INTERIM RESPONSE ACTION
GROUNDWATER INVESTIGATION NEAR THE NORTHWEST CORNER OF THE UNITS 3&4 EHP – COLSTRIP STEAM ELECTRIC STATION, PPL MONTANA, LLC

Executive Summary

PPL Montana, LLC (PPL) monitors groundwater in the area surrounding the Units 3 & 4 Effluent Holding Pond (3&4 EHP) at the PPL Colstrip Steam Electric Station (Colstrip –SES) to detect inconsistencies in water quality and/or quantity that may be attributable to seepage from the ponds. Observations made at monitoring wells include laboratory analysis for a suite of parameters indicative of process water impacts. Typical process water indicator parameters include Total Dissolved Solids (TDS), specific conductance (SC), sulfate, boron, chloride, and the ratio of dissolved calcium to magnesium. In cases where ionic indices are ambiguous with respect to process water impacts, isotope analyses may be used. The ratio of the stable oxygen and hydrogen isotopes in a water sample can be unique or characteristic of the water and therefore can often be used to trace the water to its source. As monitoring data become indicative of process water impacts, PPL mitigates impacts by converting existing wells or installing new groundwater capture wells. Recent water quality observations at McKay coal monitoring wells 657M and 1049M, located outside of the northwest corner of the 3&4 EHP, indicate the possible presence of process water impacts based levels of chloride, TDS, SC, and sulfate. However, groundwater in the wells does not have elevated boron; and the ratio of calcium to magnesium in each well is not suggestive of process water impacts. This document includes a multi-phase work plan for interim response action including isotopic characterization of existing wells, installation of one new well, and potential capture well conversion of additional wells.

Page

LIST OF TABLES

TABLE 1 NEW MONITORING WELL ANALYTICAL PARAMETERS 12

LIST OF FIGURES

FIGURE 1 PROJECT LOCATION MAP.....5
FIGURE 2 WELL NETWORK NEAR PROJECT LOCATION 6
FIGURE 3 PROPOSED NEW WELL LOCATION AND MCKAY COAL POTENTIOMETRIC MAP 8
FIGURE 4 TYPICAL CAPTURE WELL CONSTRUCTION DIAGRAM 15
FIGURE 5 SCHEDULE.....17

INTRODUCTION

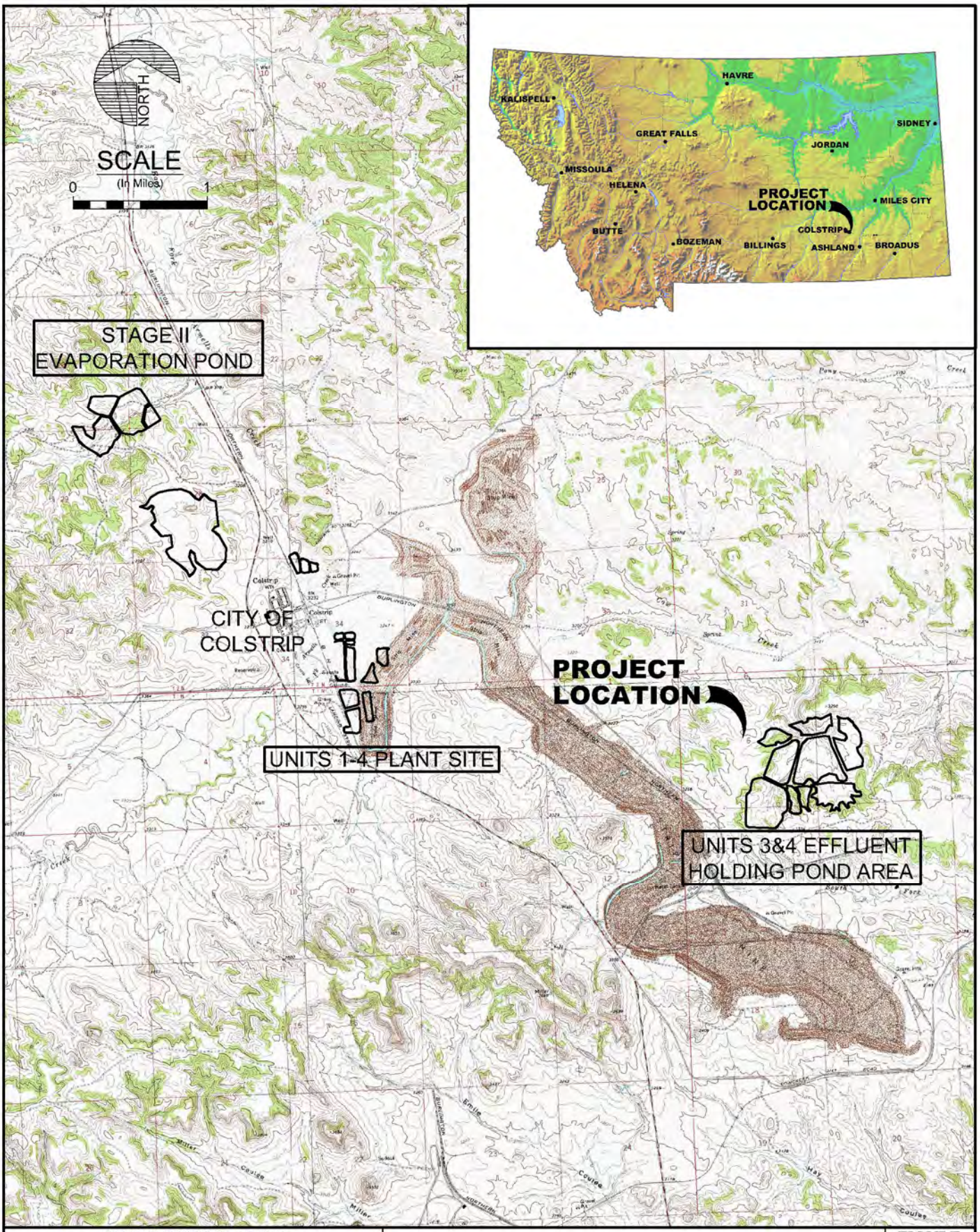
This Work Plan was prepared as an Interim Response Action in accordance with the Administrative Order on Consent (AOC) Regarding Impacts Related to Wastewater Facilities Comprising the Closed-Loop System at Colstrip Steam Electric Station, Colstrip, Montana between PPL Montana as Operator of the Colstrip Steam Electric Station and Montana Department of Environmental Quality. While the AOC provides for work to be done as an Interim Response Action, the examples provided in the AOC are not exhaustive, and the prompt action described in the following work plan is to respond to the circumstances identified in the work plan and not because of an acute threat to human health or a recent spill.

PPL Montana, LLC (PPL) monitors groundwater in the area surrounding the Units 3 & 4 Effluent Holding Pond (3&4 EHP) at the PPL Colstrip Steam Electric Station (Colstrip –SES) to detect inconsistencies in water quality and/or quantity that may be attributable to seepage from the ponds. Typical process water indicator parameters include Total Dissolved Solids (TDS), Specific Conductance (SC), sulfate, chloride, boron, and the ratio of dissolved calcium to magnesium (Ca:Mg). The ratio of the stable oxygen and hydrogen isotopes (e.g. $^{18}O/^{16}O$, denoted $\delta\ ^{18}O$, and $^{2}H/^{1}H$ denoted D/H when expressed relative to Standard Mean Ocean Water) in a water sample can be unique or characteristic of the water and therefore can be used in some cases as an additional indicator parameter for process water. When two waters are mixed, the resulting mixed water will have a composition that is intermediate between the two (assuming that all constituents behave conservatively). One test for groundwater impacts from a potential source is to plot the isotopic concentrations of the potential source (i.e. water from the 3&4 EHP), the background water quality, and the suspected or potentially impacted groundwater. If a particular groundwater is impacted, the groundwater composition will lie on a hypothetical mixing line between the background water quality and the source. As water quality becomes indicative of potential process water impacts, PPL installs additional monitoring wells and/or groundwater capture systems (or converts existing monitoring wells to recovery wells) to further characterize groundwater quality and to mitigate the influence of the 3&4 EHP on local groundwater. Through ongoing evaluation of monitoring data, gaps in the current monitoring and capture network are revealed.

Recent evaluation of water quality trends at wells 657M and 1049M (completed in the McKay Coal near the northwest corner of the 3&4 EHP) conducted as part of PPL's 2012 Evaluation of Hydrologic Monitoring Data (Hydrometrics, Inc., April 2013) indicate increases in some water quality parameters typically used to identify process water impacts. Wells 657M and 1049M and the general area northwest of the 3&4 EHP are presented in Figures 1 and 2. Specific water quality parameters and observations indicative of potential process water impacts at wells near 657M and 1049M are as follows:

- 657M – This well was completed in McKay coal in 2003. Values of SC and TDS in groundwater at this well rose from just under 3,000 μmhos/cm and 3,000 mg/L in 2003 to around 5,000 μmhos/cm and 5,000 mg/L, respectively, in 2012. Increases in concentrations of sulfate and chloride accompanied rising SC and TDS throughout the same time period; however, boron concentrations and the Ca:Mg have remained at values that are not indicative of process water impacts.
- 1049M – This well was completed in McKay coal in 2007. Similar to water quality observations made at well 657M, SC, TDS, and chloride concentrations rose steadily between 2008 and 2012. Boron concentrations actually declined gradually during the same time period. Individual concentrations of both calcium and magnesium increased over the last four years; but the Ca:Mg ratio remained greater than one throughout.

A third well of interest in the project area is well 551D. This well is completed in sub-McKay bedrock north of the McKay sub-crop line but in the known direction of groundwater flow in the coal. It is likely that groundwater from the McKay coal mixes with water in deeper strata where the coal sub-crops. Groundwater quality at well 551D has gradually declined since about 1994. Specifically, TDS, SC, and sulfate concentrations have all increased. The Ca:Mg ratio dropped below one in 1994 and decreased steadily through 2011. The initial Ca:Mg at well 551D was 1.28 in 1982. As of the end of 2012, the Ca:Mg was 0.83. Despite the apparent increase in some of the typical process water indicator parameters, the overall quality of groundwater at well 551D has not declined to a condition that would prompt remedial action. However, it may be advantageous to evaluate upgradient groundwater conditions in either the McKay coal or first sub-McKay groundwater.



INTERIM RESPONSE ACTION GROUNDWATER INVESTIGATION NEAR THE NORTHWEST CORNER OF THE UNITS 3&4 EHP - COLSTRIP STEAM ELECTRIC STATION, PPL MONTANA, LLC	**PROJECT LOCATION MAP**	FIGURE **1**

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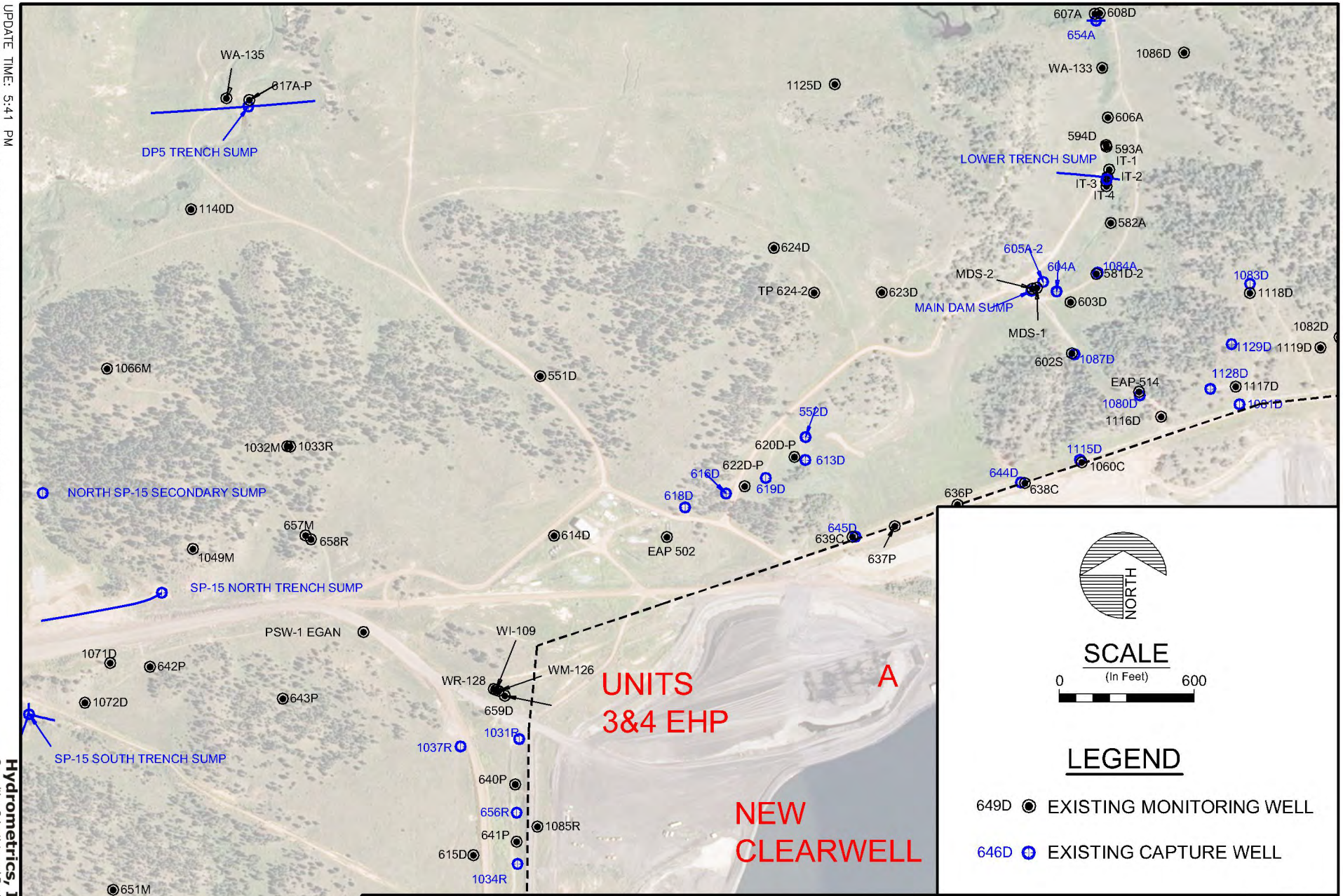

INTERIM RESPONSE ACTION
GROUNDWATER INVESTIGATION NEAR THE
NORTHWEST CORNER OF THE UNITS 3&4 EHP -
COLSTRIP STEAM ELECTRIC STATION,
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WELL NETWORK NEAR PROJECT LOCATION

FIGURE
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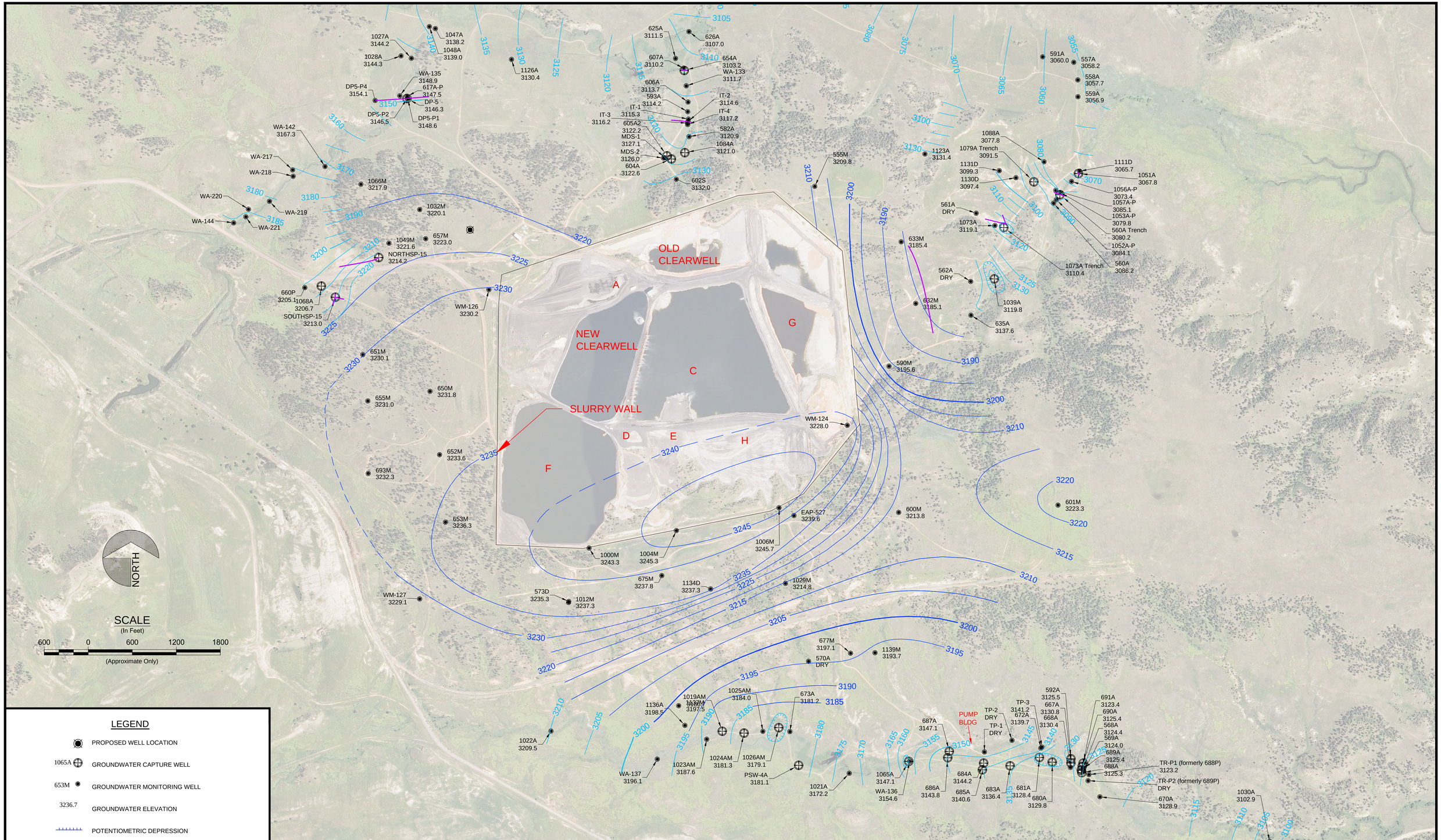
Other wells completed northwest of the 3&4 EHP (e.g. 1066M, 1032M, 658R, 1033R) have not exhibited a rising trend in any of the typical process water indicator parameters. Wells 1066M and 1032M are located further north (downgradient) of the ponds from 657M and 1049M. The lack of rising SC, TDS, and chloride trends at 1032M and 1066M suggests that migration (if any) of the source of the elevated concentrations is limited. The absence of declining water quality trends at wells 658R and 1033R (completed in the Rosebud coal or burn) suggest that potential process water impacts in the current project area are not present in the shallower horizon.

As a result of the water quality observations previously listed, additional investigation and/or groundwater quality mitigation may be necessary in the McKay coal in the area outside of the northwest corner of the 3&4 EHP. The Scope of Work for investigation and potential groundwater mitigation efforts will be completed via the following dual-phase approach.

Phase 1

- Task 1 – Monitoring Well Installation
  - A new monitoring well targeting the McKay Coal, or first sub-McKay groundwater, will be installed in the project area at the location shown on Figure 2.
- Task 2 – Aquifer Testing
  - An aquifer test will be conducted at the new well. The test will be conducted as either a pumping and recovery test or a slug test, depending on well yield.
- Task 3 – Groundwater Quality Sampling
  - A groundwater quality sample will be collected at the new well and analyzed for ionic composition, including the suite of typical process water indicator parameters.
  - A water sample will be collected and analyzed for isotopic speciation of hydrogen and oxygen at the following sites:
    - Potentially impacted monitoring wells 657M and 1049M;
    - The proposed new well location (Figure 3);
    - Apparently un-impacted wells 1032M and 1066M; and
    - The Units 3&4 C Cell.



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PROPOSED NEW WELL LOCATION AND MCKAY & ALLUVIAL HYDROSTRATIGRAPHIC UNITS POTENTIOMETRIC SURFACE OCTOBER 2012

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FIGURE
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- Isotope samples collected at these sites will provide data necessary to create a hypothetical mixing line between groundwater in the McKay coal and water present in the 3&4 EHP.
- If isotope results plot in a position that is contrary to potential impacts, no additional work will be conducted. If isotope results are not suggestive of impacts, wells 1049M and 657M will continue to be monitored at their regularly scheduled frequency.
- If isotope results plot on a position on the hypothetical mixing line that is indicative of mixing with process water, or if isotope results are ambiguous, Phase 2 of this Work Plan will be initiated.

- Task 4 – Reporting
  - Results of ionic and isotopic analysis will be presented in a report with recommendations on whether or not to proceed with Phase 2 of the Work Plan. If Phase 2 is recommended, the report specified in this task will be an Interim Report. If Phase 2 is forgone, because sampling results are not indicative of process water impacts, the report drafted in Task 3 of Phase 1 will be the final report of this Interim Response Action.

<u>Phase 2</u>

- Task 1 – Capture Well Conversion
  - The new well (Figure 3) and either or both of existing wells 657M and 1049M will be converted for groundwater capture if process water impacts are evident based on sample results.
- Task 2 – Capture System Startup Evaluation
  - Capture system pumping rates, field specific conductance, and water levels in the pumping wells and/or nearby observation wells will be monitored upon capture system startup.

- Task 3 – Analysis and Reporting
    - Results of the well installation, groundwater sampling, capture conversion, and startup evaluation will be presented in the Final Report of this Interim Response Action.

<u>Phase 1</u>

Task 1 -- Monitoring Well Installation

A single new well is proposed at the site identified in Figure 3. The proposed new well will target the McKay coal or first groundwater at a location that is downgradient of the 3&4 EHP and represents a potential gap in the monitoring well network.

The borehole for the new well will be drilled using air-rotary methods. If necessary, 8-inch diameter steel casing will be advanced through incompetent surface intervals (clinker, fill, sloughing alluvium/ colluvium, etc.) using drill and drive methods. In such an instance, 4.5-inch PVC casing will be installed through the steel casing. The target interval will be screened with 0.025-inch slot, four-and-one–half-inch diameter PVC screen. The target interval of the new well is shallow alluvium consistent with that found at well 673A; however, the new well will be advanced up to five feet beyond the bottom of the alluvium to create a more efficient pumping well. The total depth of the new well is expected to be less than 20 feet below ground surface. A filter pack, consisting of 10-20 silica sand, will be placed across the entire length of the screened interval. Bentonite chips will be used to create an annular seal from the top of the silica sand to ground surface. If necessary, steel casing will be pulled back to expose the slotted section of PVC. A minimum of five feet of eight-inch steel surface casing will be left in the completed borehole (approximately two feet of steel will extend above ground). A locking steel lid will be installed at the wellhead.

Cuttings from the boring will be logged for lithology, including texture, color, relative moisture, and origin (alluvium, colluvium, bedrock, etc.), by a geologist, hydrogeologist, or engineer. A log of borehole lithology and well completion will be prepared and submitted to PPL and the Montana Board of Water Well Contractors.

The well will be developed using air-lift methods or bailing. Air-lift development involves forcing compressed air into the completed well to purge water, cuttings, fines, and debris from the casing. Providing the well makes sufficient water, development will continue until fine-grained sediments have been adequately removed from the well to allow pumping with a submersible pump. Bailing involves repeatedly removing water from the well with a steel bailer (with check valve) until the well has been effectively purged. Field parameters (specific conductance (SC), pH, temperature) will be measured and recorded during development.

Task 2 – Aquifer Testing

A pumping test or slug test will be conducted at the proposed new well. A pumping test will be conducted if sufficient water is present in the new well. If well three has a low estimated yield (less than 1.5 gpm), it will be slug tested. Results of the tests will be used in the evaluation of groundwater flow in the area, for groundwater modeling purposes, and to design mitigation measures, if necessary. Pumping tests will consist of 100 minutes of pumping followed by a recovery period. Water levels will be measured during the pumping and recovery phases of the test using pressure transducers with data loggers and/or electronic water level probes. Alternatively, a slug test will be conducted by displacing water from the well casing using a "slug" and measuring groundwater recovery following the slug injection or withdrawal. Water levels will be measured in the slug test well using electronic pressure transducers and/or electronic water level probes. Pump test and/or slug test data will be entered into Aqtesolv software for analysis. Test curves will be fit with appropriate analytical solutions included in the software.

Task 3 -- Groundwater Quality Sampling

A single groundwater quality sample will be collected from the new well and analyzed for ionic composition, including typical process water indicator parameters, at the proposed well. The sample will be collected using methods consistent with Hydrometrics, Inc. Standard Operating Procedures (SOP) and methods commonly used by PPL for operational monitoring. The samples will be collected after three well casing volumes are removed from the well using either a submersible sampling pump or a disposable bailer. Field parameters (SC, pH, temperature) will

be measured and recorded during sampling. Samples will be submitted to Energy Laboratories in Billings, Montana for analysis of the parameters listed in Table 1.

TABLE 1. New Monitoring Well Analytical Parameters

- **Physical properties**
  - pH
  - Specific Conductance
  - Total Dissolved Solids
- **Common Ions**
  - Alkalinity, Total as $CaCO_3$
  - Bicarbonate as HCO_3
  - Carbonate as CO_3
  - Chloride
  - Sulfate
  - Magnesium
  - Calcium
  - Potassium
  - Sodium
  - Bromide
- **Nutrients**
  - Nitrate plus nitrite
- **Dissolved Metals**
  - Boron
  - Selenium
  - Mercury

Analytical results will be evaluated to identify potential process water impacts. Process water indicator parameters include SC, TDS, B, and Cl^-. Groundwater mixed with process water typically exhibits a strong Mg-SO_4 ionic composition; thus, SO_4 concentration and the ratio of Ca:Mg are also important process water indicators.

A water sample will be collected and analyzed for isotopic speciation of hydrogen and oxygen at monitoring wells 657M , 1049M, 1032M, 1066M, the proposed new well location, and the Units 3&4 EHP Old Clearwell. The samples will be collected using methods consistent with Hydrometrics, Inc. Standard Operating Procedures (SOP) and methods commonly used by PPL for operational monitoring. Groundwater samples will be collected after three well casing volumes are removed from each well using either a submersible sampling pump or a disposable

bailer. Field parameters (SC, pH, temperature) will be measured and recorded during sampling. Samples will be submitted to Isotech Laboratories, Inc. Champaign, Illinois for analysis of $\delta\ ^{18}O$ in H_2O and δ D in H_2O. Results will be used to create a hypothetical mixing line between groundwater in the McKay coal and water present in the 3&4 EHP. Evaluation of results will include comparison to the meteoric water line.

Task 4 – Reporting

As previously discussed, a report will be drafted upon receipt and evaluation of laboratory results. The report will include recommendations on whether or not to proceed with Phase 2 of the Work Plan. If Phase 2 is recommended, the report specified in this task will be an Interim Report. If Phase 2 is not necessary, because sampling results are not indicative of process water impacts, the report drafted in Task 4 of Phase 1 will be the final report of this Interim Response Action. Per requirements of the Administrative Order On Consent Regarding Impacts Related to Wastewater Facilities Comprising the Closed-Loop System and Colstrip Steam Electric Station, Colstrip, Montana, the interim report will be submitted within 60 days of completing, sampling, and analyzing samples at new and existing wells.

Phase 2

Phase 2 of this Interim Response Action will only be completed pending laboratory analytical results that are indicative of process water impacts at wells 657M, 1149M, or the new proposed well.

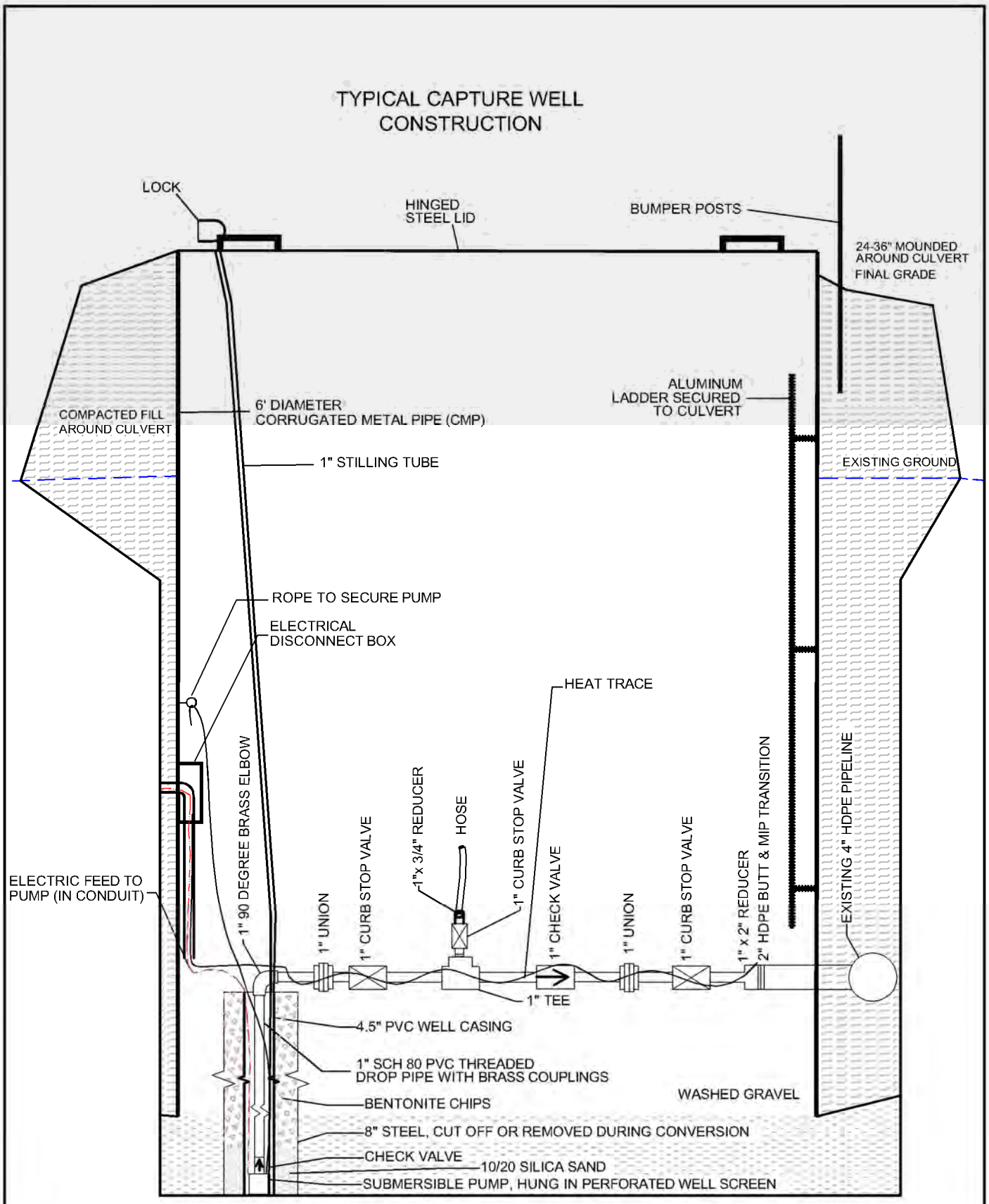
Task 1 Capture Well Construction

If necessary, monitoring well to capture well conversion will be completed according to PPL's commonly used and accepted procedure, as follows:

- The existing monument and concrete pad, if present, will be removed and the area around the wells will be excavated to an approximate depth of five feet below ground surface with a backhoe or track excavator.
- The excavations will be of sufficient width to place a six-foot diameter Corrugated Metal Pipe (CMP) over the existing wellheads.

- Excavated materials will be backfilled around the CMPs and mounded at the surface to promote drainage from the capture wells.
- Washed gravel will be placed in the bottom of the CMPs at an approximate thickness of one-foot.
- Existing PVC well casing will be cut off so that it extends just above the washed gravel in the bottom of the CMP vaults.
- Hinged metal lids will be installed at the top of the CMPs.
- Aluminum ladders will be secured to the inside of the CMPs for access/egress into and out of the culverts.
- A submersible pump sized for the well yield and anticipated pumping heads will be installed in each well at total depth.
- Submersible pumps will be hung in the wells by one-inch schedule 80 PVC threaded drop pipe with brass couplings.
- Drop pipe will extend from the well to a one-inch brass pipeline on the floor of each vault.
- Necessary pipe fittings (i.e. one-inch unions, tees, valves, and sample port) will be plumbed into the one-inch line in each vault; and the one-inch lines will be connected to existing HDPE pipelines.
- Redundant check valves will be installed both immediately above the pump and inside the vault to prevent backflow to the wells.
- Electrical controls, an hour meter, and automated pump protection (i.e. pumptec) will be installed in a secure electrical enclosure adjacent to each wellhead.

Captured groundwater from the wells will be routed to existing HDPE pipelines outside the northwest corner of the 3&4 EHP. The pipeline configuration will be specified once it is determined which, if any, wells are to be captured. A typical capture well construction diagram is presented in Figure 4.



INTERIM RESPONSE ACTION GROUNDWATER INVESTIGATION NEAR THE NORTHWEST CORNER OF THE UNITS 3&4 EHP - COLSTRIP STEAM ELECTRIC STATION, PPL MONTANA, LLC	**TYPICAL CAPTURE WELL CONSTRUCTION DIAGRAM**	FIGURE **4**

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Task 2 Capture System Startup/Evaluation

New capture wells will be instrumented with pressure transducers and automated data-loggers to record the aquifer response to pumping at the new capture wells. Pumping rates and frequent checks of the hour meter will be used to calculate capture volumes during the evaluation period. Water levels in the pumping well and/or nearby monitoring wells will be recorded to measure the capture radii of the pumping wells. Water level responses to pumping will be entered into Aqtesolv software for analysis. The evaluation will begin immediately upon capture system startup and is expected to last for up to one month. The duration of the evaluation will be dependent on groundwater level responses to pumping at the new capture system.

Task 3 Reporting

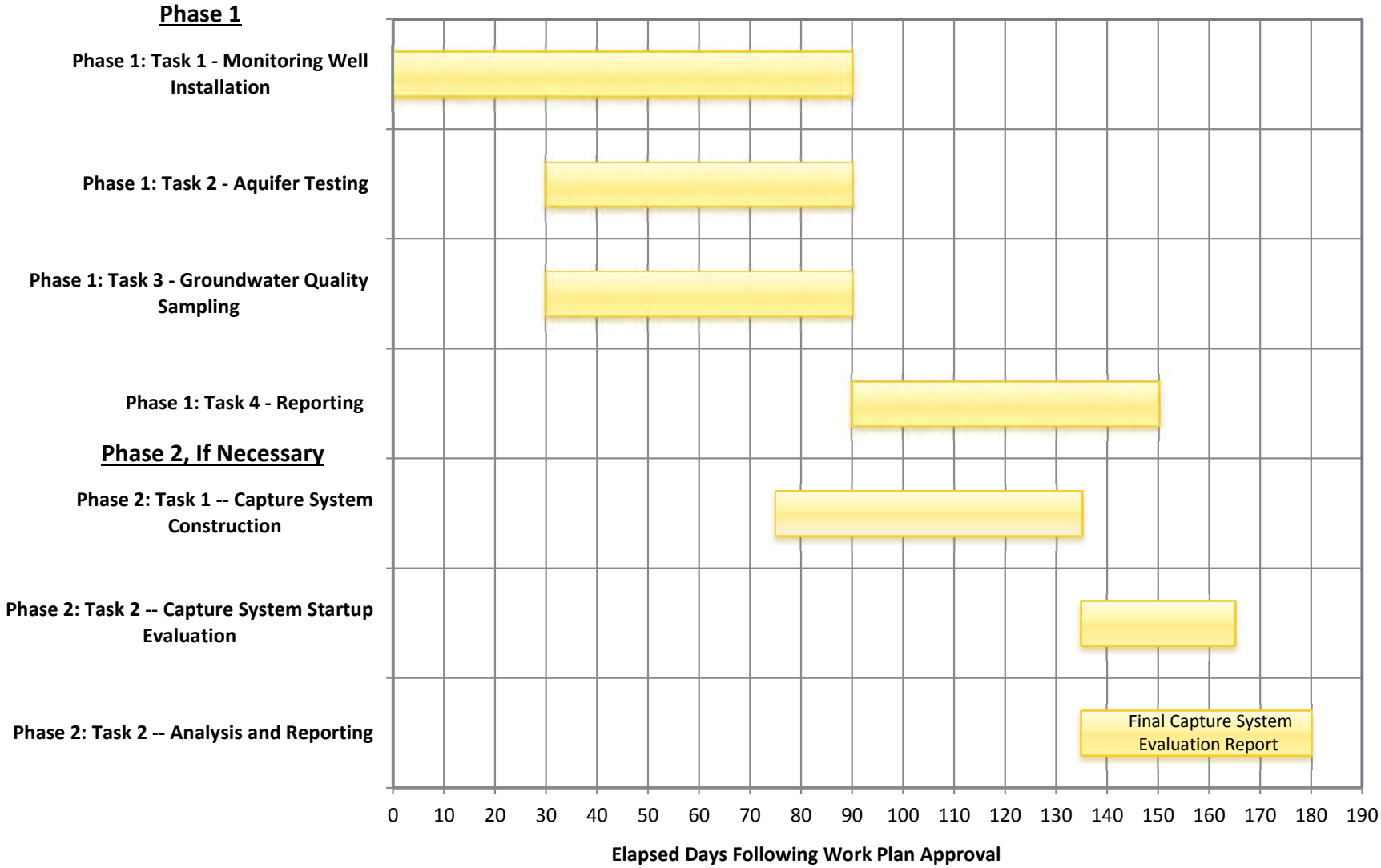
Results of the well installation, groundwater sampling, capture conversion, and startup evaluation will be presented in the Final Report of this Interim Response Action. The Final Report will be written for submittal to the Montana Department of Environmental Quality (MT-DEQ). It will contain a narrative of sampling, testing, construction procedures and an interpretive summary of groundwater quality and capture system startup results. If necessary, the report will include recommendations for additional groundwater capture locations and/or groundwater monitoring activities.

Schedule

The proposed timeline to complete the scope of work outlined for this Interim Response Action is included in Figure 5. New well installation and groundwater quality sampling is expected to be completed within 60 days of approval of this plan by the Montana Department of Environmental Quality. Conversion of new wells and submittal of an Interim Report are to be completed within 90 days of installation. The final evaluation report will be submitted approximately 180 days after work plan approval.

Figure 5. Interim Response Action Schedule

GROUNDWATER INVESTIGATION NEAR THE NORTHWEST CORNER OF THE UNITS 3&4 EHP – COLSTRIP STEAM ELECTRIC STATION, PPL MONTANA, LLC



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Hydrometrics, Inc. (April 2013). *Evaluation of 2012 Hydrologic Monitoring Data from Colstrip Units 1 through 4 Process Pond System Colstrip Steam Electric Station* .

PPL MONTANA, LLC
COLSTRIP STEAM ELECTRIC STATION

INTERIM RESPONSE ACTION– GROUNDWATER INVESTIGATION NEAR THE NORTHWEST CORNER OF THE UNITS 3&4 EHP
COLSTRIP STEAM ELECTRIC STATION, PPL MONTANA, LLC

Pursuant to: ADMINISTRATIVE ORDER ON CONSENT REGARDING IMPACTS RELATED TO WASTEWATER FACILITIES COMPRISING THE CLOSED-LOOP SYSTEM AT COLSTRIP STEAM ELECTRIC STATION, COLSTRIP, MONTANA SECTION XI - SUBMISSIONS

CERTIFICATION:

I, the undersigned, hereby certify that this document was prepared under my direction and to the best of my knowledge the information contained herein is correct and accurate.

Mike Holzwarth	Compliance Professional	8/12/13
Name	Title	Date