DEQ had not completed an environmental review for the final cap design. It was DEQ's and CR Kendall's express understanding that the growth media might have to be removed if the final reclamation plan requires the capping of the process pads to be modified (such as the inclusion of a barrier cover). DEQ determined that CR Kendall would have to submit a reclamation bond covering the cost of removing the soil if required by the final reclamation plan. DEQ approved the minor revision (Minor Revision 11-001) contingent on receipt of the additional reclamation bond which was subsequently posted.



LEGEND

Permit Boundary

Mine Facilities (Treatment Facilities, Ponds, Pumps,and Maintenance Buildings

0 850'

SCALE: 1" = 850 feet
Source of Base: Google Earth Pro
Date: 7/1/2014

FIGURE 1-2
CR Kendall Mine
Site Map

1.4 Scope of the Document

Four alternatives are described and evaluated in detail in this EIS. Chapter 2 describes the No Action Alternative, the Proposed Action, the Process Pad Drainage Pretreatment Alternative, and the Process Pad Barrier Cover Alternative. Chapter 3 describes the existing environment and environmental consequences to the resource areas from implementation of the alternatives. Resource areas discussed in detail include: geology and minerals; soil, vegetation, and reclamation; surface and groundwater; and wildlife. Chapter 4 describes the cumulative, unavoidable, irreversible, and irretrievable, and secondary impacts that may occur under the alternatives. Chapter 5 provides a comparison of alternatives and Chapter 6 lists the preparers. Chapter 7 contains the glossary and acronym list and Chapter 8 has the references.

Brief summaries of the four alternatives are presented below with detailed descriptions in Chapter 2.

1.4.1 No Action Alternative

The No Action Alternative reflects the current CR Kendall Mine operations under Operating Permit 00122, including six Amendments **(Table 1-2)** and 23 minor revisions up through Minor Revision #11-001. The main mine components consist of four mine pits (Horseshoe, Muleshoe, Barnes-King, and Kendall), three waste rock dumps (Horseshoe, Muleshoe, and Kendall), two process pads (3 and 4), various WTP facilities including ponds 2B, 3B, 7, and 8, and other disturbances. The mine would continue to collect the process pad drainage water in Pond 7 and land applied during growing season. The captured alluvial groundwater would continue to be pumped to the WTP and treated by a media filtration step (sand filtration) and zeolite adsorption to remove thallium and discharged to groundwater through the Kendall Pit. Concentrations of thallium, arsenic, cyanide, nitrate, and other parameters in the process pad drainage have been decreasing over the last 20 years. Under the No Action Alternative, CR Kendall has not estimated how long water treatment would need to be continued. CR Kendall's time estimate for continued water treatment under the Proposed Action (Section 1.4.2) is between 10 and 40 years (Hydrometrics and CR Kendall, 2012). The alluvial groundwater capture system may need to continue operating after groundwater standards are met to achieve surface water standards. Under this alternative, CR Kendall would address the remaining reclamation items at the mine, including spreading the remaining stockpiled soil, completing some additional revegetation work, and providing long-term reclamation monitoring and maintenance.

TABLE 1-2
CR KENDALL MINE OPERATING PERMIT, AMENDMENTS, AND REVISIONS

Permit, Amendment, or Minor Revision No.	Effective Date	Brief Description
Operating Permit 00122	Sept. 14, 1984	Compliance with the Metal Mine Reclamation Act to permit 119 acres and a mill.
Amendment 001	April 22, 1987	Water treatment and land application disposal (LAD). Addition of 6.8 acres for LAD area. Permit increased to 125.8 acres (submitted January 1, 1987).
Amendment 002	August 19, 1988	Addition of 61.3 acres for disturbance and facilities. Permit area increased to 187.1 acres (submitted May 27, 1989).
Second Amendment 002	July 12, 1989	Increased capacity of process pad 3 by adding 3.8 acres. Permit increased to 190.9 acres (submitted May 30, 1989).
Amendment 004	November 1, 1989	Addition of 994.1 acres for "Life of Mine" expansion of disturbance and facilities. Permit increased to 1,185 acres.
Amendment 005	June 16, 1992	Relocation of part of the area for LAD (area 3).
Amendment 006	March 17, 1993	Change location of the Horseshoe waste rock dump from north of the Horseshoe Pit to south of and adjacent to the pit (submitted December 18, 1992).
Revision 93001	April 6, 1993	Modification of approved plan to dispose of spent ore from process pad 1 (placement beneath liner during construction of process pad 4 Phase IV expansion).
Revision 93002	June 1, 1993	Removal of undisturbed lands (162 acres) from Permit Boundary
Revision 93003	June 8, 1993	Modification to plan of off-loading spent ore from process pad 1 (placement of coarse rock into borrow area)
Minor Revision 94-001	March 14, 1994	Modified Water Resources Monitoring Program (including addition of four new monitoring wells)
Minor Revision 94-002	March 14, 1994	Modification to Processing Facility: Addition of a building to house a Carbon Adsorption plant for gold recovery, to replace the Merrill-Crowe system.
Minor Revision 94-003	July 28, 1994	Soils and Revegetation Plan
Minor Revision 94-004	December 19, 1994	Drainage and Sediment Control Plan (withdrawn)
Minor Revision 95-001	July 29, 1995	Construction of new sediment retention pond between Kendall waste rock dump and South Fork Last Chance Creek
Minor Revision 95-002	March 25, 1995	Drainage and Sediment Control Plan
Minor Revision 96-001	July 3, 1996	Proposal to construct seepage capture systems and to use the water for irrigation of reclaimed areas (withdrawn)
Minor Revision 97-002	April 14, 1997	Revision to water monitoring program
Minor Revision 97-001	May 1997	Change in pond freeboard requirement from storage of 6.3 inches of precipitation to 4.2 inches
Minor Revision 97-003	August 18, 1997	Treatment of process water with Reverse Osmosis, followed by zeolite polishing, followed by discharge to groundwater via the Kendall Pit

TABLE 1-2
CR KENDALL MINE OPERATING PERMIT, AMENDMENTS, AND REVISIONS

Permit, Amendment, or Minor Revision No.	Effective Date	Brief Description
Water Management Plan	Submitted May 28, 1997; Not approved	Water Management Plan (replaces Minor Revision 96-001) (Tentatively, Amendment 007); withdrawn in 1999.
Minor Revision 99-001	Rejected by DEQ April 2, 1999	Final Closure Plan; rejected by DEQ as incomplete and not a minor revision
Minor Revision 99-002	July 1, 1999	Expansion of LAD areas
Minor Revision 00-001	December 11, 2000	Request to reclaim 7 acres
Amended Closure Plan	Submitted March 6, 2001; Not approved	DEQ determined that an EIS would be required. The EIS was not completed at that time because CR Kendall requested time to develop a final water management plan. That plan was included as part of the revised amended closure plan submitted in 2012.
Minor Revision 01-001	April 18, 2001 (Partial Approval)	Request to decommission several water monitoring sites
Minor Revision 02-001	Not Approved	Request for additional irrigation areas
Minor Revision 04-001	October 8, 2004	Approved 4 items; (1) partial regrade Kendall Pit, (2) regrade area on Kendall waste rock dump, (3) relocate excess limestone, and (4) extend Muleshoe pumpback system.
Minor Revision 05-001	May 4, 2006	Approved changes to replace the 12 inch Reduced Permeability Layer (RPL) basal layer with 18 inches of soil amended with sodium bentonite.
Minor Revision 05-002	October 21, 2005	Construction of a pilot-scale treatment facility in Process Valley for demonstration of passive treatment technology
Minor Revision 05-003	September 29, 2005 (Partial Approval)	Request to modify water monitoring schedule
Minor Revision 06-001	January 25, 2006	Request to complete regrading of Kendall Pit and Kendall waste rock dump
Minor Revision 07-001	July 13, 2007	Approved construction of a pilot-scale treatment facility and access road.
Minor Revision 11-001	October 27, 2011	Approved placement of 17 inches of growth media over existing basal layer on process pads 3 and 4.
Amendment 007	Draft approved March 16, 2015	Proposed Closure Water Management Plan that includes water treatment, discussion of facilities to be retained, and discussion of long-term maintenance and monitoring (submitted July 25, 2012).

As indicated in Section 1.3, DEQ approved Minor Revision 11-001 allowing CR Kendall to place 17 inches of growth media over the already placed 18-inch basal layer containing 6 inches of bentonite amended soil, as an interim reclamation measure. The minor revision was approved based on the parties' understanding that the growth media would have to be removed if the final reclamation plan required a liner under the growth media or otherwise required the capping material to be modified. Under the No Action Alternative, the capping completed by CR Kendall under Minor Revision 11-001 would remain.

1.4.2 Proposed Action

Under the Proposed Action, CR Kendall would complete the tasks developed and described in the Amended Closure Water Management Plan (Amendment 007) prepared by Hydrometrics, Inc., and CR Kendall Corporation (2012). The Proposed Action would provide for long-term water management (estimated up to 40 years), accept the interim capping of the former process pads as the final reclamation plan for those facilities, specify the final water treatment design as described below, and outline the long-term reclamation monitoring and maintenance activities. The long-term water management tasks would include:

1. Capturing and temporarily storing process pad drainage and alluvial groundwater;
2. Long-term treating of process pad drainage and captured alluvial groundwater with zeolite adsorption to remove thallium;
3. Disposing of spent zeolites in Pond 7;
4. Discharging treated water to groundwater through the Kendall Pit;
5. Maintaining the ponds, buildings, pipelines and other infrastructure needed to support the water management and treatment system;
6. Monitoring and mitigation plans for water management facilities; and
7. Augmenting stream flows to offset stream flow reductions resulting from continued operation of the pumpback systems and to supply downgradient water users.
8. Soil stockpiled in TS-13a would remain in place.
9. Reclamation of ponds and creating a channel after water capture and treatment is no longer necessary.

Under the Proposed Action, the 17 inches of growth media that CR Kendall Mine placed on the process pads as an interim reclamation measure under Minor Revision 11-001 would become the final reclamation cover for the process pads. Long-term reclamation monitoring and maintenance under the Proposed Action are detailed in Section 2.3.

1.4.3 Process Pad Drainage Pretreatment Alternative

The Process Pad Drainage Pretreatment Alternative is similar to the Proposed Action. The main difference for this alternative would be the separate collection and pretreatment of the process pad drainage for removal of arsenic and possibly other constituents if necessary to comply with groundwater discharge criteria. The average arsenic concentration in the process pad drainage (2010 to 2011) was 0.148 milligrams per liter (mg/L) which exceeds the groundwater quality standard of 0.01 mg/L (DEQ 2012). This alternative would include pretreatment for the process pad drainage and not the captured groundwater.

CR Kendall would construct a separate piping system to collect the drainage water from process pads 3 and 4 that have a combined average flow of 13.7 gallons per minute (gpm). The pretreatment would most likely include an adsorption process to remove constituents not susceptible to zeolite treatment. After pretreatment, the drainage water would be combined with the captured groundwater and further treated with zeolite adsorption to remove thallium. All treated water would be discharged to groundwater at the Kendall Pit. A new or expanded WTP and associated facilities would be needed for the process pad drainage pretreatment.

Like the Proposed Action, the 17 inches of growth media placed on the process pads under Minor Revision 11-001 would become the final reclamation cover. The other component of this alternative that differs from the Proposed Action is placing additional stockpiled soil, in excess of the quantity required to complete reclamation of facilities required for long term water treatment, on regraded slopes in the Kendall Pit and poorly vegetated areas in the Muleshoe Pit and reseeding these areas.

1.4.4 Process Pad Barrier Cover Alternative

The Process Pad Barrier Cover Alternative is similar to the Proposed Action with the addition of barrier covers on process pads 3 and 4 to reduce the volume of drainage water requiring treatment. Under this Alternative, CR Kendall would remove the upper 17 inches of growth media from process pads 3 and 4, install a barrier cover cap, replace the 17 inches of growth media, and seed the process pads.

The barrier cap would consist of a geomembrane liner, drainage net, and filter fabric. The geomembrane would consist of a textured polyvinyl chloride (PVC) or high-density polyethylene (HDPE) material to reduce slipping and movement of the soil on the barrier cap. The barrier would be installed on top of the existing 6 inches of subsoil basal layer material that was amended with 5 to 8 percent sodium bentonite and placed over 12 inches of subsoil basal layer material. The growth media would be returned and placed on the barrier cap and all disturbed areas reseeded with an approved reclamation seed mixture.

This alternative would require placing the remaining soil, in excess of the quantity required to complete reclamation of facilities required for long term water treatment, on regraded slopes in the Kendall Pit and poorly vegetated areas in the Muleshoe Pit and reseeding these areas.

1.5 Agency Roles and Responsibilities

DEQ is responsible for administrating the MMRA and the rules and regulations governing the Metal Mine Reclamation Act. Approval and enforcement of Operating Permit 00122 and all subsequent amendments and minor revisions has been the responsibility of DEQ. Since the Operating Permit was approved in 1984, there have been six amendments and 23 minor revisions approved and attached to the Operating Permit. The amendments and minor revisions are listed in **Table 1-2**.

1.6 Public Participation

The following scoping activities were completed in 2003 as part of the scoping process for this EIS:

1. Private interviews of interested members of the public were conducted in Lewistown, Montana. The interviews were widely advertised to ensure that all interested parties would have an opportunity to participate. Twenty-five people were interviewed.
2. An open house was held at the Yogo Inn in Lewistown. Technical representatives were present to discuss five individual topic areas with members of the public. Notes of the discussions were recorded to summarize the event.
3. A public meeting was held at the Yogo Inn to obtain comments from the public on the proposed permit amendment.
4. There was a series of working meetings with technical specialists and stakeholders. Persons who were interviewed or attended the open house and public meeting were asked if they were interested in participating in the technical meetings. Recipients of the scoping document were advised that they could participate in the technical meetings. Twenty people expressed interest. Issues raised during the technical meeting were added to the list of issues gathered from other scoping activities.

DEQ held an open house in Lewistown on March 31, 2015, to kick off the environmental review process for the proposed amendment to CR Kendall's operating permit.

The public will have additional opportunities to participate in this environmental review process. Members of the public may submit comments on the draft EIS during a comment period. DEQ will review the comments received and respond to all substantive comments in the final EIS. Some responses may require changes to be made in the draft EIS.

1.7 Issues of Concern

From the public involvement, two relevant issues were identified that should be addressed through the alternatives analysis process for the closure EIS - (1) the effects of the mine closure actions on surface water and groundwater quantity and quality; and (2) the effects of the mine closure actions on soils and reclamation. These issues will be evaluated in detail to address impacts to resources and to help determine reasonable alternatives for mine closure, including the Proposed Action. The specific components of the two relevant issues are:

Issue 1: Effects on quantity and quality of surface water and groundwater resources:

- Discharges from the mine to surface water and groundwater may exceed water quality standards for certain contaminants: arsenic, antimony, selenium, thallium, cyanide, and nitrate.
- Pumpback of contaminated groundwater and capture of surface water have reduced downgradient water quantity in four watersheds. Water management at the mine may continue to reduce downgradient water quantity.
- Pumping clean groundwater from water wells WW-6 and WW-7 may have reduced water quantity in downgradient wells.
- The mine facilities have intercepted natural drainages that channeled stormwater and snowmelt that no longer reach drainages below the mine.
- Water quantity in each drainage could be augmented by rerouting surface water and developing springs and other groundwater sources.
- Water and sediment from the mine may contribute arsenic to the Boy Scout pond downgradient of the permit boundary in South Fork Last Chance Creek.
- The underdrain in the process valley could be receiving impacted water.

Issue 2: Effects on soils and reclamation

- Reclamation efforts may have resulted in inadequate vegetation in some areas, erosion on steeper slopes, and excessive infiltration through the cover systems.
- Application of reverse osmosis (RO) brine on the leach pads may have caused elevated levels of salts and other potential contaminants possibly affecting the reclamation cover system and future revegetation.
- Insufficient and unsuitable on-site reclamation materials may limit reclamation cover system alternatives.

1.8 Issues Considered But Not Studied in Detail

An Interdisciplinary Team (IDT) review determined that because a number of resource areas and associated issues would not be affected or would be minimally affected by the closure plan alternatives, they would not be studied in detail through the EIS alternatives analysis process. The description of resource areas and rationale for eliminating these issues are:

- The cost of the selected alternative may exceed the reclamation bond. If CR Kendall cannot fund the entire cost of the reclamation and long-term water treatment, the public would have to pay. *Alternatives are developed to address environmental concerns. MEPA requires the evaluation of reasonable alternatives to the Proposed Action that will achieve the purpose and need for action, comply with water quality standards, and would be economically feasible for similar projects having similar conditions. If the cost of implementing the selected alternative exceeds the amount of the reclamation bond currently held by DEQ, CR Kendall will be required to submit additional bond. This issue will not be carried forward and is addressed by law and regulation. It should be noted that, as discussed previously, CR Kendall has already submitted a bond covering the cost of removing the growth media on the process pads if DEQ selects an alternative that requires removal or modification.*
- Since DEQ previously approved a reclamation plan, an EIS is not necessary. *An EIS is required when there is state action that may significantly affect the human environment. Previous approval and issuance of the operating permit and the current proposed Amendment 007 to the operating permit are both state actions that require preparation of an environmental review. DEQ concluded in its 2001 Environmental Assessment on CR Kendall's Amended Closure Plan (CR Kendall, 2001a) there might be significant impacts from approval of the final closure plan for the CR Kendall Mine, so preparation of an EIS is required under MEPA.*
- DEQ will develop the EIS with a predetermined preferred alternative for reclamation and water treatment. *DEQ did not have a predetermined alternative regarding the final closure plan for the CR Kendall Mine. However, MEPA authorizes DEQ to identify a preferred alternative in the draft EIS if it has one. This issue will not be carried forward.*
- DEQ and CR Kendall have shown a lack of interest in involving the public on mine-related issues. *Since 2003, DEQ has involved the public in the CR Kendall Mine closure process with multiple activities, including 1 public meeting, 2 open houses, 4 technical meetings, 25 public interviews, and a published scoping document (CDM, 2004). The public will have an opportunity to submit comments on the draft EIS. DEQ is required to consider and address these comments in the final EIS. This issue will not be carried forward.*

- DEQ should ensure the reclamation is effectively implemented and meets legal requirements. *CR Kendall has reclaimed much of the mining-related disturbed areas and DEQ completes field inspections annually, or more frequently. DEQ would monitor implementation of the selected mine closure alternative and pursue enforcement actions if reclamation does not achieve legal requirements. This issue will not be carried forward.*
- The overall effect of the Kendall Mine on the local economy should be evaluated. *The EIS addresses the alternatives for mine closure primarily for reclamation monitoring and long-term water treatment. Mitigating the economic impacts of mine closure are beyond the scope of this EIS.*
- The Bureau of Land Management (BLM) should be a co-lead agency in preparing the EIS. *In 1995 BLM and CR Kendall completed a land exchange making all lands within the permit boundary privately owned. BLM has no land management responsibilities. BLM's permitting involvement in the past is outside the scope of this EIS. DEQ has no authority to require BLM to participate, but BLM will be given an opportunity to comment on the draft EIS. This issue is outside the scope of this EIS and will not be carried forward.*
- Hazardous wastes should receive special treatment. *Waste rock, spent ore, and historical tailings do not qualify as hazardous waste under the Code of Federal Regulations (CFR) (40 CFR 261.4(17), etc.) because they are exempt (Bevill Amendment). Spent zeolite from water treatment columns is buried in the process pads and is not considered hazardous waste based on toxicity characteristic leaching procedure (TCLP) analyses (CR Kendall, 2015d). Reverse osmosis (RO) brine was recirculated to the process pads, mixed with process water, and eventually land applied. All mining wastes either pass TCLP or are Bevill Amendment excluded. Water and seepage from all facilities are intercepted and captured by the pumpback systems and either land applied or treated by zeolite adsorption and discharged to groundwater through the Kendall Pit. Hazardous materials from the assay lab were disposed off-site. No further hazardous materials are on site (CR Kendall, 2015d). Therefore, this concern will not be carried forward as a separate issue.*
- The slopes of the heap leach pad should be terraced to catch surface water until vegetation can use it. *The regrading on the process pads was approved after an environmental assessment and was completed per the approved reclamation plan. The proposed Amendment 007 does not seek to modify the permit requirements for regrading of the process pads. Therefore, this concern will not be carried forward as a separate issue.*
- The buffering capacity of the waste rock should be enough to prevent acid mine drainage. *Waste rock dumps and the process pads contain materials dominated by limestone. The pH of all seepage from waste rock dumps and process pad is above 7. DEQ does not expect the buffering capacity to be depleted over time. The long-term problem at the Kendall Mine is not acid mine drainage, but near-neutral metal mobility, especially*

metalloids including thallium, arsenic, and selenium, that are most soluble in non-acidic conditions. Near-neutral mobilization of metalloids is addressed in the water quality section. The only natural acidic seep in the area is associated with a coal seam outside the disturbed areas of the mine. The issue is not relevant to this site.

- Disposal of mine wastes into pits could result in contaminated seepage into the Madison limestone and could affect the Lewistown water supply and Petroleum County. *Reclamation of the open pits was approved after an environmental assessment and was completed per the approved reclamation plan. The proposed Amendment 007 does not seek to modify the permit requirements for reclamation of the open pits at the CR Kendall Mine, with the single exception that it is proposing not to place soil on regraded areas at the Kendall Pit. Therefore, this concern will not be carried forward as a separate issue.*
- The pit floors should be lined with impermeable materials before backfilling. *The proposed Amendment 007 does not seek to modify the permit requirements for reclamation of the open pits at the CR Kendall Mine, with the single exception that it is proposing not to place soil on regraded areas at the Kendall Pit. The reclamation of the open pits was approved after an environmental assessment and was completed per the approved reclamation plan. Therefore, this concern will not be carried forward as a separate issue.*
- Highwall stability should be evaluated. *The proposed Amendment 007 does not seek to modify the permit requirements for reclamation of the open pits at the CR Kendall Mine, with the single exception that it is proposing not to place soil on regraded areas at the Kendall Pit. The reclamation of the open pits was approved after an environmental assessment and was completed per the approved reclamation plan. Therefore, this concern will not be carried forward as a separate issue.*
- Ditches should be constructed on native grounds rather than on disturbed materials. *All major drainage channels have been constructed. Minor drainage modifications might be required as roads and other facilities are reclaimed under the proposed closure alternatives. This concern will not be carried forward as a separate issue. Where possible, drainage channels have been constructed on native ground.*
- Surface water quality monitoring may not adequately identify all exceedances. *In its Amendment 007 application, CR Kendall has not requested authorization to discharge to surface water. Neither of the Agency modified alternatives include discharges to surface water, so surface water quality monitoring beyond the scope of current monitoring plans will not be carried forward as a separate issue.*
- Piping water from Little Dog Creek around the mine instead of letting it go underground may unfairly allocate water to a specific landowner. *Addressing the fairness of where this water goes is outside the scope of this EIS. The pumpback system*

diverts water from lower Little Dog Creek drainage. CR Kendall proposed this means of augmentation as a way to replace water to the drainage.

- DEQ shows favoritism to CR Kendall and/or specific landowners. *DEQ is a neutral regulator and administers the Metal Mine Reclamation Act without favoring CR Kendall, specific landowners, or any other interested persons who may be affected by DEQ's decision on Amendment 007 proposed by CR Kendall.*
- The compensation to local ranchers by CR Kendall for alleged water losses may be an admission of guilt. *Water quantity issues are covered under Issue 1 and water quality and quantity in Chapter 3. This issue is outside the scope of this EIS.*
- Existing water rights may be compromised by mining or reclamation activities. *Effects on water quantity are predicted by estimating changes in water availability as a result of mining and reclamation and water treatment activities. Impacts to individual water rights are beyond the scope of the EIS.*
- A water reservoir should be retained for firefighting. *Retaining an existing pond or constructing a new reservoir for firefighting purposes was raised during the scoping process.*
- Noxious weeds from the mine may have spread to exploration roads and neighboring properties. *Noxious weed control has been conducted during mine life, but Canada thistle and houndstongue continue to expand on the site. These weeds are common throughout the region and it would be difficult to determine the seed source. Seeds are spread by wind or carried by animals. Noxious weed control will be addressed as part of the revegetation and long-term monitoring for each alternative but will not be carried forward as a separate issue.*
- Historical tailings in the streambeds below the permit area should be removed to prevent recontamination of treated water discharge. *DEQ cannot legally require CR Kendall to remove the historical tailings outside the permit area. DEQ will evaluate impacts and recontamination of any treated water discharged directly into drainages, but will not carry this forward as a separate issue.*
- Reclamation should protect people and property from long-term effects from the mine. Reclamation should meet laws and regulations relative to non-degradation, property rights, trespass, etc. *Reclamation of the mine site must comply with all requirements of the Metal Mine Reclamation Act and the Montana Water Quality Act. This issue is addressed by existing laws and regulations.*
- Sediment from the mine site has contaminated the Boy Scout Pond. *Water sampling indicates that arsenic levels are sometimes above water quality standards (MDEQ-7). Skin exposure to arsenic is regarded as safe at much higher concentrations*

than for drinking water. CR Kendall is required to monitor the pond under its permit and will be required to continue monitoring until DEQ determines it is no longer necessary.

- Several resources areas will not be affected by the No Action, Proposed Action, Process Pad Drainage Pretreatment, or Process Pad Barrier Cover Alternatives and are not evaluated in detail in the EIS. Summaries of why these resources are not considered issues are:
    - Cultural resources: No cultural resource issues have been raised during the life of the mine. *Alternatives being considered would disturb no new acreage. A cultural resources evaluation report was completed for the permit area in 1989 (GCM Services Inc., 1989). Cultural issues were addressed in previous environmental assessments. Cultural resources do not need to be carried forward in the EIS.*
    - Fisheries and aquatics: Fisheries and aquatics were not raised as issues during scoping. *The only fisheries issue identified during mine life concerned a fish kill at the Boy Scout Pond in South Fork Last Chance Creek in May 1989 Montana Fish Wildlife and Parks (FWP) investigated the incident and concluded the fish kill was due to oxygen depletion and that the fish had died before the ice left the pond. Reasons for oxygen depletion were a combination of very low water levels due to previous drought years, and long-lasting ice on the pond. (FWP, 1989). No changes in discharge to surface water resources are proposed in Amendment 007. Impacts to fisheries and aquatics will not be carried forward in the analysis.*
    - Threatened and endangered species: No threatened and endangered species have been observed during the baseline surveys or the life of the mine. *CR Kendall attempted to introduce peregrine falcons in the mid-1990s, but the falcons have since left the site. No new disturbances would occur under the Proposed Action or either of the Agency-Modified alternatives. No impact to threatened or endangered species habitat would result from implementation of alternatives in this EIS. Impacts to fisheries and aquatics will not be carried forward in the analysis.*
    - Air quality: No air quality issues were raised during mine operations, or expected to be raised from mine closure. *Dust control would continue as needed throughout the remaining mine closure efforts. Reclamation of the remaining areas and roads would further reduce potential sources of dust. Equipment emissions would be similar to operational levels during reclamation activities, but would cease when reclamation was completed. Impacts to air quality will not be carried forward in the analysis.*

- Socioeconomics: Socioeconomics was not raised as an issue during scoping. *Socioeconomic impacts were evaluated when the mine was permitted and in the Environmental Analysis of Revised Bond Calculations (DEQ, 2000). No new socioeconomic impacts would result from the actions of Amendment 007. Impacts to socioeconomics will not be carried forward in the analysis.*
- Aesthetics: *Aesthetic issues were addressed when the mine was permitted. No new disturbances would occur under Amendment 007. Impacts to aesthetics will not be carried forward in the analysis.*

Description of Alternatives

2.1 Introduction

The No Action Alternative reflects the current, approved plan and is a benchmark against which the Proposed Action and other alternatives can be evaluated. For this analysis, the No Action Alternative is CR Kendall's Operating Permit 00122 and the previously approved amendments (through Amendment 006) and minor revisions, including Minor Revision #05-001 and Minor Revision #11-001.

The Proposed Action is the proposed Closure Water Management Plan CR Kendall submitted in their Application for Amendment 007 to Operating Permit No. 00122 (Hydrometrics, Inc. and CR Kendall Corp., 2012). MEPA requires the evaluation of reasonable alternatives to the Proposed Action. Reasonable MEPA alternatives are those that are achievable under current technology and are economically feasible as determined solely by the economic viability for similar projects having similar conditions and physical locations and determined without regard to the economic strength of the specific project sponsor. Two Agency-Modified alternatives were developed that include measures to mitigate specific environmental impacts from the Proposed Action. **Table 2-1** has a detailed comparison of the components and activities for the No Action Alternative, Proposed Action, and the two Agency-Modified alternatives.

Additional alternatives were considered, but were determined to be not reasonable and were eliminated from further study. These alternatives and the rationale for dismissing them are discussed in Section 2.5.

Because the mine is in closure and the proposed Operating Permit Amendment 007 is primarily limited to water treatment, consideration of the need for Agency-Modified alternatives was based on how well the components met the Purpose and Need outlined in Chapter 1 (Section 1.2).

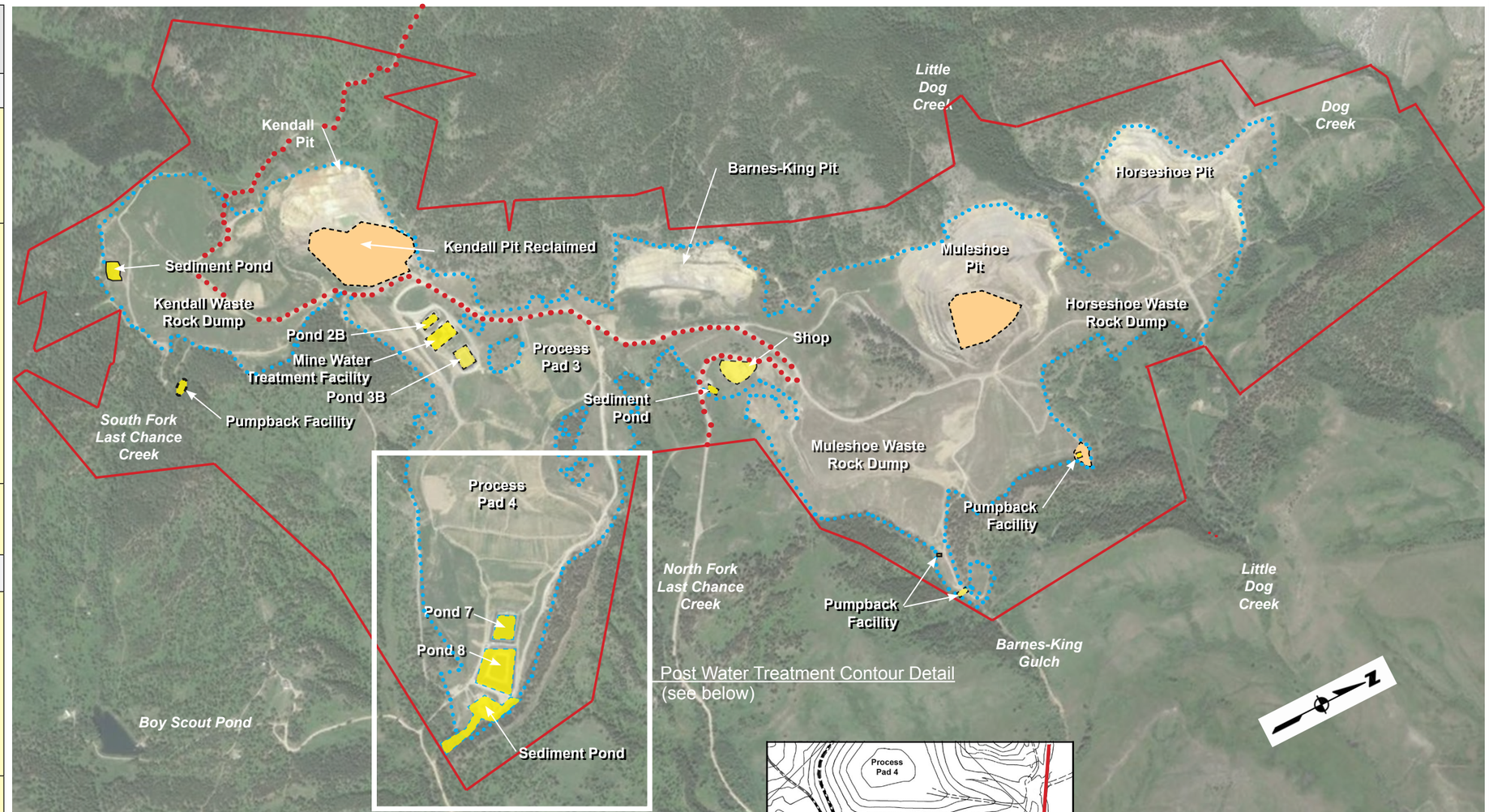
2.2 No Action Alternative

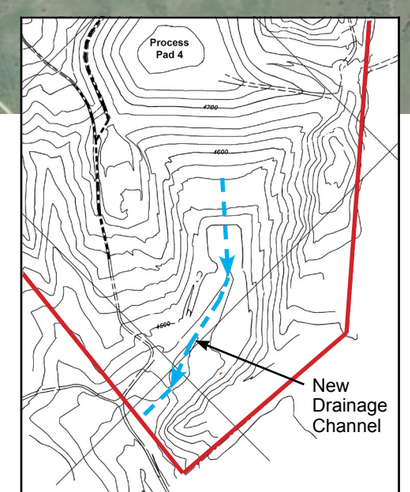
For this EIS, the 1989 Plan of Operations (Kendall Venture and Hydrometrics, 1989; Revised 1995), Soils and Revegetation Plan (Shafer and Associates, 1995), and the pumpback and water treatment plans are considered to be the No Action Alternative. The main features of the No Action Alternative are shown on **Figure 2-1** and the pumpback and water treatment components are shown on **Figure 2-2**.

TABLE 2-1
COMPARISON OF CR KENDALL MINE CLOSURE EIS ALTERNATIVES

Alternative Component	No Action Alternative (Approved, Current Plan, or Already Completed)	Proposed Action	Process Pad Drainage Pretreatment Alternative	Process Pad Barrier Cover Alternative
Water				
Process Pad Drainage Water	Process pad drainage water is not actively treated but is collected in Pond 7 and land applied during growing season. Annual average flow rate after installing caps (2009 to 2014) ranged from 11.3 gpm to 20.5 gpm, with an average of 13.7 gpm.	Process pad drainage water would be captured, combined with other mine waters, filtered to remove particulate, treated by zeolite adsorption, and discharged to the Kendall Pit. LAD would be retained as contingency disposal during the growing season.	Process pad drainage water would be separately collected and piped to a pretreatment system (likely a specific media filtration system) primarily for the treatment and removal of arsenic. The treated water would be combined with the other mine water for zeolite adsorption treatment and discharged to groundwater through the Kendall Pit.	Same as Proposed Action.
Groundwater Capture and Pumpback Water Treatment	Groundwater that does not meet water quality standards is pumped back from South Fork Last Chance Creek (KVPB-5) and the Process Valley Underdrain (TMW-26) to the Process Valley Ponds 2B and 3B, then treated with zeolite adsorption before being discharged to groundwater through the Kendall Pit. Groundwater pumped back from Barnes-King Gulch (KVPB-2) and Little Dog Creek (KVPB-6) is land applied in the growing season. Otherwise, groundwater is stored in Ponds 7 and 8 for LAD during the growing season. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.	All captured groundwater would be combined with process pad drainage water in Ponds 7 and 8, filtered to remove particulate, and treated with zeolite adsorption before being discharged to groundwater through the Kendall Pit. LAD would be retained as contingency disposal during the growing season. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.	All captured groundwater would be combined with the pretreated pad drainage water, then treated by zeolite adsorption, and discharged to groundwater through the Kendall Pit. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.	Same as Proposed Action.
Disposal of Spent Zeolites	Disposal in leach pads until capped in 2012. Currently retained on site and stored in the truck shop.	Place into Pond 7. If zeolite generation is higher than anticipated, could transport off-site for disposal at a Class II or III landfill, or store in a purpose-built, on-site repository. All disposal methods would comply with Montana solid waste regulations.	Same as Proposed Action.	Same as Proposed Action.
Reclamation				
Process Pads Reclamation Design	Process pads were regraded to 3:1 slopes with 10 foot benches every 100 feet in 2004 (1989 Plan of Operations). A modified water-balance cover was installed in 2008 and 2012 consisting of 17 inches of growth media over 6 inches of subsoil basal layer material amended with 5 to 8 percent bentonite, over 12 inches of subsoil basal layer material (Minor Revision 11-001). Process pads were seeded in 2012.	Same as No Action.	Same as No Action.	Remove the upper 17 inches of growth media and vegetation from process pads 3 and 4 and install barrier cap (liner with drainage net). Replace the growth media on top of liner and revegetate.
Process Pads Underliner	Underliner would be perforated by drilling to the underdrain to eliminate water ponding (1989 Plan of Operations).	Maintain underliner integrity for drainage water discharge to Ponds 7 and 8.	Same as Proposed Action.	Same as Proposed Action.
Kendall and Muleshoe Pits	Rock stockpiles in the Kendall Pit were regraded in 2006 (Minor Revision 06-001). The placement of 8 to 10 inches of soil on regraded areas with less than 2:1 slopes and reseeding has not been completed. The lower slopes of the Muleshoe Pit were backfilled but not covered with soil and are poorly vegetated.	Same regrading (completed in 2006) in Kendall Pit but no additional soil placed on areas in Kendall or Muleshoe Pits.	Similar to No Action except soil from stockpile TS-13a would be placed on regraded slopes in the Kendall Pit and lower slopes in Muleshoe Pit and the areas reseeded.	Same as Process Pad Drainage Pretreatment.
Facilities	All buildings (including the WTP) will be removed at closure when reclamation is completed (1989 Plan of Operations). All ponds will be backfilled or graded to drain and the areas covered with soil and reseeded after water treatment is no longer required.	Most buildings will remain after closure for private use. After water treatment is no longer required, all ponds will be backfilled or graded to drain and the areas covered with soil and reseeded.	Same as Proposed Action	Same as Proposed Action.
Roads	All reclaimed except BLM right of way.	All roads retained until no longer needed for access for water treatment. After water treatment is no longer needed, all roads reclaimed except BLM right of way.	Same as Proposed Action	Same as Proposed Action

Alternative Component	No Action Alternative (Approved, Current Plan, or Already Completed)
Water	
Process Pad Drainage Water	Process pad drainage water is not actively treated but is collected in Pond 7 and land applied during growing season. Annual average flow rate after installing caps (2009 to 2014) ranged from 11.3 gpm to 20.5 gpm, with an average of 13.7 gpm.
Groundwater Capture and Pumpback Water Treatment	Groundwater that does not meet water quality standards is pumped back from South Fork Last Chance Creek (KVPB-5) and the Process Valley Underdrain (TMW-26) to the Process Valley Ponds 2B and 3B, then treated with zeolite adsorption before being discharged to groundwater through the Kendall Pit. Groundwater pumped back from Barnes-King Gulch (KVPB-2) and Little Dog Creek (KVPB-6) is land applied in the growing season. Otherwise, groundwater is stored in Ponds 7 and 8 for LAD during the growing season. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.
Disposal of Spent Zeolites	Disposal in leach pads until capped in 2012. Currently retained on site and stored in the truck shop.
Reclamation	
Process Pads Reclamation Design	Process pads were regraded to 3:1 slopes with 10 foot benches every 100 feet in 2004 (1989 Plan of Operations). A modified water-balance cover was installed in 2008 and 2012 consisting of 17 inches of growth media over 6 inches of subsoil basal layer material amended with 5 to 8 percent bentonite, over 12 inches of subsoil basal layer material (Minor Revision 11-001). Process pads were seeded in 2012.
Process Pads Underliner	Underliner would be perforated by drilling to the underdrain to eliminate water ponding (1989 Plan of Operations).
Kendall and Muleshoe Pits	Rock stockpiles in the Kendall Pit were regraded in 2006 (Minor Revision 06-001). The placement of 8 to 10 inches of soil on regraded areas with less than 2:1 slopes and reseeding has not been completed. The lower slopes of the Muleshoe Pit were backfilled but not covered with soil and are poorly vegetated.
Facilities	All buildings (including the WTP) will be removed at closure when reclamation is completed (1989 Plan of Operations). All ponds will be backfilled or graded to drain and the areas covered with soil and reseeded after water treatment is no longer required.
Roads	All reclaimed except BLM right of way.





Post Water Treatment Detail

LEGEND

- Permit Boundary
- Permitted Disturbance Boundary
- BLM Road to Remain - All Other Roads To Be Ripped, Regraded & Reclaimed (see Figure 2-3)
- Additional Revegetation Needed
- All Facilities To Be Removed & Reclaimed (includes: buildings, ponds, process pads, roads and pumpback facilities)

0 1,100'

SCALE: 1" = 1,100 feet
Source of Base: Google Earth Pro
Date: 7/1/2014

FIGURE 2-1
CR Kendall Mine
No Action Alternative

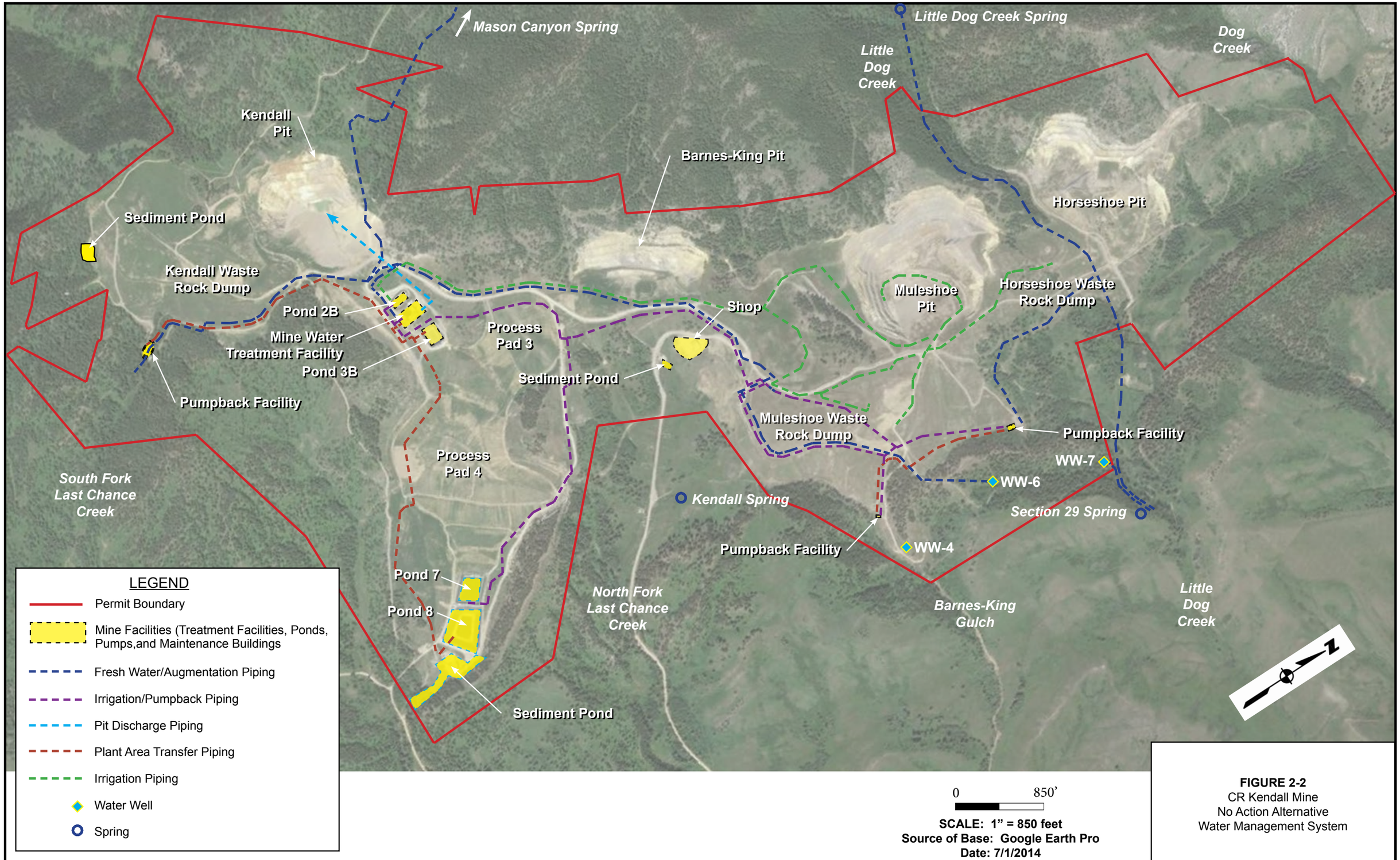
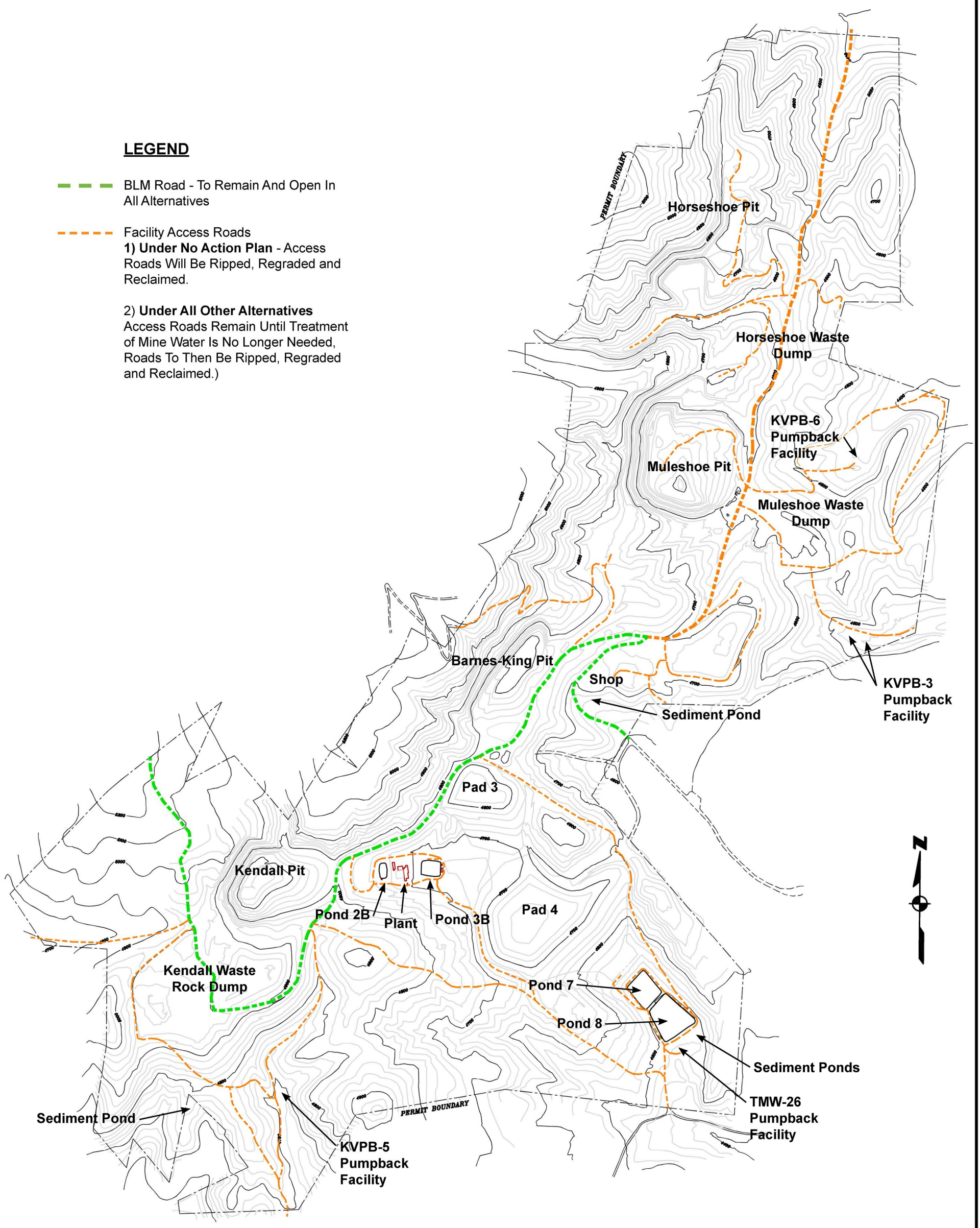


FIGURE 2-2
CR Kendall Mine
No Action Alternative
Water Management System



NOTE:
BLM = Bureau of Land Management

0 875'

SCALE: 1" = 875 feet
Source of Base: CR Kendall Mine
Date: 4/15/2015

FIGURE 2-3
CR Kendall Mine
Mine Road Plan

The No Action Alternative reflects the current CR Kendall Mine operations under Operating Permit 00122, including six Amendments **(Table 1-2)** and 23 minor revisions up through Minor Revision 11-001. Most reclamation activities under the permit have been completed. Major disturbed areas have been reclaimed, including the Horseshoe Pit and Horseshoe Waste Rock Dump; Muleshoe Waste Rock Dump; Barnes-King Pit; Kendall Waste Rock Dump, and most of the Kendall and Muleshoe Pits. Minor Revision 11-001 was approved in 2011 and allowed CR Kendall to place a 17-inch layer of growth media directly over the basal layer on process pads 3 and 4 as an interim reclamation measure. As a condition for the approval of Minor Revision 11-001, CR Kendall was required to submit additional reclamation bond to DEQ to cover the costs of removing the growth media if this capping of the process pads was not approved in the final reclamation closure plan or was otherwise modified.

Other mine facilities will be retained until water treatment is no longer needed, including pumps and piping; ponds 2B, 3B, 7, and 8; stormwater controls; water treatment and maintenance facilities; roads; power lines; and land application disposal (LAD) facilities. The BLM road and mine facility roads are shown on **Figure 2-3**. The remaining and ongoing reclamation components addressed under this amendment include:

Process pads drainage water capture and LAD – The drainage from process pads 3 and 4 is currently captured but not actively treated. It is collected in Pond 7 and land applied during the growing season. The combined average flow rate is 13.7 gpm.

Captured groundwater pumpback treatment – Captured groundwater not meeting groundwater standards is land applied or pumped back to the central WTP, filtered to remove particulate, and treated with zeolite adsorption to remove thallium and then discharged to groundwater through the Kendall Pit. The combined flow rate from the four pumpback systems has ranged from 33 gpm to 125 gpm over the last 18 years (1997 to 2014). The groundwater captured from Barnes-King Gulch and Little Dog Creek is directly land applied during the growing season, or pumped and stored in Ponds 7 and 8 for LAD during the growing season. Spent zeolites are retained on site and stored in the truck shop.

Process pad underliner – The underliners would be perforated by drilling to the underdrain to eliminate water ponding.

Soil placement on slopes in Kendall and Muleshoe Pits – 8 to 10 inches of soil would be placed on regraded slopes in the Kendall Pit and poorly vegetated areas in the Muleshoe Pit and the areas reseeded.

Building removal – All buildings (including water treatment) would be removed at closure when reclamation is completed.

Soil stockpile use – All soil stockpiles would be used for reclamation.

2.3 Proposed Action

The Proposed Action consists of the Amended Closure Water Management Plan in CR Kendall's application to amend its operating permit (Hydrometrics & CR Kendall Corp., 2012). It primarily addresses the long-term water treatment of the process pad drainage and captured groundwater. The alternative would retain the installed vegetated soil cover authorized under Minor Revision 11-001 and outlines reclamation monitoring and maintenance activities. The main features of the Proposed Action are shown on **Figure 2-4**. The specific items different from the No Action Alternative are:

Process Pad Drainage Treatment– Drainage water would be captured, combined with other waters, filtered to remove particulate, treated with zeolite adsorption to remove thallium, and discharged to groundwater through the Kendall Pit. The option for LAD during the growing season is retained as a contingency.

Groundwater Capture Pumpback Systems – All captured water would be combined with process pad drainage water in ponds 7 and 8, filtered to remove particulate, treated to remove thallium, and discharged to groundwater through the Kendall Pit or the Muleshoe Pit. LAD during the growing season would be retained as a contingency.

Process Pad Underliner – The integrity of the liner would be maintained to route drainage water to ponds 7 and 8 for water treatment. After the cessation of mine water treatment, the drainage water would either be discharged to the Kendall Pit without treatment or discharged as Mason Canyon surface water after treatment.

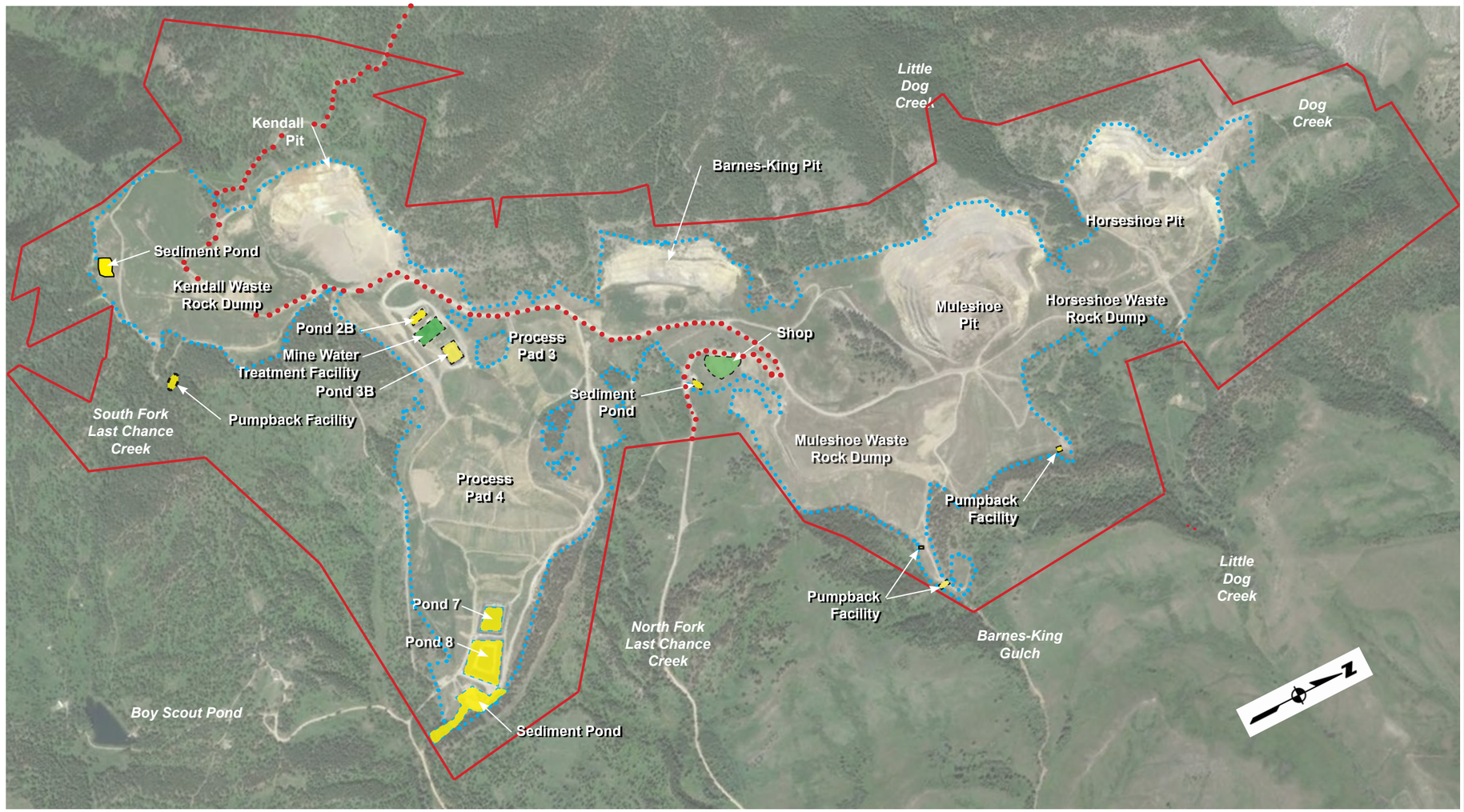
Soil Placement on slopes in Kendall and Muleshoe Pits – No additional growth media (soil) would be placed on the regraded areas of the Kendall Pit with slopes less than 2:1 or the lower slopes in the Muleshoe Pit with poor vegetation establishment.

Building Removal – Most buildings would remain for private use after closure.

Pond Reclamation – All ponds would be maintained for pumpback storage until groundwater quality standards are met and the need for treatment has been eliminated. After completing water treatment, the ponds would be reclaimed. Liners in Pond 7 would be folded over the zeolite and a free-flowing drainage established that would discharge to surface water in Mason Canyon. Liners in all other ponds would be cut, folded into the pond bottoms, and buried with clean fill. The pond sites would then be regraded, soil placed on surfaces, and reseeded.

Soil Placement on Kendall and Muleshoe Pits – No additional growth media (soil) would be placed on the regraded areas of the Kendall and Muleshoe Pits with slopes less than 2:1.

Alternative Component	Proposed Action
Water	
Process Pad Drainage Water	Process pad drainage water would be captured, combined with other mine waters, filtered to remove particulate, treated by zeolite adsorption, and discharged to the Kendall Pit. LAD would be retained as contingency disposal during the growing season.
Groundwater Capture and Pumpback Water Treatment	All captured groundwater would be combined with process pad drainage water in Ponds 7 and 8, filtered to remove particulate, and treated with zeolite adsorption before being discharged to groundwater through the Kendall Pit. LAD would be retained as contingency disposal during the growing season. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.
Disposal of Spent Zeolites	Place into Pond 7. If zeolite generation is higher than anticipated, could transport off-site for disposal at a Class II or III landfill, or store in a purpose-built, on-site repository. All disposal methods would comply with Montana solid waste regulations.
Reclamation	
Process Pads Reclamation Design	Same as No Action.
Process Pads Underliner	Maintain underliner integrity for drainage water discharge to Ponds 7 and 8.
Kendall and Muleshoe Pits	Same regrading (completed in 2006) in Kendall Pit but no additional soil placed on areas in Kendall or Muleshoe Pits.
Facilities	Most buildings will remain after closure for private use. After water treatment is no longer required, all ponds will be backfilled or graded to drain and the areas covered with soil and reseeded.
Roads	All roads retained until no longer needed for access for water treatment. After water treatment is no longer needed, all roads reclaimed except BLM right of way.



LEGEND

- Permit Boundary
- Permitted Disturbance Boundary
- Main BLM Road to Remain - All Other Mine Facility Roads To Remain and Maintained Until Water Treatment Is No Longer Required (see Figure 2-3)
- Facilities To Remain Intact After Closure Until Water Treatment Is No Longer Required
- Buildings To Remain For Private Use

0 1,100'

SCALE: 1" = 1,100 feet
Source of Base: Google Earth Pro
Date: 7/1/2014

FIGURE 2-4
CR Kendall Mine
Proposed Action

Reclamation Seeding – Seed mixes and seeding methods would be modified based on actual techniques and successful revegetation practices used to date.

Soil Stockpile Use – Some of the soil stockpiles would be used for maintenance of reclaimed areas and for final reclamation of ponds, buildings, and maintenance roads.

2.4 Agency-Modified Alternatives

DEQ developed two Agency-Modified alternatives (Process Pad Drainage Pretreatment Alternative and Process Pad Barrier Cover Alternative) to address issues associated with:

(1) Arsenic and possibly other contaminants that may be above groundwater quality standards in the drainage water after treatment through zeolite adsorption alone, and

(2) Reducing the volume of process pad drainage water that contains contaminants that require treatment (arsenic and thallium).

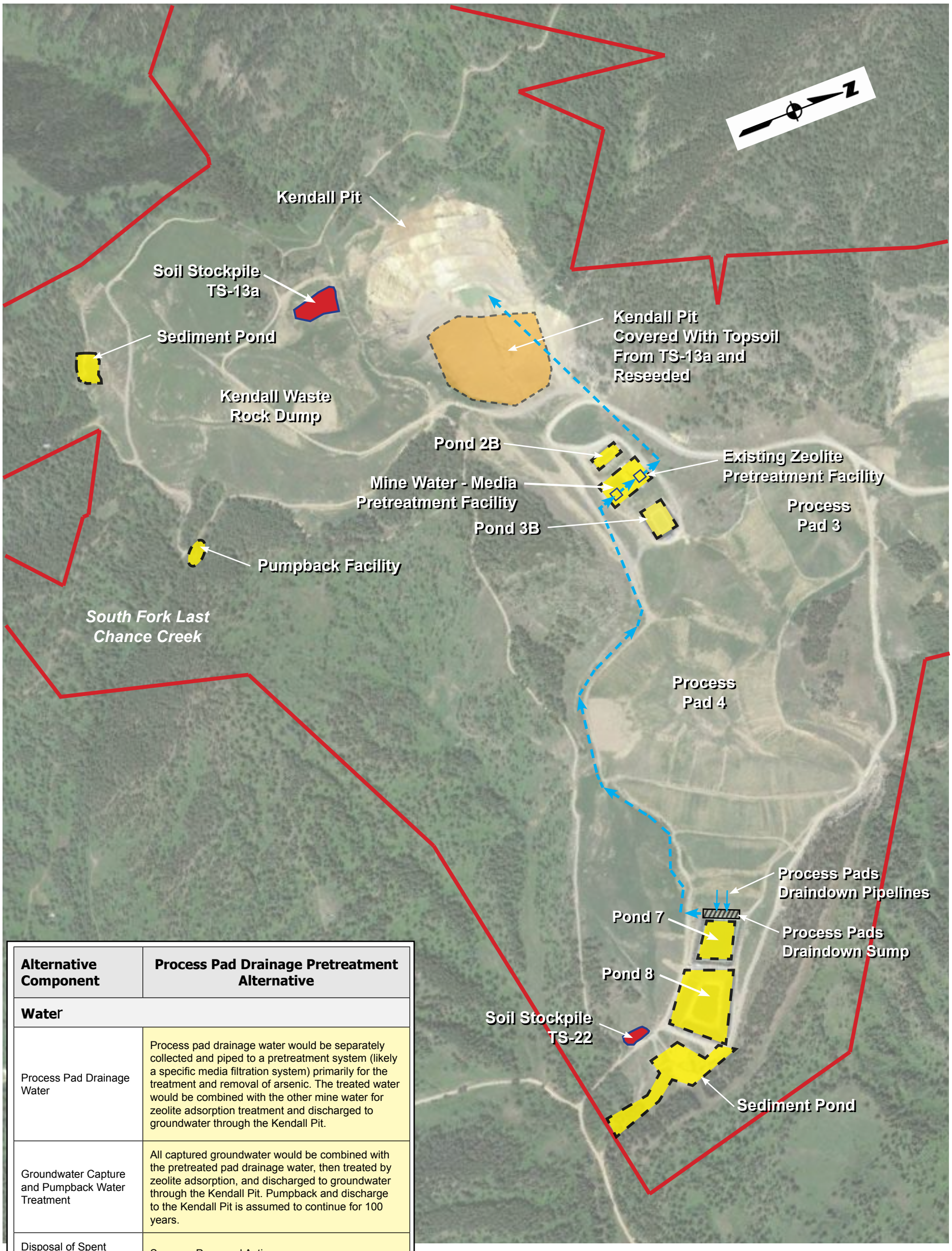
To address the elevated arsenic levels and possible other constituents above groundwater quality standards in the drainage water, DEQ developed the Process Water Pretreatment Alternative that would include an additional treatment process. The Process Pad Barrier Cover Alternative was developed to minimize the volume of process pad drainage that would require long term treatment. The addition of a barrier liner would involve removing the current growth media cover, installing a textured barrier liner on the process pads, and replacing the salvaged soil.

The placement of soil from stockpile TS-13a **(Figure 2-1)** onto the Kendall and Muleshoe Pit slopes and reseeding the areas was a component included in both Agency-Modified alternatives. The two Agency-Modified alternatives are described in more detail below.

Removal of water treatment facilities in the buildings and the LAD system would be required when water treatment is no longer needed.

2.4.1 Process Pad Drainage Pretreatment Alternative

Process Pad Drainage Pretreatment – A separate piping system would collect the drainage water from process pads 3 and 4 for pretreatment prior to blending the drainage water with other mine waters. Arsenic is one of the contaminants in the process pad drainage water, and is projected to exceed groundwater standards even after waters are combined. The pretreatment system could remove other contaminant constituents, if necessary to comply with discharge criteria. A conceptual diagram and flow chart of a possible pretreatment method for the process pad drainage water is on **Figure 2-5**.



Alternative Component	Process Pad Drainage Pretreatment Alternative
Water	
Process Pad Drainage Water	Process pad drainage water would be separately collected and piped to a pretreatment system (likely a specific media filtration system) primarily for the treatment and removal of arsenic. The treated water would be combined with the other mine water for zeolite adsorption treatment and discharged to groundwater through the Kendall Pit.
Groundwater Capture and Pumpback Water Treatment	All captured groundwater would be combined with the pretreated pad drainage water, then treated by zeolite adsorption, and discharged to groundwater through the Kendall Pit. Pumpback and discharge to the Kendall Pit is assumed to continue for 100 years.
Disposal of Spent Zeolites	Same as Proposed Action.
Reclamation	
Process Pads Reclamation Design	Same as No Action.
Process Pads Underliner	Same as Proposed Action.
Kendall and Muleshoe Pits	Similar to No Action except soil from stockpile TS-13a would be placed on regraded slopes in the Kendall Pit and lower slopes in Muleshoe Pit and the areas reseeded.
Facilities	Same as Proposed Action
Roads	Same as Proposed Action

LEGEND

- Permit Boundary
- Proposed Future Reseeding of Kendall Pit Slopes
- All Facilities To Remain
- Pipeline to Pretreatment Process
- Soil Stockpiles

0 500'

SCALE: 1" = 750 feet
Source of Base: Google Earth Pro
Image Date: 7/1/2014

FIGURE 2-5
CR Kendall Mine
Process Pad Drainage
Pretreatment Alternative
(Mine Facilities, Permitted Disturbance Boundary, and Permit Boundary)

The likely pretreatment system would involve the oxidation and adsorption of arsenic onto an adsorbent compound (ferric chloride, iron filings, or other). The pretreatment process would most likely be developed specifically for the CR Kendall process pad drainage water to effectively remove arsenic. After pretreatment, the water would be combined with the other captured groundwater for thallium removal through the current method of zeolite adsorption. The spent zeolites would be disposed of in Pond 7, where additional adsorption of thallium and other contaminants may occur (same as Proposed Action). Treated water would be discharged to groundwater through the Kendall Pit.

New water treatment equipment would be required to pretreat the process pad drainage water. The annual average flow rate after installing the current process pads caps (2009 to 2014) ranged from 11.3 gpm to 20.5 gpm, with an average rate of 13.7 gpm.

The specific process water pretreatment technology chosen by CR Kendall to remove arsenic could generate a contaminated treatment media, or byproduct, that requires proper disposal. Because the specific technology has not been chosen or designed, this alternative assumes proper disposal options for the contaminated media would be to: (1) ship it back to the manufacturer when exhausted; (2) ship it off-site for disposal; or (3) bury it on-site if confirmed as non-hazardous.

Groundwater Capture Pumpback System – This system would operate the same as the Proposed Action.

Process Pad Reclamation Design – No major changes from the No Action Alternative or Proposed Action would be needed; some minor regrading and reclamation would be associated with the installation of the new process pad drainage water piping.

Soil Placement on Kendall and Muleshoe Pit Slopes– This would be similar to the No Action Alternative, except the soil remaining in TS-13a would be placed on regraded slopes in the Kendall Pit and on the lower slopes of the Muleshoe Pit, then reseeded.

Water Treatment Facilities Removal– The buildings would remain. The LAD system would be removed. Ponds, pipelines, and vessels required for water treatment would be removed from the site when no longer needed.

The other components of this alternative would be the same as the No Action Alternative.

2.4.2 Process Pad Barrier Cover Alternative

The Process Pad Barrier Cover Alternative was developed to minimize the process pad drainage flows that require treatment. Adding a barrier liner to the process pads could effectively reduce drainage water flows. CR Kendall would select the effective cover materials to use, however DEQ would have final review and approval. DEQ would require the barrier liner be of HDPE or a similar product rather than a geosynthetic clay liner (GCL). The current 17 inches of soil would be temporarily removed and a geomembrane liner installed. The geomembrane liner would consist of a textured HDPE liner overlaid with a geocomposite drainage net. The salvaged soil would be replaced over the geomembrane liner and the process pads reseeded. A conceptual diagram showing the main components of this alternative is on **Figure 2-6.** A cross-sectional diagram showing the vertical components of the process pads barrier cover is on **Figure 2-7**. Specific aspects of this alternative are:

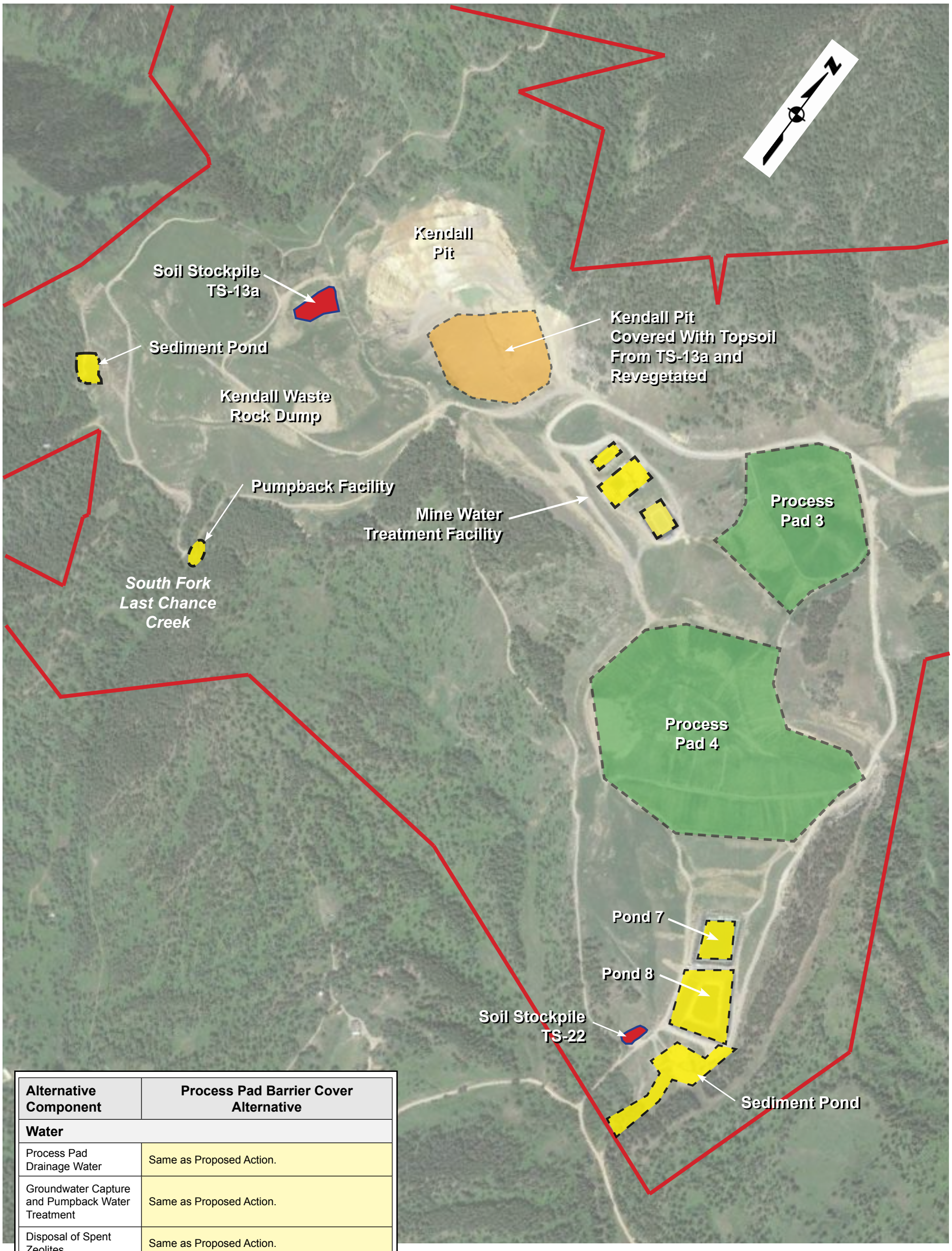
Process Pad Drainage Pretreatment – These components would be the same as the Proposed Action, with the process pad drainage combined with the captured groundwater system water at a central WTP, filtered to remove particulate, treated by zeolite adsorption, and discharged to groundwater through the Kendall Pit.

Groundwater Capture Pumpback Systems – These components would be the same as the Proposed Action.

Process Pad Reclamation Design – CR Kendall would remove the upper 17 inches of growth media (soil) and vegetation from process pads 3 and 4. A barrier cover cap, consisting of a textured HDPE liner and geocomposite drainage net, would be installed on top of the existing 6 inches of subsoil basal layer material amended with 5 to 8 percent sodium bentonite, over 12 inches of subsoil basal layer material. The approximate 17 inches of growth media would then be replaced on the geomembrane liner and the area reseeded with an approved reclamation grass mixture. A textured PVC or HDPE material would be needed to reduce slipping and movement of the soil on the barrier cover cap.

Soil Placement on Kendall and Muleshoe Pit Slopes– This component would be similar to the No Action Alternative and the same as the Process Pad Drainage Pretreatment Alternative. The soil remaining in TS-13a would be placed on regraded slopes in the Kendall Pit and on the lower slopes in the Muleshoe Pit and the areas reseeded.

Water Treatment Facilities Removal – The same action as for the Process Pad Drainage Pretreatment Alternative.



Alternative Component	Process Pad Barrier Cover Alternative
Water	
Process Pad Drainage Water	Same as Proposed Action.
Groundwater Capture and Pumpback Water Treatment	Same as Proposed Action.
Disposal of Spent Zeolites	Same as Proposed Action.
Reclamation	
Process Pads Reclamation Design	Remove the upper 17 inches of growth media and vegetation from process pads 3 and 4 and install barrier cap (liner with drainage net). Replace the growth media on top of liner and revegetate.
Process Pads Underliner	Same as Proposed Action.
Kendall and Muleshoe Pits	Same as Process Pad Drainage Pretreatment.
Facilities	Same as Proposed Action.
Roads	Same as Proposed Action

LEGEND

- Permit Boundary
- Proposed Future Reclamation Using Soil Stockpile TS-13a
- Proposed Process Pads Upper 17" Removed and Single Barrier Cap and 17" Cover Returned and Revegetated (see Figure 3-6)
- Proposed Facilities To Remain
- Soil Stockpiles

0 500'

SCALE: 1" = 750 feet

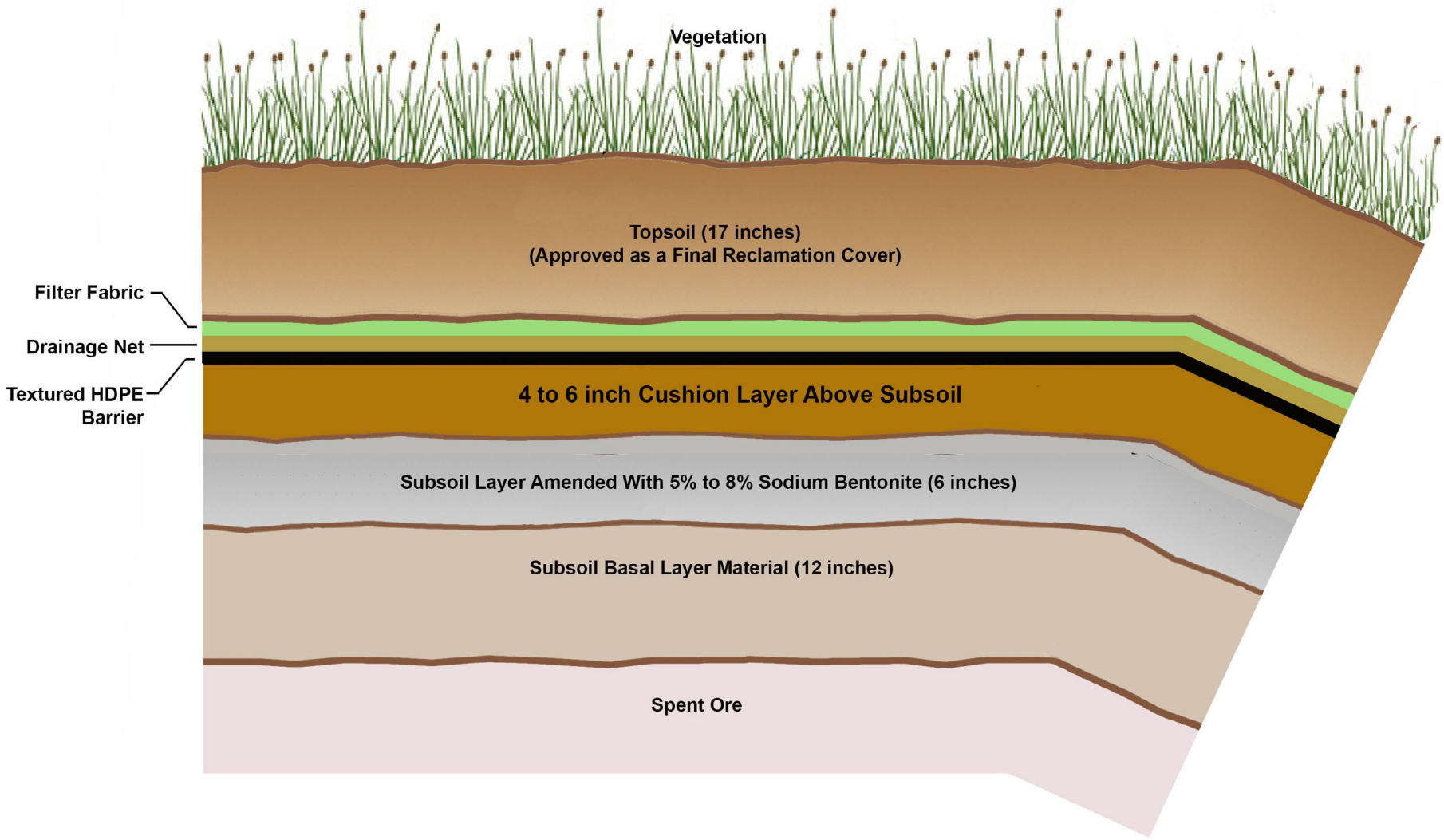
Source of Base: Google Earth Pro

FIGURE 2-6

CR Kendall Mine

Process Pads Barrier Cover Alternative

(Mine Facilities, Permitted Disturbance Boundary, and Permit Boundary)



Leach Pad 3 & 4 Proposed Cap

Not To Scale

NOTE:

HDPE = High Density Polyethylene

Figure 2-7

CR Kendall Mine

Process Pad Barrier Cover Alternative

Cross-Sectional Diagram Of Single Barrier Liner

2.5 Alternatives Considered But Dismissed

Additional alternatives were considered and evaluated. Those dismissed from detailed consideration are explained below.

2.5.1 Process Pad Removal

Scoping comments suggested that spent ore from the process pads should be removed. Removed spent ore would need to be placed somewhere. The most logical sites would be to backfill into the mine pits, including the Kendall, Barnes-King, and portions of Muleshoe pits.

This alternative was not considered further because moving the spent ore containing remnant cyanide solution and elevated concentrations of leachable metalloids, into the pits would require the pits to be lined and a seepage collection system installed (much like the process pads). Installing a liner would require 3:1 slopes to maintain stability of the liners, which would be achieved through placement of waste rock and a cushion layer of finer material of subsoil or historical tailings. Appropriately-sized subsoil with low leaching potential is limited on-site and using it for the cushion material or to achieve desired slopes beneath the lower liner would be an inefficient use of resources.

The relocation of spent ore does not solve any specific problem. The spent ore would still have to be isolated to minimize infiltration of meteoric water and subsequent groundwater contamination. The concerns associated with the spent ore would simply be moved from one site to another.

Inspection reports in 2004 documented the liner under the process pads was in good condition and that all the spent ore was on the liner (Womack and Associates, 2004). Stakeholders concurred there would be no beneficial reason to move the spent ore from the pads (CDM, 2004b).

2.5.2 Waste Isolation in Mine Pits

A suggestion was made to isolate the waste rock in mine pits with liners and covers.

This alternative was not considered in detail because the pits could not hold all of the waste rock. Liners and a soil cover would be needed to eliminate water infiltrating into the waste rock. The capping systems on the waste rock dumps, currently well vegetated, would have to be removed and used to cap the new pit disposal sites. There is not enough suitable soil available to cover waste rock dump areas and the new pit disposal sites. There would be at least a temporary increase in erosion until the vegetation was reestablished. This disturbance would cause additional and renewed flushing of metalloids in addition to the flushing of metalloids from the remaining excess waste rock that could not be placed in pits.

The pits are currently providing raptor and bat habitat, which would be eliminated in this alternative. CR Kendall is currently meeting groundwater standards so there is no benefit from disturbing the waste rock dumps again. This measure would not eliminate the current pumpback systems.

2.5.3 GCL Cover on Process Pads

GCLs contain a thin layer of sodium-saturated bentonite clay, create a layer with a low hydraulic conductivity, and can be self-healing if there is a puncture. The performance of a GCL cover is dependent on proper installation in an appropriate environment (EPA, 2001). A GCL-type cover system could be used as a barrier cover for the process pads and would require:

- Removing the existing 17 inches of plant growth media from the surface of the process pads,
- Regrading the top 6 inches of subsoil basal layer material amended with 5 to 8 percent sodium bentonite to provide a lower cushion layer,
- Installing a drainage net with non-woven fiber on both sides,
- Installing the GCL,
- Spreading a 6-inch upper cushion layer of soil or borrow material with low thallium levels screened to less than ½-inch particle size to protect the GCL,
- Reapplying the approximately 17 inches of the salvaged growth media to the top of the process pads, and
- Reseeding the disturbed areas.

The presence of calcium in infiltration water can reduce the expansive properties of the clay and lead to higher hydraulic conductivities because the sodium in the bentonite will be replaced by calcium. CR Kendall Mine soils are naturally high in calcium because much of the soils developed from limestone parent materials. Thus, limiting contact of calcium-rich water with the GCL at this mine would not be possible.

GCLs are often not as effective in cold climates where freezing and thawing cycles can desiccate and cause cracks in the GCL causing higher hydraulic conductivities (EPA, 2001).

2.5.4 Other Water Treatment and Water Discharge Alternatives

2.5.4.1 Biological Treatment – Active or Passive

Use of active or passive biological treatment methods was dismissed because past systems failed to work effectively to remove contaminants (Golder Associates, 2006). Three different, small passive systems were tested and failed to work satisfactorily for removing thallium and other metals from the Barnes-King captured groundwater (KVSW-2). Biological treatment systems would not be reliable during colder

temperatures. Unless a groundwater collection and pumping system is included, each drainage would need to have its own gravity-fed treatment system, requiring higher maintenance. Space below the waste rock dumps is limited in most drainages.

2.5.4.2 Reverse Osmosis (RO) Treatment

RO with Brine Disposal On-Site. RO is a frequently used water treatment system. This method was tried at the CR Kendall Mine site for 2 years but the resulting water quality did not meet the standard for thallium, consequently zeolite treatment would still be required. Additionally, RO systems have high energy requirements. On-site RO brine storage and disposal would require constructing a new lined repository for permanent storage. Brine would need to be evaporated on-site to reduce the volume required for storage. The use of an evaporator or crystallizer would require additional time and more energy.

RO with Brine Disposal Off-Site. Off-site disposal of RO brine would increase impacts from truck traffic and use more fuel, as the nearest licensed disposal facility for brine is in Idaho. Liquid waste cannot be disposed of in a solid waste landfill, so evaporation or crystallization would also be necessary.

2.5.4.3 Sulfide Precipitation through Chemical Addition

It has been suggested that thallium could be precipitated out of the water with the addition of chemicals. Bench-scale tests were done before 1996; (1) using a pH adjustment and addition of sodium sulfide, (2) addition of trimercaptan product TMT-15, and 3) treatment with permanganate.

This alternative was not considered further because none of the bench-scale tests showed that thallium would be removed to a level that would meet water quality standards (Hydrometrics, Inc., 1996). Thallium levels were reduced, but it is likely that additional treatment would be necessary to remove hydrogen sulfide that would be created in the process. This alternative would require high chemical usage and sludge disposal.

2.6 Related Future Actions

Related future actions are those related to the Proposed Action by location or type. For future actions, an agency need only evaluate those actions under concurrent consideration by any state agency, specifically state agency actions through pre-impact statement studies, separate impact statement evaluation, or permit process procedures.

Because of the limited extent of the project effects, the CR Kendall Mine DEQ permit area is used as the effects analysis area for all resources evaluations. Based on the MEPA model rules definition, there are no related future actions in the CR Kendall Mine DEQ permit area.

Affected Environment and Environmental Consequences

Information in this chapter describes the relevant resource components of the existing environment. Only resources that could be affected by the alternatives are described. They are: geology and minerals; surface and groundwater; soils, vegetation, and reclamation; and wildlife. After the environment of each resource is described, the impacts of the No Action Alternative, Proposed Action, Process Pad Drainage Pretreatment Alternative, and Process Pad Barrier Cover Alternative are discussed.

3.1 Location Description and Study Area

The project location and associated study area for the mine include all lands and resources in the mine permit area, plus those additional areas identified by technical disciplines as "resource analysis areas" that are beyond the mine permit area. Resource analysis areas are identified for each technical discipline. Additional information on analysis areas is in Chapter 4. By definition, the resource analysis areas that extend beyond the mine permit boundary are included in the "study area" for this EIS.

3.2 Geology and Minerals

A discussion of the geology and mineralization in the mining district is in this section. The stability of the regraded waste rock and process pad slopes is also discussed.

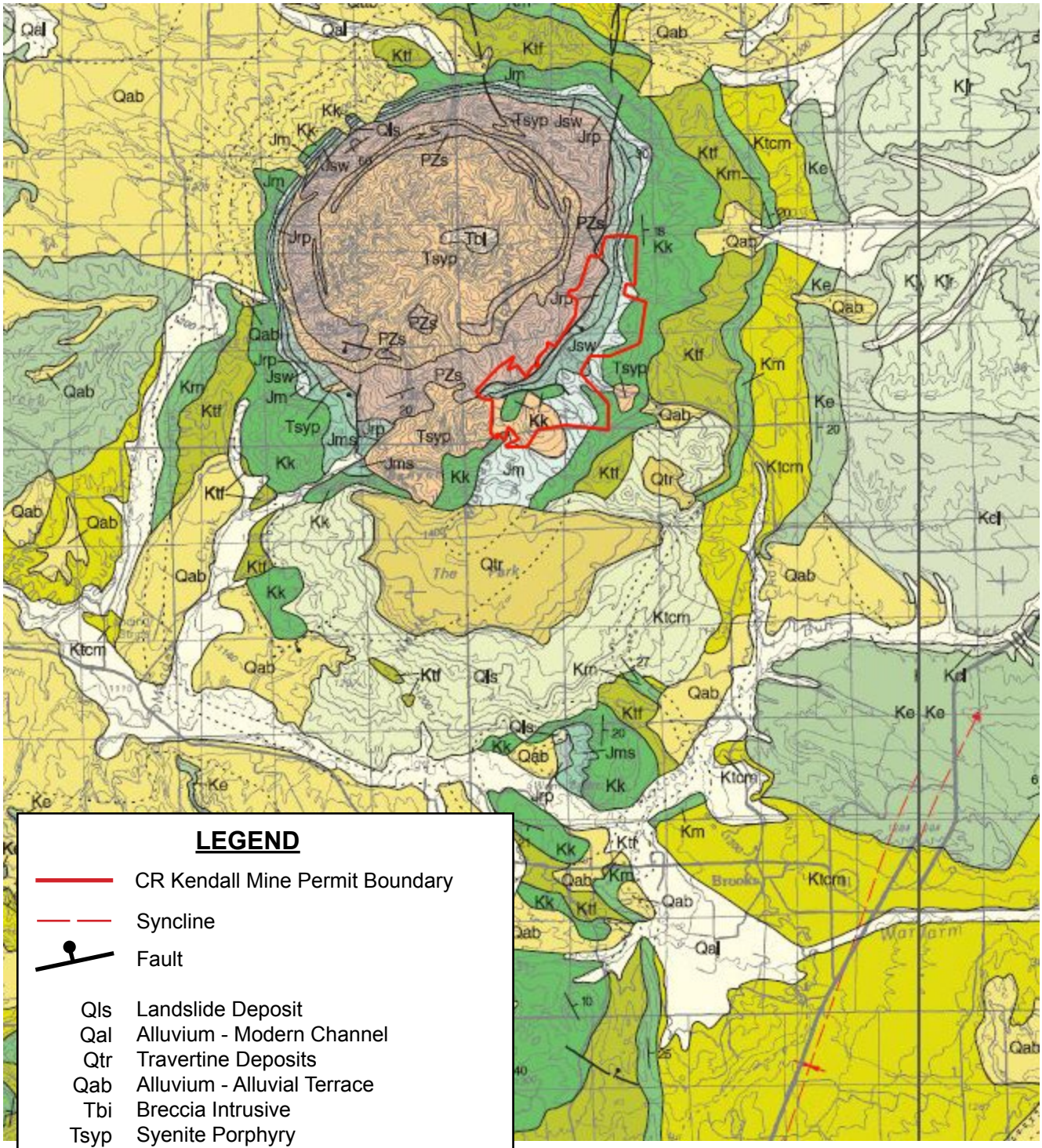
3.2.1 Analysis Area and Methods

The analysis area for geology and minerals is the North Moccasin Mining District including the Horseshoe, Muleshoe, Barnes King, and Kendall pits.

The analysis methods for geology and minerals included reviewing publications of the U.S. Geological Survey and other sources along with their associated geology maps and drawings. Historical mining in the area was summarized by CDM in 2004 and was included in the analysis.

3.2.2 Affected Environment

The geology and mineral deposits of the North and South Moccasin Mountains were evaluated by Lindsey (1982) who describes the area as dominated by Tertiary laccolith intrusions of syenite and quartz monzonite porphyry mantled by older Paleozoic and Mesozoic sedimentary rocks. The Paleozoic and Mesozoic formations are steeply dipping on the flanks of the intrusions with dip angles decreasing away from the mountains. Mineralization at the CR Kendall Mine on the eastern flank of the North Moccasin Mountains was initially exploited in the late 1800s. The primary ore zone was an oxidized and silicified limestone breccia at the top of the Madison Limestone Group emplaced along a north-south trending normal fault (hanging wall on the east). The regional geology map with the boundary of the CR Kendall Mine is provided in **Figure 3-1**.



LEGEND

CR Kendall Mine Permit Boundary

Syncline

Fault

Qls	Landslide Deposit
Qal	Alluvium - Modern Channel
Qtr	Travertine Deposits
Qab	Alluvium - Alluvial Terrace
Tbi	Breccia Intrusive
Tsyp	Syenite Porphyry
Kjr	Judith River Formation
Kcl	Claggett Shale Formation
Ke	Eagle Formation
Ktcm	Telegraph Creek & Marias River Form.
Ktcb	Telegraph Creek & Belle Fourche Form.
Km	Mowry Shale Formation
Ktf	Thermopolis & Fall River Formation
Kk	Kootenai Formation
Jm	Morrison Formation
Jms	Morrison & Swift Formation
Jsw	Swift Formation
Jrp	Rierdon & Piper Formation
PZs	Paleozoic Sedimentary Rock

0 2 miles

SCALE: 1" = 2 miles

Geologic Map of Lewistown - 1999

Karen W. Porter and Edith M. Wilde

FIGURE 3-1

CR Kendall Mine

Regional Geology Map

Gold mineralization in the North Moccasin Mining District is directly related to the intrusion of igneous rocks and associated hydrothermal activity. During and after the emplacement of the syenite porphyry, hydrothermal groundwater flow was directed along existing zones of structural weakness near the top of the Madison Limestone. The Madison Limestone is a complex interbedded group of sedimentary rock formations identified as the Lodgepole Limestone, Mission Canyon Limestone, and Charles Formation members (USGS, 1984). The gold ore in the North Moccasin Mining District is in the upper unit of the Madison Limestone (Charles Formation) within interbedded carbonate rock and shale zones and in irregularly distributed dikes. The major historical gold mining activities along the eastern slope of the North Moccasin Mountains involved underground and open-pit mining and cyanide processing. Fergus County was the leading gold producing county in Montana in 1903 and 1904 (Koschmann and Bergendahl, 1968).

3.2.3 Environmental Consequences

3.2.3.1 No Action Alternative

Active mining ceased in February 1995, with gold recovery continuing through the fall of 1997. The No Action Alternative reflects the current CR Kendall Mine operations and reclamation under Operating Permit 00122, including six Amendments (Table 1-2) and minor revisions up through Minor Revision 11-001. The current and proposed activities under the approved reclamation plan are the capture and treatment of process pad drainage water, capture and treatment of alluvial groundwater that does not meet water quality standards, disposal of spent zeolites, augmenting flows in South Fork Last Chance Creek and Little Dog Creek, removing all buildings and reclaiming the disturbances, removing all ponds and reclaiming the sites, reclaiming all mine roads except for the one public access road, and using all stockpiled soil for reclamation.

Additional geotechnical oversight was completed during 2004 for placement of the pad liner extension between process pads 3 and 4 (Womack and Associates, 2005b). The work was completed as part of reclamation associated with the CR Kendall Mine closure. The pad extension construction was in accordance with plans and specifications under the direction of the DEQ. The installation met or exceeded the engineering requirements.

Impacts to geology and minerals at the CR Kendall Mine site occurred during active mining. No additional specific impacts to these resources would be expected from the No Action Alternative mine closure activities. Some areas of the CR Kendall Mine site (e.g., portions of regraded slopes in the Kendall and Muleshoe Pits) have yet to receive soil or to be reseeded as required by the currently approved reclamation plan.

3.2.3.2 Proposed Action

There would be no additional adverse impacts to the geology and minerals from implementing the Proposed Action compared to the No Action Alternative. Soil would be placed on current roads, footprints of buildings, and parking areas after water treatment ceases. Soil would also be used for maintenance of rills, slumps, and other erosion features. No soil would be placed on the areas of the Kendall Pit with less than 2:1 slopes; or unvegetated areas of the Muleshoe Pit.

3.2.3.3 Process Pad Drainage Pretreatment Alternative

This alternative would be similar to the No Action Alternative and Proposed Action with no additional adverse impacts to the geology and minerals. The main difference between this alternative and the No Action Alternative and Proposed Action would be the pretreatment of the process pad drainage prior to combining it with the captured alluvial groundwater. The combined waters would then be treated at the central WTP with media filtration and zeolite adsorption and discharged to groundwater in the Kendall Pit.

3.2.3.4 Process Pad Barrier Cover Alternative

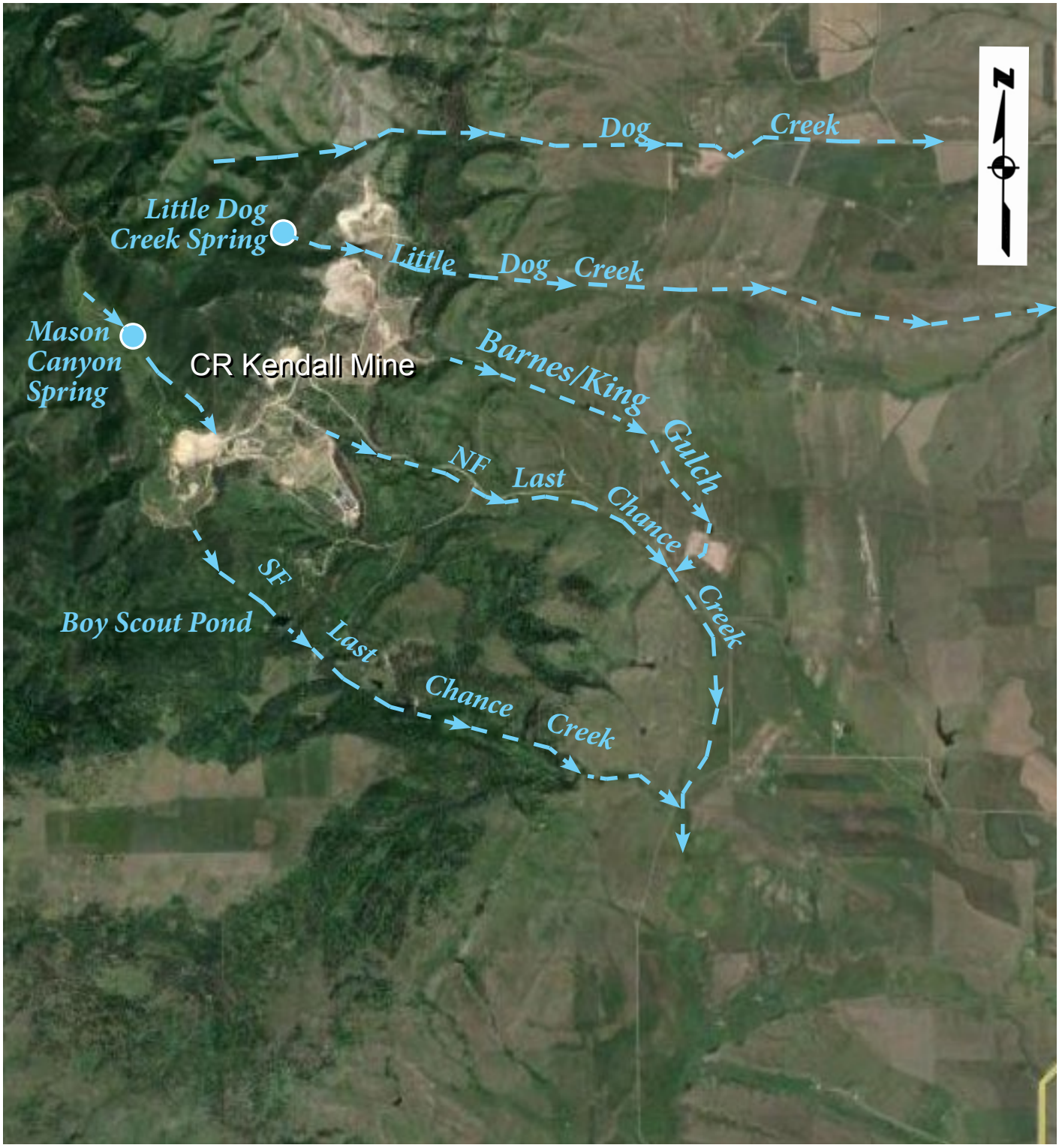
The Process Pad Barrier Cover Alternative would involve removing the upper 17 inches of soil/growth media and vegetation from process pads 3 and 4 and installing a barrier cap system. After the geomembrane liner is installed, soil would be replaced on the process pads. Most of the process pads area consists of 3:1 slopes (estimated to be 71 percent). Placing soil on a barrier material on 3:1 slopes (even for textured geomembrane liners) would increase geotechnical instability for the reclamation cover soil by creating a potential slippage plane. All other specific impacts to the geology and mineralization would be similar to those for the No Action Alternative and Proposed Action.

3.3 Surface and Groundwater

3.3.1 Analysis Area and Methods

The analysis area for all surface water and groundwater resources and water treatment is the eastern side of the North Moccasin Mountains, including all upgradient and downgradient drainages that flow across or near the CR Kendall Mine permitted mine boundary. **Figure 3-2** shows these major drainages in relationship to the mine.

The water resources for the CR Kendall Mine area were analyzed by reviewing documents and publications by various consultants and specialists that worked for CR Kendall; other technical reports prepared by the mine for DEQ; inspection reports and memoranda from DEQ; technical reports and publications with specific information on water quality and water treatment; and associated maps and drawings.



0 4000'

SCALE: 1" = 4,000 feet
Source of Base: Google Earth Pro
Image Date: 7/1/2014

FIGURE 3-2
CR Kendall Mine
Regional Water Features Map

3.3.2 Affected Environment

3.3.2.1 Climate

Climatic conditions play a major role in the availability of surface water and the evapotranspiration and recharge of groundwater at the CR Kendall Mine. Rainfall has been monitored at the mine site since 1992. Regional precipitation data for nearby monitoring stations through 2014 are summarized in **Table 3-1**. The mine receives an average of approximately 25.8 inches of precipitation per year while the surrounding areas receive approximately 13 to 16 inches. This difference is likely due to the higher elevation at the CR Kendall Mine and orographic effects from the mountains surrounding the mine.

TABLE 3-1
PRECIPITATION DATA CR KENDALL MINE AREA, FERGUS CO., MT

Station Name	Annual Precipitation 1993-2014		
	Mean (inches)	Maximum (inches)	Minimum (inches)
Winifred	16.0	23.8	12.1
Moccasin	14.8	23.4	10.9
Roy	13.2	19.6	10.2
Grass Range	16.0	23.1	12.8
Denton	15.6	24.6	11.1
CR Kendall Mine	25.8	36.4	16.3

Precipitation data from the CR Kendall Mine reported by CR Kendall from 1992 to 2014 show that about 60 percent of the annual precipitation occurs from April through July, and 14 percent during December through February. The average annual temperature at Lewistown is 43 degrees Fahrenheit (°F) with the average monthly low temperature of 20 °F occurring in January and the average maximum temperature of 65 °F in July. (Lewistown Weather Data, 2015).

3.3.2.2 Water Quantity

Surface Water Quantity

The North Moccasin Mountains reach an elevation slightly over 5,600 feet, and are on a surface water drainage divide between the Judith and Missouri River Basins. Surface water in the CR Kendall Mine area is primarily composed of runoff from snowmelt and storm water in ephemeral drainages. Some of the drainages receive supplemental flow from groundwater discharged as springs and seeps. The majority of surface flow from the upper portions of the North Moccasin Mountain watersheds is intercepted by porous and possibly karstic Madison Limestone. Little or no surface water flows reach the CR Kendall Mine.

There are six surface drainage systems in the mine permit area that generally trend east to southeast (**Figures 3-2 and 3-3**). These drainages, from south to north, are:

South Fork of Last Chance Creek
Mason Canyon
North Fork of Last Chance Creek
Barnes-King Gulch
Little Dog Creek
Dog Creek

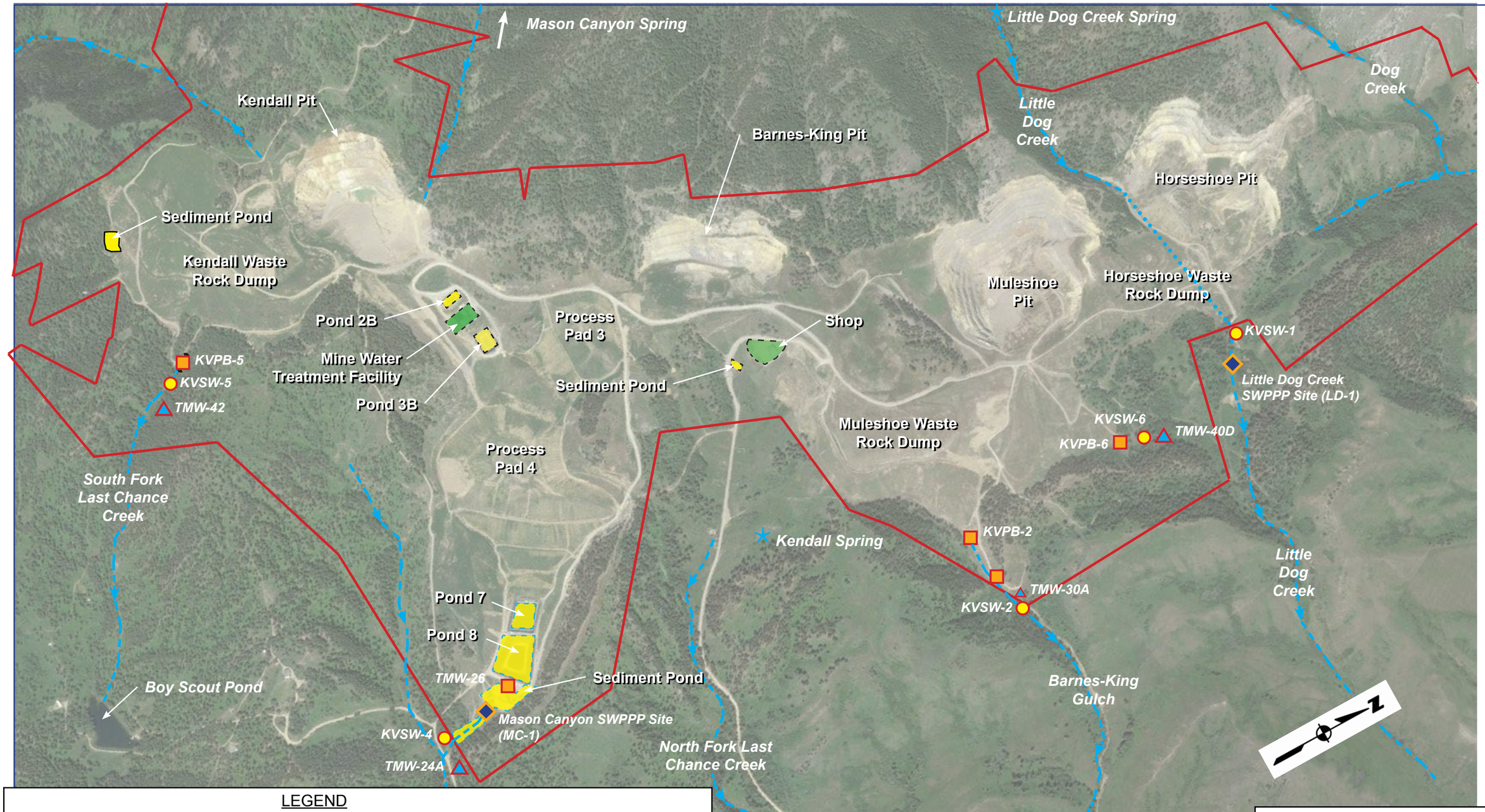
The majority of the headwater areas for the South and North Forks of Last Chance Creek and Barnes-King Gulch are in the mine permit area. The headwater areas of Mason Canyon, Little Dog Creek, and Dog Creek are at higher elevations above the mine permit area. The Little Dog and Dog Creek drainages flow toward the Missouri River and the remaining drainages flow toward the Judith River.

Surface water monitoring began in 1990-91 at four stations in the mine permit area (KVSW-1 through KVSW-4) (**Figure 3-3**). Three additional sites (KVSW-5 through KVSW-7) were added in 1994. Instantaneous flow measurements collected between 1990 and 2014 are summarized in **Table 3-2** (CR Kendall, 2015b). In general, the maximum flow occurred in the wetter spring months, followed by declining flows over the summer. Little or no flow was observed during fall months. All stations exhibited periods of no flow.

TABLE 3-2
SUMMARY OF INSTANTANEOUS STREAMFLOW MEASUREMENTS (1990-2014)
CR KENDALL MINE, FERGUS CO., MT

Station Number	Drainage	Number of Events	Number of Events with Flow	Average Flow (gpm)	Maximum Flow (gpm)	Minimum Flow (gpm)
KVSW-1	North Fork Little Dog Creek	92	2	54	5,000	0
KVSW-2	Barnes-King Gulch	161	31	1.5	80	0
KVSW-3	North Fork Last Chance Creek	51	13	2.2	35.0	0
KVSW-4	Mason Canyon	170	104	12.4	1,200.0	0
KVSW-5	South Fork Last Chance Creek	158	131	16.5	375	0
KVSW-6	South Fork Little Dog Creek	65	2	0.4	25.1	0
KVSW-7	Mason Canyon LAD Area	93	78	7.3	50.0	0

Notes: gpm = gallons per minute



LEGEND

- Permit Boundary
- Stream (dotted where underground)
- Facilities To Remain Intact After Closure Until Water Treatment Is No Longer Required
- Buildings To Remain For Private Use
- Existing Monitoring Well
- Surface Water Monitoring Site
- Spring
- Pumpback Site
- Stormwater Monitoring Site

0 850'

SCALE: 1" = 850 feet
Source of Base: Google Earth Pro
Image Date: 7/1/2014

FIGURE 3-3
CR Kendall Mine
Mine Features Map and Water Quality Sampling Locations

Continuous flow measurements over several months are only available in the southern drainages. Analysis of one storm in September 1996 showed little groundwater recharge in the drainages from the event (Water Management Consultants [WMC], 1996). WMC (1999) reported that surface water in the drainages above the mine was either ephemeral or intermittent and that surface flows above the mine are lost as recharge into the Madison Limestone. DEQ has routinely observed the loss of all surface flow in Little Dog Creek, downstream of Little Dog Spring, at the contact of the Madison Limestone and the syenite porphyry (DEQ, 2003).

The average annual precipitation reported for the CR Kendall Mine site for 1993 to 2014 was 25.8 inches. Gallagher (2002) documented drought conditions that persisted in the area between 1990 and 2001. Hydrologic drought is defined as declining groundwater levels due to decreased recharge and increased water loss through evaporation and plant uptake. Hydrologic drought was a major contributing factor in decreased flows in springs and ephemeral and intermittent stream flows reported in the drainages originating on or crossing the mine site (Gallagher, 2002). Surface water flows at several monitoring sites have increased since the drought ended in 2001.

Groundwater Quantity

All mine pits are dry indicating modern mining did not intercept groundwater in the Madison Limestone and no groundwater was historically reported in the underground workings. The Kendall shaft was excavated down to approximately 650 feet, putting it approximately 100 to 200 feet below the floor of the current Kendall Pit. Historical mining operations and the town of Kendall obtained water supply from Little Dog Spring above the mine.

There are springs and seeps above and below the CR Kendall Mine site that are derived from shallow flow systems. Springs above the mine, such as Little Dog Spring, originate from the Tertiary syenite and are recharged from precipitation higher in the North Moccasin Mountains. A portion of upper Little Dog Spring is currently diverted for augmentation in lower Little Dog Creek. The portion of upper Little Dog Spring discharge that is not diverted does not reach the mine and is lost as recharge to the Madison Limestone. Similarly, the Mason Canyon Spring flows are lost as recharge to the Madison Limestone. One time in the last 25 years, the flow from the Mason Canyon Spring reached the Kendall Pit during an extreme precipitation event (Volberding, 2015c).

Springs in the drainages east and downgradient of the mine site appear to be related to low permeability units in the Morrison and Kootenai formation bedrock aquifers, in combination with groundwater movement in the alluvial aquifer sediments. WMC (1999) reported that most of the water in the seeps and springs is derived from local recharge sources. These springs are highly susceptible to small fluctuations in water table elevation resulting in variable seasonal discharge. Fluctuations in water table elevation may be caused by one or more factors including increased groundwater

withdrawal, seasonal recharge variations, decreasing recharge from precipitation from drought, and variations in agricultural practices.

Mine Pumpback, Monitoring, and Water Supply Wells

CR Kendall Mine installed four groundwater pumpback systems to capture contaminated seepage below waste rock dumps and the process pads (**Table 3-3**). The pumpback volumes varied from a low of 17,517,103 gallons in 2001 to 65,256,850 gallons in 2011 (CR Kendall, 2015b).

TABLE 3-3
ANNUAL PUMPBACK VOLUMES (GALLONS) BY FOUR DRAINAGES AND TOTALS (1997-2014)

Year	South Fork Last Chance Creek	Mason Canyon	Barnes-King Gulch	South Fork Little Dog Creek	Total
1997	6,432,390	6,152,471	3,367,715	8,030,050	23,982,626
1998	5,678,400	6,886,823	2,613,020	8,152,220	23,330,463
1999	4,367,690	7,226,157	3,149,815	8,253,945	22,997,607
2000	4,194,260	7,559,250	3,409,090	8,536,600	23,699,200
2001	3,358,183	5,494,520	2,651,320	6,013,080	17,517,103
2002	4,739,810	8,473,350	5,491,790	11,309,340	30,014,290
2003	6,348,430	10,427,810	7,741,060	14,774,970	39,292,270
2004	6,669,470	11,868,690	8,435,590	12,666,700	39,640,450
2005	5,800,870	7,884,930	6,827,790	10,488,730	31,002,320
2006	10,137,300	12,885,000	10,783,000	15,652,380	49,457,680
2007	9,042,120	9,139,000	8,937,000	11,784,240	38,902,360
2008	7,504,890	7,584,000	7,545,000	9,613,350	32,247,240
2009	9,104,610	9,382,000	7,030,000	8,777,590	34,294,200
2010	10,983,180	13,511,000	13,130,000	17,109,520	54,733,700
2011	5,953,220	17,698,000	19,795,000	21,810,630	65,256,850
2012	8,075,980	11,621,900	6,816,800	12,783,030	39,297,710
2013	5,226,050	5,463,700	10,294,700	8,068,130	29,052,580
2014	7,130,340	6,060,400	7,745,200	7,999,660	28,935,600

The company installed numerous monitoring wells and water supply wells that date back to 1985. Most monitoring wells are associated with a pumpback system or in the process valley to monitor the former process pads for leaks. All monitoring wells are less than 100 feet deep and are screened in the shallow alluvium or in the first bedrock formation encountered. Water levels in several monitoring wells have increased since the drought ended in 2002 (CR Kendall, 2006).

Eight water supply wells were drilled on the mine site. Two, WW-6 and WW-7, have historically been used to augment surface flows in the South Fork of Last Chance Creek and Little Dog Creek. However, more recently, springs above the mine have been diverted to provide augmentation water and have replaced the wells as an augmentation water source. Historical augmentation volumes are in **Table 3-4**. The static water level in WW-7 has been near or above the ground surface since mid-2002. At this level, artesian flow from WW-7 flows into Little Dog Creek.

TABLE 3-4
AUGMENTATION VOLUMES (GALLONS) BY YEAR IN TWO DRAINAGES

Year	South Fork Last Chance Creek	Little Dog Creek
1998	NA	4,755,350
1999	NA	8,348,980
2000	4,494,530	9,498,610
2001	5,675,580	9,447,278
2002	5,053,700	7,976,073
2003	6,928,300	16,423,317
2004	6,509,000	15,959,410
2005	6,719,000	15,370,380
2006	6,075,640	32,992,590
2007	10,905,900	29,390,680
2008	10,316,140	21,092,560
2009	9,526,940	20,898,360
2010	15,075,260	28,136,370
2011	14,190,910	31,162,400
2012	11,518,910	27,974,220
2013	10,988,850	20,543,060
2014	9,513,880	29,608,110

3.3.2.3 Water Chemistry

Metals, metalloids, and other contaminant concentrations can be elevated at mine sites from disturbances to the natural mineralogy that allow previously immobile metals or metalloids to become mobile, or from the addition of the contaminants during mining or ore processing. Described below are the properties of the main contaminants found in the geologic materials, reclamation resources, and water at the CR Kendall Mine. The probable sources, forms, and fate and transport are described for each contaminant. Elevated arsenic, selenium, and thallium concentrations are often encountered with

carbonate-replacement gold deposits, which are termed Carlin-like deposits when associated with alkaline igneous intrusions (Berger and Bagby, 1991).

Arsenic

Arsenic is present in the ore body mined by CR Kendall and in the surrounding rocks and soils that have been influenced by the emplacement of the ore body. Elevated background levels of arsenic around some gold-bearing ore bodies are common due to the geochemical association of arsenic-containing minerals with gold in many areas (Nekrasov, 1996). Arsenic can occur in many oxidation states, which is a value indicating the degree of oxidation (or loss of electrons) of a particular atom, and is hypothetically equal to the net charge of that atom. The oxidation state of arsenic can range from the 3- reduced state to its most oxidized state, 5+. Naturally occurring arsenic typically exists in a reduced state, such as arsenic (1-) in arsenopyrite. In such reduced states, arsenic is not soluble or mobile in water, but on exposure to air, reduced arsenic can be oxidized to form arsenic (3+) (arsenite) or arsenic (5+) (arsenate) ions that are soluble and mobile in water. Arsenate is sorbed more strongly on soils and sediments compared to arsenite, and adsorbs more strongly to iron hydroxide or oxide minerals.

In addition to the oxidation state of arsenic, the pH of the water affects arsenic mobility through sediment. At high pH, arsenic does not adsorb onto soil and sediment surfaces as well as it does at lower pH levels, especially for soils and sediment with relatively high levels of iron or aluminum. Because the cyanide leaching process requires raising the pH of process solutions to greater than 10, the high pH in the process solution and the oxidative conditions encouraged arsenic mobilization. The increased mobility of arsenic in the process pad combined with the high concentrations in the ore resulted in high arsenic levels (approximately 0.2 mg/L or higher) in process pad drainage effluent from 1994 to 2002, with a decreasing trend to approximately 0.12 mg/L arsenic in August, 2014.

Selenium

Selenium occurs in local geologic materials associated with carbonate-replacement deposits (Berger and Bagby, 1991). The selenium is released into solution by oxidation of the sulfide minerals in the process pads or waste rock dumps. As with arsenic, the two most oxidized states of selenium, selenium (4+) (selenite) and selenium (6+) (selenate), are the most water-soluble and mobile forms. Selenium distribution varies across the site. Little Dog Creek has higher selenium concentrations in water than other mine-site drainages, and selenium was occasionally detected in water samples from Little Dog Creek prior to the start of modern mining in the drainage.

Because the oxidized forms of selenium (selenite and selenate) are similar to the oxidized forms of arsenic in that they are oxyanions, they exhibit similar geochemical properties. Selenium adsorbs better onto soils and sediments at lower pH compared to

higher pH. As opposed to arsenic, where the most oxidized form (arsenate) is adsorbed more strongly to iron oxides or hydroxides, the most oxidized form of selenium (selenate), adsorbs less strongly to iron oxides or hydroxides compared to selenite.

Thallium

Thallium was deposited at the same time as the gold in the mineralized rock. Thallium is known to occur with Carlin-like carbonate-replacement gold deposits (Berger and Bagby, 1991; Percival and Radtke, 1993). Weathering of these minerals can release thallium into mine drainage and stormwater from the site.

Thallium occurs in two oxidation states in natural water: thallium (1+) and thallium (3+). Thallium (1+) behaves similarly to the alkali metal ions (sodium, potassium, etc.), and is extremely soluble and mobile in water. Thallium (3+) has chemical similarities to aluminum and precipitates as a thallium (3+) hydroxide or co-precipitates with iron oxyhydroxides in higher pH waters.

Nitrogen

The most important forms of nitrogen in natural waters are ammonia (NH_3), nitrite (NO_2^-), nitrate (NO_3^-), and various nitrogen-bearing organic compounds. The most important forms of nitrogen at the site are nitrite and nitrate, which are usually reported by analytical laboratories as the sum of the two species due to holding time constraints. Nitrates in this discussion will include nitrate and nitrite.

Nitrates at the CR Kendall Mine are derived from a number of sources including degradation of cyanide used in the leaching process, nitrate-containing explosives, and oxidation of nitrogenous organic matter. During operations, residues from blasting were the primary source of nitrates. Since operations ceased, degradation of residual cyanide has been the major source of nitrates in the process valley and LAD areas.

Nitrates can be reduced and converted to nitrogen gas by bacteria under low oxygen (anoxic) conditions if a source of organic carbon is present, such as in wetland areas. Under oxidizing conditions, nitrates tend to persist and are relatively mobile in the environment because of the high solubility of nitrate and the fact that nitrate does not adsorb strongly to sediments and soils. Growing plants require nitrogen as a nutrient and can remove nitrates from water by uptake through roots.

Cyanide

Cyanide (CN^-) was used by CR Kendall to solubilize gold from the crushed ore in the process pads in Mason Canyon. The gold-bearing solution was collected and conveyed to the processing plant where the gold was separated from the cyanide and the cyanide solution was recycled back to the process pads. Cyanide was used by the historical mills in Little Dog Creek, Barnes-King Gulch, and Mason Canyon as discussed in Chapter 1.

Dissolved cyanide can occur as free cyanide (either as HCN or CN^-, depending on the pH), weak acid dissociable (WAD) cyanide, or strong cyanide complexes, such as iron cyanide complexes. Free cyanide, the most toxic form, generally does not persist in the environment due to loss by volatilization as HCN gas, biodegradation, uptake by plants, or reaction with metals to form WAD cyanide complexes, or strong cyanide complexes. Strong cyanide complexes tend to persist, but are considerably less toxic than free or WAD cyanide compounds. Water quality analyses can measure total cyanide that includes all forms of cyanide, WAD cyanide, or free cyanide. Montana water quality standards conservatively use total cyanide analytical results as a guideline.

3.3.2.4 Water Quality

The overall quality of on-site waters is expressed in terms of concentration ranges and the percentage of time that substances of concern have exceeded water quality standards. This is a summary of data found elsewhere (WMC, 1999 and 2003; Gallagher, 2002; CDM, 2004b; Golder, 2006). Concentrations of arsenic, selenium, and thallium in the CR Kendall Mine groundwater and the process pad drainage over the last 20 years are provided in **Figures A-1 through A-9** in Appendix A. Surface water quality standards for metals are based on total recoverable concentrations that include dissolved and suspended components. Since 1994, CR Kendall Mine has obtained both dissolved and total recoverable analyses for surface water samples. Groundwater quality standards for metals are based solely on dissolved concentrations.

Process Pad Water Chemistry

Several lined process ponds containing the process pad drainage and captured alluvial groundwater are located in the Mason Canyon process valley. Pond 7 contains primarily water draining from the process pads. **Table 3-5** shows the quality of Pond 7 water and the concentrations of arsenic, selenium, and thallium over the last 20 years is provided in **Figure A-1 (Appendix A)**. The process pad drainage water is disposed by LAD, so the applicable groundwater standard is shown for comparison in Table 3-5. Groundwater standards would only apply to the process pad drainage if it were discharged to groundwater.

TABLE 3-5
ANALYSES FOR POND 7 WATER (1990-2014)

Parameter[1]	DEQ-7 Criteria[2]	Range of Data[3]	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
Specific Conductance (µS/cm)	---	1770-5870	---	3240 (62)	1930
Sulfate	---	702-2690-2510	---	1500 (52)	871
Cyanide as total	0.2	**0.005-302**	44	**7.54** (62)[6]	0.019
Nitrate/nitrite as N	10	0.01-**199**	87	**61.0** (62)	**10.2**
Arsenic	0.010	**0.**003-**0.129**	96	**0.052** (27)[5]	**0.042**
Iron	---	0.01-0.9	--	0.121 (10)	NA[4]
Selenium	0.05	0.018-**0.202**	37	**0.058** (27)	0.030
Thallium	0.002	**0.249-9.03**	100	**5.75** (26)	**5.7**
Zinc	2.0	0.13-**14.6**	13	**2.06** (8)	NA

Notes: Bold values indicate the groundwater criteria are exceeded.
[1] Units are mg/L unless otherwise noted (metals are dissolved and total recoverable concentrations combined).
[2] Values listed are the groundwater criteria
[3] Data from February 1990 to August 2014.
[4] NA = not analyzed, removed from the monitoring plan.
[5] One anomalous data point (84.1 mg/L) from August of 2001 was omitted for purposes of computing average and number of exceedances.
[6] Average shown may be skewed by high values during 2002 and 2003

Surface Water Quality

The default surface water classification for streams in Montana is B-1, which means it is assumed to be suitable for drinking water and the growth and propagation of salmonid fishes and associated aquatic life. Consequently, the lowest value between the human health drinking water standards and chronic aquatic life criteria applies to streams classified as B-1. The six drainages leaving the CR Kendall permit area are classified as B-1 even though they are ephemeral or intermittent. Sampling locations have been modified due to expansion of and changes to mine facilities. Data from sampling locations are sporadic due to freezing or lack of the surface water at the designated sampling stations. A summary of the surface water sampling locations and the dates they were sampled is in **Table 3-6**.

TABLE 3-6 SURFACE WATER SAMPLING LOCATIONS AND YEARS SAMPLED, BY DRAINAGE		
Drainage	**Stream Water Locations**	**Pond Water Locations**
South Fork Last Chance Creek	KVSW-5 (1994-2014), KVSW-5E (1996), KVSW-5W (1996), S Fork Boundary (1997-2005), S Fork Fence (1996-97), S Fork Inlet (1999)	Boy Scout Pond (1990, 1996, 1998-2014)
Mason Canyon	TSW-1 (1984-85), KVSW-4 (1990-2014), KVSW-7 (1994-2005)	TPO-1 (1984-86)
North Fork Last Chance Creek	TSW-2 (1982-85), KVSW-3 (1990-2005)	TPO-2 (1984-86), Peters Pond #1 (2001)
Barnes-King Creek	TSW-3 (1984-85), KVSW-2 (1990-2014), BKSW-1 (2001)	
Little Dog Creek	TSW-4 (1984-85), KVSW-1 (1981, 1991-2014), KVSW-6 (1984-85, 1994-2001), #1 (1998), #14 (1998), #15 (1998), Section 29 Spring (1984-2014)	#12 (1998), TPO-3 (1984-86), Tailings Pond (2002)
Dog Creek	#3 (1998), #6 (1998), #10 (1998)	#2 (1998), #4 (1998), #5 (1998), #7 (1998)

The locations of current sampling points are shown on **Figure 3-3**. The surface water quality in each of the six drainages is described in the following sections. The tables for each sampling station compare the concentrations of each parameter of concern to the human health or chronic aquatic life water quality standards, whichever is more stringent.

South Fork Last Chance Creek

The water quality results for surface water station KVSW-5 in the South Fork Last Chance Creek are in **Table 3-7**. Average thallium concentrations have decreased in recent years to levels at or near 0.002 mg/L with a few exceptions.

TABLE 3-7
ANALYSES FOR SURFACE WATER STATION KVSW-5 IN SOUTH FORK LAST CHANCE CREEK 1994-2014

Parameter[1]	DEQ-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)[3]	---	686-2250	---	1519 (175)	956
Sulfate[3]	---	204-1240	---	675 (175)	310
Nitrate/nitrite as N[3]	10 (1.3 in summer)	0-6.05	28	2.7 (174)	0.62
Cyanide as total	0.0052	<0.005-**3.36**[5]	0	0.005	NA[6]
Arsenic[4]	0.010	<0.003-**0.02**	4	0.003 (174)	<0.003
Iron[4]	1.0	<0.01-**2.92**	18	0.43 (41)	NA[6]
Selenium[4]	0.005	<0.001-**0.012**	1.7	0.002 (174)	0.001
Thallium[4]	0.00024	**0.002-0.10**	100[7]	**0.005 (174)**	**0.002**
Zinc[4]	0.388 @ >400 mg/L hardness	0.01-0.19	0	0.033 (25)	NA[6]

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.

[1]Units are mg/L unless otherwise noted (metals are total recoverable).

[2]The lowest value between the surface water human health and chronic aquatic life criteria.

[3]Data from May 1994 to November 2014.

[4]Total recoverable metals data from May 1994 to November 2014.

[5]Sample error with very first sample, as cyanide has never been detected since. The results from the first sample have been omitted from calculations for the average and number of samples exceeding standards.

[6]NA = not analyzed, removed from the monitoring plan.

[7]Analytical detection limit (0.002) exceeds the standard, leading to this apparent high percentage of samples which exceed the standard.

The analytical results for the Boy Scout pond water are in **Table 3-8**. Arsenic is the only parameter that frequently exceeds the human health standard.

The source of the arsenic in the pond is believed to be from sediments transported down the South Fork Last Chance Creek during storms, or from naturally occurring arsenic in the sediment beneath the pond. Sources of this sediment may include mine waste rock or tailings or natural sources of sediment eroding from the mineralized zone. South Fork Last Chance Creek sediment sample results, collected by DEQ in April 1998, are in **Table 3-9**.

TABLE 3-8
WATER ANALYSES – BOY SCOUT POND 1990-2014

Parameter[1]	DEQ-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)[3]	---	174-1420	---	777 (82)	521
Sulfate[3]	---	36-601	---	272 (82)	176
Nitrate/nitrite as N[3]	10 (1.3 in summer)	<0.01-1.86	0	0.07 (81)	<0.01
Cyanide as total	0.2	<0.005-**0.6**[5]	33		NA[6]
Arsenic[4]	0.010	<0.003-**0.05**	66	0.016 (82)	**0.014**
Iron[4]	1.0	<0.01-**1.78**	16.7	0.28 (6)	NA[6]
Selenium[4]	0.005	<0.001-0.005	0	0.001 (82)	<0.001
Thallium[4]	0.00024	**<**0.002-**0.006**	100[7]	0.002 (82)	<0.002
Zinc[4]	0.388 @ >400 mg/L hardness	0.01-0.02	0	0.015 (6)	NA[6]

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the surface water human health and chronic aquatic life criteria.
[3]Data from May 1990 to November 2014.
[4]Total recoverable metals data from May 1990 to November 2014
[5]Believed to be sample error with very first sample, as cyanide has not been detected since.
[6]NA = not analyzed, removed from the monitoring plan.
[7]Analytical detection limit (0.002) exceeds the standard leading to this apparent high percentage of samples which exceed the standard.

TABLE 3-9
ARSENIC IN SEDIMENT FROM SAMPLES COLLECTED BY DEQ IN APRIL 1998 (CR KENDALL MINE 1998)

Sample ID	Location	Arsenic Concentration (mg/kg)
CRK-1	In the Boy Scout Pond	98
CRK-2	Areas adjacent to the pond and SFLCC[1]	8.4
CRK-3	Sediment in SFLCC	128
CRK-4	Areas adjacent to the pond and SFLCC	26
CRK-5	Areas adjacent to the pond and SFLCC	8.0
CRK-6	Sediment in SFLCC	138
CRK-7	Sediment in SFLCC	132

[1]SFLCC means South Fork Last Chance Creek

The results show that the sediments in the South Fork Last Chance Creek channel (CRK-3, CRK-6, and CRK-7) have 5 to 16 times higher arsenic concentrations than areas adjacent to the Boy Scout Pond and South Fork Last Chance Creek (CRK-2, CRK-4, and CRK-5). The presence of dissolved arsenic above the human health standard in the Boy Scout Pond, but not in the surface waters of South Fork Last Chance Creek, as measured at KVSW-5, suggests that arsenic is being mobilized from sediment in the bottom of the pond under seasonal reducing conditions. Because reducing conditions are not present in the surface waters at KVSW-5, arsenic is not mobilized in the drainage to the same extent as at the bottom of the pond.

The Harrell and Jack Ruckman ponds below the Boy Scout Pond were sampled in July 2003 and were within water quality standards for all substances (CDM, 2003). The ponds are on the main fork and side tributaries of South Fork Last Chance Creek.

Mason Canyon

The water quality results for surface water station KVSW-4 in Mason Canyon are in **Table 3-10**. Based on these data, the pumpback system has improved surface water quality at KVSW-4, except when the creek is turbid from stormwater runoff. Station KVSW-4 is downstream of the process valley below TMW-26 and the stormwater settling pond (**Figure 3-3**). Thallium concentrations generally exceed the human health standard, but there has been a noticeable reduction in average concentration since about 2006. This may also be related to historical tailings removal between the process pads and KVSW-4. Elevated cyanide concentrations (0.1 mg/l and higher) were observed between 1991 and 1993. These are believed to be related to spills in the process valley during operations. Cyanide concentrations have been non-detectable (<0.005 mg/L) since 2003. Total arsenic concentrations at KVSW-4 sometimes exceed the human health standard. These exceedances are believed to be related to the occurrence of turbidity at the time of the sample as the corresponding dissolved concentration of arsenic generally does not exceed the human health standard. Selenium sometimes exceeded the chronic aquatic life standards at this station when the creek was turbid, but has not exceeded standards since 2000. Iron occasionally exceeded standards at this station when the creek was turbid, and samples have not been analyzed for iron since 2001.

The water quality results for surface water station KVSW-7 in a tributary of Mason Canyon are in **Table 3-11**. KVSW-7 was established in 1994 downgradient of the LAD site used for disposal of treated process water in 1993. The LAD site was also used for disposal of waste rock dump seepage during 1997 through 1998. Trends in data since 1994 show a decrease in concentrations in most substances since the cessation of LAD, except when the creek is turbid from stormwater runoff. No data have been collected at this site since 2005.

TABLE 3-10
ANALYSES FOR SURFACE WATER STATION KVSW-4 IN MASON CANYON (PROCESS VALLEY) 1990-2014

Parameter[1]	DEQ-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)[3]	---	139-1320	---	792 (131)	905
Sulfate[3]	---	15-323	---	132 (121)	191
Nitrate/nitrite as N[3]	10 (1.3 in summer)	<0.01-**10.8**	8	0.953 (132)	0.01
Cyanide as total	0.0052	<0.005-**1.26**	28	**0.023 (121)**	<0.005
Chloride	---	1-60	---	17.4 (23)	NA[5]
Arsenic[4]	0.010	<0.03-**0.398**	28	**0.016 (120)**	**0.011**
Iron[4]	1.0	<0.03-**57.8**	14	**2.945 (43)**	NA[6]
Selenium[4]	0.005	0.001-**0.017**	8	0.002 (119)	<0.001
Thallium[4]	0.00024	**0.002-0.149**	100	**0.019 (115)**	**0.006**
Zinc[4]	0.388 @ >400 mg/L hardness	0.01-0.33	0	0.040 (28)	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the surface water human health and chronic aquatic life criteria.
[3]Data from May 1990 to November 2014; data from 1984-86 were collected from TSW-1 located further upstream.
[4]Total recoverable metals data from May 1990 to November 2014.
[5]Most recent sample for chloride was collected on 5/24/1999; chloride has been removed from the monitoring plan.
[6]NA = not analyzed, removed from the monitoring plan.

TABLE 3-11
ANALYSES FOR SURFACE WATER STATION KVSW-7 IN MASON CANYON (PROCESS VALLEY) 1994-2005

Parameter[1]	DEQ-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2005)
SC (µS/cm)[3]	---	633-1300	---	883 (85)	814
Sulfate[3]	---	52-154	---	86 (85)	65
Nitrate/nitrite as N[3]	10 (1.3 in summer)	0.17-3.23	5.9	0.91 (85)	0.32
Cyanide as total	0.0052	<0.005-**0.093**	33.6	0.008 (80)	0.005
Chloride[5]	---	48-164	---	98 (18)	NA
Arsenic[4]	0.010	<0.003-**0.287**	31.3	0.004 (85)	0.003
Iron[4]	1.0	0.06-**69.9**	54.2	8.67 (24)	NA[6]
Selenium[4]	0.005	<0.001-**0.015**	6.25	0.002 (85)	0.001
Thallium[4]	0.00024	**<0.002-0.032**	100.0	0.003 (80)	**0.002**
Zinc[4]	0.388 @ >400 mg/L hardness	0.01-0.180	0	0.03 (19)	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the surface water human health and chronic aquatic life criteria.
[3]Data from May 1994 to September 2005.
[4]Total recoverable metals data from May 1994 to September 2005.
[5]Most recent sample for chloride was collected on 11/18/1998, chloride has been removed from the monitoring plan.
[6]NA = not analyzed, removed from the monitoring plan.

North Fork Last Chance Creek

The water quality results for surface water station KVSW-3 in the North Fork Last Chance Creek are in **Table 3-12**. CR Kendall has not disturbed lands in this drainage. Greyhall Resources constructed two small waste rock dumps at the head of this drainage adjacent to the Barnes-King Pit that were reclaimed in the late 1980s. There is no pumpback in the North Fork Last Chance Creek drainage. Concentrations of selenium have exceeded the chronic aquatic life standard by up to twice the standard. Thallium concentrations exceeded the human health standard by up to four times the standard. Elevated levels of arsenic and iron occurred when the stream was turbid from stormwater runoff. These levels may represent background conditions. No samples have been collected from this site since 2005.

TABLE 3-12
ANALYSES FOR SURFACE WATER STATION KVSW-3 IN NORTH FORK LAST CHANCE CREEK 1990-2005

Parameter[1]	DEQ-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2005)
SC (µS/cm)[3]	---	598-1070	---	818 (21)	853
Sulfate[3]	---	94-289	---	170 (16)	226
Nitrate/nitrite as N[3]	10 (1.3 in summer)	<0.01-1.85	0	0.80 (20)	0.01
Cyanide as total[5]	0.0052	<0.005-0.01	8.3	0.005 (15)	NA
Chloride[5]	---	2-48	---	16 (10)	NA
Arsenic[4]	0.010	0.005-**0.19**	46.7	**0.025 (15)**	0.006
Iron[4]	1.0	0.11-**75.2**	27.3	**7.10 (12)**	NA
Selenium[4]	0.005	0.002-**0.01**	33.3	**0.006 (15)**	0.004
Thallium[4]	0.00024	<0.003-**0.01**	100.0	**0.005 (11)**	**0.005**
Zinc[4]	0.388 @ >400 mg/L hardness	<0.01-0.120	0	0.05 (12)	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the surface water human health and chronic aquatic life criteria.
[3]Data from May 1990 to May 2005.
[4]Total recoverable metals data from May 1990 to May 2005.
[5]Most recent samples for cyanide and chloride were collected on 5/14/1996; both substances have been removed from the monitoring plan for this station.
[6]NA = not analyzed, removed from monitoring plan.

Barnes-King Gulch

The water quality results for surface water station KVSW-2 in Barnes-King Gulch are in **Table 3-13**. The station is below the South Muleshoe Waste Rock Dump that was constructed over historical tailings from the Barnes-King mill. Historical tailings between the toe of the waste rock dump and permit boundary were removed in 1997. The data collected since pumpback system KVPB-2 was put into service have been sparse due to a lack of water at the sampling location. Thallium consistently exceeds the human health standard at this site. Average concentrations of all other substances have improved since removal of the historical tailings in 1997 and initiation of pumpback above KVSW-2. A substantial quantity of historical tailings remains within Barnes-King Gulch from the permit boundary down to its confluence with the North Fork Last Chance Creek. This results in substantial increases in concentrations of arsenic and thallium in surface waters between KVSW-2 and the mouth of the gulch.

TABLE 3-13
ANALYSES FOR SURFACE WATER STATION KVSW-2 IN BARNES-KING GULCH 1990-2014

Parameter[1]	DEQ-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)[3]	---	358-2170	---	1,150 (39)	549
Sulfate[3]	---	54-1230	---	433 (35)	84
Nitrate/nitrite as N[3]	10 (1.3 in summer)	<0.01-5.56	8.1	1.1(39)	0.1
Cyanide as total	0.0052	<0.005-**0.01**	8.3	**0.007 (14)**	NA[6]
Chloride	---	5-13	---	7.7(10)	NA[6]
Arsenic[4]	0.010	0.004-**0.167**	21.2	**0.038 (33)**	**0.069**
Iron[4]	1.0	0.03-**2.62**	27.3	**1.30(12)**	NA[5]
Selenium[4]	0.005	0.001-**0.045**	33.3	**0.008 (33)**	0.002
Thallium[4]	0.00024	**0.005-0.549**	100	**0.108 (30)**	**0.033**
Zinc[4]	0.388 @ >400 mg/L hardness	0.04-0.33	0	0.197 (9)	NA[5]

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the surface water human health and chronic aquatic life criteria.
[3]Data from May 1990 to November 2014
[4]Total recoverable metals data from May 1990 to November 2014.
[5]NA = not analyzed, removed from the monitoring plan for this station.
[6]Most recent samples for cyanide and chloride were collected on 5/14/1996; both substances have been removed from the monitoring plan for this station.

Little Dog Creek

Two surface water monitoring stations and one spring (Section 29 Spring) are monitored in Little Dog Creek, but few water quality data are available for the surface water sites due to the ephemeral nature of this drainage. Additional data have been collected from Upper Little Dog Spring.

The data from surface water stations KVSW-1 and KVSW-6 are in **Table 3-14**. KVSW-1 is downgradient of the Horseshoe Waste Rock Dump in the North Fork Little Dog Creek. KVSW-6 is downgradient of the North Muleshoe Waste Rock Dump in the South Fork Little Dog Creek. Flows at KVSW-1 have been observed and sampled twice – once in 1991 and once in 2011. Flow at KVSW-6 has been observed and sampled once in 1995. The samples exceeded water quality standards for some substances as shown in **Table 3-14**. The operation of the pumpback system since 1996 has intercepted flows above KVSW-6.

TABLE 3-14
ANALYSES FOR SURFACE WATER STATIONS KVSW-1 AND KVSW-6 IN LITTLE DOG CREEK

Parameter[1]	DEQ-7 Criteria[2]	KVSW-1 1991/2011	KVSW-6 1995
SC (µS/cm)	---	2490/199	2240
Sulfate	---	1500/5	1220
Nitrate/nitrite as N	10 (1.3 in summer)	7.76/0.01	**25.4**
Cyanide as total	0.0052	**0.007**/--	<0.005
Chloride	---	8/--	20
Arsenic	0.010	**0.037**/0.003	0.006
Iron	1.0	0.38/--	<0.03
Selenium	0.005	**0.053**/0.001	**0.036**
Thallium	0.00024	NA[3]/**0.002**	**0.28**
Zinc	0.388 @ >400 mg/L hardness	0.06/--	0.05

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1] Units are mg/L unless otherwise noted (metals are total recoverable).
[2] The lowest value between the surface water human health and chronic aquatic life criteria.
[3] NA = not analyzed.

The data from the Section 29 Spring are in **Table 3-15**. The Section 29 Spring is below the confluence of the North and South forks of Little Dog Creek and below the historical tailings pond in the North Fork Little Dog Creek (**Figure 3-3**). Nitrates, sulfate, and selenium concentrations increased after the North Muleshoe Waste Rock Dump was developed. Nitrate concentration rose from an average background concentration of approximately 1 mg/L to a high of 14 mg/L in 1995 after the dump was constructed, but before the pumpback system in this drainage was installed and operated. Nitrate slowly diminished to about 1 mg/L or less in 2014. The average concentrations of most substances remained relatively constant at this site, while selenium frequently slightly exceeds chronic aquatic life criteria prior to mixing with augmentation water at the stock tank.

This spring represents the beginning of intermittent surface flows downgradient of the mine. This spring has been developed and discharges to a stock tank. Installation of pumpback system KVPB-6 temporarily reduced flow of this spring, so CR Kendall Mine augmented flow to this spring from WW-7 and Upper Little Dog Spring. The flow augmentation discharged to Little Dog Creek occurs below the Section 29 Spring sampling point to avoid influencing water quality monitoring results for the spring.

TABLE 3-15
ANALYSES FOR SECTION 29 SPRING IN LITTLE DOG CREEK 1990-2014

Parameter[1]	DEQ-7 Criteria[2]	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)[3]	---	710-1900	---	1335 (173)	1260
Sulfate[3]	---	61-768	---	482(173)	381
Nitrate/nitrite as N[3]	10 (1.3 in summer)	0.37-**14.1**	33.9	3.42 (175)	0.61
Cyanide as total	0.0052	<0.005	0	0.005 (8)	NA
Arsenic[4]	0.010	<0.003-0.005	0	0.003 (153)	<0.003
Iron[4]	1.0	<0.01-0.22	0	0.024 (21)	NA[5]
Selenium[4]	0.005	<0.001-**0.013**	76.5	**0.007 (153)**	**0.007**
Thallium[4]	0.00024	<0.002-**0.029**	100.0	**0.002 (171)**	<0.002
Zinc[4]	0.388 @ >400 mg/L hardness	<0.01-0.03	0	0.013 (9)	NA

Note: Bold values indicate the human health or chronic aquatic life criteria are exceeded.
[1]Units are mg/L unless otherwise noted (metals are total recoverable).
[2]The lowest value between the surface water human health and chronic aquatic life criteria.
[3]Data from May 1990 to November 2014.
[4]Total recoverable metals data from May 1990 to November 2014.
[5]NA = not analyzed, removed from monitoring plan.

Dog Creek

The Dog Creek drainage is north of the CR Kendall Mine site. No water monitoring stations were established in this watershed. Several sites in this watershed were sampled by DEQ in 1998 for estimating background water quality. The majority of the sampling locations were not downgradient of the Kendall mine site and are indicative of the quality of local surface water sources not potentially influenced by the mine. The results of the stream and stock pond water sampling are in **Tables 3-16** and **3-17**. Most of the surface water samples from the Dog Creek watershed were within human health and chronic aquatic life standards with the exceptions that iron slightly exceeded chronic aquatic life standards in surface water site #10 and stock pond #7, and arsenic, which was detected in most of the stock ponds and stream sampling sites, exceeded the current drinking water standard in one of the stock ponds.

TABLE 3-16 ANALYSES FOR SURFACE WATER SITES IN DOG CREEK[1]				
Parameter	**DEQ-7 Criteria[2]**	**Concentration (mg/L unless noted otherwise)**		
		#3	**#6**	**#10**
SC (µS/cm)	---	855	737	507
Sulfate	---	74.8	44.5	11.7
Nitrate/nitrite as N	10 (1.3 in summer)	N/A	N/A	N/A
Arsenic[3]	0.010	0.002	<0.001	0.006
Iron[3]	1.0	0.46	0.16	**1.11**
Selenium[3]	0.005	0.002	<0.001	<0.001
Thallium[3]	0.00024	<0.001	<0.001	<0.001

[1] Data collected by DEQ June 30, 1998.
[2] The lowest value between the surface water human health and chronic aquatic life criteria.
[3]Total recoverable metals.

TABLE 3-17 ANALYSES FOR STOCK PONDS IN DOG CREEK[1]					
Parameter	**DEQ-7 Criteria[2]**	**Concentration (mg/L unless noted otherwise)**			
		#2	**#4**	**#5**	**#7**
SC (µS/cm)	---	517	518	343	754
Sulfate	---	98.7	83.8	22.1	9.8
Arsenic[3]	0.010	0.006	0.008	**0.015**	<0.001
Iron[3]	1.0	0.54	0.35	0.26	**1.07**
Selenium[3]	0.005	<0.001	<0.001	<0.001	<0.001
Thallium[3]	0.00024	<0.001	<0.001	<0.001	<0.001

[1] Data collected by DEQ June 30, 1998.
[2] The lowest value between the surface water human health and chronic aquatic life criteria.
[3]Total recoverable metals.

Groundwater Quality

The groundwater quality beneath the CR Kendall Mine site has been monitored at 45 groundwater monitoring wells starting in 1981, of which 4 continue to be sampled regularly. Groundwater has also been sampled at three water supply wells, four pumpback systems, and several local springs and seeps. The pumpback systems have a wide capture zone and represent a larger volume of groundwater than a monitoring well or a seep. The remaining monitoring wells and the pumpback systems are in the South Fork Last Chance Creek (TMW-42 and KVPB-5), Mason Canyon (process valley) (TMW-24A and TMW-26), Barnes-King Gulch (TMW-30A and KVPB-2), and South Fork Little Dog Creek (TMW-40D and KVPB-6) watersheds (**Figure 3-3**). Trends in the concentrations of arsenic, selenium, and thallium in CR Kendall Mine groundwater and the process pad drainage over the last 20 years are provided in **Figures A-1 through A-9** in Appendix A. These wells are below the pumpback systems to monitor the

effectiveness of the systems. The water from the pumpback systems is routed, treated, and disposed of as described in Section 2.2.

The groundwater in the monitoring wells and pumpback water has exceeded the DEQ-7 groundwater quality standard for thallium in most samples since monitoring began. Some exceedances of nitrate or arsenic standards have also occurred.

South Fork Last Chance Creek

Groundwater monitoring in South Fork Last Chance Creek began in December 1989 at well TMW-31. In 1996, pumpback system KVPB-5 was constructed downgradient of this well and TMW-31 was abandoned. TMW-42 was installed downgradient of the pumpback system in 1998. The only parameter that exceeded standards in TMW-42 water has been thallium (**Table 3-18**). Trends in the concentrations of arsenic, selenium, and thallium in South Fork Last Chance Creek groundwater over the last 20 years are shown for KVPB-5 (**Figure A-2; Appendix A**) and for TMW-42 (**Figure A-3; Appendix A**).

TABLE 3-18
WATER ANALYSES FOR MONITORING WELL TMW-42, IN SOUTH FORK LAST CHANCE CREEK (1998-2014)[2]

Parameter[1]	DEQ-7 Criteria	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)	---	610-1750	---	1288 (128)	885
Sulfate	---	76-863	---	494 (128)	270
Nitrate/nitrite as N	10	0.03-4.26	0	1.36 (128)	0.52
Arsenic	0.010	<0.003	0	<0.003 (128)	<0.003
Selenium	0.050	<0.001-0.005	0	0.002 (128)	<0.001
Thallium	0.002	<0.002-**0.009**	73	0.003 (128)	<0.002
Zinc	2.0	0.01-0.02	0	0.01 (5)	NA[3]

Note: Bold indicates value at or above the groundwater human health standards.

[1] Units are mg/L unless otherwise noted.

[2] Data from February 1998 to November 2014

[3] NA = not analyzed, removed from monitoring plan in 1998.

Water chemistry data for pumpback system KVPB-5 are in **Table 3-19** and shown graphically in **Figure A-3 (Appendix A)**. The only substances that exceeded human health standards were nitrate, arsenic, and thallium.

TABLE 3-19
WATER ANALYSES FOR PUMPBACK SYSTEM KVPB-5, IN SOUTH FORK LAST CHANCE CREEK (1996-2014)[2]

Parameter[1]	DEQ-7 Criteria	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)	---	1750-3370	---	2650 (112)	2520
Sulfate	---	673-2210	---	1624 (112)	1470
Nitrate/nitrite as N	10	1.81-**12.6**	12.5	6.46 (112)	2.74
Arsenic	0.010	<0.003-**0.018**	0.9	0.004 (112)	0.003
Selenium	0.050	<0.001-0.028	0	0.012 (112)	0.017
Thallium	0.002	**0.008-0.156**	100	0.028 (112)	**0.023**
Zinc	2.0	0.020-0.070	0	0.039 (7)	NA[3]

Note: Bold indicates value at or above the groundwater human health standards.
[1] Units are mg/L unless otherwise noted.
[2] Data from November 1996 to November 2014
[3]NA = not analyzed, removed from monitoring plan in 1998.

Mason Canyon

Groundwater monitoring in Mason Canyon began in 1985. Since then, there have been 15 monitoring wells installed in the drainage. Most of these wells were installed to monitor for leaks from process ponds and were removed due to expansion of mine facilities. TMW-24A was installed near the permit boundary in 1994 and continues to be monitored. The substances that exceeded standards were thallium and arsenic (**Table 3-20**). Trends in the concentrations of arsenic, selenium, and thallium for TMW-24A are shown in **Figure A-4 (Appendix A)**.

TABLE 3-20
WATER ANALYSES FOR MONITORING WELL TMW-24A, MASON CANYON (1994-2014)[2]

Parameter[1]	DEQ-7 Criteria	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)	---	974-1770	---	1150 (231)	1320
Sulfate	---	23-483	---	295 (231)	394
Nitrate/nitrite as N	10	0.01-0.14	0	0.02 (230)	0.01
Arsenic	0.010	0.003-**0.039**	**79.2**	0.019 (231)	**0.020**
Selenium	0.050	<0.001-0.005	0	0.001 (231)	<0.001
Thallium	0.002	<0.002-**0.004**	0.43	0.002 (231)	<0.002
Zinc	2.0	0.01-0.08	0	0.03 (34)	NA[3]

Note: Bold indicates value at or above the groundwater human health standards.
[1] Units are mg/L unless otherwise noted.
[2] Data from May 1994 to November 2014
[3]NA = not analyzed, removed from monitoring plan in 1998.

Process pad 4 and its underdrain system were constructed in 1989 (Section 2.2.1.1), and water flowing through the underdrain system reports to a sump, TMW-26. Water chemistry data for TMW-26 are in **Table 3-21** and shown graphically in **Figure A-5 (Appendix A)**. Until 1996, the sump discharged into Mason Canyon except when it was pumped back in response to cyanide spills. Since 1996, the sump has been continuously pumped back. Nitrate, thallium, and cyanide have exceeded groundwater human health standards in the past. Since process pad operations ceased, only thallium continues to exceed its standard.

TABLE 3-21
WATER ANALYSES FOR TMW-26, PROCESS PADS UNDERDRAIN SUMP (1990-2014)[2]

Parameter[1]	DEQ-7 Criteria	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)	---	467-3100	---	1369 (188)	2370
Sulfate	---	23-1650	---	392 (175)	428
Nitrate/nitrite as N	10	0.88-**13.0**	2	4.42 (192)	1.47
Arsenic	0.010	<0.003-0.009	0	0.004 (176)	0.008
Selenium	0.050	<0.001-0.024	0	0.012 (176)	0.008
Thallium	0.002	0.002-**0.074**	**100**	0.032 (172)	**0.035**
Zinc	2.0	0.040-0.180	0	0.08 (18)	NA[3]

Note: Bold indicates value at or above the groundwater human health standards.
[1] Units are mg/L unless otherwise noted.
[2] Data from August 1990 to November 2014
[3]NA = not analyzed, removed from monitoring plan in 1998.

Barnes-King Gulch

Groundwater monitoring in Barnes-King Gulch began in 1990 at TMW-30. This well was replaced by TMW-30A due to concerns about well construction. TMW-30A was installed near the permit boundary in 1994 and continues to be monitored (**Figure 3-3**). Thallium, arsenic, and selenium have all exceeded standards in the past, but only thallium continues to exceed its standard (**Table 3-22**). Trends in the concentrations of arsenic, selenium, and thallium from TMW-304A for the last 20 years are shown in **Figure A-6 (Appendix A)**.

TABLE 3-22
WATER ANALYSES FOR GROUNDWATER WELL TMW-30A, BARNES-KING GULCH (1994-2014)[2]

Parameter[1]	DEQ-7 Criteria	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)	---	398-1400	---	1087 (45)	935
Sulfate	---	60-594	---	400 (45)	281
Nitrate/nitrite as N	10	0.01-3.93	0	0.73 (44)	0.12
Arsenic	0.010	0.002-**0.120**	13	0.011 (45)	<0.003
Selenium	0.050	<0.001-**0.050**	2	0.009 (45)	0.005
Thallium	0.002	<0.002-**0.100**	36	0.007 (45)	**0.003**
Zinc	2.0	0.01-0.13	0	0.04 (18)	NA[3]

Note: Bold indicates value at or above the groundwater human health standards.
[1] Units are mg/L unless otherwise noted.
[2] Data from May 1994 to August 2014
[3]NA = not analyzed, removed from monitoring plan in 1998.

Pumpback system KVPB-2 was installed in 1996 in Barnes-King Gulch downgradient of the South Muleshoe Waste Rock Dump (**Figure 3-3**). Water chemistry data for pumpback system KVPB-2 are in **Table 3-23** and shown graphically in **Figure A-7 (Appendix A)**. Nitrate, arsenic, and thallium have all exceeded standards in the past, but only thallium continues to exceed its standard.

TABLE 3-23
WATER ANALYSES FOR PUMPBACK SYSTEM KVPB-2, BARNES-KING GULCH (1996-2014)[2]

Parameter[1]	DEQ-7 Criteria	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)	---	662-3560	---	2486 (120)	1450
Sulfate	---	572-1700	---	1353 (120)	1240
Nitrate/nitrite as N	10	0.23-**14.7**	8.3	3.76 (120)	0.57
Arsenic	0.010	<0.003-**0.051**	58	0.013 (120)	0.003
Selenium	0.050	0.006-0.030	0	0.014 (120)	0.012
Thallium	0.002	**0.033-1.80**	100	1.102 (120)	**0.033**
Zinc	2.0	0.170-0.350	0	0.24 (8)	NA[3]

Note: Bold indicates value at or above the groundwater human health standards.
[1] Units are mg/L unless otherwise noted.
[2] Data from November 1996 to November 2014
[3]NA = not analyzed, removed from monitoring plan in 1998.

Little Dog Creek

South Fork Little Dog Creek. Groundwater monitoring in South Fork Little Dog Creek began in 1994 at TMW-36. This well was replaced by TMW-40D in 1998 because TMW-36 was too close to the pumpback system (**Figure 3-3**). The only substances that exceeded human health standards in TMW-40D were nitrate and thallium (**Table 3-24**). Trends in the concentrations of arsenic, selenium, and thallium from TMW-40D for the last 20 years are shown in **Figure A-8 (Appendix A)**.

TABLE 3-24
WATER ANALYSES FOR GROUNDWATER WELL, TMW-40D, IN LITTLE DOG CREEK (1998-2014)[2]

Parameter[1]	DEQ-7 Criteria	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)	---	1200-2650	---	1939 (142)	1640
Sulfate	---	361-1440	---	918 (142)	606
Nitrate/nitrite as N	10	1.52-**18.8**	37	8.34 (142)	1.91
Arsenic	0.010	<0.003-0.003	0	<0.003 (142)	<0.003
Selenium	0.050	0.007-0.038	0	0.018 (142)	0.018
Thallium	0.002	<0.002-**0.006**	7	<0.002 (142)	<0.002
Zinc	2.0	0.01-0.04	0	0.01 (7)	NA[3]

Note: Bold indicates value at or above the groundwater human health standards.
[1] Units are mg/L unless otherwise noted.
[2] Data from February 1998 to November 2014
[3] NA = not analyzed, removed from monitoring plan in 1998.

Pumpback system KVPB-6 was installed in 1996 in South Fork Little Dog Creek downgradient of the North Muleshoe Waste Rock Dump (**Figure 3-3**). Water chemistry data for pumpback system KVPB-6 are in **Table 3-25** and shown graphically in **Figure A-9 (Appendix A)**. This pumpback system consists of two interception trenches and three pumpback wells. The substances that exceeded human health standards in the past were nitrate, arsenic, selenium, and thallium, while selenium and thallium continue to exceed standards.

TABLE 3-25
WATER ANALYSES FOR PUMPBACK SYSTEM, KVPB-6, IN LITTLE DOG CREEK (1996-2014)[2]

Parameter[1]	DEQ-7 Criteria	Range of Data	% of Samples Exceeding Standards	Average Concentration (Number of Samples)	Recent (2014)
SC (µS/cm)	---	760-2950	---	2324 (111)	2090
Sulfate	---	649-1870	---	1346 (111)	1120
Nitrate/nitrite as N	10	1.73-**39.8**	62	11.79 (111)	1.95
Arsenic	0.010	<0.003-**0.018**	50	0.010 (111)	0.008
Selenium	0.050	0.008-**0.070**	23	0.038 (111)	**0.052**
Thallium	0.002	**0.020-0.820**	100	0.360 (111)	**0.219**
Zinc	2.0	0.030-0.120	0	0.05 (8)	NA[3]

Note: Bold indicates value at or above the groundwater human health standards.
[1] Units are mg/L unless otherwise noted.
[2] Data from November 1996 to November 2014
[3]NA = not analyzed, removed from monitoring plan in 1998.

North Fork Little Dog Creek. Groundwater monitoring in North Fork Little Dog Creek began in 1989 at TMW-15. This well was replaced by TMW-15B in 1993 due to construction of the Horseshoe Waste Rock Dump (**Figure 3-3**). Both wells are typically dry or contain too little water to sample; therefore, no groundwater analyses could be completed.

3.3.3 Environmental Consequences

3.3.3.1 No Action Alternative

Surface Water

The existing water capture systems are intercepting shallow groundwater that contains some contaminants at concentrations above surface water standards (DEQ, 2012). The captured water could influence and degrade the quality of surface waters in these drainages if not captured and treated. The No Action Alternative would continue the operations of the current water capture systems and would result in minimal additional impacts to surface water. Current surface water drainage patterns and runoff volumes and rates would likely remain as they are now. Water augmentation from Mason Canyon Spring to South Fork Last Chance Creek and from Little Dog Spring to Little Dog Creek would continue. WW-6 would be maintained as a contingency for augmentation as necessary. WW-7 would continue to flow seasonally to Little Dog Creek. Over the long-term, and as vegetation on reclaimed surfaces becomes more dense, ephemeral surface water runoff rates would likely decrease.

Groundwater

Currently, groundwater that does not meet human health groundwater quality standards is pumped from South Fork Last Chance Creek and the Process Valley Underdrain to Process valley ponds 2B and 3B where it is treated with particulate filtration and zeolite adsorption before being discharged to the Kendall Pit. Treated groundwater discharge is also permitted to the Muleshoe Pit, but this location has not been used. Groundwater with occasional exceedances of standards for arsenic, selenium, and/or nitrates could also be land applied during the growing season.

Under the No Action Alternative, CR Kendall Mine would continue with its current treatment configuration. Treated water that is discharged to groundwater is expected to infiltrate to the Madison aquifer. There are no monitoring wells at the site deep enough to collect samples from the Madison aquifer, so the local water chemistry in this aquifer is unknown.

Process Pad Drainage

Water draining from process pads is currently collected in Pond 7 and is land applied during the growing season. Selenium concentrations have been increasing in the process pad drainage water since 2011, which may be related to decreased dilution since the process pads were reclaimed.

3.3.3.2 Proposed Action

Surface Water

If the Proposed Action is selected, no additional impacts to surface water beyond those described in section 3.3.2.2 would occur. Current surface water drainage patterns and runoff volumes and rates would likely remain as they are now. Water augmentation from Mason Canyon Spring to South Fork Last Chance Creek and from Little Dog Spring to Little Dog Creek would continue. Well WW-6 would be maintained as a contingency for augmentation as necessary, and artesian well WW-7 would continue to flow seasonally to Little Dog Creek. Over time, as vegetation on reclaimed surfaces becomes more dense, ephemeral surface water runoff rates would likely decrease.

Groundwater

Under the Proposed Action all captured waters including the process pad drainage and water captured from KVPB-5, TMW-26, KVPB-2, and KVPB-6, would be routed to Pond 7 for storage before being pumped to the centrally located WTP for particulate filtration and zeolite adsorption, and then discharged to groundwater through the Kendall Pit.

There are several benefits of routing all impacted waters to a central WTP for removal of thallium before discharging to groundwater through the Kendall Pit. First, it would not be cost effective to build and operate multiple WTPs at the groundwater capture sources. Another reason is that drainage from the process pads has not met, and does not currently meet DEQ-7 groundwater standards for total cyanide, nitrate/nitrite-N,

antimony, arsenic, selenium, and thallium. By blending the process pad drainage with water from the pumpback systems, the combined water is projected to meet DEQ-7 groundwater standards for total cyanide, nitrate/nitrite-N, antimony, and selenium. A third reason is that while KVPB-6 groundwater does not meet the DEQ-7 groundwater standard for selenium, the other pumpback waters, KVPB-2, TMW-26, and KVPB-5, all have low selenium concentrations. Fourth, by implementing a centralized water treatment system and combining all waters, CR Kendall projects that treatment for selenium would not be necessary to achieve groundwater discharge standards. All captured mine water sources exceed the DEQ-7 groundwater standard for thallium and would require treatment prior to discharge to groundwater.

The water quality mixing model by Hydrometrics (2015) titled "*Updated Mixing Model Predictions of Combined Water Quality,*" indicates that the blended and treated water would exceed groundwater human health standards for arsenic, and that the effluent arsenic concentration would be projected to range between 0.012 mg/L and 0.022 mg/L. CR Kendall's closure plan assumed that these arsenic concentrations would be acceptable for discharge to groundwater based upon the "Evaluation of Background Hydrochemistry" studies conducted by Water Management Consultants in 1999 and 2003 which indicated that natural background concentrations of arsenic are elevated in the CR Kendall Mine area. However, those studies only addressed surface water and shallow alluvial groundwater. No data were collected that documented elevated arsenic concentrations within the Madison limestone aquifer to which the treated water is proposed to be discharged.

It is possible that this deep aquifer beneath the mine site either contains naturally elevated arsenic concentrations (thus allowing for water of similar quality to be added to it) or that a sufficient volume of groundwater flows through the Madison aquifer to rapidly dilute any discharge from the mine to within groundwater standards. However, no monitoring wells have been drilled into the Madison aquifer within the region of the CR Kendall Mine and thus no conclusive data are available that would support the discharge of water containing elevated levels of arsenic into the deep groundwater system. The depth to groundwater within the Madison limestone in the area of the Kendall mine is unknown, but is greater than the 650 foot depth below ground surface that was reached by the historic underground mines in the area. The general direction of groundwater flow within the regional Madison aquifer is from south (Big Snowy Mountains) to north (Feltis, 1973). Downgradient of the Kendall mine, groundwater from the Madison aquifer is not used as a drinking water supply and does not discharge to the surface as springs within the immediate area. The nearest spring which may be derived from the Madison aquifer is Warm Spring located to the south of the North Moccasin Mountains, approximately 4 miles from the mine and presumably upgradient based upon the regional flow direction. The nearest discharge points for the regional flow within the Madison aquifer to the north of the North Moccasin Mountains are a series of warm springs which surround the Little Rocky Mountains about 60 miles to the northeast.

Selenium concentrations in the process pad drainage have been increasing since approximately 2010, which is also a concern because the Proposed Action water treatment process primarily removes thallium. If selenium from the process pad drainage continues to increase, selenium concentrations in the blended water may exceed the DEQ-7 groundwater human health standard in the future.

The projected impacts to groundwater would be from the inability of the proposed water treatment processes to meet human health groundwater standards for arsenic, and for selenium if concentrations in the process pad drainage continue to increase.

3.3.3.3 Process Pad Drainage Pretreatment Alternative

Surface Water

Similar to the No Action and Proposed Action alternatives, there would be minimal future impacts to surface water under the Process Water Pretreatment Alternative. Current surface water drainage patterns and runoff volumes and rates would likely remain as they are now. Water augmentation from Mason Canyon Spring to South Fork Last Chance Creek and from Little Dog Spring to Little Dog Creek would continue. Well WW-6 would still be maintained as a contingency for augmentation as necessary, and artesian well WW-7 would continue to flow seasonally to Little Dog Creek. Over the long-term, as vegetation on reclaimed surfaces becomes more dense, stormwater runoff rates would likely decrease.

Groundwater

Under the Process Pad Drainage Pretreatment Alternative, drainage from the process pads would be pretreated for the removal of arsenic before being combined at the central WTP with waters from the groundwater capture pumpback systems in the South Fork Last Chance Creek, Mason Canyon, Barnes King Gulch, and South Fork Little Dog Creek drainages. The combined water would be treated with particulate filtration and zeolite adsorption, and discharged to groundwater through the Kendall Pit. The pretreatment for arsenic under this alternative would achieve the DEQ-7 groundwater human health standard for arsenic.

CR Kendall Mine WTP data (Volberding, 2015c) shows the WTP effluent consistently meeting all DEQ-7 groundwater standards. CR Kendall Mine currently disposes of all captured water that does not meet the DEQ-7 groundwater standards via LAD on the mine site.

Exceedances for arsenic are almost exclusively due to high concentrations in the process pad drainage. An exception is for KVPB-6 water that occasionally exceeded 0.010 mg/L arsenic. The combined groundwater pumpback waters would not have arsenic concentrations that exceed 0.010 mg/L. It would be more effective to pretreat only the process pad drainage to remove arsenic rather than treat the combined mine waters. Arsenic speciation analyses show the arsenic in the process pad drainage exists

primarily as arsenic (5+), or arsenate, which is more amenable to removal through adsorptive treatment.

While antimony levels in the combined waters have not exceeded DEQ-7 standards, the process pad drainage has had some exceedances for antimony. As a side-benefit, some arsenic removal processes also remove or lower antimony concentrations. The potential lowering of antimony in the process pad drainage waters would be an added benefit for pretreating the process pad drainage prior to treatment at the WTP.

Pretreating drainage from the process pads for arsenic would be important for several reasons. First, the process pad drainage is the primary source of arsenic and the cause of most potential exceedances in the blended water. Second, unlike cyanide or nitrate/nitrite that should continue to decrease over time, the trend and timeframe for decreasing arsenic concentrations to reach steady-state are less predictable. Cyanide and nitrate/nitrite were added to the process pads during the gold mining and heap leach operations, so it is reasonable to expect total cyanide and nitrate/nitrite concentrations to continue declining and ultimately to meet DEQ-7 standards (0.2 mg/L total cyanide; 10 mg/L nitrate/nitrite as N). There are no natural sources of cyanide in the area and few natural sources of nitrate/nitrite, but thallium and arsenic are naturally occurring elements. Even though elevated thallium and arsenic concentrations in the process pad drainage are likely influenced by human activities, the quantities of these elements in the process pad and their rates of dissolution over the long term are uncertain. It is unknown how quickly, or to what level, the concentrations of thallium and arsenic will decrease in the process pad drainage.

The uncertainties with projecting future concentrations for thallium and arsenic also apply for selenium concentrations in drainage from the process pads. Selenium concentrations appear to have a long-term decline from 1994 through 2010, but have recently leveled off and may have increased (**Figure A-1; Appendix A**). The short period (between 2010 and 2013) of increasing selenium concentrations makes it difficult to establish a trend. If selenium levels in the process pad drainage continue to increase, there could be a point where the blended water and the current water treatment process would no longer meet the DEQ-7 selenium groundwater standard of 0.050 mg/L. Additional pre-treatment or a larger volume of low-selenium water would be needed to meet the selenium groundwater standard. This would also be true if selenium concentrations continue to increase in KVPB-6 water (**Figure A-9; Appendix A**). Because selenium pre-treatment of drainage from the process pads may become necessary, it may be appropriate to select a pretreatment technology that will effectively remove both arsenate and selenate, or that can easily be modified at a later date to treat for selenate as well as arsenate.

The recent water quality mixing model (Hydrometrics, 2015) showed maximum selenium concentration estimates above 0.04 mg/L for two pond storage sizes (7.2 million gallons and 20.5 million gallons) and three flow conditions (low flow, average

flow, and maximum flow). Although there are no selenium speciation data for these two waters, it is reasonable to assume most of the selenium will be selenium (6+) or selenate because the arsenic speciation showed primarily oxidized arsenic (5+) or arsenate, which suggests the water has been exposed to air and is relatively oxidizing.

There would be fewer adverse impacts to groundwater under this alternative, compared to the No Action or Proposed Action alternatives because the addition of pretreatment for arsenic would produce water treatment effluent that meets all human health groundwater standards prior to discharge.

Other water treatment technologies (e.g., biological treatment, reverse osmosis) were evaluated and considered, but dismissed from detailed evaluations. The complete list of the water treatment and disposal options considered but dismissed are in Section 2.5.4.

3.3.3.4 Process Pad Barrier Cover Alternative

Surface Water

Similar to all of the other actions, under the Process Pad Barrier Cover Alternative there would be minimal future impacts to surface water if the Proposed Action is selected. Current surface water drainage patterns and runoff volumes and rates would likely remain as they are now. Water augmentation from Mason Canyon Spring to South Fork Last Chance Creek and from Little Dog Spring to Little Dog Creek would continue. Well WW-6 would still be maintained as a contingency for augmentation as necessary, and artesian well WW-7 would continue to flow seasonally to Little Dog Creek. Over the long-term as vegetation on reclaimed surfaces becomes more dense, stormwater runoff rates would likely decrease.

Groundwater

Under the Process Pad Barrier Cover Alternative all captured mine waters, including process pad drainage, and water captured from KVPB-6, KVPB-2, TMW-26, and KVPB-5, would be routed to Pond 7 before being pumped to the central WTP for particulate filtration and zeolite adsorption, and then discharged to groundwater through the Kendall Pit.

Instead of pretreating the process pad drainage for arsenic to achieve the groundwater human health standards, the Process Pad Barrier Cover Alternative would consist of a liner cover installation on process pads 3 and 4. Drainage water from these process pads would be routed to Pond 7 and combined with the captured alluvial groundwater from KVPB-6, KVPB-2, TMW-26, and KVPB-5. The blended waters would be pumped to the central WTP for particulate filtration and zeolite adsorption, and discharged to groundwater at the Kendall Pit.

Hydrologic Evaluation of Landfill Performance (HELP) modeling has shown that a geomembrane liner would greatly decrease the amount of rainfall infiltrating into and draining from the process pads (Tetra Tech 2004, Hydrometrics 2012). The reduced process pad drainage volume could reduce the total arsenic load discharging from the process pads. With the reduction in the amount of arsenic, the proposed water treatment system may be able to achieve concentrations of arsenic below human health standards. However, until a liner is installed and any increases or decreases in arsenic and selenium concentrations and loading are determined, the ability of the proposed treatment system to meet groundwater discharge standards remains unknown. Although a barrier cover is almost certain to reduce the volume of water infiltrating into the process pads, it is not known whether the concentrations of arsenic and selenium in the residual drainage would remain the same or increase, in response to changing oxidative conditions in the process pads. Therefore, it is not certain that groundwater standards would be met after blending of this water with water from the pumpback systems and treatment for thallium removal.

By decreasing the rate at which contaminants are flushed from the process pads, it is possible that placing a barrier cover over the pads may significantly increase the length of time that treatment of the residual process pad draindown is required.

The impacts of concern to groundwater are the potential inability of the Process Pad Barrier Cover Alternative to meet human health groundwater standards for arsenic, increasing selenium concentrations in the process pad drain-down water, and the potential degradation of groundwater quality in the Madison aquifer from the infiltration of the water with untreated arsenic.

3.4 Soils, Vegetation, and Reclamation

Reclamation status for the CR Kendall Mine is discussed in the description of the No Action Alternative in Chapter 2. The most current summary and reporting on the soils, vegetation, and reclamation are found in the Annual Progress Report for each year (CR Kendall, 2014). This section discusses the soil, vegetation, and reclamation resources at the CR Kendall Mine.

3.4.1 Analysis Area and Methods

The analysis for the soils, vegetation, and reclamation includes the area within the CR Kendall Mine disturbance boundary of 447.5 acres. The mine area, topography, disturbance boundary, and undisturbed areas within the disturbance boundary are shown on **Figure 1-2**.

For soils, the amount (depth) used for final reclamation and its ability to support the post-mine reclamation goals were analyzed. For vegetation, the level of success achieved through reclamation efforts to date and its ability to meet the post-mine land use were analyzed. For reclamation, the potential success of current reclamation

methods and their ability to stabilize the disturbed areas and reestablish vegetation that supports the post-mining land use were evaluated.

3.4.2 Affected Environment

3.4.2.1 Soil Resources

The current disposition of the soils in the analysis area is: process pads 3 and 4 received a 17 inch soil cover in addition to an 18 inch basal layer (6 inches of 5 to 8 percent sodium bentonite amended subsoil and 12 inches of subsoil basal layer), and other disturbance areas received 8 to 10 inches of soil. The flat waste rock dump tops received the originally permitted reduced permeability layer cover that consists of (top down): 10-14 inch topsoil layer, 18 inch subsoil layer, 12 inch of coarse drainage layer (limestone) and 12 inches of onsite clayey materials placed over the waste rock (CR Kendall, 2012). Currently, 38,300 cubic yards of soil material remain in stockpiles; 35,800 cubic yards in TS-13a and 2,500 cubic yards in other stockpiles. The stockpiled soil is classified as A and B soil types (CR Kendall, 2015a), except stockpile TS-13a that contains subsoil that could include tailings (Volberding, 2015a). Soil type A has moderate to high organic matter with low to moderate coarse fragment content. Soil type B has low to moderate organic matter with moderate to high coarse fragment content.

The final grading, soil covering and seeding for the CR Kendall Mine is mostly complete following the approved reclamation plan. Including facilities that would be retained post mine for water treatment, there are 51 acres unvegetated (Table 1-1). The current estimate of soil needed to finish reclamation under the Agency Modified Alternatives is 15,043 cubic yards; the BLM road, facilities and access roads would remain unvegetated. The Proposed Action would require 6,984 cubic yards of soil resources for final reclamation, with portions of the Kendall and Muleshoe Pits, BLM road, facilities, and access roads remaining unvegetated. CR Kendall has 38,300 cubic yards of soil resources stockpiled as of the 2014 annual report.

3.4.2.2 Vegetation Resources

The CR Kendall Mine site is on east-facing slopes surrounded by relatively dry forests dominated by ponderosa pine and Douglas-fir with deciduous shrubs and quaking aspen occupying the moist, headwater drainages of Dog Creek, Little Dog Creek, the South Fork of Last Chance Creek, and Barnes-King Gulch. Native grasslands dominated by bluebunch wheatgrass, arrowleaf balsamroot, and other grasses and forbs are interspersed in forest habitats on warmer and drier slopes with bedrock close to the surface. The conifer forests on and adjacent to the mine site include mature stands of ponderosa pine on the drier slope with denser stands of Douglas-fir at higher elevations and on moister, cooler sites. Patches of quaking aspen of multiple age classes are present on moist sites interspersed with conifers and riparian areas (Elliott, 2010).

The vegetation on the reclaimed areas is in various stages of development based on the different treatments and years of growth (Bighorn Environmental Sciences, 2003). A self-sustaining cover of agronomic grasses, with few trees and shrubs or other native plant species, dominates most of the reclaimed areas. Although these areas have low species diversity, they produce large amounts of forage for grazing species such as livestock, elk, and small mammals, and provide nesting cover for some grassland birds (vesper sparrow). Controlled livestock grazing is currently occurring on reclaimed areas with vegetation cover capable of sustaining livestock use. The partially backfilled Horseshoe Pit was not seeded with agronomic species as part of the reclamation program, but has been colonized by native species from the surrounding landscape including ponderosa pine, Douglas-fir, common juniper, and numerous forbs and grasses (Elliott, 2010).

The DEQ inspection report from September 8, 2014 describes the vegetation growth on the waste dumps as "robust" (DEQ, 2014). Field inspections have noted the vegetative growth on the process pads, reclaimed in 2012, has established successfully in most areas (**Figure 3-4**). Small populations of planted and volunteer conifers are growing on some of the reclaimed waste dumps. CR Kendall Mine performs annual weed control.

3.4.2.3 Reclamation Resources

Post-mining land use objectives include: (1) protection of public health and safety, (2) establishment of wildlife habitat and livestock grazing through revegetation, (3) protection of water quality by establishment of a stable landform, (4) enhancement of aesthetics by reforestation of waste rock dump faces and pit benches (where pit walls are visible to the public) (CR Kendall, 1995). Current analysis of the vegetation and soils indicate some areas may need increased soil or seeding to reach reclamation goals (DEQ 2014; Bighorn Environmental Sciences, 2003). The area received 9 inches of rain in 24 hours in late August 2014 (CR Kendall, 2015a). This caused minor slumping in areas directly northwest of Pond 7 and west of Pond 8. That event provided a significant amount of rain, considering the 10–year, 24-hour event for this area is 2.6 inches (CR Kendall, 1995). The stability of the reclaimed process pads and waste rock dumps was not affected by this event.

The possibility that some of the remaining stockpiled soil is contaminated with tailings is a concern for final reclamation; however, if that soil is used for reclamation internal to mine pits, it is less of a concern because there would be no off-site impacts due to erosion.

Figure 3-4 Revegetated Plant Communities at the CR Kendall Mine

July 7, 2014 photograph of vegetation on Process Pad 4 (foreground)

July 7, 2015 photograph of top of Process Pad 4 (foreground) and Process Pad 3 (background) with vegetation on slopes and tops.

To evaluate the leachability of metals in the reclamation resource stockpiles, samples were collected in July 2003, and analyzed using the Synthetic Precipitation and Leaching Procedure (EPA Method 1312). Results indicated that antimony, arsenic, and thallium are leachable at levels above water quality criteria from all six of the 2003 samples (Womack and Associates 2005). Selenium was detected in five of the six samples, but at levels well below the human health water quality criteria level of 0.050 mg/L.

In 2004, the CR Kendall Mine began recontouring the process pads and constructing ditches in natural geologic materials adjacent to the pads. CR Kendall Mine sampled the natural geologic materials to determine their suitability for reclamation (Womack & Associates, Inc., 2005). Results indicated the natural geologic materials have lower concentrations of leachable metals than the stockpiled soils sampled in 2003. Exceptions were that two natural geologic material samples contained antimony at levels above water quality criteria.

DEQ field checked CR Kendall Mine's proposed reclamation resource material and found some natural geologic layers contain abundant black shale and were acid producing. A seep originating nearby the undisturbed black shales was acidic indicating natural acid rock drainage. These materials were not used for reclamation.

3.4.3 Environmental Consequences

3.4.3.1 No Action Alternative

The current CR Kendall Mine operating permit calls for the final reclamation of all disturbed areas. The current 17 inch soil and 18 inch cover system for the process pads would remain in place as the final cover for the pads. The approved reclamation cover was modified by Minor Revision 05-001 to include 5 to 8 percent sodium bentonite incorporated into the upper 6 inches of the lower 18 inch subsoil basal material layer.

Other disturbance areas would be covered with 8 to 10 inches of soil, and would be subject to the currently approved reclamation goals for the site as defined by the reclamation plan. As identified by site inspections and records (DEQ, September 9, 2014), several areas of the mine have not achieved the reclamation goals that include the establishment of wildlife habitat and livestock grazing through revegetation. Some portions of the Kendall Pit and Muleshoe Pit have poor vegetation establishment, or have not yet been covered with soil and reclaimed, and do not currently meet the reclamation goals. The poor vegetation establishment in some areas is primarily due to lack of soil cover.

The total current disturbance of 447.5 acres and the 1,040.4 acre permit area would not change. No new soil would be stripped or stockpiled. The stockpiled soil would be used to reclaim up to approximately 15 acres of facilities, ponds, roads and other areas (CR

Kendall, 2015a). All soil stockpiles would ultimately be used for reclamation. The facilities would not be retained post mine.

These soil, vegetation, and reclamation components and actions would be part of the No Action Alternative:

- **Process pads regrading –** Process pads 3 and 4 were regraded to 3:1 slopes with 10 foot benches every 100 feet in 2004 (Minor Revision 04-001).
- **Process pads cover design –** A modified water balance cover of 17 inches of soil, over a 6 inch subsoil basal layer amended with 5 to 8 percent sodium bentonite, over 12 inches of subsoil basal layer material was approved and completed by CR Kendall Mine (Minor Revision 11-001). This functioning cover would remain in place as part of this alternative.
- **Process pads drainage ditches –** A final cover of subsoil/sodium bentonite amended subsoil basal layer with geomembrane liner was approved and has been completed (Minor Revision 11-001).
- **Process pads underliners –** The underliners for process pads 3 and 4 would be perforated by drilling after water discharge standards have been met, to eliminate water ponding (1989 Plan of Operations).
- **Kendall Pit –** Regrading of pit walls and spreading of stockpiled materials in the pit was completed in 2006 as a beneficial step toward final reclamation (Minor Revision 04-001). Eight to 10 inches of soil would be placed on the regraded pit slopes that are less than 2:1 and those regraded areas would be reseeded.
- **Kendall Waste Rock Dump –** Slopes have been regraded to a combination of 2:1 and 3:1 slopes and covered in 8 to 10 inches of soil (1989 Plan of Operations). In 1995, an RPL was used on some flatter portions of the regraded dump (Shafer and Associates, 1995).
- **Barnes-King Pit –** Reclamation work included completing a partial pit wall reduction in 2004 under Minor Revision 04-001. The regraded areas of less than 2:1 were covered with 8 to 10 inches of soil.
- **Muleshoe Pit –** Reclamation included partially backfilling the pit with waste rock, regrading, replacing soil over most areas, and seeding in 1993-1995. Not all of the regraded pit backfill received soil placement and vegetation establishment has not been successful where no soil was placed. Eight to 10 inches of soil would be placed on the areas where no soil was placed and seeded.

- **Muleshoe Waste Rock Dump –** The southeast face was graded to 2:1 in 1991 (CR Kendall, 1989), and grading was completed to 3:1 in 1995 (Shafer and Associates, 1995). Slopes were covered with 8 to 10 inches of soil and seeded. In 1995, an RPL was used on some flat portions of the dump.
- **Horseshoe Pit –** The Horseshoe pit was partially backfilled and was covered with soil and seeded in 1993-1994.
- **Facilities –** All buildings, including the WTP and associated ponds would be removed at mine closure when reclamation is completed (Plan of Operations, 1989).
- **Ponds –** All ponds would be drained and liners folded in and covered with 8 to 10 inches of soil. For ponds 7 and 8, the lower pond berms would be breached to allow free draining surface water (Plan of Operations, 1989).
- **Roads –** One public access road through the mine site would be left at mine closure in a location approved by the BLM. All other mine roads would be ripped, graded, covered with soil, and seeded (Plan of Operations, 1989).
- **Seed Mixes –** Five seed mixes were approved for different forest or grassland areas, and for moderate or harsh site conditions (Shafer and Associates, 1995). Currently, three seed mixtures are approved by DEQ for different slope conditions.
- **Soil Stockpiles –** All soil stockpiles would be used for reclamation.

The impacts of the No Action Alternative on the soil, vegetation, and reclamation resources are: (1) all 447.5 acres of disturbance would be reclaimed per the approved and revised reclamation plan. The approved reclamation plan allows the single BLM access road through the mine to be retained for post-mine land use. All soil stockpiles would be used for reclamation. All current mine facilities would be removed at mine closure and the areas reclaimed.

The revegetated cover currently in place on process pads 3 and 4 appears stable and is growing vegetation (Figure 3-4). Recent DEQ inspections have stated that the vegetation growth is robust and that vegetation has established successfully on these pads. The process pad covers have shown no sign of erosion or slumping. The large rain event in 2014 produced very little erosion or slumping on the process pads. It is reasonable to conclude that the process pad covers would continue to function under this alternative.

3.4.3.2 Proposed Action

The Proposed Action was developed from the Closure Water Management Plan (Hydrometrics & CR Kendall Corp., 2012) and was designed primarily for long-term water treatment of the process pad drainage and captured groundwater. The Proposed Action would reference and document actions for approval of the final capping and reseeding of process pads 3 and 4 and would outline some long-term reclamation

monitoring and maintenance activities. The components and actions are part of the Proposed Action and would differ from those for the No Action Alternative. They are:

- **Process pads underliners –** The underliners would not be perforated and their integrity would be maintained to provide capture and treatment of process pad drainage water into ponds 7 and 8.
- **Kendall and Muleshoe Pits –** There would be no additional soil replacement for any areas of these pits.
- **Facilities –** All buildings would remain after closure for private use (Volberding, 2015b).
- **Ponds –** All ponds would be maintained for pumpback storage and fire control until water quality standards are met and treatment is no longer needed. When water treatment is not needed, ponds would be reclaimed per the approved reclamation plan.
- **Roads –** Similar to the No Action alternative, one public access road would be left at closure. The other roads currently used for accessing water treatment facilities would be left until water treatment is no longer needed.
- **Soil Stockpiles –** Soil stockpile would remain for use to repair erosion rills and other features requiring vegetation maintenance during the closure period.

The impacts of the Proposed Action on the soil, vegetation and reclamation resources of the analysis area would be similar to the No Action Alternative. It would differ in that: facility buildings would be left for beneficial post-mine uses, roads used to access the facilities would remain open for additional years, and soil stockpiles would be used for erosion maintenance rather than for growth media in the Kendall or Muleshoe Pits. No new disturbance is proposed and no new soil stripping or stockpiling would occur.

The revegetated cover currently in place on process pads 3 and 4 appears stable and is growing vegetation (Figure 3-4). Recent DEQ inspections have stated that the vegetation growth is robust and that vegetation has established successfully on these pads. The process pad covers have shown no sign of erosion or slumping. The large rain event in 2014 produced very little erosion or slumping on the process pads. It is reasonable to conclude that the process pad covers would continue to function under this alternative.

3.4.3.3 Process Pad Drainage Pretreatment Alternative

DEQ developed this alternative to include a water pretreatment action to address issues associated with arsenic concentrations exceeding groundwater quality standards in the process pads drainage. This alternative would not have any major impacts to soils, vegetation, and reclamation. The main differences for this alternative compared to the No Action and Proposed Action alternatives would be the use of all

stockpiled soil and the potential need for a storage facility for the pretreatment waste products (sludge).

Soil Stockpiles – The soil in stockpile TS-13a would be used for reclamation of the interior slopes of the Kendall and Muleshoe Pits, where surface water runoff cannot leave the pit. Soil from TS-13a and all other stockpiled soil resources would likely be used for reclamation of the pond areas at final mine closure.

Pretreatment Byproducts Storage Facility – This alternative would not stipulate the exact pretreatment process or methods CR Kendall Mine would use to remove arsenic and other contaminants from the process pad drainage. Any water pretreatment process would likely have some byproducts or spent media (e.g., sludge, precipitates, iron filings) from the treatment that would require proper handling and disposal. The treatment byproducts or spent media could be disposed of on-site with DEQ approval in a constructed landfill that would require soil salvage and a final closure plan, or placed in an existing lined pond.

The impacts of the Process Pad Drainage Pretreatment Alternative on the soil, vegetation and reclamation resources would be minimally different and potentially beneficial in the long-term compared to impacts for the Proposed Action. The soil in stockpile TS-13a would be used to reclaim some slopes in the Kendall and Muleshoe Pits and not left in the existing stockpile. Similar to the Proposed Action, final reclamation would retain facilities and access roads for beneficial post mine use. Like the No Action Alternative, all ponds currently used for water treatment would be reclaimed at mine closure by draining the water, folding the liner in on itself, covering with 8 to 10 inches of soil, and seeding. The need to construct a landfill on-site to store the byproducts from the pretreatment of process pad drainage would cause impacts to the soil and vegetation while the landfill is operating. After the process pad drainage pretreatment ceases, the landfill would be properly closed and reclaimed.

The revegetated cover currently in place on process pads 3 and 4 appears stable and is growing vegetation (Figure 3-4). Recent DEQ inspections have stated that the vegetation growth is robust and that vegetation has established successfully on these pads. The process pad covers have shown no sign of erosion or slumping. The large rain event in 2014 produced very little erosion or slumping on the process pads. It is reasonable to conclude that the process pad covers would continue to function under this alternative.

3.4.3.4 Process Pad Barrier Cover Alternative

The Process Pad Barrier Cover Alternative was developed to help minimize the volume of precipitation infiltrating into the process pads, where drainage contains levels of arsenic, selenium, and other contaminants exceeding groundwater discharge standards. Water treatment at a central WTP would still occur under this alternative. The installation of a barrier liner would involve temporarily removing 17 inches of soil covering the pads, installing a textured barrier liner over the pad areas, and replacing

the salvaged soil. This alternative would result in impacts to soils, vegetation and reclamation and differs from the No Action and Proposed Action alternatives in these ways:

Process pads – The upper 17 inches of growth media and vegetation would be removed from process pads 3 and 4 and a barrier cap (textured liner with drainage net) installed over the areas. After the barrier cap is installed, the salvaged growth media would be replaced on top of the liner and the disturbed areas reseeded.

Soil Stockpiles – The soil in stockpile TS-13a would be used for reclamation of the interior slopes of the Kendall and Muleshoe Pits, where surface water runoff internally collects. All other stockpiled soil resources would be used for reclamation of pond areas and road closures at final mine closure.

The impact of this alternative on the soil, vegetation, and reclamation resources at the CR Kendall Mine would be different from the No Action and Proposed Action alternatives. The removal of 17 inches of growth media (soil) and vegetation from process pads 3 and 4 and installation of a barrier cover cap would cause additional impacts to the soil, vegetation, and reclamation resources during this operation. The mine wastes in the process pads would probably not be encountered or disturbed because the barrier cover cap would be installed on top of the existing 6 inches of subsoil basal layer material amended with 5 to 8 percent sodium bentonite, over 12 inches of subsoil basal layer material. The activities associated with stripping and replacing the approximate 17 inches of growth media (104,925 cubic yards of soil) would cause some mechanical and physical impacts to the soil (dis-aggregation, soil compaction, lost soil). The replaced growth media would be reseeded with an approved grass seed mixture, but some soil erosion and soil slumping could occur until the pads have sufficient vegetation established.

The disturbance of the existing process pads vegetated cover would set back the established vegetation (see Section 3.4.2.2) and would increase the potential for erosion until the new vegetation becomes established. Some soil loss and increased soil compaction would likely occur from the extra soil handling activities.

Installing a barrier cover on the process pads and covering with approximately 17 inches of soil would increase the potential for soil slumping, particularly on the slope faces. Soil slumping could occur from the formation of a saturated slippage plane on top of the impermeable geomembrane liner. Mass soil slumping would disturb the vegetation, increase soil erosion, and expose the geomembrane liner to damage.

Tree growth on the process pads would be a concern if a geomembrane barrier cover is placed on the process pads. Trees would likely naturally grow on the reclaimed areas. The trees would be shallow rooted (only 17 inches of growth media) and would be susceptible to blowdown. The uprooted trees would potentially expose and puncture

the liner when toppled, resulting in disturbance to the vegetation, increased soil erosion, and punctures that would increase pad drainage flows.

Soil in stockpile TS-13a would be used to reclaim the Kendall and Muleshoe Pit slopes. An estimated 38,300 cubic yards of stockpiled topsoil remained on the CR Kendall Mine at the end of 2014 (CR Kendall, 2015a).

Similar to the Proposed Action, final reclamation would retain facilities and access roads for beneficial post mine use. Ponds currently used for water treatment would be reclaimed at closure by draining the water, cutting and folding the liners, covering the areas with soil, and seeding

3.5 Wildlife

The CR Kendall Mine is on forested lands along the eastern flanks of the North Moccasin Mountains. The site and surrounding area provide good quality habitat for deer, turkeys, and other wildlife and are used for hunting. The primary post-mining reclamation land use is to provide habitat for wildlife and grazing for livestock. A biological resources technical report was done in 2010 in support of Amendment 007 (Elliott, 2010). The report included visual observations of wildlife, pedestrian surveys, a bat survey, use of mist nets and photographs, and evaluated the current and potential use of the mine for wildlife habitat.

3.5.1 Analysis Area and Methods

The analysis area for wildlife includes the 1,040 acre CR Kendall Mine permit area and the adjacent lands in the North Moccasin Mountains in Fergus County. The mine permit area and forested areas immediately adjacent to the mine area are shown on **Figure 1-2**.

The impacts analysis considered CR Kendall Mine wildlife notes, applicable websites pertaining to the presence of wildlife, and the 2010 Biological Resources Report (Elliott, 2010). Professional judgement based on the changed disturbance or timing of activities was used to evaluate impacts.

3.5.2 Affected Environment

The habitats on the mine site include diverse areas of ponderosa pine and Douglas-fir forest, aspen in moist sites, riparian, native and disturbed grasslands, water, and pit highwalls. Some surrounding lands are agricultural. Activities at the mine site (including pits, stockpiles, roads, ponds, process pads, and buildings) have modified the wildlife habitat from natural conditions for more than 100 years.

All of the mined land (447 acres) has been or is in the process of being reclaimed. Approximately 55 acres of pit highwall have been reclaimed (Elliott, 2010). Reclaimed and undisturbed areas provide trees, shrubs, and grass used as forage by elk, mule deer, white-tailed deer, wild turkey, and small mammals, and hiding and nesting cover

for birds. Raptors, including golden eagles, hunt there. Natural cavities and mined areas, including pit highwalls, provide breeding and roosting habitat for bats, birds, and small mammals.

The 2010 report noted that beaver had constructed dams and created wetlands and riparian habitat supporting birds and amphibians in Dog Creek, Little Dog Creek, South Fork of Last Chance Creek, and Barnes-King Gulch down slope from the mine (Elliott, 2010). A pond where water is pumped for LAD near the top of Barnes-King Gulch created a wetland providing breeding habitat for frogs and foraging habitat for bats.

No threatened or endangered species are known to exist near the permit area. Biological surveys of the area in 1984 and 1988 did not identify any federally threatened or endangered species. The US Fish and Wildlife Service (USFWS) indicated elk, mule deer, white-tail deer, wild turkey, and small mammals would be reasonably expected to occur in and around the mine (Fergus County) (USFWS, 2015a). Other wildlife noted near the project include antelope, mountain lion, sharp-tailed grouse, pheasant, and gray partridge. Greater sage-grouse and Sprague's pipit may occur in or around the mine area, but their habitat is primarily grassland and agricultural areas. There is no habitat near the mine for the pallid sturgeon, black-footed ferret, or Canada lynx.

3.5.3 Environmental Consequences

3.5.3.1 No Action Alternative

The impacts of the No Action Alternative on wildlife would be minimal and would be associated with the ongoing water treatment activities for the process pad drainage and groundwater capture. The major reclamation activities are completed and the mine traffic limited to the operations and maintenance of piping and water treatment processes. Wildlife species recorded on and adjacent to the mine site are typical species in central Montana that occupy mountain ranges and habitats (Elliott, 2010).

Completing reclamation of other areas by placing 8 to 10 inches of soil and seeding should provide beneficial results for wildlife and help achieve the reclamation goal of establishing wildlife habitat. The actual reclamation activities may create minor, short-term impacts to wildlife. As the reclaimed areas develop sustainable vegetation, impacts should be beneficial with the revegetated areas providing additional habitat. Spreading the remaining soil in stockpile TS-13a onto the Kendall and Muleshoe pit slopes should improve reclamation and revegetation for that area.

3.5.3.2 Proposed Action

Under the Proposed Action, there would be no additional adverse impacts to wildlife resources from implementing the mine closure activities, compared to the No Action Alternative. The soil from TS-13a would not be placed on the Kendall or Muleshoe pit slopes and there would be no minor, short-term, adverse impact to wildlife from those

reclamation activities. Because there would be no additional soil placement or vegetation in the Kendall and Muleshoe Pits under the Proposed Action, no additional habitat or forage would be established. The delay for reclaiming several mine access roads, and the use by mining staff during water treatment, would cause some minor adverse impacts to wildlife compared to the No Action Alternative.

3.5.3.3 Process Water Pretreatment Alternative

DEQ developed this alternative for the pretreatment of the process water to remove arsenic to below the groundwater discharge standard. This reduction in arsenic would have minor benefits for wildlife in overall improved water quality, compared to the No Action and Proposed Action alternatives.

The Process Water Pretreatment Alternative would likely provide long-term benefit to wildlife resources compared to the Proposed Action because of the additional topsoil and revegetation on regraded slopes for reclamation of the Kendall and Muleshoe Pits.

3.5.3.4 Process Pad Barrier Cover Alternative

This Alternative would remove the existing 17 inches of soil (including established vegetation that provides some wildlife habitat), install a textured barrier liner, replace the salvaged soil, and reestablish the vegetation. This removal of soil and vegetation would result in short-term loss of foraging for wildlife.

The impacts of the Process Pad Barrier Cover Alternative on wildlife resources would be adverse in the short-term compared to all other alternatives. As in the Process Water Pretreatment Alternative, wildlife resources would benefit in the long-term due to the additional topsoil and revegetation on regraded slopes for reclamation of the Kendall and Muleshoe Pits.

Cumulative, Unavoidable, Irreversible and Irretrievable, and Secondary Impacts

4.1 Cumulative Adverse Impacts

DEQ is required to conduct a cumulative impact analysis to ensure that DEQ's decisions consider the full range of effects of its action on the human environment.

Cumulative impacts are the collective impacts on the human environment when considered in conjunction with other past, present, and future actions by location and generic type. Cumulative impact analysis under the MEPA Model Rules requires an agency to consider all past and present state and non-state actions. Related future actions must also be considered when these actions are under concurrent consideration by any state agency through pre-impact statement studies, separate impact statement evaluation, or permit process procedures. Analysis of cumulative environmental impacts includes other actions that are related to all action alternatives by location or generic type, recognizing that impacts on water resources, wildlife resources, and other resources might be manifested beyond the actual mine site.

The geographical extent of the study area was selected for each resource based on the location, timing, and duration of anticipated effects from the alternatives evaluated. Resource specific study areas for direct and indirect impacts are limited to the areas were activities (such as topsoil placement) or water discharge would occur. The cumulative impacts region of influence includes all areas in which planned or expected actions might affect one or more resources. The DEQ permit area is used as the cumulative impacts analysis area for all resources **(Figure 1-2)**, because the minimal direct and indirect impacts on any of the resources will not be distinguishable from existing conditions by the time they reach the DEQ permit area.

Based on the MEPA model rules definition, since there are no future actions in the CR Kendall Mine DEQ permit area, the cumulative impacts consider the present and past actions that may continue to have impacts or may affect future management. These activities include reclamation of roads and facilities, grazing, hunting, general recreation, weed management, fire and fuel mitigation, and road maintenance.

4.1.1 Surface and Groundwater

CR Kendall Mine completed two previous studies to determine background concentrations for arsenic, selenium, thallium, and other water quality parameters in the surface water of five main drainages that traverse the mine (WMC, 1999 and 2003). DEQ scientists reviewed both reports and provided technical memoranda with their comments and overall assessments (DEQ, 2001 and 2004). Concentrations of contaminants in Dog Creek, South Fork of Last Chance Creek, and North Fork of Last Chance Creek were all fairly low. The Mason Canyon and Barnes-King Gulch drainages had elevated concentrations of arsenic, selenium, and thallium. These two drainages

have had the most historical mining and could also be assumed to have the most naturally occurring mineralization. However, DEQ's interpretations for background water quality are that background levels of arsenic, selenium, and thallium in Mason Canyon and Barnes-King drainages are similar and not very different from those in the unimpacted drainages.

The current conditions and activities of the Proposed Action are a direct result of past mining and previously completed reclamation. Past mining activities created the need for water treatment of the contaminated groundwater and process pads drainage water. The past mining actions will continue to have effects on water quality, as demonstrated by the elevated concentrations of thallium, arsenic, and other contaminants requiring treatment to be below groundwater discharge standards. Consequently, the impacts described in Chapter 3 on water resources include the cumulative effects of past and present actions.

4.1.2 Soils, Vegetation, and Reclamation

All alternatives involve long-term water treatment (up to 40 years). Mine facilities dedicated to water treatment include the WTP building, storage ponds, discharge system to the Kendall Pit, and roads that must be maintained. The cumulative impacts on soil, vegetation, and reclamation for all alternatives are from the delayed reestablishment of vegetative cover due to the retention of the water treatment facilities. The impacts would be minor, but could include the reduction of favorable soil properties in the long-term stockpiled soil and loss of grazing for the areas until finally reclaimed.

4.2 Unavoidable Adverse Effects

4.2.1 Geology and Minerals

Under the No Action, Process Pad Drainage Pretreatment, and Process Pad Barrier Cover alternatives, soil from stockpile TS-13a would be used for reclamation of the interior slopes of the Kendall and Muleshoe Pits and the areas would be reseeded. Soil from TS-13a and all other stockpiled soil resources would likely be used for reclamation of the pond areas at final mine closure.

4.2.2 Surface and Groundwater Resources

All alternatives involve long-term water treatment to improve water quality and close and reclaim the CR Kendall Mine. Water treatment would cease once the process pads drainage and groundwater capture system water quality standards are met, which could be 40 years or more.

Under the Proposed Action, CR Kendall Mine would not directly dispose of water with concentrations above groundwater standards, but would continue to use LAD as the contingency disposal method for water with concentrations above standards. This

would be an unavoidable adverse impact if contaminants cause contamination of groundwater beyond the mine site. The Process Pad Drainage Pretreatment and Process Pad Barrier Cover alternatives include additional water treatment for arsenic or a barrier on the process pads to reduce future drainage rates.

4.2.3 Soil, Vegetation, Reclamation

Soil compaction and erosion from respreading the remaining soil in TS-13a onto the Kendall and Muleshoe Pit slopes are minor, unavoidable impacts. Short-term impacts of soil compaction, soil erosion from the newly reclaimed areas, reduction of favorable physical and chemical properties, and changes in nutrient levels would likely occur. After the soil is spread and the vegetation communities established, the soil properties would return to a level that reestablishes nutrient cycling, supports the vegetation, and has reduced erosion.

4.3 Irreversible and Irretrievable Commitment of Resources

Irreversible resource commitments are generally related to the use of nonrenewable resources, such as minerals, soils, or cultural resources, and the impacts this use could have on future use options. Irreversible commitments are usually permanent, or at least persist for a long time. Irretrievable resource commitments involve a temporary loss of the resource or loss in its value.

No irreversible or irretrievable commitments of resources have been identified for any of the alternatives. Nothing in the Proposed Action would obligate any resources that are irretrievable (i.e., capping of mineralized rock would not render it irretrievable; it could still be mined at a later date). There were no irreversible or irretrievable commitments of the other resource areas (geology and minerals; soil, vegetation, reclamation; or wildlife) identified in this EIS.

4.4 Regulatory Restrictions

Alternatives and mitigation measures are designed to further protect environmental, cultural, visual, and social resources, but they add to the cost of the project. MEPA requires state agencies to evaluate any regulatory restrictions proposed to be imposed on the proponent's use of private property (Section 75-1-201(1)(b)(iv)(D), MCA). Alternatives and mitigation measures required by federal or state laws and regulations to meet minimum environmental standards do not need to be evaluated for extra costs to the proponent.

CR Kendall Mine will need DEQ approval of their final closure plans for mine facilities. DEQ's selection of an alternative will be designed to make the project meet minimum environmental standards or will have been proposed and/or agreed to by CR Kendall Mine. Thus, the conditions should not constitute a compensable taking of private

property. DEQ will perform a final regulatory restrictions analysis when it selects the preferred alternative in the final EIS.

4.5 Secondary Impacts

Based on the MEPA model rules definition, secondary impacts are further impacts to the human environment that may be stimulated or induced by, or otherwise result from a direct impact of the action. The direct impacts to most resources areas evaluated in this EIS (geology and minerals; soils, vegetation, and reclamation; and wildlife) occurred during active mining and no secondary impacts to these resources would be expected from any of the mine closure alternatives. For surface and groundwater resources, the secondary impacts would be to groundwater if the Proposed Action water treatment approach fails to treat water to meet human health groundwater standards for arsenic (and selenium if the increasing trend continues), and the potential degradation of groundwater quality in the Madison aquifer from the discharge of treated water containing these elements. DEQ developed the Process Pad Drainage Pretreatment and Process Pad Barrier Cover alternatives to address these potential secondary impacts.

Comparison of Alternatives

5.1 Comparison of Alternatives

Table 2-1 summarizes important components of the four alternatives and the effects of implementing each alternative. Information in **Table 2-1** quantitatively or qualitatively lists effects among the No Action Alternative, Proposed Action (Amendment 007), the Process Pad Drainage Pretreatment Alternative, and the Process Pad Barrier Cover Alternative.

The alternatives compared are described in detail in Chapter 2 and summarized below.

5.1.1 No Action Alternative

For this EIS, the 1989 Plan of Operations and 1995 Soils and Revegetation Plan along with the pumpback and water treatment plans are considered to be the No Action Alternative. The No Action Alternative reflects the current CR Kendall Mine operations under Operating Permit 00122, including six Amendments and 23 minor revisions up through Minor Revision 11-001. Most reclamation activities under the permit have been completed. Major disturbed areas have been reclaimed, including the Horseshoe Pit and Horseshoe Waste Rock Dump; Muleshoe Waste Rock Dump; Barnes-King Pit; Kendall Waste Rock Dump, and most of the Kendall and Muleshoe Pits. Minor Revision 11-001 was approved in 2011 and allowed CR Kendall to place a 17-inch layer of growth media directly over the basal layer on process pads 3 and 4 as an interim reclamation measure.

Under this alternative, CR Kendall would address the remaining reclamation items at the mine, including spreading the remaining stockpiled soil, completing some additional revegetation work, and providing long-term reclamation monitoring and maintenance.

Other mine facilities will be retained until water treatment is no longer needed, including pumps and piping; ponds 2B, 3B, 7, and 8; stormwater controls; water treatment and maintenance facilities; roads; power lines; and LAD facilities.

5.1.2 Proposed Action

The Proposed Action is the proposed Closure Water Management Plan CR Kendall submitted in their Application for Amendment 007 to Operating Permit No. 00122. The Proposed Action primarily addresses the long-term water treatment of the process pad drainage and captured groundwater. The alternative would retain the installed vegetated soil cover authorized under Minor Revision 11-001 and outlines reclamation monitoring and maintenance activities. The main items different from the No Action Alternative are:

- The process pad drainage and all captured groundwater would be combined for treatment by filtering to remove particulate, treating with zeolite adsorption to

remove thallium, and discharged to groundwater through the Kendall Pit. The option for LAD is retained as a contingency.

- No additional growth media (soil) would be placed on the regraded areas of the Kendall Pit with slopes less than 2:1 or the lower slopes in the Muleshoe Pit with poor vegetation establishment. No additional reseeding is planned.
- Most buildings would remain for private use after closure.

5.1.3 Process Pad Drainage Pretreatment Alternative

A separate piping system would collect the drainage water from process pads 3 and 4 for pretreatment prior to blending the drainage water with other mine waters. Arsenic is one of the contaminants in the process pad drainage water, and is projected to exceed groundwater standards even after the drainage water and captured groundwater are combined. The pretreatment system could remove other contaminant constituents, if necessary to comply with discharge criteria.

The likely pretreatment system would involve the oxidation and adsorption of arsenic onto an adsorbent compound (ferric chloride, iron filings, or other). The pretreatment process would most likely be developed specifically for the CR Kendall process pad drainage water to effectively remove arsenic. After pretreatment, the water would be combined with the other captured groundwater for thallium removal through the current method of zeolite adsorption. Treated water would be discharged to groundwater through the Kendall Pit.

New water treatment equipment would be required to pretreat the process pad drainage water. The annual average flow rate after installing the current process pads caps (2009 to 2014) ranged from 11.3 gallons per minute (gpm) to 20.5 gpm, with an average rate of 13.7 gpm.

The specific pretreatment technology chosen by CR Kendall to remove arsenic could generate a contaminated treatment media, or byproduct, that requires proper disposal. Because the specific technology has not been chosen or designed, the possible disposal options for the contaminated media could include: (1) shipping it back to the manufacturer when exhausted; (2) shipping it off-site for disposal; or (3) burying it on-site if confirmed as non-hazardous.

5.1.4 Process Pad Barrier Cover Alternative

The Process Pad Barrier Cover Alternative was developed to minimize the process pad drainage flows that require treatment. Adding a barrier liner to the process pads could effectively reduce drainage water flows. CR Kendall would select the effective cover materials to use, however, DEQ would have final review and approval. DEQ would require the barrier liner be of HDPE or a similar product rather than a geosynthetic clay liner (GCL). The current 17 inches of soil would be temporarily removed and a

geomembrane liner installed. The geomembrane liner would consist of a textured HDPE liner overlaid with a geocomposite drainage net. The salvaged soil would be replaced over the geomembrane liner and the process pads reseeded.

As with the Proposed Action, the process pad drainage and all captured groundwater would be combined for treatment by filtering to remove particulate, treating with zeolite adsorption to remove thallium, and discharged to groundwater through the Kendall Pit. The option for LAD is retained as a contingency.

Similar to the No Action Alternative and the Process Pad Drainage Pretreatment Alternative, the soil remaining in TS-13a would be placed on regraded slopes in the Kendall Pit and on the lower slopes in the Muleshoe Pit and the areas reseeded.

5.2 Preferred Alternative

The rules and regulations implementing MEPA (ARM 17.4.617) require agencies to indicate a preferred alternative in the draft EIS, if one has been identified. DEQ has identified the Process Pad Drainage Pretreatment Alternative as the preferred alternative for several reasons discussed below.

5.2.1 Rationale for the Preferred Alternative

The Process Pad Drainage Pretreatment Alternative is the only alternative that ensures compliance with all groundwater standards for all water to be treated and discharged. This would be achieved through the development of an additional water treatment system to specifically remove arsenic from the process pad drainage. The system would be modified as necessary to include treatment for other elements, such as selenium, which may require treatment in the future to comply with groundwater discharge standards.

Mixing models developed for the Proposed Action predict the combined drainage water and captured groundwater would not meet groundwater standards for thallium and arsenic, but only treatment for thallium was proposed. CR Kendall assumed (1) either the natural background arsenic concentration in the Madison Limestone aquifer is also above the standard, or (2) dilution provided by mixing of the effluent from the treatment plant with groundwater moving through the aquifer would result in compliance with groundwater quality standards after mixing. CR Kendall has not collected data from the local Madison Limestone aquifer to document the validity of either assumption or if effluent limits higher than groundwater standards would be allowed.

The Process Pad Barrier Cover Alternative is intended to reduce the rate of infiltration into, and drainage from, the process pads. Reduced flows from the process pads and combining this water with other captured groundwater may result in sufficient dilution of constituents, other than thallium, so that no other water treatment would be

required to achieve standards. However, reclamation of process pads using barrier covers at other mine sites has not reduced seepage to levels where treatment is no longer required. In some cases, higher concentrations of contaminants in the residual seepage has resulted. Therefore, the Process Pads Barrier Cover Alternative does not provide assurance that it would eliminate the need for additional water treatment steps in order to achieve compliance with groundwater discharge standards.

The Process Pad Drainage Pretreatment Alternative provides for better growth media to support vegetation on the process pads compared to the Process Pad Barrier Cover Alternative. The existing 17 inch process pad soil cover overlies 6 inches of subsoil amended with bentonite and 12 inches of unamended subsoil. Plant roots are able to penetrate the entire soil profile, and thus should be more tolerant of drought. Plant roots may extend into the underlying spent ore. In contrast, the Process Pad Barrier Cover Alternative would restrict plant roots to the upper 17 inches of soil, resulting in the vegetation being more susceptible to drought. There would also be an increased potential for soil slumping along a saturated zone on top of the liner and increased potential for exposure and damage to the barrier cover from toppling of shallow-rooted trees. Additional impacts to soils and vegetation would be expected due to salvage, stockpiling, and replacement of the soil materials on the process pad barrier cover.

The Process Pad Drainage Pretreatment Alternative would result in some additional acres of revegetated land compared to the Proposed Action. CR Kendall would use the remaining stockpiled soil, other than the soil reserved for the eventual reclamation of roads and facilities, on the remaining areas of pit backfill that have not previously received soil.

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Bond – Financial assurance posted by an applicant/permittee to guarantee that funds are available for state and/or federal agencies to complete the reclamation plan associated with an operating permit or license, including water treatment if needed, in the event the permittee is unable or unwilling to do so.

Buffer Area - An undisturbed area left around the area permitted for disturbance within the operating permit boundary.

Cyanide Leach Process – Recovery of gold and other metals by soaking an ore in a cyanide solution.

Deficiency Letter – In this case, DEQ's response to an operating permit amendment application identifying additional items needing clarification so an application can be called complete and compliant with the MMRA.

DEQ-7 Water Quality Standards – Numeric water quality standards for Montana's surface water and groundwater developed to protect the designated beneficial uses of state waters, such as growth and propagation of fishes and associated wildlife, waterfowl and furbearers, drinking water, culinary and food processing, recreation, and agriculture.

Draft Operating Permit/Operating Permit Amendment – Permit or permit amendment issued on completion of the completeness and compliance review, prior to the completion of the required MEPA review.

Groundwater Capture System – System used to capture alluvial groundwater and control seepage from the waste rock piles, process pads, and historic tailings since 1998 with capture wells in South Fork Last Chance Creek, Mason Canyon (Process Valley), Barnes-King Gulch, and Little Dog Creek drainages.

Heap Leaching - The mining process used by CR Kendall to extract gold and other precious metals from ore by applying cyanide solution to ore to react, dissolve, and leach metals with later separation of the metals from the solution.

Highwall - The face of overburden and ore in an open pit mine.

Highwall Stability – The potential for a highwall to maintain structural integrity.

Interdisciplinary Team – A group of technical experts conducting an impact analysis.

Particulate Filtration – For CR Kendall, the first water treatment step used to remove suspended solids in the mine impacted water by passing the water through a multi-media filter.

Mitigation - A measure used to reduce impacts by (1) avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of an action; or (5) compensating for an impact by replacing or providing substitute resources or environments.

Montana Environmental Policy Act – Title 71, Chapter 1 of the Montana Code Annotated.

Open Pit Mining – A surface mining method where rock is ripped or drilled and blasted, then removed as overburden or removed as ore for further processing.

Operating Permit –Permit issued by DEQ to mine, process ore, construct or operate a hard-rock mill or disturb land in anticipation of those activities.

Ore – A mineral or an aggregate of minerals from which a commodity can be profitably mined or extracted.

Permitted Disturbance Boundary – The area in an operating permit that is designated to be disturbed.

Permit Area or Boundary - The disturbed land as defined in 82-4-303 , MCA, and a minimal area delineated around a disturbance area for the purposes of providing a buffer adjacent to all disturbances.

Process Pads Drainage – Water with residual contaminants that continues to drain from the former process pads 3 and 4.

Reclamation – Returning a surface disturbance to support desired post-mining uses, including recontouring and plant growth, and minimizing hazardous conditions, ensuring stability, and protecting against wind or water erosion.

Scoping – Determining the scope of the analysis, i.e., the range of reasonable alternatives, mitigation, issues, and potential impacts to be considered in an environmental assessment or an environmental impact statement.

Soil Salvage – Soil or other growth media removed and saved for use during reclamation.

Spent Zeolites – Zeolites that have been used for treating water and have adsorbed and trapped other molecules (particularly cations) inside their crystal lattice to become part of the zeolite crystal.

Waste Rock - Rock that is removed for access, but does not contain enough mineral to be mined and processed at a profit.

Waste Rock Dump – Engineered location where waste rock is stored.

Zeolites – A group of microporous, hydrated, aluminosilicate minerals with a relatively open, three-dimensional crystal structure made from interlinked tetrahedra of AlO_4 and SiO_4. Zeolites are commonly used as commercial adsorbents.

Zeolite Adsorption - For CR Kendall, the water treatment process used primarily to remove thallium by passing the mine impacted water through tanks filled with zeolites.

<	Less than
>	Greater than
%	Percent
µS/cm	Microsiemens per centimeter
BLM	Bureau of Land Management
CDM	Camp, Dresser and McKee
CFR	Code of Federal Regulations
DEQ	Montana Department of Environmental Quality
EIS	Environmental Impact Statement
°F	Degree Fahrenheit
GCL	Geosynthetic clay liner
gpm	Gallons per minute
HDPE	High-density polyethylene
HELP	Hydrologic Evaluation of Landfill Performance
IDT	Interdisciplinary team
LAD	Land application disposal
MCA	Montana Code Annotated
MEPA	Montana Environmental Policy Act
mg/L	Milligrams per liter
MMRA	Metal Mine Reclamation Act
NH3	Ammonia
NO2-	Nitrite
NO3-	Nitrate
PVC	Polyvinyl chloride
RO	Reverse osmosis
ROD	Record of Decision
RPL	Reduced permeability layer
SC	Specific conductance
TCLP	Toxicity Characteristic Leaching Procedure
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAD	Weak acid dissociable
WMC	Water Management Consultants
WTP	Water treatment plant

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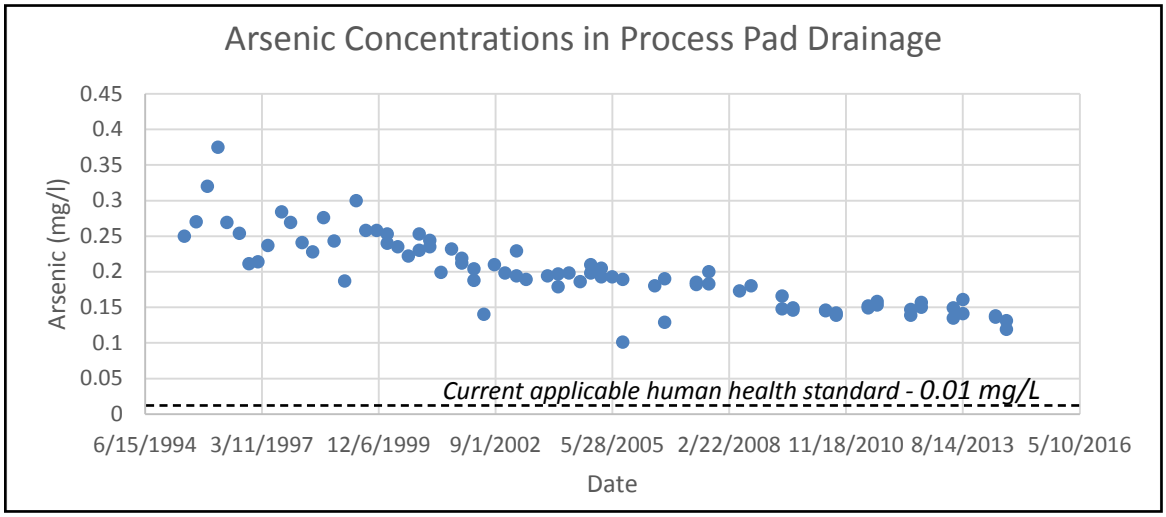
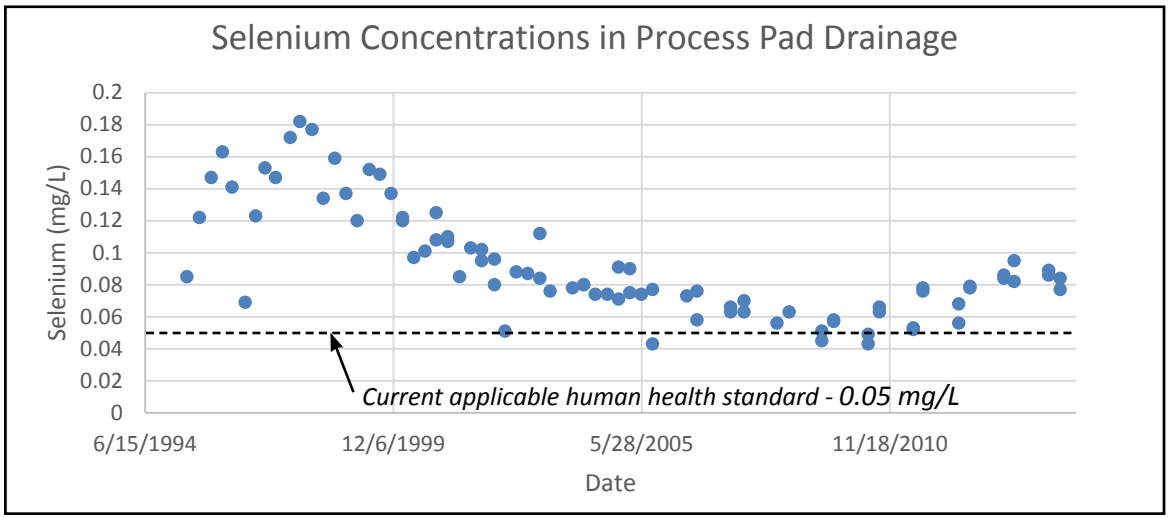
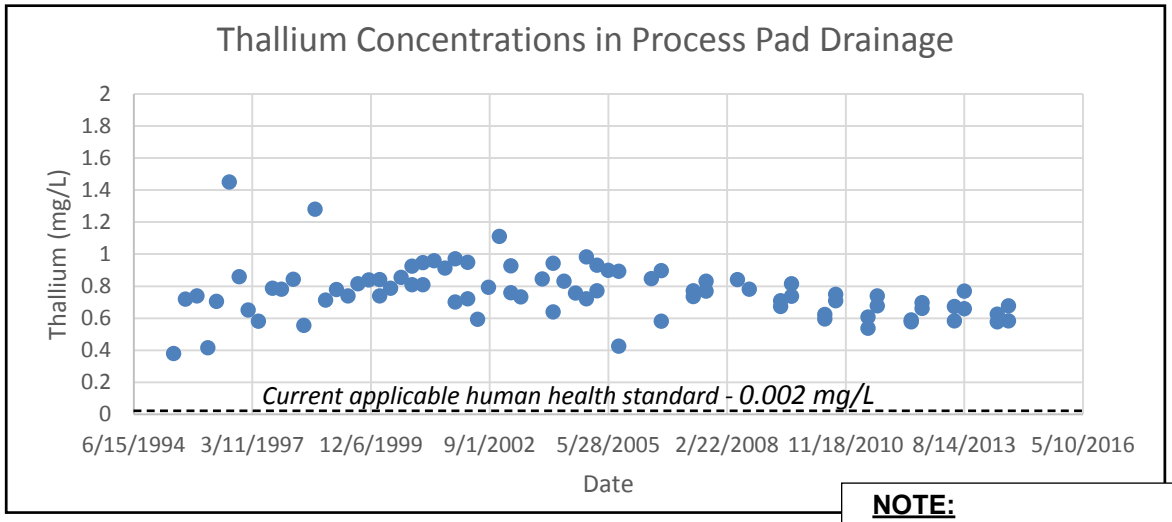
Appendix A

Arsenic, Selenium, and Thallium Concentrations in Monitoring and Pumpback Wells

Note: *"The detection limits of specific analytes can vary depending on the specific sample matrix, even on the same analytical instrument at the same analytical laboratory. However, for the data shown in the following figures, the detection limits are generally 0.003 mg/L for arsenic, 0.001 mg/L for selenium, and 0.002 mg/L for thallium. Therefore, most flat lines or clusters of data at those concentrations represent non-detect samples for that particular analyte."*

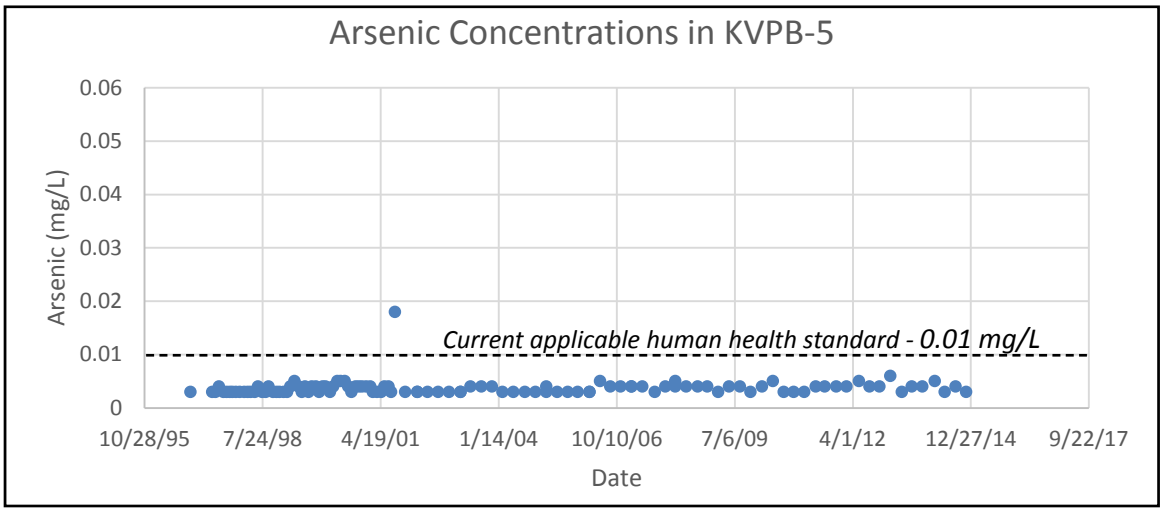


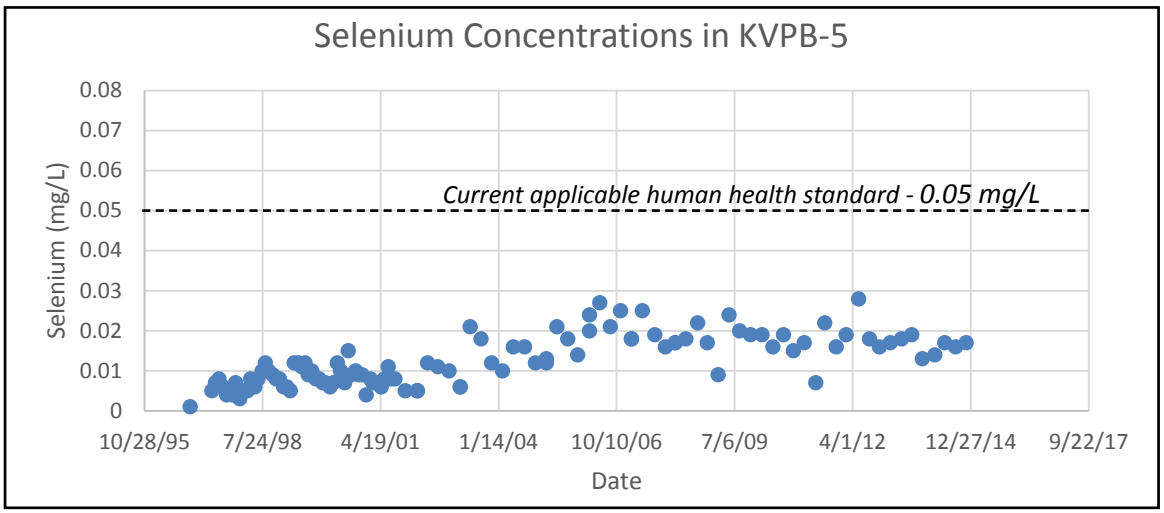


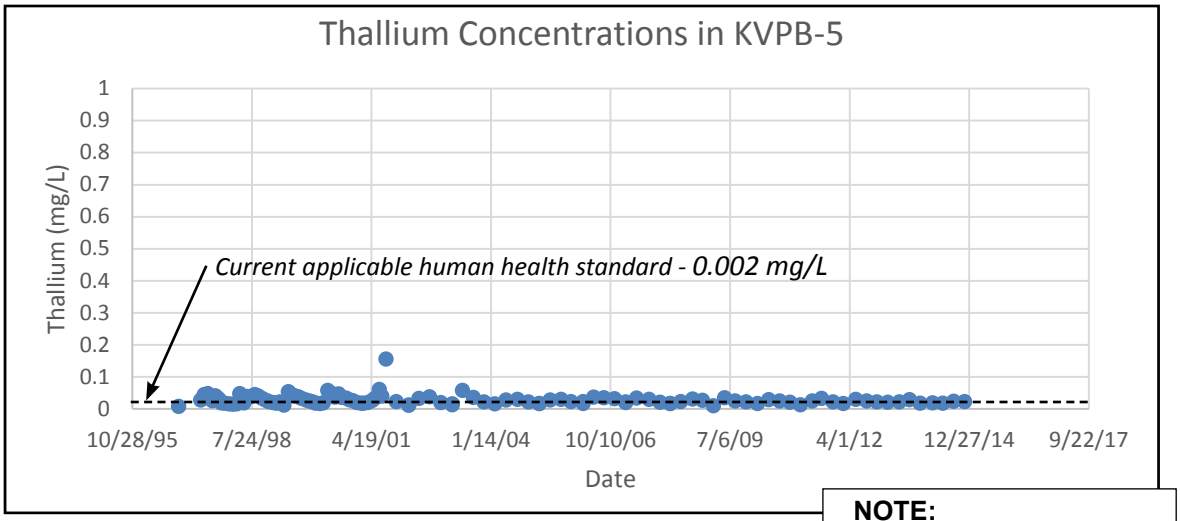


NOTE:
mg/L = Milligrams per Liter

FIGURE A-1
CR Kendall Mine
Arsenic, Selenium, and Thallium Levels in Process Pad Drainage







NOTE:
mg/L = Milligrams per Liter

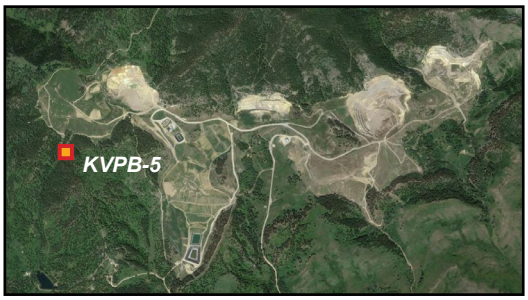
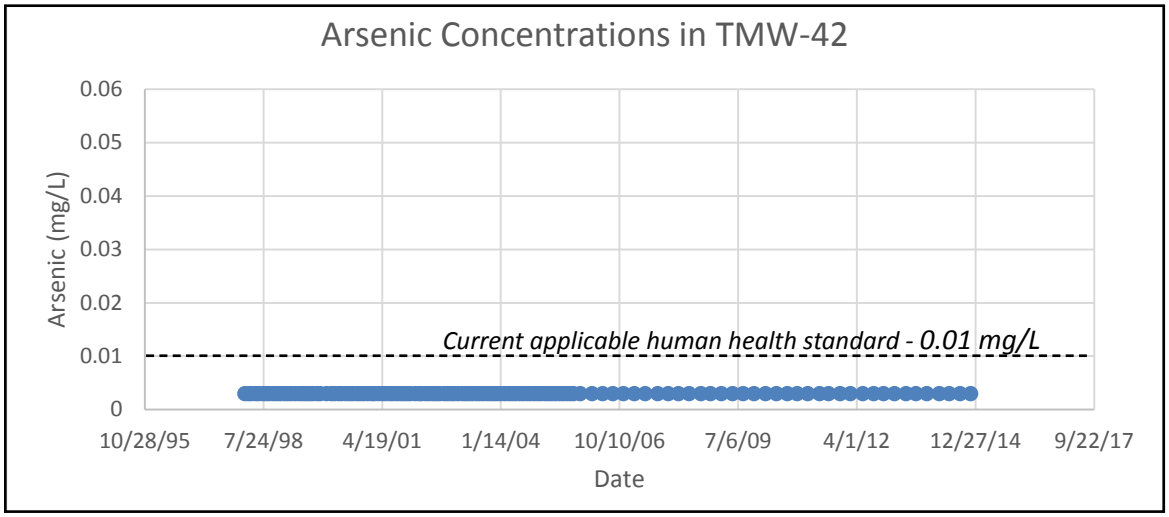
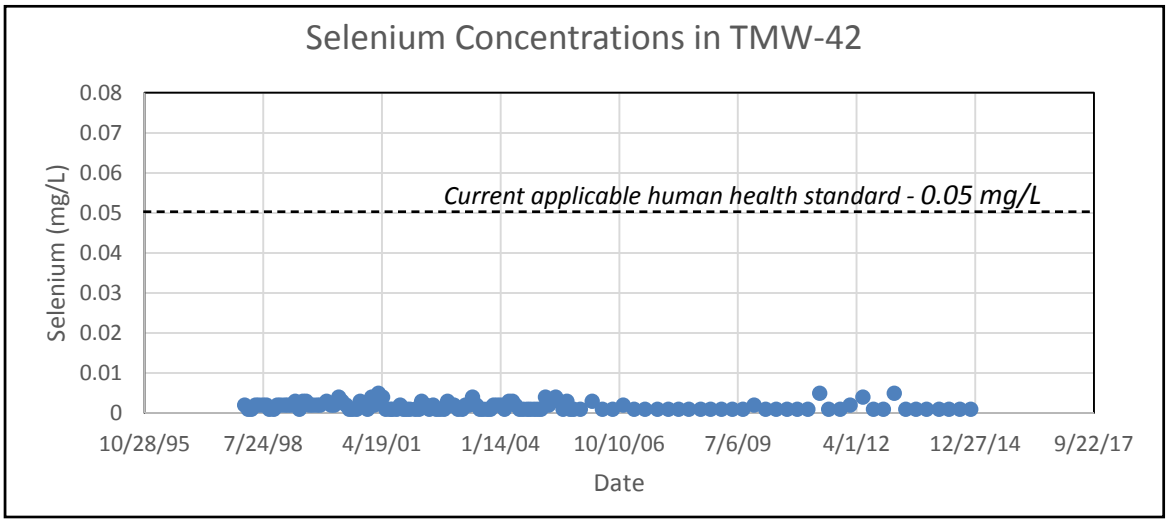
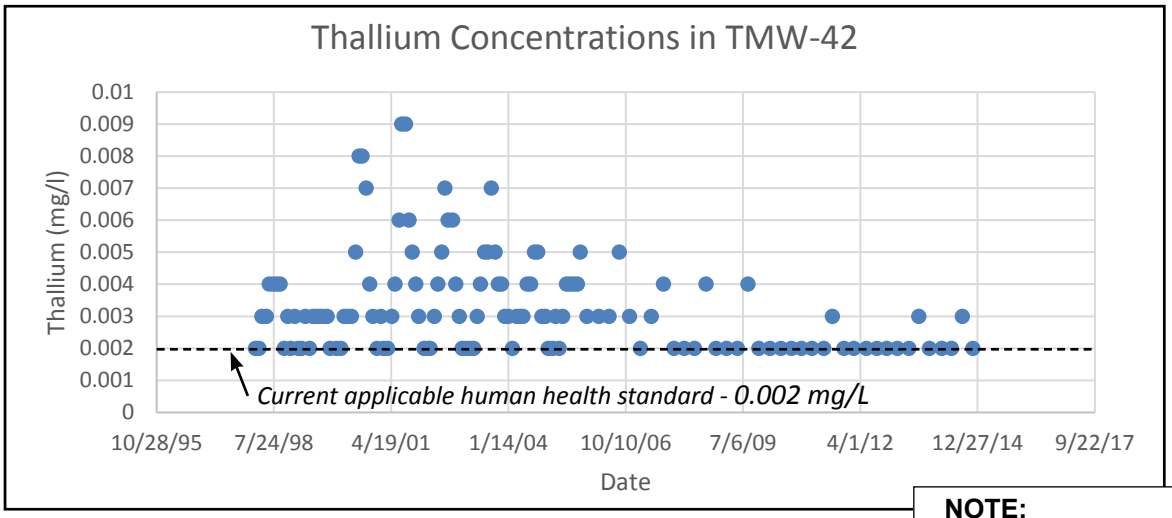


FIGURE A-2
CR Kendall Mine
Arsenic, Selenium, and Thallium Levels in South Fork Last Chance Creek Pumpback Water (KVPB-5)

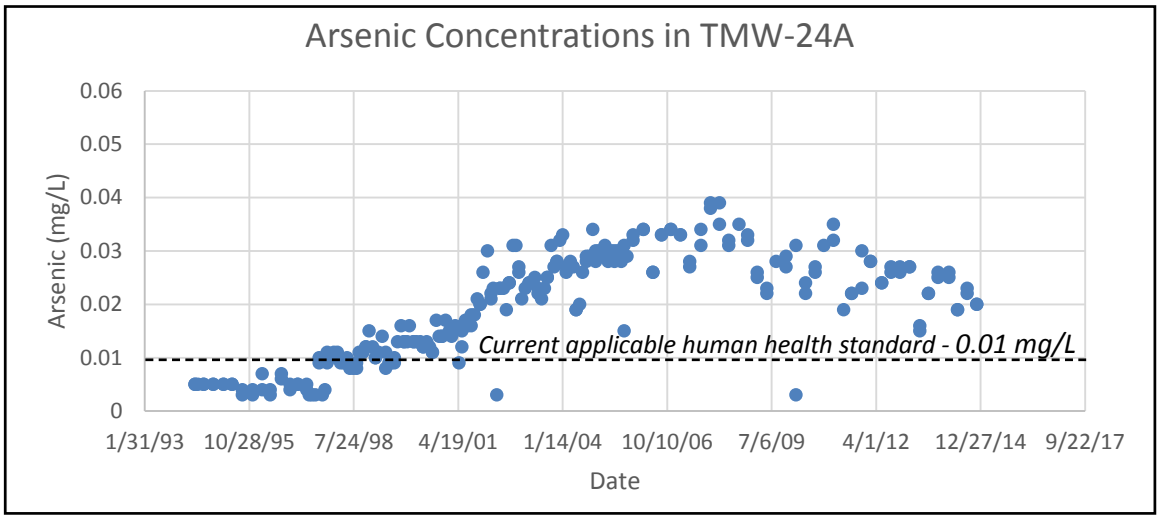


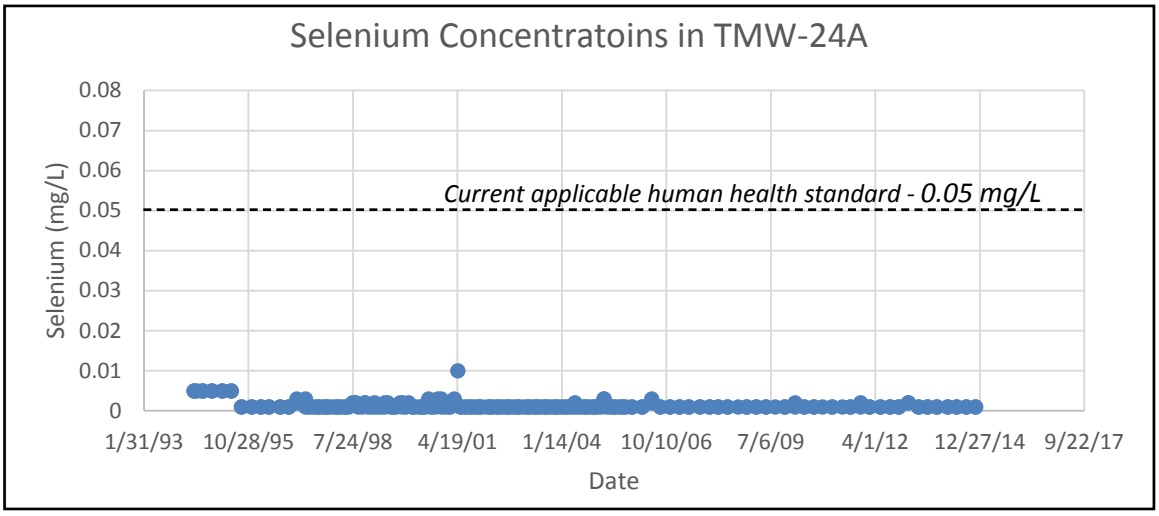


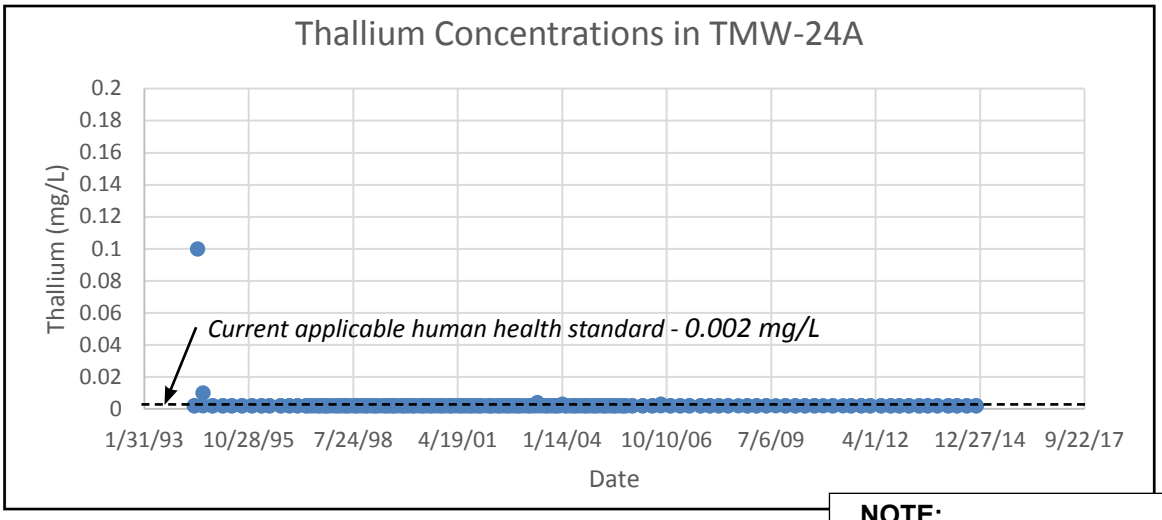


NOTE:
mg/L = Milligrams per Liter

FIGURE A-3
CR Kendall Mine
Arsenic, Selenium, and Thallium
Levels in South Fork Last Chance Creek
Groundwater
(TMW-42)

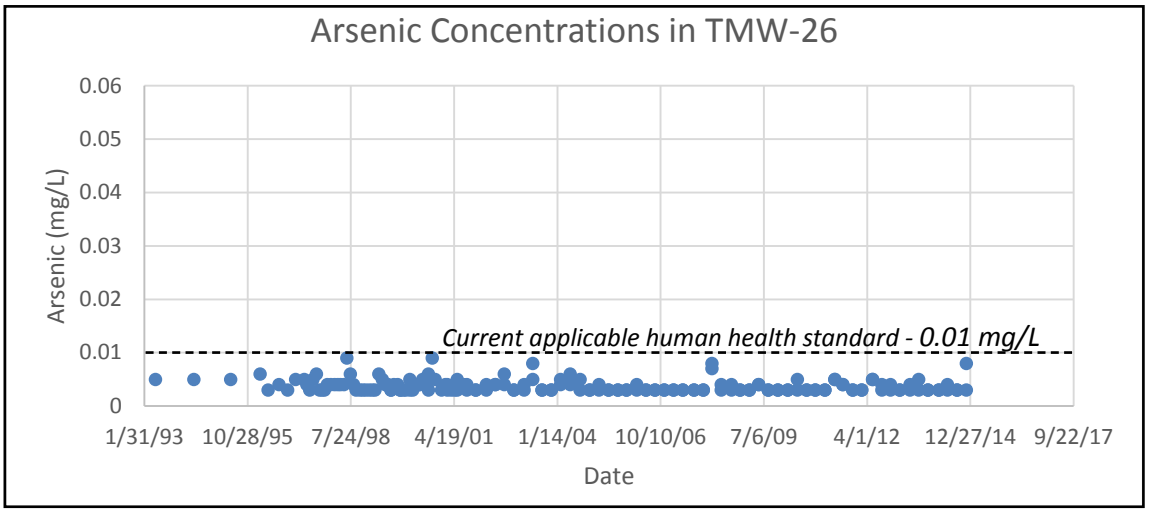


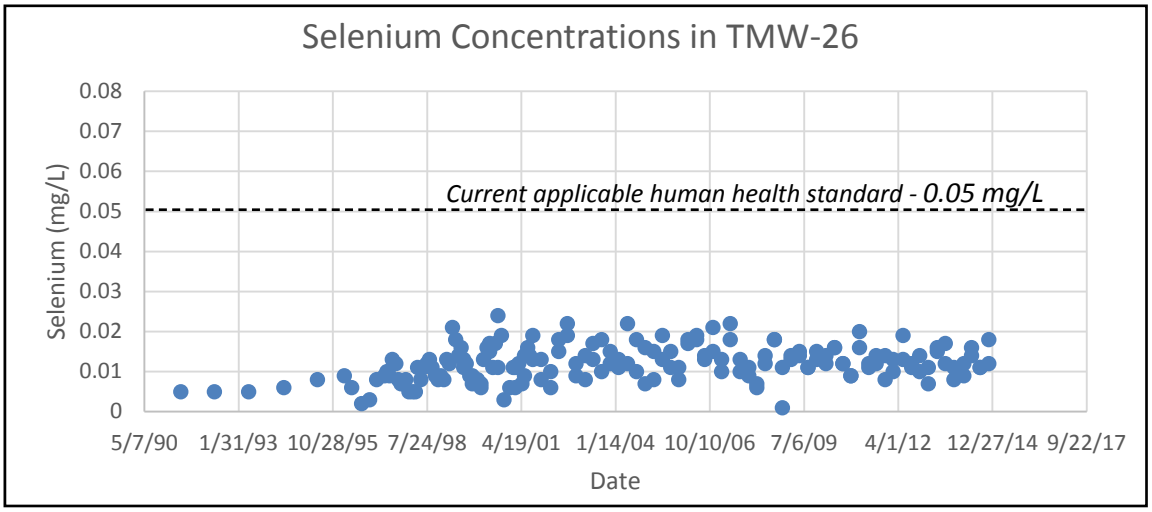


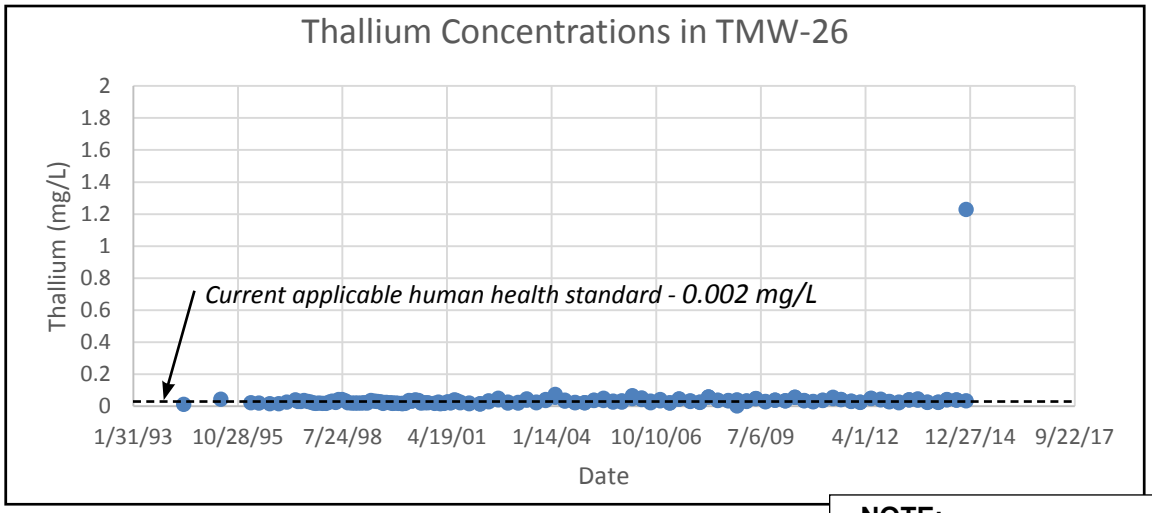


NOTE:
mg/L = Milligrams per Liter

FIGURE A-4
CR Kendall Mine
Arsenic, Selenium, and Thallium Levels in
Mason Canyon Groundwater
(TMW-24A)

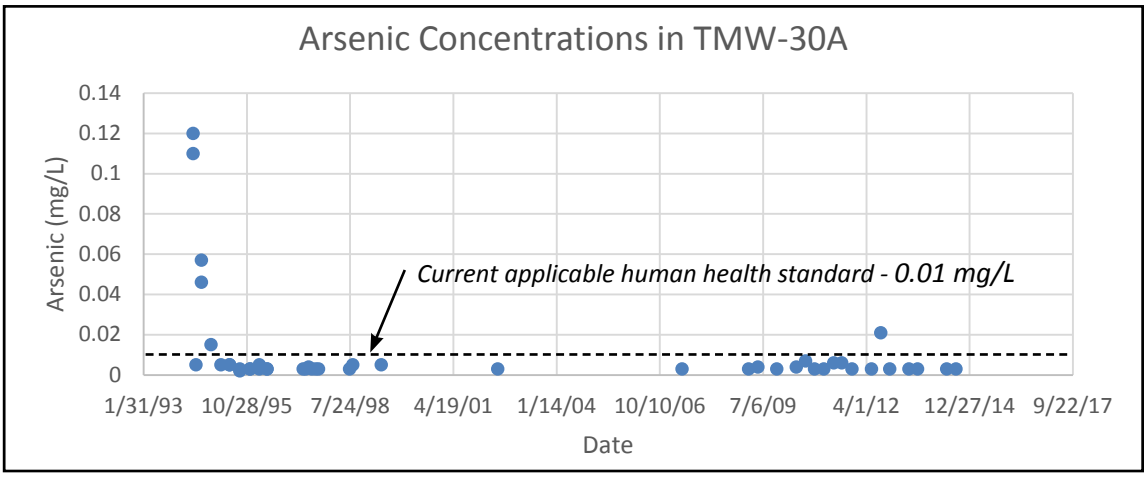


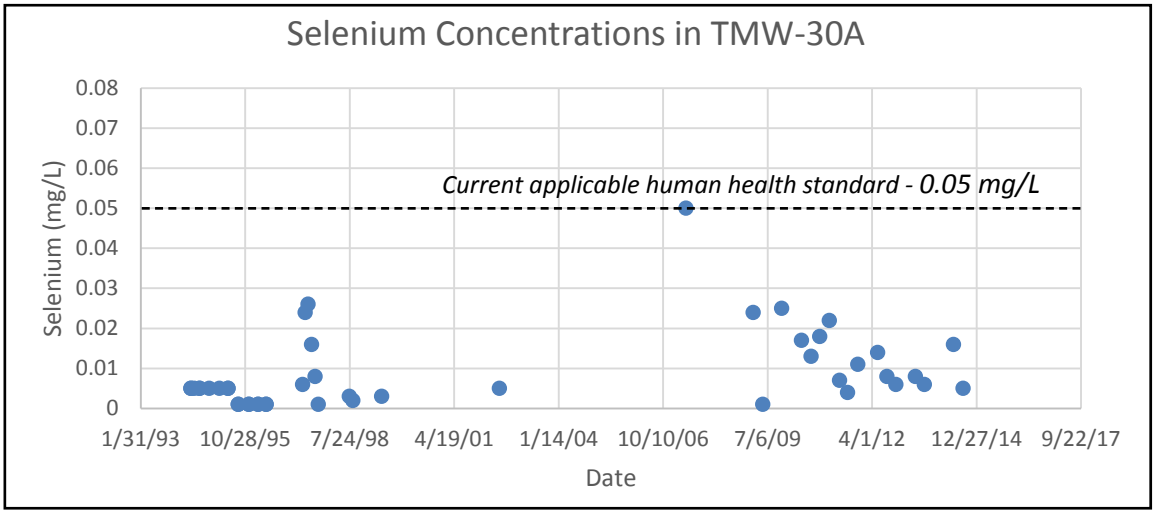


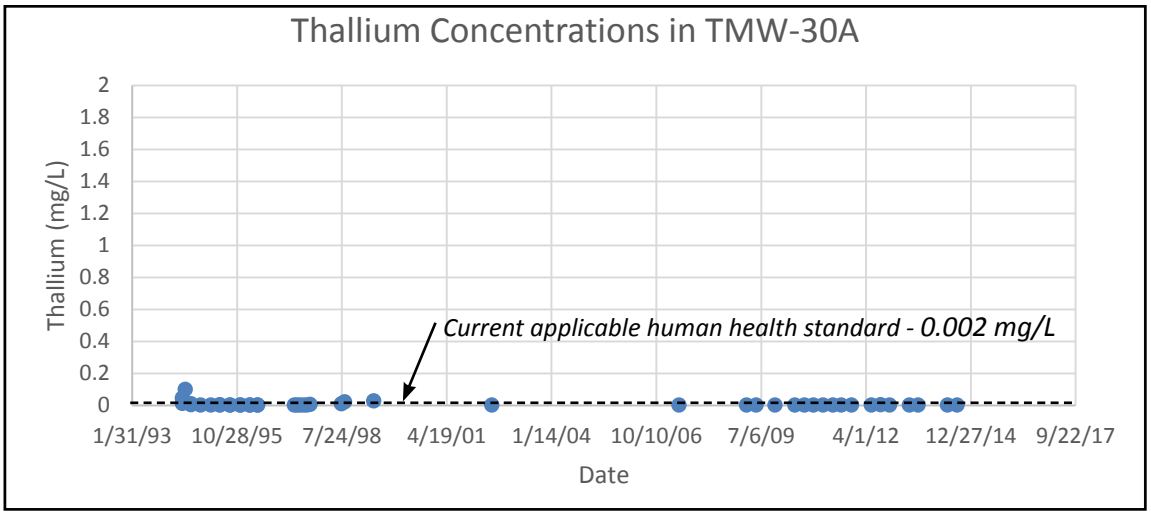


NOTE:
mg/L = Milligrams per Liter

FIGURE A-5
CR Kendall Mine
Arsenic, Selenium, and Thallium Levels in Mason Canyon Sediment Pond Pumpback (TMW-26)

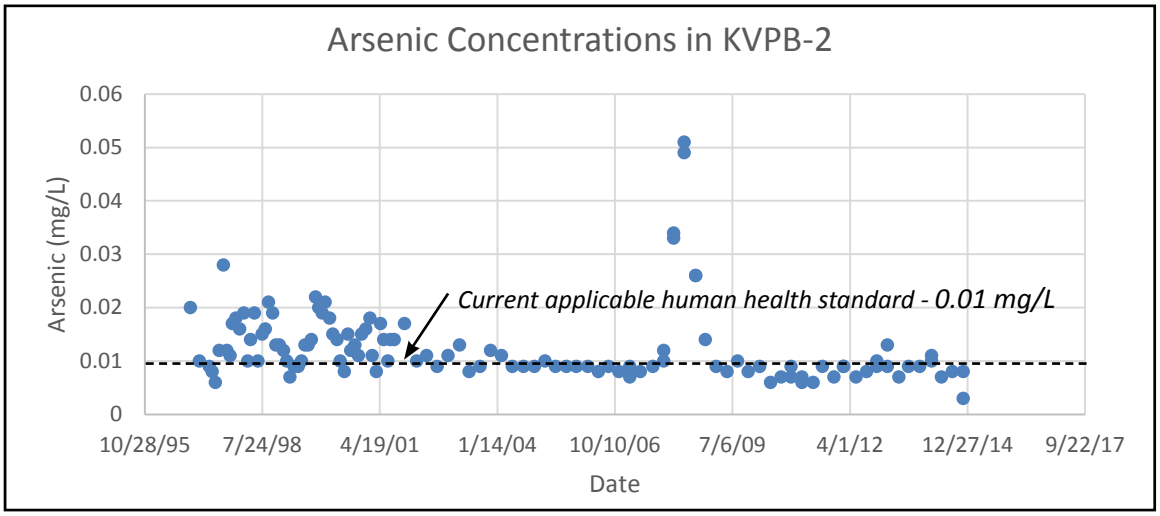


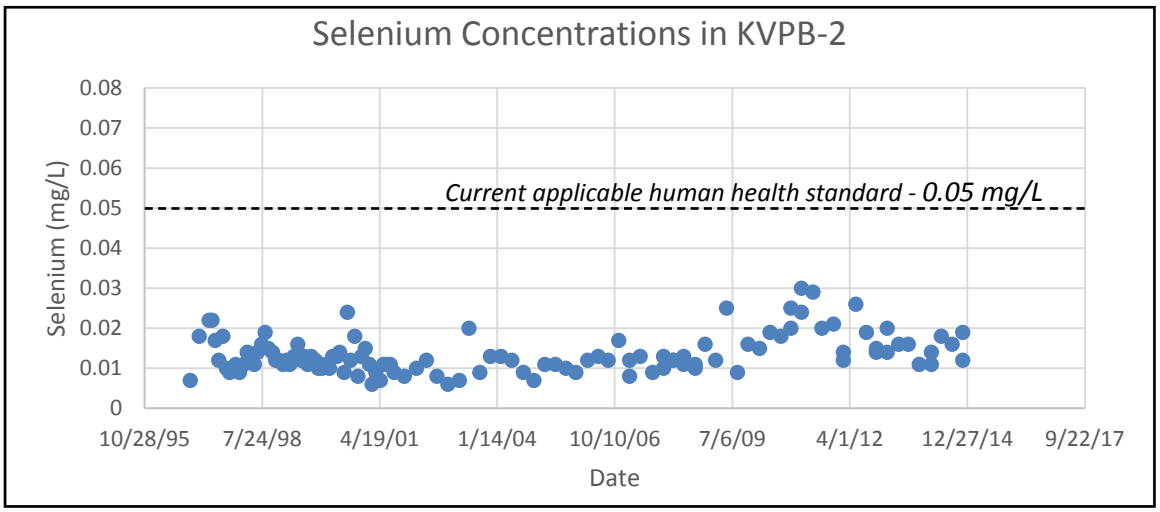


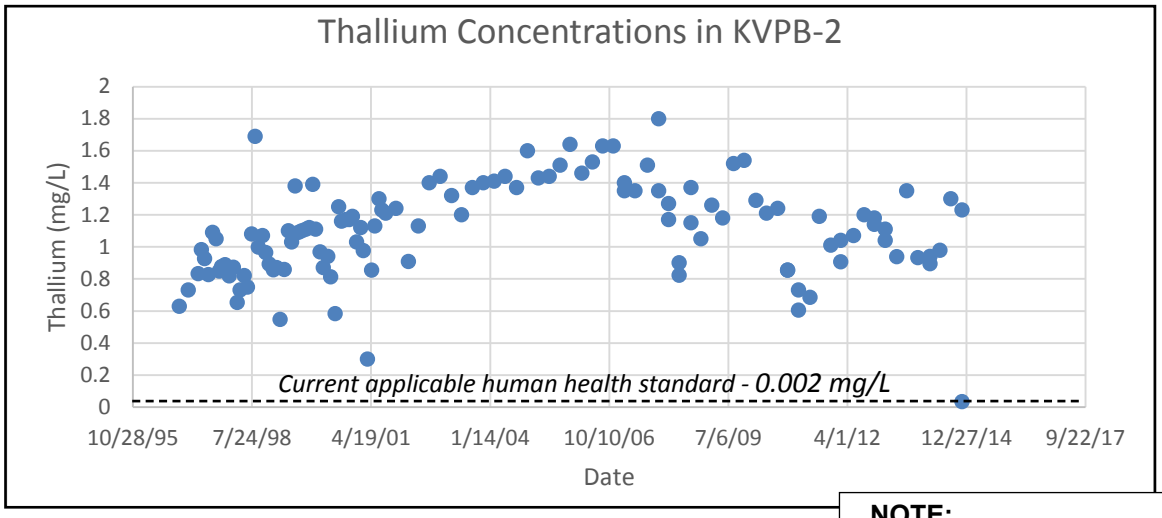


NOTE:
mg/L = Milligrams per Liter

FIGURE A-6
CR Kendall Mine
Arsenic, Selenium, and Thallium Levels in
Barnes-King Gulch Groundwater
(TMW-30A)

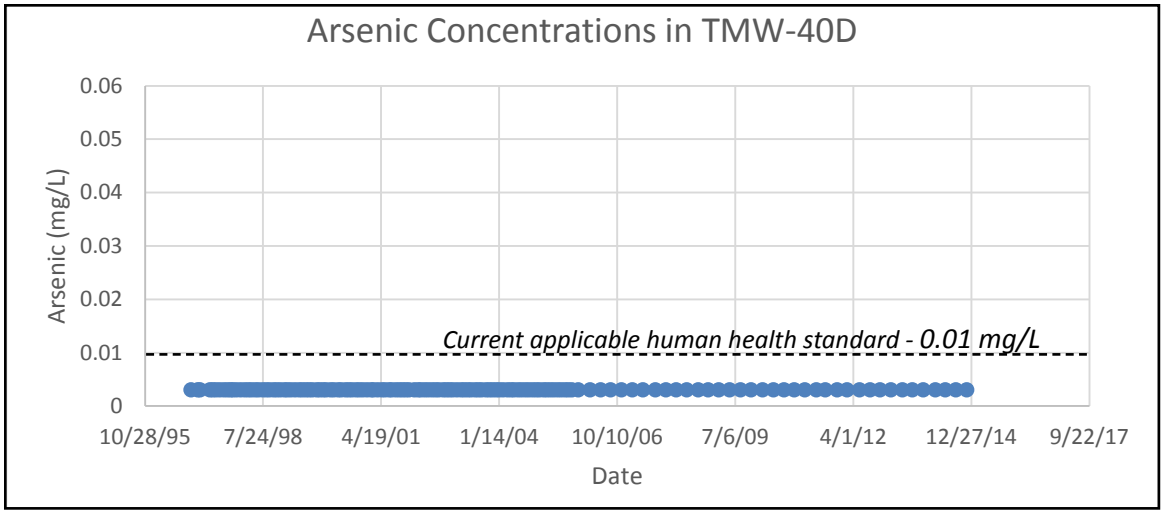


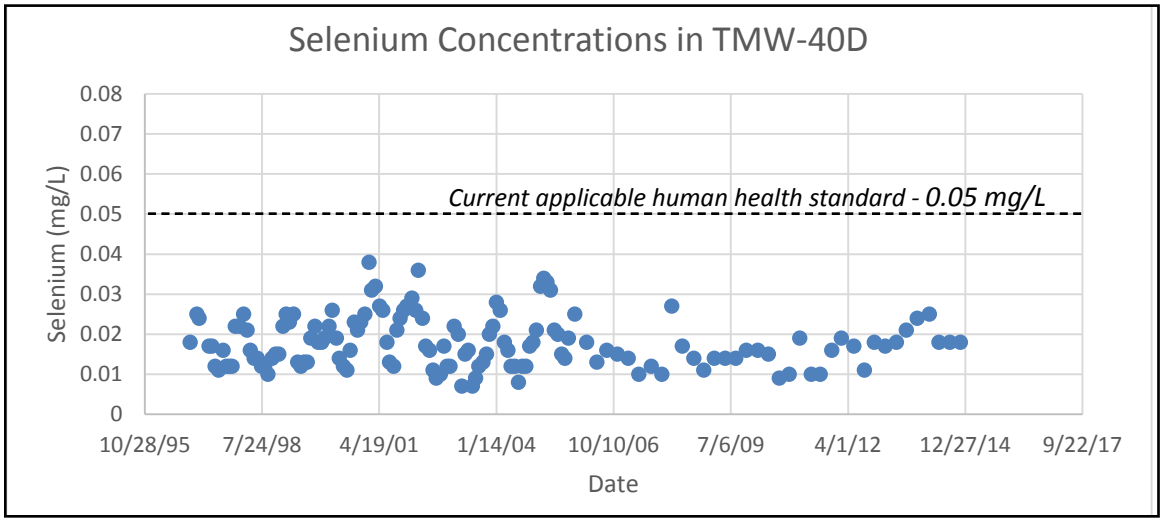


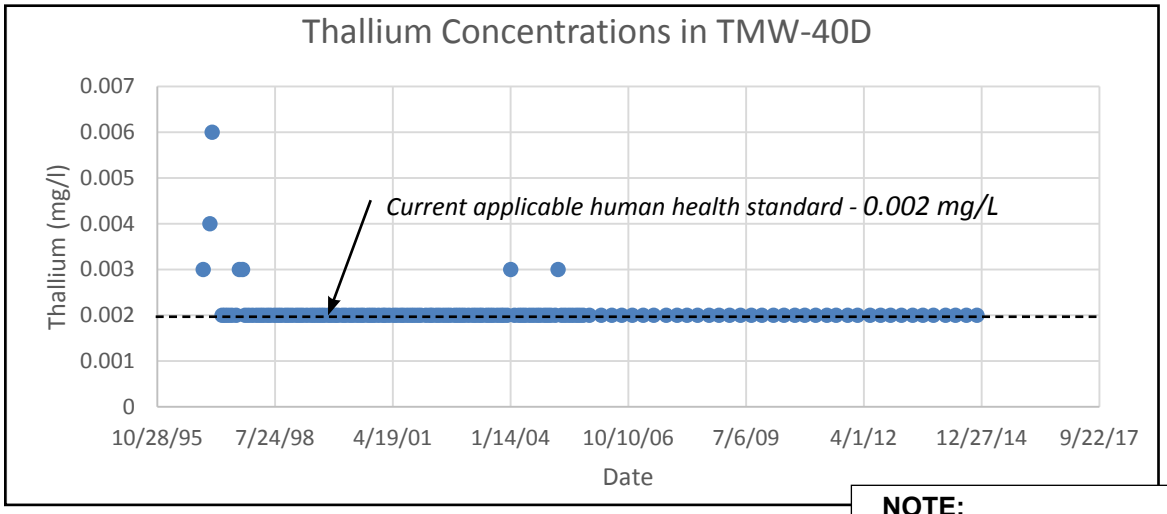


NOTE:
mg/L = Milligrams per Liter

FIGURE A-7
CR Kendall Mine
Arsenic, Selenium, and Thallium Levels in
Barnes-King Gulch Pumpback
(KVPB-2)

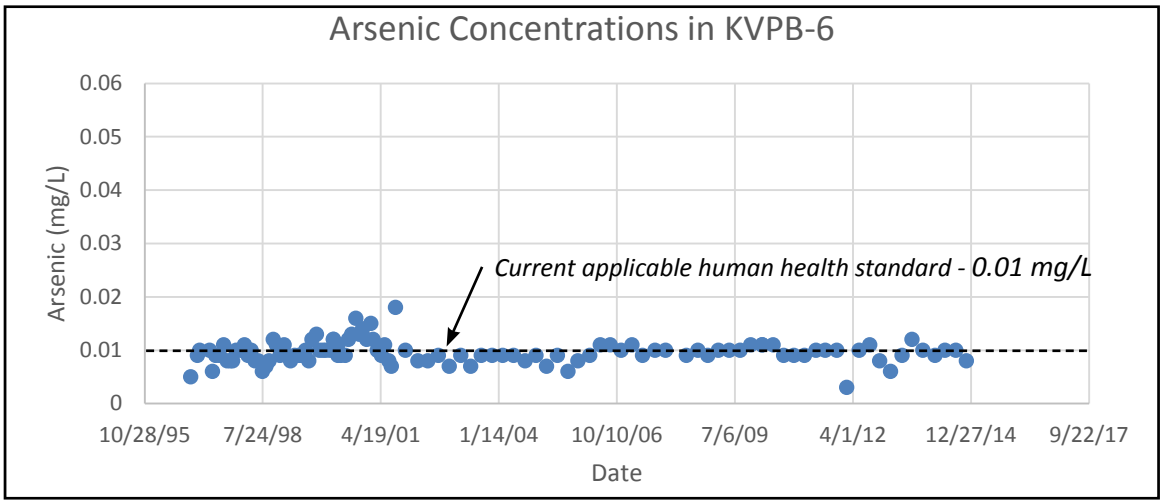


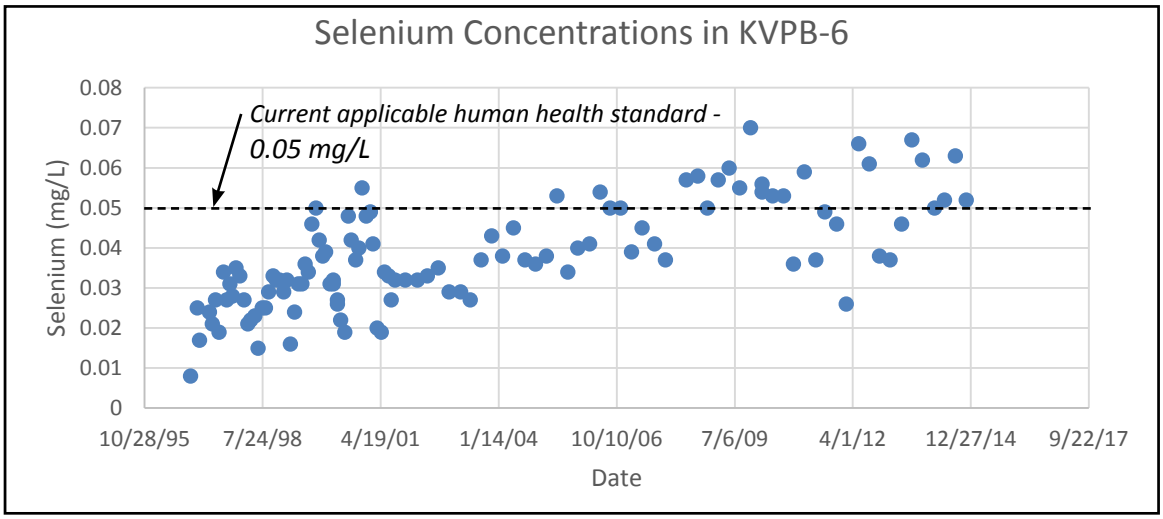


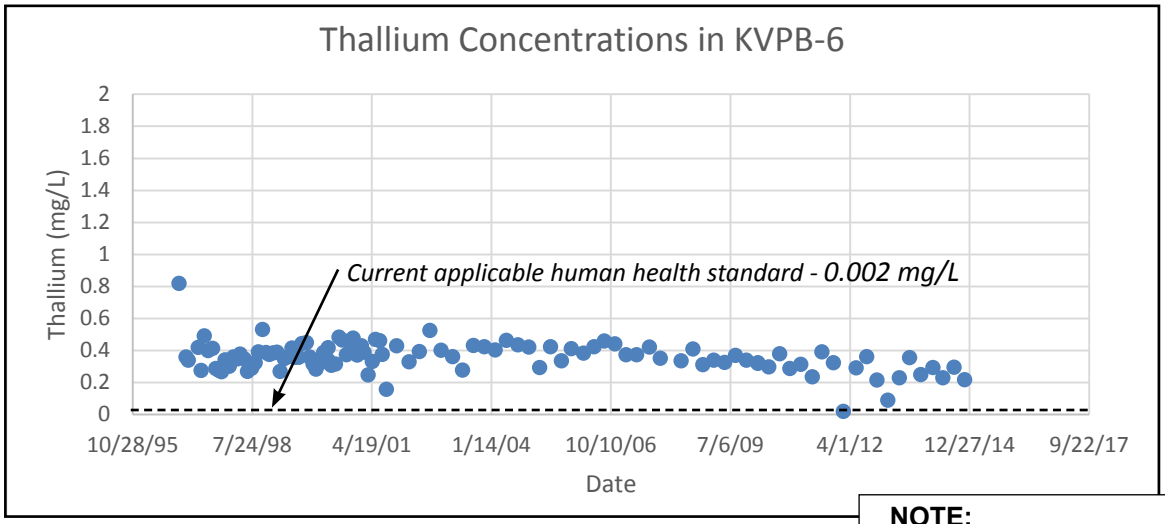


NOTE:
mg/L = Milligrams per Liter

FIGURE A-8
CR Kendall Mine
Arsenic, Selenium, and Thallium Levels in South Fork Little Dog Creek Groundwater (TMW-40D)







NOTE:
mg/L = Milligrams per Liter

FIGURE A-9
CR Kendall Mine
Arsenic, Selenium, and Thallium Levels in South Fork Little Dog Creek Pumpback Water (KVPB-6)

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