INTERIM RESPONSE ACTION
WORK PLAN
GROUNDWATER INVESTIGATION
NORTH OF THE UNITS 1&2 STAGE TWO EVAPORATION POND
TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION

AREA: Plant Site Stage One or Two Evaporation Pond Area

Units 3& 4 Effluent Holding Pond Area

LAND USE AND OWNERSHIP: Industrial, Talen Montana, LLC

MEDIA: Soil

Surface Water (identify water body):___________________

Groundwater

Alluvial McKay/Rosebud Sub-McKay Other

LEVEL OF IMPACTS:

Results of typical process water indicator parameters are summarized for select wells in bedrock north of the Units 1&2 Stage One and Two Evaporation Ponds as follows.

Analyte	**903D**	**2022D**	**2023D**	**2032D**	**2033D**	**2024D-2***	**BSL**
	3/13/2015	**9/1/2015**	**8/25/15**	**8/25/15**	**3/23/2016**	**8/6/2015**	**sub-McKay**
SC (μmhos/cm)	**5000 >**	**5240 >**	**4720 >**	4250 <	**5620 >**	**6170 >**	4470
Boron (mg/L)	0.6 <	0.3 <	0.4 <	0.3 <	**3.4 >**	**16.8 >**	1.3
Sulfate (mg/L)	**3100 >**	**3320 >**	**2560 >**	**2630 >**	**3800 >**	**4240 >**	2200
Chloride (mg/L)	**46 >**	**33 >**	18 <	30 >	**79 >**	**61 >**	24

Values are most recent laboratory analytical results for each well.
\> Result is greater than BSL
< Result is less than BSL
*Capture well

PROJECT SCOPE & OBJECTIVE: Investigation Capture Other

The objective of this Interim Response Action (IRA) is to investigate the extent of potential process water impacts north of the former Units 1&2 Stage One Evaporation Pond (SOEP) and the existing Stage Two Evaporation Pond (STEP). Specifically, this investigation will target potential flow paths identified via conservative particle tracking analyses conducted on a steady-state numerical modeling solution (Newfields, 2016).

SITE ASSESSMENT HISTORY *(List reports/summary of work done in general area in chronological order)*:

DATE	**INVESTIGATION/ REPORT**	**SCOPE**	**FINDINGS/RESULTS**
May 2012	*DRAFT Groundwater Model Expansion and Calibration Stage I and II Evaporation Ponds Area Colstrip Steam Electric Station, Colstrip, Montana.* AMEC Geomatrix	Development of numerical groundwater model of the STEP, expanded to include the SOEP.	Particle tracking was used to simulate flow paths from source beyond current capture network. Model recommendations included installation of two wells between existing wells 902D and 903D, one screened at first water and the second screened similar to 903D.
May 2012	*Work Plan -- Monitoring Well Installation West/Northwest of Stage I and II Evaporation Ponds 370D Area .* Hydrometrics, Inc.	Work Plan to install new wells north of STEP	Hydrogeologic/Hydrogeochemical analysis of existing monitoring well network was included and a Work Plan for installation of several new wells was presented.
November 2012	*Monitoring Well Installation and Groundwater Investigation West/Northwest of Stage I and Stage II Evaporation Ponds.* Hydrometrics, Inc.	Examination of current area conditions, monitoring well installation, well testing and sampling, and reporting to further delineate groundwater conditions north of the SOEP and STEP.	Wells 2022D through 2026D were installed, sampled, and tested to evaluate area north of STEP and SOEP, as identified in (AMEC Geomatrix, May 2012). Water from well 2024D was indicative of process water impacts. Based on the results of the investigation, it was recommended that additional wells be installed near wells 2024D and 2025D and that well 2024D be converted to a groundwater capture well.
September 2013	*Capture System Construction, Startup, and Preliminary Performance Evaluation of Well 2024D.* Hydrometrics, Inc.	Additional investigation north of STEP and conversion of well 2024D were documented.	Three new monitoring wells (2031D, 2032D, and 2033D) were installed north of the SOEP and STEP. Water quality analytical results of samples collected at each of the three new wells indicated that none of the new monitoring wells had groundwater that exhibited process pond water impacts. Monitoring well 2024D, which had previously been identified as having process water impacts, was converted to a capture well and began pumping
March 2016	*Stage I & II Evaporation Ponds Area Groundwater Conceptual Model and Expanded Numerical Model Colstrip Steam Electric Station, Colstrip, MT.* Newfields Companies, LLC	Development of numerical groundwater model of the STEP and SOEP.	Three-dimensional numerical modeling analysis and particle tracking were used to evaluate current capture system effectiveness. Data gaps north of SOEP and STEP were identified.

NEAREST DOMESTIC OR STOCK WELL(S) (indicate direction, distance, and completion zone):

No domestic or stock wells will be impacted by work proposed in this IRA Work Plan.

DISTANCE FROM PROPERTY BOUNDARY:

Work conducted under this Work Plan will take place on Talen property, 900 feet or more from the existing property boundaries in the SOEP and STEP Area. The proposed work is closest to the western property boundary.

PROPOSED ACTION:

The following four tasks are proposed in this Interim Response Action Work Plan.

- Task 1 – Monitoring Well Installation
- Task 2 – Pumping and/or Slug Testing
- Task 3 – Groundwater Quality Sampling and Analysis
- Task 4 – Capture Well Conversion
- Task 5 – Data Analysis and Reporting

MAPS/FIGURES:

Figure 1. Project Location Map
Figure 2. Project Area Map
Figure 3. Geologic Cross Sections A-A' and B-B'
Figure 4. Potentiometric Surface Map in Shallow and Sub-McKay Bedrock
Figure 5. Proposed New Capture Well and Monitoring Well Locations
Figure 6. Typical Monitoring Well Construction Diagram
Figure 7. Typical Capture Well Construction Diagram

SCHEDULE:

A timeline to complete the scope of work outlined above will be scheduled upon notice to proceed (NTP). Work described in this plan will begin within 60 days of NTP, weather and field conditions permitting. Monitoring well installation and groundwater quality sampling are expected to be completed within 90 days of initiating drilling, weather permitting. The final report for this IRA will be submitted within 60 days of final analysis of sampling and testing results.

REFERENCE:

AMEC Geomatrix. (May 2012). *DRAFT Groundwater Model Expansion and Calibration Stage I and II Evaporation Ponds Area Colstrip Steam Electric Station, Colstrip, Montana.*

Hydrometrics, Inc. (May 2012). *Work Plan -- Monitoring Well Installation West/Northwest of Stage I and II Evaporation Ponds 370D Area .*

Hydrometrics, Inc. (November 2012). *Monitoring Well Installation and Groundwater Investigation West/Northwest of Stage I and Stage II Evaporation Ponds.*

Hydrometrics, Inc. (September 2013). *Capture System Construction, Startup, and Preliminary Performance Evaluation of Well 2024D .*

Neptune. (January 2016). *Final Report on Updated Background Screening Levels Plant Site, 1&2 SOEP and STEP, and 3&4 EHP Colstrip Steam Electric Power Station Colstrip, Montana.*

Newfields Companies, LLC. (March 2016). *Stage I & II Evaporation Ponds Area Groundwater Conceptual Model and Expanded Numerical Model Colstrip Steam Electric Station, Colstrip, MT.*

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EXECUTIVE SUMMARY

This Work Plan was prepared as an Interim Response Action (IRA) 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 Talen Montana, LLC (Talen) as Operator of the Colstrip Steam Electric Station and the Montana Department of Environmental Quality.

Talen maintains effluent holding ponds and evaporation ponds for disposal of fly ash scrubber slurry from four electrical power generation units at the Colstrip Steam Electric Station (Colstrip SES). Concurrent with pond operations, Talen maintains an extensive monitoring and capture well network to detect and mitigate impacts on local groundwater that are attributable to seepage from the ponds. The objective of this IRA is to investigate the extent of potential process water impacts north of the Units 1&2 Stage One Evaporation Pond (SOEP) and Stage Two Evaporation Pond (STEP) and to enhance capture of local groundwater impacted by process water at well 2033D.

The project area included in this IRA, north of the SOEP and STEP, has been the subject of considerable recent evaluation based on potential data gaps implied through numerical groundwater quality modeling by AMEC Geomatrix (2012). Eight new monitoring wells (2022D, 2023D, 2024D, 2025D, 2026D, 2031D, 2032D, and 2033D) were installed and sampled for groundwater quality in two phases of investigation in 2012 and 2013 (Hydrometrics, Inc.). These wells and existing wells north of the process ponds are generally completed in one of two sandstone bedrock intervals. The basal elevation of the upper interval is roughly 3200 feet; while the basal elevation of the lower interval is about 3120 feet. Water quality in both intervals is highly variable; but each interval has some new and existing wells that exhibit groundwater quality that is impacted by process water. Well 2024D was the only well completed during the 2012 and 2013 investigations that was impacted by process water. Well 2024D was converted to a capture well in 2013. Due to a well obstruction, it was replaced by 2024D-2 in 2014. Initial samples collected at well 2033D suggested that groundwater quality at the well was not impacted by process water; however, values of process water indicator parameters have increased in recent samples. For this reason, well 2033D is recommended for conversion to a capture well under this IRA. Further, additional evaluation of groundwater in this area, primarily in the hydrostratigraphic interval consistent with 2024D and 2033D, is proposed.

Specific tasks proposed in this IRA Work Plan include: monitoring well installation, aquifer testing, groundwater quality sampling and analysis, capture well conversion, and reporting. Five new monitoring wells will be installed north of the SOEP and STEP areas. Three of the monitoring wells will be completed in the same groundwater horizon as impacted wells 2024D (2024D-2) and 2033D. Two additional wells will be installed in first water-bearing bedrock northwest of the SOEP or STEP. Pumping tests and/or slug tests will be conducted and groundwater quality samples will be collected from each new well and analyzed for a suite of parameters selected to assess process water impacts.

A report of well installation procedures and observations and groundwater quality analysis will be issued at the completion of this Work Plan.

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Introduction

This Work Plan was prepared as an Interim Response Action (IRA) 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 Talen Montana, LLC as Operator of the Colstrip Steam Electric Station and Montana Department of Environmental Quality (MDEQ). 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.

Talen Montana, LLC (Talen) monitors groundwater in the area surrounding the Units 1 & 2 Stage Two Evaporation Pond (STEP) and the reclaimed Units 1&2 Stage One Evaporation Pond (SOEP) at the Colstrip Steam Electric Station (Colstrip –SES) to detect inconsistencies in water quality and/or quantity that may be attributable to seepage from the ponds. Process water indicator parameters that include specific conductance (SC), sulfate, boron, and chloride are used to evaluate the potential presence of pond seepage in local groundwater. Statistical Baseline Screening Levels (BSLs) were developed for each of these and many more analytes, as a tool for comparison of groundwater analytical results to the expected upper limit of background concentrations (Neptune, 2016). BSLs are used with other lines of evidence, such as changes in water levels and long-term water quality trends, to assess the potential for process water influences. As monitoring data become indicative of potential process water impacts, Talen installs groundwater capture systems or converts monitoring wells to pumping wells to mitigate the influence of the Units 1&2 STEP and reclaimed SOEP on local groundwater.

This Work Plan is focused on investigating groundwater north of the STEP and SOEP. A map of the general project location is included as Figure 1. A map of the existing well network and features specific to the project area is included as Figure 2. A review of previous investigations is included in this IRA Work Plan to document work conducted in the project area to date and to provide justification for the proposed actions. A working understanding of site hydrogeology is presented and data gaps that will be filled by the current Work Plan are identified herein. The Scope of Work, consisting of five tasks is outlined in this document. Figures are used to provide clarification of key concepts presented in the Work Plan and are compiled in a single section following the body of the Work Plan. References to previous work are listed in chronological order at the end of the document.

Hydrogeology of the Project Area

Hydrogeology of the area north of the STEP and SOEP has been characterized through installation and testing of the well network shown in Figure 2. Geologic cross sections are presented in Figure 3. A potentiometric surface map of sub-McKay bedrock in the STEP and SOEP areas, based on May 2016 water level elevations, is presented in Figure 4.

In general, the stratigraphy of the area north of the SOEP and STEP consists of the following sequence from the ground surface downward.

- Colluvium – Unconsolidated sediments are present intermittently in the project area from ground surface to minimal depths, typically over low-lying portions of the project area. Examples of the presence of colluvium are found at wells 2033D and 2023D, where loose sand and silt, derived from bedrock of the Tongue River Member of the Fort Union Formation, are found from the ground surface to six or seven feet below ground surface.
- Clinker – Thermally altered and collapsed overburden (sandstone, siltstone, shale, etc.) formed by the in situ burning of the Rosebud coal is present on isolated hilltops of the project area. Clinker is less abundant north of the SOEP and STEP than it is south of the process ponds, as much of the area north of the ponds is outside of the Rosebud and McKay coal crop/burn lines.
- Sub-McKay Bedrock – Bedrock in the project area is of the Tongue River Member of the Fort Union Formation and consists of siltstone, shale, and/or sandstone. Lateral continuity of individual beds is variable and often minimal. The majority of the water-bearing units in this formation are sandstone; and the direction of groundwater flow in

sub-McKay bedrock is from southwest to northeast.

The occurrence and quality of bedrock groundwater in the project area is variable; but groundwater is generally found in one of two shallow sub-McKay bedrock intervals. The basal elevation of the shallowest water-bearing sandstone ranges in elevation from approximately 3200 to 3250 feet and tends to vary with surface topography. The basal elevation of the deeper water-bearing interval ranges from approximately 3120 to 3180 feet, locally. Additional discussion of groundwater quality, bedrock hydrogeologic properties, and groundwater flow patterns are discussed in regard to previous evaluation of the project area in the section to follow.

Previous Investigation and Recommendations

The SOEP was originally designed to store 10 years of fly ash (Bechtel, May 1976). However, the pond was operated from 1975 to 1997. During its operation, scrubber slurry was pumped from the Units 1 & 2 A/B Pond on the Plant Site through a rubber-lined steel pipeline to the SOEP. Fly ash settled in the SOEP and the decanted water was periodically pumped back to the Plant Site for re-use. After closure of the SOEP, a soil cap was constructed over the pond area to support a vegetative cover over the former pond. Ultimately, the soil cap was designed to reduce infiltration of moisture into the underlying ash and subsequent percolation to the local groundwater system.

The STEP Clearwell, A Cell, and E Cell were lined with High Density Polyethylene (HDPE) during construction. Each of these cells has operated since 1992. B Cell was constructed in 2006 with a leachate collection system between and underneath dual Reinforced Polypropylene (RPP) liners. The upper and lower liners are 45-mil and 36-mil RPP, respectively. Most recently, D Cell was installed in 2011 with a liner system similar to that of B Cell. Process water contained in the ponds typically has high levels of dissolved constituents that may influence local groundwater quality if co-mingled; thus, liners are designed to minimize seepage of pond water.

As noted previously, Talen monitors groundwater in the area surrounding the STEP and the reclaimed SOEP to detect inconsistencies in water quality and/or quantity that may be attributable to seepage from the ponds. A potential data gap in the monitoring well network north of the STEP, between wells 902D and 903D was identified through numerical modeling analyses conducted by AMEC Geomatrix (May 2012). As a result, additional analyses of existing hydrogeologic data were conducted by Hydrometrics, Inc. (May 2012) in preparation of a Work Plan to install and evaluate groundwater monitoring wells north of the STEP and SOEP. The evaluation focused on two sub-McKay groundwater-bearing intervals, comprised primarily of sandstone bedrock, that are present in the shallow subsurface of the project area.

Two phases of field investigation were conducted, in which additional new monitoring wells in both hydrostratigraphic intervals were installed, sampled, and subjected to aquifer testing. Wells 2022D, 2023D, 2024D, 2025D, and 2026D were installed and tested in 2012 (Hydrometrics, Inc., November 2012). Wells 2031D, 2032D, and 2033D were installed and tested in 2013 (Hydrometrics, Inc., September 2013). Key observations made during installation and through subsequent evaluation of these wells are as follows.

- 2022D – This well targeted groundwater in the shallow sandstone, known to exist at an elevation of 3200 to 3250 feet, north of STEP B Cell. The actual basal elevation of the sandstone encountered in this borehole is 3215.6 feet. Cuttings from the sandstone interval in the 2022D borehole were dry to very moist during drilling but no free water was apparent. The well was completed in the dry hole to monitor for the presence and quality of groundwater. A water column of nearly 12 feet was observed in the well one day after completion. The hydraulic conductivity (K) of the sandstone at this low yield well was estimated to be approximately 0.12 ft/day (Transmissivity (T) = 1.44 ft^2/day), based on slug test analysis. Results of ongoing groundwater quality sampling at well 2022D indicate that concentrations of some process water indicator parameters exceed BSLs; but the overall character of groundwater at the well is not suggestive of process water impacts. Most notably, boron concentrations have remained at 0.34 mg/L or less since 2022D was installed.
- 2023D – First groundwater was targeted at the 2023D drilling location to monitor for potential process water influences. Water-bearing bedrock was encountered at an elevation that corresponds with the sandstone interval found in well 2022D. Groundwater yield was estimated during development to be around 2 gpm; and the subsequent K and T were approximately eight to ten times higher at 2023D than at

2022D (K = 0.8 ft/day, T = 14 ft/day). Despite the increased presence of groundwater and apparently greater T of the sandstone at 2023D, groundwater quality at this well is similar to that at 2022D. Boron at the well has remained at 0.4 mg/L or less throughout the life of the well.

- 2024D/2024D-2 – This well also targeted first groundwater; which was not found in the upper sandstone but in a deeper sandstone interval with a basal elevation of approximately 3,160 feet. Relative to other shallow bedrock wells, new and existing, in the area north of the STEP, well 2024D had a much higher yield (estimated at 10 gpm) and a groundwater quality signature that was indicative of process water impacts. Initial sample results at well 2024D were: SC = 6,090 μmhos/cm, boron = 16.2 mg/L, sulfate = 4,370 mg/L, and chloride = 48 mg/L. Well 2024D was converted to a groundwater capture well in June 2013. The submersible pump at 2024D became stuck, causing a permanent obstruction in the well. Well 2024D was plugged, abandoned, and immediately replaced by well 2024D-2 in July 2014. The most recent analysis at 2024D-2 are consistent with the initial results at 2024D: SC = 6,170 μmhos/cm, boron = 16.8 mg/L, sulfate = 4,240 mg/L, and chloride = 61 mg/L. Despite unchanging water quality, 2024D-2 (and previously 2024D) has proven to be an effective capture location.
- 2025D – The chosen location of well 2025D was the farthest west of all new wells. The well at this location targeted shallow groundwater on a flow path downgradient of the reclaimed Stage One Pond. The borehole was advanced to about 105 feet below ground; and a well was completed in a sandstone interval with a basal elevation of 3185 feet. Local groundwater at well 2025D has not exhibited any process water influences.
- 2026D – Well 2026D is completed in a sandstone bedrock unit consistent with that found at well 2025D. The ground surface elevation at 2026D is nearly 20 feet higher than at 2025D; so greater drilling depths were required to reach the water-bearing bedrock. Like 2025D, groundwater at well 2026D has not exhibited any process water influences.
- 2031D – This well is paired with existing well 2025D and targeted near surface groundwater that was observed while drilling at 2025D (Hydrometrics, Inc., November 2012). Well 2031D was advanced to a total depth of 45 ft-bgs and completed in sandstone bedrock. Well yield was estimated to be 1 gpm during development. As evidenced by recent groundwater quality results, well 2031D does not exhibit process

water impacts. In August 2015, SC at the well was 2,900 μmhos/cm and sulfate was 1,340 mg/L. Chloride concentrations have ranged from 15 to 25 mg/L in the same time period. Boron has been consistently low at 2031D, ranging from 0.3 m/L to 0.53 mg/L.

- 2032D – Thermally altered bedrock, or clinker, was encountered in the top 44 feet below ground surface (ft-bgs). The borehole was advanced beyond the clinker to a total depth of 134 ft-bgs. Saturated sandstone bedrock was encountered from 120 to 131 ft-bgs; and well 2032D was completed at total depth. The elevation of the bottom of the well is approximately 3208 feet, suggesting that this well is completed in the shallower of the two prominent sandstone intervals in the project area. Since the completion of well 2032D, values of chloride and sulfate have consistently been greater than BSLs; but values of SC and boron have consistently been less than BSLs. Overall, the ambiguous water quality at 2032D is not indicative of process water impacts.
- 2033D – Well 2033D was drilled to a total depth of 160 ft-bgs and was completed in sandstone bedrock consistent with lithology at well 2024D. Based on observations made during drilling and development, well 2033D was estimated to be a very high yielding well (up to 20 gpm). Groundwater quality at well 2033D has consistently been of better quality than that at well 2024D (or 2024D-2); however, SC, sulfate, and chloride levels have been above BSLs at 2033D since it was installed. Boron concentrations were routinely less than one mg/L but have risen to 2.5 mg/L and 3.4 mg/L in the two most recent successive groundwater quality samples at 2033D. These samples were collected in September 2015 and March 2016. Note that SC, sulfate, and chloride concentrations also increased in the latest two samples. Increases in process water indicator parameters may be attributable to changes in flow direction induced by nearby pumping well 2024D-2. This suggests that a source of impacted water is present laterally, possibly east of well 2033D.

Groundwater flow in the area north of the SOEP/STEP was further evaluated in a recent update to the numerical model that included simulated groundwater capture at well 2024D. The model domain encompassed the entire SOEP and STEP area but several conclusions were made regarding the current project area north of the ponds (Newfields, 2016):

- “Capture analysis indicates particles within an area where groundwater exceeds BSLs for indicator parameters in the northwest portion of the SOEP area are partially captured by wells 2024D, EAP-205, 375D, and 376D. According to the model, some uncaptured particles in this area travel north toward monitoring wells 354D, 2025D, 2026D, and 2031D. However, groundwater samples from these wells do not currently exceed BSLs for indicator parameters.”
- “Capture analysis indicates particles within an area where groundwater exceeds BSLs for indicator parameters immediately north of STEP Cell A and Cell B near wells 2022D and 2023D are not captured. Model simulations sugget that particles originating near 2022D travel north toward wells 398D, 399D, and 901D, and particles originating near 2023D travel north toward 2009D. Groundwater samples from wells 398D, 399D, 901D have not exceeded BSLs, and samples from well 2009D slightly exceed the BSL for sulfate but not BSLs for dissolved boron, chloride or SC. However, there are no indications of impacts from process water at this location, as sulfate levels have shown a slight decline while all other indicators are stable.”
- “Groundwater that exceeds BSLs in areas north of the SOEP and STEP appears to be moving very slowly due to relatively low permeability (with the exception of near well 2024D). This results in low yield wells and is a major reason for lack of complete capture in this area.”

The particle tracking analysis applied in the model is a very conservative tool for assessing capture system effectiveness, as particles are not only input at source areas but also in all areas with BSL exceedances. As discussed previously, not all wells with a BSL exceedance for a single parameter, or even multiple parameters, have process water impacts. As such, many of the conclusions derived from the modeling analyses are bolstered by the presence of physical data that suggest groundwater quality impacts are not present at particle ending locations downgradient of existing capture wells.

Tracking analyses were also conducted on particles originating in source areas (Newfields, 2016). Source area particle tracking analyses were consistent in flow direction but much less expansive than the more conservative BSL exceedance particles; however, an additional potential gap in the existing well network in both the upper and lower hydrostratigraphic intervals west/southwest of well 2023D was identified through review of the source area particle tracks.

Recommendations for a single new capture well conversion and five additional monitoring wells are made based on review of results of previous investigation and/or interpretation of numerical groundwater modeling analysis. The locations of the recommended wells are shown in Figure 5. Justification for the new capture and monitoring wells is as follows.

1. Monitoring well 2033D should be converted to a groundwater capture well. This recommendation is simultaneously congruent with but alternative to the recommendation of Newfields (2016) to convert well 903D. Well 2033D is a favorable alternative because it is closer to the source (SOEP/STEP), has a higher well yield, and exhibits groundwater quality with apparent process water impacts. While 903D has levels of individual process water indicator parameters that are greater than BSLs, the overall water quality is not suggestive of process water impacts. Pumping at 2033D will expand the capture radius laterally, perpendicular to the direction of flow. This is advantageous to capture at 903D which is already nearly directly downgradient of existing capture at 2024D.
2. A new monitoring well should be installed between existing wells 367D and 369D. This well will be used to evaluate groundwater quality and quantity along a potential flow path from the northwest corner of the reclaimed SOEP toward well 2025D in the north. This recommendation is supported by the conclusion of Newfields (2016) that particles in the numerical model may be travelling north toward 2025D. Also, this proposed well location is located along the prevailing direction of groundwater flow interpreted from the potentiometric map of physical water level elevations. This proposed well is labeled as D1 on Figure 5.
3. A new monitoring well targeting the deeper bedrock hydrostratigraphic interval is recommended at a location paired with existing well 2032D (D 2 on Figure 5). This well will be used to evaluate the western extent of process water impacts in the horizon consistent with 2024D-2. Recall that 2032D is completed in the upper groundwater horizon.
4. New well D3 (Figure 5) is recommended to evaluate the downgradient extent of impacts in the deeper horizon. This recommendation is consistent with that of Newfields (2016). As groundwater at well 903D is ambiguous with respect to process water impacts, impacted groundwater is not anticipated at this proposed well. However, this location will be used for long-term monitoring to identify any impacted groundwater migrating beyond existing well 2024D-2 and proposed capture well 2033D.

5. Paired wells are proposed at location D4 (Figure 5) based on the ending locations of source area particles in model layers representative of the two primary bedrock hydrostratigraphic intervals in the project area. This recommended location is near well 2023D. The existing well is completed in the shallower horizon and may be outside of the flow path of process water. The bottom elevation of well 2023D is 3206 feet; and the shallower well at D4 will target saturated bedrock with a similar basal elevation. The deeper well at D4 will target groundwater in sandstone with a basal elevation below 3180 feet.

Each of these recommendations is addressed in the Scope of Work to follow.

<u>Scope of Work</u>

The Scope of Work proposed for this IRA includes the following four tasks:

- Task 1 –Borehole Drilling and Well Installation;
    - Five borings will be advanced and monitoring wells will be installed at the locations shown in Figure 5 to evaluate local groundwater quantity and quality.
        - New monitoring well number D1 will be installed in first groundwater encountered in the boring. It is anticipated that first groundwater will be present in the upper sandstone bedrock (above an elevation of 3200 feet) at this location.
        - New monitoring wells at locations D2 through D3 will be in the bedrock groundwater horizon that ranges in basal elevation from about 3120 feet to 3180 feet.
        - A pair new monitoring wells, one in each of the two shallow bedrock hydrostratigraphic intervals, is planned at location D4.
- Task 2 – Pumping and/or Slug Testing;
    - A pumping test or slug test will be performed on each of the four new wells to define the local hydraulic parameters.
- Task 3 – Groundwater Quality Sampling;
    - Water quality samples will be collected from the new wells and analyzed for Talen’s typical parameter list.
- Task 4 – Capture Well Conversion; and

    - Monitoring well 2033D will be converted to a capture well using Talen's typical procedure.
    - Pumping rates, water levels, and field SC will be monitored at the capture well, upon startup, to provide a preliminary evaluation of capture system effectiveness.
- Task 5 – Data Analysis and Reporting.
    - Results of well installation, groundwater quality analyses, pumping test solutions, and groundwater collection volumes will be summarized a final report.

Methodologies of each of the three tasks listed above are detailed herein.

Task 1 –Monitoring Well Installation

Monitoring wells will be drilled and installed at the locations shown on Figure 5. Boreholes will be advanced using air-rotary methods to the targeted water-bearing bedrock interval and up to three feet into the lower confining siltstone. If necessary, steel casing will be advanced using drill and drive methods to help maintain circulation in any clinker and/or colluvium encountered in the upper borehole. Once the base of the targeted water-bearing interval is reached, the steel casing will be pulled back to evaluate groundwater conditions in the open borehole. If groundwater is present, the open borehole will be stimulated with compressed air from the drilling rig. An open hole yield estimate will be made and field SC of water from the borehole will be measured.

If no groundwater is present in the targeted interval of a given boring, said borehole will be advanced up to 200 feet below ground surface in search of water-bearing bedrock. If first groundwater is encountered at a depth below the targeted interval open hole estimates of yield and SC will be made and the borehole will be plugged with cuttings and bentonite chips. If no groundwater is encountered at a depth of 200 feet in a given borehole, it will be plugged with cuttings and bentonite chips.

Once total depth and the completion interval are identified, the wells will be constructed as follows.

- Four-and-one–half-inch schedule 40 bell and collar PVC casing with 0.025-inch slotted pipe will be placed in the targeted water-bearing interval. The bottom of the well will be capped with a solvent welded PVC cap. Note that wells with groundwater having a measured SC of over 5000 μmhos/cm will be slightly over drilled (~3 feet) into the next underlying strata to accommodate a pump at a later time, if necessary.
- Solid four-and-one-half-inch schedule 40 bell and collar PVC casing will be installed in the upper portion of the borehole.
- A filter pack, consisting of 10-20 silica sand, will be placed across the entire length of the screened interval. The filter pack will extend a minimum of two feet above the perforations.
- Bentonite chips will be used to create an annular seal from the top of the silica sand to ground surface.
- Steel casing, if used, will be pulled back to expose the slotted section of PVC. A minimum of three feet of eight-inch steel surface casing will be left in each completed borehole and approximately two feet of steel will extend above ground.
- In addition to the bentonite seal, a concrete pad will be poured around the eight-inch steel surface casing.
- A locking steel lid will be installed at each wellhead.

Typical monitoring well construction is illustrated in Figure 6. Cuttings from the borings 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 for each well and will be submitted to Talen and the Montana Board of Water Well Contractors.

The monitoring wells 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 sufficient fines have been removed from the well to allow pumping using a submersible pump. Bailing involves repeatedly removing water from the well with a steel bailer (with check valve) until the well has been adequately purged. Field parameters (SC, pH, temperature) will be measured and recorded during development.

Task 2 – Aquifer Testing

A pumping test and/or slug test will be conducted at each new well. A pumping test will be conducted if preliminary observations made during development indicate sustainable yield from the well in excess of two gallons per minute. If applicable, each pumping test 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.

Slug tests will be conducted at the new wells if insufficient groundwater is present for pump testing. The slug test will be conducted by displacing water from the well casing using a "slug" and measuring groundwater recovery following slug injection and withdrawal. Water levels will be measured in the well using submersible electronic pressure transducers and/or electronic water level probes.

Pump test and/or slug test data will be entered into Aqtesolv® computer program for analysis. At a minimum, test results will be used to estimate hydraulic conductivity and transmissivity of targeted formations. Water levels will also be observed at nearby monitoring wells, if present. A storativity will be calculated if measureable drawdown is recorded in the observation wells.

Task 3 – Groundwater Quality Sampling

Groundwater quality will be evaluated at each new monitoring well using methods consistent with those commonly used by Talen for operational monitoring. 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. Monitoring Well Analytical Parameters

- **Physical properties**
  - pH, s.u. (lab & field)
  - Specific Conductance (umhos/cm) (lab & field)
  - Total Dissolved Solids measured at 180ºC
- **Common Ions**
  - Alkalinity, Total as $CaCO_3$, mg/L
  - Bicarbonate as HCO_3, mg/L
  - Carbonate as CO_3 , mg/L
  - Chloride (Cl), mg/L
  - Sulfate (SO4), mg/L
  - Bromide (Br), mg/L
- **Dissolved Metals**
  - Boron (B), mg/L
  - Selenium (Se), mg/L
  - Mercury (Hg), mg/L
  - Magnesium (Mg), mg/L
  - Calcium (Ca), mg/L
  - Potassium (K), mg/L
  - Sodium (Na), mg/L

Groundwater quality samples will be collected using either a submersible sampling pump or a disposable bailer; and three well casing volumes will be removed from each well prior to sample collection. Where applicable, samples may be collected during the pumping test at a given well, provided that three well casing volumes have been purged during testing.

Task 4 – Capture Well Conversion

Monitoring well 2033D will be converted to a groundwater capture well using Talen's Typical capture well conversion procedure. Typical capture well construction is shown in Figure 7 and is outlined in general, as follows.

- The area around the wellhead will be excavated to an approximate depth of five to six feet with a backhoe or track excavator.
- The excavation will be of sufficient width to place a six-foot diameter Corrugated Metal Pipe (CMP) over the existing wellhead.
- The CMP will be inserted in the excavation to a depth of approximately five feet and the CMP will extend above grade by about one foot. Additional earthen materials will be

mounded around the CMP to promote drainage away from the capture well and insulate the manhole.

- Washed gravel will be placed in the bottom of the CMP at an approximate thickness of six inches.
- Existing PVC well casing will be cut off so that it extends just above the washed gravel in the bottom of the CMP vault.
- A metal lid with a stainless steel piano hinge will be installed at the top of the CMP. A hinged access port with dimensions of one foot by two feet will be installed in the CMP lid directly above the monitoring well.
- An aluminum ladder will be secured to the inside of the CMP for access/egress into and out of the culvert.
- A submersible pump will be specified based on static water level observations in the well and will be installed in the well at total depth.
- The submersible pump will be hung by one-inch schedule 80 PVC threaded drop pipe with brass couplings.
- Drop pipe will extend from each well to a one-inch brass pipeline on the floor of the CMP vault.
- Necessary pipe fittings (i.e. one-inch unions, tees, valves, and sample port) will be plumbed into the one-inch line in the bottom of the vault.
- Redundant check valves will be installed both immediately above the pump and inside the vault to prevent backflow to the well.
- The one-inch brass pipeline will be transitioned to HDPE via a one-inch HDPE x MIP transition.
- A stilling well, constructed of one inch Class 200 PVC, will be installed in the well and will extend from near the top of the submersible pump to the top of the CMP.
- Heat trace will be installed in the well to protect the pipelines in the CMP from freezing.

- Electrical controls, an hour meter, and automated pump protection that is compatible with a Franklin pump motor (Franklin Pumptec) will be installed in an electrical enclosure adjacent to the wellhead.
- Direct bury electrical wire will be routed in an electric utility trench from an existing source to the new well.
- A buried discharge pipeline will be routed from the wellhead to the existing capture system pipeline that services well 2024D-2.

An ongoing evaluation of the quantity and quality of water captured at the new well will be conducted as pumping commences. Water quality will be assessed via field SC measurements made from the sample port within the CMP. Pumping rates will also be measured at the wellhead and paired with pump run times to estimate total capture volumes. At a minimum, these measurements are made twice monthly at capture wells. More frequent measurements will be made during the initial startup period to evaluate preliminary capture system effectiveness. The actual frequency of measurements will be determined based on the well's response to pumping and the duration of time it takes for pumping water levels to reach quasi-equilibrium.

<u>Task 5 – Data Analysis and Reporting</u>

A Final Report, including a narrative of borehole advancement and monitoring well installation, aquifer testing results, groundwater quality sampling and analysis, and capture system startup and performance will be written for submittal to MDEQ. 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 report will be submitted within 60 days of completing this IRA. This IRA will be deemed complete when all groundwater quality samples and aquifer tests have been analyzed, capture system startup has been thoroughly assessed, and appropriate conclusions and recommendations have been made.

Figures

Figure 1. Project Location Map
I:\Land Projects\TALEN\127916\IRA North of Stage II – Figures\ 127916B003-FIG 1.pdf

Figure 2. Project Area Map
I:\Land Projects\TALEN\127916\IRA North of Stage II – Figures\ 127916B003-FIG 2.pdf

Figure 3. Geologic Cross Sections A-A’ and B-B’
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Figure 4. Potentiometric Surface Map in Shallow and Sub-McKay Bedrock
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Figure 5. Proposed New Capture Well and Monitoring Well Locations
I:\Land Projects\TALEN\127916\IRA North of Stage II – Figures\ 127916B003-FIG 5.pdf

Figure 6. Typical Monitoring Well Construction Diagram
I:\Land Projects\TALEN\127916\IRA North of Stage II – Figures\ 127916B003-FIG 6.pdf

Figure 7. Typical Capture Well Construction Diagram
I:\Land Projects\TALEN\127916\IRA North of Stage II – Figures\ 127916B003-FIG 7.pdf

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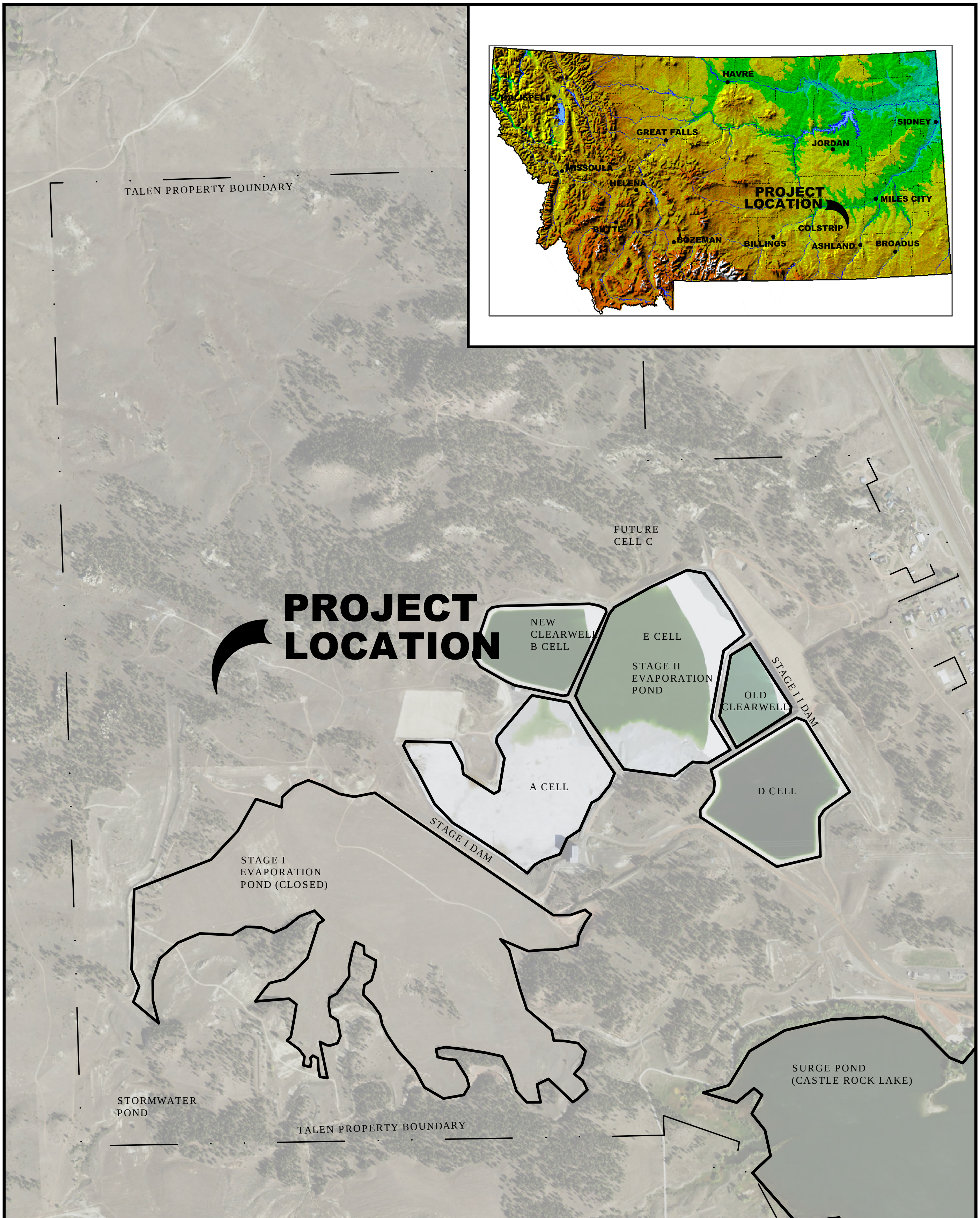
INTERIM RESPONSE ACTION
WORK PLAN
GROUNDWATER INVESTIGATION
NORTH OF THE UNITS 1&2 STAGE TWO EVAPORATION POND
TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION

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.

Kordell Stephenson   Compliance Professional   7/20/16
Name   Title   Date



INTERIM RESPONSE ACTION WORK PLAN GROUNDWATER INVESTIGATION NORTH OF THE UNITS 1&2 STAGE TWO EVAPORATION POND TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION	**PROJECT LOCATION MAP**	FIGURE **1**

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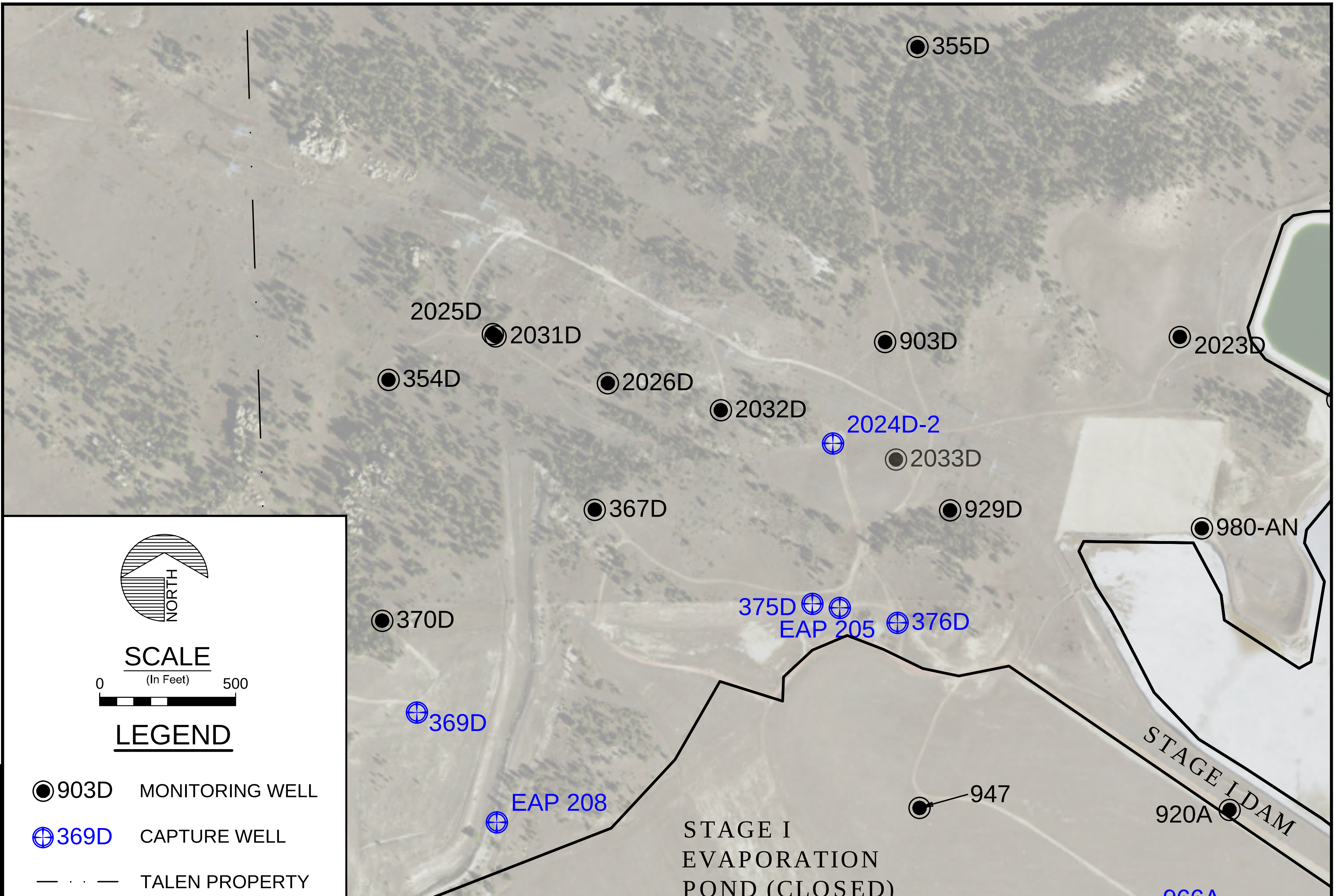

INTERIM RESPONSE ACTION WORK PLAN
GROUNDWATER INVESTIGATION
NORTH OF THE UNITS 1&2 STAGE TWO EVAPORATION POND
TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION

PROJECT AREA MAP

FIGURE 2

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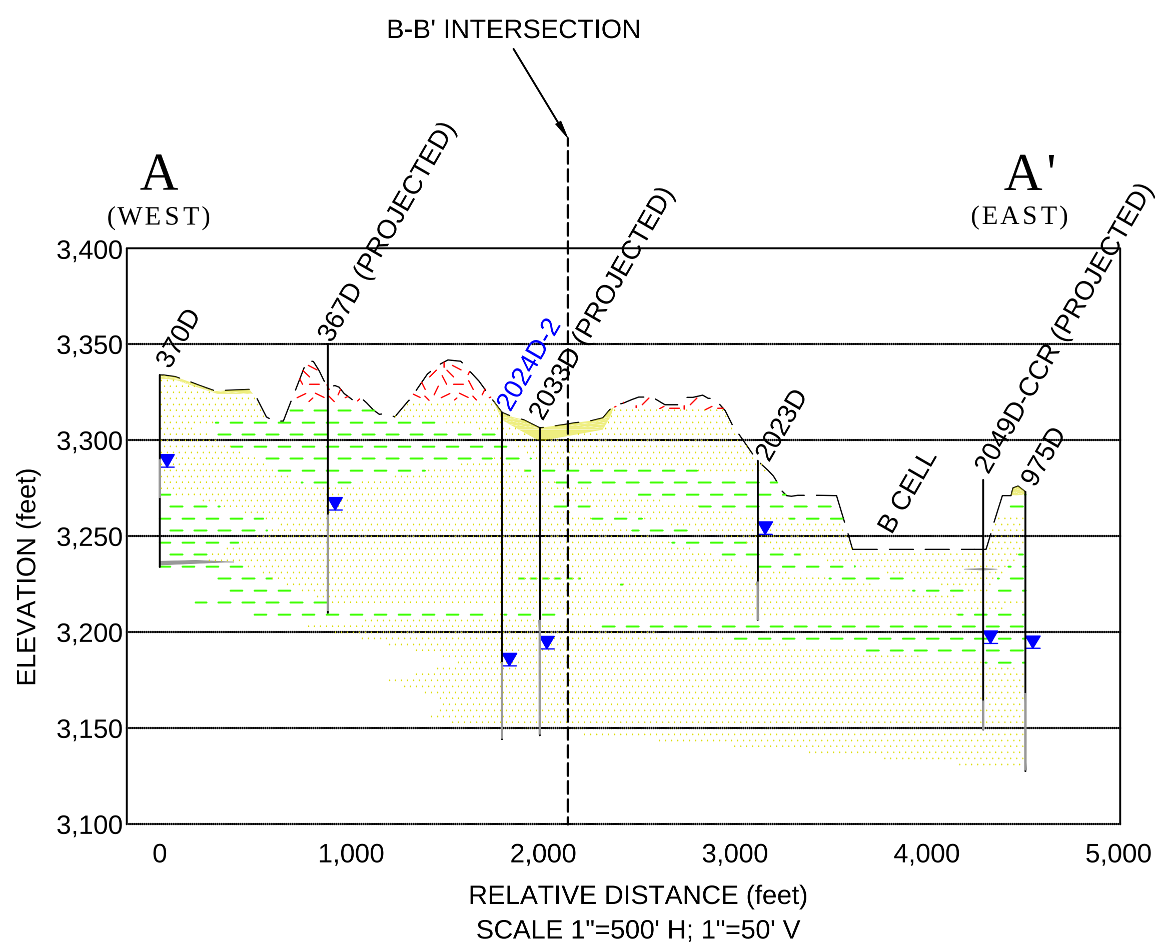

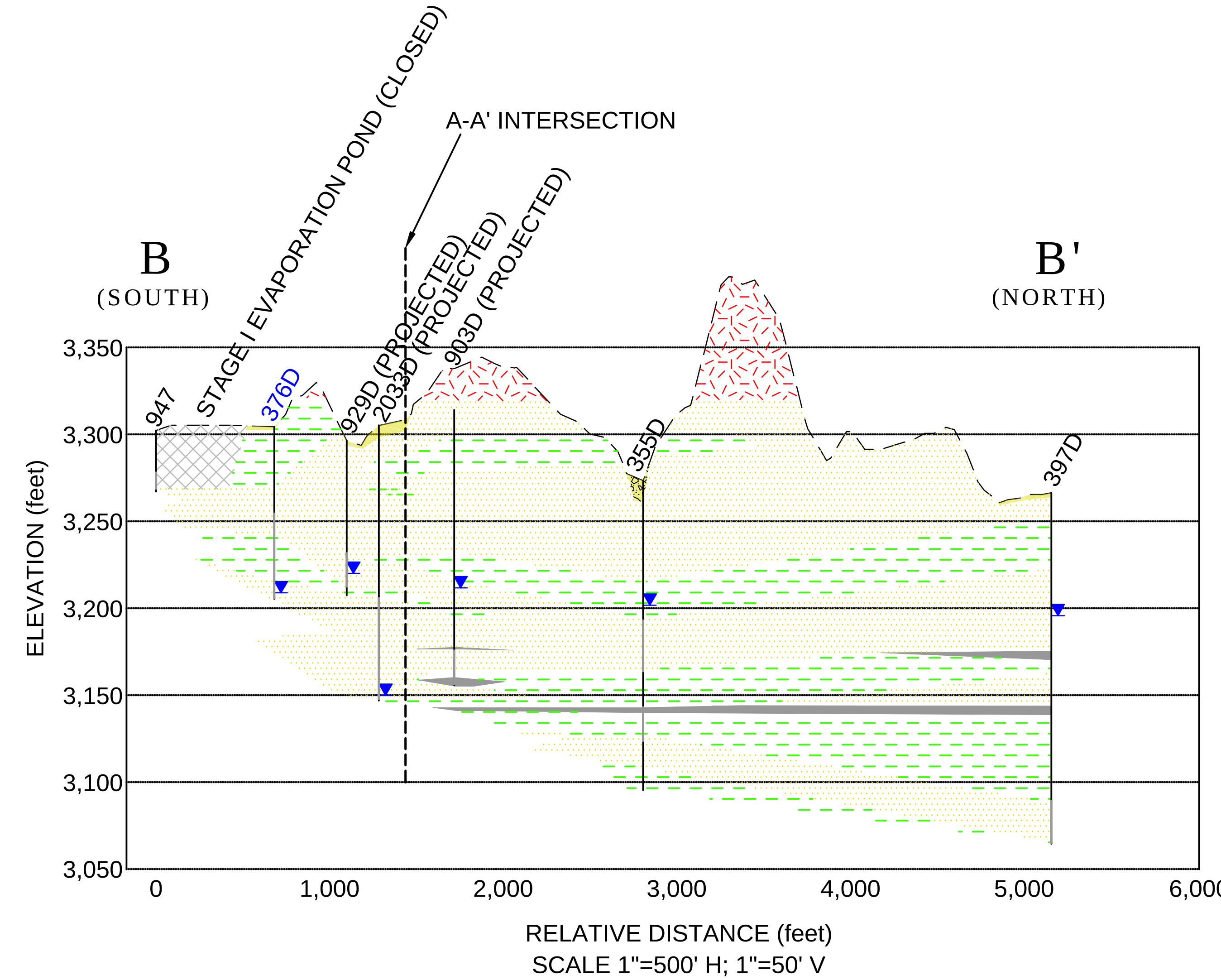

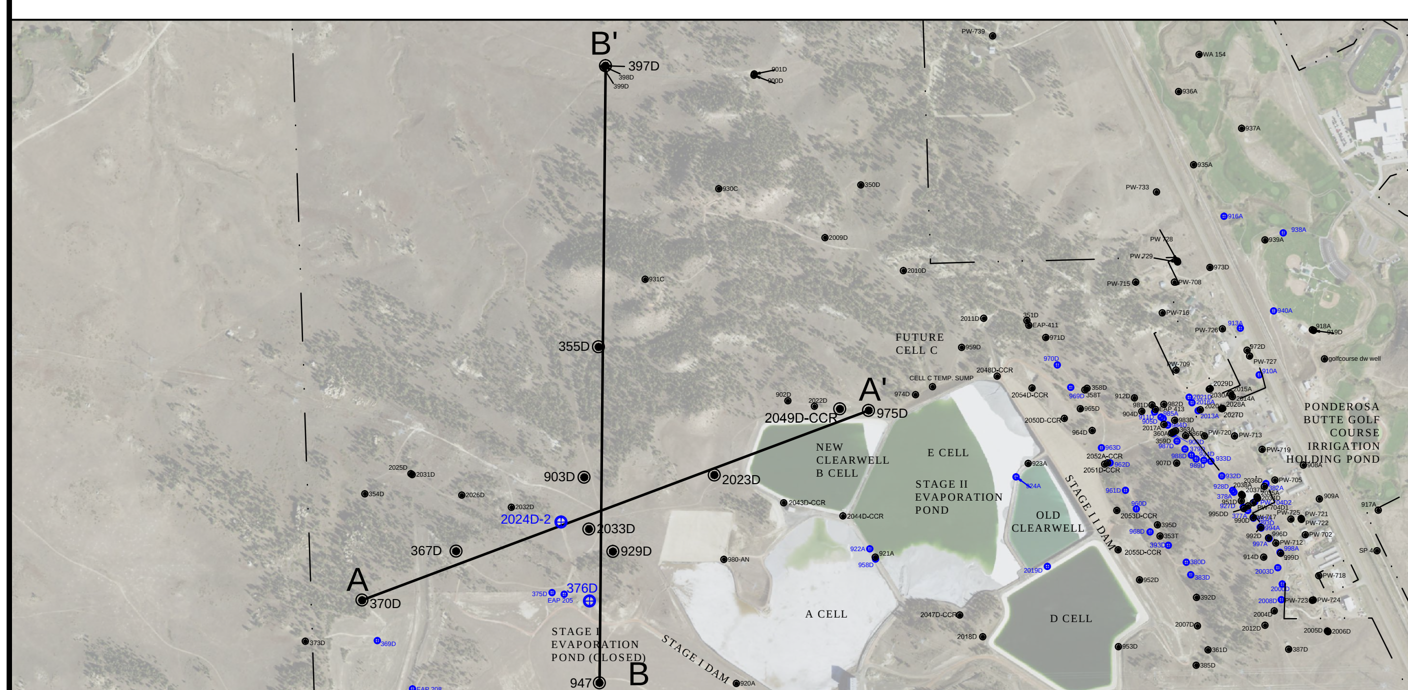

NORTH

SCALE
(In Feet)
800 0 800 1600 2400
(Approximate Only)

903D MONITORING WELL
369D CAPTURE WELL
UNITS 1 & 2 STAGE 1 & 2 EVAPORATION POND AREA BOUNDARY
CROSS SECTION LINE

LEGEND

- CLINKER
- FLYASH
- COLLUVIUM
- ALLUVIUM- MIXTURE OF GRAVEL, SAND, SILT, AND CLAY
- SANDSTONE
- SHALE/SILTSTONE
- COAL

376D — CAPTURE WELL DESIGNATION
947 — MONITORING WELL DESIGNATION
WELLBORE
SWL (SPRING 2016)
SCREENED INTERVAL
TOTAL DEPTH OF HOLE

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana 59106
5602 Hesper Road
(406) 656-1172

TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION ADMINISTRATIVE ORDER ON CONSENT UNITS 1&2 STAGE I AND II EVAPORATION POND SITE REPORT

GEOLOGIC CROSS SECTION A-A' AND B-B'

DRAWING FILE NUMBER
127916B004
AUTOCAD 2000 DRAWING (DWG)
FIGURE
3

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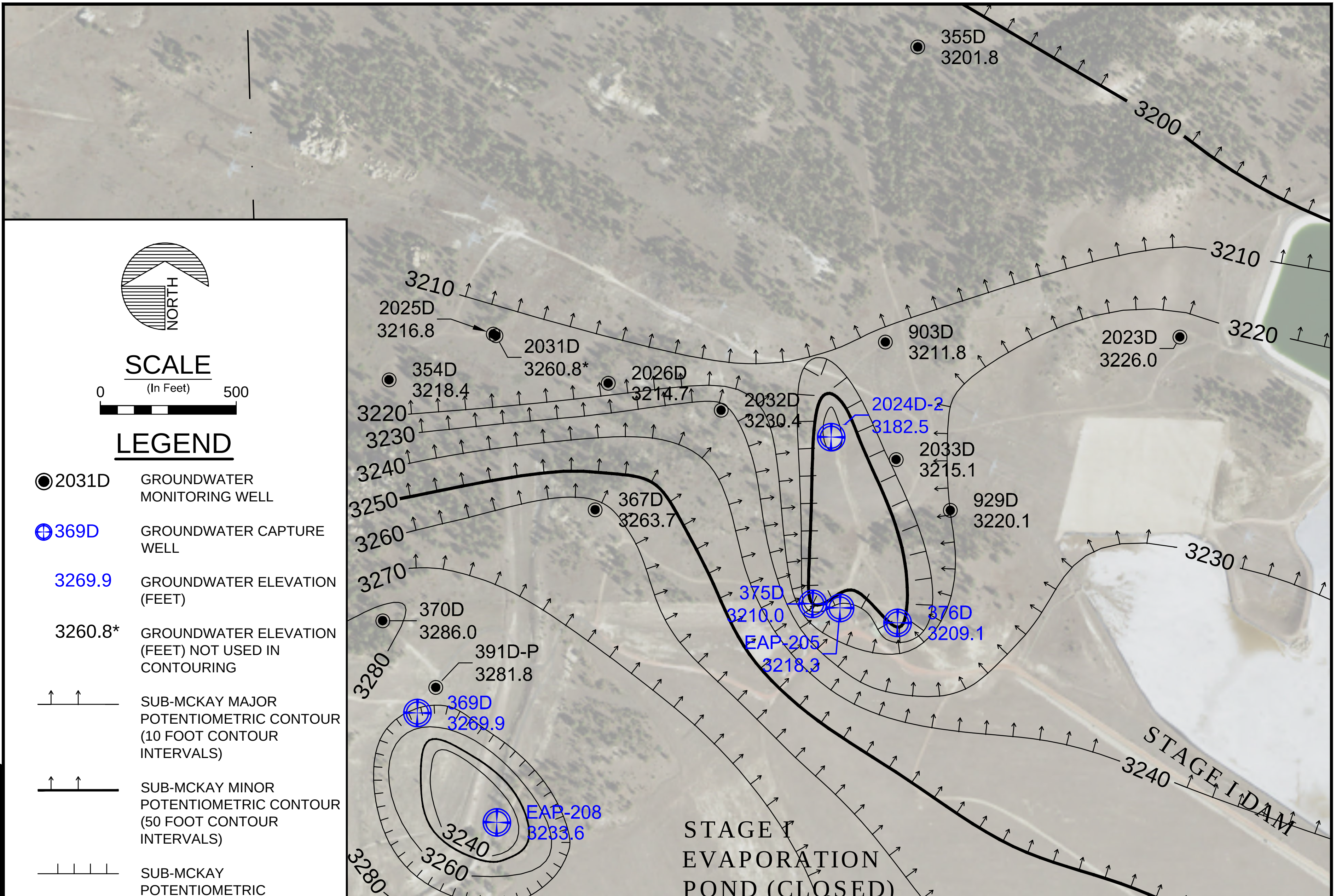

NORTH

SCALE
(In Feet)
0 500

LEGEND

2031D	GROUNDWATER MONITORING WELL
369D	GROUNDWATER CAPTURE WELL
3269.9	GROUNDWATER ELEVATION (FEET)
3260.8*	GROUNDWATER ELEVATION (FEET) NOT USED IN CONTOURING
	SUB-MCKAY MAJOR POTENTIOMETRIC CONTOUR (10 FOOT CONTOUR INTERVALS)
	SUB-MCKAY MINOR POTENTIOMETRIC CONTOUR (50 FOOT CONTOUR INTERVALS)
	SUB-MCKAY POTENTIOMETRIC DEPRESSION
	TALEN PROPERTY BOUNDARY

INTERIM RESPONSE ACTION WORK PLAN
GROUNDWATER INVESTIGATION
NORTH OF THE UNITS 1&2 STAGE TWO EVAPORATION POND
TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION

POTENTIOMETRIC SURFACE MAP IN SUB-MCKAY BEDROCK (SPRING 2016)

FIGURE
4

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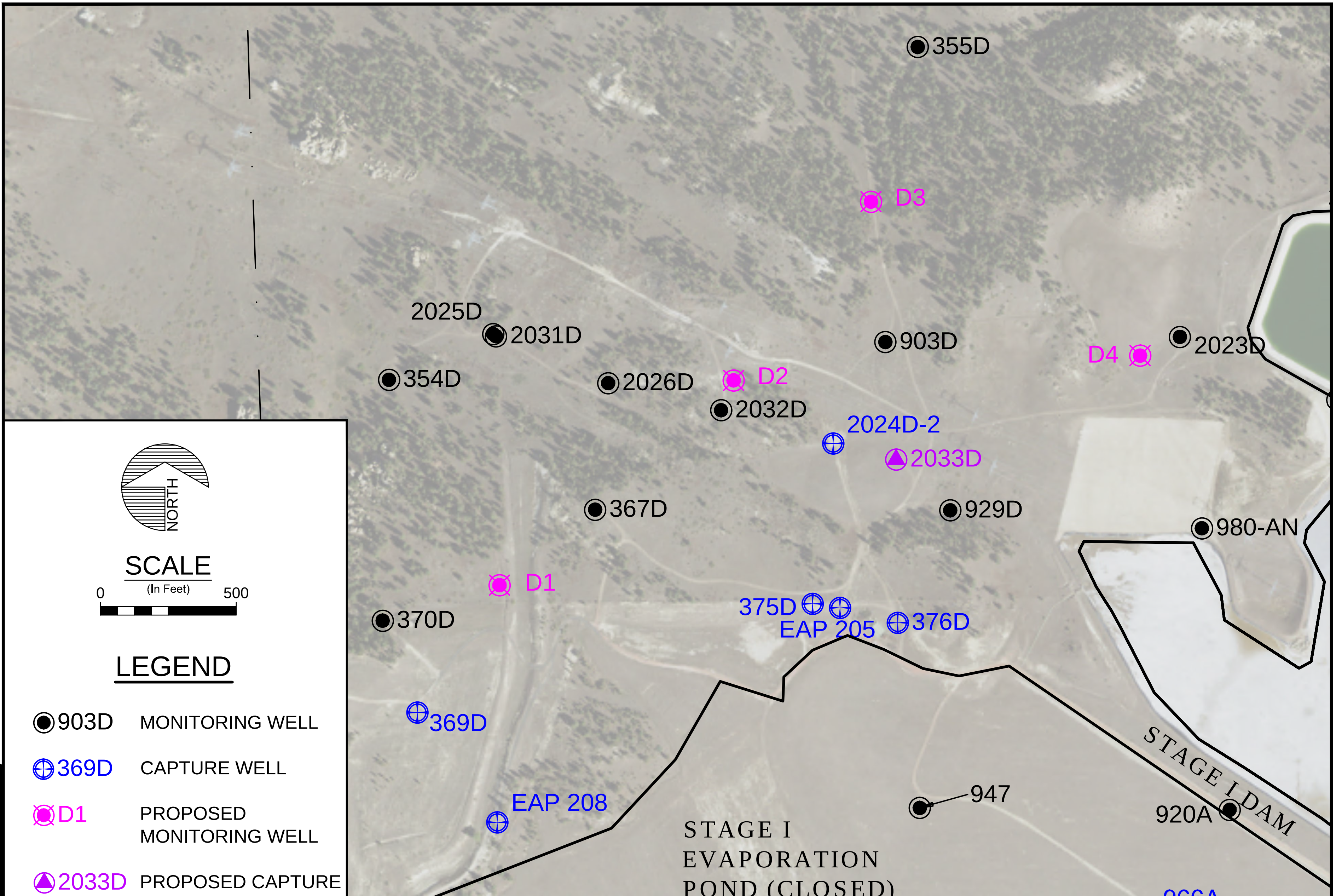

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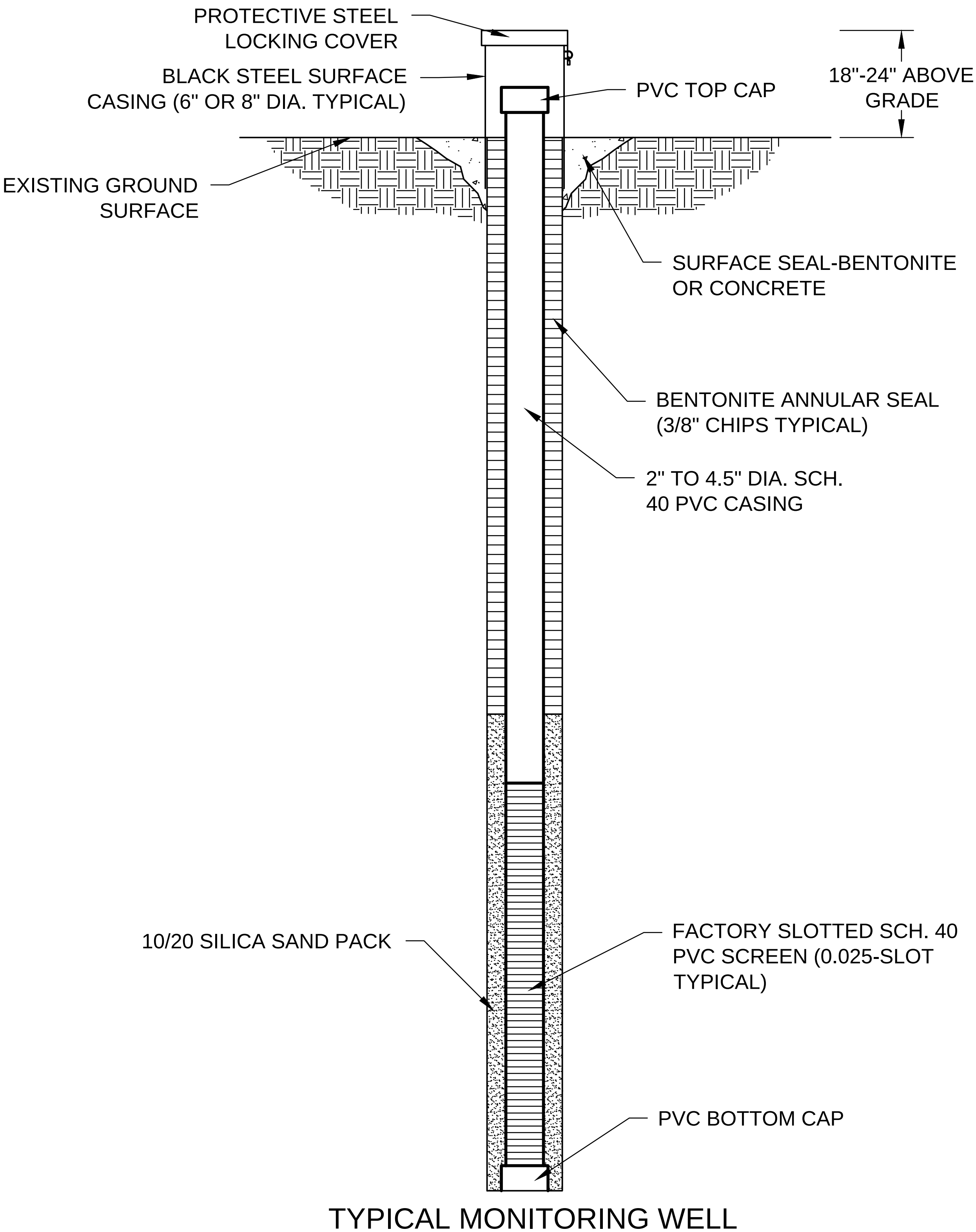
INTERIM RESPONSE ACTION WORK PLAN
GROUNDWATER INVESTIGATION
NORTH OF THE UNITS 1&2 STAGE TWO EVAPORATION POND
TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION

PROPOSED NEW CAPTURE WELL AND MONITORING WELL LOCATIONS

FIGURE
5



TYPICAL MONITORING WELL
COMPLETION DETAILS FOR
ALLUVIAL AND BEDROCK WELLS

NOT TO SCALE

INTERIM RESPONSE ACTION WORK PLAN GROUNDWATER INVESTIGATION NORTH OF THE UNITS 1&2 STAGE TWO EVAPORATION POND TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION	**TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM**	FIGURE **6**

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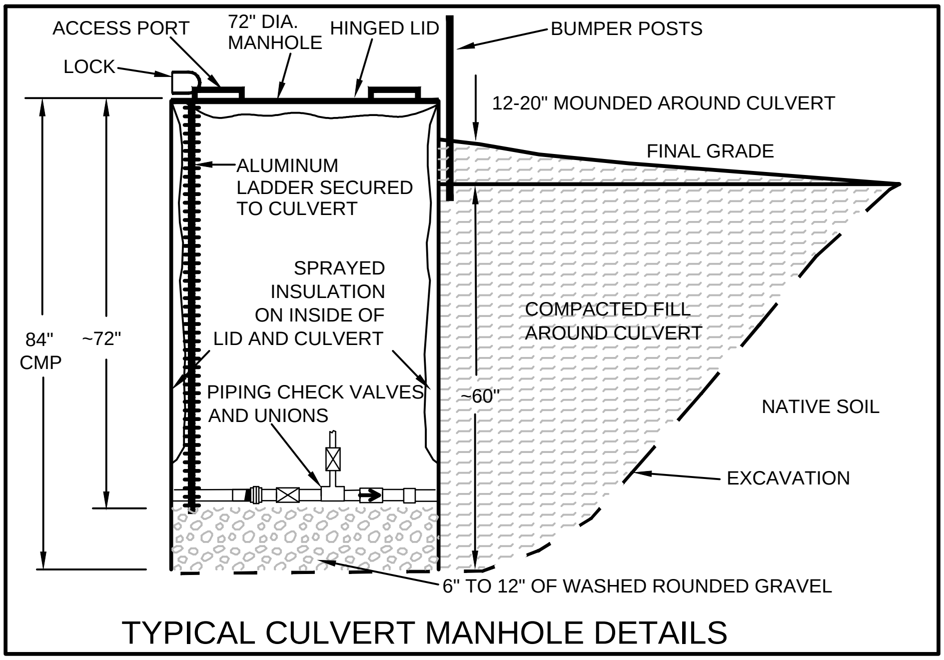
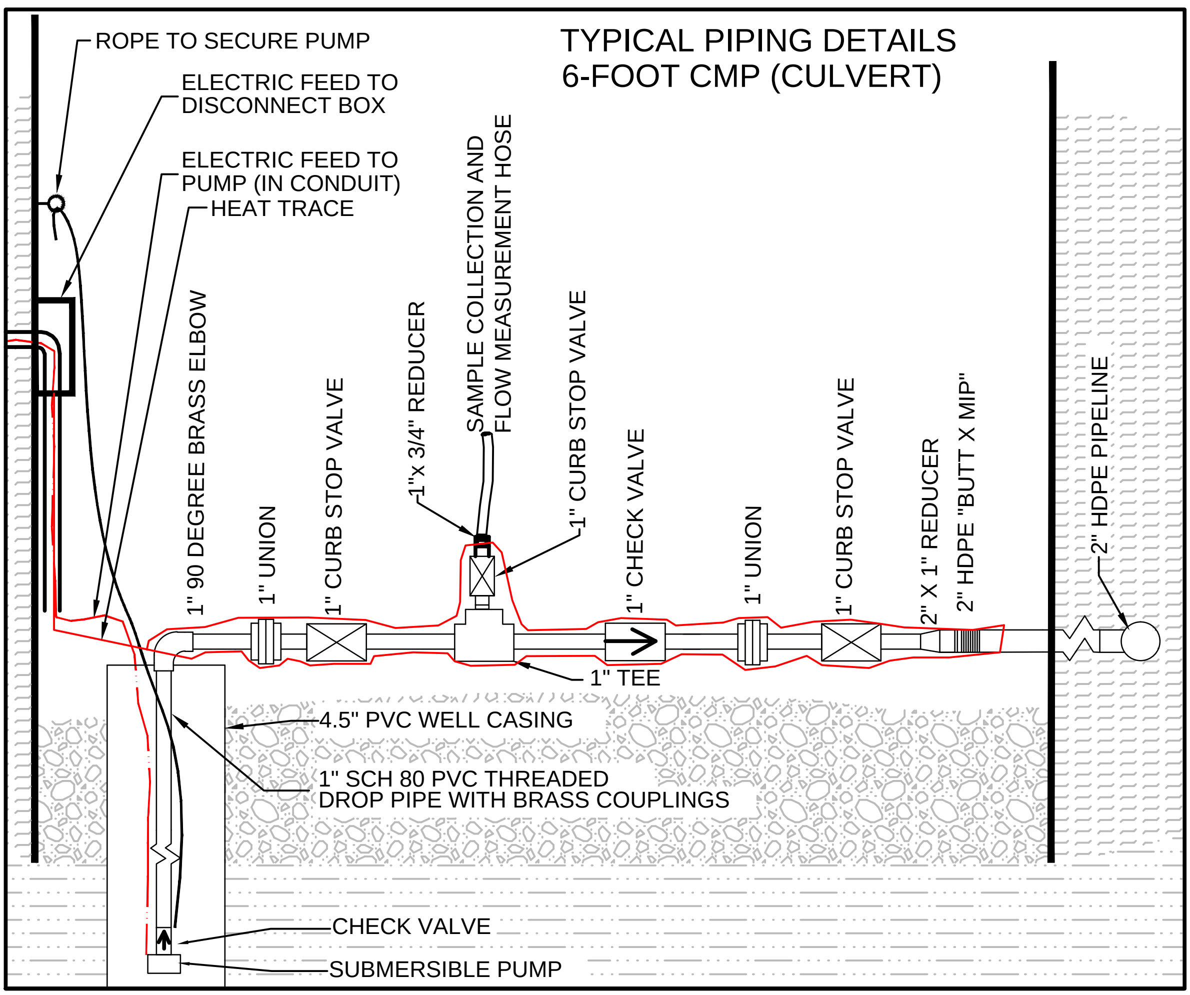


TYPICAL CULVERT MANHOLE DETAILS



TYPICAL PIPING DETAILS
6-FOOT CMP (CULVERT)

INTERIM RESPONSE ACTION WORK PLAN
GROUNDWATER INVESTIGATION
NORTH OF THE UNITS 1&2 STAGE TWO EVAPORATION POND
TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC
STATION

TYPICAL CAPTURE WELL CONSTRUCTION DIAGRAM

FIGURE

7

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