PROPOSED PLAN

Proposed Final Cleanup for the Joslyn Street Tailings
State Superfund Facility
Helena, Montana

Prepared by:
Montana Department of Environmental Quality
Remediation Division
1225 Cedar Street
P.O. Box 200901
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May 30, 2019

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ACRONYNMS AND ABBREVIATIONS

ARM – Administrative Rules of Montana
ATSDR – Agency for Toxic Substances and Disease Registry
bgs – below ground surface
BNSF – BNSF Railway Company
CALA – Controlled Allocation of Liability Act
CDC – Centers for Disease Control
CECRA – Montana Comprehensive Environmental Cleanup and Responsibility Act
DEQ – Montana Department of Environmental Quality
DEQ-7 – Montana Water Quality Standards
DHES – Montana Department of Health and Environmental Sciences
EA – Exposure Area
EPA – U.S. Environmental Protection Agency
ERCLs – Environmental Requirement, Criteria or Limitations
Facility – Joslyn Street Tailings Facility
HHRA – Human Health Risk Assessment
MCA – Montana Code Annotated
MDT – Montana Department of Transportation
mg/kg – Milligrams per kilogram
MNA – Monitored Natural Attenuation
RI – Remedial Investigation
SSCL – Site-specific Cleanup Level
µg/dL – Micrograms per deciliter
µg/L – Micrograms per liter
USDA – U.S. Department of Agriculture
USGS – U.S. Geological Survey
VCRA – Voluntary Cleanup and Redevelopment Act

SECTION 1.0 – INTRODUCTION

The Montana Department of Environmental Quality (DEQ) has prepared this Proposed Plan to identify its preferred final remedy for completing cleanup activities at the Joslyn Street Tailings Facility, which is a Comprehensive Environmental Cleanup and Responsibility Act (CECRA – State Superfund) Facility on the edge of Helena in Lewis and Clark County, Montana (Figure 1). DEQ has determined there has been a release or substantial threat of a release of a hazardous or deleterious substance into the environment that presents an imminent and substantial endangerment to the public health, safety, or welfare or the environment. The Proposed Plan identifies and explains DEQ's preferred remedy for addressing this imminent and substantial endangerment. The document also summarizes the cleanup alternatives evaluated for the Facility. DEQ will select the final remedy for the Facility and present it in a Record of Decision after reviewing and considering relevant information, including but not limited to any comments submitted during the public comment period on the Proposed Plan. DEQ may modify the preferred remedy or select another remedy if DEQ determines a different remedy is more appropriate. The public is encouraged to comment and to offer suggestions for improving the remedy or reasons to implement other cleanup alternatives for the Joslyn Street Tailings Facility.

DEQ's issuance of this Proposed Plan complies with its public participation responsibilities under Section 75-10-713, Montana Code Annotated (MCA). This Proposed Plan summarizes information found in greater detail in the Remedial Investigation (RI) documents such as the Supplemental Investigation Report and Data Gap Report, the Feasibility Study (FS), and other documents contained in DEQ's files for the Joslyn Street Tailings Facility. The preferred alternative discussed in the Proposed Plan is based on the information found in these documents and is summarized in sections within this proposed plan. The complete file is available at DEQ's office in Helena.

Montana Department of Environmental Quality
1225 Cedar Street
Helena, MT 59601 Business Hours: Monday - Friday: 8:00 am – 5:00 pm
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SECTION 2.0 – PUBLIC INVOLVEMENT

Public involvement is an important part of CECRA (the state superfund law) and DEQ encourages public comment on this Proposed Plan. The public comment period for the Proposed Plan will extend for 30 days, from June 1, 2019, to 11:59 pm MDT on June 30, 2019. Comments received through the postal service must be postmarked no later than June 30, 2019, and comments submitted electronically must be received no later than 11:59 pm MDT on June 30, 2019. During this time, the public can comment in writing to:

Scott Owen
DEQ Waste Management and Remediation Division
P.O. Box 200901
Helena, MT 59620-0901
or
SOwen2@mt.gov

DEQ will hold a combined public meeting and hearing on June 13, 2019, at 7:30 pm at the Lewis and Clark Library, 120 South Last Chance Gulch, Helena, Montana. DEQ will summarize the preferred remedy in the Proposed Plan during the first segment of the public meeting and will answer questions concerning the preferred remedy. During the second portion of the meeting, questions will not be answered, but DEQ will accept and record verbal comments. A responsiveness summary, which is a written response to public comments (including both written comments and verbal comments from the public hearing), will be included in the Record of Decision.

Verbal comments will not be accepted over the phone; however, you may call Scott Owen for additional information at 406-444-6804.

SECTION 3.0 – BACKGROUND AND REGULATORY HISTORY

The Joslyn Street Tailings Facility (Facility) was operated as a metal ore mill from approximately1935-1938 by Montana Lead, Inc. (Olympus 2011). The facility processed lead ore from the Rimini, Montana area, which left mill tailings as a waste product (Olympus 2011). Tailings were disposed of onto the ground surface, which has caused metals contamination of the soil and groundwater (Olympus 2011). The Green Meadow mill operated prior to permitting requirements on land leased from Northern Pacific Railway (predecessor to BNSF) where mill tailings were disposed. No known milling operations occurred at the site after Montana Lead's bankruptcy in the late 1930s. Little other information is known about the historical operation of the mill.

A portion of the Facility is located within the city of Helena and a portion is located within Lewis and Clark County. The Facility is generally located south of Crystal Springs Road, west of Joslyn Street, primarily north of the Centennial Trail, and east of Tenmile Creek. In broad terms, the Facility is located southwest of the Lewis and Clark County Fairgrounds. The actual Facility boundaries are based on the extent of contamination. Soils and shallow groundwater are contaminated with hazardous or deleterious substances including arsenic and lead resulting from the processing, transportation, and disposal of metal ore tailings from the former ore mill (Olympus 2011).

In 1994, a resident who was living on the facility contacted EPA to report concerns with tailings at the facility (Montana DHES 1994). EPA referred the issue to the Montana Department of Health and Environmental Sciences (predecessor to DEQ) and to the Montana Department of State Lands Abandoned Mine Reclamation Bureau (Montana DHES 1994). The Montana Department of State Lands Abandoned Mine Reclamation Bureau conducted an investigation and discovered elevated arsenic and lead concentrations in the tailings (Montana Department of State Lands, 1994). Using the results from the initial investigations, the Agency for Toxic Substances and Disease Registry (ATSDR) conducted a health consultation in 1994 (ATSDR 1994) and concluded that the site posed a potential risk to people frequenting the site, and recommended additional action.

In 1995, the Montana Department of Health and Environmental Sciences issued notice letters to two parties, informing them of potential liability for the Facility under the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA) (Montana DHES 1995a, Montana DHES 1995b). In 1996-1997, following a 30-day public comment period, BNSF conducted a voluntary cleanup at the facility that consolidated and stabilized visual mine waste tailings to prevent direct contact and leaching to groundwater (Olympus 1996, Olympus 1997). In 1995, the Montana legislature enacted a mixed funding pilot program. The Facility was eligible for the mixed funding and in 1997, BNSF was reimbursed $300,000 for its voluntary cleanup (DEQ 1997). Based upon BNSF's voluntary cleanup, DEQ ranked the Facility as being in operations and maintenance.

In 2002, the Helena School District was exploring irrigation options for Capital High School grounds and additional contamination was discovered near the large well located on BNSF right-of-way (Figure 4). Based upon this new information, DEQ re-ranked the Facility as a high priority (Montana DEQ 2004). This resulted in DEQ sending a letter to BNSF and Walter Crane requesting that additional investigation activities be performed properly and expeditiously (Montana DEQ 2005). This ultimately triggered a supplemental investigation which re-evaluated areas that had previously been evaluated during the voluntary cleanup, and also evaluated areas beyond the tailings footprint addressed under the voluntary cleanup.

In November 2005, BNSF petitioned for allocation under the Controlled Allocation of Liability Act (CALA). As required by CALA, DEQ conducted a good faith investigation to identify potentially liable persons and in 2009 issued notice letters to seven parties, informing them of potential liability for the Facility under CECRA (Montana DEQ 2009a, Montana DEQ 2009b, Montana DEQ 2009c, Montana DEQ 2009d, Montana DEQ 2009e, Montana DEQ 2009f, Montana DEQ 2009g). In May 2009, BNSF purchased a residential home located on the Facility to eliminate potential contaminant exposure to the residents (Olympus 2009).

In 2013, BNSF, Montana Rail Link, and Lewis and Clark County participated in CALA and signed a stipulated agreement (Montana DEQ 2013a). This agreement specified that BNSF would be the lead person in the remediation of the facility. The agreement allows for BNSF to request reimbursement of a portion of the eligible remedial action costs upon completion of certain remedial activities.

In June 2014, BNSF relocated a residential home from the Facility to eliminate potential contaminant exposure to the residents (Arcadis 2014b).

Two other facilities are located near Joslyn Street Tailings Facility. One of these is the CECRA MDOT Maintenance Facility Helena, which lies directly northeast of the Facility (Figure 3). Soil contamination at this facility was addressed under a voluntary cleanup plan submitted by Montana's Department of Transportation (MDT 2009) under the Voluntary Cleanup and Redevelopment Act (VCRA). The other is the Abandoned Mine Lands Spring Meadow Lake Site located southwest of the Facility (Figure 3). Montana's Abandoned Mine Lands program cleaned up soil and sediment around the lake in 2009 and 2010 (Tetra Tech 2010), and residential properties in the area in 2014 (Trihydro 2014).

SECTION 4.0 – PREVIOUS INVESTIGATIONS AND INTERIM REMEDIAL ACTIONS

There have been a number of investigations and interim remedial actions conducted at the Joslyn Street Tailings Facility. These investigations and interim remedial actions are briefly discussed below:

- In 1994, a site investigation was conducted by the Montana Department of State Lands, Abandoned Mine Reclamation Bureau. The investigation noted elevated arsenic and lead concentrations in tailings surrounding the old mill formerly operated by Montana Lead (Montana Department of State Lands, 1994). This data, along with some additional data collected by the Montana Department of Health and Environmental Sciences, was provided to the U.S. Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR evaluated the information and concluded that the Facility may pose health risks to on-site residents and recreators (ATSDR 1994).

- In the fall of 1994, Burlington Northern Railroad conducted site characterization work at the facility and began to estimate the extent of mill tailings. The site characterization report indicated that the tailings generated acid and recommended excavation or reclamation of the tailings area (Olympus 1994).

- In 1995, Burlington Northern Railroad installed three groundwater monitoring wells and conducted groundwater monitoring. The results indicated the approximate direction of groundwater flow was to the northeast, and tailings at the Facility had likely resulted in elevated concentrations of arsenic in the groundwater near the former mill (Olympus 1995).

- In the summer and fall of 1996, Burlington Northern Railroad conducted a voluntary cleanup of tailings. This action included construction of a lined and capped repository on-site in which approximately 12,732 cubic yards of excavated tailings were placed (Olympus 1997). This work was conducted under the Voluntary Cleanup and Redevelopment Act (VCRA), §§ 75-10-730 through 738, MCA and was approved by DEQ in June 1996 prior to work commencing. The assessment and design for the repository considered stability, drainage, potential settlement, infiltration/water balance, acid/leachate production, erosion control, floodplain protection, and revegetation. Ongoing groundwater monitoring and maintenance of the repository are required. See Section 9.1 for further discussion on the constructed repository.

- In 2002, Helena Public Schools approached BNSF to attempt to purchase a large well and property from BNSF in order to irrigate park and school property located east of the Joslyn Street Tailings Facility (Tetra Tech 2002). Helena Public Schools conducted soil sampling around the well as part of due diligence in anticipation of the purchase (Tetra Tech 2002). Sample results exceeded the site-specific cleanup levels established in the 1996 voluntary cleanup plan.

- In 2004, DEQ re-evaluated the ranking of the Facility, based on the Helena School District sampling data that indicated contamination extended beyond the scope addressed during the voluntary cleanup (Montana DEQ 2004). This resulted in the Facility being ranked as a high priority and triggered additional investigation activities.

- In February 2006, BNSF collected 133 soil samples from 12 sample locations (at multiple depth levels) (Olympus 2006). The sample results indicated that soil exceeding the screening levels for lead and arsenic continued to be present in the surface and subsurface soils at the Facility (Olympus 2006).

- In December 2006, BNSF dug 14 test pits to further investigate the surface and subsurface soils (Olympus 2007). The sample results indicated that soil exceeded the screening levels for lead and arsenic at some of the locations sampled (Olympus 2007).

- In 2007-2008, additional groundwater sampling was conducted at the Joslyn Street Tailings Facility. The data indicated that some of the wells exceeded the groundwater standard for dissolved arsenic (Montana DEQ 2009h).

- In May 2009, BNSF purchased a residential property in order to eliminate potential contaminant exposure to residents (Olympus 2009).

- In 2009-2010, BNSF conducted an expanded supplemental investigation. This included collection of soil samples along the active and inactive rail corridors, surface soil sampling in an expanded area to delineate the extent of Facility-related impacts, installation of additional groundwater monitoring wells, and groundwater sampling (Olympus 2011). This investigation continued to indicate arsenic and lead impacts to the soil. The report also identified data gaps.

- In January 2011, Trihydro, working on behalf of Montana DEQ, collected 130 soil samples as part of a naturally occurring lead and arsenic evaluation conducted in the same geologic unit as the Facility (Trihydro 2011). The report established concentration thresholds that may be used as surface and subsurface soil arsenic and lead background levels (Trihydro 2011).

- In September and October 2011, BNSF collected soil samples from residential yards in a mobile home park and from a former rail corridor to help delineate the extent of contamination (Olympus 2011). The results indicated that some residential yards and some portions of the former rail corridor exceeded the site-specific arsenic background concentration (Montana DEQ 2012).

- In May 2012, BNSF collected additional soil samples in the residential yards at the mobile home park, collected additional soil samples along the railroad corridors, and undeveloped portions of the Facility (Olympus 2012). This data was collected to provide additional detail regarding the extent of contamination at the Facility, as well as to determine whether additional contaminants existed at the Facility.

- Between 2013 and 2014, a baseline human health risk assessment was completed. The risk assessment identified contaminants of concern at the Joslyn Street Tailings Facility and established site-specific cleanup levels that may be used for soils and groundwater at the Facility (Arcadis 2014a).

- In June 2014, a residential house that existed on contamination was relocated in order to eliminate potential contaminant exposure to the residents (Arcadis 2014b).

- In August 2014, BNSF collected soil samples from multiple areas of the Facility to further assess the geology/hydrogeology of the Facility and gain a better understanding of the source and mobility of Facility related contaminants. Soil samples were also collected to evaluate the bioavailability of lead found at the Facility (Arcadis 2014c).

- In March and April 2015, samples were collected from 12 groundwater monitoring wells and an additional 9 groundwater monitoring grab samples were collected in the vicinity of well MW6 (Arcadis 2015a). The results indicate that the groundwater impacts to well MW6 are limited in extent and are not contributing to elevated arsenic concentrations in groundwater on the downgradient side of the Facility (Arcadis 2015a). Arsenic impacts to wells MW4 and MW8 appear to be related to reducing conditions (see Section 5.2) in the vicinity of these wells (Arcadis 2015a).

- In September 2015, samples were collected from 16 monitoring wells, including monitoring wells at a nearby Montana Department of Transportation Facility (Arcadis 2015b). The report indicates that arsenic concentrations are generally stable in groundwater monitoring wells at the Facility (Arcadis 2015b). Arsenic impacts to the groundwater appear to be localized and reducing conditions (see Section 5.2) continue to cause arsenic impacts to wells MW4 and MW8 (Arcadis 2015b).

- Between November 2015 and June 2016, contaminated soils were removed from one residential yard and along the Centennial Trail expansion corridor (an idle former railroad corridor) (Arcadis 2016a). Confirmation sampling was conducted to ensure soil contamination that exceeded site-specific cleanup levels was removed.

- In May 2016, DEQ conducted an investigation in the vicinity of monitoring wells MW4 and MW8 to determine if reducing conditions are present. This investigation was prompted by DEQ staff noting the presence of wetland vegetation in this area of the Facility. The investigation documented hydric soils, which indicate subsurface reducing conditions occur in these locations. Section 5.2 provides more detail on this investigation (DEQ 2016).

- In August 2016, three new monitoring wells were installed to provide additional information on groundwater conditions downgradient of areas of known groundwater contamination (Arcadis 2016b). Soil was also analyzed from the drill cores obtained from the well installation and was found to have naturally occurring background concentrations of lead and arsenic (Arcadis 2016b).

- The groundwater monitoring wells at the facility were sampled in April and September 2016 (Arcadis 2016c) during high and low groundwater elevations. The monitoring events confirmed that the groundwater flow direction continued to be to the northeast, and arsenic in monitoring wells MW4 and MW8 continues to be elevated by naturally occurring reducing conditions (see Section 5.2) in the vicinity of these wells (Arcadis 2016c). Dissolved arsenic concentrations continued to be stable (Arcadis 2016c). The three monitoring wells installed in August 2016 indicated that groundwater in those locations did not exceed the human health standard (DEQ-7 standard) for arsenic (Arcadis 2016c).

- In 2017, in response to concerns received by local citizens, surface soil at two residential yards east of the former mill was sampled. The sample results indicated the soils in this area were below the residential site-specific screening levels for arsenic and lead (DEQ 2018d).

- In 2016 and 2017, BNSF prepared a feasibility study to evaluate various cleanup options at the Facility. The feasibility study provides a technical review of cleanup alternative effectiveness, costs associated with those alternatives, and compliance with cleanup criteria. An evaluation of the alternatives is included in Section 8.0 (Arcadis 2017).

- In 2018, BNSF removed contaminated soil from five residential yards in the Mobile City mobile home park. Contaminated soil was excavated and disposed in an off-site landfill (Arcadis, 2019). Confirmation sampling was conducted to ensure soil contamination that exceeded site-specific cleanup levels was removed (Arcadis 2019). Placement of topsoil and revegetation of these areas will occur in 2019. There is one remaining area within the mobile home park (sample SS31 – Figure 5) that does not meet the residential site-specific cleanup level (SSCL) for arsenic. Analytical data from the most recent 2009 sampling activities indicated that this sample contained 54.4 milligrams per kilogram (mg/kg) of arsenic (the residential arsenic SSCL is 49.6 mg/kg). This area was not excavated during the interim action because it is located beneath the paved street and the pavement prevents exposure to the residents. In addition, the adjacent yard did not exceed SSCLs. This individual sample location was collected from 0-6" beneath the asphalt surface and represents a small area, and does not exceed the arsenic SSCL for construction workers (515 mg/kg) who may perform work beneath the pavement.

SECTION 5.0 – FACILITY CHARACTERISTICS

The following summarizes some of the characteristics of the Joslyn Street Tailings Facility.

5.1 Climate and Setting

The Joslyn Street Tailings Facility is located at an elevation of approximately 3,900 feet above sea level within the Helena valley, which is generally flat, sloping gently to the north and east. The facility is bordered to the east by the Ryan Park athletic fields, to the south by the Mobile City Home Park, and to the north and west by open meadows and woods. An active railroad line crosses the facility from northeast to southwest. Tenmile Creek is located northwest of the facility and flows to the northeast.

The climate is semi-arid. The closest weather station to the facility is the Helena Airport, which provides data to the National Climatic Data Center, part of the National Oceanic and

Atmospheric Administration. Based on weather data averages from this station between 1981 and 2010, the average annual precipitation is 11.22 inches, with the wettest months being May and June (National Climatic Data Center 2018). The mean annual temperature is 45.3 degrees Fahrenheit, ranging from a mean monthly temperature of 21.8 degrees Fahrenheit in December to a mean monthly temperature of 70.0 degrees Fahrenheit in July (National Climatic Data Center 2018). During the 2017 calendar year, wind speed averaged 6 miles per hour, with gusts as high as 56 miles per hour (Weather Underground 2018). Winds are typically from the west (Weather Underground 2018).

5.2 Geology

Briar and Madsen (1992) provides a description of geology and hydrogeology of the Helena Valley basin which consists of sedimentary, metamorphic, and igneous rocks from the Precambrian to Cretaceous age. The valley is underlain by valley fill to an estimated depth of 6,000 feet consisting of fine and coarse-grained Tertiary sediments overlain by approximately 100 feet of Quaternary alluvium. The west side of the valley where the Facility is located is underlain by this alluvium and consists of coarse, moderately sorted, and well-rounded to sub-rounded cobbles, gravel, and sand intercalated with silt and clay. However, the southeastern portion of the Facility is underlain by colluvium composed of poorly sorted, unstratified gravel, sand and silt deposits. Monitoring wells MW1 and MW10 are installed in this colluvium (Olympus 2011).

The Natural Resources Conservation Service identifies three soil class combinations within the boundary of the Joslyn Street Tailings Facility: Meadowcreek-Fairway, Crittenden-Kalsted, and Musselshell-Crago (USDA 2018). These soil classes are mixtures ranging from loam to gravel (USDA 2018). The topsoil at the facility supports vegetation, but is also well drained, which minimizes the timeframe for plant growth to occur without irrigation (USDA 2018). DEQ conducted a field investigation in May 2016 (DEQ 2016) to determine if hydric (wetland) soils occur in the areas of MW4 and MW8, which would indicate reducing conditions and explain elevated levels of arsenic occurring in groundwater in those wells. Based on the investigation of the areas in the vicinity of MW4 and MW8, it does appear that reducing conditions are occurring in the subsurface due to the presence of hydric soils that could account for the observation of increased arsenic in groundwater collected from these wells.

5.3 Groundwater

The Helena valley aquifer is an unconfined aquifer system. The upper few-hundred feet of the aquifer are best described as a sequence of complexly stratified lenses of cobbles, gravels, and sand, with abundant (30 to 70 percent) intercalated silt and clay (Briar and Madison 1992). Due to disconnected lenses containing high contents of silt and clay and large variation in aquifer particle sizes, permeability of the aquifer varies widely. However, lateral discontinuity of the fine-grained layers allows hydraulic interconnection of the coarse-grained water-yielding zones, which therefore function as one complex aquifer system. Hydraulic conductivities, estimated from slug test data collected at each alluvial monitoring well (except MW1, MW11, MW12, and

MW13), ranged from 0.48 foot per day (MW10) to 147 feet per day (MW6) with an arithmetic mean of 29 feet per day (Olympus 2011a).

Depth-to-groundwater in alluvial monitoring wells at the Facility is generally less than 10 feet below ground surface (bgs). Alluvial groundwater levels exhibit seasonal fluctuations and are generally higher in the spring than the fall. Seasonal groundwater fluctuations have been observed to be as large as 3 feet (e.g., monitoring well MW1); however, the fluctuations are variable across the Facility. Groundwater flow at the Facility is consistently to the northeast and north-northeast as measured during ten groundwater monitoring events between 2006 and 2015. Estimated horizontal hydraulic gradients range from 0.015 and 0.019 feet/foot (Olympus 2011). Vertical hydraulic gradients could not be directly measured due to the lack of nested monitoring wells at the Facility; however, groundwater in the area reportedly has a downward flow component (Briar and Madison 1992).

This aquifer system is believed to be primarily recharged by Tenmile Creek, with a smaller amount of recharge likely also occurring from surface water infiltration (Olympus 2011). During recent groundwater monitoring events, groundwater was encountered at approximately 2 to 12 feet below monitoring well casings (Arcadis 2016c). Montana regulations ARM 17.30.1006 classify groundwater as Classes I through IV, with class I being the highest quality and class IV being the lowest quality (ARM 17.30.1006). Based on specific conductance measurements, groundwater at the Facility would be classified as a Class I aquifer, meaning that concentrations of contaminants may not exceed the human health standards for groundwater listed in DEQ-7, Montana Numeric Water Quality Standards 2017. In addition to surface water sources (see Section 5.4), the City of Helena produces drinking water from the Eureka well located at Cruse and Park Avenue near the downtown area. This well is located approximately 2.2 miles to the southeast and is not at risk of contamination from the Facility.

Olympus (2011) identified four water wells at or immediately downgradient of the Facility:

- An irrigation well on property owned by BNSF.
- Two former domestic wells on property owned by BNSF. These wells are no longer used for domestic purposes.
- A 32-foot diameter open well on property owned by BNSF that was historically used for providing water to the locomotives.

The MDOT Maintenance Facility Helena and the Joslyn Street Tailings Facility also have numerous monitoring wells installed to sample groundwater conditions. There is also an irrigation well (Woolston well) located in the northwest corner of the MDOT facility that is used for watering the Ryan Park ball fields. This is a hand dug well, approximately 20 to 30 feet in diameter and 20 to 30 feet deep. No other wells are known to exist at or near the Joslyn Street Tailings Facility.

Naturally occurring levels of elevated arsenic in groundwater have been determined to occur in the areas of monitoring wells MW4 and MW8 at the Facility. In 2016, DEQ personnel conducted a field investigation after noting the presence of wetland vegetation in the area of MW4 and MW8. Reducing conditions within those areas were determined to be a likely contributor to arsenic exceedances above DEQ-7 in those areas (DEQ 2016).

5.4 Surface Water

In addition to the Eureka well, the City of Helena obtains drinking water for the Helena municipal water system from the Missouri River and from Tenmile Creek (and from several tributaries of Tenmile Creek) near the town of Rimini (City of Helena 2018a). The water intakes for these sources are not within the Joslyn Street Tailings Facility and are located upgradient of the Facility.

Generally, no year-round surface water features are present at the Joslyn Street Tailings Facility. Tenmile Creek is located west and northwest of the Facility. The City of Helena/Lewis and Clark County maintain storm water detention ponds east of the Facility. A low-lying area along the active rail corridor, northwest of the large diameter well (Figure 4), briefly collects some surface water during periods of precipitation that infiltrates into the subsurface. This area was identified as having reducing conditions that likely influence conditions in groundwater monitoring wells MW4 and MW8 (Figure 4), DEQ 2016). Surface water has also been observed on both sides of the former Great Northern Railway Line during spring runoff conditions (Figure 13). These are low lying areas north and south of the abandoned rail bed that periodically contain surface water as a result of receiving runoff from a pasture area directly to the south. These ephemeral waters flow beyond the abandoned rail bed to a wetland area. Stormwater also collects in a limited area directly south and adjacent to the active rail line but is confined to the site. Surface waters within the boundaries of the facility fall within the Tenmile Drainage and would be classified as A1. Other nearby surface waters include Spring Meadow Lake to the southwest and a duck pond located at the Lewis and Clark County Fairgrounds.

5.5 Facility Contamination

DEQ evaluated data collected during initial Facility investigations, during and after the voluntary cleanup, data collected during the supplemental investigation, and data collected subsequent to the supplemental investigation to identify sources of contamination, determine the extent of contamination in soils and groundwater, determine risks to human health and the environment, and evaluate cleanup options. Specific sampling data and the extent of contamination is briefly summarized below.

5.5.1 Groundwater

Groundwater sampling has occurred at the Facility beginning in 1995 and continuing to the present. Initially, groundwater sampling was limited to three monitoring wells. More monitoring wells were subsequently installed to better understand the extent of groundwater contamination. Currently, there are 13 monitoring wells being sampled at the Facility twice a year. Groundwater samples are analyzed for chloride, sulfate, alkalinity, nitrate/nitrite, dissolved organic carbon, orthophosphate, arsenic, lead, iron, and manganese. The most recent sampling results (2018) indicate that arsenic is the only groundwater contaminant that exceeds the Montana Numeric Water Quality Standards (DEQ-7 standards) (Arcadis 2018). Dissolved arsenic concentrations in monitoring wells MW3A, MW5, MW6, MW12, MW14, and MW15 exceeded the DEQ-7 standard during 2018 (Arcadis 2018). Figure 4 indicates the approximate areas of arsenic in groundwater that exceed the DEQ-7 standard of 10 micrograms per liter (ug/L). Groundwater impacts are limited to these three localized areas.

Historic groundwater sampling included drinking water wells and an irrigation well at the Facility. The drinking water wells and irrigation well have never exceeded DEQ-7 standards. The drinking water wells are no longer in service and the irrigation well is not being sampled due to concerns over quality of the data from that well. The drinking water wells no longer in service will be properly abandoned and decommissioned as per the Administrative Rule of Montana (ARM) ARM 36.21.810. Groundwater is currently being utilized for Ryan Ball fields from an irrigation well not associated with the Facility. Past sampling of the Ryan Ball fields irrigation well indicated that it did not exceed cleanup levels for chemicals of concern at the Facility.

5.5.2 Surface Water

Surface water and storm water have not been sampled at the Facility. As explained in Section 5.4, surface water is seasonally present on the Facility in the area of the abandoned rail bed. Tenmile Creek, the most significant surface water body in the vicinity, recharges the groundwater in the vicinity (i.e. the creek loses surface water to the underlying groundwater), which makes it unlikely that contaminated groundwater from the Facility could drain into Tenmile Creek and impact the surface water (Olympus 2011). A potential for contaminated surface water contact exists in the form of pooled storm water runoff during periods of high precipitation. When surface soil is remediated, contact with storm water is not expected to result in significant human or ecological exposure. Remediation of surface soil will remove the source of potential surface water contamination from storm water runoff (when present) and mitigate potential risk associated with human and ecological exposure to this media. Therefore, no separate remedial alternative or action is necessary to address surface water.

5.5.3 Soil

Over 700 soil samples have been collected at the Facility, including samples from Ryan Ballfields and nearby residences. Analyses included metals, petroleum hydrocarbons, pesticides, and herbicides. Railroad ballast was also sampled. Contaminants determined to be present in soil at the Joslyn Street Tailings Facility are polycyclic aromatic hydrocarbons (PAHs), arsenic, and lead (Arcadis 2014a). Arsenic is the primary contaminant at the Facility and is found in surface soil, and groundwater. There are limited areas where lead is present in surface and subsurface soil. Arsenic has been detected in Facility soils at concentrations ranging from below background levels (49.9 mg/kg and 149 mg/kg for surface soils and subsurface soils, respectively) to 7,970 mg/kg (Arcadis 2014c). Lead has been detected in Facility soils at concentrations ranging from 0.9 mg/kg to 85,965 mg/kg.

In 2010, DEQ conducted an investigation of background metals concentrations in soil (TriHydro 2011). At the Facility, representative background arsenic concentrations have been measured to be 49.6 mg/kg in surface soil (<2 feet bgs) and 149.2 mg/kg in subsurface soil (>2 feet bgs).

SECTION 6.0 – SUMMARY OF BASELINE HUMAN HEALTH RISK ASSESSMENT

In 2014, Arcadis, on behalf of BNSF, completed a Baseline Human Health Risk Assessment (HHRA), which identified constituents of potential concern (potential contaminants), evaluated exposures, conducted a toxicity assessment, and calculated SSCLs for soil and groundwater at the Joslyn Street Tailings Facility. The risk assessment identified that lead, arsenic, and benzo(a)pyrene equivalents were the only three contaminants of concern that are present above the SSCLs for the facility. In 2014, Arcadis, on behalf of BNSF, conducted a bioavailability assessment to use Facility specific lead information to revise site specific cleanup levels (Arcadis, 2014d). The SSCL for arsenic in soil (leaching to groundwater value) was subsequently revised (DEQ 2015). Revisions to EPA toxicity values for benzo(a)pyrene in January 2017 and updated SSCL calculations resulted in no exceedances of benzo(a)pyrene equivalents above the SSCLs at the Facility; therefore, it was subsequently removed as a contaminant of concern (Arcadis, 2017). In October 2018, DEQ issued a memorandum noting that revised cleanup levels for lead would be based on the 5 micrograms per deciliter (ug/dL) blood lead endpoint (DEQ 2018c) versus the 10 ug/dL blood lead endpoint that had been used prior to that time.

The risk assessment identifies the extent of contamination that exceeds site-specific cleanup levels for surface soil, subsurface soil, and groundwater. The feasibility study identifies the extent of subsurface soils and groundwater exceeding the site-specific cleanup levels for lead and arsenic (Arcadis 2017). Soil and/or groundwater that exceeds the site-specific cleanup levels is present in eight exposure areas (EAs) identified in the HHRA. DEQ re-evaluated the data based upon the 5 ug/dL blood lead endpoint and determined that the SSCLs are exceeded in the same eight EAs (1, 3, 4, 5, 6, 9, 10, 11 – Figure 10) as identified in the HHRA.

The risk assessment indicated that there is no domestic use of the groundwater at the Facility. However, there is a potential for construction workers to be exposed to the water, and groundwater is used for irrigation near the Facility. In some locations, contamination also has the potential to leach from soil into the groundwater.

6.1 Future Anticipated Land Use

DEQ has evaluated the reasonably anticipated future use of the Joslyn Street Tailings Facility by assessing the four factors found in 75-10-701(18), MCA. This includes:

1) Local land use and resource use regulations, ordinances, restriction, or covenants.
2) Historical and anticipated uses of the Joslyn Street Tailings Facility.
3) Patterns of development in the immediate area.
4) Relevant indications of anticipated land use from the owners of the Joslyn Street Tailings Facility and local planning officials.

Based on this assessment, DEQ has come to the following conclusions:

1) The Ryan Park Ballfields are zoned PLI - Public Lands and Institutions. This zoning designation applies to recreational, educational, and public service use designed for the general public's benefit (City of Helena 2018b). The far southeastern portion of the BNSF active railway corridor is zoned CLM – Commercial Light Manufacturing. This zoning designation allows for certain commercial and industrial uses, but also allows for residential uses in some instances (City of Helena 2018b). Residential use in an area zoned CLM is permitted by right in a building story that is above retail or commercial use. A conditional use permit would be necessary for that use to be allowed (Helena, Montana, Municipal Code Title 11-2-3). The Mobile City Mobile Home Park property that is actively used for residential purposes within the Facility is zoned R-3 – Residential, which allows for a mixture of residential uses (City of Helena 2018b). The residential property located at the northwest of the Facility is within the county zoning designation Special Zoning District #25 (Racetrack Meadows). This zoning designation allows for single-family residential use, with agricultural use as well and limits the density of the housing (Lewis and Clark County 2018). The remainder of the Facility is unzoned.

2) At some time during the early history of development of the Helena area, numerous railroad tracks were constructed within the area that is now the Joslyn Street Tailings Facility. The Lewis and Clark County Fairgrounds were constructed to the northeast of the main portion of the Facility in 1870. Between 1935 and 1938, an ore mill was constructed and tailings were disposed of on the ground surface (Olympus 1994). After the mill ceased operation, a mobile home park, other residences, and a park were constructed at the Facility (USGS 2008). Land within the Facility appears to have been used for transportation, ore processing, agriculture, residences, and recreation. With the exception of ore processing, all of these uses continue at the Facility. Currently, a warehouse located in the Green Meadow Mill area is on property owned by Montana Rail Link and used for storage purposes. The Centennial Trail divides the Mobile City property and is used for recreational purposes.

3) Both the City of Helena and Lewis and Clark County have been growing faster than the national average (Census Bureau 2018). Between 2010 and 2017, the population of Lewis and Clark County increased by 6.9% (4,378 residents) and the City of Helena grew by 11.3% (3,188 residents) (Census Bureau 2018). Review of USGS aerial photographs from 1947, 1978, and 2008 indicates that significant development occurred along the northwest portion of Helena between 1947-1978 (USGS 1947, USGS 1978, USGS 2008). Much of the area appeared to be agricultural in 1947, with sparse residential development (USGS 1947). By 1978, significant portions of the agricultural land had been converted to residences (including part of the mobile home park within the Facility boundary), Custer Avenue had been extended to the west, Capital High School had been built, and baseball fields are visible at Ryan Park (USGS 1978). By 2008, additional residential development had occurred along Brady Street, directly east of the Facility, road improvements had been made to Joslyn Street/Brady Street, a storage facility had been constructed along Joslyn Street, and additional residential structures were present on the Joslyn Street Tailings Facility west of Ryan Park (USGS 2008). The development patterns and the population increase in the area suggest that the property within and surrounding the Facility will continue to face development pressures into the future.

4) DEQ sent letters to all property owners within the Facility, asking how the property owners plan to utilize their properties in the future. Arthur Mann and Jon Satre responded and said that future use of their properties would likely be residential (DEQ 2018a, DEQ 2018b). Kelly Kugler, owner of Mobile City Home park responded and explained that future use of the currently-developed mobile home park is unlikely to change, and that future use on the property adjacent to the railroad tracks is likely to remain for recreational vehicle storage purposes only (Kugler 2018). BNSF and MRL responded and explained that they anticipate both the rail corridor and adjacent land that they own to either remain undeveloped or be used for commercial/industrial purposes consistent with railroad operations (BNSF 2018, Montana Rail Link 2018). Lewis and Clark County responded and explained that it does not anticipate the use of the Ryan Park Ballfields or the fairgrounds to change in the near future (Lewis and Clark County 2018). The Laborers AGC Training Program responded and explained that the facility is currently used both for excavation training (digging on the property) and for groups that use the property for picnicking and wildlife observation and that they do not anticipate the use to change in the future (Laborers 2018).

The Joslyn Street Tailings Facility is in an area that is anticipated to continue growing, based on development patterns in the area. Portions of the Facility have unique characteristics that make some future uses either more or less likely. Some of these characteristics include the active railroad line, County ownership of park land/fairgrounds, and proximity to existing residential development. Property owners have expressed their intentions regarding future use of the properties. Based upon evaluation of the four statutory factors, DEQ has identified the reasonably anticipated future uses of the Joslyn Street Tailings Facility (see Figure 3) as follows:

a) DEQ anticipates future use of the areas currently developed as a residential mobile home park, and the Centennial Trail corridor, to remain residential in the future. Centennial Trail has been designated as residential in this area due to the proximity of adjacent mobile homes. The trail serves as an extension of the residential yards within the mobile home park allowing children that reside there to utilize the trail area.

b) DEQ anticipates the properties owned by Arthur Mann and Jon Satre will likely be developed for residential use at some point in the future.

c) DEQ anticipates that the BNSF, Montana Rail Link, and portions of the Mobile City recreational vehicle storage area adjacent to the railroad tracks (parcel geocodes 05-1887-21-1-19-25-1000, 05-1887-21-1-19-25-1001, and 05-1887-23-1-19-30-0000) will be used for commercial/industrial purposes in the future. There is also a warehouse on property leased from BNSF by Montana Rail Link that is expected to continue to be used for commercial use.

d) DEQ anticipates that the Ryan Park Ballfields will continue to be used for recreational purposes in the future.

e) DEQ anticipates that the use of the Fairgrounds will remain as commercial/industrial because the people who are on this property most frequently are workers who maintain and run the Fairgrounds complex. There will also be periodic recreational use.

f) DEQ anticipates that the future use of the Laborers AGC Training Program property will be residential. The existing use of the property is unique; it is used both for recreational use (wildlife viewing, picnicking) and for training in how to safely excavate. The routine disturbance of soils on this property for training purposes could result in contaminated subsurface soils being brought to the surface. This is a property that could easily be converted to residential use due to zoning and the layout of the property. This site differs from the Fairgrounds complex in that it would not require a drastic change of structures, etc. to be used as a residential property.

6.2 Human Health Risks

BNSF evaluated the risk to current and potential future receptors as part of the Baseline Human Health Risk Assessment (Arcadis 2014a). Site-specific cleanup levels designed to be protective of the future use scenarios were calculated. Scenarios considered include residents, indoor and outdoor commercial/industrial workers, construction workers, recreators, and railroad workers. A conceptual site exposure model from the Human Health Risk Assessment is provided as Figure 11 of this proposed plan. Soil and groundwater are the two pathways that could result in unacceptable exposure to contaminants at the Facility. Although areas of groundwater contain arsenic above the site-specific cleanup level, there are currently no users consuming the contaminated groundwater.

BNSF calculated site-specific cleanup levels for the Facility. Contaminants of potential concern were identified based on detection frequency and exceedance of screening levels. Contaminants were evaluated based on their critical effect (i.e. cancer or non-cancer health effects). Cleanup levels were calculated to ensure that lifetime excess cancer risk[1] does not exceed a one in 100,000 increased risk of developing cancer. For contaminants that have a non-cancer health effect, cleanup levels were calculated to ensure that the hazard quotient does not exceed 1 for any target organ or effect (i.e. the cleanup level is below the threshold concentration at which non-cancer health effects may be observed).

Because the Facility has elevated naturally occurring background metal concentrations, the background level is used as a baseline for cleanup in instances when the cleanup level would otherwise be below background concentrations. Lead is evaluated using EPA modeling methodology that is intended to ensure that the cleanup level will result in a high probability (95% probability) that blood lead concentrations will not exceed certain criteria. Per EPA guidance, DEQ required BNSF to evaluate a target blood lead concentration of 5 ug/dL and 10 ug/dL.

6.3 Determination of Contaminants of Concern and Site-Specific Cleanup Levels

In the Baseline Human Health Risk Assessment, BNSF identified the contaminants of potential concern for the Joslyn Street Tailings Facility. Arsenic and lead are the two contaminants of

[1] Lifetime excess cancer risk is risk from Facility-related contamination. The term “excess” is used because all individuals have a baseline risk of getting cancer from sources not related to the Facility, such as from ultraviolet sunlight exposure, vehicle emissions, or diet.

concern for surface and subsurface soil. Arsenic is the only contaminant of concern with documented exceedances of the groundwater standard (DEQ-7 standard). Benzo(a)pyrene equivalents were initially identified as a contaminant of concern in the HHRA; however, EPA revisions to toxicity data in January 2017 and subsequent recalculation of site-specific cleanup levels based on DEQ's revised Risk Based Corrective Action (DEQ 2018e) values resulted in benzo(a)pyrene equivalents being removed as a contaminant of concern (Arcadis 2017). A brief discussion about the health effects from exposure to the contaminants present at the Joslyn Street Tailings Facility is provided below.

According to ATSDR (2007a), human exposure to lead occurs primarily through diet, air, drinking water, dust, and paint chips. The efficiency of lead absorption depends on the route of exposure, age, and nutritional status (ATSDR 2007a). It also depends upon the bioavailability (rate and extent of absorption) to receptors based on site-specific conditions (e.g., type of lead, how tightly it is bound to soil particles, etc.). In many human populations, exposure to elevated lead levels can create an increased risk of high blood pressure (ATSDR 2007a). The most sensitive system is the central nervous system, particularly in children (ATSDR 2007a). Irreversible brain damage occurs at blood lead levels greater than or equal to 100 micrograms per deciliter (µg/dL) in adults and at 80 to 100 µg/dL in children; death can occur at the same blood levels in children (ATSDR 2007a). For children in particular, lead exposure can lead to a decrease in brain development and learning abilities, particularly with arithmetic and reading skills (ATSDR 2007a).

The most common exposure route for arsenic is through diet, though exposure to dusts or soils containing arsenic may also result in unintentional ingestion (ATSDR 2007b). Ingestion of extremely high concentrations of arsenic may result in stomachache, nausea, vomiting, and diarrhea (ATSDR 2007b). Long-term ingestion of arsenic may result in patches of darkened skin or bumps (ATSDR 2007b). Arsenic exposure has also been associated with skin, liver, bladder, and lung cancer (ATSDR 2007b).

When evaluating the inhalation of soil in calculating the soil cleanup level, indoor workers were treated the same as outdoor workers, as future commercial/industrial use may not be limited to indoor or outdoor worker activity. Therefore, DEQ is proposing the more protective of the SSCLs for commercial/industrial workers (the outdoor worker value).

The following sections provide a discussion of contaminants of concern for each media (i.e. groundwater and soil) and provide a discussion of the calculation of site-specific cleanup levels. The site-specific cleanup levels establish acceptable levels of cleanup that are protective of human health associated with soil and groundwater, and are protective of the environment by minimizing the migration of contaminants from soil into the groundwater at levels that could exceed groundwater cleanup levels.

6.3.1 Groundwater

The groundwater contaminants of concern at the Joslyn Street Tailings Facility are lead and arsenic. As discussed in Section 5.3, groundwater at the Facility is designated as a Class I. The Montana Numeric Water Quality Standards (DEQ-7 standards) identify human health standards to ensure that the groundwater is adequately protective of human health (DEQ 2017). Arsenic is the only contaminant observed at the Facility above the DEQ-7 standard. However, since lead is a contaminant in the soil at the Facility, lead is also monitored as a groundwater contaminant of concern to ensure that lead leaching to groundwater does not exceed the DEQ-7 standard in the future. Leaching to groundwater is further discussed in Section 6.3.2.3 below.

The three areas of groundwater at the Facility that exceed the DEQ-7 groundwater standard are identified on Figure 4. Groundwater standards for the Joslyn Street Tailings Facility contaminants of concern are identified on Table 1. No evidence exists to indicate that tailings were deposited within the areas of monitoring wells MW4 and MW8. As noted in sections 5.2 and 5.3, DEQ has determined that arsenic exceedances in monitoring wells MW4 and MW8 are due to naturally occurring conditions in those locations. Reducing conditions, based on evidence of hydric (wetland) soils, have led to elevated arsenic concentrations in those two locations. Due to these naturally occurring conditions, groundwater from MW4 and MW8 was not evaluated as part of the alternatives for groundwater remediation.

6.3.2 Soil

Lead and arsenic are the contaminants of concern in surface and subsurface soil at the Joslyn Street Tailings Facility. The human health risk assessment considered cancer and non-cancer health effects to calculate site-specific cleanup levels protective of current and potential future uses (Arcadis 2014a). Since the human health risk assessment, site-specific cleanup levels for lead were revised by DEQ based on adoption of an updated reference level for blood lead of 5 ug/dL versus the former 10 ug/dL reference level (DEQ 2018c). The overall factors used in this assessment are described briefly in Section 6.2 and are described in detail in the Baseline Human Health Risk Assessment. The potential human exposure pathways are discussed below.

The potential for direct contact with contaminants is considered to be a primary driver for the need for cleanup at the Facility. The potential for contaminants to leach from the soil to the groundwater is an interrelated issue that will also drive the need for cleanup. Initially, benzo(a)pyrene equivalents were also believed to be a contaminant of concern. However, revised toxicity data from EPA indicated that the concentrations of benzo(a)pyrene equivalents present that the Joslyn Street Tailings Facility do not pose unacceptable risk (Arcadis 2017). Areas of the Joslyn Street Tailings Facility that exceed the site-specific cleanup levels are identified on figures 5 through 9.

6.3.2.1 Direct Contact

Direct contact is exposure to the contaminated soil through skin contact adsorption and unintentional ingestion of particles (for example, dust on hands may unintentionally be eaten during meals). The Joslyn Street Tailings Facility includes current or potential future use by residents, commercial/industrial workers, construction workers, railroad workers, and recreators (i.e. visitors using Ryan Park). Site-specific cleanup levels were developed for all of these scenarios except recreators (see Table 1). Because the risk assessment determined that contaminants observed on the Ryan Park property do not pose an unacceptable risk for recreators, a recreator site-specific cleanup level was not necessary (Arcadis 2014a).

Recreational use is also present on the Centennial Trail, which runs through the center of the Mobile City mobile home park. Because the Centennial Trail within the facility is adjacent to mobile home yards and are used by children as an extension of those yards, the more protective residential cleanup levels will be applied to the trail within the Facility.

Background arsenic concentrations at the Joslyn Street Tailings Facility are elevated due to naturally-occurring arsenic (Trihydro 2011). The development of site-specific cleanup levels account for background metals concentrations. Therefore, the background arsenic concentration is used as the residential site-specific cleanup level at the Joslyn Street Tailings Facility. Background metals concentrations did not change any of the other site-specific cleanup levels because the cleanup level calculated for all other scenarios was above the background metal concentration.

Lead was evaluated using EPA's adult lead modeling (for adults) and using EPA's Integrated Exposure Uptake Biokinetic model (for children) to derive cleanup levels designed to result in blood lead levels that are below specified thresholds (Arcadis 2014a). In 2012, the Centers for Disease Control (CDC) identified a blood lead level of 5 µg/dL as the level above which significant health risks may occur (CDC 2012). DEQ requires that cleanup levels at facilities containing lead in soil must be protective of the 5 ug/dL blood lead end point (DEQ 2018c).

6.3.2.2 Leaching to Groundwater

Leaching to groundwater is the process of soil contaminants moving through the soil and into the groundwater via infiltration of precipitation or by the contaminants being in direct contact with the groundwater. Lead and arsenic are present in soils at the Joslyn Street Tailings Facility at concentrations sufficient to potentially leach to groundwater. Therefore, site-specific cleanup levels were calculated to prevent future leaching of arsenic and lead to groundwater at concentrations that could result in the groundwater exceeding the DEQ-7 groundwater standard. Figure 9 identifies the locations of samples that exceed the site-specific cleanup levels for leaching to groundwater.

6.4 Ecological Risk Assessment

Ecological risks were evaluated qualitatively and are summarized in the Baseline Human Health Risk Assessment. Although much of the Joslyn Street Tailings Facility is not developed, the Facility is not particularly attractive to wildlife in the area (Arcadis 2014a). No year-round surface water is available within the Facility and more suitable habitat for wildlife is available in the Helena National Forest which lies west of the Facility (Arcadis 2014a). Noise from the active rail line, recreational baseball fields, and nearby roadways may also make the Facility less attractive to wildlife (Arcadis 2014a). Small mammals and birds are present at the Facility at times, but the qualitative assessment concluded that the risk to wildlife would not be significant

(Arcadis 2014a). Remediation of the surface soils for protection of human health and leaching to groundwater will further reduce any minimal risks to wildlife that may exist.

6.5 Summary of Contaminants Exceeding Site-specific Cleanup Levels

This section summarizes the contaminants of concern that exceed site-specific cleanup levels (see Table 1) at the Joslyn Street Tailings Facility.

1. **Surface soil (0-2 feet below ground surface) –** Lead and arsenic.

2. **Subsurface soil (2 – 10 feet below ground surface)** – Lead.

3. **Groundwater** – Arsenic.

4. **Surface water** – No year-round surface water is present at the Facility. However, remediation of surface soil will address any future potential for onsite surface water or storm water to become contaminated.

SECTION 7.0 – PRELIMINARY REMEDIAL ACTION OBJECTIVES

This section summarizes preliminary remedial action objectives. DEQ established these preliminary remedial action objectives to allow the identification and screening of remedial alternatives that will achieve protection of public health, safety, and welfare and the environment.

Preliminary remedial action objectives for soil:

- Prevent direct contact with areas of surface soil (0-2 feet below ground surface) that have concentrations of contaminants greater than the site-specific cleanup levels listed in Table 1.
- Prevent construction worker contact with areas of subsurface soil (2-10 feet below ground surface) that have concentrations of contaminants greater than the site-specific cleanup levels listed in Table 1.
- Meet the leaching to groundwater site-specific cleanup levels listed in Table 1.

Preliminary remedial action objectives for groundwater:

- Prevent human exposure to groundwater containing arsenic or lead at concentrations greater than the site-specific cleanup levels (DEQ-7 water quality standards) listed in Table 1.
- Reduce concentrations of dissolved arsenic in groundwater to DEQ-7 water quality standards listed in Table 1.
- Prevent potential future migration of groundwater exceeding DEQ-7 for contaminants of concern.

SECTION 8.0 – SUMMARY AND EVALUATION OF ALTERNATIVES

The draft Feasibility Study Report (Arcadis 2017) describes the alternatives evaluated to clean up surface soil, subsurface soil, and groundwater at the Joslyn Street Tailings Facility. These alternatives are summarized and evaluated in the following sections using the following remedy selection criteria provided in Section 75-10-721, MCA:

1. Protectiveness. Overall protection of public health, safety, and welfare and the environment addresses whether an alternative provides adequate protection in both the short-term and the long-term from unacceptable risks posed by hazardous or deleterious substances present at the Joslyn Street Tailings Facility by eliminating, reducing, or controlling exposure to levels that are protective.

2. Compliance with environmental requirements, criteria, or limitations. This criterion evaluates whether each alternative will meet applicable or relevant state and federal laws, regulations, requirements, etc.

3. Mitigation of Risk. This criterion evaluates mitigation of exposure to risks to public health, safety, and welfare and the environment to acceptable levels.

4. Effectiveness and Reliability. Each alternative is evaluated, in the short-term and the long-term, based on whether acceptable risk levels are reached and maintained and further releases are prevented.

5. Practicability and Implementability. Under this criterion, alternatives are evaluated with respect to whether a technology and approach could be applied at the Joslyn Street Tailings Facility.

6. Use of Treatment or Resource Recovery Technologies. This criterion addresses use of treatment technologies or resource recovery technologies, if practicable, giving due consideration to engineering controls. These technologies are generally preferred to simple disposal options.

7. Cost Effectiveness. Cost effectiveness is evaluated through an analysis of incremental costs and incremental risk reduction and other benefits of alternatives considered. This analysis includes consideration of the total anticipated short-term and long-term costs, including operation and maintenance activities.

The first two criteria, protectiveness and compliance with environmental requirements[2], are threshold criteria that must be met in order for a remedy to be further considered or selected. The next five criteria are balancing criteria that DEQ evaluates to obtain the best balance in selecting the remedy. In addition to evaluating the listed criteria, DEQ also considers present and reasonably anticipated future uses of the Joslyn Street Tailings Facility when choosing a preferred remedy. DEQ will also consider the acceptability of the preferred alternative to the affected community, as indicated by community members and local government, during the public comment period on this Proposed Plan. Following the public comment period, DEQ will determine whether any necessary revisions to the preferred remedy are appropriate.

The cost estimates are based on the assumption that the alternatives will meet the estimated cleanup timeframes (as identified in the individual alternative discussions) and these are preliminary estimates only. They are used to ensure that the costs of each alternative are compared and evaluated based upon consistent information. Actual costs and cleanup timeframes may vary and cost estimates will be further refined during remedial design. Initial soil volumes to be excavated included an analysis of both 5 ug/dL and 10 ug/dL blood level endpoints. However, subsequent to BNSF calculating soil volume estimates based on both the 5 ug/dL and the 10 ug/dL blood level endpoints, the method for calculating the 5 ug/dL blood endpoint was modified slightly. This resulted in a change to the 5 ug/dL blood level endpoint specific to the Joslyn Street Tailings Facility from 222 mg/kg to a revised value of 235 mg/kg for

[2] Environmental requirements, criteria, or limitations as specified in 75-10-721, MCA

the residential SSCL. Based upon historic data for the Facility, this will have a negligible affect regarding changes to the calculated soil volumes to be remediated.

8.1 Alternatives Evaluation

8.1.1 Site Wide Elements

All remedial alternatives, except No Further Action, have common elements. These common elements are described here. These elements include site preparation, ground surface re-grading and revegetation, and long-term monitoring. The following assumptions are provided for the common elements.

Institutional controls. Institutional controls are defined in Section 75-10-701(11), MCA as a restriction on the use of real property that mitigates the risk posed to public health, safety, and welfare and the environment. Although institutional controls do not remediate the contamination, they can be effective for managing human exposure to contaminants. The effectiveness of institutional controls depends on the mechanisms used and the durability of the institutional control. Institutional controls may be layered to improve effectiveness. Institutional controls are considered easy to implement and inexpensive to implement and maintain, although long-term enforcement may increase these costs. Specific institutional controls that may be used at the Joslyn Street Tailings Facility are listed below.

Land Use Controls: DEQ has identified that the reasonably anticipated future use of the Joslyn Street Tailings Facility includes residential, commercial/industrial, railroad worker, and recreational uses. Institutional controls, such as restrictive covenants or zoning, could be used to prohibit or limit future residential use for certain portions of the Facility. Such restrictions would limit human exposure by not allowing construction and development of residences in those areas that do not meet residential cleanup levels.

Similarly, a waste repository for containment of contaminated soil already exists at the Joslyn Street Tailings Facility, and if a new waste repository was constructed or if the existing one was expanded, an institutional control that protects the containment area in perpetuity and requires periodic inspection and reporting would be required. Institutional controls that meet DEQ requirements would be needed for any land use controls that become part of the selected remedy.

Groundwater Use Restrictions: Institutional controls can be used to limit groundwater use at the Joslyn Street Tailings Facility until site-specific cleanup levels are met. A restrictive covenant or controlled groundwater area could be used to prohibit the use of groundwater for drinking water until such time as the DEQ-7 water quality standards are met. A restrictive covenant or controlled groundwater area could also be needed to restrict groundwater use in the area of MW-4 and MW-8 because of the naturally occurring high concentrations of arsenic.

Engineering Controls. Engineering controls are measures that help manage environmental and health risks by reducing exposure to contamination levels or limiting exposure pathways. Engineering controls can encompass a variety of approaches, such as fencing to contain and/or reduce exposure to contamination and/or physical barriers intended to limit access to property. Although engineering controls do not remediate contamination, they can be effective for managing exposure to contaminants. The effectiveness of engineering controls depends on the mechanisms used and the durability of the engineering control. The initial cost of some engineering controls can be high, and generally engineering controls require some long-term maintenance. Examples of engineering controls that may be used at the Joslyn Street Tailings Facility include fencing, signage, and other security measures. Fencing already exists around the existing waste repository.

Long-term Monitoring. Monitoring is a common element to all remedial alternatives except No Further Action. However, the monitoring requirements may vary for each remedial alternative. The general objective of monitoring is to evaluate the effectiveness of the remedy, determine when site-specific cleanup levels are achieved, and ensure the ongoing protection of public health, safety and welfare and of the environment.

Long-term monitoring has two key components: long-term monitoring and performance monitoring. Long-term monitoring is independent of remedial alternatives and is used to determine whether the groundwater plume is changing in area or composition. Performance monitoring is specific to individual remedial alternatives and is used to evaluate the effectiveness of the remedy. This may include periodic inspection of any waste repositories, fencing, signage, and property use. Details of the required long-term monitoring will be developed after the Record of Decision is issued.

8.1.2 Remedial Alternatives

In the Feasibility Study, remedial actions are organized by affected media: soil and groundwater. Remedial alternatives that could reasonably be expected to work at the Joslyn Street Tailings Facility were identified and evaluated. Additional screening of these alternatives in the FS resulted in one baseline alternative (no action) that may be applied to both soil and groundwater, three alternatives for soil, and four alternatives for groundwater. The following alternatives were retained for further evaluation and comparative analysis:

Alternative 1 – No further action (applies to both soil and groundwater)

Soils
Alternative 2 – Low permeability cap
Alternative 3 – Excavation and on-site disposal
Alternative 4 – Excavation and offsite disposal with treatment as needed

Groundwater
Alternative 5 – Monitored natural attenuation
Alternative 6 – Phytoremediation (plant-based remediation)

Alternative 7 – Permeable reactive groundwater barrier
Alternative 8 – Pump and treat

These alternative technologies are discussed in detail in the Feasibility Study and are summarized below.

8.1.2.1 Alternative 1 – No Further Action

DEQ requires that all other options be compared against the baseline, no action alternative. No further cleanup is considered under this alternative. Contamination would remain onsite and would continue to affect the soil and groundwater. No institutional controls would be implemented and no engineering controls would be put in place. Alternative 1 is not protective of human health and the environment in the short-term or long-term. Joslyn Street Tailings Facility occupants and visitors would continue to have the potential for exposure to unacceptable levels of contamination in the soil and groundwater above site-specific cleanup levels. Unacceptable risks would remain and would not be mitigated. Alternative 1 does not meet environmental requirements, criteria, and limitations (ERCLs). This alternative would not be effective and reliable in the short-term or long-term because unacceptable levels of contamination would remain and human receptors would continue to have the potential for exposure to the contaminants. Alternative 1 is easily implemented, but does not use treatment or resource recovery technologies. The total present worth cost for implementing no further action at the Joslyn Street Tailings Facility is $0.

8.1.2.2 Soil Alternative 2 – Low Permeability Cap

A low permeability cap is a surface covering constructed of a material that would prevent human exposure to the underlying soils and reduce the amount of precipitation infiltrating into the contaminated soils. This alternative would require construction of a cap, as well as infrastructure designed to handle precipitation runoff that the cap would generate.

Groundwater would not be addressed and would remain at unacceptable levels. Therefore, Alternative 2 alone is not protective of human health and the environment, and ERCLs would not be met. However, this alternative could be used in conjunction with other alternatives to meet the protectiveness and ERCLs compliance criteria. This technology is technically implementable at the Joslyn Street Tailings Facility and could be completed in approximately 1 year (Arcadis 2017). The technology is effective and reliable in the short term. However, this alternative would require long-term maintenance of the cap and runoff infrastructure to be effective in the long-term. This technology may not be practical in some areas of the Facility, such as in residential yards. The total present worth (2016 dollars) for implementing a low permeability cap at the Joslyn Street Tailings Facility, assuming a mixed future use scenario, is $3,120,000 (Arcadis 2017). Cost estimates are provided in Appendix A.

8.1.2.3 Soil Alternative 3 – Excavation and Onsite Disposal

Under this alternative, contaminated soils would be excavated and placed into an onsite repository designed to store the contaminated soils over the long-term similar to what was done with contaminated soils during the 1996 voluntary cleanup. The repository would be lined and capped to reduce the possibility of people or wildlife coming in contact with the waste and to reduce the possibility of contaminants leaching into the groundwater. Once contaminated soil is removed, sampling would be conducted to ensure that soils that remain at the bottom or sides of the excavation do not exceed the site-specific cleanup levels. Long-term monitoring and maintenance of the repository would be necessary to ensure long-term effectiveness.

Groundwater would not be addressed and would remain at unacceptable levels. Therefore, Alternative 3 alone is not protective of human health and the environment, and ERCLs would not be met. However, this alternative could be used in conjunction with other alternatives to meet the protectiveness and ERCLs compliance criteria. This technology is technically implementable at the Joslyn Street Tailings Facility and could be completed in approximately 1 year (Arcadis 2017). This technology is effective and reliable in the short term, but treatment of some soil may be necessary to minimize the potential for continued leaching of contaminants. However, this alternative would require long-term maintenance of the repository and engineering controls. The total present worth (2016 dollars) for implementing excavation and onsite disposal at the Joslyn Street Tailings Facility, assuming a mixed future use scenario, is $2,100,000 (Arcadis 2017). Cost estimates are provided in Appendix A.

8.1.2.4 Soil Alternative 4 – Excavation and Offsite Disposal

Under this alternative, contaminated soils would be excavated and temporarily stockpiled onsite. The soil would be sampled to determine whether treatment is needed (using portland cement, cement kiln dust, or a similar soil amendment) to comply with requirements of the offsite landfill. Once sampling demonstrates that the waste is acceptable for offsite disposal, the waste would be hauled to an offsite permitted landfill. Once contaminated soil is removed, sampling would be conducted to ensure that soils that remain at the bottom or sides of the excavation do not exceed the site-specific cleanup levels.

Groundwater would not be addressed and would remain at unacceptable levels. Therefore, Alternative 4 alone is not protective of human health and the environment, and ERCLs would not be met. However, this alternative could be used in conjunction with other alternatives to meet the protectiveness and ERCLs compliance criteria. This technology is technically implementable at the Joslyn Street Tailings Facility and could be completed in approximately 1-2 years (Arcadis 2017). This technology is effective and reliable in both the short term and the long-term. Land within the Facility boundary would not be consumed for construction of a repository, but institutional controls could be used to ensure future use is protective. The total present worth (2016 dollars) for implementing excavation and offsite disposal with treatment as needed, assuming a mixed future use scenario, is $2,300,000 (Arcadis 2017). Cost estimates are provided in Appendix A.

8.1.2.5 Groundwater Alternative 5 – Monitored Natural Attenuation

Monitored natural attenuation (MNA) refers to the natural breakdown of contaminants in groundwater. These natural processes may be physical, chemical, or biological and they reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. For MNA to be effective, the contaminant and facility conditions must be conducive to this type of remediation and the source of groundwater contamination is either removed or contained. Although chemical and biological degradation are not occurring at the Joslyn Street Tailings Facility, sorption and dilution are playing a role in attenuation processes. Arsenic is predisposed to natural attenuation in groundwater conditions observed at the Facility based on available data and as demonstrated in the Conceptual Site Model (Figure 12). Collected data indicates that the aquifer has adequate attenuation capacity based on an abundance of iron and manganese in saturated soil, specific identification of iron oxide minerals in soils, soil-water partition coefficients, rapid attenuation observed along groundwater flow paths, and the relative stability of dissolved arsenic concentrations in groundwater despite the presence of surface soils containing arsenic above SSCLs (Arcadis 2017).

Under this alternative, groundwater concentrations would continue to be monitored to ensure that concentrations of contaminants in groundwater continue to decline, and ultimately meet DEQ-7 groundwater standards. Natural attenuation of arsenic in groundwater is believed to be occurring at the Joslyn Street Tailings Facility (Arcadis 2017).

It may take 15 years for groundwater to reach cleanup levels (Arcadis 2017) under Alternative 5 once the contaminant source is removed or controlled. Therefore, this alternative by itself is not protective of human health and the environment in the short-term and long-term, but could be combined with other alternatives to meet the protectiveness criteria. ERCLs would not be met for potentially 15 years under Alternative 5. This technology is easily implementable at the Joslyn Street Tailings Facility. If Alternative 5 was used alone, contamination would remain in soil; therefore, this alternative alone would not be effective and reliable in the short term and long-term. The total present worth (2016 dollars) for implementing monitored natural attenuation is $450,000 (Arcadis 2017). Cost estimates are provided in Appendix A.

8.1.2.6 Groundwater Alternative 6 – Phytoremediation (plant-based remediation)

Phytoremediation refers to the use of plants to clean up contaminated groundwater. Certain types of plants may be better suited to removing metals contamination from groundwater. For phytoremediation to be effective, the type of contaminant, plant species, depth to groundwater, climate, and soil characteristics need to be optimal. Since plants often store the contaminants in the roots, stems, or leaves, it is also necessary to consider ultimate end use or disposal of the plants used in the process.

Under this alternative, plants adept at removing metal contamination would be placed above areas with groundwater contamination and downgradient of the groundwater plume. Over the long-term, these plants may extract arsenic from surface soils and shallow groundwater, and may reduce water infiltrating the contaminated soils (Arcadis 2017). However, the technology is not completely proven for arsenic remediation and is not anticipated to decrease the timeframe for remediation compared to monitored natural attenuation (Arcadis 2017). Groundwater monitoring would continue to ensure that concentrations of contaminants in groundwater continue to decline, and ultimately meet DEQ-7 groundwater standards.

It may take 15 years for groundwater to reach cleanup levels (Arcadis 2017) under Alternative 6 once the plants become established. Therefore, this alternative by itself is not protective of human health and the environment in the short-term and long-term, but could be combined with other alternatives to meet the protectiveness criteria. ERCLs would not be met for potentially 15 years under Alternative 6. This technology is technically implementable at the Joslyn Street Tailings Facility. However, several climatological factors and soil characteristics can affect plant growth; therefore, this alternative may require more monitoring and maintenance than other alternatives. If Alternative 6 was used alone, contamination would remain in groundwater; therefore, this alternative alone would not be effective and reliable in the short term and long-term. The total present worth (2016 dollars) for implementing phytoremediation is $740,000 (Arcadis 2017). Cost estimates are provided in Appendix A.

8.1.2.7 Groundwater Alternative 7 – Permeable Reactive Groundwater Barrier

Permeable reactive barriers consist of a wall created below ground to clean up contaminated groundwater. Groundwater can flow through the wall and be treated by the materials that are placed in the wall. The reactive materials either trap the contaminants or make them less harmful. The treated groundwater flows out the other side of the wall. The reactive material may need to be periodically replaced and site-specific conditions can influence the rate at which the reactive material needs to be replenished.

This alternative would involve excavation of a trench or similar soil cut and placement of zero valent iron (a metal powder or granule) and sand to create a barrier on the downgradient edge of the groundwater plume. The groundwater would come into contact with the zero-valent iron as it flows naturally through the ground, which would cause the arsenic to be removed from solution in the groundwater due to absorption and precipitation. The barrier would not eliminate the groundwater plume, but could prevent migration of the plume. Groundwater monitoring would continue to occur and, over time, natural attenuation would be expected to reduce concentrations of contaminants in groundwater in the existing areas of the groundwater plume to below DEQ-7 groundwater standards.

It may take 15 years for groundwater to reach cleanup levels (Arcadis 2017) under Alternative 7. Therefore, this alternative by itself is not protective of human health and the environment in the short-term and long-term, but could be combined with other alternatives to meet the protectiveness criteria. ERCLs would not be met for potentially 15 years under Alternative 7. This technology is implementable at the Joslyn Street Tailings Facility. If Alternative 7 was used alone, contamination would remain in soil and groundwater; therefore, this alternative alone would not be effective and reliable in the short term and long-term. The total present worth (2016 dollars) for implementing a permeable reactive barrier is $1,310,000 (Arcadis 2017). Cost estimates are provided in Appendix A.

8.1.2.8 Groundwater Alternative 8 – Pump and Treat

Pump and treat is a common method for cleaning up groundwater contaminated with dissolved chemicals, including metals. Groundwater is pumped from wells to an above-ground treatment system that removes the contaminants. Pump and treat systems also are used to "contain" the contaminant plume. Once treated water meets regulatory standards, it may be discharged for disposal or further use. For example, treated water may be pumped back underground or into a nearby stream, or a sprinkler system may distribute the water over the ground surface to irrigate soil and plants. Treated water also may be discharged to the area's public sewer system for further treatment at the local wastewater treatment plant. Other wastes produced as a result of treatment, such as sludge or used filters, are disposed of properly (EPA 2012).

This alternative would involve installation of a series of groundwater capture wells, which would extract contaminated groundwater. The groundwater would then be treated via a combination of acidification, oxidation, and neutralization before being reinjected into the aquifer.

It may take 15 years for groundwater to reach cleanup levels (Arcadis 2017) under Alternative 8. Therefore, this alternative by itself is not protective of human health and the environment in the short-term and long-term, but could be combined with other alternatives to meet the protectiveness criteria. ERCLs would not be met for potentially 15 years under Alternative 8. This technology is implementable at the Joslyn Street Tailings Facility. If Alternative 8 was used alone, contamination would remain in soil and groundwater; therefore, this alternative alone would not be effective and reliable in the short term and long-term. This technology is technically implementable at the Joslyn Street Tailings Facility. However, this alternative would require significant ongoing operation and maintenance to ensure the system performed as intended. Some of the challenges to successful implementation of this technology at the Joslyn Street Tailings Facility include extreme cold weather (freezing of pipes) and the very high groundwater extraction rate that would be necessary at the Facility (Arcadis 2017). The total present worth (2016 dollars) for implementing pump and treat is $17,500,000 (Arcadis 2017). Cost estimates are provided in Appendix A.

8.2 COMPARATIVE ANALYSIS

The alternatives were evaluated and compared against the seven cleanup criteria identified in Section 75-10-721, MCA. Protectiveness and compliance with ERCLs are threshold criteria that must be met for any remedy to be further considered or selected. In the comparative analysis, the remaining criteria are evaluated to select the best overall alternatives for each media. This evaluation includes considerations of present and reasonably anticipated future uses of the Joslyn Street Tailings Facility and the use of institutional controls. Each criterion is listed individually below. A list of the alternatives and their corresponding numbers is also provided to aid in this analysis.

Alternative 1 – No Further Action
Soil Alternative 2 – Low Permeability Cap
Soil Alternative 3 – Excavation and Onsite Disposal

Soil Alternative 4 – Excavation and Offsite Disposal
Groundwater Alternative 5 – Monitored Natural Attenuation
Groundwater Alternative 6 – Phytoremediation (plant-based remediation)
Groundwater Alternative 7 – Permeable Reactive Groundwater Barrier
Groundwater Alternative 8 – Pump and Treat

8.2.1 Protectiveness

Alternative 1 is not protective. Alternatives 2 through 8 are protective when combined with other alternatives that address all contaminated media at the Joslyn Street Tailings Facility. However, Alternatives 2, 3, and 6 may be slightly less protective than the other alternatives because waste would be disposed onsite and the plants associated with phytoremediation would accumulate metals that could create alternative pathways of contaminant exposure if not properly handled during the remedy.

Institutional controls would be necessary for short term and long-term protectiveness regardless of which alternatives are selected because of the need to restrict future use for certain portions of the Joslyn Street Tailings Facility, and to ensure that contaminated groundwater is not used for drinking purposes. Alternatives 2 and 3 would also require an institutional control to prevent disturbance of the cap and onsite repository.

8.2.2 Compliance with environmental requirements

Alternative 1 does not meet ERCLs because it would not address soil contamination that is an ongoing source of groundwater contamination at the Joslyn Street Tailings Facility, which would increase the timeframe for groundwater to reach site-specific cleanup levels beyond the estimated 15 years for most of the remaining alternatives.

Alternatives 2 through 8 are anticipated to comply with ERCLs within approximately 15 years of implementation. Any remedial design documents will need to demonstrate that ERCLs will be met during and post remedy.

8.2.3 Mitigation of Risk

Alternative 1 would allow soil and groundwater contamination to remain in place at the Joslyn Street Tailings Facility which would continue to pose an unacceptable risk.

Alternatives 2 through 4 all mitigate risk posed by contaminated soil at the Facility, though mitigation is achieved via different mechanisms. Alternative 2 relies on an asphalt or concrete cap to prevent human exposure and to prevent continued leaching of contamination to the groundwater. Risk mitigation under this alternative is dependent on ongoing operation and maintenance activities to ensure cap integrity is not compromised. Alternative 3 would also require ongoing operation and maintenance to ensure cap (and liner) integrity is not compromised. Although Alternatives 2 through 4 all mitigate risk, Alternative 4 provides risk mitigation that does not rely on increasing the footprint of the existing onsite repository and associated short-term risk from reopening the existing onsite repository within the Joslyn Street Tailings Facility. Therefore, Alternative 4 likely achieves a greater mitigation of risk in the long-term.

Alternatives 5 through 8 all mitigate risk posed by contaminated groundwater within the same estimated timeframe. Alternatives 5 and 6 provide a similar level of risk reduction. Alternative 7 increases risk mitigation, by providing a barrier that serves to ensure the groundwater plume does not potentially spread downgradient in the future. However, Alternative 7 does not decrease the amount of time estimated to remediate groundwater at the Facility. Alternative 8 also serves to ensure that the groundwater plume does not potentially spread in the future. However, Groundwater Alternative 8 may increase short-term risks because acidic, basic, and oxidizing materials would be necessary to run the treatment operation. These risks could be mitigated through proper planning.

8.2.4 Effectiveness & Reliability

Alternative 1 is not effective and reliable in the short term or long-term because unacceptable levels of contamination would remain and contaminants could continue to be released to the environment.

Alternative 2 is effective if cap maintenance is conducted in the long-term to ensure cracks and other potential cap degradation is properly repaired. Alternative 2 is less reliable than the other soil alternatives because it requires the greatest operation and maintenance over the largest area. Alternatives 3 and 4 are effective and reliable. Alternative 3 relies on long-term operation and maintenance of an onsite soil repository. An onsite soil repository was constructed as part of the voluntary cleanup conducted in 1996 and routine operation and maintenance has occurred since it was constructed; its effectiveness and reliability have been demonstrated when used in conjunction with institutional controls. Both Alternatives 2 and 3 require institutional controls to ensure the integrity of the engineered features are maintained. Alternative 4 is effective and reliable in the short and long-term because waste would be disposed of off-site and managed at an approved landfill.

Alternatives 5 through 8 are all effective and reliable in the long-term at addressing groundwater contamination; however, the effectiveness of Alternative 6 is subject to successful establishment and ongoing care of specific plants. Therefore, Alternative 6 may be less effective and reliable than Alternatives 5, 7, and 8. Alternatives 7 and 8 may be slightly more reliable in the short-term because the groundwater plume would be controlled onsite, which would minimize the potential for the plume to spread. However, Alternatives 7 and 8 are not expected to decrease the amount of time required to achieve site-specific cleanup levels in groundwater compared to Alternatives 5 and 6.

8.2.5 Technically Practicable & Implementable

Alternatives 1, 3, and 4 are practicable and implementable for addressing contaminated soil at the Joslyn Street Tailings Facility. Alternative 2 is impracticable for residential yards at the

Facility, because it would result in the pavement of residential yards with an asphalt or concrete cap. For other portions of the Facility, Alternative 2 is less practicable and implementable than the other soil alternatives, because it would require ongoing operation and maintenance or a large cap area and significant stormwater diversion/management over the long-term to be successful.

Alternatives 1, and 5 through 8 are practicable and implementable for addressing contaminated groundwater at the Joslyn Street Tailings Facility. Alternative 8 is less practicable and implementable than other alternatives due to weather conditions (freezing temperatures), the rate of recharge of the aquifer, and ongoing operation and maintenance requirements that could pose challenges to the success of this alternative. However, Alternative 8 is still considered to be practicable and implementable at the Facility.

8.2.6 Treatment or Resource Recovery Technologies

Alternatives 1, 2, 3, and 5 do not use treatment or resource recovery technologies. Alternative 4 relies on treatment technology to stabilize the contaminants in the waste soil, if necessary, prior to disposal off site. Alternative 6 relies on the natural processes of trees to uptake contaminants from groundwater, but does not transform the contaminants into less toxic substances and may require the trees to ultimately be disposed. Alternatives 7 and 8 include the use of a treatment technology, but also have the potential to generate waste that requires disposal at an approved landfill.

8.2.7 Cost Effectiveness

Costs developed for the Feasibility Study were primarily based on a 10 ug/dL blood lead endpoint; however, the cost to meet the 5 ug/dL blood lead site-specific cleanup level was also evaluated and resulted in an additional soil volume of 3,400 cubic yards that would require cleanup.

Alternative 1 is the lowest cost alternative. However, this alternative is not protective and does not meet ERCLs.

Alternative 2 is the highest cost of the soil alternatives (see Appendix A). However, Alternative 2 is also less technically practicable and reliable in the long-term than Alternatives 3 and 4, which can also be used to address soil contamination. Alternative 3 is a lower overall cost than Alternative 4. However, both of these Alternatives are within 10% of the cost of one another. Alternative 4 would return more of the Facility to productive use than Alternative 3 and would not require the long-term operation and maintenance activities of a repository to meet the cleanup objectives.

Alternative 8 is by far the highest cost of the groundwater Alternatives (see Appendix A). However, Alternative 8 is considered the least technically practicable and implementable of the groundwater Alternatives and it is not anticipated to reduce risk more than Alternatives 5 through 7. Alternatives 5 through 7 are all anticipated to achieve the remedial action objectives in the same timeframe, with Alternative 5 being the lowest cost for addressing groundwater contamination. Alternatives 7 and 8 provide additional protection against the future potential for groundwater plume migration, but also at a cost of approximately 3 times the cost of Alternative 5.

SECTION 9.0 – SCOPE OF THE PREFERRED REMEDY

The preferred remedy for the Joslyn Street Tailings Facility is a combination of Alternative 4 to address contaminated soil and Alternative 5 to address contaminated groundwater. The preferred remedy also includes the site-wide common elements described earlier in the Proposed Plan (e.g. institutional controls, engineering controls, and long-term monitoring). Institutional controls would be placed on some properties within the Facility to restrict the property use to prevent unacceptable exposure to contaminated soil or groundwater.

The estimated total cost for the preferred remedy (2016 dollars) is $2,750,000. Costs and assumptions used in calculating the total present value are presented in Appendix A. As explained in Section 6.1, DEQ has evaluated the reasonable anticipated future uses of the properties within the Joslyn Street Tailings Facility. The reasonably anticipated future uses for each property parcel are presented in Figure 3. The soil cleanup levels consider background concentrations of metals and are based upon the 5 ug/dL blood lead endpoint. The DEQ-7 groundwater standards are the site-specific cleanup levels for groundwater at the Facility. The cleanup levels are presented in Table 1. DEQ's preferred remedy was evaluated as provided for in Section 75-10-721, MCA; however, DEQ may revise or select a different remedy based on public comment or new information. DEQ's final remedy decision will be documented in the Joslyn Street Tailings Facility Record of Decision.

9.1 The Preferred Remedy

As discussed in Section 4.0, interim actions conducted at the Joslyn Street Tailings Facility helped reduce the risks to public health, safety, welfare, or the environment. These actions include excavation of visible tailings and placement into an onsite repository, and excavation of contaminated soils from portions of the Centennial Trail and residential yards at the Mobile City mobile home park. The Centennial Trail and Mobile City interim actions involved disposing of excavated soils in an off-site licensed landfill (Arcadis, 2019). There is one remaining area within the mobile home park (sample SS31 – Figure 5) that does not meet the residential SSCL for arsenic. However, this location is beneath the paved street and the pavement prevents exposure to residents. In addition, the adjacent yard did not exceed SSCLs. This individual sample location was collected from 0-6" beneath the asphalt surface and represents a small area and does not exceed the arsenic cleanup level for construction workers (515 mg/kg) who may perform work beneath the asphalt.

These interim actions have been effective and are proposed for inclusion as part of the final remedy. Visible tailings were placed in a geosynthetic clay-lined onsite repository with controlled access to impede trespassers and wildlife from coming into contact with the repository and potentially disturbing the cap. The onsite repository design considered stability, drainage, potential settlement, infiltration/water balance (HELP modeling), acid/leachate production, erosion control, floodplain protection, and revegetation. The Centennial Trail interim action removed contaminated soils to levels that met SSCLs along a portion of the trail and one residential yard; the contaminated soils were properly disposed at an offsite landfill and the disturbed areas were reclaimed for the intended use. The Mobile City mobile home park residential yard interim action removed contaminated soils to levels that met SSCLs from 5 yards within the mobile home park. The contaminated soils were properly disposed at an offsite landfill; placement of topsoil and revegetation of the yards remains to be completed in 2019. The interim actions are protective and meet ERCLs.

DEQ selected a combination of alternatives to clean up soil and groundwater at the Facility. These include excavating contaminated soils that exceed site specific cleanup levels, disposing of this contaminated soil at an offsite landfill, and monitored natural attenuation to ensure contaminant concentrations in groundwater continue to decline. Other Facility-wide common elements include institutional and engineering controls designed to prevent exposure to contamination. The estimated total cost of the preferred remedy is $2,750,000.

This section describes remedial actions necessary to complete cleanup at the Joslyn Street Tailings Facility. Engineering and design details for the selected remedy will be specified in the remedial design documents to be issued after the Record of Decision.

9.1.1 Excavation and Offsite Disposal With Treatment as Needed (Alternative 4)

An estimated 30,000 tons of contaminated soil would be excavated, staged onsite and sampled to ensure the soil meets the requirements of the landfill. If necessary, soil will be treated in the staging area with a soil amendment to meet the requirements for disposal at the landfill. Upon receipt and validation of sample results that indicate the soil is acceptable for disposal, the soil would be transported and disposed of at an offsite landfill. Contaminated soil would be transported in a manner to prevent blowing or tracking of the contaminated soils. The Feasibility Study estimated that this remedy can be completed in two years (Arcadis 2017).

Confirmation samples would be collected from the bottom and sidewalls of excavations to ensure that the remaining soil does not exceed the SSCLs. Upon receipt and validation of confirmation sample results that indicate SSCLs have been met, the excavations will be regraded/backfilled with soil that has been sampled and determined to be acceptable for use at the Facility. Areas within the Facility that will continue to have soil that exceeds the residential SSCLs following cleanup will have an institutional control recorded on the property that prohibits residential use of the property and prohibits soil disturbance activities that are inconsistent with the Record of Decision. The estimated cost of this alternative (using 2016 dollars) is $2,300,000 (Arcadis 2017).

9.1.2 Monitored Natural Attenuation (Alternative 5)

Following implementation of the soil cleanup identified in Section 9.1.1 that will remove contamination that is leaching to groundwater, groundwater monitoring will continue on a routine frequency (semi-annually for the first 5 years, followed by annual monitoring). Monitoring results will be reviewed to ensure that: a) the groundwater plume is not migrating or expanding in size; and b) contaminant concentrations in groundwater are continuing to decrease via natural processes and are on a path towards achieving compliance with the SSCLs for groundwater. Institutional controls that prohibit the installation of groundwater wells would also be placed on properties that are within the groundwater plume, and areas where groundwater exceeds SSCLs due to naturally occurring conditions. The estimated cost of this alternative (using 2016 dollars) is $450,000 (Arcadis 2017).

9.1.3 Site-Wide Elements

Assumptions used for estimating costs for this preferred remedy are provided in Appendix A, Table A-4, Soil Alternative 4-2. The estimated cost for Joslyn Street Tailings Facility remediation (using 2016 dollars) is $2,750,000 (Arcadis 2017). This cost estimate includes the cost of all site-wide elements except for engineering controls, institutional controls, and the monitoring and maintenance costs associated with the existing on-site repository. A summary of site-wide elements included in the cost estimate are provided below.

Engineering Controls

Engineering controls such as fencing may be needed during soil remediation activities. The necessary specific controls will be established during the remedial design phase. Cost is estimated to be $25,000.

Institutional Controls

The preferred remedy partially relies on the placement of a DEQ-approved restrictive covenant on some of the properties that make up the Joslyn Street Tailings Facility to limit the future use of some the properties to commercial/industrial and to prevent unauthorized excavation of soils that may exceed the residential site-specific cleanup levels. This may include non-residential current and future use properties owned by Mobile City/Reynolds Irrevocable Trust, BNSF Railway, Montana Rail Link, and Lewis and Clark County. In addition, a restrictive covenant to prohibit use of groundwater where it exceeds the SSCLs is necessary. This may include portions of properties owned by Mobile City/Reynolds Irrevocable Trust, BNSF Railway, Montana Rail Link, P&S MT Properties, LLC, and Lewis and Clark County. Cost is estimated to be $25,000.

Long-Term Monitoring

Long-term monitoring is specified as part of the remedy. Following removal of soil that exceeds SSCLs, long-term monitoring will be used to ensure that the groundwater remedy is proceeding as anticipated, and that the on-site repository remains protective. Cost is estimated to be $15,900 per year.

9.2 Evaluation of the Preferred Remedy

The preferred remedy would remove contamination from soil by excavation and offsite disposal and allow natural processes to reduce contamination in groundwater. Institutional controls in the form of restrictive covenants limiting the future use of portions of the Joslyn Street Tailings Facility to commercial/industrial use and preventing unauthorized soil disturbance are also included in the preferred remedy. Institutional controls would also be placed to limit the installation of wells in certain areas until SSCLs are met.

The preferred remedy for soil was selected over other alternatives because it is expected to achieve timely, substantial, and long-term risk reduction through excavation and offsite disposal, and is expected to allow properties within the Facility to be used for their reasonably anticipated future land uses. The preferred remedy for groundwater was selected over the other alternatives because, after excavating the soils that have the potential to leach contamination to the groundwater, it is expected to achieve substantial risk reduction through cost-effective natural processes and have the same timeframe for compliance as other more costly alternatives.

The preferred remedy reduces the risk within a reasonable timeframe and is cost-effective because it attains the highest level of long-term risk reduction compared to cost, while returning the entire Facility to a condition that is acceptable for the reasonably anticipated future uses. The preferred remedy provides for long-term reliability because soil exceeding the SSCLs will be disposed offsite and confirmation sampling will be used to demonstrate that the SSCLs have been achieved. The onsite repository will continue to be maintained and monitored to detect any potential changes in the repository, and institutional controls will limit development in the vicinity of the repository. Current fencing impedes trespassers and wildlife from coming in contact with and potentially disturbing the repository.

In addition, the cleanup includes long-term monitoring of the groundwater, as well as institutional controls.

Based on the information available at this time, the preferred remedy is protective of public health, safety, and welfare and the environment, would comply with ERCLs, would mitigate risk, would be effective in the short and long-term, is practicable and implementable, and is cost-effective. The preferred remedy may be revised in response to public comment or new information; DEQ will identify the selected remedy in the Record of Decision.

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TABLES

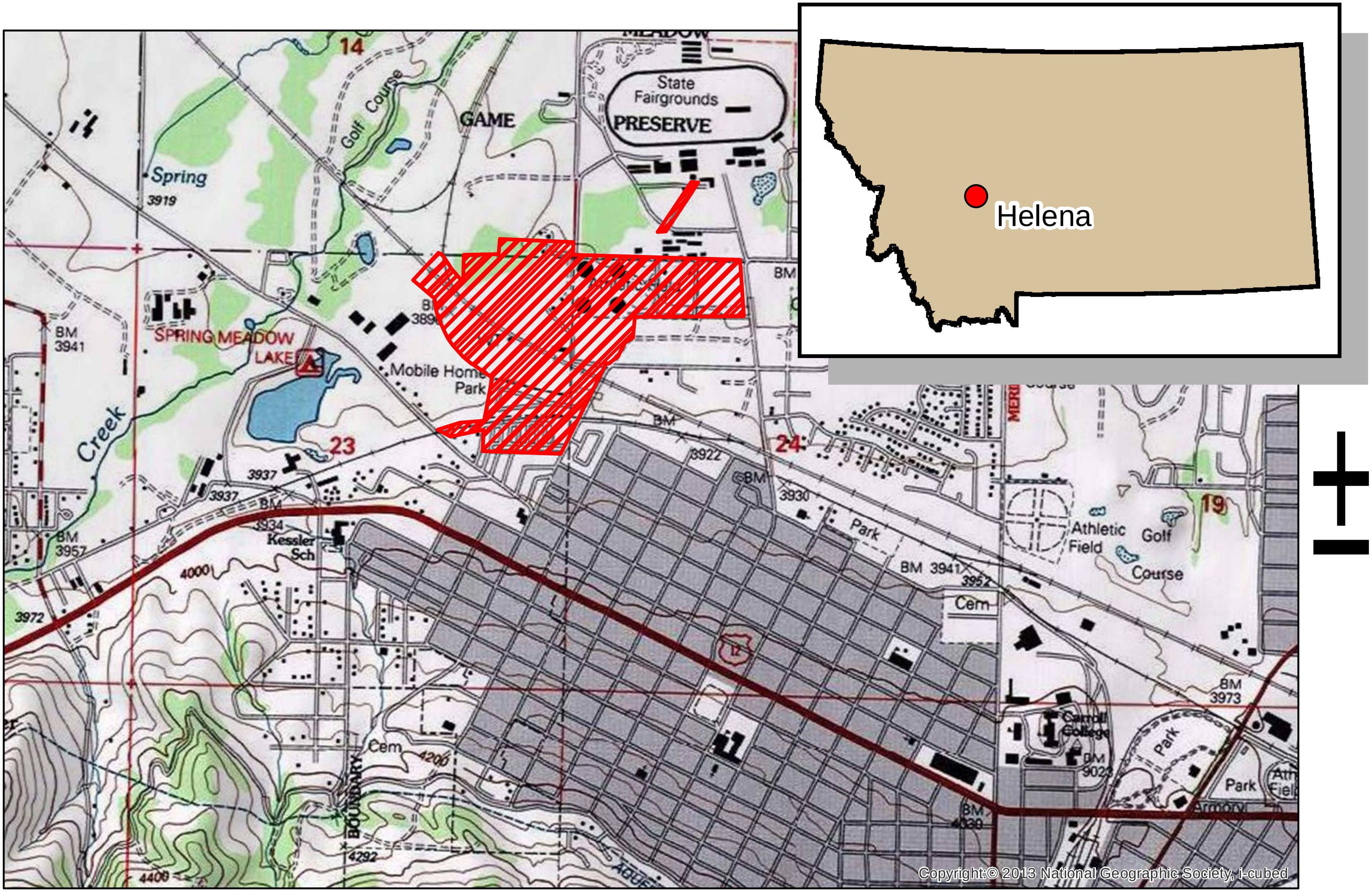
Table 1
Site-Specific Cleanup Levels
Joslyn Street Tailings Facility

Receptor	Arsenic site-specific cleanup level	Lead site-specific cleanup level (5 ug/dL blood lead level)
Residential surface soil	49.6 mg/kg	235 mg/kg
Commercial/industrial surface soil (indoor/outdoor worker)	68 mg/kg	1713 mg/kg
Railroad worker	414 mg/kg	1292 mg/kg
Construction worker (surface and subsurface soil)	515 mg/kg	1292 mg/kg
Protection against leaching to groundwater (surface and subsurface soil)	385 mg/kg	617 mg/kg
Groundwater	10 ug/L	15 ug/L*

Notes:
SSCL - Site-specific cleanup level
Surface soil - surface to two feet below ground surface
Subsurface soil - greater than two feet below ground surface
mg/kg - milligrams per kilogram (parts per million)
ug/L - micrograms per liter (parts per billion)
* The cleanup level for lead in groundwater is based on the DEQ-7 human health standard and is not based on the blood lead target level

FIGURES

Joslyn Street Tailings Facility



DEQ
Montana Department of Environmental Quality

Legend
Facility

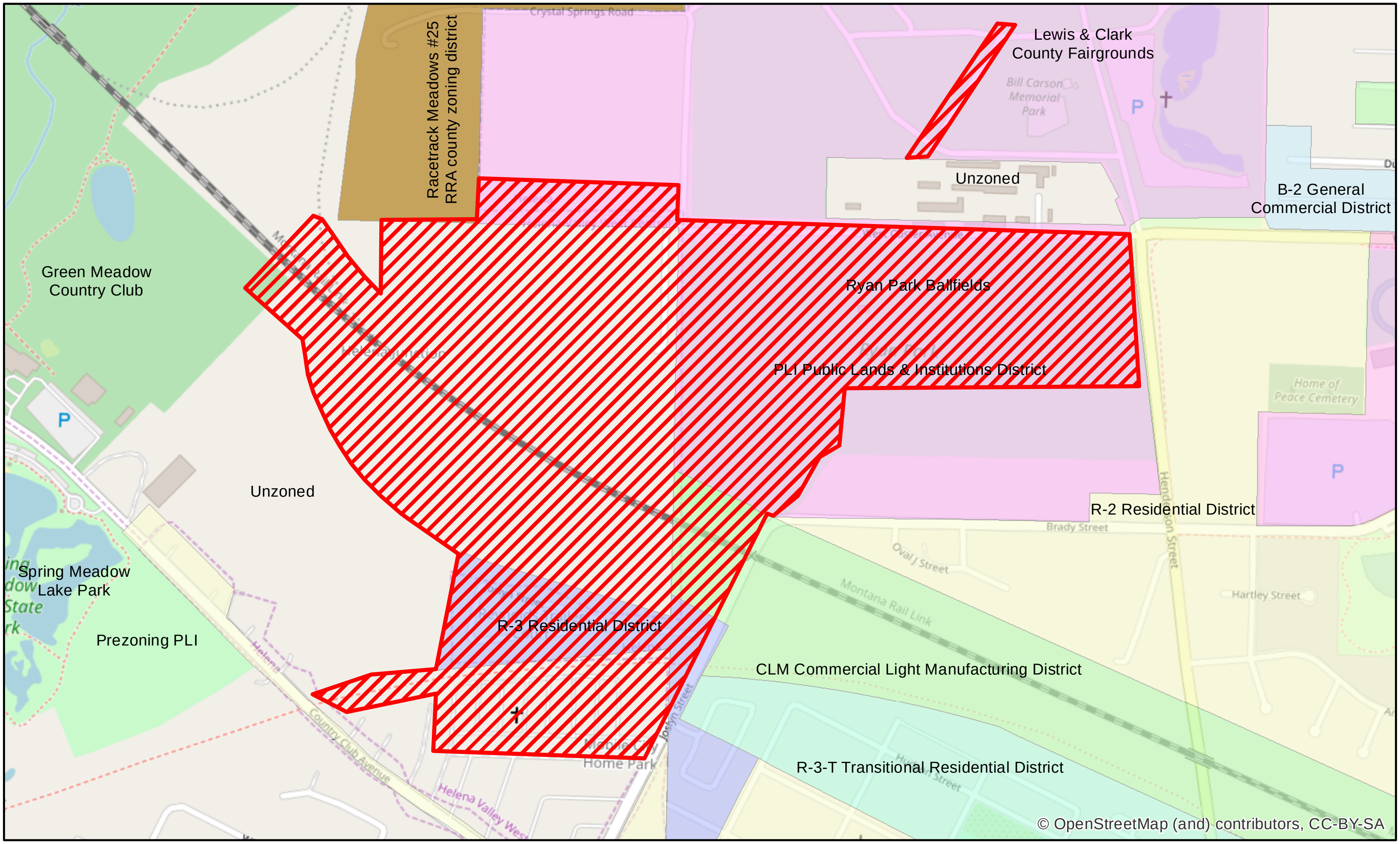
The Joslyn Street Tailings Facility also includes any area where a hazardous or deleterious substance has been deposited, stored, disposed of, placed, or otherwise come to be located.

Last Updated 3/21/2019

0 0.25 0.5 1 Miles

Figure 1 - Facility location

Joslyn Street Tailings Facility
City and County Zoning



Legend

- Facility
- Racetrack Meadows #25 RRA (county zoning)
- B-2 General Commercial District
- CLM Commercial Light Manufacturing District
- PLI Public Lands & Institutions District
- R-2 Residential District
- R-3 Residential District
- R-3-T Transitional Residential District

DEQ
Montana Department of Environmental Quality

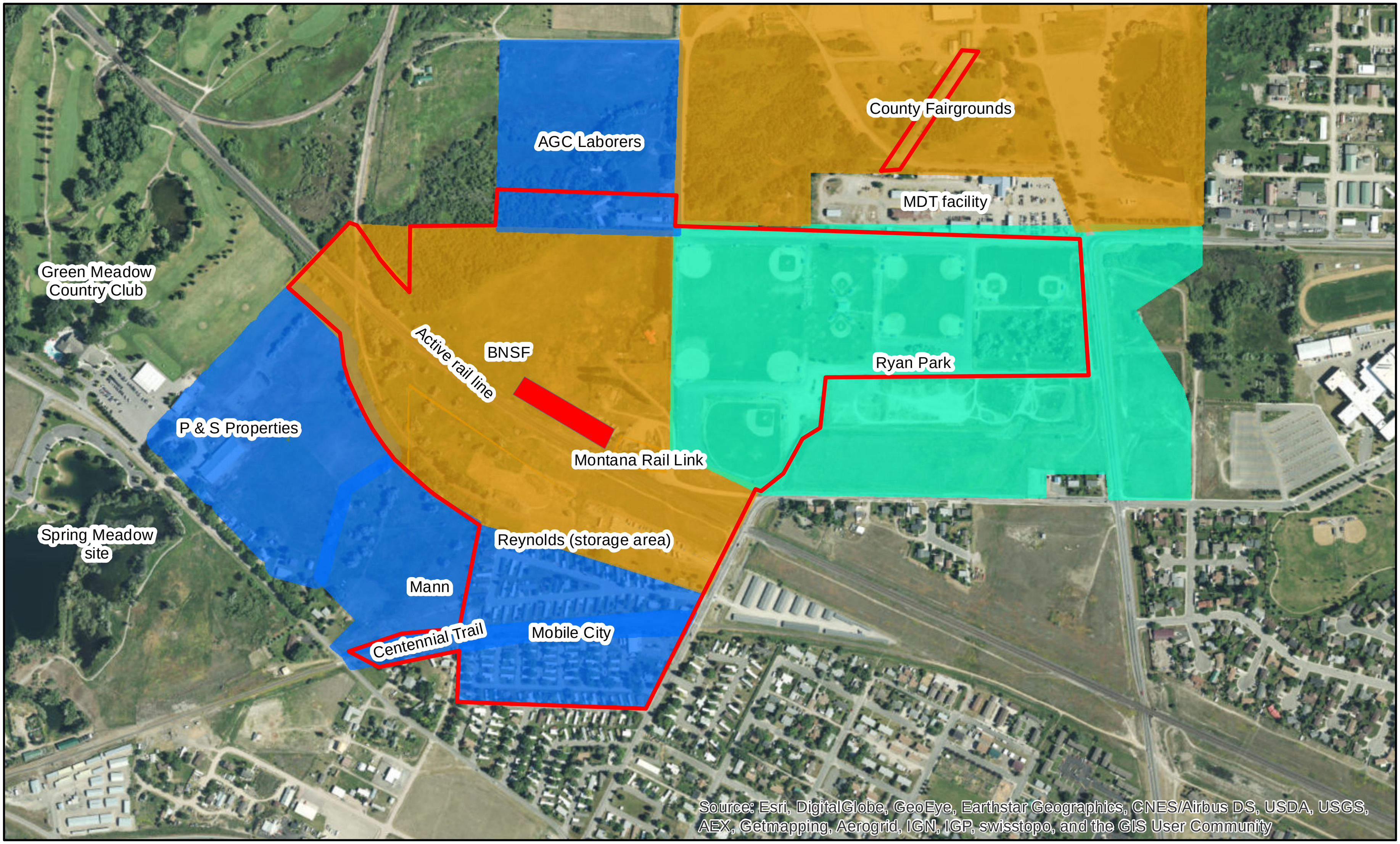
Last Updated 3/21/2019

The Joslyn Street Tailings Facility also includes any area where a hazardous or deleterious substance has been deposited, stored, disposed of, placed, or otherwise come to be located.

0 250 500 1,000 Feet

Figure 2 - City and County Zoning

Joslyn Street Tailings Facility
Anticipated Future Use



Last Updated 3/22/2019

Legend

- Existing Repository Boundary
- Facility
- Commercial/Industrial
- Recreational
- Residential

The Joslyn Street Tailings Facility also includes any area where a hazardous or deleterious substance has been deposited, stored, disposed of, placed, or otherwise come to be located.

0 250 500 1,000 Feet

DEQ
Montana Department of Environmental Quality

Figure 3 - Anticipated future use

Joslyn Street Tailings Facility
Arsenic in Groundwater

Legend

- Groundwater Monitoring Wells
- Arsenic in Groundwater Above Site-Specific Cleanup Level of 10 ug/L

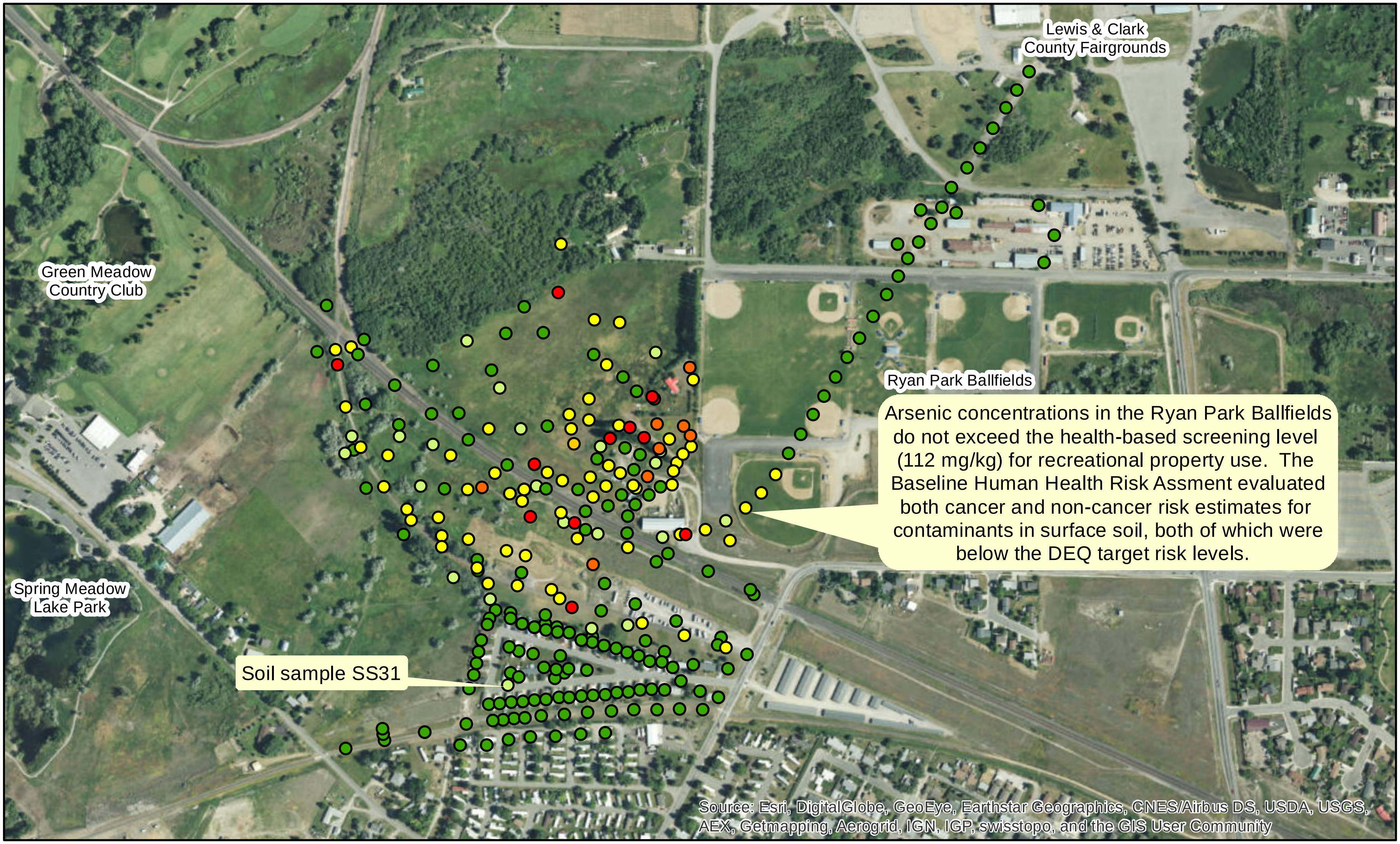
Last Updated 3/22/2019

0 250 500 1,000 Feet

DEQ
Montana Department of Environmental Quality

Figure 4 - Groundwater areas exceeding site-specific cleanup level

Joslyn Street Tailings Facility
Arsenic in Surface Soil



Last Updated 4/25/2019

Legend

Arsenic Concentration (mg/kg)

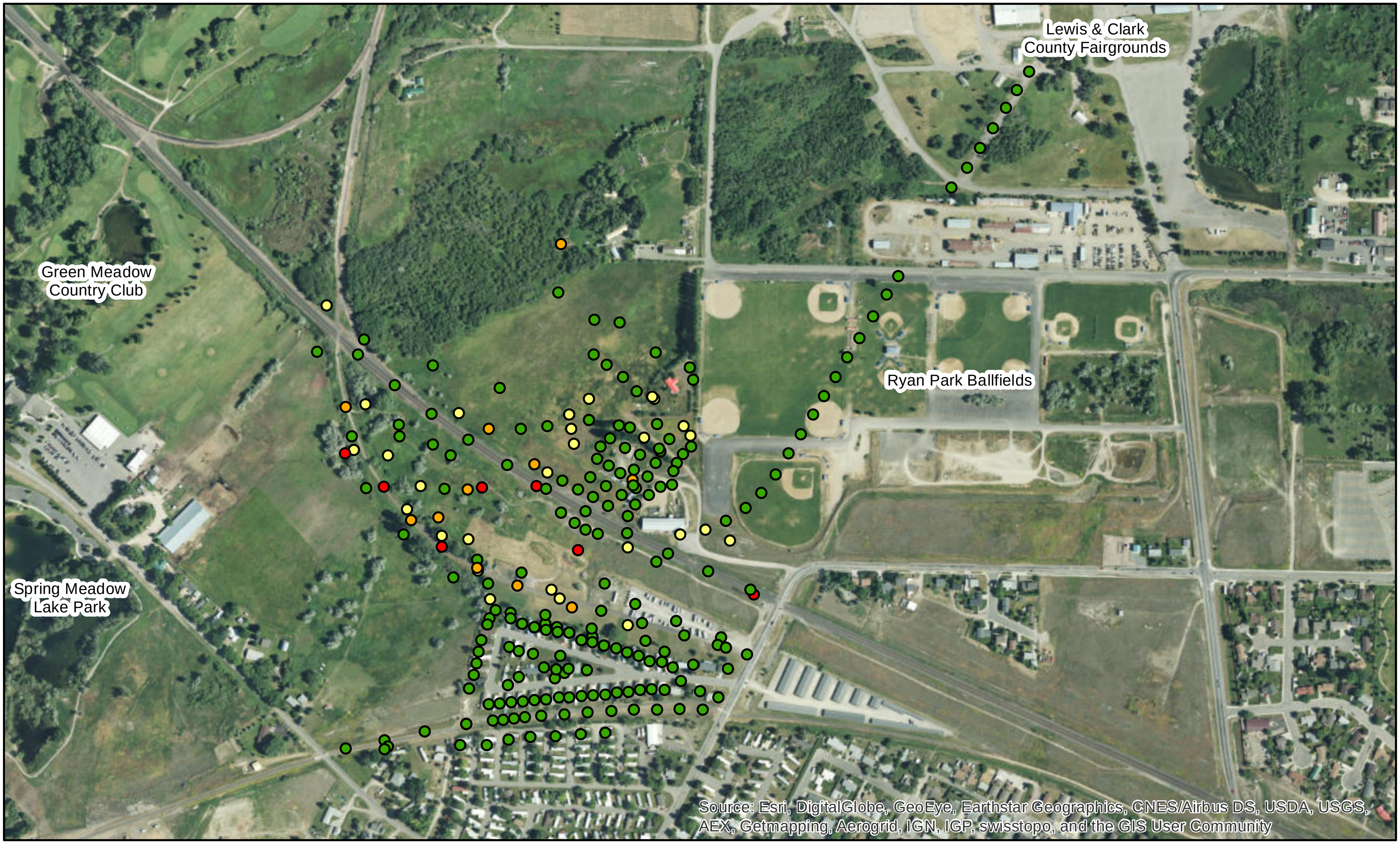
- 0-49.6 (below residential SSCL)
- 49.6-68 (below commercial/industrial SSCL)
- 68-385 (below leaching to groundwater SSCL)
- 385-414 (below railroad worker SSCL)
- 414-515 (below construction worker SSCL)
- 515-962 (exceeds all SSCLs)

SSCL = Site-specific cleanup level

Montana Department of Environmental Quality

Figure 5 - Arsenic concentrations in surface soil

Joslyn Street Tailings Facility
Lead in Surface Soil



Last Updated 5/13/2019

Legend

Lead Concentration (mg/kg)

- 0-235 (below residential SSCL)
- 235-617 (below leaching to groundwater SSCL)
- 617-1292 (below construction worker SSCL)
- 1292-1713 (exceeds all SSCLs)

SSCL = Site-specific cleanup level

Worker SSCL (1292 mg/kg) applies to commercial, industrial, and construction workers

0 250 500 1,000 Feet

DEQ
Montana Department of Environmental Quality

Figure 6 - Lead concentrations in surface soil

Joslyn Street Tailings Facility
Arsenic in Subsurface Soil

Last Updated 3/22/2019

Legend

Arsenic Concentration (mg/kg)

- 0 - 385 (below leaching to groundwater SSCL)

Note: All subsurface soil samples are also below the arsenic SSCL for construction workers (515 mg/kg) and for railroad workers (414 mg/kg).

SSCL = Site-specific cleanup level

0 250 500 1,000 Feet

DEQ Montana Department of Environmental Quality

Figure 7 - Arsenic concentrations in subsurface soil

Joslyn Street Tailings Facility
Lead in Subsurface Soil

Last Updated 3/22/2019

Legend

Lead Concentration (mg/kg)

- 0 - 617 (below leaching to groundwater SSCL)
- 617-1292 (below construction worker SSCL)
- 1292-9033 (exceeds all SSCLs)

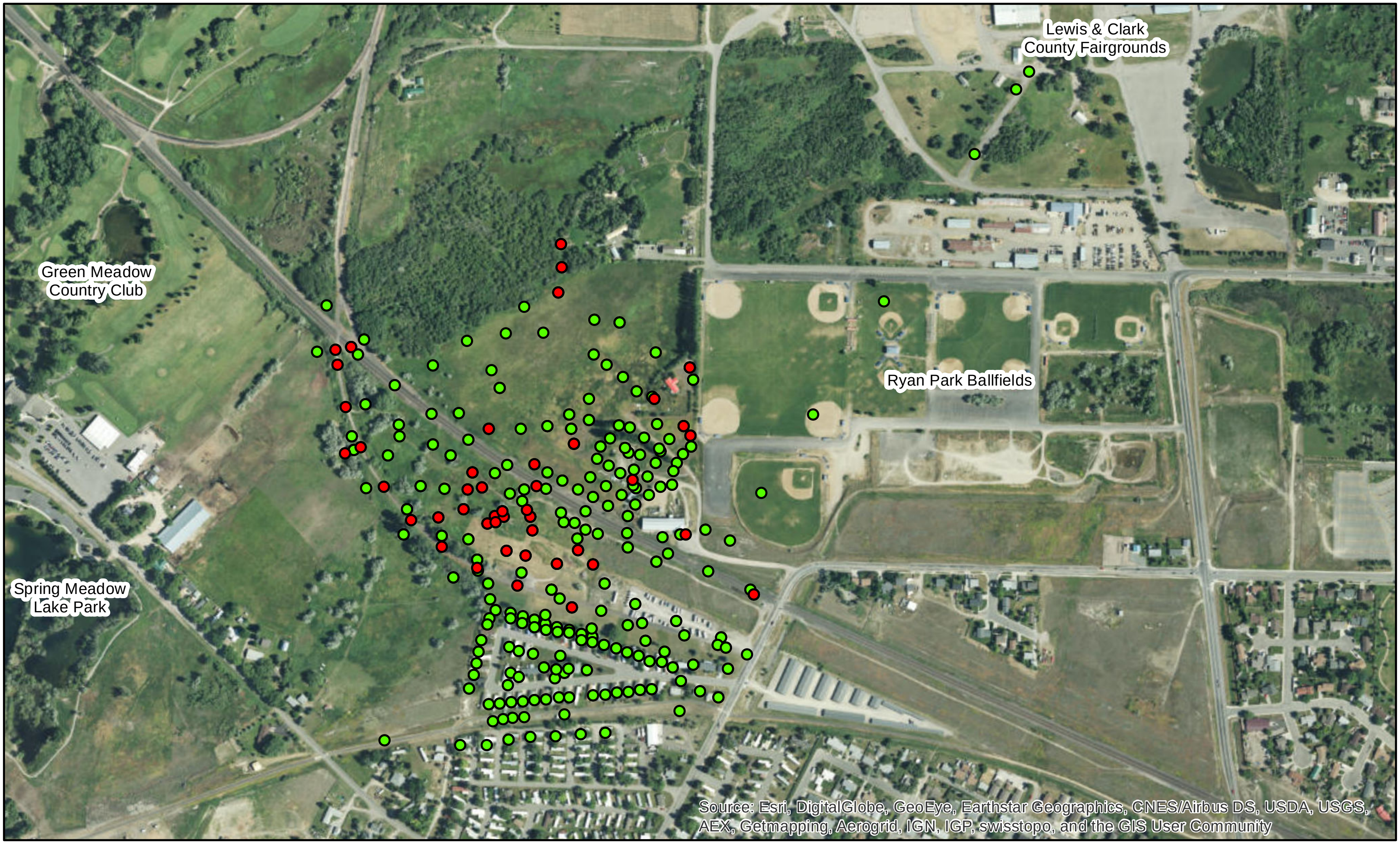
SSCL = Site-specific cleanup level

0 250 500 1,000 Feet

DEQ Montana Department of Environmental Quality

Figure 8 - Lead concentrations in subsurface soil

Joslyn Street Tailings Facility
Soil Concentrations Compared to Leaching to Groundwater Site-Specific Cleanup Levels



Last Updated 3/22/2019

Legend

- Lead or arsenic above leaching to groundwater SSCL
- Lead and arsenic below leaching to groundwater SSCL

SSCL = Site-specific leaching to groundwater cleanup level
385 mg/kg for arsenic
617 mg/kg for lead

0 250 500 1,000 Feet

DEQ Montana Department of Environmental Quality

Figure 9 - Arsenic and lead in soils compared to site-specific cleanup levels for leaching to groundwater

Joslyn Street Tailings Facility
Human Health Risk Assessment Exposure Areas

Last Updated 3/26/2019

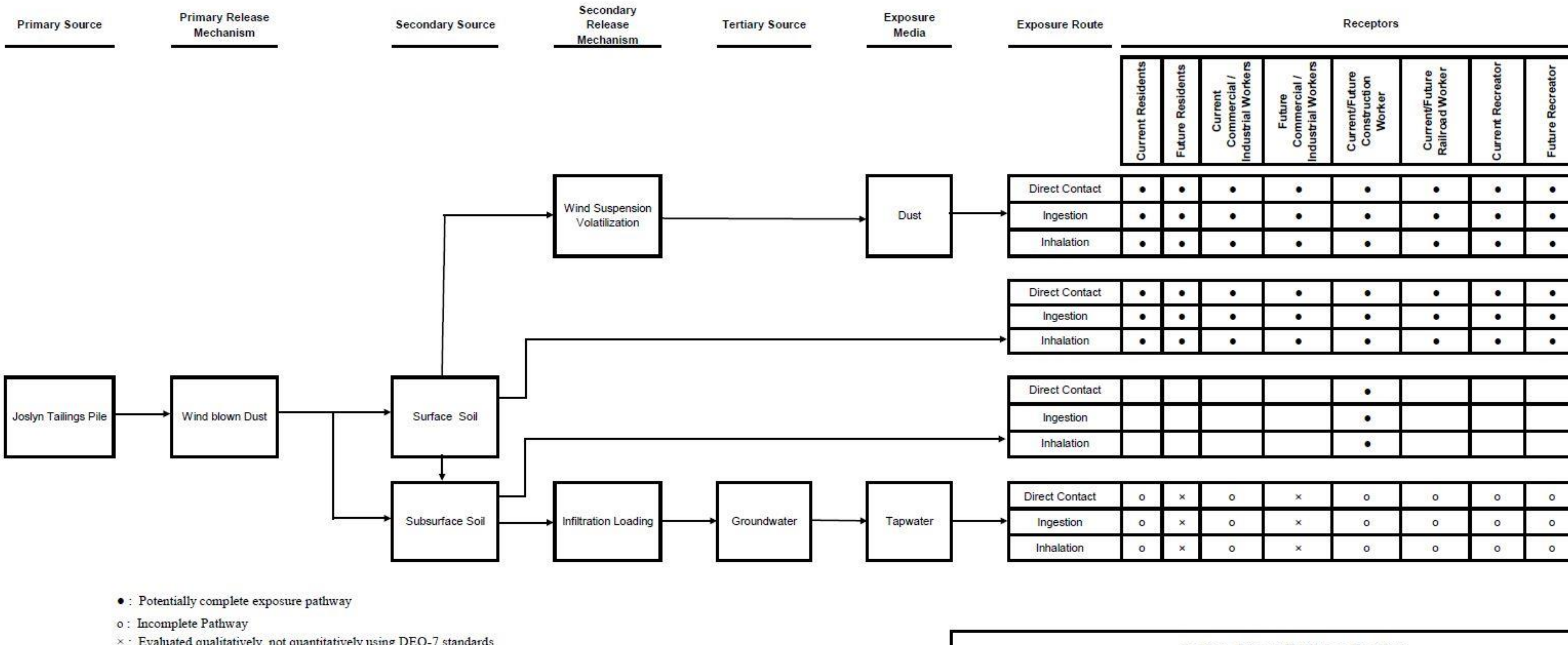
0 250 500 1,000 Feet

Montana Department of Environmental Quality

Legend

Exposure Area

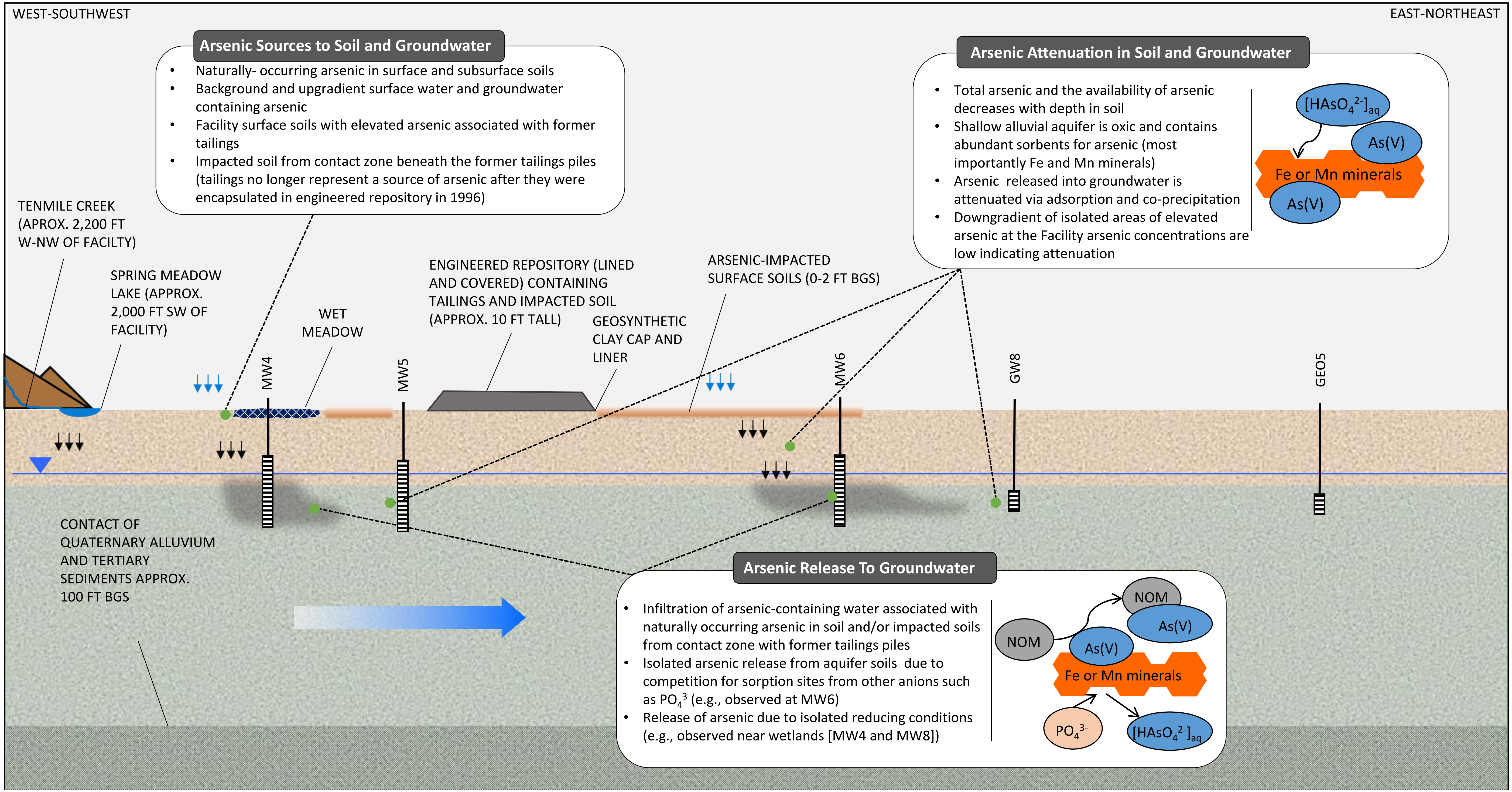
Figure 10 - Exposure Areas



Joslyn Street Tailings Facility
Lewis and Clark County, Montana

BHHRA CONCEPTUAL SITE MODEL

Figure 11 – HHRA Conceptual Exposure Model
(From Arcadis 2014a)



LEGEND:

- WATER TABLE (DTW = 1.3 to 11.9 FT BGS)
- GROUNDWATER FLOW DIRECTION (NORTH-NORTHEAST TO NORTHEAST)
- PRECIPITATION
- INFILTRATION
- MONITORING WELL
- SCREENED INTERVAL
- GRAB GROUNDWATER SAMPLE
- LOCALIZED ARSENIC GROUNDWTER IMPACTS
- QUATERNARY ALLUVIUM, CONSISTING OF STRATIFIED LENSES OF COBBLES, GRAVELS, AND SAND WITH ABUNDANT INTERCALATED SILT AND CLAY.
- SATURATED QUATERNARY ALLUVIUM
- TERTIARY SEDIMENTS, CONSISTING OF STRATIFIED LENSES OF COBBLES, GRAVELS, AND SAND WITH ABUNDANT INTERCALATED SILT AND CLAY

NOTES:

$[HAsO_4^{2-}]_{aq}$ = dissolved arsenate
APPROX. = approximately
As(V) = Arsenic in the +5 oxidation state
BGS = below ground surface
DTW = depth to groundwater
Fe = iron
FT = feet
Mn = manganese
PO_4^3 = orthophosphate
SO_4^{2-} = sulfate
SW = southwest
W-NW = west-northwest

FIGURE NOT TO SCALE

JULY 2017

Joslyn Street Tailings Facility
Helena, Montana

CONCEPTUAL SITE MODEL AND GENERALIZED CROSS SECTION

ARCADIS Design & Consultancy for natural and built assets

FIGURE 12

Joslyn Street Tailings Facility
Location of State Waters

Last Updated 5/14/2019

Montana "State waters" are defined under Section 75-5-103, Montana Code Annotated (MCA) and further classified per the Administrative Rule of Montana (ARM) 17.30.615.

DEQ
Montana Department of Environmental Quality

Figure 13 - State Waters

APPENDIX A

(Appendix L from the Draft Feasibility Study Report – Arcadis 2017)

APPENDIX L

Cost Estimates

Appendix L
Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Cost Estimates

The cost estimates presented in this appendix and the associated cost analysis information are provided for use in evaluating the costs of the alternatives presented in the Feasibility Study (FS) Report. An evaluation of capital and operation, maintenance, and monitoring (OMM) costs is provided for each alternative based on the conceptual approach and the estimated cleanup timeframes. The level of accuracy of these estimated FS-level costs is plus 50 percent and minus 30 percent. Cost estimates at this level may be used to compare alternatives. The cost estimate was prepared in general accordance with regulatory guidance for cost estimating (USEPA 2000). Unit costs were selected based on previous remediation and project experience and based on budgetary quotes for some materials and services.

- Capital costs, including cost for engineering, construction; equipment, labor, and materials, disposal costs, construction oversight and testing, regulatory oversight and contingency (20 percent of subtotal of the capital costs). Because of the conceptual level design of each alternative, a contingency of 20 percent is applied to all alternatives, which is consistent with experience on other projects at a conceptual level of design.
- Annual and periodic OMM costs for a 30-year period, including costs for post-construction labor, maintenance, project management, long-term monitoring, equipment replacement, and periodic reviews. The OMM plan for the selected alternative will be prepared following design.

For each alternative, the 30-year net present value costs (capital and OMM costs) were estimated using a 3.0% discount rate. Tables L-1 through L-8 of this appendix present the preliminary cost estimates for the soil and groundwater remedial alternatives.

References

U.S. Environmental Protection Agency (USEPA). 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA-540-R-00-002, Office of Emergency and Remedial Response. July.

Appendix L
Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Cost Estimates

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References

U.S. Environmental Protection Agency (USEPA). 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA-540-R-00-002, Office of Emergency and Remedial Response. July.

Table L-1
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Existing Repository O&M And Groundwater Monitoring

Operation, Maintenance, and Monitoring Costs				
Annual Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**
Annual O&M				
Repository Operations and Maintenance, including inspections and vegetation maintenance (labor, expenses, materials)	1	YEAR	$5,000	$5,000
Management and Reporting	1	YEAR	$1,500	$1,500
Annual Groundwater Monitoring of Select Wells				
Sampling & Analysis, including 5 monitoring wells, costs for labor, equipment, and supplies	1	EVENT	$3,500	$3,500
Laboratory Analytical Costs, including 5 monitoring wells, plus QA/QC samples, lab $150/sample	6	EACH	$150	$900
Management & Reporting, including labor for data validation/review, reporting, and submittal to DEQ.	1	YEAR	$5,000	$5,000
TOTAL ANNUAL OMM COSTS (Years 1-30)				**$15,900**

Notes:
O&M = operations and maintenance
QA/QC = quality assurance/quality control
OMM = operations, monitoring, and maintenance

Table L-2
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Soil Alternative 2 - Low Permeability Cap

Capital Costs							
Description	**Quantity**		**Unit**	**Unit Cost**	**Total Cost**		**Notes/Source**
	Scenario 1	**Scenario 2**			**Scenario 1**	**Scenario 2**	
Work Plan, Agency Correspondence, and Design	1.5	1	LS	$125,000	$187,500	$125,000	Based on experience with similar projects
Mob/Demob, Insurance, Bonding	1	1	LS	10% / 15%	$541,770	$200,428	% of total costs except disposal, reporting, and testing. Based on previous experience and Centennial Trail Projects. Lower percentage used for projects over $5 million.
Wetland Delineation and Restoration Assessment	1	1	LS	$50,000	$50,000	$50,000	Includes field assessment, initial report, restoration design, and agency interactions.
Soil Removal							
Grade, Screen, and Haul to Lewis and Clark County Landfill from Non-Residential Yards	49,858	14,681	CY	$30.00	$1,495,739	$440,416	Centennial Trail and previous projects (includes clearing and grubbing)
Grade, Screen, Haul from Existing Residential Areas/Yards	1,929	1,929	CY	$100.00	$192,854	$192,854	Centennial Trail Project (includes clearing and grubbing)
Disposal							
Dispose at Lewis and Clark County Landfill (Buried Waste)	19,420	8,720	TON	$15.00	$291,299	$130,797	Quote from Lewis & Clark County Landfill
Dispose at Lewis and Clark County Landfill (Daily Cover)	55,260	13,194	TON	$10.00	$552,598	$131,939	Quote from Lewis & Clark County Landfill
Stabilize and Dispose at Lewis and Clark County Landfill	3,000	3,000	TON	$35.00	$105,000	$105,000	Based on previous projects, assumes $15/ton for buried + $20/ton treatment
Cap Installation							
Foundation Grading & Compaction	676,566	108,714	SF	$0.11	$71,798	$11,537	RSMeans 2013
Dense Graded Aggregate Base	16,705	2,684	CY	$25.00	$417,633	$67,108	Recent Project Quote
Hot Mix Asphalt Base Course (4 inches)	75,174	12,079	SY	$18.89	$1,419,999	$228,173	RSMeans 2013
Hot Mix Asphalt Surface Course (2 inches)	75,174	12,079	SY	$10.93	$821,685	$132,033	RSMeans 2013
Stormwater Infrastructure	1	1	LS	30.0%	$819,335	$131,655	Estimated as 30% of Paving Costs, includes stormwater drainage and conveyance features (i.e., piping, manholes, catch basins, and bedding/backfill materials).
Backfill, Grading, Vegetation and Well Abandonment							
Backfill	399	399	CY	$12.00	$4,789	$4,789	Previous Bids
Placement & Compaction for Backfill	399	399	CY	$4.00	$1,596	$1,596	Previous Bids
Grading Commercial/Industrial Areas	790,884	352,736	SF	$0.06	$43,938	$19,596	Previous Bids
Topsoil and Sod Placement for Residential Yards in EA 1 (6 inches)	21,550	21,550	SF	$1.80	$38,790	$38,790	Centennial Trail Project
Demolition and Well Abandonment	1	1	LS	$50,000	$50,000	$50,000	Includes and demolition of construction infrastructure and abandonment of monitoring wells and wells at the Facility formerly used for other uses.
Seeding (Mechanically Spread)	790,884	352,736	SF	$0.05	$39,544	$17,637	Previous Bids
Testing, Reporting, and Oversight							
Construction Oversight	158	51	DAY	$1,500	$237,000	$76,500	Based on estimates of labor, equipment, and expenses and anticipated production/duration (500 cy/day excavation, 5000 sy/day grading & compaction, 4,500 sy/day aggregate, 6,000 sy/day asphalt, and 10 days for mob/demob/other close out activities).
CQA Testing and Laboratory	2	1	LS	$50,000	$100,000	$50,000	Includes CQA testing and laboratory costs associated with soil removal and disposal, backfill and grading, and installation of the cap (i.e., placement of base, paving, grading, stormwater infrastructure).
Construction Completion Report	1	1	LS	$50,000	$50,000	$50,000	
		Subtotal Capital Cost			$7,532,869	2,255,847	
		Contingency		20%	$1,506,574	451,169	
		Total Capital Cost (Rounded up)			**$9,040,000**	**2,710,000**	

Capital Cost Notes:

LS = lump sum — EA = exposure area
CY = cubic yards — CQA = construction quality assurance
SF = square feet — SY = square yard

1. The level of accuracy of these estimated costs is “Order of Magnitude,” as defined by the American Association of Cost Engineers. The accuracy of an Order of Magnitude estimate is plus 50 percent and minus 30 percent. Cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects. Changes in the cost elements are likely to occur during the engineering design of the remedial alternative. The cost estimate was prepared in general accordance with regulatory guidance for cost estimating (USEPA 2000). Unit costs were selected based on previous remediation and project experience and based on budgetary quotes for some materials and services.
2. Estimated a maximum of approximately 3,000 total cubic yards of material may require treatment under both scenarios. Assumed that approximately 25% of material for Scenario 1 and 35% for Scenario 2 will be buried, remaining is assumed to be suitable for daily cover. The assumptions regarding disposal (cover, buried, or hazardous) are based on available soil data and landfill acceptance criteria.
3. Backfill is assumed only within residential yards beneath topsoil and sod. Grading and vegetation was assumed over the non-residential excavation/uncapped areas (i.e., 12-inch depth remedial areas that have removal but are not capped).
4. Assumed soil density is 1.5 tons per cubic yard
5. The costs for silt fence, water, and other ancillary work items are included in the mob/demob or excavation units

Table L-2
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Soil Alternative 2-1 - Low Permeability Cap, Scenario 1

Groundwater remedy and monitoring costs included in the groundwater alternative costs.

Operation, Maintenance, and Monitoring Costs					
Annual Costs					
Description		**Quantity**	**Unit**	**Unit Cost**	**Total**
Years 1-30					
Post-Remedial Annual Cap Operations and Maintenance, including inspections		1	YEAR	$5,000	$5,000
Management and Reporting		1	YEAR	$2,000	$2,000
TOTAL ANNUAL OMM COSTS (Years 1-30)					**$7,000**
Periodic Costs					
Description	**Year**	**Quantity**	**Unit**	**Unit Cost**	**Total**
Years 5, 10, 15, 20, 25					
Repair Holes	Every 5 Years	1	YEAR	$17,000	$17,000
Repair Patches	Every 5 Years	1	YEAR	$32,000	$32,000
Sealing	Every 5 Years	1	YEAR	$19,000	$19,000
TOTAL PERIODIC OMM COSTS (Years 5, 10, 15, 20, 25)					**$68,000**
Year 30 Maintenance					
Repave Capped Area	30	1	LS	$2,800,000	**$2,800,000**

PRESENT VALUE ANALYSIS, Scenario 1

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$9,040,000	$7,000	$0	$9,047,000	1	$9,047,000
1	$0	$7,000	$0	$7,000	0.97	$6,796
2	$0	$7,000	$0	$7,000	0.94	$6,598
3	$0	$7,000	$0	$7,000	0.92	$6,406
4	$0	$7,000	$0	$7,000	0.89	$6,219
5	$0	$7,000	$68,000	$75,000	0.86	$64,696
6	$0	$7,000	$0	$7,000	0.84	$5,862
7	$0	$7,000	$0	$7,000	0.81	$5,692
8	$0	$7,000	$0	$7,000	0.79	$5,526
9	$0	$7,000	$0	$7,000	0.77	$5,365
10	$0	$7,000	$68,000	$75,000	0.74	$55,807
11	$0	$7,000	$0	$7,000	0.72	$5,057
12	$0	$7,000	$0	$7,000	0.70	$4,910
13	$0	$7,000	$0	$7,000	0.68	$4,767
14	$0	$7,000	$0	$7,000	0.66	$4,628
15	$0	$7,000	$68,000	$75,000	0.64	$48,140
16	$0	$7,000	$0	$7,000	0.62	$4,362
17	$0	$7,000	$0	$7,000	0.61	$4,235
18	$0	$7,000	$0	$7,000	0.59	$4,112
19	$0	$7,000	$0	$7,000	0.57	$3,992
20	$0	$7,000	$68,000	$75,000	0.55	$41,526
21	$0	$7,000	$0	$7,000	0.54	$3,763
22	$0	$7,000	$0	$7,000	0.52	$3,653
23	$0	$7,000	$0	$7,000	0.51	$3,547
24	$0	$7,000	$0	$7,000	0.49	$3,444
25	$0	$7,000	$68,000	$75,000	0.48	$35,820
26	$0	$7,000	$0	$7,000	0.46	$3,246
27	$0	$7,000	$0	$7,000	0.45	$3,151
28	$0	$7,000	$0	$7,000	0.44	$3,060
29	$0	$7,000	$0	$7,000	0.42	$2,970
30	$0	$7,000	$2,800,000	$2,807,000	0.41	$1,156,447
TOTAL PRESENT VALUE OF SOIL ALTERNATIVE 2-1 (Rounded up to next $10,000)						**$10,570,000**

Table L-2
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Soil Alternative 2-2 - Low Permeability Cap, Scenario 2
Groundwater remedy and monitoring costs included in the groundwater alternative costs.

Operation, Maintenance, and Monitoring Costs						
Annual Costs						
Description		**Quantity**	**Unit**	**Unit Cost**	**Total**
Years 1-30					
Post-Remedial Annual Cap Operations and Maintenance, including inspections		1	YEAR	$2,500	$2,500
Management and Reporting		1	YEAR	$1,500	$1,500
TOTAL ANNUAL OMM COSTS (Years 1-30)					**$4,000**
Periodic Costs					
Description	**Year**	**Quantity**	**Unit**	**Unit Cost**	**Total**
Years 5, 10, 15, 20, 25					
Repair Holes	Every 5 Years	1	EACH	$8,700	$8,700
Repair Patches	Every 5 Years	1	EACH	$16,000	$16,000
Sealing	Every 5 Years	1	EACH	$9,400	$9,400
TOTAL PERIODIC OMM COSTS (Years 5, 10, 15, 20, 25)					**$34,100**
Year 30 Maintenance					
Repave Capped Area	20	1	LS	$500,000	**$500,000**

PRESENT VALUE ANALYSIS, Scenario 2

Year	**Capital Cost**	**Annual Cost**	**Periodic Cost**	**Total Cost Per Year**	**Discount Factor (3.0%)**	**Present Value**
0	$2,710,000	$4,000	$0	$2,714,000	1	$2,714,000
1	$0	$4,000	$0	$4,000	0.97	$3,883
2	$0	$4,000	$0	$4,000	0.94	$3,770
3	$0	$4,000	$0	$4,000	0.92	$3,661
4	$0	$4,000	$0	$4,000	0.89	$3,554
5	$0	$4,000	$34,100	$38,100	0.86	$32,865
6	$0	$4,000	$0	$4,000	0.84	$3,350
7	$0	$4,000	$0	$4,000	0.81	$3,252
8	$0	$4,000	$0	$4,000	0.79	$3,158
9	$0	$4,000	$0	$4,000	0.77	$3,066
10	$0	$4,000	$34,100	$38,100	0.74	$28,350
11	$0	$4,000	$0	$4,000	0.72	$2,890
12	$0	$4,000	$0	$4,000	0.70	$2,806
13	$0	$4,000	$0	$4,000	0.68	$2,724
14	$0	$4,000	$0	$4,000	0.66	$2,644
15	$0	$4,000	$34,100	$38,100	0.64	$24,455
16	$0	$4,000	$0	$4,000	0.62	$2,493
17	$0	$4,000	$0	$4,000	0.61	$2,420
18	$0	$4,000	$0	$4,000	0.59	$2,350
19	$0	$4,000	$0	$4,000	0.57	$2,281
20	$0	$4,000	$34,100	$38,100	0.55	$21,095
21	$0	$4,000	$0	$4,000	0.54	$2,150
22	$0	$4,000	$0	$4,000	0.52	$2,088
23	$0	$4,000	$0	$4,000	0.51	$2,027
24	$0	$4,000	$0	$4,000	0.49	$1,968
25	$0	$4,000	$34,100	$38,100	0.48	$18,197
26	$0	$4,000	$0	$4,000	0.46	$1,855
27	$0	$4,000	$0	$4,000	0.45	$1,801
28	$0	$4,000	$0	$4,000	0.44	$1,748
29	$0	$4,000	$0	$4,000	0.42	$1,697
30	$0	$4,000	$500,000	$504,000	0.41	$207,641
TOTAL PRESENT VALUE OF SOIL ALTERNATIVE 2-2 (Rounded up to next $10,000)						**$3,120,000**

Table L-3
Appendix L Cost Estimates
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Lewis and Clark County, Montana

Soil Alternative 3 - Excavation and On-site Disposal

Capital Costs							
Description	Quantity		Unit	Unit Cost	Total Cost		Notes/Source
	Scenario 1	Scenario 2			Scenario 1	Scenario 2	
Work Plan, Agency Correspondence, and Design	1.5	1	LS	$125,000	$187,500	$125,000	Based on experience with similar projects
Mob/Demob, Insurance, Bonding	1	1	LS	10% / 15%	$311,000	$157,000	% of total costs except disposal, reporting, and testing. Based on previous experience and Centennial Trail Projects. Lower percentage used for projects over $5 million.
Wetland Delineation and Restoration Assessment	1	1	LS	$50,000	$50,000	$50,000	Includes field assessment, initial report, restoration design, and agency interactions.
Soil Removal							
Excavate	72,550	17,550	CY	$10.00	$725,500	$175,500	Centennial Trail and previous projects
Excavate from Existing Residential Areas/Yards (EA 1 and 11)	2,450	2,450	CY	$80.00	$196,000	$196,000	Centennial Trail Project
Hauling	75,000	20,000	CY	$3.00	$225,000	$60,000	
Repository							
Surface Preparation	230,080	68,504	SF	$0.30	$69,024	$20,551	
Bottom GCL (material and install)	230,080	68,504	SF	$0.90	$207,072	$61,654	Quote from supplier
Waste Placement and Grading	75,000	20,000	CY	$3.00	$225,000	$60,000	
Waste Compaction	75,000	20,000	CY	$2.00	$150,000	$40,000	
Drainage (top and sides)	232,999	70,008	SF	$0.40	$93,200	$28,003	Quote from supplier
Cover (top and sides) GCL	232,999	70,008	SF	$1.40	$326,198	$98,011	Quote from supplier
Cover Soil Import and Placement	12,782	3,806	CY	$16.00	$204,516	$60,892	
Backfill, Grading, Vegetation and Well Abandonment							
Backfill	24,356	4,846	CY	$12.00	$292,271	$58,151	Previous Bids
Placement & Compaction for Backfill	24,356	4,846	CY	$4.00	$97,424	$19,384	Previous Bids
Grading Commercial/Industrial Areas	1,467,450	461,450	SF	$0.06	$81,525	$25,636	Previous Bids
Topsoil and Sod Placement for Residential Yards in EA 1 (6 inches)	21,550	21,550	SF	$1.80	$38,790	$38,790	Centennial Trail Project
Demolition and Well Abandonment	1	1	LS	$50,000	$50,000	$50,000	Includes and demolition of construction infrastructure and abandonment of monitoring wells and wells at the Facility formerly used for other uses.
Seeding (Mechanically Spread)	1,467,450	461,450	SF	$0.05	$73,373	$23,073	Previous Bids
Fence and Signage	2	1	LS	$25,000	$50,000	$25,000	
Testing, Reporting, and Oversight							
Construction Oversight	358	109	DAY	$1,500	$537,000	$163,500	Based on estimates of labor, equipment, and expenses and anticipated production (500 cy/day excavation, 1,000 cy/day backfill and cover soil placement, 500 cy/day for construction of repository on average including liners, waste placement, and compaction, and 20 days for mob/demob/other close out activities).
CQA Testing and Laboratory	2	1	LS	$50,000	$100,000	$50,000	Includes CQA testing and laboratory costs associated with soil removal, backfill and grading, and construction of the repository (i.e., placement of liner and cover geosynthetics; waste placement, compaction, and grading; cover soil import and placement).
Construction Completion Report	1	1	LS	$50,000	$50,000	$50,000	
		Subtotal Capital Cost			$4,340,392	$1,636,145	
		Contingency		20%	$868,078	$327,229	
		Total Capital Cost (Rounded up)			**$5,210,000**	**$1,970,000**	

Capital Cost Notes:

LS = lump sum | EA = exposure area
CY = cubic yards | CQA = construction quality assurance
SF = square feet | YR = year
SY = square yards | GCL = geo-composite layer

1. The level of accuracy of these estimated costs is "Order of Magnitude," as defined by the American Association of Cost Engineers. The accuracy of an Order of Magnitude estimate is plus 50 percent and minus 30 percent. Cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects. Changes in the cost elements are likely to occur during the engineering design of the remedial alternative. The cost estimate was prepared in general accordance with regulatory guidance for cost estimating (USEPA 2000). Unit costs were selected based on previous remediation and project experience and based on budgetary quotes for some materials and services.
2. Height of impacted soil in repository assumed to be 10 feet high.
3. Compaction achieved within the repository assumed to be 100% of in-situ compaction.
4. Material costs for GCL and geocomposite include shipment and installation costs.
5. Backfill is assumed within all of EA1 and EA11, and as needed to bring remaining excavation areas to within 1-ft of original grade. Grading and vegetation was assumed over the excavation area that is does not have topsoil and sod placed.
6. Assumed soil density is 1.5 tons per cubic yard
7. The costs for silt fence, water, and other ancillary work items are included in the mob/demob or excavation units costs.

Table L-3
Appendix L Cost Estimates
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Soil Alternative 3-1 - Excavation and On-Site Disposal, Scenario 1
Groundwater remedy and monitoring costs included in the groundwater alternative costs.

Operation, Maintenance, and Monitoring Costs				
Annual Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**
Years 1-30				
Post-Remedial Repository Operations and Maintenance, including inspections and vegetation maintenance (labor, expenses, materials)	1	YEAR	$11,000	$11,000
Management and Reporting	1	YEAR	$1,500	$1,500
TOTAL ANNUAL OMM COSTS (Years 1-30)				**$12,500**

PRESENT VALUE ANALYSIS, Scenario 1

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$5,210,000		$0	$5,210,000	1	$5,210,000
1	$0	$12,500	$0	$12,500	0.97	$12,136
2	$0	$12,500	$0	$12,500	0.94	$11,782
3	$0	$12,500	$0	$12,500	0.92	$11,439
4	$0	$12,500	$0	$12,500	0.89	$11,106
5	$0	$12,500	$0	$12,500	0.86	$10,783
6	$0	$12,500	$0	$12,500	0.84	$10,469
7	$0	$12,500	$0	$12,500	0.81	$10,164
8	$0	$12,500	$0	$12,500	0.79	$9,868
9	$0	$12,500	$0	$12,500	0.77	$9,580
10	$0	$12,500	$0	$12,500	0.74	$9,301
11	$0	$12,500	$0	$12,500	0.72	$9,030
12	$0	$12,500	$0	$12,500	0.70	$8,767
13	$0	$12,500	$0	$12,500	0.68	$8,512
14	$0	$12,500	$0	$12,500	0.66	$8,264
15	$0	$12,500	$0	$12,500	0.64	$8,023
16	$0	$12,500	$0	$12,500	0.62	$7,790
17	$0	$12,500	$0	$12,500	0.61	$7,563
18	$0	$12,500	$0	$12,500	0.59	$7,342
19	$0	$12,500	$0	$12,500	0.57	$7,129
20	$0	$12,500	$0	$12,500	0.55	$6,921
21	$0	$12,500	$0	$12,500	0.54	$6,719
22	$0	$12,500	$0	$12,500	0.52	$6,524
23	$0	$12,500	$0	$12,500	0.51	$6,334
24	$0	$12,500	$0	$12,500	0.49	$6,149
25	$0	$12,500	$0	$12,500	0.48	$5,970
26	$0	$12,500	$0	$12,500	0.46	$5,796
27	$0	$12,500	$0	$12,500	0.45	$5,627
28	$0	$12,500	$0	$12,500	0.44	$5,463
29	$0	$12,500	$0	$12,500	0.42	$5,304
30	$0	$12,500	$0	$12,500	0.41	$5,150
TOTAL PRESENT VALUE OF SOIL ALTERNATIVE 3-1 (Rounded up to next $10,000)						**$5,460,000**

Table L-3
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
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Soil Alternative 3-2 - Excavation and On-Site Disposal, Scenario 2
Groundwater remedy and monitoring costs included in the groundwater alternative costs.

Operation, Maintenance, and Monitoring Costs				
Annual Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**
Years 1-30				
Post-Remedial Repository Operations and Maintenance, including inspections and vegetation maintenance (labor, expenses, materials)	1	YEAR	$5,000	$5,000
Management and Reporting	1	YEAR	$1,500	$1,500
TOTAL ANNUAL OMM COSTS (Years 1-30)				**$6,500**

PRESENT VALUE ANALYSIS, Scenario 2

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$1,970,000		$0	$1,970,000	1	$1,970,000
1	$0	$6,500	$0	$6,500	0.97	$6,311
2	$0	$6,500	$0	$6,500	0.94	$6,127
3	$0	$6,500	$0	$6,500	0.92	$5,948
4	$0	$6,500	$0	$6,500	0.89	$5,775
5	$0	$6,500	$0	$6,500	0.86	$5,607
6	$0	$6,500	$0	$6,500	0.84	$5,444
7	$0	$6,500	$0	$6,500	0.81	$5,285
8	$0	$6,500	$0	$6,500	0.79	$5,131
9	$0	$6,500	$0	$6,500	0.77	$4,982
10	$0	$6,500	$0	$6,500	0.74	$4,837
11	$0	$6,500	$0	$6,500	0.72	$4,696
12	$0	$6,500	$0	$6,500	0.70	$4,559
13	$0	$6,500	$0	$6,500	0.68	$4,426
14	$0	$6,500	$0	$6,500	0.66	$4,297
15	$0	$6,500	$0	$6,500	0.64	$4,172
16	$0	$6,500	$0	$6,500	0.62	$4,051
17	$0	$6,500	$0	$6,500	0.61	$3,933
18	$0	$6,500	$0	$6,500	0.59	$3,818
19	$0	$6,500	$0	$6,500	0.57	$3,707
20	$0	$6,500	$0	$6,500	0.55	$3,599
21	$0	$6,500	$0	$6,500	0.54	$3,494
22	$0	$6,500	$0	$6,500	0.52	$3,392
23	$0	$6,500	$0	$6,500	0.51	$3,293
24	$0	$6,500	$0	$6,500	0.49	$3,198
25	$0	$6,500	$0	$6,500	0.48	$3,104
26	$0	$6,500	$0	$6,500	0.46	$3,014
27	$0	$6,500	$0	$6,500	0.45	$2,926
28	$0	$6,500	$0	$6,500	0.44	$2,841
29	$0	$6,500	$0	$6,500	0.42	$2,758
30	$0	$6,500	$0	$6,500	0.41	$2,678
TOTAL PRESENT VALUE OF SOIL ALTERNATIVE 3-2 (Rounded up to next $10,000)						**$2,100,000**

Table L-4
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
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Soil Alternative 4 - Excavation and Off-site Disposal with Treatment As Needed

Capital Costs							
Description	Quantity		Unit	Unit Cost	Total Cost		Notes/Source
	Scenario 1	Scenario 2			Scenario 1	Scenario 2	
Work Plan, Agency Correspondence, and Design	1.5	1	LS	$125,000	$187,500	$125,000	Based on experience with similar projects
Mob/Demob, Insurance, Bonding	1	1	LS	10% / 15%	$306,000	$148,000	% of total costs except disposal, reporting, and testing. Based on previous experience and Centennial Trail Projects. Lower percentage used for projects over $5 million.
Wetland Delineation and Restoration Assessment	1	1	LS	$50,000	$50,000	$50,000	Includes field assessment, initial report, restoration design, and agency interactions.
Soil Removal							
Excavate, Screen, and Haul to Lewis and Clark County Landfill from Non-Residential Yards	72,550	17,550	CY	$30.00	$2,176,500	$526,500	Centennial Trail and previous projects
Excavate, Screen, Haul from Existing Residential Areas/Yards	2,450	2,450	CY	$100.00	$245,000	$245,000	Centennial Trail Project
Disposal							
Dispose at Lewis and Clark County Landfill (Buried Waste)	28,125	10,500	TON	$15.00	$421,875	$157,500	Quote from Lewis & Clark County Landfill
Dispose at Lewis and Clark County Landfill (Daily Cover)	81,375	16,500	TON	$10.00	$813,750	$165,000	Quote from Lewis & Clark County Landfill
Stabilize and Dispose at Lewis and Clark County Landfill	3,000	3,000	TON	$35.00	$105,000	$105,000	Based on previous projects, assumes $15/ton for buried + $20/ton treatment
Backfill, Grading, Vegetation and Well Abandonment							
Backfill	24,356	4,846	CY	$12.00	$292,271	$58,151	Previous Bids
Placement & Compaction for Backfill	24,356	4,846	CY	$4.00	$97,424	$19,384	Previous Bids
Grading Commercial/Industrial Areas	1,467,450	461,450	SF	$0.06	$81,525	$25,636	Previous Bids
Topsoil and Sod Placement for Residential Yards in EA 1 (6 inches)	21,550	21,550	SF	$1.80	$38,790	$38,790	Centennial Trail Project
Demolition and Well Abandonment	1	1	LS	$50,000	$50,000	$50,000	Includes and demolition of construction infrastructure and abandonment of monitoring wells and wells at the Facility formerly used for other uses.
Seeding (Mechanically Spread)	1,467,450	461,450	SF	$0.05	$73,373	$23,073	Previous Bids
Testing, Reporting, and Oversight							
Construction Oversight	195	65	DAY	$1,500.00	$292,500	$97,500	Based on estimates of labor, equipment, and expenses and anticipated production/duration (500 cy/day excavation, 1,000 cy/day backfill, and 20 days for mob/demob/other close out activities).
CQA Testing and Laboratory	2	1	LS	$25,000	$50,000	$25,000	Includes CQA testing and laboratory costs associated with soil removal and offsite disposal, backfill, and grading.
Construction Completion Report	1	1	LS	$50,000	$50,000	$50,000	
		Subtotal Capital Cost			$5,331,507	$1,909,533	
		Contingency		20%	$1,066,301	$381,907	
		Total Capital Cost (Rounded up)			**$6,400,000**	**$2,300,000**	

Capital Cost Notes:

LS = lump sum	EA = exposure area
CY = cubic yards	CQA = construction quality assurance
SF = square feet	YR = year
SY = square yards	

1. The level of accuracy of these estimated costs is “Order of Magnitude,” as defined by the American Association of Cost Engineers. The accuracy of an Order of Magnitude estimate is plus 50 percent and minus 30 percent. Cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects. Changes in the cost elements are likely to occur during the engineering design of the remedial alternative. The cost estimate was prepared in general accordance with regulatory guidance for cost estimating (USEPA 2000). Unit costs were selected based on previous remediation and project experience and based on budgetary quotes for some materials and services.
2. Estimated a maximum of approximately 3,000 total cubic yards of material may require treatment under both scenarios. Assumed that approximately 25% of material for Scenario 1 and 35% for Scenario 2 will be buried, remaining is assumed to be suitable for daily cover. The assumptions regarding disposal (cover, buried, or hazardous) are based on available soil data and landfill acceptance criteria.
3. Backfill is assumed within all of EA1 and EA11, and as needed to bring remaining excavation areas to within 1 feet of original grade. Grading and vegetation was assumed over the excavation area that is does not have topsoil and sod placed.
4. Assumed soil density is 1.5 tons per cubic yard
5. The costs for silt fence, water, and other ancillary work items are included in the mob/demob or excavation units costs.

Table L-4
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
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Soil Alternative 4-1 - Excavation and Off-Site Disposal with Treatment As Needed, Scenario 1

Groundwater remedy and monitoring costs included in the groundwater alternative costs.

Operation, Maintenance, and Monitoring Costs				
Annual Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**
Years 1-30				
None	--	--	--	--
TOTAL ANNUAL OMM COSTS (Years 1-30)				**$0**

PRESENT VALUE ANALYSIS, Scenario 1

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$6,400,000	$0	$0	$6,400,000	1	$6,400,000
1	$0	$0	$0	$0	0.97	$0
2	$0	$0	$0	$0	0.94	$0
3	$0	$0	$0	$0	0.92	$0
4	$0	$0	$0	$0	0.89	$0
5	$0	$0	$0	$0	0.86	$0
6	$0	$0	$0	$0	0.84	$0
7	$0	$0	$0	$0	0.81	$0
8	$0	$0	$0	$0	0.79	$0
9	$0	$0	$0	$0	0.77	$0
10	$0	$0	$0	$0	0.74	$0
11	$0	$0	$0	$0	0.72	$0
12	$0	$0	$0	$0	0.70	$0
13	$0	$0	$0	$0	0.68	$0
14	$0	$0	$0	$0	0.66	$0
15	$0	$0	$0	$0	0.64	$0
16	$0	$0	$0	$0	0.62	$0
17	$0	$0	$0	$0	0.61	$0
18	$0	$0	$0	$0	0.59	$0
19	$0	$0	$0	$0	0.57	$0
20	$0	$0	$0	$0	0.55	$0
21	$0	$0	$0	$0	0.54	$0
22	$0	$0	$0	$0	0.52	$0
23	$0	$0	$0	$0	0.51	$0
24	$0	$0	$0	$0	0.49	$0
25	$0	$0	$0	$0	0.48	$0
26	$0	$0	$0	$0	0.46	$0
27	$0	$0	$0	$0	0.45	$0
28	$0	$0	$0	$0	0.44	$0
29	$0	$0	$0	$0	0.42	$0
30	$0	$0	$0	$0	0.41	$0
TOTAL PRESENT VALUE OF SOIL ALTERNATIVE 4-1 (Rounded up to next $10,000)						**$6,400,000**

Table L-4
Appendix L Cost Estimates
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Joslyn Street Tailings Facility
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Soil Alternative 4-2 - Excavation and Off-Site Disposal with Treatment As Needed, Scenario 2
Groundwater remedy and monitoring costs included in the groundwater alternative costs.

Operation, Maintenance, and Monitoring Costs				
Annual Costs				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**
Years 1-30				
None	--	--	--	--
TOTAL ANNUAL OMM COSTS (Years 1-30)				**$0**

PRESENT VALUE ANALYSIS, Scenario 2

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$2,300,000	$0	$0	$2,300,000	1	$2,300,000
1	$0	$0	$0	$0	0.97	$0
2	$0	$0	$0	$0	0.94	$0
3	$0	$0	$0	$0	0.92	$0
4	$0	$0	$0	$0	0.89	$0
5	$0	$0	$0	$0	0.86	$0
6	$0	$0	$0	$0	0.84	$0
7	$0	$0	$0	$0	0.81	$0
8	$0	$0	$0	$0	0.79	$0
9	$0	$0	$0	$0	0.77	$0
10	$0	$0	$0	$0	0.74	$0
11	$0	$0	$0	$0	0.72	$0
12	$0	$0	$0	$0	0.70	$0
13	$0	$0	$0	$0	0.68	$0
14	$0	$0	$0	$0	0.66	$0
15	$0	$0	$0	$0	0.64	$0
16	$0	$0	$0	$0	0.62	$0
17	$0	$0	$0	$0	0.61	$0
18	$0	$0	$0	$0	0.59	$0
19	$0	$0	$0	$0	0.57	$0
20	$0	$0	$0	$0	0.55	$0
21	$0	$0	$0	$0	0.54	$0
22	$0	$0	$0	$0	0.52	$0
23	$0	$0	$0	$0	0.51	$0
24	$0	$0	$0	$0	0.49	$0
25	$0	$0	$0	$0	0.48	$0
26	$0	$0	$0	$0	0.46	$0
27	$0	$0	$0	$0	0.45	$0
28	$0	$0	$0	$0	0.44	$0
29	$0	$0	$0	$0	0.42	$0
30	$0	$0	$0	$0	0.41	$0
TOTAL PRESENT VALUE OF SOIL ALTERNATIVE 4-2 (Rounded up to next $10,000)						**$2,300,000**

Table L-5
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
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Groundwater Alternative 2 - Monitored Natural Attenuation

Capital Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes/Source**
Work Plan and Agency Correspondence	1	LS	$25,000	$25,000	Based on experience with similar projects
Replace/Install Groundwater Monitoring Wells	1	LS	$30,000	$30,000	Assume up to 5 wells to be replaced/installed for groundwater monitoring following implementation of soil remedy.
		Subtotal Capital Cost		$55,000	
		Contingency	20%	$11,000	
		Total Capital Cost (Rounded up)		**$66,000**	

Capital Cost Notes:
LS = lump sum
CY = cubic yards
SF = square feet
YR = year

1. The level of accuracy of these estimated costs is "Order of Magnitude," as defined by the American Association of Cost Engineers. The accuracy of an Order of Magnitude estimate is plus 50 percent and minus 30 percent. Cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects. Changes in the cost elements are likely to occur during the engineering design of the remedial alternative. The cost estimate was prepared in general accordance with regulatory guidance for cost estimating (USEPA 2000). Unit costs were selected based on previous remediation and project experience and based on budgetary quotes for some materials and services.

Groundwater Alternative 2 - Monitored Natural Attenuation

Operation, Maintenance, and Monitoring Costs					
Annual Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
Years 1-5, Semi-annual Monitoring					
Sampling & Analysis	2	EVENT	$6,500	$13,000	Assumes 8-10 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	22	EACH	$150	$3,300	Assumes 8-10 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$10,000	$10,000	Based on labor for data validation/review, reporting, interpretation, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 1-5)				**$26,300**	
Years 6-15, Annual Monitoring					
Sampling & Analysis	1	EVENT	$6,000	$6,000	Assumes 8-10 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	11	EACH	$150	$1,650	Assumes 8-10 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$7,500	$7,500	Based on labor for data validation/review, reporting, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 6-15)				**$15,200**	
Years 16-30, Annual Monitoring of Select Wells					
Sampling & Analysis	1	EVENT	$3,500	$3,500	Assumes 5 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	6	EACH	$150	$900	Assumes 5 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$5,000	$5,000	Based on labor for data validation/review, reporting, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 16-30)				**$9,400**	
Periodic Costs					
Description	**Year**	**Unit**	**Unit Cost**	**Notes**	
Additional MNA Evaluation	5, 10, 15	EVENT	$20,000	Analysis and evaluation of MNA constituent trends and geochemical parameters to ensure on-going effectiveness, including preparation of report.	

Table L-5
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Groundwater Alternative 2 - Monitored Natural Attenuation
PRESENT VALUE ANALYSIS

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$66,000	$26,300	$0	$92,300	1	$92,300
1	$0	$26,300	$0	$26,300	0.97	$25,534
2	$0	$26,300	$0	$26,300	0.94	$24,790
3	$0	$26,300	$0	$26,300	0.92	$24,068
4	$0	$26,300	$0	$26,300	0.89	$23,367
5	$0	$26,300	$20,000	$46,300	0.86	$39,939
6	$0	$15,200	$0	$15,200	0.84	$12,730
7	$0	$15,200	$0	$15,200	0.81	$12,359
8	$0	$15,200	$0	$15,200	0.79	$11,999
9	$0	$15,200	$0	$15,200	0.77	$11,650
10	$0	$15,200	$20,000	$35,200	0.74	$26,192
11	$0	$15,200	$0	$15,200	0.72	$10,981
12	$0	$15,200	$0	$15,200	0.70	$10,661
13	$0	$15,200	$0	$15,200	0.68	$10,350
14	$0	$15,200	$0	$15,200	0.66	$10,049
15	$0	$15,200	$20,000	$35,200	0.64	$22,594
16	$0	$9,400	$0	$9,400	0.62	$5,858
17	$0	$9,400	$0	$9,400	0.61	$5,687
18	$0	$9,400	$0	$9,400	0.59	$5,522
19	$0	$9,400	$0	$9,400	0.57	$5,361
20	$0	$9,400	$0	$9,400	0.55	$5,205
21	$0	$9,400	$0	$9,400	0.54	$5,053
22	$0	$9,400	$0	$9,400	0.52	$4,906
23	$0	$9,400	$0	$9,400	0.51	$4,763
24	$0	$9,400	$0	$9,400	0.49	$4,624
25	$0	$9,400	$0	$9,400	0.48	$4,489
26	$0	$9,400	$0	$9,400	0.46	$4,359
27	$0	$9,400	$0	$9,400	0.45	$4,232
28	$0	$9,400	$0	$9,400	0.44	$4,109
29	$0	$9,400	$0	$9,400	0.42	$3,989
30	$0	$9,400	$0	$9,400	0.41	$3,873
TOTAL PRESENT VALUE OF GROUNDWATER ALTERNATIVE 2 (Rounded up to next $10,000)						**$450,000**

Table L-6
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Groundwater Alternative 3 - Phytoremediation

Capital Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes/Source**
Work Plan, Agency Correspondence, and Design	1	LS	$50,000	$50,000	Based on experience with similar projects
Replace/Install Groundwater Monitoring Wells	1	LS	$30,000.00	$30,000	Assume up to 5 wells to be replaced/installed for groundwater monitoring following implementation of soil remedy.
Mob, Insurance, Bonding	1	LS	15.0%	$9,000	% of total costs based on previous experience
Phytoremediation Installation (topsoil and amendments, planting/labor, trees)	120,000	SF	$0.50	$60,000	Based on FRTR cost estimates, average cost per square foot excluding groundwater monitoring and MNA.
Testing, Reporting, and Oversight					
Construction Oversight	20	DAY	$750.00	$15,000	Based on estimates of labor, equipment, and expenses and anticipated production/duration
Construction Completion Report	1	LS	$25,000	$25,000	
		Subtotal Capital Cost		$189,000	
		Contingency	20%	$37,800	
		Total Capital Cost (Rounded up)		**$227,000**	

Capital Cost Notes:
LS = lump sum	FRTR = Federal Remediation Technology Roundtable
CY = cubic yards	MNA = monitored natural attenuation
SF = square feet

1. The level of accuracy of these estimated costs is “Order of Magnitude,” as defined by the American Association of Cost Engineers. The accuracy of an Order of Magnitude estimate is plus 50 percent and minus 30 percent. Cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects. Changes in the cost elements are likely to occur during the engineering design of the remedial alternative. The cost estimate was prepared in general accordance with regulatory guidance for cost estimating (USEPA 2000). Unit costs were selected based on previous remediation and project experience and based on budgetary quotes for some materials and services.
2. Assumed soil density is 1.5 tons per cubic yard.
3. The costs for silt fence, water, and other ancillary work items are included in the mob/demob or excavation units costs.

Groundwater Alternative 3 - Phytoremediation

Operation, Maintenance, and Monitoring Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
Annual Costs					
Years 1-5, Phytoremediation OMM and Semi-annual Groundwater Monitoring					
Phytoremediation Maintenance (weed controls, watering, fertilizer, replacement, vegetation disposal) and Monitoring	1	YEAR	$12,500	$12,500	Assume needed for 5 years to establish
Sampling & Analysis	2	EVENT	$6,500.00	$13,000	Assumes 8-10 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	22	EACH	$150.00	$3,300	Assumes 8-10 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$10,000.00	$10,000	Based on labor for data validation/review, reporting, interpretation, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 1-5)				**$38,800**	
Years 6-15, Phytoremediation OMM and Annual Groundwater Monitoring					
Phytoremediation Maintenance (weed controls, watering, fertilizer, replacement, vegetation disposal) and Monitoring	1	YEAR	$7,500	$7,500	Assume less OMM needed after vegetation is established
Sampling & Analysis	1	EVENT	$6,000.00	$6,000	Assumes 8-10 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	11	EA	$150.00	$1,650	Assumes 8-10 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$7,500.00	$7,500	Based on labor for data validation/review, reporting, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 6-15)				**$22,700**	
Years 16-30, Annual Monitoring of Select Wells					
Phytoremediation Maintenance (weed controls, watering, fertilizer, replacement, vegetation disposal) and Monitoring	0	YEAR	$0	$0	Assume phytoremediation monitoring is complete when groundwater cleanup levels are met
Sampling & Analysis	1	EVENT	$3,500.00	$3,500	Assumes 5 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	6	EA	$150.00	$900	Assumes 5 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$5,000.00	$5,000	Based on labor for data validation/review, reporting, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 16-30)				**$9,400**	
Periodic Costs					
Description	**Year**	**Unit**	**Unit Cost**	**Notes**	
Additional Phytoremediation and MNA Evaluation	5, 10, 15	EVENT	$20,000	Analysis and evaluation of phytoremediation effectiveness, including water levels, vegetation status, MNA constituent trends, and geochemical parameters, to ensure on-going effectiveness, including preparation of report.	
Disposition of Plants after Groundwater meets DEQ-7 (if needed based on risk evaluation)	16	LS	$20,000	An analysis of risk pathways for vegetation will be completed and proper disposal, if required, will be completed.	

Table L-6
Appendix L Cost Estimates
Feasibility Study Report
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Groundwater Alternative 3 - Phytoremediation
PRESENT VALUE ANALYSIS

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$227,000	$38,800	$0	$265,800	1	$265,800
1	$0	$38,800	$0	$38,800	0.97	$37,670
2	$0	$38,800	$0	$38,800	0.94	$36,573
3	$0	$38,800	$0	$38,800	0.92	$35,507
4	$0	$38,800	$0	$38,800	0.89	$34,473
5	$0	$38,800	$20,000	$58,800	0.86	$50,721
6	$0	$22,700	$0	$22,700	0.84	$19,011
7	$0	$22,700	$0	$22,700	0.81	$18,457
8	$0	$22,700	$0	$22,700	0.79	$17,920
9	$0	$22,700	$0	$22,700	0.77	$17,398
10	$0	$22,700	$20,000	$42,700	0.74	$31,773
11	$0	$22,700	$0	$22,700	0.72	$16,399
12	$0	$22,700	$0	$22,700	0.70	$15,921
13	$0	$22,700	$0	$22,700	0.68	$15,458
14	$0	$22,700	$0	$22,700	0.66	$15,007
15	$0	$22,700	$20,000	$42,700	0.64	$27,408
16	$0	$9,400	$20,000	$29,400	0.62	$18,321
17	$0	$9,400	$0	$9,400	0.61	$5,687
18	$0	$9,400	$0	$9,400	0.59	$5,522
19	$0	$9,400	$0	$9,400	0.57	$5,361
20	$0	$9,400	$0	$9,400	0.55	$5,205
21	$0	$9,400	$0	$9,400	0.54	$5,053
22	$0	$9,400	$0	$9,400	0.52	$4,906
23	$0	$9,400	$0	$9,400	0.51	$4,763
24	$0	$9,400	$0	$9,400	0.49	$4,624
25	$0	$9,400	$0	$9,400	0.48	$4,489
26	$0	$9,400	$0	$9,400	0.46	$4,359
27	$0	$9,400	$0	$9,400	0.45	$4,232
28	$0	$9,400	$0	$9,400	0.44	$4,109
29	$0	$9,400	$0	$9,400	0.42	$3,989
30	$0	$9,400	$0	$9,400	0.41	$3,873
TOTAL PRESENT VALUE OF GROUNDWATER ALTERNATIVE 3 (Rounded up to next $10,000)						**$740,000**

Table L-7
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
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Groundwater Alternative 4 - Permeable Reactive Barrier

Capital Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes/Source**
Work Plan, Agency Correspondence, and Design	1	LS	$50,000	$50,000	Based on experience with similar projects
Bench-Scale Testing - PRB	1	LS	$75,000	$75,000	Based on experience with similar projects
Replace/Install Groundwater Monitoring Wells	1	LS	$54,000.00	$54,000	Assume up to 5 wells to be replaced/installed for groundwater monitoring following implementation of soil remedy. An additional 4 monitoring wells in close proximity to the PRB are also assumed.
Mob, Insurance, Bonding	1	LS	15.0%	$14,420	% of total costs except disposal fees and specialty subcontractor costs, based on previous experience, excluding specialty subcontractor mob costs
Specialty Subcontractor Mobilization for PRB Install	1	LS	$80,000	$80,000	Based on budgetary quote and previous project quotes and experience
One Pass Trenching and Media Mixing/Installation	5,000	VSF	$25	$125,000	Based on budgetary quote and previous project quotes and experience
Zero Valent Iron (ZVI)	60	TON	$1,320	$79,200	Based on previous project quotes and experience. Assumes 10% ZVI and 90% sand by volume.
Sand	378	TON	$35	$13,230	Based on previous project quotes and experience. Assumes 10% ZVI and 90% sand by volume.
Surface Backfill/Compacted Clay Anchor Plug	74	CY	$50	$3,704	Based on previous project quotes and experience.
Transport and Dispose at Lewis and Clark County Landfill (Daily Cover)	556	TON	$30	$16,667	Quote from Lewis & Clark County Landfill for daily cover, plus hauling costs. If soils are clean then they may be evaluated for use at the Facility instead of disposal.
Testing, Reporting, and Oversight					
Construction Oversight	20	DAY	$1,500	$30,000	Based on estimates of labor, equipment, and expenses and anticipated production/duration (10 days for PRB installation plus 10 days of other oversight).
CQA Testing and Laboratory	1	LS	$10,000	$10,000	
Construction Completion Report	1	LS	$50,000	$50,000	
		Subtotal Capital Cost		$601,220	
		Contingency	20%	$120,244	
		Total Capital Cost (Rounded up)		**$722,000**	

Capital Cost Notes:

LS = lump sum ZVI = zero valent iron
CY = cubic yards PRB = permeable reactive barrier
SF = square feet CQA = construction quality assurance
VSF = vertical square feet

1. The level of accuracy of these estimated costs is "Order of Magnitude," as defined by the American Association of Cost Engineers. The accuracy of an Order of Magnitude estimate is plus 50 percent and minus 30 percent. Cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects. Changes in the cost elements are likely to occur during the engineering design of the remedial alternative. The cost estimate was prepared in general accordance with regulatory guidance for cost estimating (USEPA 2000). Unit costs were selected based on previous remediation and project experience and based on budgetary quotes for some materials and services.

2. Assumed soil density is 1.5 tons per cubic yard
3. The costs for silt fence, water, and other ancillary work items are included in the mob/demob or excavation units costs.

Table L-7
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Groundwater Alternative 4 - Permeable Reactive Barrier

Operation, Maintenance, and Monitoring Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
Annual Costs					
Years 1-5, PRB OMM and Semi-annual Groundwater Monitoring					
PRB Monitoring	1	YEAR	$15,000	$15,000	Assumes 4 additional monitoring points and additional data evaluation
Sampling & Analysis	2	EVENT	$6,500.00	$13,000	Assumes 8-10 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	22	EACH	$150.00	$3,300	Assumes 8-10 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$10,000.00	$10,000	Based on labor for data validation/review, reporting, interpretation, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 1-5)				**$41,300**	
Years 6-15, PRB OMM and Annual Groundwater Monitoring					
PRB Monitoring	1	YEAR	$15,000	$15,000	Assumes 4 additional monitoring points and additional data evaluation
Sampling & Analysis	1	EVENT	$6,000.00	$6,000	Assumes 8-10 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	11	EACH	$150.00	$1,650	Assumes 8-10 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$7,500.00	$7,500	Based on labor for data validation/review, reporting, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 6-15)				**$30,200**	
Years 16-30, Annual Monitoring of Select Wells					
PRB Monitoring	0	YEAR	$0	$0	Assumes PRB monitoring is complete when groundwater cleanup levels are met
Sampling & Analysis	1	EVENT	$3,500.00	$3,500	Assumes 5 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	6	EACH	$150.00	$900	Assumes 5 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$5,000.00	$5,000	Based on labor for data validation/review, reporting, and submittal to DEQ
TOTAL ANNUAL OMM COSTS, Rounded (Years 16-30)				**$9,400**	

Periodic Costs				
Description	**Year**	**Unit**	**Unit Cost**	**Notes**
Additional PRB and MNA Evaluation	5, 10, 15	EVENT	$20,000	Analysis and evaluation of PRB, including pre- and post- PRB concentrations, MNA constituent trends, and geochemical parameters, to ensure on-going effectiveness, including preparation of report.
Analysis of Risk Pathways after DEQ-7 is met	16	LS	$20,000	An analysis of risk pathways for the PRB to determine whether it could remain in place and potential requirements (i.e., institutional controls) for it to remain in place

Table L-7
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
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Groundwater Alternative 4 - Permeable Reactive Barrier
PRESENT VALUE ANALYSIS

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$722,000	$41,300	$0	$763,300	1	$763,300
1	$0	$41,300	$0	$41,300	0.97	$40,097
2	$0	$41,300	$0	$41,300	0.94	$38,929
3	$0	$41,300	$0	$41,300	0.92	$37,795
4	$0	$41,300	$0	$41,300	0.89	$36,695
5	$0	$41,300	$20,000	$61,300	0.86	$52,878
6	$0	$30,200	$0	$30,200	0.84	$25,292
7	$0	$30,200	$0	$30,200	0.81	$24,555
8	$0	$30,200	$0	$30,200	0.79	$23,840
9	$0	$30,200	$0	$30,200	0.77	$23,146
10	$0	$30,200	$20,000	$50,200	0.74	$37,354
11	$0	$30,200	$0	$30,200	0.72	$21,817
12	$0	$30,200	$0	$30,200	0.70	$21,182
13	$0	$30,200	$0	$30,200	0.68	$20,565
14	$0	$30,200	$0	$30,200	0.66	$19,966
15	$0	$30,200	$20,000	$50,200	0.64	$32,221
16	$0	$9,400	$20,000	$29,400	0.62	$18,321
17	$0	$9,400	$0	$9,400	0.61	$5,687
18	$0	$9,400	$0	$9,400	0.59	$5,522
19	$0	$9,400	$0	$9,400	0.57	$5,361
20	$0	$9,400	$0	$9,400	0.55	$5,205
21	$0	$9,400	$0	$9,400	0.54	$5,053
22	$0	$9,400	$0	$9,400	0.52	$4,906
23	$0	$9,400	$0	$9,400	0.51	$4,763
24	$0	$9,400	$0	$9,400	0.49	$4,624
25	$0	$9,400	$0	$9,400	0.48	$4,489
26	$0	$9,400	$0	$9,400	0.46	$4,359
27	$0	$9,400	$0	$9,400	0.45	$4,232
28	$0	$9,400	$0	$9,400	0.44	$4,109
29	$0	$9,400	$0	$9,400	0.42	$3,989
30	$0	$9,400	$0	$9,400	0.41	$3,873
TOTAL PRESENT VALUE OF GROUNDWATER ALTERNATIVE 4 (Rounded up to next $10,000)						**$1,310,000**

Table L-8
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Groundwater Alternative 5 - Pump and Treat

Capital Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Notes/Source**
Work Plan, Agency Correspondence, and Design	1	LS	$250,000	$250,000	Based on experience with similar projects
Bench Testing and Pump Testing	1	LS	$100,000	$100,000	Based on experience with similar projects
Replace/Install Groundwater Monitoring Wells	1	LS	$30,000	$30,000	Assume up to 5 wells to be replaced/installed for groundwater monitoring following implementation of soil remedy.
Mob, Insurance, Bonding	1	LS	10.0%	$452,939	% of costs except disposal fees, testing, reporting, oversight, and based on previous experience.
Extraction System Installation Costs					
Trench Installation	2000	LF	$175	$350,000	Based on experience with similar projects
Heat Tracing	2000	LF	$7	$14,000	
Conduit	2000	LF	$40	$80,000	
Electrical Connection	2000	LF	$50	$100,000	
Soil Excavation and Handling	600	CY	$13	$7,800	
Trench Backfill (Imported Material, Placement, and Compaction)	300	CY	$16	$4,800	Assumes all excavated soils meet SSCLs and can be reused at the Facility for backfilling trench or placement and regrading in other areas. Assumes half of excavated material is used for trench backfill.
Trench Backfill (Reused Material, Placement, and Compaction)	300	CY	$8	$2,400	
Haul, Place, Compact, and Grade Excavated Material	300	CY	$8	$2,400	Haul and re-grade excess excavated soils on-site. Assume half of excavated material is used for trench backfill.
Extraction and Injection Wells	8	EACH	$6,000	$48,000	
Piezometers	8	EACH	$4,000	$32,000	
Extraction Pumps	4	EACH	$7,500	$30,000	
Treatment Equipment Costs					
Equalization Tank	1	EACH	$144,000	$144,000	Based on experience and quotes from similar projects
Inline Mixer	1	EACH	$3,500	$3,500	
Reactor Vessel with Mixers	4	EACH	$32,000	$128,000	
Chemical Feed Systems	6	EACH	$15,000	$90,000	
Acid/Base Tanks	2	EACH	$25,000	$50,000	
Sodium Hypochlorite Tank	1	EACH	$5,000	$5,000	
Ferric Tank	1	EACH	$1,000	$1,000	
Flocculant Tank	1	EACH	$5,000	$5,000	
Clarifier Tank with Bridge and Internals	1	EACH	$500,000	$500,000	
Solids Thickener Tank	1	EACH	$225,000	$225,000	
MMF Pumps (Feed & Backwash)	4	LS	$15,000	$60,000	
Multimedia Filter	10	EACH	$65,000	$650,000	
Bag Filters	4	LS	$25,000	$100,000	
Transfer Pumps	6	EACH	$15,000	$90,000	
Motor Control Center	1	EACH	$75,000	$75,000	
Control Panels / SCADA System	1	EACH	$125,000	$125,000	
Piping, Valves, and Appurtenances (7% EQ)	1	LS	$160,000	$160,000	Approximately 7% of other equipment costs
Instrumentation (5% EQ)	1	LS	$110,000	$110,000	Approximately 5% of other equipment costs
Freight	1	LS	2.0%	$50,430	Estimated based on percentage of total equipment costs
Treatment System Installation Costs					
Set Process Equipment	1	LS	8.0%	$180,120	Percentage of treatment equipment costs based on experience with similar projects
Process Piping	1	LS	10.0%	$225,150	
Heat Trace/Insulation	1	LS	4.0%	$90,060	
Painting	1	LS	1.5%	$33,773	
Heating and Lighting	1	LS	8.0%	$180,120	
Electrical	1	LS	25.0%	$562,875	
Site Security	1	LS	0.5%	$11,258	
Power Drop	1	LS	$7,500	$7,500	
Testing, Reporting, and Oversight					
System Startup	1	LS	$75,000	$75,000	Based on experience with similar projects
Construction Oversight	252	DAY	$1,500	$378,000	Extraction and Treatment System
CQA Testing and Laboratory	1	LS	$25,000	$25,000	
Construction Completion Report	1	LS	$50,000	$50,000	
		Subtotal Capital Cost		$5,895,124	
		Contingency	20%	$1,179,025	
		Total Capital Cost (Rounded up)		**$7,080,000**	

Capital Cost Notes:

LS = lump sum
LF = linear foot
CY = cubic yard
LB = pound
SCADA = supervisory control and data acquisition
CQA = construction quality assurance
kW-hr = kilowatt-hour

1. The level of accuracy of these estimated costs is "Order of Magnitude," as defined by the American Association of Cost Engineers. The accuracy of an Order of Magnitude estimate is plus 50 percent and minus 30 percent. Cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects. Changes in the cost elements are likely to occur during the engineering design of the remedial alternative. The cost estimate was prepared in general accordance with regulatory guidance for cost estimating (USEPA 2000). Unit costs were selected based on previous remediation and project experience and based on budgetary quotes for some materials and services.
2. Assumed soil density is 1.5 tons per cubic yard
3. The costs for silt fence, water, and other ancillary work items are included in the mob/demob or excavation units costs.

Table L-8
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Groundwater Alternative 5 - Pump and Treat

Operation, Maintenance, and Monitoring Costs					
Description	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
Annual Costs					
Years 1-15 P&T Annual OMM Costs					
Maintenance and Replacement Parts	1	LS	$100,000.00	$100,000	
Laboratory Analytical Costs	12	EACH	$2,000.00	$24,000	Assumes ongoing biweekly sampling for system operation and monthly sample for discharge compliance
Management & Reporting	1	LS	$25,000.00	$25,000	Based on labor for data validation/review, quarterly reporting, and submittal to DEQ
Sampling / O&M Labor	4,160	EACH	$65.00	$270,400	Assumes 80 hours per week, 52 weeks per year
Chemicals	1,301,471	LB	$0.25	$325,368	System Flow - 680 gpm
Polymer	8,942	LB	$3.50	$31,297	System Flow - 680 gpm
Sludge Disposal	20	TON	$40.00	$800	
Sludge Transportation & Demurrage	2	EACH	$500.00	$1,000	10 Ton Roll-Off Bins
Electricity (1,780 kW-hr/day assumed)	649,700	kW-hr	$0.10	$64,970	Equivalent to 100 brake horsepower
TOTAL ANNUAL P&T OMM COSTS, Rounded				**$842,900**	
Years 1-5, Groundwater Semi-annual Monitoring					
Sampling & Analysis	2	EVENT	$6,500.00	$13,000	Assumes 8-10 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	22	EACH	$150.00	$3,300	Assumes 8-10 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$10,000.00	$10,000	Based on labor for data validation/review, reporting, interpretation, and submittal to DEQ
TOTAL ANNUAL GROUNDWATER MONITORING COSTS, Rounded (Years 1-5)				**$26,300**	
Years 6-15, Groundwater Annual Monitoring					
Sampling & Analysis	1	EVENT	$6,000.00	$6,000	Assumes 8-10 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	11	EACH	$150.00	$1,650	Assumes 8-10 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$7,500.00	$7,500	Based on labor for data validation/review, reporting, and submittal to DEQ
TOTAL ANNUAL GROUNDWATER MONITORING COSTS, Rounded (Years 6-15)				**$15,200**	
Years 16-30, Groundwater Annual Monitoring of Select Wells					
Sampling & Analysis	1	EVENT	$3,500.00	$3,500	Assumes 5 monitoring wells, costs for labor, equipment, supplies
Laboratory Analytical Costs	6	EACH	$150.00	$900	Assumes 5 monitoring wells, plus QA/QC samples, lab $150/sample
Management & Reporting	1	LS	$5,000.00	$5,000	Based on labor for data validation/review, reporting, and submittal to DEQ
TOTAL ANNUAL GROUNDWATER MONITORING COSTS, Rounded (Years 16-30)				**$9,400**	
Periodic Costs					
Description	**Year**	**Quantity**	**Unit**	**Unit Cost**	**Notes**
Additional MNA and Pump and Treat Evaluation	5, 10, 15	1	EVENT	$20,000	Analysis and evaluation of Pump and Treatment, including Pump and Treat system optimization and OMM review, and evaluation of MNA constituent trends, and geochemical parameters, to ensure on-going effectiveness, including preparation of report.

Table L-8
Appendix L Cost Estimates
Feasibility Study Report
Joslyn Street Tailings Facility
Lewis and Clark County, Montana

Groundwater Alternative 5 - Pump and Treat
PRESENT VALUE ANALYSIS

Year	Capital Cost	Annual Cost	Periodic Cost	Total Cost Per Year	Discount Factor (3.0%)	Present Value
0	$7,080,000		$0	$7,080,000	1	$7,080,000
1	$0	$869,200	$0	$869,200	0.97	$843,883
2	$0	$869,200	$0	$869,200	0.94	$819,304
3	$0	$869,200	$0	$869,200	0.92	$795,441
4	$0	$869,200	$0	$869,200	0.89	$772,273
5	$0	$869,200	$20,000	$889,200	0.86	$767,032
6	$0	$858,100	$0	$858,100	0.84	$718,645
7	$0	$858,100	$0	$858,100	0.81	$697,714
8	$0	$858,100	$0	$858,100	0.79	$677,392
9	$0	$858,100	$0	$858,100	0.77	$657,662
10	$0	$858,100	$20,000	$878,100	0.74	$653,389
11	$0	$858,100	$0	$858,100	0.72	$619,910
12	$0	$858,100	$0	$858,100	0.70	$601,854
13	$0	$858,100	$0	$858,100	0.68	$584,324
14	$0	$858,100	$0	$858,100	0.66	$567,305
15	$0	$858,100	$20,000	$878,100	0.64	$563,619
16	$0	$9,400	$0	$9,400	0.62	$5,858
17	$0	$9,400	$0	$9,400	0.61	$5,687
18	$0	$9,400	$0	$9,400	0.59	$5,522
19	$0	$9,400	$0	$9,400	0.57	$5,361
20	$0	$9,400	$0	$9,400	0.55	$5,205
21	$0	$9,400	$0	$9,400	0.54	$5,053
22	$0	$9,400	$0	$9,400	0.52	$4,906
23	$0	$9,400	$0	$9,400	0.51	$4,763
24	$0	$9,400	$0	$9,400	0.49	$4,624
25	$0	$9,400	$0	$9,400	0.48	$4,489
26	$0	$9,400	$0	$9,400	0.46	$4,359
27	$0	$9,400	$0	$9,400	0.45	$4,232
28	$0	$9,400	$0	$9,400	0.44	$4,109
29	$0	$9,400	$0	$9,400	0.42	$3,989
30	$0	$9,400	$0	$9,400	0.41	$3,873
TOTAL PRESENT VALUE OF GROUNDWATER ALTERNATIVE 5 (Rounded up to next $10,000)						**$17,500,000**