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October 1, 2015

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Dear Mr. Kandelin:

On behalf of Talen Montana, LLC please find enclosed two copies of the *Cleanup Criteria and Risk Assessment Work Plan, Wastewater Facilities Comprising the Closed-Loop System, Plant Site Area, Colstrip Steam Electric Station, Colstrip, Montana.* An electronic version was submitted to you via email on October 1, 2015.

Also note that a copy of the report is included for Aimee Reynolds. Please do not hesitate to contact me or Marietta Canty with comments or questions.

Sincerely,

Al Hilty, P.G.
Senior Hydrogeologist

Enclosures

Cc: Aimee Reynolds
Steve Christian, Talen Montana, LLC (2)
Gordon Criswell, Talen Montana, LLC
Marietta Canty, Ford Canty & Associates, Inc.
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FORD CANTY & ASSOCIATES, INC.
ENVIRONMENTAL SCIENTISTS & ENGINEERS

Cleanup Criteria and Risk Assessment Work Plan

Wastewater Facilities Comprising the Closed-Loop System
Plant Site Area
Colstrip Steam Electric Station
Colstrip, Montana

October 1, 2015

Prepared for:

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List of Acronyms

AOC	Administrative Order on Consent
AT	Averaging Time
AUF	Area Use Factor
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BSL	Background Screening Levels
BTAG	Biological Technical Assistance Group
BW	Body Weight
C	Concentration
CCRA	Cleanup Criteria and Risk Assessment
CDI	Chronic Daily Intake
COI	Constituent of Interest
COPC	Chemicals of Potential Concern
CR	Contact Rate
DU	Data Usability
EFD	Exposure Frequency and Duration
EHP	Evaporation Holding Pond
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
Ford Canty	Ford Canty & Associates, Inc.
g/g-d	grams per grams of body weight per day
gpm	gallons per minute
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
Hydrometrics	Hydrometrics, Inc.
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
kg/d	kilograms per day
kg/kg-d	kilograms per kilograms of body weight per day
LADD	Lifetime Average Daily Dose
L/d	liters per day
LOAEL	Lowest Observed Adverse Effect Level
MCL	Maximum Contaminant Level
MDEQ	Montana Department of Environmental Quality
mg/kg	milligrams per kilogram
Neptune	Neptune and Company, Inc.
NOAEL	No Observed Adverse Effect Level
PAH	Polynuclear Aromatic Hydrocarbon
PPLM	PPL Montana, LLC
PPRTV	Provisional Peer Reviewed Toxicity Value
RAGs	Risk Assessment Guidance for Superfund
RBCA	Risk Based Corrective Action
RBSL	Risk Based Screening Level
RfC	Reference Concentration
RfD	Reference Dose
RfD_i	Reference Dose – inhalation
RfD_o	Reference Dose - oral
RMEPC	Reasonable Maximum Exposure Point Concentration
RSL	Regional Screening Level

List of Acronyms
(Continued)

SCEM	Site Conceptual Exposure Model
SES	Steam Electric Station
SF	Slope Factor
SLERA	Screening-level Ecological Risk Assessment
SOEP	Stage One Evaporation Pond
SSL	Soil Screening Level
STEP	Stage Two Evaporation Pond
Talen	Talen Montana, LLC
TDS	Total Dissolved Solids
T&E	Threatened and Endangered
TRV	Toxicity Reference Value
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WECO	Western Energy Company

1.0 INTRODUCTION AND PURPOSE

Hydrometrics, Inc. (Hydrometrics), on behalf of Talen Montana, LLC (Talen), retained Ford Canty & Associates, Inc. (Ford Canty) and Neptune and Company, Inc. (Neptune) to prepare a Cleanup Criteria and Risk Assessment (CCRA) Work Plan for the Wastewater Facilities Comprising the Closed-Loop System at the Plant Site area, "the Plant Site," of the Colstrip Steam Electric Station (SES), the "Facility", located in Colstrip, Montana.

On August 3, 2012, PPL Montana, LLC (PPLM; predecessor of Talen) and the Montana Department of Environmental Quality (MDEQ) entered into an Administrative Order on Consent (AOC) Regarding Impacts Related to Wastewater Facilities Comprising the Closed-Loop System at the Colstrip SES (MDEQ/PPLM Montana, 2012). As part of the AOC, PPLM committed to prepare Site Reports for the Plant Site, the SOEP/STEP, and Units 3&4 Effluent Holding Pond (3&4 EHP) areas (see Figure 1 for a depiction of these areas). These site reports are the basis for further remedial activities under the AOC. A fourth category of reporting, involving area process wastewater pipeline spills or releases not included in one of the previously mentioned areas, and other miscellaneous areas that are mutually agreed upon by the parties to address in the AOC, was also defined. All past process wastewater spills and releases have fallen into one of the three areas defined earlier in this paragraph.

This document is a CCRA Work Plan for the Wastewater Facilities Comprising the Closed-Loop System and addresses impacts related to process wastewater releases at the Plant Site portion of the Facility. Seepage losses from the process wastewater ponds ("ponds") at the Plant Site appear to have impacted shallow groundwater. Facility-related wastewater constituents are largely anticipated to be derived from constituents that occur naturally in the coal formations. In addition, because the shallow groundwater gradient is toward East Fork Armells Creek (the "Creek"), which runs adjacent to and downstream of the Plant Site, surface water and sediment in the Creek need to be further evaluated through the risk assessment process. Capture wells have been placed at the Plant site that provide ongoing groundwater capture to limit migration of impacted groundwater.

The AOC requires the CCRA Report to identify, at a minimum the following (Article VI.B):

- Cleanup Criteria for the Constituents of Interest (COIs);
- Identification of Transport Mechanisms for the COIs;
- Identification of potential receptors;
- Identification of exposure pathways; and
- If there are COIs, recommendation of additional site characterization needed to determine what, if any, human health or ecological risks are posed by releases from the Site.

Additionally, the AOC indicates that the CCRA Report shall also include the following.

- An assessment of the *(potential)* risk posed by COIs that exceed soil or water screening levels, as well as an evaluation of *(potential)* environmental and human health risks based on Cleanup Criteria (as defined in Article IV.G. of the AOC).

Lastly, the AOC indicates:

- If the CCRA identifies one or more COIs that exceed Cleanup Criteria, then remedial measures are necessary and a Remedy Evaluation Report shall be prepared.

- If the CCRA does not identify COIs that exceed Cleanup Criteria, then remedial measures are not needed and there is no need for further action.

The purpose of this CCRA Work Plan is to describe the planned approach to identify and provide the information listed in the AOC (Article VI.B) associated with the COIs, Cleanup Criteria, and the Risk Assessment. The planned approach will be conducted in the following order of main tasks:

1. Identification of the COIs
2. Identification of the Cleanup Criteria for the COIs
3. Human Health and Ecological Risk Assessments of the COIs, as necessary
4. Determination regarding the necessity of remedial measures

This Work Plan is intended to facilitate discussions with MDEQ regarding appropriate approaches to provide information required by the AOC.

2.0 FACILITY OPERATION, BACKGROUND AND DESCRIPTION

2.1 FACILITY OPERATION

The Colstrip SES, the Facility, is located in the city of Colstrip, which lies within Rosebud County in the south central area of the State of Montana. The Facility consists of four units, Units 1 and 2 that are 333 megawatts each and Units 3 and 4 that are 805 megawatts each. Construction on Units 1 and 2 began in 1972 and they came on-line in the mid-1970s. Units 3 and 4 were constructed later; Unit 3 came on-line in 1983 and Unit 4 came on-line in 1985. Talen is the operator and an owner of the Facility, which is co-owned by PacifiCorp, Puget Sound Energy, Inc., Portland General Electric Company, Avista Corporation, and NorthWestern Corporation (Hydrometrics, 2015).

The Facility generates electricity through the combustion of coal. Fly ash, a by-product of coal combustion, is removed by air scrubber systems to reduce emissions. Bottom ash collects at the bottom of the boiler. Fly ash, bottom ash, and Facility wastewaters contain constituents of the original coal. A closed-loop process water/scrubber system is used at the Facility to minimize impacts to water resources in the area. Ash and water based liquid wastes from the generating plants are impounded in ponds designed and constructed to control seepage losses. The Plant Site pond system includes ponds that serve all four generating units in various capacities. Fly ash disposal is not currently conducted on the Plant Site, but rather in holding ponds at two locations: (1) to the northwest of the Plant Site at the SEOP/STEP and (2) to the east of the Plant Site at Units 3&4 EHP. Relatively minor amounts of fly ash deposited during previous operations remain in the Plant Site Units 1&2 Pond A, the Units 3&4 Wash Tray Pond, and the Units 3&4 Drain Collection Pond. The pond system presently servicing Colstrip Units 1&2 has been in use since 1975 (Hydrometrics, 2015).

2.2 PHYSICAL CHARACTERISTICS OF THE SITE

2.2.1 Regional Geology

Colstrip is located in the northern portion of the Powder River Basin, an asymmetrical basin oriented northwest to southeast. This structural basin is responsible for the general regional orientation of bedding. “In general, Fort Union Strata dip very gently (less than a few degrees) in easterly and southerly orientations from west to east across the coalfield, respectively. Locally, however, dips are steepened by high-angle faults that are present throughout much of the Colstrip area” (Roberts, et. al, 1999 as cited in Hydrometrics, 2015).

Stratigraphy in the Colstrip area consists of, in descending order, the Fort Union Formation, Hell Creek/Lance Formation, Fox Hills Sandstone, and Bearpaw Shale. The Fort Union Formation is divided into three members; the upper Tongue River Member, the middle Lebo Shale Member, and the lower Tullock Member. The Tongue River Member is at the surface in the Colstrip area. The deeper Lebo Shale, and then the Tullock Members are exposed to the north. At Colstrip, the total thickness of the Fort Union Formation is about 650 feet.

The Fort Union Formation consists of alternating and intercalated deposits of shale, claystone, mudstone, siltstone, sandstone, carbonaceous shale and coal. The formation was deposited in a fluvial system of meandering, braided, and anastomosed streams near the basin center and by alluvial fans at the margins. The fluvial systems were typically oriented northeast-southwest. (Flores and Ethridge, 1985 as cited in Hydrometrics, 2015).

- Anastomosing streams are comprised of multiple channels within a single drainage. Individual floodplains of an anastomosing system may include braided or meandering, or straight characteristics. Deposition typically occurs under low energy conditions near a local base level (Makaske, 2000 as cited in Hydrometrics, 2015).
- Braided flow systems consist of a network of flow channels within a single floodplain or flow belt (Makaske, 2000 as cited in Hydrometrics, 2015). These channels have multiple thalwegs that branch back and forth from single to multiple channels.
- Meandering streams consist of one or more individual channels that migrate back and forth across a single floodplain. Meandering channels consist of one thalweg.

Numerous coal seams are present in the Tongue River Member of the Fort Union Formation, the result of peat deposits which accumulated in swampy areas and channels. A tropical to sub-tropical climate resulted in thick peat deposits within the swamps and bogs (Nicols and others, 1989, Flores, R.M. and others, 1999 as cited in Hydrometrics, 2015). Because of the depositional setting, the coal beds may pinch out laterally or stop abruptly. The main coal seams of interest near Colstrip are the sub-bituminous Rosebud (~ 24 feet thick) and McKay seams (~ 8-10 feet thick) which can economically be strip mined. These two coal seams merge into a single seam on the west side of the Little Wolf Mountains near the Absolka Mine. The Rosebud Coal, however, is the only seam mined in the Facility area due to quality of the McKay Seam which makes it currently undesirable for use in many coal-fired boilers. Both the Rosebud and McKay coals are generally cleated. That is, they contain natural vertical fracturing generally oriented perpendicular to the bedding plane.

The depositional setting results in numerous lateral facies changes within the sedimentary rock deposits. Channel sandstones often grade laterally into siltstones or shale (facies changes) resulting in preferential pathways for groundwater flow within the more permeable sandstone. Cementation, or the chemical binding of individual grains to one another, is highly variable within the units, mostly consisting of weak calcium carbonate cement although thin deposits with silica cementation also occur. Localized thin limestone beds may also exist.

Alluvium is present along many of the drainage bottoms. The most prominent deposit at the Facility is along the Creek. At the west edge of the Plant Site area, alluvial deposits of clay, silt, sand and gravel reach thickness of 35 feet or more. A basal gravel, comprised of clinker, is often present in the alluvium. Clinker fragments are typically also found throughout finer-grained alluvial deposits.

The ancestral East Fork Armells Creek eroded through the shallow bedrock, including the Rosebud and McKay Coals, and in some places into the sub-McKay deposits. This results in groundwater flow from the eroded units into the alluvium. The Creek alluvium acts as a hydrologic sink in the vicinity of the Facility.

This “hydrologic sink” tends to collect groundwater that issues to the creek and serves to limit flow from one side of the creek to the other in shallow deposits.

As mentioned previously, the Rosebud Coal, and in some places, the McKay Coal has burned in the Colstrip area. This is most easily identified as red cap rock on hills around the region. Burning of the coal baked the overlying strata. As a result of the burning, the coal volume reduced either leaving a void for the overlying rock to collapse in or resulted in slow settling of the overlying rock into the space formerly held by the coal. The thermally altered rock is referred to a clinker or scoria. Collapse of the rock resulted in secondary porosity (fractures). Permeability varies but is typically very high and depends on the amount of fine grained sediments that have moved vertically into the available pore spaces, completeness of burning of the coal seam, and the degree and nature of fracturing. No clinker has been confirmed on the Plant Site proper.

Mining of the coal on the Plant Site has resulted in lateral heterogeneities. Strip mining of coal involves removing the overburden (sediments and rock overlying the coal), removing the coal, then backfilling the pit with the previously removed overburden. The resulting spoil material exhibits a wide range of permeability from very low to high. It also results in a higher vertical permeability when compared to the pre-mining permeability. Spoil is present over much of the southeastern part of the Plant Site (directly east of Units 1&2 Pond B and Units 1&2 Cooling Tower Blowdown Ponds, and Units 3&4 Bottom Ash Ponds). A minor amount of spoil is present directly southeast of the Units 1&2 Pond A.

2.2.2 Groundwater

Shallow groundwater flow directions at the Plant Site are locally changed by the operation of current capture systems (described in more detail below within this Section). Under non-pumping conditions, shallow groundwater flow is generally expected to mirror the topography with flow toward the Creek and discharging into the alluvium along the Creek. Under pumping conditions, overall shallow groundwater flow is locally diverted and interrupted by the capture systems.

Deep groundwater in the sub-McKay units generally flows to the northeast under a regional gradient toward the north with presumed discharge points located at various locations to the north.

It should be noted that lateral variations in groundwater flow conditions may exist near mine spoil. If the hydraulic conductivity of the spoil is higher than the adjacent deposits, the spoil will act as a drain. Conversely, if the spoil hydraulic conductivity is lower, an impediment to flow will occur. Spoil are present in the eastern portion of the Plant Site. In general, permeability of the spoil is similar to the adjacent bedrock. However, spoil with a higher permeability are present north and west of the Units 3&4 Bottom Ash Ponds. This results in the high yield (~50 gallons per minute [gpm]) of the Western Energy Company (WECO) well. The WECO well was installed to lower the groundwater level below a coal crusher at the Rosebud Mine. The well was advanced to the base of the mine spoil (60 feet below ground surface [bgs]) and five feet into the underlying interburden to a depth of 65 feet.

Several indicator parameters are used to evaluate potential process wastewater impacts to groundwater at the Facility. These include specific conductance (SC), dissolved boron, chloride, sulfate, and the ratio of calcium to magnesium.

Existing groundwater capture systems in the areas where the highest concentrations of indicator parameters have been observed (both in the shallow units and in the McKay Coal) limit migration of impacted groundwater away from the Facility. At the Plant Site, capture wells are located downgradient of the Units 1&2 Pond, Units 1&2 Bottom Ash Ponds, Units 1&2 Sediment Retention Pond, North Cooling Tower Blowdown Pond C, and South Cooling Tower Blowdown Pond C. Additional capture wells are located at the former Brine Ponds, Unit 3&4 Drain Collection Pond, and Units 3&4 Bottom Ash Ponds.

Consequently, the Plant Site capture wells are located between the various ponds and the Creek (see Figure 2). Capture wells are designed to capture shallow groundwater prior to it reaching the Creek.

It should be noted that a shallow groundwater divide is located just to the southeast of the Plant Site ponds. Groundwater in the shallow units in the southeastern part of the Plant Site flows to the east toward Cow Creek.

2.2.3 Surface Water

The nearest natural surface water is East Fork Armells Creek (the "Creek"). Regionally, the Creek is an intermittent stream, but it generally flows continuously through the town of Colstrip along the western edge of the Plant Site (see Figures 1, 2, and 3). However, flow in the creek may be diminished to zero during late summer and early fall. Flow directly upstream and downstream of Colstrip is observed only in response to storm water or precipitation runoff events.

At the Plant Site, the topography slopes downward from the Plant Site to the west/northwest toward the Creek. Colstrip SES is a zero-discharge facility, so there are no direct wastewater discharge points from the Plant to the Creek. Shallow groundwater from most of the Plant Site flows toward the northwest in the direction of the Creek, though as discussed previously, a series of capture wells control flow of groundwater to the Creek. There is also an area adjacent to the 3&4 bottom ash ponds where groundwater flow toward the southeast. A series of capture wells is also present in this area.

The City of Colstrip sewage treatment ponds are located adjacent to the west bank of the Creek to the north and downstream of the Plant Site. Flows are measured for the Creek for the reach passing the treated sewage effluent ponds. The Creek is receiving water from the ponds based on increases in flow through the reach, field observations, and variations in water quality observed above and below the ponds. A public golf course (Ponderosa Butte) is located along the Creek downstream of the sewage treatment ponds. Treated water from the Colstrip wastewater treatment plant is pumped to an irrigation pond at the golf course. Water from the pond is used for golf course irrigation.

Surface water in the Creek varies in depth and flow rate throughout the year. The Creek adjacent to the Plant Site and through the town of Colstrip is generally shallow and slow moving with abundant emergent aquatic vegetation present during the summer months. In general, the creek gains flow through the town of Colstrip. Higher amounts of flow are gained directly downstream of the City of Colstrip Wastewater Treatment Ponds. During the summer months, the Creek also may gain flow in the area of the golf course as a result of irrigation. Note that flow in the Creek decreases directly downstream of the north end of the golf course as surface water infiltrates to groundwater. The variable water levels within the Creek likely limit the types and abundance of aquatic organisms.

2.3 DEMOGRAPHICS AND LAND USE

2.3.1 Demographics

As of the 2010 Census, the population of Colstrip was 2,214 people, which included 863 households and 622 families (United States Census Bureau, 2014). The Colstrip SES employs approximately 360 people (PPL, 2014).

2.3.2 Past/Current Land Use

Colstrip was established in 1924 by Northern Pacific Railroad to provide coal for steam locomotives. Bituminous coal was/is mined from the Fort Union Formation. In 1958, diesel fuel replaced coal to power the trains and the Montana Power Company purchased the rights to the mine.

The Plant Site has been used as the location of a coal-fired power plant since the mid-1970's. A portion of the Plant Site was mined for coal prior to construction of the power plant units that commenced in 1972. In addition, soil, shallow bedrock, and coal were excavated from below the plant itself prior to construction.

The water supply for the Facility and the town of Colstrip is Castle Rock Lake, which stores water pumped via a 30-mile pipeline from the Yellowstone River to the north. Groundwater near the Plant Site is not used as drinking water. As a conservative measure, PPLM facilitated the connection of private properties with wells to the City of Colstrip water supply.

2.3.3 Future Use

The site is reasonably anticipated to remain as the location of a coal-fired power plant well into in the future. The associated land use activities in the town can also be reasonably anticipated to remain into the future.

3.0 IDENTIFICATION OF CONSTITUENTS OF INTEREST

The proposed approach for the selection of the Constituents of Interest (COIs) is presented in the following sections.

3.1 AOC DEFINITION OF COI

The AOC (MDEQ/PPLM, 2012; Article IV.F) defines Constituents of Interest (COI) as those parameters found in soil, groundwater, or surface water that (1) result from Site operations and the wastewater facilities and (2) exceed background or unaffected reference area concentrations.

As such, the following data will be reviewed to identify the COIs, as further described in the following sections:

- Available data from Facility operations, the wastewater facilities, and numerous investigations will be reviewed
- Background Screening Levels

3.2 FACILITY DATA REVIEW

Numerous investigations have been conducted at the Plant Site relating to ponds, spills associated with the pipelines, or changes in water quality identified in operational groundwater monitoring (Hydrometrics, 2015). Table 3-2 of the Plant Site Report (Hydrometrics, 2015) contains a list of the reports, dates of the reports, and short summaries of the work conducted and findings of the investigations or studies. Data are available from the following media:

- Groundwater
- Surface water (East Fork Armells Creek)
- Sediment (East Fork Armells Creek)

The available groundwater, surface water, and sediment data for the Plant Site will be reviewed as part of the identification of COIs. Specifically, the potential sources of contaminants will be evaluated to identify the list of COIs. The preliminary list of potential sources of contaminants includes the following:

- Facility-related wastewater constituents seeping from the ponds and evaporation ponds into groundwater. Facility-related wastewater constituents are largely anticipated to be derived from minerals that occur naturally in the coal formations.

- Background-related constituents in geological strata, such as rock, coal, spoils, previously burned coal seams, which may be leaching constituents into groundwater.

It should be noted that additional contaminant sources may be present resulting from non-Facility related activities, such as residential land use, highway maintenance, golf course operations, mining, and municipal sewage treatment that will not be identified as COIs.

3.3 BACKGROUND SCREENING LEVELS

As described in the previous section, part of the definition of COIs includes comparison to background or unaffected reference area concentrations. Further, Cleanup Criteria for the COIs as defined by the AOC and discussed in Section 4.0 may not be more stringent than background or unaffected reference area concentrations. Background concentrations, or Background Screening Levels (BSLs), have previously been established (Arcadis, 2007). However, at present, Neptune & Company, Inc., a firm specializing in environmental statistical analysis, has been retained to conduct a comprehensive statistical evaluation of the data, including data collected since 2007, to update the BSLs. A comprehensive discussion of the statistical approaches to be used in the calculation of the BSLs is presented in the Work Plan for Development of Updated Background Screening Levels (Neptune, 2015). The updated BSLs for the Facility will be used in the identification of COIs.

3.4 IDENTIFICATION OF TRANSPORT MECHANISMS

The AOC (Article VI.B) requires the CCRA Report to identify transport mechanisms for the COIs. At present, it appears that seepage losses from the process wastewater ponds at the Plant Site has impacted shallow groundwater. Capture wells have been placed in both areas and act as ongoing groundwater capture systems to limit migration of impacted groundwater.

If additional assessment of transport mechanisms is necessary, the MDEQ guidance document "Fate and Transport Modeling - General Field Data Needs" will be used (MDEQ, 2008). However, it should be noted that the MDEQ guidance document does not directly address sediment and surface water. As such, additional modeling approaches of these media may need to be identified.

4.0 IDENTIFICATION OF CLEANUP CRITERIA

Within this section, the approach for identification of the Cleanup Criteria for the COIs is presented.

4.1 AOC DEFINITION OF CLEANUP CRITERIA

The AOC (MDEQ/PPLM, 2012; Article IV.G) defines the following Cleanup Criteria for the COIs:

1. For each COI in ground or surface water, except for the evaluation for ecological receptors, the applicable standard contained in the most current version of Circular DEQ-7 Montana Numeric Water Quality Standards (“DEQ-7”), the USEPA maximum contaminant level, the risk-based screening level contained in the most current version of Montana Risk-Based Guidance for Petroleum Releases, *whichever* is more stringent; and, for COIs for which there is not a DEQ-7 standard, a maximum contaminant level, or a risk-based screening level contained in the Montana Risk-Based Guidance for

Petroleum Releases, the tap water screening level contained in the most current version of USEPA Regional Screening Levels for Chemical Constituents at Superfund Sites, except that no criterion may be more stringent than the background or unaffected reference areas concentrations; and

2. For each COI in ground or surface water that may impact an ecological receptor, an acceptable ecological risk determined using the most current versions of standard USEPA ecological risk assessment guidance if the criteria set pursuant to (1) above are not adequate to protect ecological receptors, except that no criterion may be more stringent than the background or unaffected reference areas concentrations;

3. For each COI in soil, the more stringent of:

   (a) A cumulative human health risk of 1×10^{-5} for carcinogens or a cumulative hazard index of 1 for non-carcinogenic COIs, except that no criterion may be more stringent than the background or unaffected reference areas concentrations;

   (b) An acceptable ecological risk, determined using the most current versions of standard USEPA ecological risk assessment guidance if the criteria set pursuant to (a) above are not adequate to protect ecological receptors, except that no criterion may be more stringent than the background or unaffected reference areas concentrations; or

   (c) The risk-based screening level contained in the most current version of Montana Risk-Based Guidance for Petroleum Releases, except that no criterion may be more stringent than the background or unaffected reference areas concentrations.

4.1 GROUNDWATER CLEANUP CRITERIA

As previously stated, according to the AOC, the Cleanup Criteria for each groundwater COI, except for the evaluation for ecological receptors, is the most stringent of the following:

- The applicable standard contained in the most current version of Circular DEQ-7 Montana Numeric Water Quality Standards ("DEQ-7"). It should be noted, in addition, that the MDEQ considers the DEQ-7 Standards to be clean-up values for groundwater, rather than screening levels (MDEQ, 2014).

- The EPA maximum contaminant level (MCL)

- The risk-based screening level (RBSL) contained in the most current version of Montana Risk-Based Guidance for Petroleum Releases

In addition, for COIs for which there is not a DEQ-7 standard, a maximum contaminant level, or a risk-based screening level contained in the Montana Risk-Based Guidance for Petroleum Releases, the cleanup criteria will be the tap water screening level contained in the most current version of the USEPA Regional Screening Levels (RSLs) for Chemical Constituents at Superfund Sites. No cleanup criterion, however, may be more stringent than the background or unaffected reference areas concentrations.

Based on the requirements of both the AOC and MDEQ guidance, groundwater Cleanup Criteria will be identified by comparison of the COI data to the following screening levels:

- The applicable standard contained in the most current version of the DEQ-7 Circular.
- The USEPA MCL.
- The RBSL contained in the most current version of Montana Risk-Based Guidance for Petroleum Releases.
- To the tap water screening level contained in the most current version of the USEPA Regional Screening Levels for Chemical Constituents at Superfund Sites (if a DEQ-7 standard, a MCL, or a RBSL contained in the Montana Risk-Based Guidance for Petroleum Releases is not available).
- BSLs
- The results of the HHRA (see Section 5.0) and the ERA (see Section 6.0).

Consequently, Cleanup Criteria for groundwater COIs will be identified as the most stringent screening level, unless the screening level concentration is below the BSL.

4.2 SURFACE WATER

As previously stated, according to the AOC, the Cleanup Criteria for each COI in surface water, except for the evaluation for ecological receptors, is the most stringent of the following:

- The applicable standard contained in the most current version of the DEQ-7 Circular. It should be noted, in addition, that the MDEQ considers the DEQ-7 Standards to be clean-up values for groundwater, rather than screening levels (MDEQ, 2014).
- The USEPA MCL.
- The RBSL contained in the most current version of Montana Risk-Based Guidance for Petroleum Releases.

In addition, for COIs for which there is not a DEQ-7 standard, a MCL, or a RBSL contained in the Montana Risk-Based Guidance for Petroleum Releases, the cleanup criteria will be the tap water screening level contained in the most current version of the EPA RSLs for Chemical Constituents at Superfund Sites. No cleanup criterion, however, may be more stringent than the background or unaffected reference areas concentrations. Note also, that some special cases may exist due to geospatial variations, in which ambient water at one site is naturally above background screening levels. Such cases will require examination on an individual basis in conjunction with the MDEQ.

Based on the requirements of both the AOC and MDEQ guidance, surface water Cleanup Criteria will be identified by comparison of the COI data to the following screening levels:

- The applicable standard contained in the most current version of DEQ-7 Circular.
- The USEPA MCL.
- The RBSL contained in the most current version of Montana Risk-Based Guidance for Petroleum Releases.

- The tap water screening level contained in the most current version of the USEPA Regional Screening Levels for Chemical Constituents at Superfund Sites (if a DEQ-7 standard, a MCL, or a RBSL contained in the Montana Risk-Based Guidance for Petroleum Releases is not available).

- BSLs

- The results of the HHRA (see Section 5.0) and the ERA (see Section 6.0).

Consequently, Cleanup Criteria for surface water COIs will be identified as the most stringent screening level, unless the screening level concentration is below the BSL.

4.3 SEDIMENT

According to the AOC, the cleanup criteria for each COI in soil (sediment data is available for the Creek) is the most stringent of the following:

(a) A cumulative human health risk of 1×10^{-5} for carcinogens or a cumulative hazard index of 1 for non-carcinogenic constituents of interest, except that no criterion may be more stringent than the background or unaffected reference areas concentrations;

(b) An acceptable ecological risk, determined using the most current versions of standard USEPA ecological risk assessment guidance if the criteria set pursuant to (a) above are not adequate to protect ecological receptors, except that no criterion may be more stringent than the background or unaffected reference areas concentrations; or

(c) The risk-based screening level contained in the most current version of Montana Risk-Based Guidance for Petroleum Releases, except that no criterion may be more stringent than the background or unaffected reference areas concentrations.

According to MDEQ guidance, sediment concentrations should be compared to the following ecological screening levels.

- USEPA Region 3 Biological Technical Assistance Group (BTAG) Freshwater Sediment Screening Benchmarks.

Also according to MDEQ guidance (2014), soil concentrations (dry-weight soil concentrations, except for arsenic in surface soil) should be compared to the following screening levels, using the most stringent level:

- The direct contact and leaching to groundwater-based soil screening levels (SSLs) contained in the most recent USEPA RSLs for Chemical Contaminants at Superfund Sites guidance document. The RSLs take into account ingestion, inhalation, and dermal contact pathways and include residential and industrial exposure. It should be noted that the non-carcinogenic contaminants screening levels found in USEPA RSL table are based upon a hazard index of 1 (a level which indicates that no adverse non-cancer human health effects are expected to occur for that contaminant). MDEQ requires that when screening contaminant concentrations to the RSLs, with the exception of lead, all non-carcinogenic levels must be adjusted by dividing by ten. This ensures that, when multiple contaminants are found at a facility that may have the same health effects, cumulative potential health effects are considered. MDEQ (2014) provides a flow chart of the soil screening process.

MDEQ indicates that exposure to lead in soils is evaluated in a unique way by calculating potential blood lead levels resulting from exposure to lead in soil in addition to other unavoidable lead exposure pathways like water and food. Therefore, MDEQ does not include exposure to lead with the other cumulative non-carcinogenic effects. The MDEQ uses the USEPA RSLs of 400 milligrams per kilogram (mg/kg) for lead in residential soils and 800 mg/kg for lead in industrial soils. Also, when screening arsenic concentrations in surface soil, compare contaminant concentrations to the Background Concentrations of Inorganic Constituents in Montana Surface Soils Report (MDEQ, Hydrometrics, 2013).

- The RBSLs provided in the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases. Note that current hydrocarbon impacted areas are being managed through the MDEQ Petroleum Tank Cleanup Section and are not subject to this evaluation.

Based on the requirements of both the AOC and MDEQ guidance, sediment Cleanup Criteria will be identified by comparison of the COI data to the following standards and screening levels:

- The RBSLs provided in the Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases.
- The USEPA Region 3 BTAG Freshwater Sediment Screening Benchmarks.
- The direct contact SSLs contained in the most recent RSLs for Chemical Contaminants at Superfund Sites guidance document.
- BSLs
- The results of the HHRA (see Section 5.0) and the ERA (see Section 6.0).

Consequently, Cleanup Criteria for sediment COIs will be identified as the most stringent screening level, unless the screening level concentration is below the BSL.

5.0 HUMAN HEALTH RISK ASSESSMENT

The AOC (MDEQ/PPLM, 2012; Article IV.B) indicates that the CCRA Report shall also include the following:

- An assessment of the *(potential)* risk posed by COIs that exceed soil or water screening levels
- An evaluation of *(potential)* environmental and human health risks based on Cleanup Criteria (as defined in Article IV.G. of the AOC and presented in Section 4.0 above).

The scope of the human health risk assessment task will be defined after the COIs and the Cleanup Criteria have been identified. The Human Health Risk Assessment (HHRA) will be prepared by Ford Canty & Associates, Inc. According to the MDEQ, the purpose of a HHRA is to estimate potential human health risks posed by current and potential future conditions assuming no further remediation of COIs at the Facility (MDEQ, 2014). In addition, based on the AOC, additional risk evaluation may be required based on the identified Cleanup Criteria. The HHRA will be conducted following both USEPA guidance (USEPA, 1989, 2001, 2009 et al.) and MDEQ guidance (MDEQ, 2009, 2014).

The general approach for the human health risk assessment is described in the following sections.

5.1 DATA EVALUATION

The available data for the Plant Site, including groundwater, surface water, and sediment, will be evaluated for the following:

- Data Usability – Data will be evaluated for usability for risk assessment generally using, as appropriate, the criteria identified by the USEPA (USEPA, 1989, 1992). Data usability (DU) is the process of determining whether the quality of data generated meets the intended use. The EPA has established a specific guidance framework to provide a consistent basis for making decisions about the minimum quality and quantity of analytical data that are sufficient to support risk assessment decisions. The DU evaluation specifically addresses: (1) procedures for assessing the quality of the analytical data intended for use in risk assessment; and (2) procedures for assessing uncertainty in health risk characterization based on the uncertainty in the analytical data.

- Data gaps – If present, data gaps will be identified to determine if additional data are needed to adequately conduct the risk assessment activities.

The data applicable to the preparation of the HHRA (and the ERA) will be summarized. Likely the data collected during the most recent monitoring events (Hydrometrics, 2014) will be most applicable for the risk assessment activities.

5.2 SELECTION OF COI AND CHEMICALS OF POTENTIAL CONCERN

For human health and ecological risk assessment purposes, the United States Environmental Protection Agency (USEPA) and MDEQ guidance have defined a process for the selection of Chemicals of Potential Concern (COPCs). However, the AOC defines COIs for the Facility. As such, the selection of COIs for the Plant Site will follow the definition provided in the AOC (MDEQ/PPLM, 2012; Article IV.F) and described in Section 3.0 above.

Not all COIs pose human health or ecological risks or hazards, or contribute significantly to the overall site risks. USEPA guidance (1989) recommends focusing on a group of COPCs based on inherent toxicity, site concentrations, and behavior of the chemicals in the environment. Evaluation of the data may indicate that the list of COIs should be further refined to a shorter list of COPCs. Table 1, located in the *Tables* section, presents the identified comparison values for each media to be used in the identification of COIs and COPCs.

5.3 EXPOSURE ASSESSMENT

The Exposure Assessment will provide a description of the potential human health exposure to releases or threatened releases of wastewater COIs from the ponds at the Plant Site based upon the current use of the Facility and adjacent properties and reasonably anticipated future uses of the Facility and adjacent properties. The Exposure Assessment will be prepared following MDEQ and USEPA guidance as described in the following sections.

5.3.1 <u>Site Conceptual Exposure Model</u>

A Site Conceptual Exposure Model (SCEM) will be prepared as the first step in the Exposure Assessment. The SCEM will identify the current and reasonably anticipated future uses of the Facility and adjacent parcels (see also Sections 2.3.2 and 2.3.3 above), as well as the Facility-specific contaminant sources, release mechanisms, transport routes and media, and potential receptors. The

preliminary SCEM is presented as Table 2, located in the *Tables* section. The preliminary SCEM is subject to change as additional information is developed.

5.3.2 Potential Receptors and Exposure Pathways

Potential human receptors will be identified that may potentially be exposed to contamination from the Facility wastewater releases. Exposure pathways (i.e., how they may be exposed) will also be identified. Current and reasonably anticipated future uses of adjacent properties will also be considered when identifying potential receptors and exposure pathways. The following preliminary human receptors and exposure pathways have been identified:

- Adult Residents (adults residing in the trailer park located along the Creek and adjacent and west of the Plant Site and those located downhill from the Stage II dam)
    - Direct contact (dermal contact) with Creek surface water
    - Direct contact (incidental ingestion and dermal contact) with Creek sediments
- Child Residents (children residing in the trailer park located along the Creek and adjacent and west of the Plant Site and those located downhill from the State II dam)
    - Direct contact (dermal contact) with Creek surface water
    - Direct contact (incidental ingestion and dermal contact) with Creek sediments
- Outdoor Workers (adults working outdoors in areas adjacent to the Facility along the Creek downstream from the Plant Site, such as golf course maintenance/landscape workers)
    - Direct contact (dermal contact) with Creek surface water
    - Direct contact (incidental ingestion and dermal contact) with Creek sediments
- Child Trespassers (children trespassing on the golf course)
    - Direct contact (dermal contact) with Creek surface water
    - Direct contact (incidental ingestion and dermal contact) with Creek sediments
- Excavation/Trench Workers (excavation/trench workers in areas adjacent to the Facility in shallow groundwater)
    - Direct contact (dermal contact) with shallow groundwater

Ingestion of groundwater is not a complete pathway because groundwater wells, specifically those located downhill from the Stage II dam, are not used for domestic purposes.

5.3.3 Exposure Assumptions

Human exposure scenarios will be identified based on the current and reasonably anticipated future use of the Facility (and adjacent areas), the potential receptors, and complete exposure pathways. Human exposure assumptions will be determined based on USEPA and MDEQ guidance. To the extent practicable for the identified exposure scenarios, the exposure parameters recommended by MDEQ (2014) will be used. The exposure parameters recommended by MDEQ are based on recent USEPA guidance (USEPA, 2011and 2014), as well as conditions, such as climate, specific to Montana. Where appropriate, site-specific exposure assumptions will be justified and used in the calculations. Table 3, located in the *Tables* section, provides a list of the preliminary exposure assumptions.

5.3.4 Exposure Areas and Exposure Point Concentrations

As site data are evaluated and potential receptors are identified, exposure areas will be defined. Primarily, the quantity of data and the size of the area in which potential receptors may be exposed will be used to define the exposure areas.

The MDEQ recommends using USEPA's most current version of USEPA software, ProUCL, to calculate reasonable maximum exposure point concentrations (RMEPCs). ProUCL also provides the means for calculating RMEPCs for data sets that include non-detects. When ProUCL calculates a RMEPC, it will recommend that an upper confidence limit (UCL) of 95% on the mean or greater (e.g., 97.5% or 99% UCL) is the best fit for the data presented. The MDEQ typically requires that the UCL recommended by ProUCL which best fits the data presented be used as the RMEPC. It should be noted that depending on a specific data set, it may not be appropriate to perform a UCL calculation, such as very small data sets or for data sets with less than five detections.

The data will undergo a comprehensive statistical evaluation, including the calculation of RMEPCs. The statistical evaluation will be performed by Neptune, a firm that specializes in environmental statistics. The calculation of RMEPCs will follow MDEQ guidance; however, the data will be evaluated more thoroughly than solely through the use of ProUCL.

5.3.5 Calculation of Chronic Daily Intakes and Lifetime Average Daily Dose

Calculation of the non-carcinogenic chronic daily intakes (CDI) and the carcinogenic lifetime average daily doses (LADD) for the HHRA will be performed for complete exposure pathways using the equations available from the USEPA (1989, 2004, and 2009). Numerous updates have been made to the intake equations and exposure parameters since the initial publication of USEPA's Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A (RAGs; USEPA, 1989), including, but not limited to, those listed below:

- Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, 2004).
- Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment, 2009).
- Exposure Factors Handbook: 2011 Edition.
- Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, 2014.

The USEPA (1989) defines the generic equation for calculating human non-carcinogenic CDIs as follows:

$$Chronic\ Daily\ Intake\ (CDI) = \frac{C \times CR \times EFD}{BW \times AT}$$

where:

C	=	COI Concentration
CR	=	Contact Rate (amount of contact with impacted media per time)
EFD	=	Exposure Frequency and Duration
BW	=	Body Weight of the receptor

AT = Averaging Time (period over which the exposure is averaged)

CDIs for the potential receptors and exposure pathways identified during the Exposure Assessment will be calculated using the most recent intake equations and exposure parameters available from the USEPA at the time that this work plan is approved. As described above, site-specific variations from the default exposure assumptions may be justified and used in the calculations. In addition, the chronic daily intakes will be calculated following MDEQ guidance (2014).

The USEPA (1989) defines the generic equation for calculating human carcinogenic LADDs as follows:

$$Lifetime\ Average\ Daily\ Dose\ (LADD) = \frac{C \times CR \times EFD}{BW \times AT}$$

where:

C	=	COI Concentration
CR	=	Contact Rate (amount of contact with impacted media per time)
EFD	=	Exposure Frequency and Duration
BW	=	Body Weight of the receptor
AT	=	Averaging Time (lifetime)

LADDs for the potential receptors and exposure pathways identified during the Exposure Assessment will be calculated using the most recent intake equations and exposure parameters available from the USEPA at the time that this work plan is approved. As described above, site-specific variations from the default exposure assumptions may be justified and used in the calculations. In addition, the LADDs will be calculated following MDEQ guidance (2014).

5.4 TOXICITY ASSESSMENT

The Toxicity Assessment for the COIs will follow the USEPA recommended approach (USEPA, 1989, et al). Toxicity values for the COIs will follow the hierarchy of human health toxicity (USEPA, 2003a), which is also recommended by MDEQ (2014).

5.4.1 Definitions of Carcinogenic and Non-Carcinogenic Risks

For the purposes of an HHRA, carcinogenic risk can be described as the probability over a receptor's lifetime of developing cancer from an exposure to cancer-causing compounds. All individuals have a risk of developing cancer because of a genetic predisposition or other causes non-related to exposure to cancer-causing compounds at a USEPA- or MDEQ-regulated facility. MDEQ (2014) indicates that any person has approximately a one in three chance of developing some type of cancer over their lifetime. "Excess lifetime cancer risk" is the additional cancer risk over this "background" probability. The MDEQ (2014) defines "excess lifetime cancer risk" as the additional risk that someone might have of getting cancer if that person is exposed to site-related cancer-causing compounds.

For the purposes of an HHRA, non-carcinogenic risk can be described as the risk of a receptor developing non-cancer health concerns around the time of an exposure to non-cancer causing compounds.

5.4.2 Carcinogenic Slope Factors and Inhalation Unit Risks

The USEPA (1989) defines a carcinogenic slope factor as a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. Carcinogenic Slope Factors and Inhalation Unit Risks (IURs) will be used in the HHRA to estimate upper-bound lifetime probabilities of a

receptor developing cancer as a result of exposure to concentrations (i.e., exposure point concentrations) of identified carcinogenic COIs. The most-recent USEPA RSL tables will be used initially to identify the carcinogenic Slope Factors and IURs. The selection of toxicity values for the COIs will follow the hierarchy of human health toxicity (USEPA, 2003a), which is also recommended by MDEQ (2014). The hierarchy is as follows:

1. USEPA Integrated Risk Information System (IRIS) toxicity values
2. USEPA Provisional Peer Reviewed Toxicity Values (PPRTVs)
3. Other USEPA and non-USEPA toxicity values

5.4.3 Non-Carcinogenic Reference Doses and Reference Concentrations

Non-carcinogen Reference Doses (RfDs) and Reference Concentrations (RfCs) will be used in the HHRA to determine the risks of a receptor developing non-cancer health hazards as a result of exposure to concentrations (i.e., exposure point concentrations) of identified non-cancer COIs. The most-recent USEPA RSL tables will be used to identify the non-cancer RfDs and RfCs. The selection of toxicity values for the COIs will follow the hierarchy of human health toxicity (USEPA, 2003a), which is also recommended by MDEQ (2014). The hierarchy is as follows:

1. USEPA IRIS toxicity values
2. USEPA PPRTVs
3. Other USEPA and non-USEPA toxicity values

5.4.4 Uncertainties Associated with Toxicity Assessment

Uncertainties associated with the Toxicity Assessment will be identified within the HHRA. Specifically, a discussion of the strength of evidence associated with the toxicity values will be presented. For example, for carcinogenic COIs, the weight-of-evidence classification indicating the likelihood that the chemical is a human carcinogen will be presented.

5.5 RISK CHARACTERIZATION

For complete exposure pathways, risk characterization will be performed to combine the exposure and toxicity assessments to produce quantitative estimates of potential health risks associated with the COIs.

5.5.1 Cancer Risk Estimates

Potential cancer risks estimates will be calculated according to the USEPA (1989) equation as presented below:

$$Incremental\ Lifetime\ Cancer\ = LADD\ \times SF$$

where:

LADD = Lifetime Average Daily Dose
SF = Cancer Slope Factor

Incremental lifetime cancer risk probabilities will be compared to the acceptable risk levels. The USEPA has established an acceptable incremental lifetime cancer risk range of 10^{-4} to 10^{-6} (i.e., one in ten thousand to one in one million; USEPA, 1991). However, the MDEQ (2014) has established an acceptable incremental lifetime cancer risk probability of 10^{-5} (i.e., one in one hundred thousand). As such, incremental lifetime cancer risk probabilities will be compared to 10^{-5} as a not to exceed value.

5.5.2 Non-Cancer Hazards

Non-cancer hazard quotients (HQ) will be calculated according to the USEPA (1989) equation as presented below:

$$Hazard\ Quotient\ (HQ) = \frac{CDI}{RfDi\ or\ RfDo}$$

where:

CDI	=	Chronic Daily Intake
RfD_i	=	inhalation Reference Dose
RfD_o	=	oral Reference Dose

HQ's that affect the same target organ are summed together to form the Hazard Index. The non-cancer hazard index is based on a comparison of the estimated site-related dose to the USEPA acceptable dose. The USEPA (2001) has indicated that a hazard index of less than 1.0 indicates an acceptable potential for non-cancer health hazards (USEPA, 2001). Similarly, the MDEQ (2014) has indicated that a total hazard index for non-carcinogenic compounds may not exceed 1.0 for each target organ. As such, the hazard indices will be compared to 1.0 as a not-to-exceed value.

5.5.3 Evaluation of Uncertainties

Uncertainties associated with Risk Characterization will be identified within the HHRA. Uncertainties in the risk characterization will originate from a cumulative effect of the uncertainties in the Exposure Assessment, the Toxicity Assessment, and the Characterization of Risk.

5.5.4 RAGs Part D Tables

Following MDEQ Guidance (MDEQ, 2014), the table format from Risk Assessment Guidance for Superfund (RAGS) Part D will be used for the risk assessment tables.

6.0 ECOLOGICAL RISK ASSESSMENT

The Ecological Risk Assessment (ERA) will be prepared by Neptune and Company, Inc. The ERA will be conducted following USEPA guidance (USEPA, 1993, 1997, 1998 et al.) and MDEQ guidance (MDEQ, 2009, 2014).

The ERA will be focused on COIs in surface water and sediment in East Fork Armells Creek. Potential ecological risk associated with sediment and water within the ponds at the Plant Site will be addressed as part of the closure process for those ponds. Initially, a screening-level ecological risk assessment (SLERA) will be conducted to conservatively rule out further evaluation of constituents and media that do not pose an ecological risk. The SLERA represents Steps 1 and 2 of the USEPA ecological risk assessment process (EPA, 1997). COIs that remain following the initial SLERA will be carried to the screening refinement, informally know as Step 3A of the EPA ecological risk assessment process. If COIs remain following screening refinement, a baseline ecological risk assessment (BERA) may be necessary. The BERA replaces the conservative assumptions used in the SLERA with more realistic, site-specific exposure assumptions, and may include direct evaluation of Creek sediment and water toxicity in the form of bioassays and comparison of site benthic communities with those in unimpacted reference areas. Identification of appropriate reference areas within the Creek is problematic because

upstream of the Plant Site the Creek becomes intermittent, and flowing water is not present year round. Portions of the Creek where water is intermittent are not appropriate for comparison to areas with permanent water because the physical properties and biotic communities will not be comparable between the two areas. Therefore, it is proposed that two sample locations, AR-12 and SW-55 be representative of the reference area. Sample location AR-12 is located just upstream of the Plant Site, but within the area of permanent water (see Figure 3). Sample location SW-55, which is monitored by Western Energy, is located a short distance upstream of AR-12. The SLERA and screening-refinement will be conducted with existing synoptic run data for the Creek.

6.1 ECOLOGICAL EXPOSURE ASSESSMENT

The Ecological Exposure Assessment will provide a description of the environmental exposure to releases or threatened releases of COIs from the ponds at the Plant Site based upon the current use of the Facility and adjacent properties and reasonably anticipated future uses of the Facility and adjacent properties. The Ecological Exposure Assessment will be prepared following MDEQ and USEPA guidance as described in the following sections.

6.1.1 Ecological Site Conceptual Exposure Model

An ecological Site Conceptual Exposure Model (SCEM) will be prepared as the first step in the Exposure Assessment. The ecological SCEM will identify the ecological exposures associated with the Creek, as well as the Facility-specific contaminant sources, release mechanisms, transport routes and media, and potential receptors. The preliminary ecological exposures are presented in the SCEM (Table 2, located in the *Tables* section).

6.1.2 Assessment Endpoints, Measures of Effect, and Exposure Pathways

Ecological assessment endpoints represent the ecological values to be protected at the Facility. Potential receptors will be identified, including the types of plants, animals and components of the environment (e.g., habitats, populations, communities) that may potentially be exposed to contamination. Exposure pathways will also be identified. Preliminary assessment endpoints for the SLERA and screening refinement include:

- Protection of populations of aquatic plants exposed to surface water and sediment in East Fork Armells Creek
- Protection of benthic invertebrate communities exposed to surface water and sediment in East Fork Armells Creek
- Protection of populations of terrestrial birds and mammals exposed to surface water and sediment in East Armells Creek

Ecological risk assessments focus on the protection of populations of organisms, except when the potential exists for threatened and endangered (T&E) species to occur at the Facility. Protection of individuals of T&E species is a goal of the ERA if such species are known or suspected to occur. Information on the potential for T&E species to be present along the Creek will be requested from Montana Department of Fish, Wildlife and Parks. Protection of individuals of T&E species known or expected to occur will be added as an assessment endpoint if their presence is expected. Currently the list of federal proposed, candidate, and listed T&E species for Rosebud County in Montana includes pallid sturgeon (bottom-feeding fish), black-footed ferret (carnivorous mammal), least tern (piscivorous bird), red knot (invertebrate-feeding bird), greater sage-grouse (omnivorous bird, mainly herbivorous), and Sprague's pipit (insectivorous bird; USFWS, 2014).

Measures of Effect describe how assessment endpoints will be evaluated to determine whether potential risk exists to a specific assessment endpoint.

Measures of Effect for the SLERA and screening refinement include:

- Comparison of Creek surface water concentrations to chronic aquatic life standards published in Montana DEQ-7
- Comparison of Creek sediment concentrations to EPA Region 3 Biological BTAG freshwater sediment screening benchmarks
- Food chain modeling to terrestrial birds and mammals utilizing the Creek as a source of food and drinking water, and comparison of average daily doses to toxicity reference values (TRVs). Food-chain models will be constructed for the following representative receptors that may utilize the Creek:
    - Raccoon (Procyon lotor), representative of omnivorous mammals
    - Common yellowthroat (Geothlypis trichas), representative of insectivorous birds
    - Great blue heron (Ardea Herodias), representative of piscivorous birds

Food chain modeling to terrestrial receptors utilizing the creek as a food/water source is being considered at this point in the process to ensure that the screening is protective of both aquatic and terrestrial receptors. The DEQ-7 and Region 3 BTAG sediment and water screening benchmarks are primarily based on protection of aquatic life living in the water and sediment.

Following the SLERA and screening refinement, the list of assessment endpoints and the SCEM will be refined based upon the results of the screening-level assessment. Current and reasonably anticipated future uses of adjacent properties will also be considered when identifying potential receptors and exposure pathways. The preliminary potential receptors and exposure pathways are presented in the ecological exposure pathways (Table 6-1 below).

Table 6-1 Ecological Exposure Pathways

Ecological Receptor	Exposure Pathway				
	Root Uptake	Dermal Contact	Water Ingestion	Sediment Ingestion	Food-chain Ingestion
Benthic Invertebrates	NA	1°	1°	1°	2°
Aquatic Plants	1°	2°	NA	NA	NA
Omnivorous Mammals	NA	2°	1°	2°	1°
Piscivorous/Insectivorous Birds	NA	2°	1°	2°	1°

1° = Primary or major pathway
2° = Secondary or minor pathway
N/A = Insignificant or Incomplete Pathway

6.1.3 Exposure Assumptions

Ecological exposure scenarios will be identified based on the current and reasonably anticipated future Facility use (and adjacent areas), the potential receptors, and complete exposure pathways. For the SLERA, conservative exposure assumptions will be used to ensure that risk is not underestimated. These assumptions include:

- An Area Use Factor (AUF) of 1 (i.e., an organism gets 100% of its exposure from East Fork Armells Creek)
- 100% bioavailability of chemical constituents in sediment and surface water

- Use of No Adverse Effects Level (NOAEL) screening levels and TRVs

For food chain modeling of dose to birds and mammals exposed to Creek surface water and sediments, organism body weights, food ingestion rates, and water ingestion rates are shown in Tables 6-2 through 6-4 below. Estimates of bioaccumulation into food/prey items will also be selected from available literature.

Table 6-2 Raccoon Exposure Parameters

Equation Term	Value	Source
Sediment Ingestion Rate (IR_{sed})	0.03 kilograms/day (kg/d)	Calculated as 10% of Total Ingestion Rate. Total Ingestion Rate of 0.3 kg/d calculated using allometric equation for non-passerine birds from Wildlife Exposure Factors Handbook (USEPA 1993). Raccoon sediment ingestion rate of 10% from Beyer et al. (1994).
Plant Ingestion Rate (IR_{plant})	0.12 kg/d	Calculated as 40% of Total Ingestion Rate. A study of raccoons in Maryland bottomland found that plant material made up ~40% of the mallard diet when averaged across all four seasons, ranging from less than 5% in spring to ~60% in fall and winter (Llewellyn and Uhler as reported in USEPA 1993).
Invertebrate Ingestion Rate (IR_{inv})	0.15 kg/d	Calculated as 50% of Total Ingestion Rate. A study of raccoons in Maryland bottomland found that invertebrates made up ~50% of the raccoon diet when averaged across all four seasons, ranging from ~25% in fall and winter to 82% in spring (Llewellyn and Uhler as reported in USEPA 1993).
Fish Ingestion Rate (IR_{fish})	0.03 kg/d	Calculated as 10% of Total Ingestion Rate. A study of raccoons in Maryland bottomland found that fish and other vertebrates made up ~10% of the raccoon diet when averaged across all four seasons, ranging from ~3% in fall to 16% in winter and spring (Llewellyn and Uhler as reported in USEPA 1993).
Water Ingestion Rate (IR_{water})	0.5 liters/day (L/d)	Based on water ingestion rate of 0.083 grams per grams of body weight per day (g/g-d) as reported in *Wildlife Exposure Factors Handbook* (USEPA, 1993)
Area Use Factor (AUF)	1	An AUF of 1 is used to be protective of all omnivorous mammals for which the raccoon serves as a surrogate.
Body Weight (BW)	6 kg	Average of the mean values of studies reporting weights of adult raccoons, reported in Wildlife Exposure Factors Handbook (USEPA, 1993).

Table 6-3 Common Yellowthroat Exposure Parameters

Equation Term	Value	Source
Sediment Ingestion Rate (IR_{sed})	0.000066 kg/d (dry weight)	Calculated as 2% of total ingestion rate.
Insect Ingestion Rate (IR_{invert})	0.0033 kg/d	Based on invertebrates comprising 100% of the diet of common yellowthroat and a total ingestion rate of 0.0033 kg/d. Total ingestion rate calculated from Nagy (1987) using equation for passerine birds.
Water Ingestion Rate (IR_{water})	0.0028 L/d	Based on water ingestion rate of 0.28 g/g-d as reported in *Wildlife Exposure Factors Handbook* (USEPA, 1993)
Area Use Factor (AUF)	1	The AUF of 1 is applied to each individual area within Abraham's Creek, assuming that individual common yellowthroats defend territories in the wetland portions of each area.
Body Weight (BW)	0.01 kg	Mean of all adult body weights from Guzy and Ritchison, 1999.

Table 6-4 Great Blue Heron Exposure Parameters

Equation Term	Value	Source
Sediment Ingestion Rate (IR_{sed})	0.002 kg/d (dry weight)	Calculated as 2% of total ingestion rate. Total Ingestion of 0.105 kg/d (dry weight) based on ingestion rate of 0.18 kg/kg-d (kilograms per kilograms of body weight per day; wet weight) from *Wildlife Exposure Factors Handbook* (USEPA, 1993) adjusted for body weight and converted to dry weight by assuming average of 75% moisture in prey items. Sediment ingestion rate of 2% from Beyer et al. (1994), based on estimates for blue-winged teal and ring-necked ducks.
Fish Ingestion Rate (IR_{fish})	0.105 kg/d	Calculated as 100% of total ingestion from USEPA (1993). The four studies listed in USEPA (1993) report the diet of the great blue heron as comprised of 94 to 100% fish, with invertebrates, amphibians, birds and mammals comprising the non-fish portion of the diet. For the purposes of evaluating risk to piscivores, the great blue heron will be assumed to have a diet of 100% fish from Abraham's Creek.
Water Ingestion Rate (IR_{water})	0.105 L/d	Based on water ingestion rate of 0.045 g/g-d as reported in *Wildlife Exposure Factors Handbook* (USEPA, 1993)
Area Use Factor (AUF)	1	Although great blue herons may disperse large distances from roosting sites to feeding sites, USEPA (1993) reports feeding territories as small as 1.5 acres. AUF is set equal to 1 for the SLERA.
Body Weight (BW)	2.336 kg	Mean of all adult body weights reported in *Wildlife Exposure Factors Handbook* (USEPA, 1993).

6.1.4 Exposure Areas and Exposure Point Concentrations

The exposure area for the ERA is defined as East Fork Armells Creek adjacent to and downstream of the Plant Site. This area may be further divided into subareas based upon the quantity of data and the size of the area in which potential receptors may be exposed.

The MDEQ recommends using USEPA's most current version of USEPA software, ProUCL, to calculate exposure point concentrations. For the initial screening-level assessment, the maximum concentration of each COI in sediment and surface water will be used. Refinement of the SLERA and the BERA will utilize a 95%UCL on the mean to represent the RMEPC provided that datasets are adequate to support the calculation of a 95%UCL. Statistical and graphical summaries of the data will be developed to support the calculation of the 95%UCL, and to determine appropriate subareas of the creek for refinement of exposure estimates. Temporal analysis of available surface water data may also be conducted to determine if exposures have changed over time, or may be changing on a seasonal basis (e.g., Spring vs Fall).

The data will undergo a comprehensive statistical evaluation, including the calculation of RMEPCs. As mentioned previously, the statistical evaluation will be performed by Neptune. The calculation of RMEPCs will follow MDEQ guidance; however, the data will be evaluated more thoroughly than solely through the use of ProUCL. It should be noted that depending on a specific data set, it may not be appropriate to perform a UCL calculation, such as very small data sets or for data sets with less than five detections.

6.2 ECOLOGICAL TOXICITY ASSESSMENT

The Toxicity Assessment for the COIs identified for East Fork Armells Creek will follow the USEPA recommended approach (USEPA, 1997, 1998). Surface water screening values will represent chronic criteria for protection of aquatic life as published in DEQ-7, and sediment screening values will be selected from freshwater sediment screening criteria recommended by USEPA Region 3 BTAG. Screening levels will represent NOAEL toxicity values. Screening refinement and the BERA will consider both NOAEL and lowest-observed adverse effect level (LOAEL) values. TRVs for evaluation of dose to upper-trophic level birds and mammals will likewise represent NOAEL values for screening and NOAEL and LOAEL values for screening refinement and the BERA. TRVs will be selected from available sources, including those derived by USEPA as part of the Ecological Soil Screening Level Guidance (EPA, 2003b), Oak Ridge National Laboratory (Sample et al., 1996), and Los Alamos National Laboratory (LANL, 2011).

6.3 ECOLOGICAL RISK CHARACTERIZATION

For complete pathways, risk characterization will be performed to combine the exposure and toxicity assessments to produce quantitative estimates of potential ecological risks associated with the COIs.

Ecological risk assessments generally characterize risk based on direct toxicity of COIs. Unlike the human health risk characterization, ecological risk characterization does not calculate carcinogenic risk directly. Ecological risk is concerned primarily with risk to populations, and the life-span of most ecological receptors is not long enough for cancer endpoints to pose population level effects.

The potential for direct toxicity of COIs to ecological receptors will be evaluated through calculation of hazard quotients. For screening of sediment and surface water data for the protection of aquatic plants and benthic communities, a hazard quotient will be calculated as follows:

$$\boldsymbol{Hazard\ Quotient = \frac{EPC}{Media\ Specific\ Screening\ Level}}$$

where:

EPC = media-specific exposure concentration

To assess potential risk to birds and mammals using the Creek area, a hazard quotient will be calculated for each COI based upon the average daily dose to the organism:

$$\boldsymbol{Hazard\ Quotient = \frac{ADD}{TRV}}$$

where:

ADD = average daily dose (mg/kg-d)
TRV = toxicity reference value (mg/kg-d)

The average daily dose is calculated as follows:

$$\boldsymbol{ADD = \frac{\sum(C_i * IR_i) * AUF}{BW}}$$

where:

ADD = average daily dose (mg/kg-d)
C_i = concentration of chemical in media "i" (mg/kg)
IR_i = organism-specific ingestion rate of media "I" (mg/kg-d)
AUF = Area Use Factor (unitless)
BW = organism body weight (kg)

6.3.1 Evaluation of Uncertainties

Uncertainties associated with Risk Characterization will be identified within the SLERA and screening-refinement. Uncertainties in the risk characterization will originate from a cumulative effect of the uncertainties in the Exposure Assessment, the Toxicity Assessment, and the Characterization of Risk. Depending on the results of the SLERA, additional studies may be conducted to reduce uncertainties associated with the SLERA. Additional studies may include biological assessments of the Creek and site-specific toxicity testing of Creek sediment and/or water to determine if SLERA hazard quotients overestimate actual risk from Plant Site COIs.

7.0 EVALUATION OF THE NEED FOR REMEDIAL MEASURES

Regarding the need for remedial measures, the AOC (Article VI.B) indicates:

- If the CCRA identifies one or more COIs that exceed Cleanup Criteria, then remedial measures are necessary and a Remedy Evaluation Report shall be prepared.

- If the CCRA does not identify COIs that exceed Cleanup Criteria, then remedial measures are not needed and there is no need for further action.

A comparison and evaluation of the COI Cleanup Criteria and the Facility data will be conducted to determine if remedial measures are necessary. This evaluation will be conducted by taking into account geospatial considerations that might require further attention due to circumstances that separate the areas from the remainder of the site. Such circumstances may include isolated areas which exhibited elevated levels of chemical constituents prior to and throughout the life of operations at the facility. Other conditions may apply where off-site sources may be contributing to conditions that limit the ability to a defined remedial level for certain areas.

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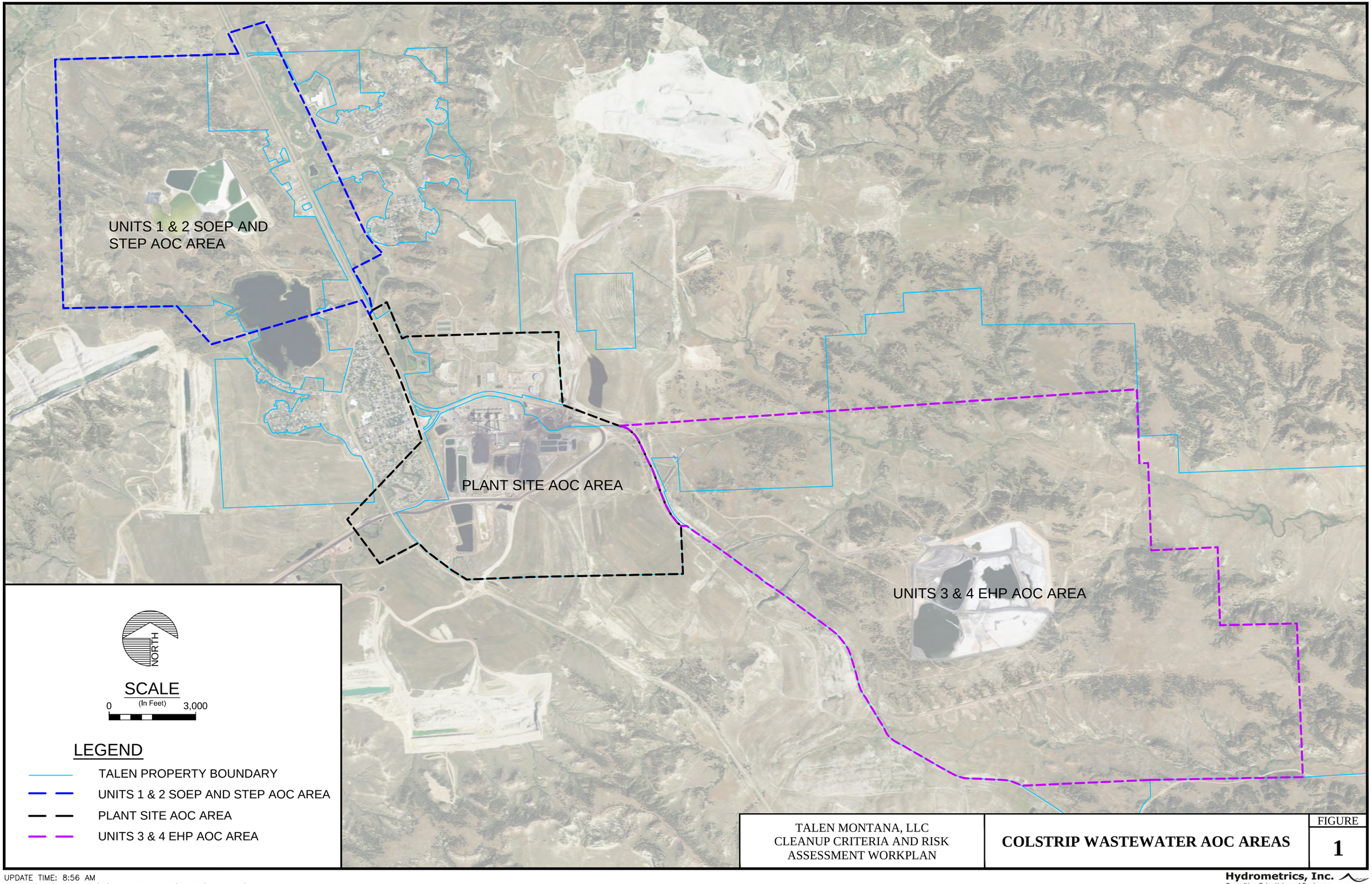
FIGURES



TALEN MONTANA, LLC
CLEANUP CRITERIA AND RISK
ASSESSMENT WORKPLAN

COLSTRIP WASTEWATER AOC AREAS

FIGURE
1

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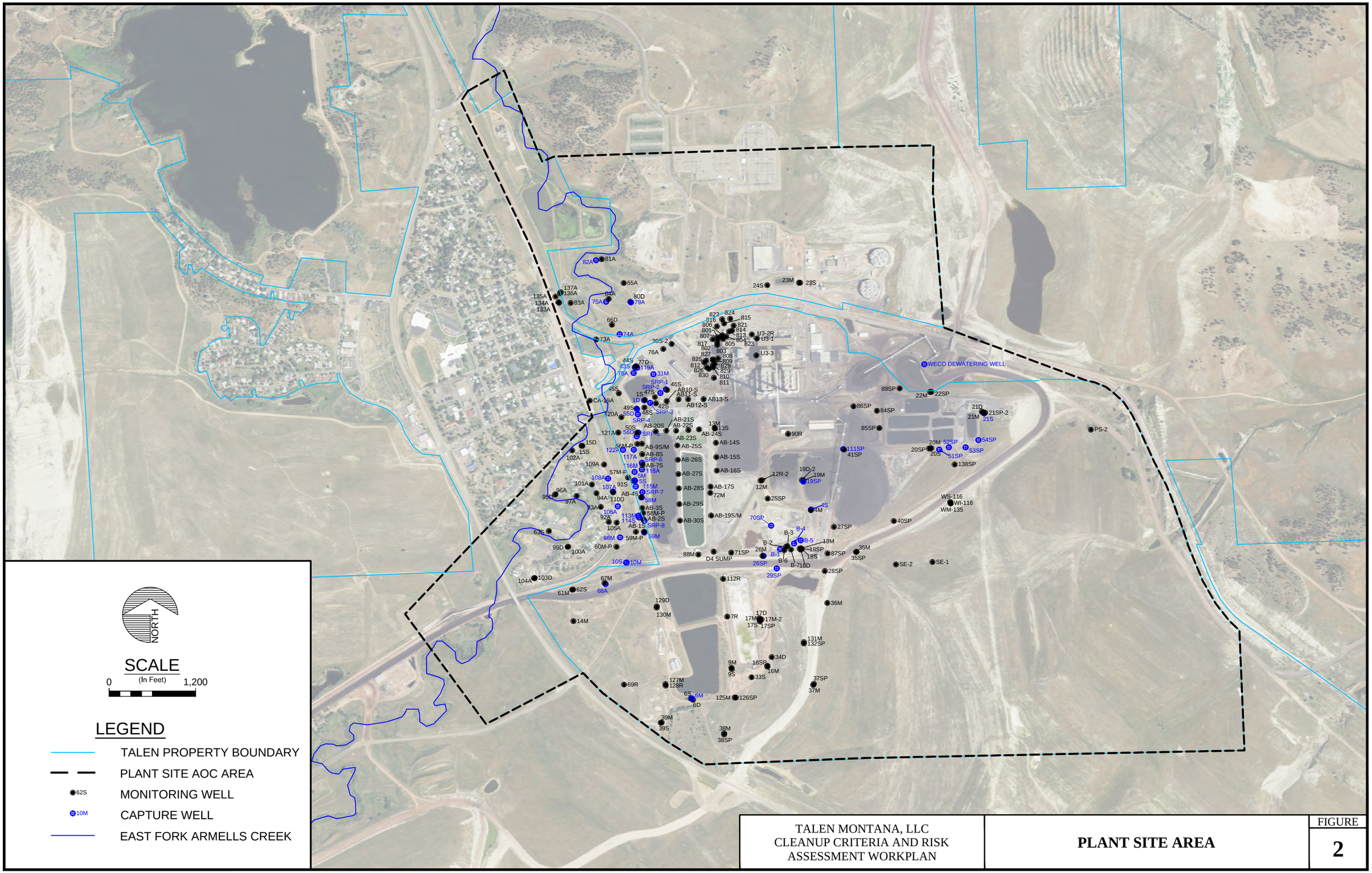

TALEN MONTANA, LLC
CLEANUP CRITERIA AND RISK
ASSESSMENT WORKPLAN

PLANT SITE AREA

FIGURE
2

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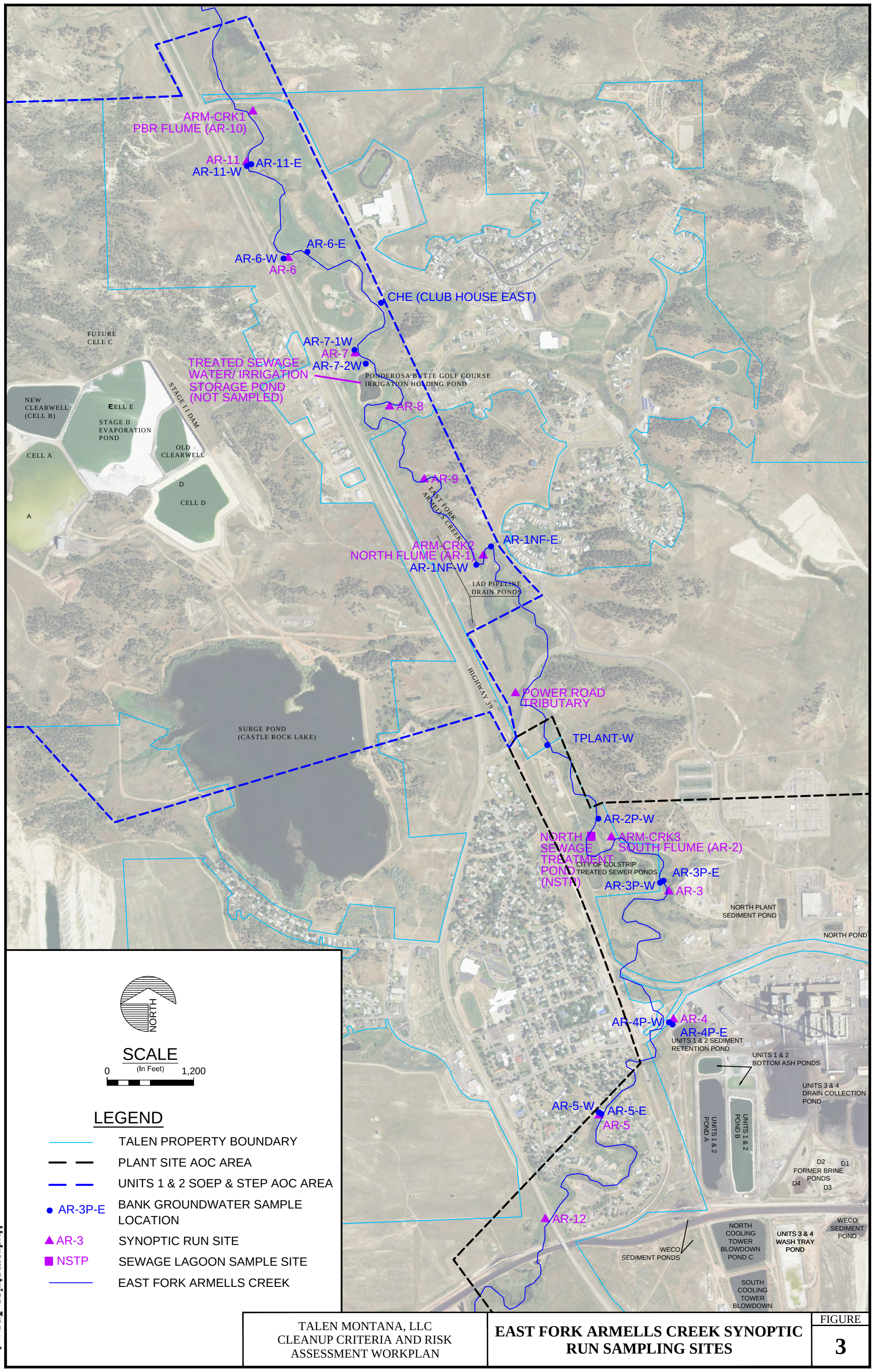

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TALEN MONTANA, LLC
CLEANUP CRITERIA AND RISK ASSESSMENT WORKPLAN

EAST FORK ARMELLS CREEK SYNOPTIC RUN SAMPLING SITES

FIGURE
3

TABLES

Table 1
Comparison Values for Identification of COIs and COPCs
Colstrip Steam Electic Station - Plant Site and 1&2 Area
Colstrip, Montana

Project Number 14-1006

Comparison Value	Groundwater	Surface Water	Sediments	Comment
DEQ-7 Circular Value	✓	✓		Cleanup Level (MDEQ) Cleanup Criterion* (AOC)
USEPA MCL	✓	✓		Screening Level (MDEQ) Cleanup Criterion* (AOC)
MDEQ RBSL	✓	✓	✓	Screening Level (MDEQ) Cleanup Criterion* (AOC)
USEPA Tap Water RSL	*	*		Screening Level (MDEQ) Cleanup Criterion* (AOC)
USEPA Region 3 BTAG Freshwater Sediment Screening Benchmark			✓	Screening Level
USEPA Residential Direct Contact RSL (carcinogens) (divided by 10 for non-carcinogens)			✓	Screening Level
USEPA Protection of Groundwater SSL (Risk-Based and using a DAF 10)			✓	Screening Level
BSLs	✓	if available	if available	Background Screening Level

Notes:

AOC	Administrative Order on Consent
BSLs	Background Screening Levels
BTAG	Biological Technical Assistance Group
DAF	Dilution Attenuation Factor
DEQ	(Montana) Department of Environmental Quality
MCL	Maximum Contaminant Level
MDEQ RBSL	Montana Department of Environmental Quality Risk-Based Screening Level
RSL	Regional Screening Level
SSL	Soil Screening Level
USEPA	United States Environmental Protection Agency
*	Used if a DEQ-7, MCL, or MDEQ RBSL is not available
Cleanup Criteria*	Cleanup Criteria may not be more stringent than background concentations

Table 2
Preliminary Site Conceptual Exposure Model
Colstrip Steam Electic Station - Plant Site and 1&2 Area
Colstrip, Montana

Project Number 14-1006

Primary Sources	Primary Release Mechanism	Secondary Sources	Secondary Release Mechanism	Media	Exposure Pathway	Current/Future Land Use						
						Human Receptors					Ecological Receptors	
						(Adjacent) Adult Residents	(Adjacent) Child Residents	(Adjacent) Outdoor Workers	(Adjacent) Child Trespassers	(Adjacent) Excavation/ Trench Workers	Terrestrial Ecological	Aquatic Ecological
Water Based Liquid Wastes in Facility Ponds	Pond Seepage	Groundwater	None	Groundwater	Ingestion	X	X	X	X	X	X	X
					Dermal	X	X	X	X	•	X	X
			Migration	East Fork Armells Creek Sediments	Ingestion	•	•	•	•	•	•	•
					Dermal	•	•	•	•	•	•	•
				East Fork Armells Creek Surface Water	Ingestion	X	X	X	X	X	•	•
					Dermal	•	•	•	•	•	•	•

Notes:

• Potentially complete exposure pathway
X Incomplete exposure pathway

Table 3
Preliminary Exposure Parameters
Colstrip Steam Electic Station - Plant Site and 1&2 Area
Colstrip, Montana

Project Number 14-1006

Parameter (Units)	(Adjacent) Adult Resident	(Adjacent) Child Resident	(Adjacent) Outdoor Worker	(Adjacent) Child Trespasser	(Adjacent) Excavation/ Trench Worker
Exposure Frequency (days/year)	270	270	187	50	124
Exposure Duration (years)	26	6	25	13	1
Body Weight (kg)	80	15	80	45	80
Averaging Period - Lifetime (years)	78	78	78	78	NA
Averaging Period - Chronic Noncancer (years)	26	6	25	13	1
Ingestion Rate (mg/day)	100	200	100	200	330
Surface Area Exposed (cm^2)	6,032	2,690	3,470	4,400	3,470
Soil to Skin Adherence Factor (mg/cm^2)	0.07	0.2	0.12	0.2056	0.04

Notes:
Exposure parameters taken from Montana DEQ Guidance (MDEQ, 2014)
cm^2 square centimeters
kg kilograms
mg milligrams