Section 3.2 Hydrogeology

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3.2 Hydrogeology

3.2.1 Site Groundwater Flow Directions

3.2.1.1 November 2012 Groundwater Contours

Figure 3.2-1 shows water table contours generated from the most recent (November 2012) measurements of the Silver Bow Site monitoring well network. Well construction information for the wells shown on these maps as well as the Rhodia production wells is summarized in Table 3.2-1. Water levels at the five new staff gauges installed in October 2012 on Silver Bow Creek and the ponds immediately to its south were included in the dataset used to generate the contours on Figure 3.2-1, but the water level in new piezometer PZ-12-1 was not used for contouring. See Section 3.2.2.1 for more discussion about PZ-12-1. Note that the water levels in the MW-12-series wells and the staff gauges are reported to the nearest 0.1 foot. This is the best available survey data for these locations at this time; a survey accurate to 0.01 foot is anticipated to be completed in 2013.

Table 3.2-2 summarizes how the monitoring wells were classified for contouring purposes. Most of the Site wells are shallow wells completed (i.e. screened) across or near the water table, and are therefore classified as "water table" wells. Only the wells classified as "water table" wells were used to generate the contours on Figure 3.2-1. Note that the water level in "water table well" MW-06-8, a well completed underneath the tailing basin in the buried former Sheep Gulch channel, is intended to represent the natural elevation of the water table in this area. The "deep" wells include the deeper nested wells and MW-02-4, a downgradient well with the top of screen approximately 30 feet below the local water table. The two "other" wells, MW-06-4 and MW-06-7, are not completed in aquifer materials. MW-06-4 is completed in a fine-grained sedimentary rock (mudstone/claystone), a material that most likely functions as an aquitard. Water levels in MW-06-4 have been consistently much lower than the nearest wells to the east and northeast, and thus inconsistent with the expected pattern of regional flow. MW-06-7 is completed in the tailing within the tailing basin; due to the low permeability of the tailing (*see* Section 3.2.3.1), water here is effectively perched.

Elevations indicate that groundwater generally flows toward Silver Bow Creek, the regional discharge area. See Section 3.2.2.1 for more discussion on the hydraulic connection between the graben-fill aquifer and Silver Bow Creek. Flow is generally to the northwest across the Site area, with a more westerly flow direction in areas of the Site west of Sheep Gulch and closer to Silver Bow Creek. Silver Bow Creek is depicted as a gaining stream upstream of its confluence with Sheep Gulch and as a neutral to slightly losing stream near SG-12-3. Sheep Gulch is depicted as a losing stream north of German Gulch Road near its confluence with Silver Bow Creek. These depictions

are consistent with the conclusions of the 2008 stream gauging on Silver Bow Creek and Sheep Gulch (*see* Section 3.3 for more information about the stream gauging).

The most current groundwater elevation contours indicate hydraulic gradients from approximately 0.003 ft/ft in the southeastern area of the Site and beneath the tailing basin, to 0.02 ft/ft in the west-central portion of the Site. The overall average gradient across the Site area is approximately 0.006 ft/ft.

3.2.1.2 Recent Groundwater Contours

Figures 3.2-2 and 3.2-3 show water table contours generated from water level measurements in the water table wells in March 2007 and April 2009, respectively. These contours are representative of Site conditions since the 06- series monitoring wells were installed in the fall of 2006. The contours on Figures 3.2-2 and 3.2-3 are very similar to each other and show little variation in flow directions and gradients over most of the Site from the November 2012 contours presented previously in Figure 3.2-1. The exception is the northwestern area of the site, where the November 2012 contours show a less pronounced westerly component of flow. Additional groundwater contours from measurements taken from October 2005 to March 2012 can be found in Appendix 3.2-A. Generally, the magnitude and direction of the hydraulic gradients across the Site appear to remain relatively consistent throughout the year. Groundwater contours from measurements taken from November 1997 to March 2005, previously published as Appendix Z of the CCRA, are also included as Appendix 3.2-B.

3.2.2 Regional Context

3.2.2.1 Site Hydrogeologic Setting

The graben-fill aquifer is likely made up of a series of coarse-grained unconsolidated sediments and sedimentary rocks, where the majority of groundwater flow occurs, interbedded with aquitard material (finer-grained unconsolidated sediments and sedimentary rocks). The coarser sediments would typically be deposited in stream channels crossing the graben and the finer-grained material would represent overbank deposits located between the channels. The locations of the stream channels changed with time during the filling of the graben, resulting in a complex distribution of aquifer material within the overall fill sequence. Data on the vertical and lateral distribution and continuity of aquifer material and aquitard material in the graben-fill sequence are limited. See Section 3.2.3.1 for more information on aquifer and aquitard materials.

Figure 3.2-4 depicts a simplified geology of the Site area; note that this is the same data presented in Figure 3.1-2 but with deposits labeled by type instead of as specific geologic units. The graben-fill

aquifer is bounded to the east and west by the low-permeability bedrock units (shown in green on Figure 3.2-4) that comprise the margins of the graben. In general, groundwater flows downslope from the margins of the graben toward Silver Bow Creek. (Silver Bow Creek is shown in brown, i.e. "Modified", on Figure 3.2-4 due to the extensive stream reconstruction as part of the SSTOU.)

The groundwater flow direction may become increasingly parallel to Silver Bow Creek as it approaches the outlet to the valley, located approximately 2 miles northwest of the Site. This pattern of groundwater flow was indicated by Botz (1969) for the Upper Silver Bow Creek drainage area, located one valley to the east of the Site. In that study area, the groundwater flow direction became more westerly (parallel to Silver Bow Creek) moving downstream toward the valley outlet above Rocker. The potential transition in flow direction to the west would likely be driven largely by topography, the geometry of the valley area, and the spatial distribution of the relatively low hydraulic conductivity igneous bedrock.

On Figure 3.2-4, the change in flow direction from northerly to northwesterly indicated by the Site groundwater contours is consistent with the "corner" in the western bedrock. Previous contours developed without water levels from the new wells installed in 2012, like those shown on Figures 3.2-2 and 3.2-3, showed a north-south 5295' contour that seemed anomalous because it suggested a westerly flow direction directly towards the granitic bedrock. The addition of water level data from wells MW-12-4 and MW-12-7 and staff gauges SG-12-3 and SG-12-4 to the contouring dataset resulted in contours that show a more northwesterly flow direction through this area.

In addition to the new monitoring wells and staff gauges, the October 2012 field work also included the installation of a drive-point piezometer, PZ-12-1, near staff gauge SG-12-3 to investigate the hydraulic connection between the graben-fill aquifer and Silver Bow Creek (Barr, 2012). PZ-12-1 was driven by hand to a depth of approximately 10 feet below ground surface along the creek bank approximately 70 feet from Silver Bow Creek and 150 feet from the location of SG-12-3. Integrated pressure transducers and dataloggers (In-Situ LevelTROLLs) were installed at SG-12-3 and PZ-12-1, and water levels were monitored at 5-minute intervals from 10/18/2012 to 11/8/2012. Appendix 3.2-E is a plot of the pressure data from PZ-12-1 and SG-12-3. The water levels recorded by the sensor in PZ-12-1 were referenced to a static water level measurement of 4.36' below the top of casing taken before the installation of the sensor. It appears that PZ-12-1 is screened in low-conductivity material, as the water level in PZ-12-1 steadily declined for about 9 hours after the installation of the pressure sensor before stabilizing. Due to space constraints, it was not possible to manually measure the water level in PZ-12-1 while the sensor was in place. Since the water level in PZ-12-1 had not

recovered to the static level before data logging began, the depth to water measurements calculated by the sensor are inaccurate. A depth to water of 5.28 feet below top of casing was measured soon after the removal of the pressure sensor on 11/8/2012; this is significantly lower than the static measurement of 4.36' taken before installation of the sensor. It is very likely that the 11/8/2012 measurement is artificially low due to the removal of the sensor, and thus this value was not included in the dataset used to generate the November 2012 groundwater contours.

The peaks and valleys in the water level data from PZ-12-1 and SG-12-3 generally coincide, confirming hydraulic connection between Silver Bow Creek and the aquifer. Water surface elevations for, and flow direction between PZ-12-1 and SG-12-3 were not evaluated from these data, because of the inaccurate water level reference for PZ-12-1 and surveyed elevations for SG-12-3 and PZ-12-1 which may be accurate to the nearest 0.1 foot.

3.2.2.2 Regional Groundwater Contours

Borduin (1999) monitored water levels in a network of 60 regional wells quarterly from March 1998 to March 1999. Representative contours from his March 1998 and September 1998 measurements are shown in Figures 3.2-5 and 3.2-6, respectively. All of Borduin's contours generally show flow to the north, toward Silver Bow Creek. His work did not extend to the opposite side of Silver Bow Creek, where groundwater would be expected to generally flow to the south, toward Silver Bow Creek. Figures 3.2-5 and 3.2-6 both indicate that flow in the vicinity of the westerly Site boundary is predominantly to the north, not to the west.

Borduin's contours on the east side of the Site are also somewhat different than the current groundwater elevation mapping shown on Figure 3.2-1. Borduin's contours appear to show a sink on the sewage plant property directly to the east of Rhodia, which significantly affects the direction of the contours on the northeastern part of the Silver Bow Site. The apparent sink is incongruous with the purpose of the sewage plant: land application of treated wastewater, which would be expected to appear as a source for groundwater. In contrast to the regional contours for the Upper Silver Bow Creek drainage area one valley to the east of the Site (Botz, 1969), Borduin's regional contours for the Site area do not suggest a significant component of flow parallel to Silver Bow Creek.

More recent regional groundwater contours (drawn from measurements from 2000-2002) are shown in Figure 3.2-7 (Waren and LaFave, 2011). This map shows gradients toward Silver Bow Creek from both the north and south and shows generally northward flow in the graben that turns to the northwest through the Silver Bow Site as it approaches the discharge area into Silver Bow Creek.

These newer contours also suggest a predominantly northerly groundwater flow direction at the west boundary of the Site. The 100-foot contour interval on this map does not provide enough detail to confirm or refute the possible sink to the east of the Site shown in Borduin's contours. Note that Waren and LaFave used wells completed in surficial, tertiary, and bedrock units in constructing these contours, suggesting that they behave as interconnected hydrogeologic units. The Waren and LaFave contours are generally consistent with the Botz contours in that they show a westerly component of flow near Silver Bow Creek, though it is difficult to directly compare these contours due to the large difference in contour interval.

In summary, the Borduin contours give some idea of the regional groundwater flow during plant operations, although pumping rates had significantly decreased by 1998 (as discussed in Section 3.2.3.2). The more recent Waren and LaFave contours reflect current conditions, with a more northwesterly direction of flow through the Site now that large-scale pumping from the production wells has ceased. The contours consistently indicate an overall flow direction through the Site to the north toward Silver Bow Creek, which acts as the regional discharge zone for groundwater. The more westerly flow direction in the northwest corner of the Site indicated on Figure 3.2-1 appears to be inconsistent with the regional flow directions shown by the Borduin, but is generally consistent with the Waren and LaFave contours.

3.2.2.3 Nearby Residential Wells

As shown on Figure 3.2-8, a number of private wells are located to the northwest of the Site area. Six residential wells located to the northwest of the Silver Bow Site and one industrial well (Port of Montana) located northeast of the Site were evaluated in 2006 (Appendix 3.2-C). Estimated well depths, locations and approximate ground surface elevations are included in the appendix. Two additional wells in the area (Schlosser and Weir) were identified in the Montana Groundwater Information System database. Logs from the Montana database for the wells shown on Figure 3.2-8 are included as Appendix 3.2-D.

The Port of Montana industrial well is located in a generally sidegradient direction with respect to groundwater flow from the Site, and is likely not a potential receptor for groundwater that may be influenced by the plant/tailing basin.

Based on elevations measured in Site groundwater monitoring wells (Figures 3.2-1 – 3.2-3), the six residential wells identified to the northwest of the plant/tailing basin are generally located in a downgradient direction with respect to groundwater flow in the area. The wells are located

approximately 3,200-6,000 feet northwest of the tailing basin. The closest shallow monitoring wells to the residential wells are MW-06-1, MW-12-4, and MW-12-7 and are located approximately 2,500 feet downgradient of the tailing basin (500-3,600 feet upgradient of the residential wells).

Construction data for the wells northwest of the Silver Bow Site is sparse and often inconsistent (see Appendices 3.2-C and 3.2-D) and groundwater elevation data are also quite limited. The log for the new Hess well (#164857) was the only one that could be confirmed by the 2006 survey; this well is completed in the graben-fill sequence and screened from 49 to 55 feet below ground surface. According to the Montana database, the water level in the Hess well was measured at 5293.45 ft MSL on 10/30/2001. While measured 11 years earlier than the contours shown on Figure 3.2-8, this water level is a bit higher but generally consistent with the water levels measured recently in the most northwestern Site monitoring wells.

The Baldry (#143518) and Schlosser (#50503) wells are completed in the Tertiary volcanics, and the Weir well (#153520) is completed in the Boulder Batholith (granitic bedrock). Water elevations for the Schlosser (5293.89') and Weir (5377.14') wells were also measured in 2001. These water levels cannot be compared directly to the 2012 Site contours because of the time difference and because the wells are not completed in the graben-fill. The water level in the Schlosser well, however, appears to be consistent with the level in the Hess well. This suggests that the volcanic rocks in this area may function as part of the graben-fill aquifer system. Figure 3.1-2 identifies the volcanic unit the Schlosser and Baldry wells are completed in as "Tuff of Lowland Creek Volcanics," and differentiates this material from welded tuff in other areas. Welded tuff is expected to have a very low hydraulic conductivity and would function as a no-flow boundary, but unwelded tuff can have a high hydraulic conductivity and thus may function as part of a local aquifer. Botz (1969) notes that little groundwater has been developed from the Lowland Creek volcanic rocks near Butte. Only unconsolidated graben-fill materials were encountered during the drilling of MW-12-4 through MW-12-8 (*see* Appendix 3.1-A for boring logs).

3.2.3 Site Context

This section presents additional data for the Silver Bow Site and surrounding region that is used to develop the conceptual model presented in Section 3.2.4.

3.2.3.1 Geological Materials and Hydraulic Conductivity Estimates

Rocks and sediments in the region capable of transmitting significant quantities of water under ordinary hydraulic gradients (i.e. aquifers, as defined by Freeze and Cherry, 1979, p. 47) likely include:

- Quaternary-age sediments associated with the area streams (alluvium).
- Coarse-grained zones in the Tertiary-age graben-fill sedimentary sequence.
- Interflow zones in the Tertiary-age extrusive igneous rocks (Foxworthy et al; 1988, p. 28).
- Fractured portions of the intrusive and extrusive igneous rocks of the Boulder Batholith and Tertiary-aged volcanics, respectively (Botz, 1969).

Less-permeable zones are referred to as aquitards and likely include:

- Fine-grained sediment and sedimentary rocks in the graben-fill deposits.
- Unfractured portions of the intrusive and extrusive igneous rocks of the Boulder Batholith and Tertiary-aged volcanics, respectively (Botz, 1969).

A previous (2004) geologic map of the area identified a relatively large area of Quaternary gravel deposits to the west of Sheep Gulch. However, a March 13, 2012 conversation with the author of the map suggested the gravel deposit was a relatively thin, surficial deposit that would not likely influence groundwater flow direction or velocity in this area (Berg, 2012). Drilling in the area for Barr-installed monitoring wells encountered some gravel, but only as a minor constituent in deposits that were mostly silt and/or sand. The updated (2009) geologic map of the area (Figure 3.1-2) indicates the extent of alluvium and graben-fill material is relatively limited near the valley outlet.

Table 3.2-3 presents estimates of transmissivity and/or hydraulic conductivity at various wells and soil boring locations on the Site and in the general vicinity. For the slug tests completed in 2006 on Site monitoring wells, multiple slug tests were completed at each well location and the hydraulic conductivity estimates shown on Table 3.2-3 are the geometric mean of the results from the individual tests performed at a given location. At wells where the screen intersected the water table, results from the falling head portion of the slug test were not analyzed.

Materials tested included alluvial sediment, material in the graben-fill aquifer, and tailing in the tailing basin. Hydraulic conductivity estimates from wells completed in native soil ranged from 0.02 feet/day at MW-97-11 to 2200 feet/day at BSB-1, indicating a large range of hydraulic properties as a result of the heterogeneous material at the Site. However, about half of the hydraulic conductivity estimates fall within a relatively narrow range between 0.1 feet/day and 10 feet/day. The majority of the wells that fall into this range are completed within the graben-fill sequence and are screened in predominantly silty material with varying amounts of sand and clay. It should be noted that since the slug tests were completed in wells screened in water-bearing (aquifer) material, the slug testing results likely do not reflect the full range of hydraulic conductivity present across the Site. The fine-grained graben-fill materials believed to act as aquitards likely have substantially lower hydraulic conductivity than the materials where the wells are screened. The production wells are typically screened over a significant thickness of aquifer and the hydraulic conductivity estimates obtained from these locations would represent a bulk estimate for the soil column intersected by the screen, rather than estimates for a specific soil type.

Slug tests in wells completed within the Sheep Gulch and Silver Bow Creek alluvial deposits indicate that this material tends to have higher hydraulic conductivity, generally on the order of 10 feet/day to 100 feet/day.

Estimated hydraulic conductivities of tailing material at MW-06-7 and SB-97-4 are 5.9×10^{-3} feet/day and 4.5×10^{-3} feet/day, respectively, indicating that the tailings have significantly lower hydraulic conductivity than the native aquifer materials.

Figure 3.2-9 illustrates the spatial distribution of hydraulic conductivity values; for locations with multiple estimates, the geometric mean is displayed on the figure. Significant spatial variability in hydraulic conductivity is apparent, as expected based on the Site geology, and distinguishing specific zones of common hydraulic properties is difficult. However, the following general trends in hydraulic conductivity were identified:

- The hydraulic conductivity estimates from the production wells are generally higher than estimates from monitoring wells. This may reflect the fact the production wells are screened over a significant thickness of aquifer and therefore would tend to intersect more conductive units than the monitoring wells. Monitoring wells have much shorter screens and would intersect a smaller portion of the aquifer.

- Hydraulic conductivity estimates from wells completed within the Silver Bow Creek and Sheep Gulch alluvium tend to be higher than wells completed in the graben-fill deposits.
- The hydraulic conductivity of the graben-fill deposits is variable, but generally falls into the range of 0.1 to 10 feet/day. Higher hydraulic conductivity estimates were obtained at some locations completed within the graben-fill material (e.g. MW-02-2, MW-06-4, MW-06-5) and likely reflect the natural variability of the deposits.

3.2.3.2 Usage of Rhodia Production Wells

Water for Plant operations was supplied from a subset of the nine deep pumping wells on the Site, all of which are located north or east of the tailing basin. See Figure 3.2-10 for the locations of these wells, and Table 3.2-1 for construction data. Figure 3.2-11 summarizes important water-related aspects of Plant operations in a timeline (Balentine 1998, 1999a, 1999b, 2012a, and 2012b).

Plant staff indicated that three wells, typically RP-W-1, RP-W-4, and RP-W-7, operated continuously at rates averaging 300 to 400 gpm, and that RP-W-5 and RP-W-6 were used as auxiliary supply wells (Balentine, 1998). RP-W-5 was preferred over RP-W-6 due to superior water quality based on internal analysis of hardness, fluoride, chloride, total dissolved solids, and conductance (Balentine, 2012a). Staff estimated that RP-W-5 was in use 70-80% of the time, and RP-W-6 was in use 50% of the time (Balentine, 2012b). RP-W-2, RP-W-2A, and RP-W-3 produced significant sediment and were not used to supply Plant water.

Two replacement wells, RP-W-2A and RP-W-1A, were drilled in 1971 and 1990, respectively, near the original wells RP-W-2 and RP-W-1. RP-W-2A was used intermittently for equipment cleaning and to supply water for fire control in the electrostatic precipitator area until the early 1980s (Balentine, 2012b). RP-W-1A has been used in place of RP-W-1 since 1990, when RP-W-1 was abandoned following an equipment failure (Balentine, 2012a).

Pumping volumes decreased significantly when Plant shutdown activities started in 1996: RP-W-5 and RP-W-6 were no longer used; RP-W-4 continued to supply water to the tailing basin until 2000 and RP-W-1A operated continuously through the end of Plant demolition in 2000 (Balentine, 2012b). Pumping from Site production wells has been minimal since 2000. RP-W-1A is still used to provide sanitary water for the Plant office building. During the summer months, RP-W-7 is used to fill a 6,000 gallon water truck approximately 60 times for dust suppression in the tailing basin (Balentine, 2012b). RP-W-4 is maintained as a backup well in case RP-W-1A or RP-W-7 fail, and is flushed out twice per year (Balentine, 2012b). These wells also provide firefighting capacity, if needed. The

remaining wells are not used, but have not been plugged (Balentine, 2012b). The current pumping is considerably less than during Plant operations, and likely does not significantly affect groundwater flow directions on the Site.

Staff indicated that they struggled to supply enough water to the Plant. Pumping noticeably affected the water levels in the beaver pond and Sheep Gulch north of the tailing basin, both of which would go completely dry in drought years (Balentine, 1999a). Given the combination of low recharge in the area and the high water demand of the Silver Bow Plant, it seems likely that the production wells drew at least some water from Silver Bow Creek and the adjacent alluvium, especially RP-W-5, located approximately 200 feet from the original Silver Bow Creek channel. The better water quality in RP-W-5 than in RP-W-6 supports this hypothesis.

3.2.3.3 Vertical Gradients

The first part of this section evaluates the potential for the Rhodia production wells to induce downward vertical gradients and capture water from the tailing basin during operations. This assessment is based on evaluation of groundwater quality data dating to the 1980s from the Rhodia production wells. This section is not intended to provide a comprehensive discussion of groundwater quality trends at the Silver Bow Site. See the relevant portions of Sections 4 and 5 for more detailed information about groundwater quality. The second part of Section 3.2.3.3 presents all other available data on Site vertical gradients, including vertical gradient estimates calculated from monitoring well nests.

3.2.3.3.1 Vertical Gradients from Rhodia Production Wells

Figure 3.2-10 shows the locations of the Rhodia production wells. Note that wells RP-W-1 and RP-W-1A will be treated as one well in this analysis since the wells are located adjacent to each other and RP-W-1A replaced RP-W-1. While RP-W-2, RP-W-2A, and RP-W-3 are shown on Figure 3.2-10 for completeness, these wells were pumped sparingly or not at all during Plant operations and would have had minimal influence on the Site hydrogeology. There is also no water quality data available for these three wells.

Available sampling data from RP-W-1, RP-W-4, RP-W-5, RP-W-6, and RP-W-7 for chloride and sulfate are plotted in Figure 3.2-12. Chloride was selected because it is a conservative solute found at concentrations of approximately 250 mg/L in the tailing basin during operations. Sulfate was reported at approximately 800 mg/L in the tailing basin during operations. Both chloride and sulfate in process-affected water are quite distinct from upgradient groundwater samples, in which median concentrations are approximately 12 mg/L and 33 mg/L, respectively. Pre-1997 chloride data are

from internal Rhodia sampling of their production wells (Rhône-Poulenc, 1996). These chloride data were reported in ppm, which is broadly equivalent to mg/L, so they can reasonably be included on the same plot with the more recent data reported in mg/L.

If pumping at the production wells was pulling shallow groundwater deeper into the aquifer, chloride concentrations in the well water would be expected to decrease following the cessation of pumping since the mechanism supplying the shallower process-impacted water to deeper strata would have been eliminated. With the exception of RP-W-5, the chloride data in Figure 3.2-12 show declining trends for all production wells since the Plant shutdown in the late 1990s. All wells, except RP-W-5, also showed increasing trends in chloride concentrations during the last decade of Plant operation from 1985-1996. The highest chloride concentration and the strongest increasing trend were observed at RP-W-4, with similarly high concentrations at RP-W-6. These are the two production wells located closest to the tailing basin, and RP-W-4 was one of the production wells that was continuously pumped. RP-W-1 and RP-W-7, located further east of the tailing basin, also had increasing trends of chloride concentration during this time, but at lower average concentrations.

RP-W-5 is the exception to the decreasing trends in chloride post-shutdown. Chloride concentrations have increased compared to 1985-1996 levels. The chloride behavior lends support to the hypothesis that RP-W-5 drew water from Silver Bow Creek rather than capturing tailing basin water and suggests that flow in this area has changed direction since pumping at RP-W-5 ceased. This assumes that chloride concentrations in Silver Bow Creek were low relative to process-impacted water during Plant operations. Figure 3.2-1 indicates that groundwater currently flows northwest towards RP-W-5. If RP-W-5 was previously capturing water from Silver Bow Creek, there would have been southerly flow paths from the creek to the well. Figure 3.2-1 also shows that RP-W-5 is now downgradient of the Plant area, and the increasing chloride and sulfate concentrations since the Plant shutdown may be due to migration of impacted groundwater from the south and southeast along the principal northwesterly flow direction across the Site. Recent chloride concentrations at RP-W-5 are relatively similar to concentrations observed at RP-W-4 during operations and may indicate that groundwater from the vicinity of RP-W-4 has migrated toward RP-W-5 since operations ceased. Declining concentrations at RP-W-4 suggest that concentrations downgradient at RP-W-5 will likely begin to decline in the future.

Sulfate data has only been available since 1998, but the trends in sulfate concentrations since then corroborate the trends seen in the chloride data, including a lack of declining trend at RP-W-5. The highest concentrations of sulfate are also observed at RP-W-4 and RP-W-6, further evidence that

these wells likely captured tailing basin water. Similar to chloride, sulfate is also a conservative solute. The sulfate concentrations observed at RP-W-5 are stable and are lower than those observed upgradient at RP-W-4, suggesting that some attenuation is taking place moving downgradient.

In summary, the analysis of chloride and sulfate data for the Rhodia production wells suggests that the production wells (with the exception of RP-W-5) were likely capturing process-impacted shallow groundwater during Plant operations but that there are no longer significant downward gradients in these areas since Plant operations ended. Silver Bow Creek appears to have been the source of water to RP-W-5, though now that it is no longer pumping, flow in the area is directed to the northwest.

3.2.3.3.2 Well Nest Vertical Gradient Data

Groundwater elevations measured in November 2012 were used to evaluate vertical hydraulic gradients at locations where wells at multiple depths (i.e. nested wells) have been completed. Calculated vertical gradients are shown on Table 3.2-4. Observed vertical gradients across the Site are primarily downward, with the exception of the gradient between MW-06-8 and MW-06-9 under the tailing basin and the fluctuating gradient direction at MW-97-3/MW-97-4/MW-06-12.

Well nests MW-97-1/MW-97-2 and MW-06-5/MW-06-6 are located to the south of the Site within close proximity of the Sheep Gulch channel. The downward vertical gradients at these locations are consistent with surface water discharge measurements in this area (see Section 3.3), which indicate that Sheep Gulch is losing water to the aquifer. Further evidence that Sheep Gulch is a losing stream in this area comes from the fate of the discharge to Sheep Gulch from the REC Advanced Silicon Materials (formerly ASiMI) Plant located to the south of the Silver Bow Site. From early 1999 to early 2004 when the average daily discharge from the ASiMI Plant was reported to be approximately 0.4 million gallons per day (MGD), the surface-water discharge evaporated and infiltrated before the visible flow reached the tailing basin. The discharge flowed as groundwater within the existing and historical Sheep Gulch channel sediments and appeared to raise groundwater levels.

Monitoring wells MW-06-7, MW-06-8, and MW-06-9 are completed within the tailing basin, within the Sheep Gulch sediment buried beneath the tailing basin, and within the graben-fill deposits beneath the Sheep Gulch sediment, respectively. The hydraulic head within the buried Sheep Gulch sediment (MW-06-8) is lower than the head within the tailing basin and the deeper graben-fill material, consistent with the low permeability of the tailing material. Thus, the remaining water in the tailing basin drains very slowly despite the relatively high downward gradient. The pre-tailing basin aerial photo in Figure 3.2-13 shows the channel and overbanks in this area as wet or well-

vegetated, so the channel would be gaining groundwater in this area, and the upward gradient between MW-06-9 and MW-06-8 is consistent with this observation. The fact that the hydraulic head at MW-06-8 is lower than the head within the tailing basin and within the graben-fill deposits supports the concept that the buried Sheep Gulch sediments are likely a discharge zone and conduit for groundwater flow.

Well nest MW-97-3/MW-97-4/MW-06-12 is located approximately 250 feet north of the tailing basin. The vertical head differences between these three wells are very small (no difference between MW-97-3 and MW-97-4, < 0.1 ft difference between MW-97-4 and MW-06-12), indicating minimal potential for vertical flow within the aquifer in this area. As discussed earlier in Section 3.2.1.1, Silver Bow Creek represents an area of regional groundwater discharge and vertical gradients near the creek would be expected to be upward. Table 3.2-5 shows calculations of gradients between MW-97-3 and MW-97-4 going back to 1997, and gradients between MW-97-4 and MW-06-12 going back to 2006. The gradients are typically very small, and the direction fluctuates. The small vertical gradients and direction changes at this well nest may indicate that MW-97-3/MW-97-4/MW-06-12 are completed in an area where vertical groundwater gradients transition from primarily downward in areas further from Silver Bow Creek to primarily upward in areas closer to the creek.

Upward gradients at the MW-97-3/MW-97-4/MW-06-12 well nest are consistent with the beaver pond just to the west, which is a surface expression of groundwater. This is further corroborated by historical photographs (see Figure 3.2-13), maps, Site observations, and an interview of Mr. Ralph Erickson by Rhodia staff which indicated the area was previously used as a dairy farm and had a spring-fed pond in the current location of the beaver pond (Erickson, 1996). Groundwater enters the beaver pond from surface seeps such as those visible along the eastern edge of the pond and underwater springs. The observations by Plant staff that water levels in the beaver pond responded to groundwater pumping (Section 3.2.3.2) not only confirm that the beaver pond is fed by groundwater, but also indicate that vertical gradients in this area were downward at least some of the time during Plant operations. Streamflow data collected in the beaver pond area will be discussed in Section 3.3.

In 2012, additional well nests were added to the monitoring network (MW-12-4/MW-12-5/MW-12-6 and MW-12-7/MW-12-8), and three other nests were created by installing deep well MW-12-1 adjacent to water table well MW-06-10, water table well MW-12-2 adjacent to deep well MW-02-4, and deep well MW-12-3 adjacent to water table well MW-02-3. Vertical gradients at these five nests will be evaluated once surveyed elevations accurate to 0.01 foot are available for the new wells.

3.2.3.4 Aquifer Continuity

On Figure 3.2-1, only the water table wells (indicated in blue) were used to generate the contours. However, as seen in the calculations of vertical gradients, it is worth noting that the water elevations in the deep wells (indicated in red) except MW-02-4, MW-12-1, and MW-12-3 are quite similar to the nearby shallow wells. Differences in hydraulic head between shallow and deep wells do not exceed 0.6 feet at any of the other nested well locations (with the exception of the tailing basin well MW-06-7), and generally average around 0.2 feet. Figure 3.2-14 shows contours generated using only the deep wells. Note that at nest locations with three wells, only the deepest well was used for contouring. These contours show similar flow directions to those shown on Figure 3.2-1, which used only the water-table wells.

The small differences in hydraulic head between shallow and deep wells (with the exceptions discussed below) are consistent with the sampling results at the production wells from Section 3.2.3.3.1 and the anecdotal evidence in Section 3.2.3.2 that production well pumping affected groundwater levels in the beaver pond and Sheep Gulch north of the tailing basin. Together, these observations suggest that the shallow and deep deposits are hydraulically connected and function as a single hydrostratigraphic unit. If the shallow and deep deposits behaved as separate aquifer systems, larger differences in hydraulic head would be expected between the shallow and deep wells, process-impacted water that would have originated as shallow groundwater would not be produced by the deep production wells, and shallow groundwater features like the beaver pond would not respond to pumping from the deep deposits.

Hydraulic head measurements at deep wells MW-02-4, MW-12-1, and MW-12-3 are all at least 0.95 feet lower than at their respective adjacent water table wells. These differences suggest that the hydraulic connection between shallow and deep graben-fill deposits is likely poor at these locations. The difference is greatest (about 9.7 feet) at MW-06-10/MW-12-1. Some difficulty in finding water-bearing strata was experienced during the drilling of MW-12-1, and consequently the well was drilled 15 feet deeper than originally proposed (205 feet bgs instead of 190 feet bgs). Based on boring logs (*see* Appendix 3.1-A), the lithology encountered at MW-12-1 appears similar to that observed during construction of RP-W-6, located approximately 600 feet southeast of MW-12-1. At RP-W-6, deposits capable of producing significant water were not encountered until a depth of 185 feet below ground surface (at roughly the same elevation as water-bearing material was encountered at MW-12-1). The hydraulic head measured at MW-02-4 is about 1 foot lower than at adjacent water table well MW-12-2, and the hydraulic head measured at MW-12-3 is about 5 feet lower than at adjacent water table well MW-02-3. As discussed above, available information suggests that the

shallow and deep graben-fill deposits appear to be hydraulically connected and effectively function as a single hydrostratigraphic unit. However, given the heterogeneity of the Site geology, it is not surprising that that the degree of hydraulic connection between the shallow and deep deposits would vary spatially across the Site.

3.2.4 Conceptual Site Hydrogeologic Model

A hydrogeologic conceptual model is a schematic description of how water enters, flows, and leaves the groundwater system. The conceptual model includes aspects such as: major sources and sinks of water; an evaluation of the geologic setting and geologic units to identify hydrostratigraphic units (both aquifers and aquitards) and the nature of the interaction between them; an evaluation of groundwater flow directions based on available data; and an assessment of the nature of interaction between surface water and groundwater. Most of the supporting information has already been presented in the previous sections; this section brings together all of the preceding data and observations into a single conceptual model for the Site. This conceptual model helps identify data gaps and informs appropriate approaches to resolve them.

Figure 3.2-15 presents two generalized cross-sections through the graben area, which illustrate the Site hydrogeology in the context of the regional hydrogeology. Groundwater generally flows downslope from the margins of the graben toward Silver Bow Creek, the regional discharge zone. The majority of groundwater flow in the graben-fill aquifer occurs in Quaternary-age sediments associated with the area streams (alluvium) and coarse-grained fluvial sediments within the Tertiary-age graben-fill. Though the aquifer materials are quite heterogeneous, the graben-fill aquifer behaves as a single hydrostratigraphic unit. The graben-fill aquifer is bounded to the south by the Continental Divide (a groundwater divide and hydraulic boundary) and to the east, west, and north by the low-permeability bedrock units (Boulder Batholith and Tertiary volcanic rocks) that comprise the margins of the graben. In addition to direct precipitation and snowmelt, the primary source of recharge to the shallow aquifer is likely infiltration from losing streams as they flow from the margins of the graben toward Silver Bow Creek. Moving downstream from the margins of the valley, the flow in streams tends to decrease as they lose water to the underlying aquifer. Approaching Silver Bow Creek, the flow in some streams begins to increase, indicating that discharge from the aquifer into the stream is occurring. Groundwater is discharged into streams, where it runs off as surface water (Botz, 1969). Groundwater flow directions near surface water features are likely more variable and reflect localized groundwater-surface water interaction and seasonal fluctuations. Surface water flow in the vicinity of the Site is discussed in greater detail in Section 3.3.

Figure 3.2-16 illustrates the conceptual hydrogeologic model for groundwater flow within the graben-fill sequence in the Site area. Figure 3.2-17 presents a conceptual cross-section for conditions during Plant operations. While the Plant was in operation, groundwater from upgradient of the Site would pass around or under the tailing basin or would be captured by the production wells. The tailing basin water level was maintained by the closed-loop water recycle system from Plant operations. Open ditches carried process water from the Plant to the tailing basin and from the tailing basin back to the Plant. Due to the low conductivity of the tailing, the primary source of process water lost to seepage was likely through these ditches. Groundwater and any seepage from the tailing basin and process water ditches not captured by the production wells would flow northward, discharging to Silver Bow Creek directly or via Sheep Gulch. The groundwater discharge to the beaver pond area during Plant operations would likely be a combination of groundwater and infiltrated tailing basin water. Figure 3.2-17 also conceptually illustrates how pumping from the Rhodia production wells could affect the water level in the beaver pond and potentially draw water from Silver Bow Creek (as discussed in Sections 3.2.3.2 and 3.2.3.3.1).

Similar to Figure 3.2-17, Figure 3.2-18 illustrates a cross-section of the conceptual model of the conditions after shutdown activities at the Silver Bow Plant. The basic Site groundwater flow system is unchanged from that during Plant operations with the following exceptions: there is no longer ponded water in the tailing basin and the Rhodia production wells are no longer operating. As discussed in Section 3.2.3.3.2, the seepage rate from the tailing basin is limited by the low hydraulic conductivity of the tailing, and the higher permeability deposits associated with the former Sheep Gulch channel form the likely primary pathway for seepage to leave the basin. Without the downward vertical gradients induced by pumping at the deep production wells, there is no longer a mechanism for shallow groundwater in the area of the Plant and tailing basin to be pulled down into deeper strata. The regional groundwater discharge zone remains Silver Bow Creek, with the beaver pond and Sheep Gulch north of the beaver pond receiving some of the shallow groundwater as well. Some of the contribution from the tailing basin flows into gaining reaches of Sheep Gulch, while surface water discharges to groundwater in losing reaches of Sheep Gulch.

3.2.5 Summary and Data Gaps

Groundwater flow in the area of the Silver Bow Site occurs primarily in Quaternary-age sediments associated with the area streams and coarse-grained fluvial sediments within the Tertiary-age graben-fill. Groundwater flows generally to the north and northwest toward Silver Bow Creek, with Site groundwater elevations indicating a more westerly flow direction in the northwestern corner of the Site that appears generally consistent with the bedrock geology.

A number of shallow and deep residential wells are located west of the Site and one or more may be considered downgradient of the Site.

Hydraulic conductivity estimates from pumping tests, slug tests, and specific capacity data indicate that the hydraulic properties within the graben-fill and alluvial sediment are highly variable, though the alluvial sediment tends to have a higher conductivity than the graben-fill deposits. There do not appear to be extensive areas of higher or lower hydraulic conductivity, likely due to the highly heterogeneous nature of the graben-fill deposits.

The shallow and deep graben-fill deposits appear to be hydraulically connected and effectively function as a single hydrostratigraphic unit. This conclusion is supported by several lines of evidence discussed above: (1) pumping of the production wells during operations resulted in process-impacted water that would have originated as shallow groundwater being drawn into deeper portions of the aquifer; (2) anecdotal evidence that pumping the production wells affected water levels in the beaver pond, a shallow groundwater feature; and (3) the general similarity between groundwater elevations in shallow and deep wells in nested well pairs. Cessation of high-capacity pumping at the Rhodia production wells has changed groundwater flow directions on the Site; in particular, the downward vertical gradients produced by these wells are no longer present, limiting the potential for further downward migration of shallow groundwater at the Site.

Based on the discussion above and the conceptual model for the Site, a limited number of data gaps have been identified. These data gaps will be addressed prior to the submission of the Long Term Groundwater Monitoring Plan (anticipated 2013). The following data gaps have been identified:

- An elevation survey accurate to 0.01 foot will be performed for all monitoring locations installed in October 2012. This survey should be conducted via level loop to ensure consistency with previously surveyed elevations at the Site. Vertical gradients at newly completed well nests can be evaluated once the survey is complete.
- Available groundwater quality data from the production wells suggests that they likely induced downward hydraulic gradients during operations and drew process-impacted shallow groundwater into deeper portions of the aquifer. Declining concentrations at the production wells since Plant operations ended suggest that there are no longer significant downward gradients in these areas and deep groundwater quality is expected to improve over time. The monitoring wells installed in October 2012 were sampled in November 2012, and the data

from the deep wells should be evaluated to assess deeper groundwater quality, especially north and northwest of the tailing basin.

3.2.6 References

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Tables

Table 3.2-1
Well Construction Information
Rhodia Silver Bow Plant

Monitoring Location	X[1] [ft]	Y[1] [ft]	Top of Riser [ft. MSL]	Ground Surface [ft. MSL]	Top of Screen [ft. MSL]	Bottom of Screen [ft. MSL]	Well Depth[2] [ft.]	Avg. Water Elevation[3] [ft. MSL]
MW-EPA-1	1158858.21	649713.24	5366.76	5364.76	5339.6	5319.6	45.2	5336.70
MW-EPA-3	1161467.10	653670.48	5328.52	5326.52	5305.0	5295.0	31.5	5313.73
MW-EPA-4[4]	1159876.98	653787.54	5323.31				46.68[5]	5303.82
MW-97-1	1159304.37	648574.00	5357.81	5355.8	5334.1	5324.1	31.7	5338.15
MW-97-2	1159307.23	648586.50	5357.68	5355.7	5305.1	5295.1	60.6	5338.00
MW-97-3	1159167.37	652776.45	5337.81	5335.9	5323.6	5303.6	32.3	5313.43
MW-97-4	1159167.63	652764.97	5337.93	5336.0	5285.6	5275.6	60.4	5313.41
MW-97-5	1161837.90	648614.52	5402.31	5400.1	5348.5	5328.5	71.6	5337.36
MW-97-6	1162077.07	651165.89	5367.03	5364.6	5333.2	5313.2	51.4	5328.74
MW-97-7	1161380.29	651459.92	5364.19	5362.1	5320.1	5300.1	62.0	5326.27
MW-97-8	1160626.81	652217.33	5379.21	5377.2	5326.6	5306.6	70.6	5320.06
MW-97-9	1159925.47	652697.71	5376.56	5374.7	5322.6	5302.6	72.1	5313.40
MW-97-10	1158684.66	652180.19	5341.06	5338.9	5321.1	5301.1	37.8	5311.94
MW-97-11	1158317.07	650811.17	5351.06	5348.8	5337.3	5317.3	31.5	5328.46
MW-97-12	1161691.57	653317.16	5337.80	5335.8	5323.9	5303.9	31.9	5319.88
PW-99-1	1158630.13	652878.91	5315.64	5312.8	5310.5	5301.3	11.5	5309.34
P-99-2	1158613.33	652864.69	5315.40	5312.5	5307.3	5302.3	10.2	5309.41
PW-99-3	1159648.14	649605.00	5363.63	5360.9	5339.6	5319.6	41.3	5336.84
MW-01-1	1161625.24	650846.24	5372.79	5370.7	5330.4	5320.4	50.3	5329.66
MW-01-2	1161511.26	651686.07	5363.47	5361.3	5327.9	5317.9	43.4	5326.49
MW-01-3	1161476.29	651796.73	5358.99	5357.0	5326.7	5316.7	40.3	5326.35
MW-01-4	1161612.64	651130.42	5368.05	5366.4	5328	5318	48.4	5328.43
MW-01-5	1161635.08	651127.73	5368.33	5366.2	5329.9	5319.9	46.3	5328.47
MW-01-6	1161532.06	651799.42	5357.75	5356.0	5325.7	5315.7	40.3	5326.18
MW-02-1	1161390.13	651993.05	5358.70	5356.54	5327	5317	40	5323.49
MW-02-2	1161463.00	651824.71	5358.81	5357.10	5329	5319	38	5325.98
MW-02-3	1157198.54	652621.20	5371.53	5370.16	5301	5281	89	5295.37
MW-02-4	1157849.03	653575.83	5324.66	5322.15	5263	5243	79	5295.80
MW-06-1	1157140.37	654013.16	5309.76	5307.21	5299	5279	28	5294.59
MW-06-2	1157953.72	652815.59	5358.15	5355.25	5303.5	5283.5	71.8	5297.84
MW-06-3	1156992.08	651766.41	5377.57	5374.81	5296.2	5276.2	98.6	5291.92

Table 3.2-1
Well Construction Information
Rhodia Silver Bow Plant

Monitoring Location	X[1] [ft]	Y[1] [ft]	Top of Riser [ft. MSL]	Ground Surface [ft. MSL]	Top of Screen [ft. MSL]	Bottom of Screen [ft. MSL]	Well Depth[2] [ft.]	Avg. Water Elevation[3] [ft. MSL]
MW-06-4	1157381.74	648392.37	5391.04	5388.22	5315	5295	93	5308.94
MW-06-5	1159469.86	648350.44	5350.08	5348.19	5344.7	5324.7	23.5	5339.10
MW-06-6	1159479.47	648355.30	5350.78	5348.33	5194	5174	174	5338.94
MW-06-7	1159395.02	651424.26	5366.98	5364.54	5343	5338	27	5347.04
MW-06-8	1159406.21	651431.90	5366.45	5364.58	5311	5306	59	5314.26
MW-06-9	1159407.26	651425.17	5366.89	5364.48	5292	5282	82	5314.51
MW-06-10	1158810.25	653648.59	5329.52	5327.20	5310	5290	37	5302.82
MW-06-11	1159757.72	653190.43	5330.86	5328.30	5318.8	5298.8	29.5	5312.44
MW-06-12	1159167.37	652791.31	5337.31	5335.44	5168	5148	187	5313.35
MW-06-13	1160568.87	653349.05	5329.26	5327.55	5320	5300	28	5312.29
MW-06-14	1161615.62	653398.66	5336.09	5334.21	5327	5307	27	5319.30
MW-06-15	1161792.69	653134.23	5351.89	5349.58	5327.1	5307.1	42.5	5321.01
MW-06-16	1160940.49	652836.33	5345.76	5343.65	5326.2	5306.2	37.5	5318.3
MW-06-17	1161255.22	652760.93	5348.01	5345.92	5326.1	5306.1	39.8	5319.0
MW-06-18	1161486.36	652572.78	5355.22	5353.35	5328	5308	45	5320.5
MW-06-19	1161964.24	652243.91	5355.70	5353.31	5331.1	5311.1	42.2	5324.03
MW-06-20	1161465.49	652269.63	5357.77	5355.94	5330	5310	46	5322.26
MW-06-21	1160278.91	651801.85	5376.00	5373.99	5322.5	5302.5	71.5	5315.58
MW-06-22	1161114.90	651667.56	5363.84	5361.62	5332.4	5312.4	49.2	5324.63
MW-06-23	1161768.38	647386.04	5428.80	5426.28	5349.5	5329.5	96.8	5341.40
MW-06-24	1161765.43	647391.13	5428.64	5426.08	5279.5	5269.5	156.6	5341.10
MW-06-25	1161188.29	651376.91	5364.11	5362.45	5332.4	5312.4	50.1	5326.10
P-06-1	1158645.32	652621.43	5316.20	5313.94	5301.4	5300.4	13.5	5311.13
P-06-2	1158650.11	652620.97	5316.51	5313.70	5312	5310	4	5311.41
P-06-3[6]	1158316.29	653594.07	5308.17	5305.17	5297.4	5296.4	8.8	5302.76
P-06-4[7]	1158320.98	653595.90	5307.13	5304.71	5304.2	5302.2	5.11[5]	5304.19
MW-12-1	1158810.30	653641.96	5330.5	5327.6	5133	5123	205	5293.3
MW-12-2	1157861.88	653574.48	5324.2	5321.3	5306	5286	35	5296.5
MW-12-3	1157201.87	652613.48	5372.6	5370.1	5199	5189	181	5290.7
MW-12-4	1156548.00	653448.16	5318.0	5315.1	5295.6	5275.6	39.5	5289.6
MW-12-5	1156548.92	653452.89	5318.0	5315.1	5231.6	5221.6	93.5	5289.0
MW-12-6	1156549.11	653457.71	5317.8	5315.0	5125.5	5115.5	199.5	5289.0

P:\Mpls\26 MT\46\2646006\WorkFiles\RFI\RFI Final Ph I 2012\Section 3.0\Section 3.2-Hydrogeology\Tables 3.2\UPDATED Table 3.2-1_Well_Construction

Table 3.2-1
Well Construction Information
Rhodia Silver Bow Plant

Monitoring Location	X[1] [ft]	Y[1] [ft]	Top of Riser [ft. MSL]	Ground Surface [ft. MSL]	Top of Screen [ft. MSL]	Bottom of Screen [ft. MSL]	Well Depth[2] [ft.]	Avg. Water Elevation[3] [ft. MSL]
MW-12-7	1155675.16	652987.53	5347.4	5344.4	5295	5275	69	5288.9
MW-12-8	1155679.66	652989.01	5347.2	5344.2	5259	5249	95	5288.9
PZ-12-1	1156818.86	655290.52	5294.8	5292.7	5285	5283	12.26[5]	--

Notes:

[1] Montana State Plane Coordinates in International feet: Northing and Easting (by GPS)

[2] Measured from ground surface, depth to bottom of screen

[3] Average calculated from available water level data from 10/21/97 to the present (11/2012 measurements)

[4] No construction data available for this well.

[5] Measured from top of riser with water level tape

[6] No longer present as of 11/2012

[7] P-06-4 was disturbed during 10/2012 field campaign, top of casing elevation will need to be resurveyed. Total depth measured 11/2012.

Production Well	X[1] [ft]	Y[1] [ft]	Ground Surface[8] [ft. MSL]	Top of Screen[9] [ft. MSL]	Bottom of Screen[9] [ft. MSL]	Well Depth[2] [ft.]	In Use As of 2012?	Abandoned?/ Plugged?
RP-W-1	1161659.32	652961.68	5352	5332	5130	222	No	Yes/No
RP-W-1A	1161634.97	652966.58	5351	5215	5086	265	Yes[10]	No/No
RP-W-2	1161444.72	651193.70	5371	5170	5145	226	No	Yes/No
RP-W-2A	1161471.82	651177.89	5371	5171	5114	257	No	Yes/No
RP-W-3	1160902.07	652196.19	5366	5243	5116	250	No	Yes/No
RP-W-4	1160299.54	652998.65	5355	5309	5060	295	No	No[12]/No
RP-W-5	1160079.66	654005.41	5326	5246	5036	290	No	Yes/No
RP-W-6	1159352.66	653350.43	5336	5246	5136	200	No	Yes/No
RP-W-7	1162158.53	651980.64	5365	5165	5085	280	Yes[11]	No/No

Notes:

[8] From DEM

[9] Computed from screened interval depths below ground surface on well logs

[10] Main non-potable water supply well for Site

[11] Back-up well, used as water supply for summer dust suppression program on tailing basin

[12] RP-W-4 is not regularly used but is kept in functional condition in case of emergency

See Section 3.2.3.2 for more detailed information about the Site production wells

Table 3.2-2
Monitoring Well Classification for Groundwater Contours
Rhodia Silver Bow Site

Water Table Wells					
MW-EPA-1	MW-97-9	MW-01-2	MW-06-2	MW-06-16	P-06-1
MW-EPA-3	MW-97-10	MW-01-3	MW-06-3	MW-06-17	P-06-2
MW-EPA-4	MW-97-11	MW-01-4	MW-06-5	MW-06-18	P-06-3
MW-97-1	MW-97-12	MW-01-5	MW-06-8	MW-06-19	P-06-4
MW-97-3	PW-99-1	MW-01-6	MW-06-10	MW-06-20	PZ-12-1
MW-97-5	P-99-2	MW-02-1	MW-06-11	MW-06-21	MW-12-2
MW-97-6	PW-99-3	MW-02-2	MW-06-13	MW-06-22	MW-12-4
MW-97-7	P-99-4	MW-02-3	MW-06-14	MW-06-23	MW-12-7
MW-97-8	MW-01-1	MW-06-1	MW-06-15	MW-06-25	
Deep Wells					
MW-97-2	MW-02-4	MW-06-9	MW-06-24	MW-12-3	MW-12-6
MW-97-4	MW-06-6	MW-06-12	MW-12-1	MW-12-5	MW-12-8
Other Wells					
MW-06-4	MW-06-7				

Water Table Wells - screened across or near the water table.

Deep Wells - screened well below the water table.

"Other" Wells - screened in an aquitard (MW-06-4) and screened in tailings (MW-06-7).

See Section 3.2.1.1 for additional information.

Table 3.2-3
Hydraulic Conductivity Estimates
Rhodia Silver Bow Plant

Location	Material	Transmissivity (gpd/ft)	Horizontal Hydraulic Conductivity[1] (ft/day)	Method	Source
MW-01-1	Silty sand with clay	--	4.5	Slug test	Barr, 2006
MW-01-2	Silty sand with clay	--	1.9	Slug test	Barr, 2006
MW-01-3	Silty sand with clay	--	0.51	Slug test	Barr, 2006
MW-01-4	Silty sand with clay	--	0.38	Slug test	Barr, 2006
MW-01-5	Silty sand with clay	--	6.3	Slug test	Barr, 2006
MW-01-6	Silty sand with clay, sand and gravel, sand	--	0.61	Slug test	Barr, 2006
MW-02-1	Silty sand with clay	--	0.40	Slug test	Barr, 2006
MW-02-2	Silty sand	--	560	Slug test	Barr, 2006
MW-02-3	Silty sand, clay, sand, clayey sand	--	0.31	Slug test	Barr, 2006
MW-02-4	Silty sand with clay	--	5.4	Slug test	Barr, 2006
MW-06-1	Sand, clayey sand, silty sand	--	0.83	Slug test	Barr, 2006
MW-06-2	Silt, silty sand	--	0.25	Slug test	Barr, 2006
MW-06-3	Silt, silty sand	--	0.78	Slug test	Barr, 2006
MW-06-4	Mudstone/claystone	--	140	Slug test	Barr, 2006
MW-06-5	Sand, clay, clayey gravel	--	210	Slug test	Barr, 2006
MW-06-6	Silty clay, clayey silt	--	0.14	Slug test	Barr, 2006
MW-06-7	Tailings	--	0.0059	Slug test	Barr, 2006
MW-06-8	Clayey sand, sand, silt	--	0.69	Slug test	Barr, 2006
MW-06-9	Clayey silt, clay	--	1.5	Slug test	Barr, 2006
MW-06-10	Sand with silt, clay, silt	--	0.60	Slug test	Barr, 2006
MW-06-11	Silt, silty sand	--	0.57	Slug test	Barr, 2006
MW-06-12	Clay, sand, silt	--	200	Slug test	Barr, 2006
MW-06-13	Silt, gravel, sand	--	2.2	Slug test	Barr, 2006
MW-06-14	Silt with sand	--	0.28	Slug test	Barr, 2006
MW-06-15	Silt, silt with gravel	--	0.34	Slug test	Barr, 2006
MW-06-16	Silty sand, silty clay	--	2.4	Slug test	Barr, 2006
MW-06-17	Silty sand, silt	--	4.1	Slug test	Barr, 2006
MW-06-18	Silt with sand, clayey silt	--	0.43	Slug test	Barr, 2006
MW-06-19	Silt	--	0.19	Slug test	Barr, 2006
MW-06-20	Silty sand, silty sand	--	1.7	Slug test	Barr, 2006
MW-06-21	Clay, sand, silty clay	--	3.4	Slug test	Barr, 2006
MW-06-22	Silty sand, silt	--	1.4	Slug test	Barr, 2006
MW-06-23	Silt, silty sand	--	0.11	Slug test	Barr, 2006
MW-06-24	Silt, silty sand	--	5.6	Slug test	Barr, 2006
MW-06-25	Clayey silt, silty sand, clay	--	1.3	Slug test	Barr, 2006
MW-97-1	Silty lean clay	--	2.1	Slug test	Barr, 2006
MW-97-1	Silty lean clay	2,000	14	Specific Capacity Test	Barr, 1999
MW-97-1	Silty lean clay	4,800	--	Recovery Test	Barr, 1999
MW-97-2	Silty lean clay	--	17	Slug test	Barr, 2006
MW-97-2	Silty lean clay	2,800	37	Specific Capacity Test	Barr, 1999
MW-97-2	Silty lean clay	740	--	Recovery Test	Barr, 1999
MW-97-3	Sandstone? (poorly graded sand with silt)	--	130	Slug test	Barr, 2006
MW-97-3	Sandstone? (poorly graded sand with silt)	34,000	540	Specific Capacity Test	Barr, 1999
MW-97-4	Sandstone? (poorly graded sand with silt)	--	280	Slug test	Barr, 2006
MW-97-4	Sandstone? (poorly graded sand with silt)	67,000	910	Specific Capacity Test	Barr, 1999
MW-97-5	Silty sand, sand with silt, sand	--	1.5	Slug test	Barr, 2006
MW-97-6	Silty sand	--	2.1	Slug test	Barr, 2006
MW-97-7	Silty sand, silty sand with clay	--	2.4	Slug test	Barr, 2006
MW-97-8	Sand with silty, silty sand	--	0.56	Slug test	Barr, 2006
MW-97-9	Silty sand with clay, silt	--	96	Slug test	Barr, 2006
MW-97-10	Silty sand, sand with silt	--	4.7	Slug test	Barr, 2006
MW-97-11	Silty lean clay	--	0.020	Slug test	Barr, 2006
MW-97-12	Silty sand, silty sand with clay	--	0.51	Slug test	Barr, 2006
MW-EPA-1	Clay, silty clay	--	60	Slug test	Barr, 2006
MW-EPA-3	Sand, silty sand, clayey sand	--	56	Slug test	Barr, 2006

Table 3.2-3
Hydraulic Conductivity Estimates
Rhodia Silver Bow Plant

Location	Material	Transmissivity (gpd/ft)	Horizontal Hydraulic Conductivity[1] (ft/day)	Method	Source
MW-EPA-4	Sand, silty sand	--	30	Slug test	Barr, 2006
P-99-2	Alluvial sand	--	68	Slug test	Barr, 2006
P-99-2	Sheep Gulch Alluvial Sand	6,000	160	Pumping Test	Barr, 1999
P-99-2	Sheep Gulch Alluvial Sand	6,400	171	Pumping Test	Barr, 1999
P-99-2	Sheep Gulch Alluvial Sand	5,900	158	Recovery Test	Barr, 1999
P-99-2	Sheep Gulch Alluvial Sand	5,300	142	Recovery Test	Barr, 1999
P-99-4	Sheep Gulch Alluvial Sand	4,700	126	Pumping Test	Barr, 1999
P-99-4	Sheep Gulch Alluvial Sand	5,100	136	Pumping Test	Barr, 1999
P-99-4	Sheep Gulch Alluvial Sand	2,300	61	Recovery Test	Barr, 1999
P-99-4	Sheep Gulch Alluvial Sand	3,600	96	Recovery Test	Barr, 1999
PW-99-1	Alluvial sand	--	40	Slug test	Barr, 2006
GS-03	Silver Bow Creek alluvium	189,000 - 250,000	98 - 130	Unknown	Titan Environmental, 1994
TS-01	Silver Bow Creek alluvium	789,000	410	Unknown	Titan Environmental, 1994
Fortune Ranch	Shallow graben-fill	10 - 22	1 - 3	Pumping Test	Borduin, 1999
Joe Nelson	Sand and shale	--	10 - 140	Specific Capacity Data	Borduin, 1999
SB-97-5	Clay	--	--	Laboratory Test	Barr, 1998
SB-97-5	Clay	--	0.0043	In-situ falling head tests	Barr, 1998
Silver Bow Sludge Site	Clays to silty sand	2,900 - 42,400	1.1 - 15	Unknown	Titan Environmental, 1994
ASM-3	--	153,000	--	Unknown	Leonard Rice Consulting Engineers, Inc., 1997
ASM-8 Supply Well	Shale	25,000 - 34,000	150 - 180	Pumping Test	Borduin, 1999
BSB-1	Graben-fill sediment and Lowland Creek Volcanics	97,000 - 420,000	300 - 1,900	Pumping Test	Borduin, 1999
BSB-1	Graben-fill sediment and Lowland Creek Volcanics	--	2,200	Oscillatory Slug Test	Borduin, 1999
BSB-4	Graben-fill sediment and Lowland Creek Volcanics	1,200	3	Pumping Test	Borduin, 1999
BSB-4	Graben-fill sediment and Lowland Creek Volcanics	--	50	Oscillatory Slug Test	Borduin, 1999
BSB-5	Sand and clay	--	20	Specific Capacity Data	Borduin, 1999
RP-W-1	Sand and clay	50,000	220	Specific Capacity Data	Barr, 1999
RP-W-2	Sand and clay	71,000	340	Specific Capacity Data	Barr, 1999
RP-W-2	Sand and clay	40,000	70	Pumping Test	Borduin, 1999
RP-W-2A	Sand, gravel, clay	12,000	29	Specific Capacity Data	Barr, 1999
RP-W-2A	Sand, gravel, clay	2,700 - 5,600	5 - 9	Pumping Test	Borduin, 1999
RP-W-2A	Sand, gravel, clay	--	20	Specific Capacity Data	Borduin, 1999
RP-W-3	Sand and clay	59,000	350	Specific Capacity Data	Barr, 1999
RP-W-4	Sand, chert and clay	127,000	630	Specific Capacity Data	Barr, 1999
RP-W-5	Sand and clay	15,217	23	Specific Capacity Data	Barr, 1999
RP-W-6	Sand, chert and clay	700,000	2,100	Specific Capacity Data	Barr, 1999
RP-W-7	Sand and clay	12,000	20	Specific Capacity Data	Barr, 1999
RP-W-7	Sand and clay	--	10 - 40	Specific Capacity Data	Borduin, 1999
Site Production Wells	Graben-fill	38,500 - 148,000	--	Specific Capacity Data	Leonard Rice Consulting Engineers, Inc., 1997
Numerous	Graben-fill	170 - 88,000	0.14 - 2,900	Specific Capacity Data	Analysis of data obtained from the Montana Bureau of Mines and Geology, 1999
Numerous	Graben-fill	3,000 - 30,000	--	Unknown	Leonard Rice Consulting Engineers, Inc., 1997
SB-97-4	Tailings	--	0.0045	In-situ falling head tests	Barr, 1998

[1] Where both transmissivity and hydraulic conductivity are reported, the hydraulic conductivity was calculated using the transmissivity and the screen length of the well.

Table 3.2-4
Site Vertical Hydraulic Gradients
Rhodia Silver Bow Plant

Station ID	Location	Screened Interval [ft MSL]		Groundwater Elevation (11/2012)	Monitoring Well Nest	Magnitude of Gradient	Direction of Gradient
		Top	Bottom				
MW-97-1	Near Sheep Gulch, South of Tailing Basin	5343.1	5324.1	5338.36	MW-97-1/MW-97-2	6.7E-03	Down
MW-97-2		5305.1	5295.1	5338.15			
MW-06-5	Near Sheep Gulch, South of Tailing Basin	5344.7	5324.7	5339.45	MW-06-5/MW-06-6	1.6E-03	Down
MW-06-6		5194	5174	5339.22			
MW-97-3	North of Tailing Basin, East of Beaver Pond	5323.6	5303.6	5313.43	MW-97-3/MW-97-4	0.0E+00	None
MW-97-4		5285.6	5275.6	5313.43	MW-97-4/MW06-12	5.7E-04	Down
MW-06-12		5168	5148	5313.36			
MW-06-7	Tailing Basin	5343	5338	5345.49	MW-06-7/MW-06-8	9.8E-01	Down
MW-06-8		5311	5306	5314.28	MW-06-8/MW-06-9	-1.1E-02	Up
MW-06-9		5292	5282	5314.51			

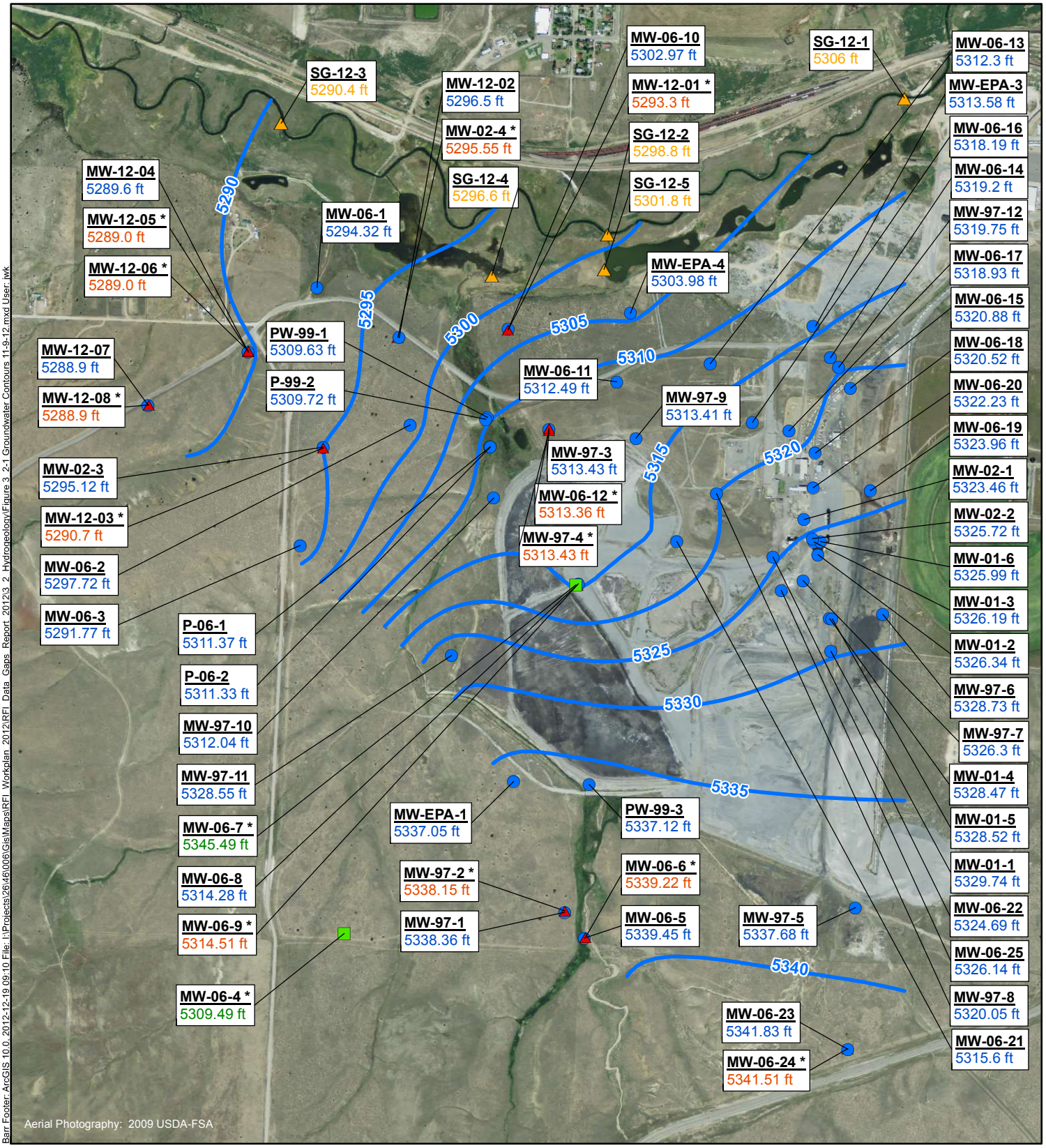
Note: Midpoint between water level and bottom of well used to calculate hydraulic gradient when water level intersects the screen.

Table 3.2-5
Historical Vertical Gradients at MW-97-3/MW-97-4/MW-06-12 Nest
Rhodia Silver Bow Site

Date	MW-97-3 Groundwater Elevation	MW-97-4 Groundwater Elevation	MW-06-12 Groundwater Elevation	MW-97-3/MW-97-4		MW-97-4/MW-06-12	
				Magnitude of Gradient	Direction of Gradient	Magnitude of Gradient	Direction of Gradient
10/1997	5313.81	5313.83	--	-7.1E-04	Up	--	--
11/1997	5313.46	5313.43	--	1.1E-03	Down	--	--
2/1998	5313.51	5313.53	--	-7.2E-04	Up	--	--
3/1998	5313.28	5313.28	--	0.0E+00	None	--	--
5/1998	5313.73	5313.68	--	1.8E-03	Down	--	--
7/1998	5314.02	5314.04	--	-7.1E-04	Up	--	--
8/1998	5313.84	5313.83	--	3.6E-04	Down	--	--
10/1998	5313.93	5313.92	--	3.6E-04	Down	--	--
10/1998	5314.07	5314.07	--	0.0E+00	None	--	--
1/1999	5314.03	5314.02	--	3.5E-04	Down	--	--
1/2002	5313.45	5313.43	--	7.2E-04	Down	--	--
8/2002	5313.35	5313.61	--	-9.3E-03	Up	--	--
9/2002	5313.50	5313.51	--	-3.6E-04	Up	--	--
5/2004	5313.60	5313.61	--	-3.6E-04	Up	--	--
9/2004	5313.75	5313.66	--	3.2E-03	Down	--	--
11/2004	5313.81	5313.76	--	1.8E-03	Down	--	--
1/2005	5313.71	5313.71	--	0.0E+00	None	--	--
3/2005	5313.70	5313.72	--	-7.1E-04	Up	--	--
10/2005	5313.68	5313.68	--	0.0E+00	None	--	--
3/2006	5313.54	5313.54	--	0.0E+00	None	--	--
5/2006	5313.55	5313.56	--	-3.6E-04	Up	--	--
8/2006	5313.51	5313.61	--	-3.6E-03	Up	--	--
11/2006	5313.68	5313.69	5313.61	-3.6E-04	Up	6.4E-04	Down
3/2007	5313.47	5313.48	5313.58	-3.6E-04	Up	-7.8E-04	Up
6/2007	5313.65	5313.65	5313.59	0.0E+00	None	4.8E-04	Down
10/2007	5313.61	5313.61	5313.53	0.0E+00	None	6.4E-04	Down
2/2008	5313.44	5313.43	5313.38	3.6E-04	Down	4.0E-04	Down
5/2008	5313.57	5313.56	5313.50	3.6E-04	Down	4.8E-04	Down
9/2008	5313.56	5313.56	5313.49	0.0E+00	None	5.6E-04	Down
11/2008	5313.48	5313.48	5313.39	0.0E+00	None	7.2E-04	Down
4/2009	5313.46	5313.48	5313.38	-7.2E-04	Up	7.9E-04	Down
7/2009	5313.45	5313.43	5313.41	7.2E-04	Down	1.7E-04	Down
10/2009	5313.46	5313.41	5313.34	1.8E-03	Down	5.6E-04	Down
2/2010	5313.29	5313.26	5313.20	1.1E-03	Down	4.8E-04	Down
7/2010	5313.41	5313.41	5313.35	3.3E-14	None	4.8E-04	Down
8/2011	5313.44	5313.41	5313.37	1.1E-03	Down	3.2E-04	Down
3/2012	5313.29	5313.25	5313.21	1.4E-03	Down	3.2E-04	Down
11/2012	5313.43	5313.43	5313.36	0.0E+00	None	5.5E-04	Down

12/18/2012
P:\Mpls\26 MT\46\2646006\WorkFiles\RFI\RFI Final Ph I 2012\Section 3.0\Section 3.2-Hydrogeology\Tables 3.2\UPDATED Table 3.2-5_Historical_MW9734_Gradients.xls

Figures



Well Depth

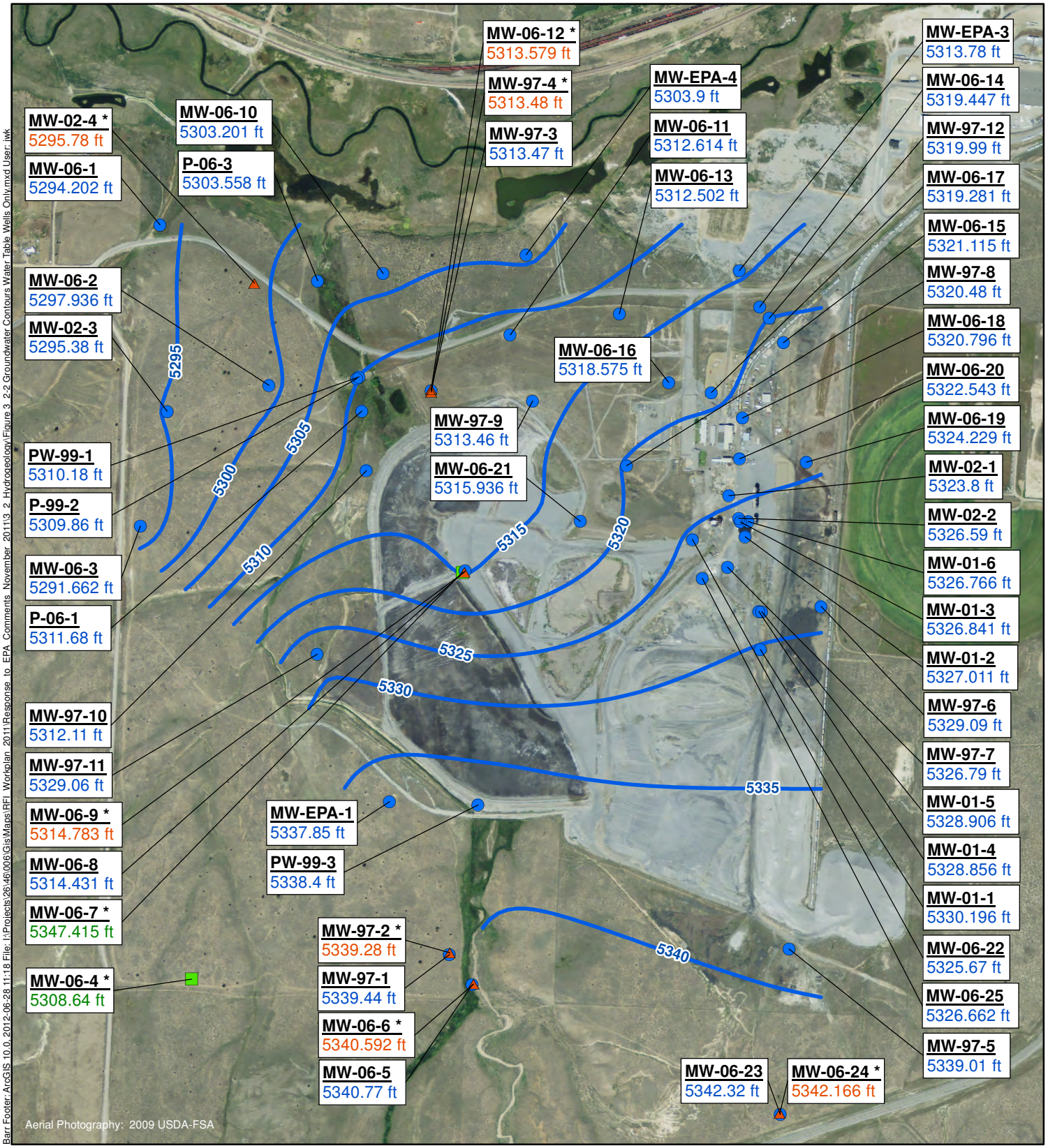
- Deep
- Water Table
- Staff Gauge
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-1

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
11/9/2012 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Barr Footer: ArcGIS 10.0, 2012-06-28 11:18 File: I:\Projects\26\46006\Gis\Maps\RFI Workplan 2011\Response to EPA Comments November 2011\3 2 Hydrogeology\Figure 3 2-2 Groundwater Contours Water Table Wells Only.mxd User: jwk

Well Depth

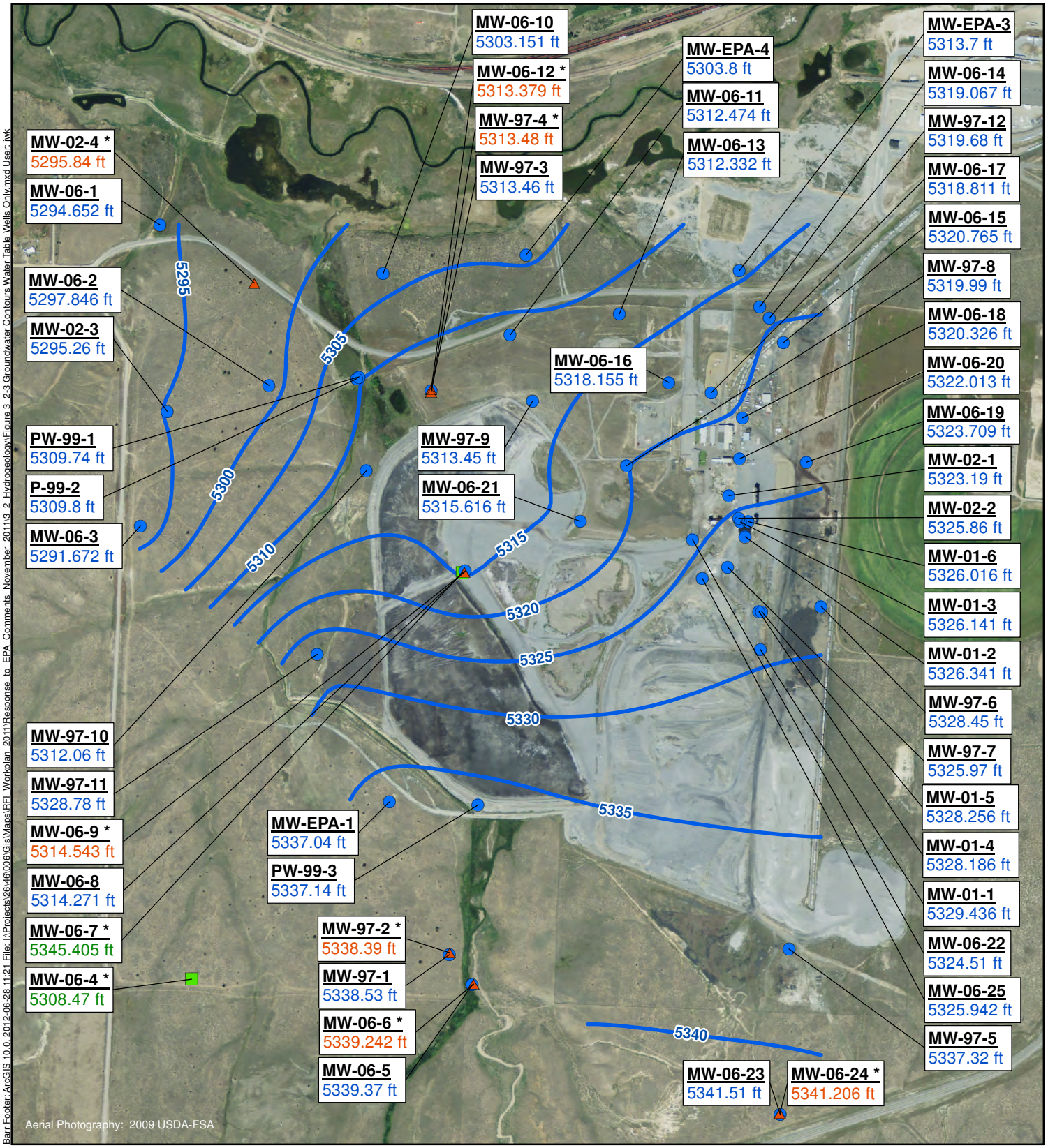
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-2

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
03/09/2007 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

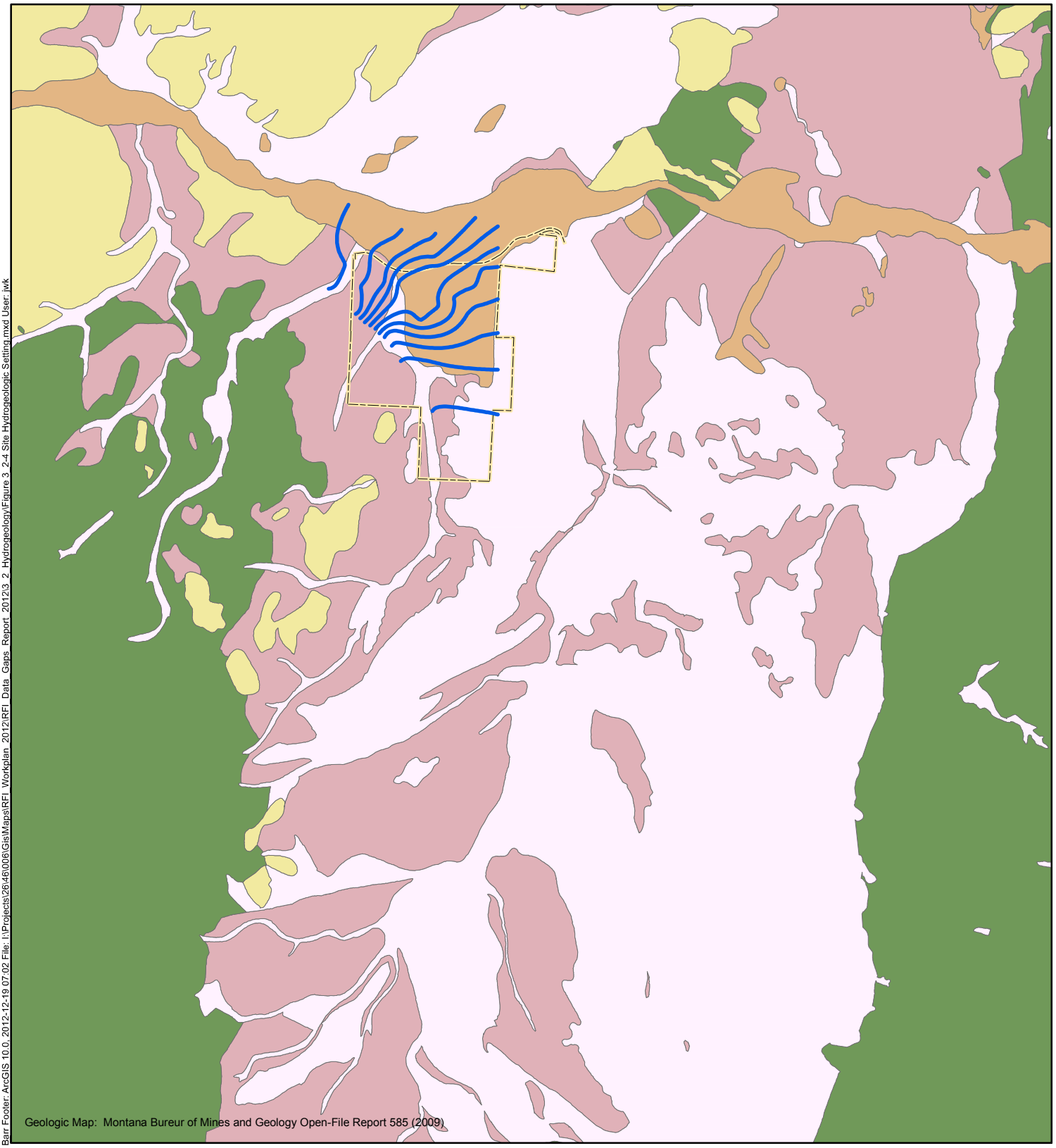
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-3

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
04/04/2009 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



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Site Groundwater Contour (ft MSL)

Property Boundary

GEOLOGY

- Graben-Fill Deposit
- Granitic
- Modified
- Surficial Deposit
- Volcanic

N

1 0 1

Miles

Figure 3.2-4

SITE HYDROGEOLOGIC SETTING
GROUNDWATER CONTOURS
11/9/2012 MEASUREMENTS
Rhodia Silver Bow Plant
Montana

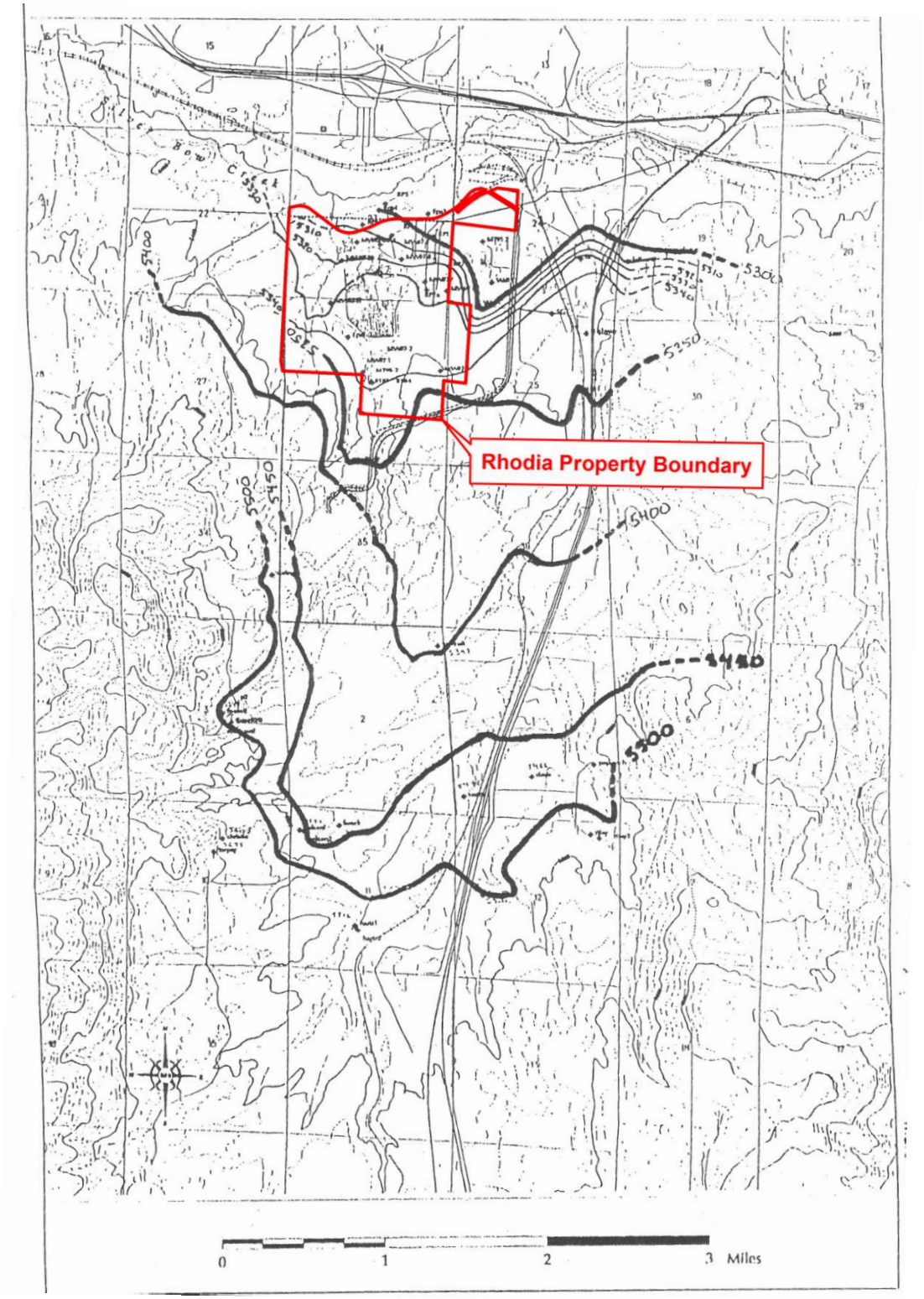


Figure 3.2-5
MARCH 1998 REGIONAL GROUNDWATER CONTOURS (50-FT INTERVAL)
(Reproduced from Borduin, 1999)
Rhodia Silver Bow Plant
Montana

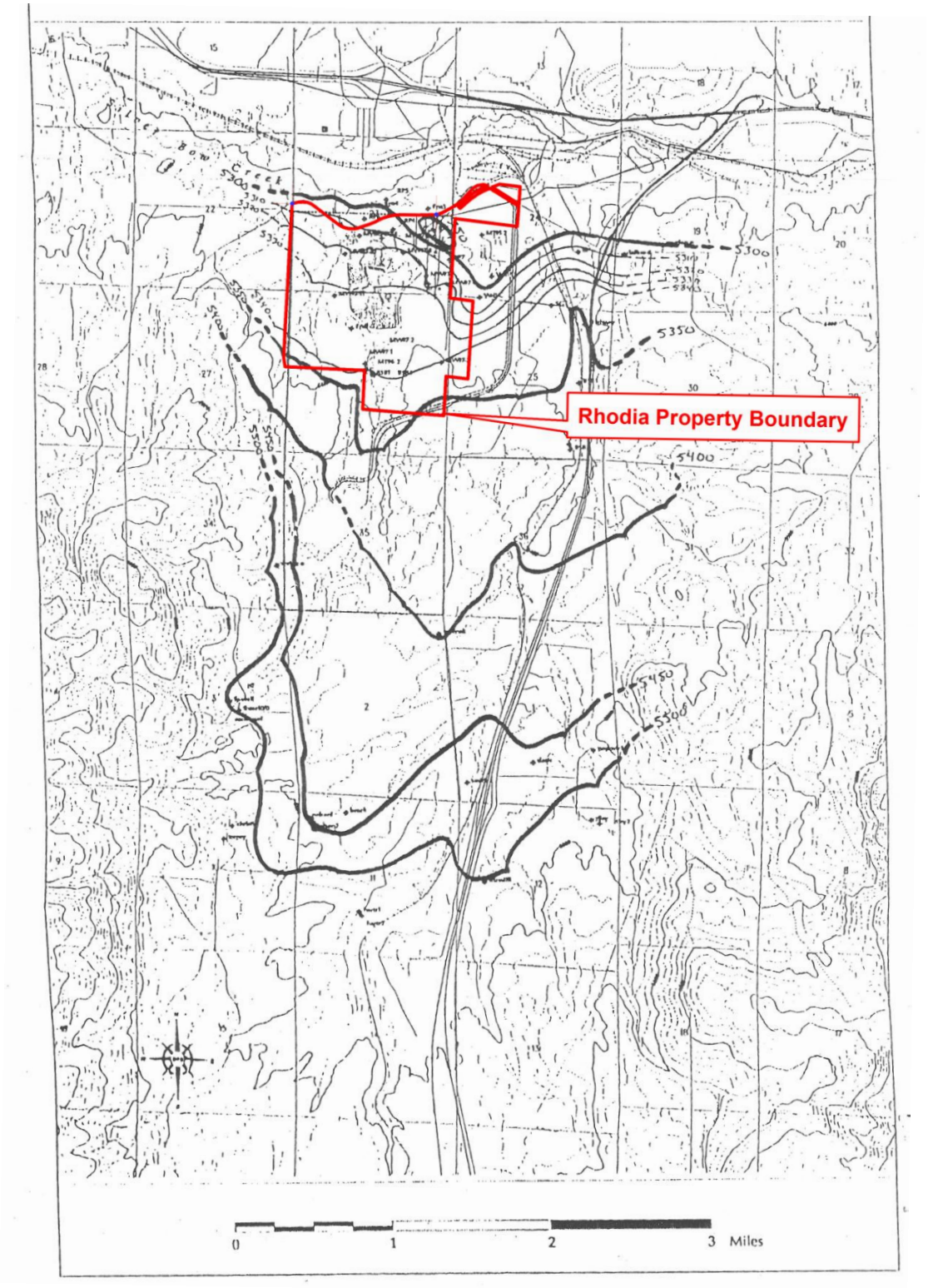


Figure 3.2-6
SEPTEMBER 1998 REGIONAL GROUNDWATER CONTOURS (50-FT INTERVAL)
(Reproduced from Borduin, 1999)
Rhodia Silver Bow Plant
Montana

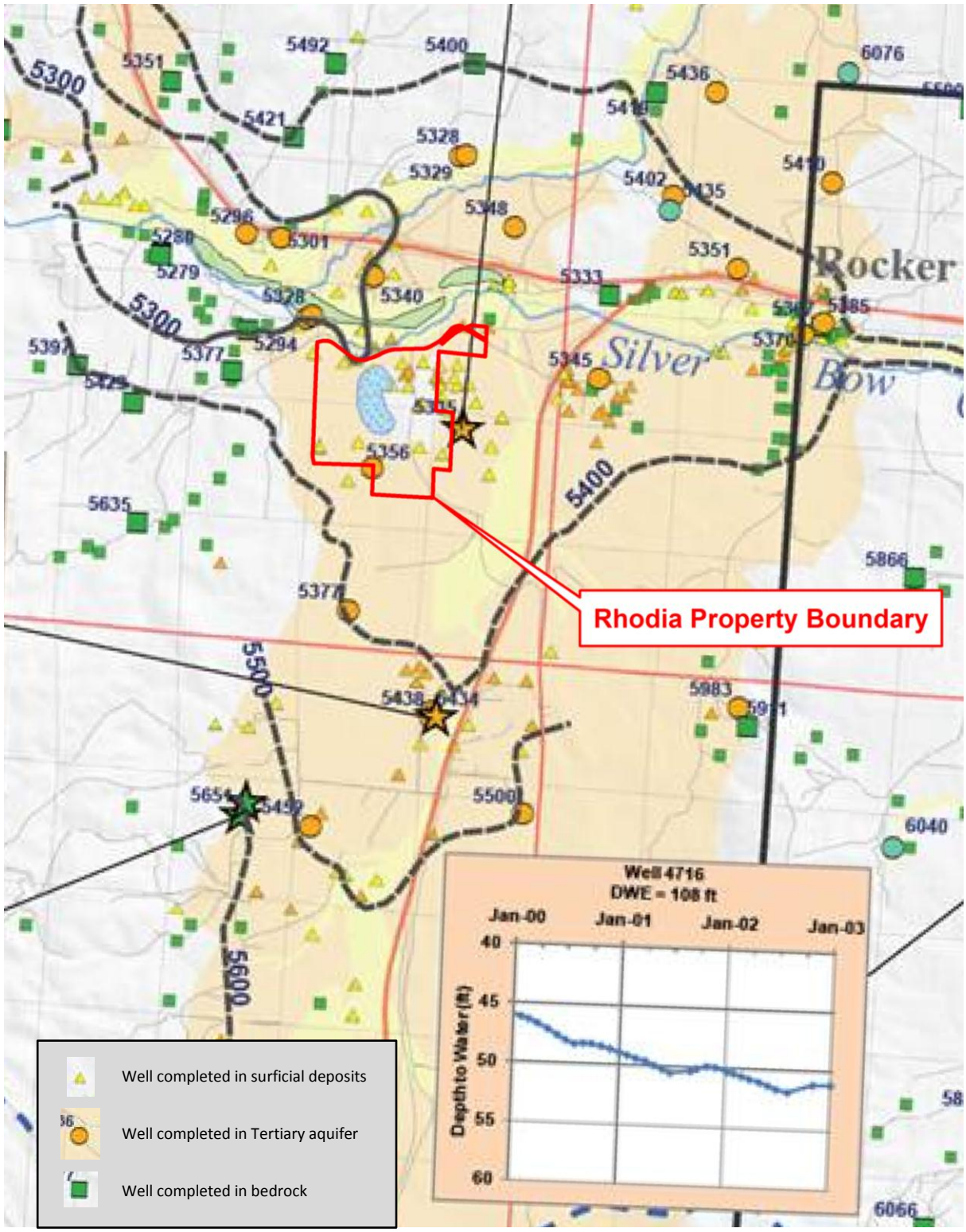
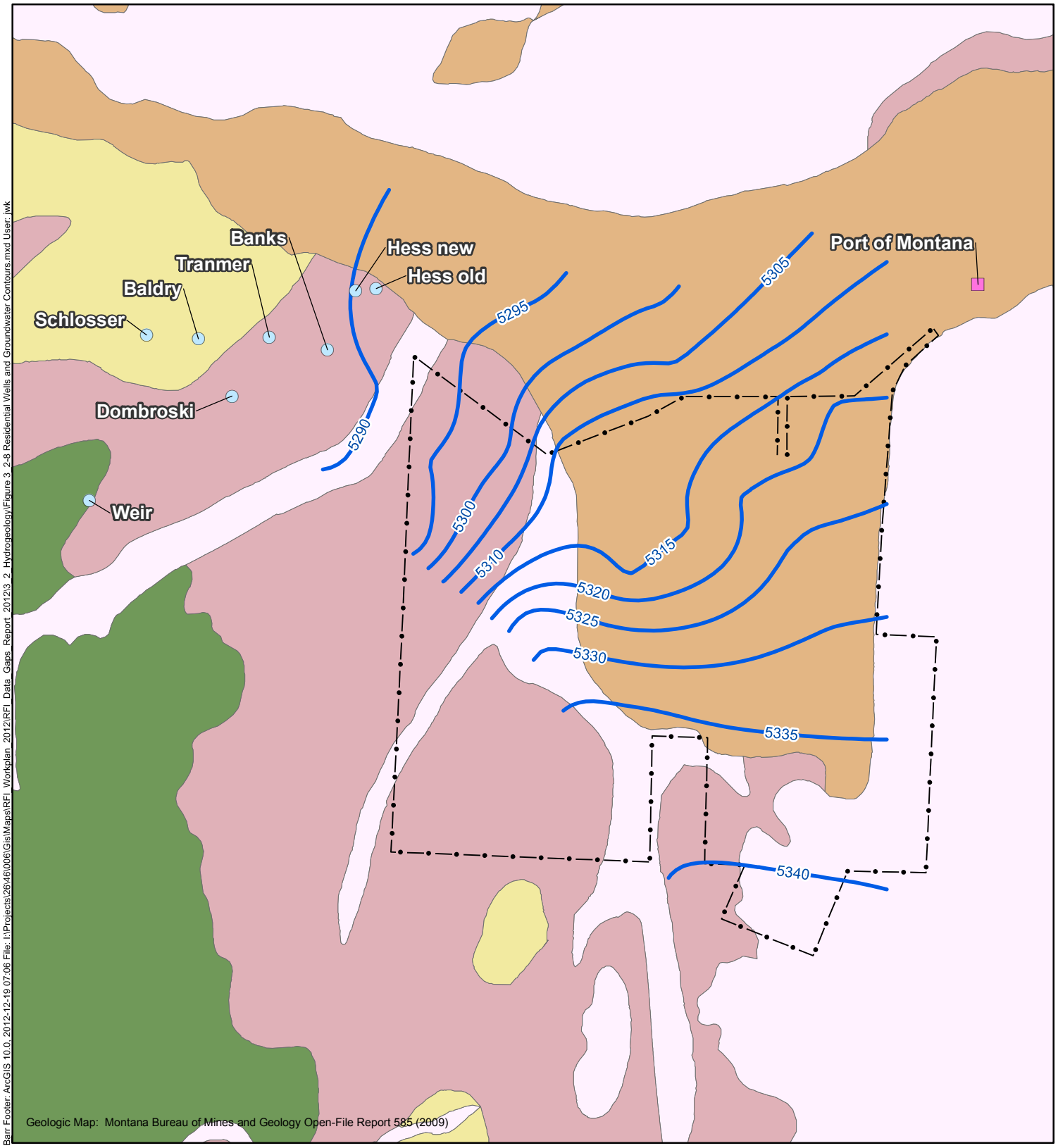


Figure 3.2-7
REGIONAL GROUNDWATER CONTOURS (100-FT CONTOUR INTERVAL)
(Source: Waren and LaFave, 2011)
Rhodia Silver Bow Plant
Montana



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Residential Well
Industrial Well
Site Groundwater Contour (ft MSL)
Fence Line

GEOLOGY

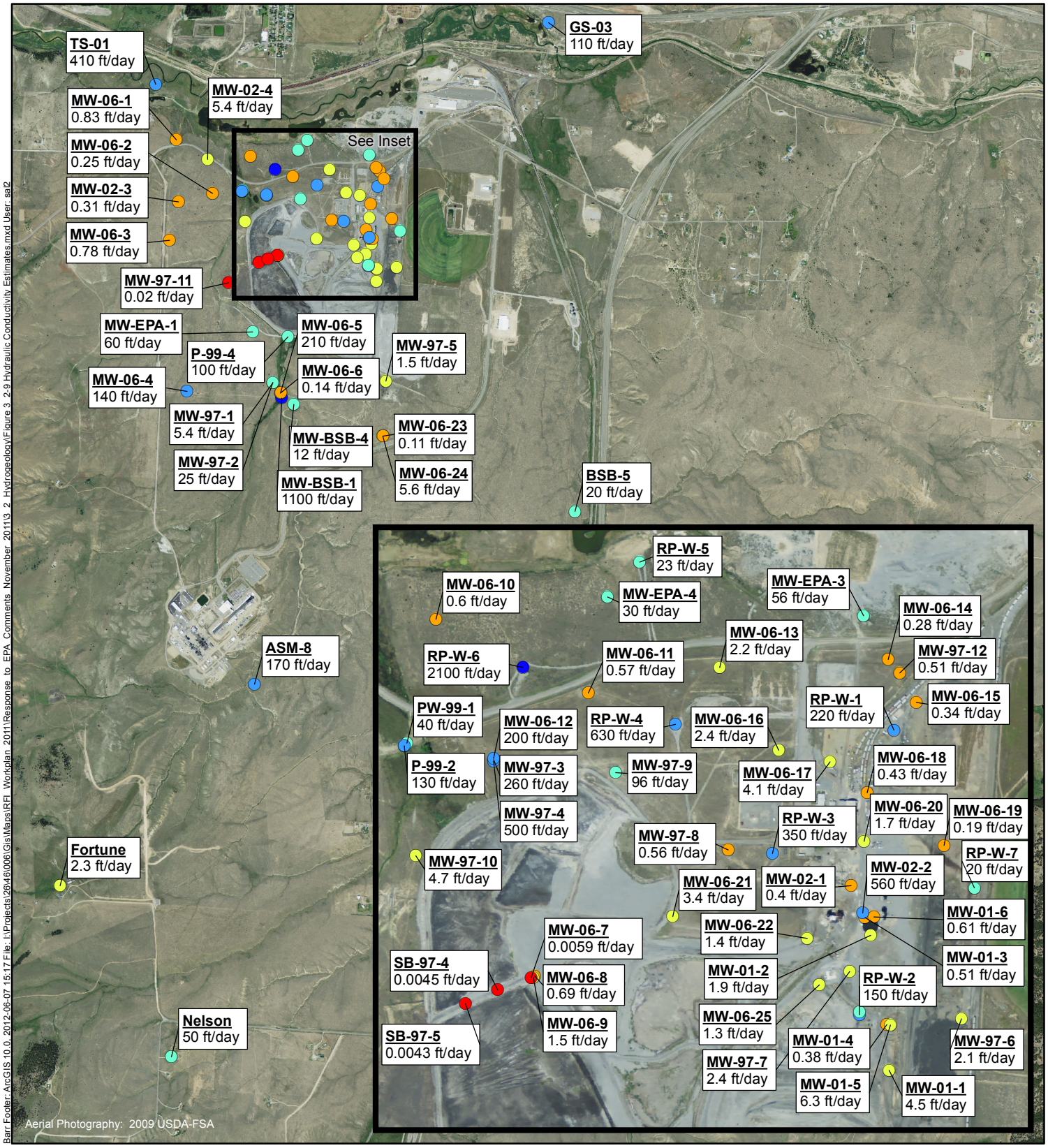
Graben-Fill Deposit
Granitic
Modified
Surficial Deposit
Volcanic

N

Feet
1,500 0 1,500

Figure 3.2-8

RESIDENTIAL WELL LOCATIONS
GROUNDWATER CONTOURS
11/9/2012 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Hydraulic Conductivity (Feet/Day)

- 0.01 - 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100
- 100 - 1,000
- 1,000 - 10,000

N

Feet

3,000 0 3,000

Figure 3.2-9

HYDRAULIC CONDUCTIVITY ESTIMATES
Rhodia Silver Bow Plant
Montana

Barr Footer: ArcGIS 10.0, 2012-06-07 15:15 File: i:\Projects\26\46\006\Gis\Maps\RFI Workplan 2011\Response to EPA Comments November 20113 2 Hydrogeology\Figure 3 2-10 Production Wells.mxd User: sal2

- Continuously Operated Well
- Intermittently Used Well
- Unused Well

N

Feet

1,000 0 1,000

FIGURE 3.2-10

PRODUCTION WELLS
Rhodia Silver Bow Plant
Montana

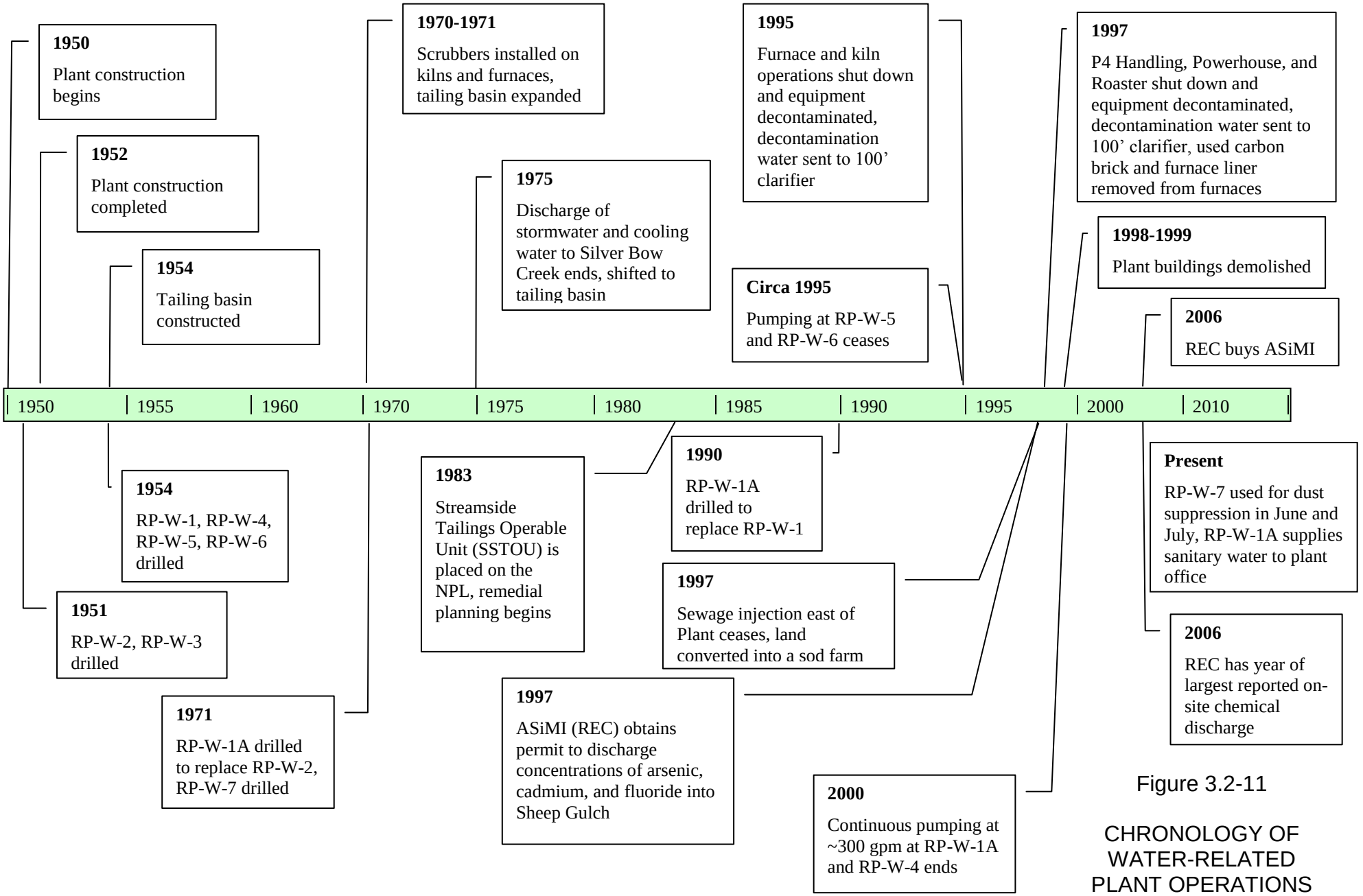


Figure 3.2-11

CHRONOLOGY OF WATER-RELATED PLANT OPERATIONS
Rhodia Silver Bow Plant
Montana

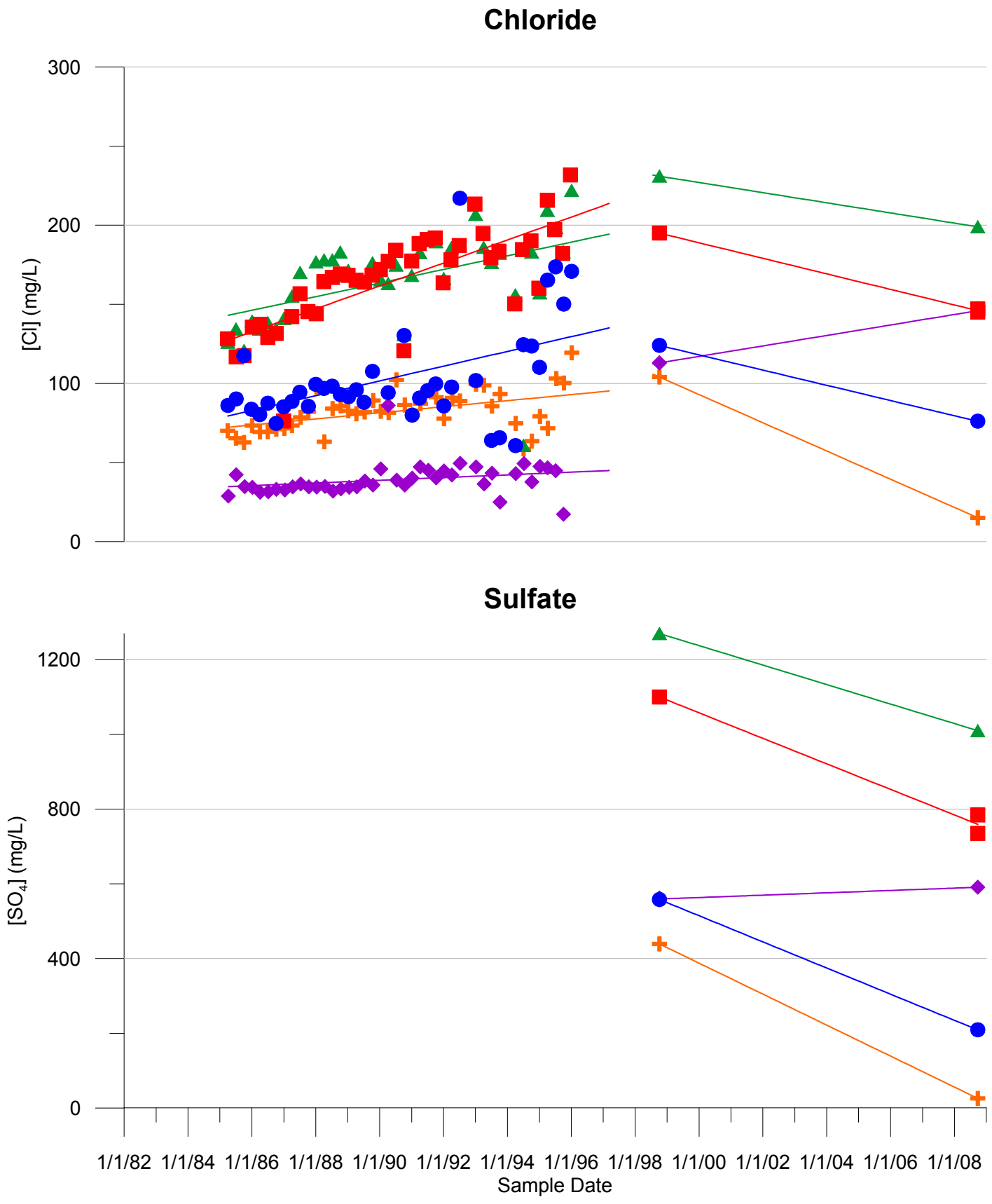
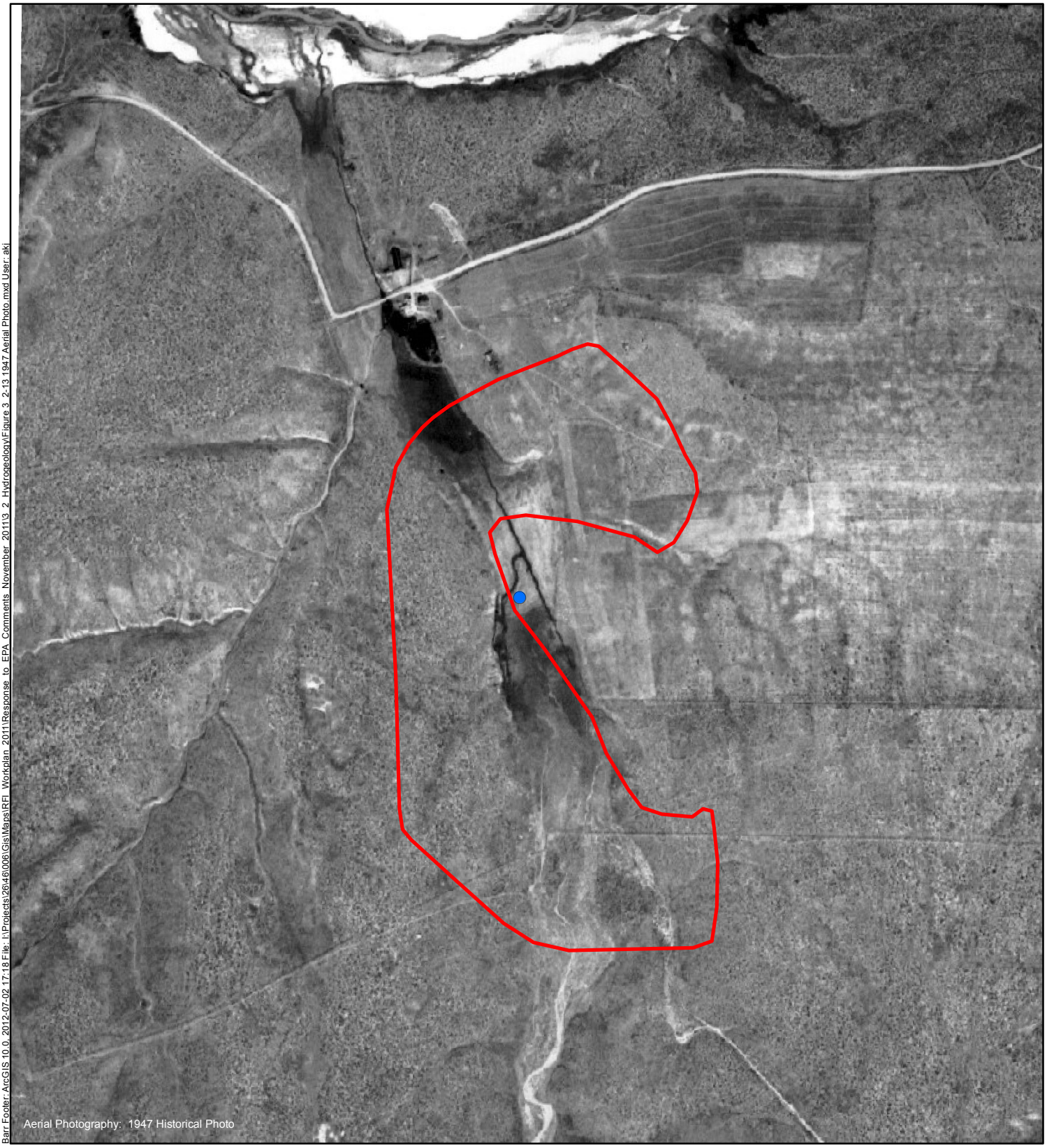


Figure 3.2-12

SAMPLING DATA AT
RHODIA PRODUCTION WELLS
Rhodia Silver Bow Plant
Montana



MW-06-7/MW-06-8/MW-06-9 Well Nest

Tailing Basin Outline

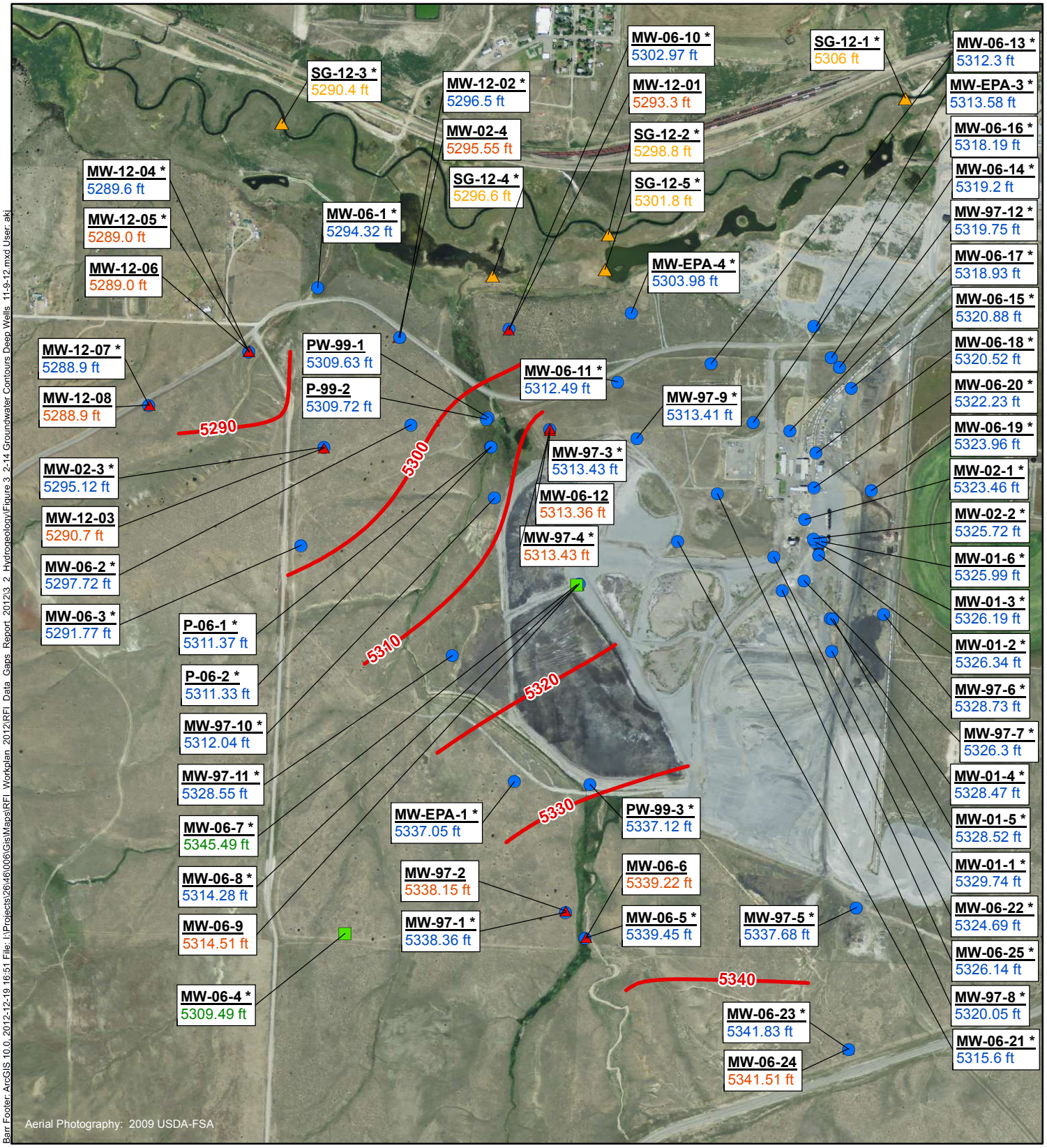
N

Feet

1,000 0 1,000

Figure 3.2-13

PRE-PLANT AERIAL PHOTO
August 27, 1947
Rhodia Silver Bow Plant
Montana



Well Depth

- Deep
- Water Table
- Staff Gauge
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

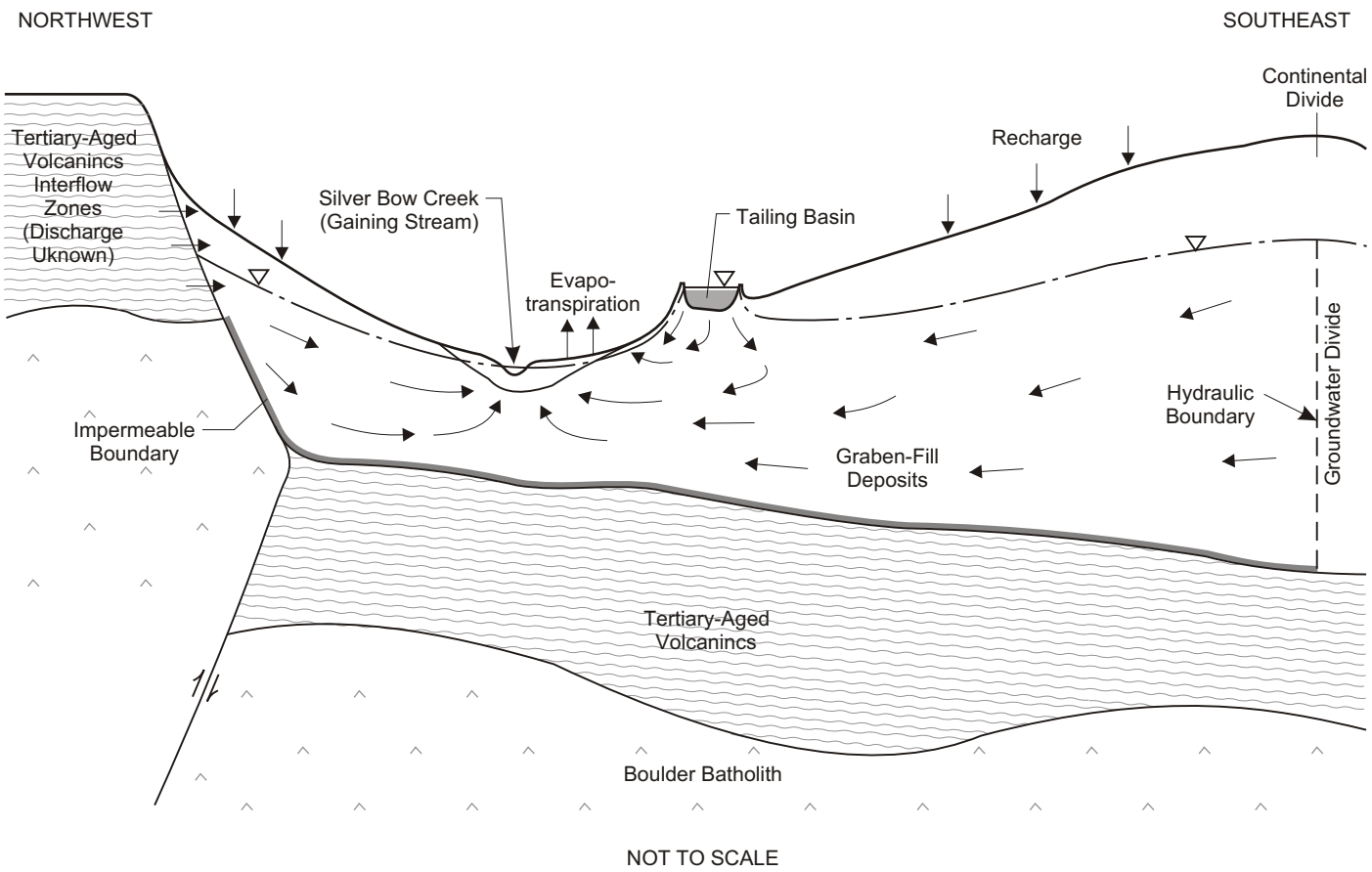
N

Feet

1,000 0 1,000

Figure 3.2-14

GROUNDWATER CONTOURS
DEEP WELLS ONLY
11/9/2012 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



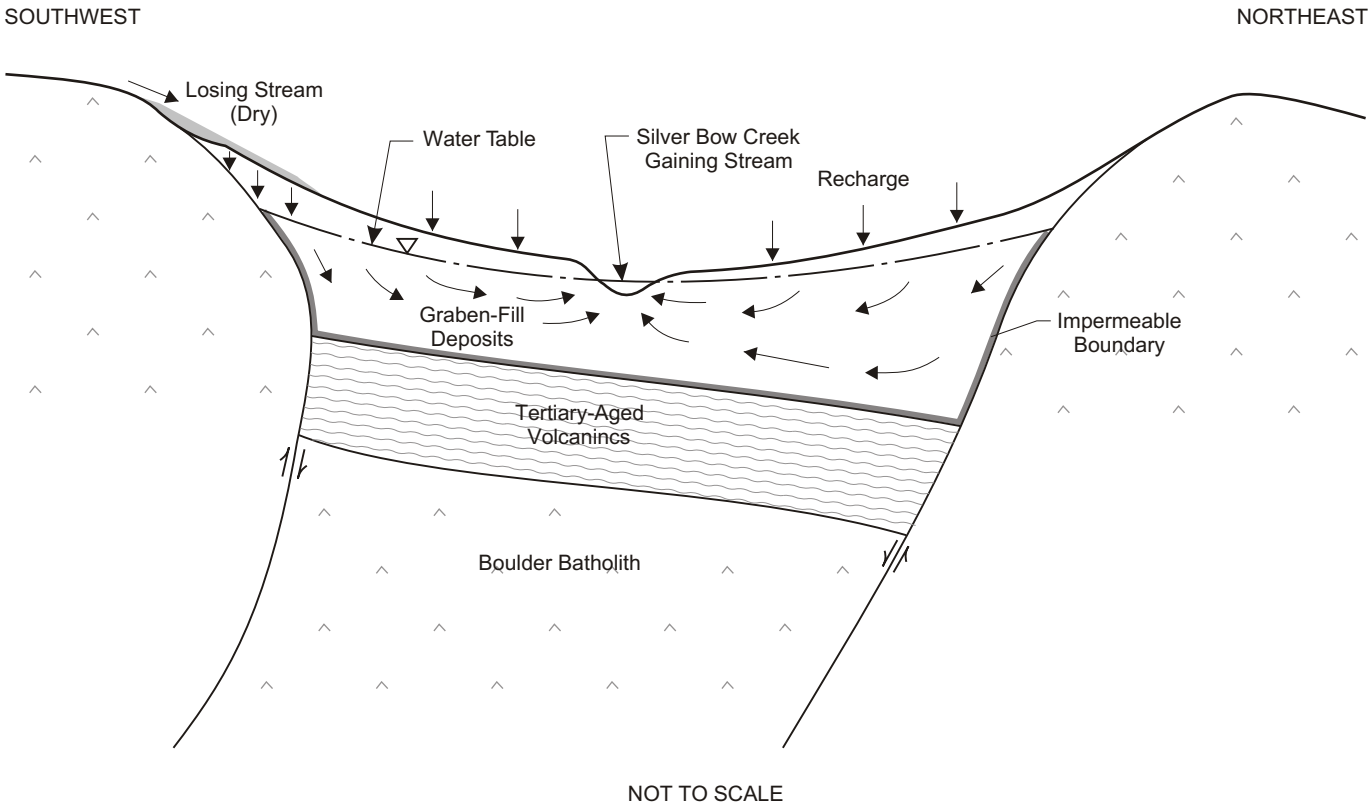
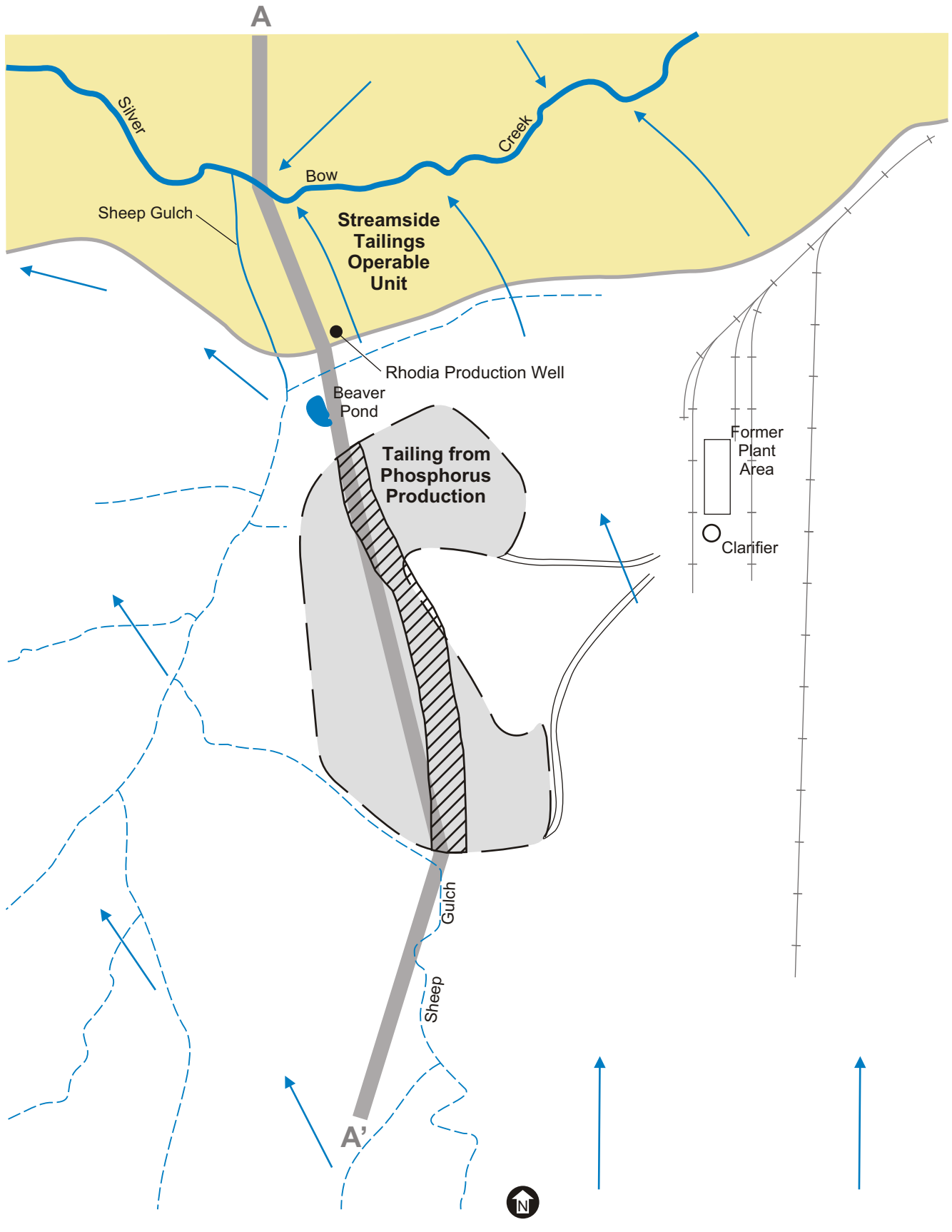


Figure 3.2-15

REGIONAL CONCEPTUAL
HYDROGEOLOGIC CROSS SECTIONS
Rhodia Silver Bow Plant
Montana

P:\26\46006\Workfiles\Figures_Graphics\Hydrogeologic Cross Sections.CDR RLG 06-28-12



P:\26\46\006\WorkFiles\Figures_Graphic\Conceptual Model of Site Area Groundwater Flow.CDR RLG 06-28-12

Figure 3.2-16

CONCEPTUAL MODEL OF SITE AREA
GROUNDWATER FLOW
Rhodia Silver Bow Plant
Montana

P:\Mpls\26 MT\46\2646006\WorkFiles\Figures_Graphics\2012 Cross Sections\Conceptual Cross Section During Operations.CDR RLG 06-28-12

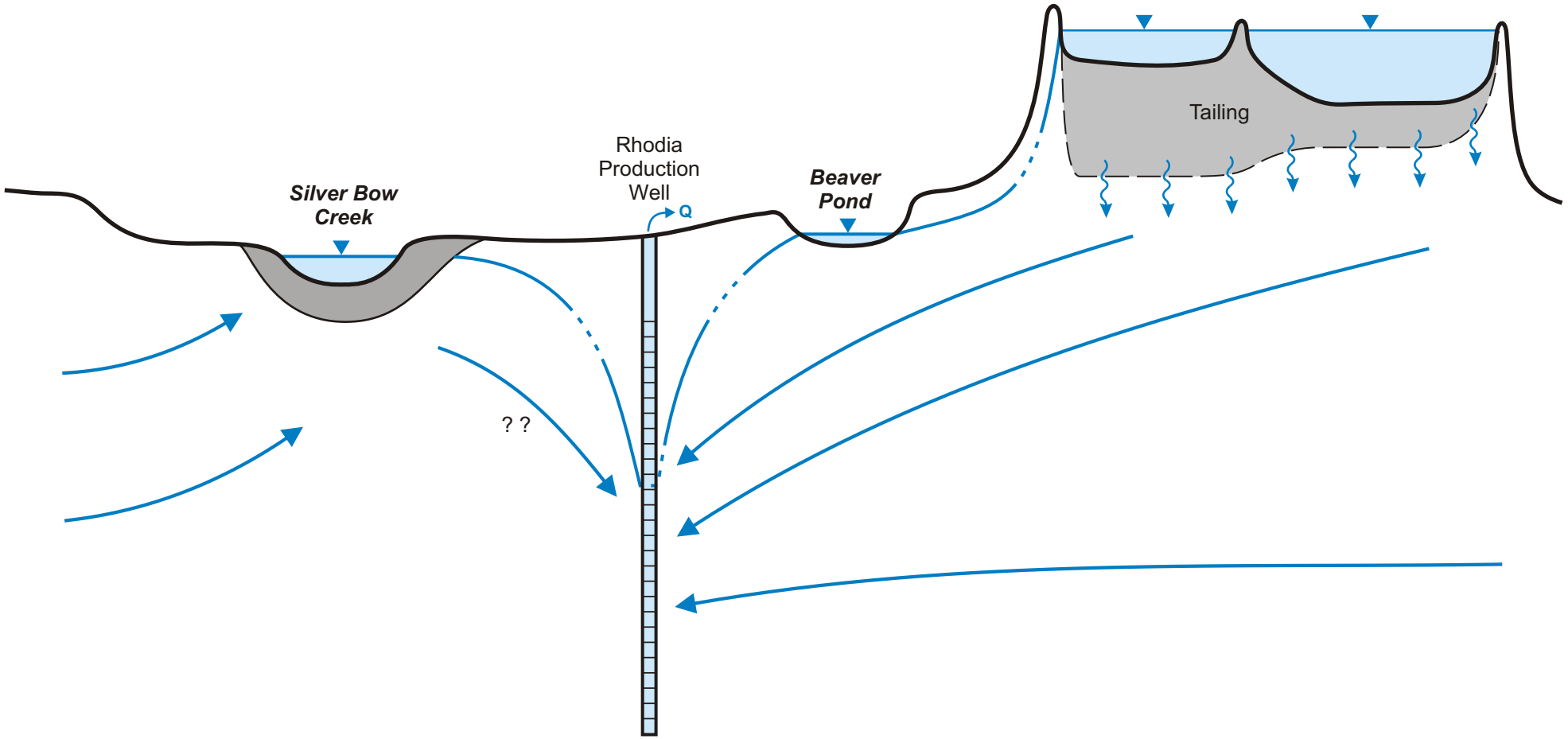


Figure 3.2-17

CONCEPTUAL CROSS SECTION DURING OPERATIONS
Rhodia Silver Bow Plant
Montana

P:\Mpls\26 MT\46\2646006\WorkFiles\Figures_Graphics\2012 Cross Sections\Conceptual Cross Section Post Shutdown.CDR RLG 06-28-12

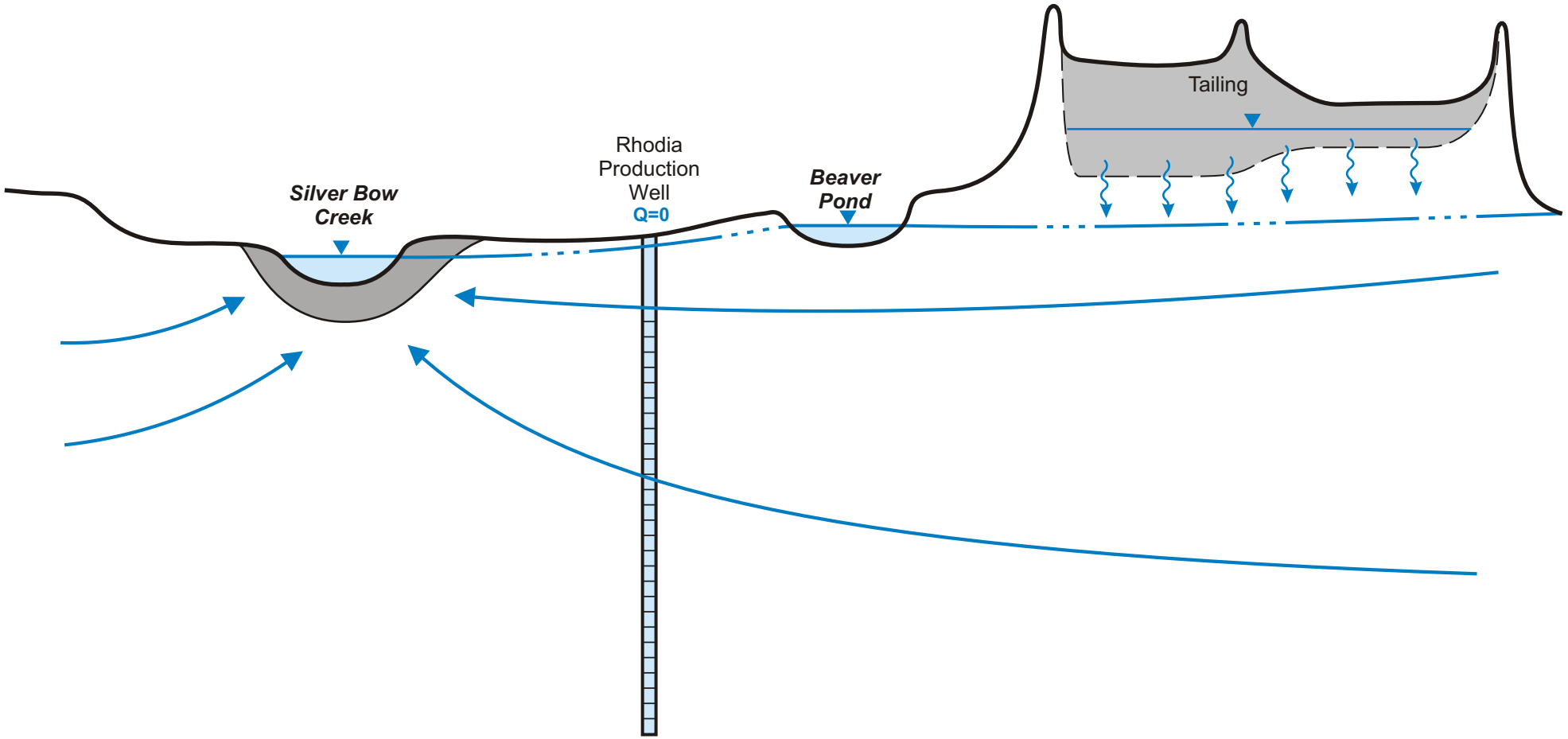


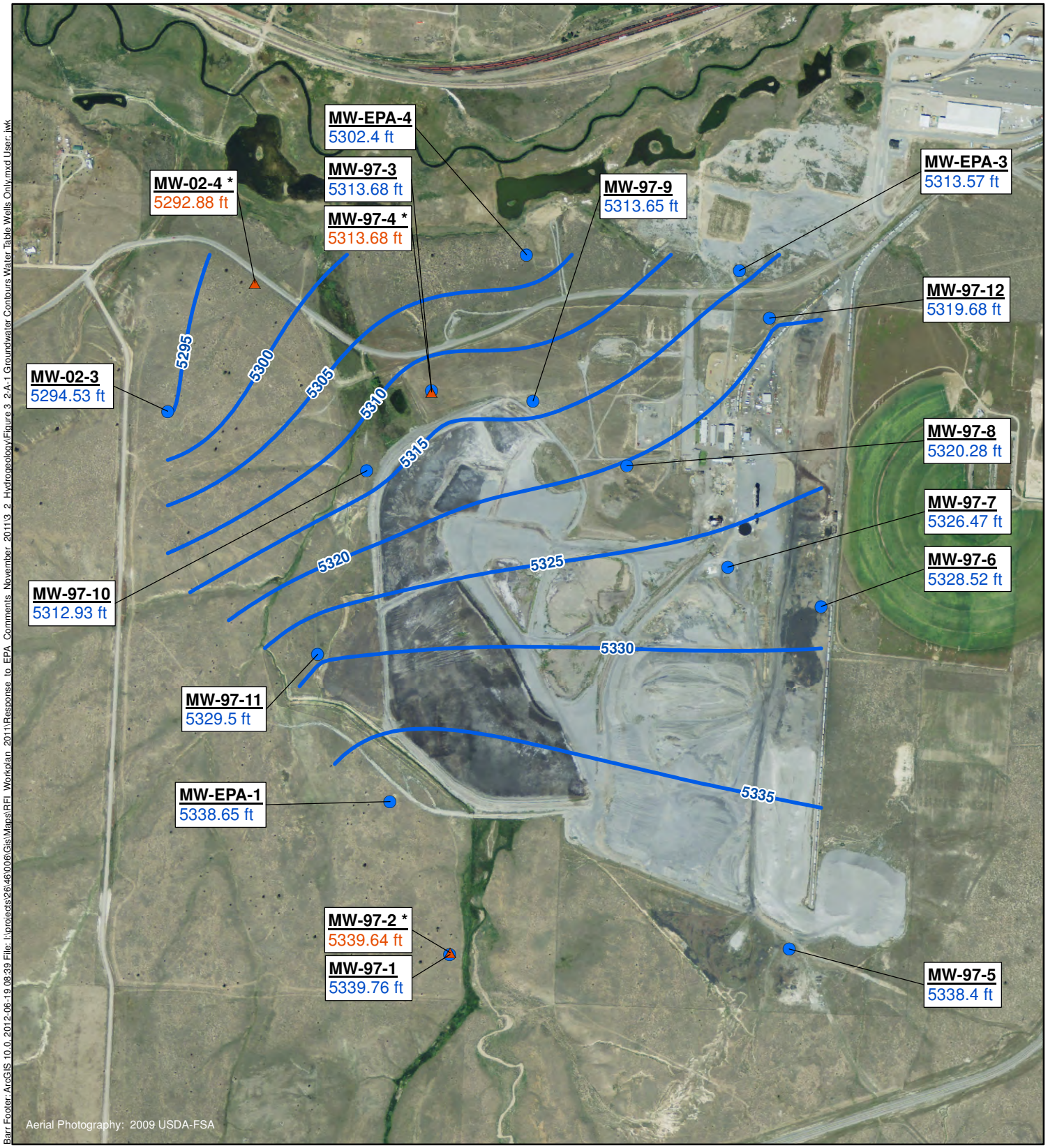
Figure 3.2-18

CONCEPTUAL CROSS SECTION POST SHUTDOWN
Rhodia Silver Bow Plant
Montana

Appendices

Appendix 3.2-A

Groundwater Contours (10/2005 – 3/2012)



Barr Footer: ArcGIS 10.0, 2012-06-19 08:39 File: I:\projects\26\46006\Gis\Maps\RFI Workplan 2011\Response to EPA Comments November 2011\3_2 Hydrogeology\Figure 3_2-A-1 Groundwater Contours Water Table Wells Only.mxd User: jwk

Well Depth

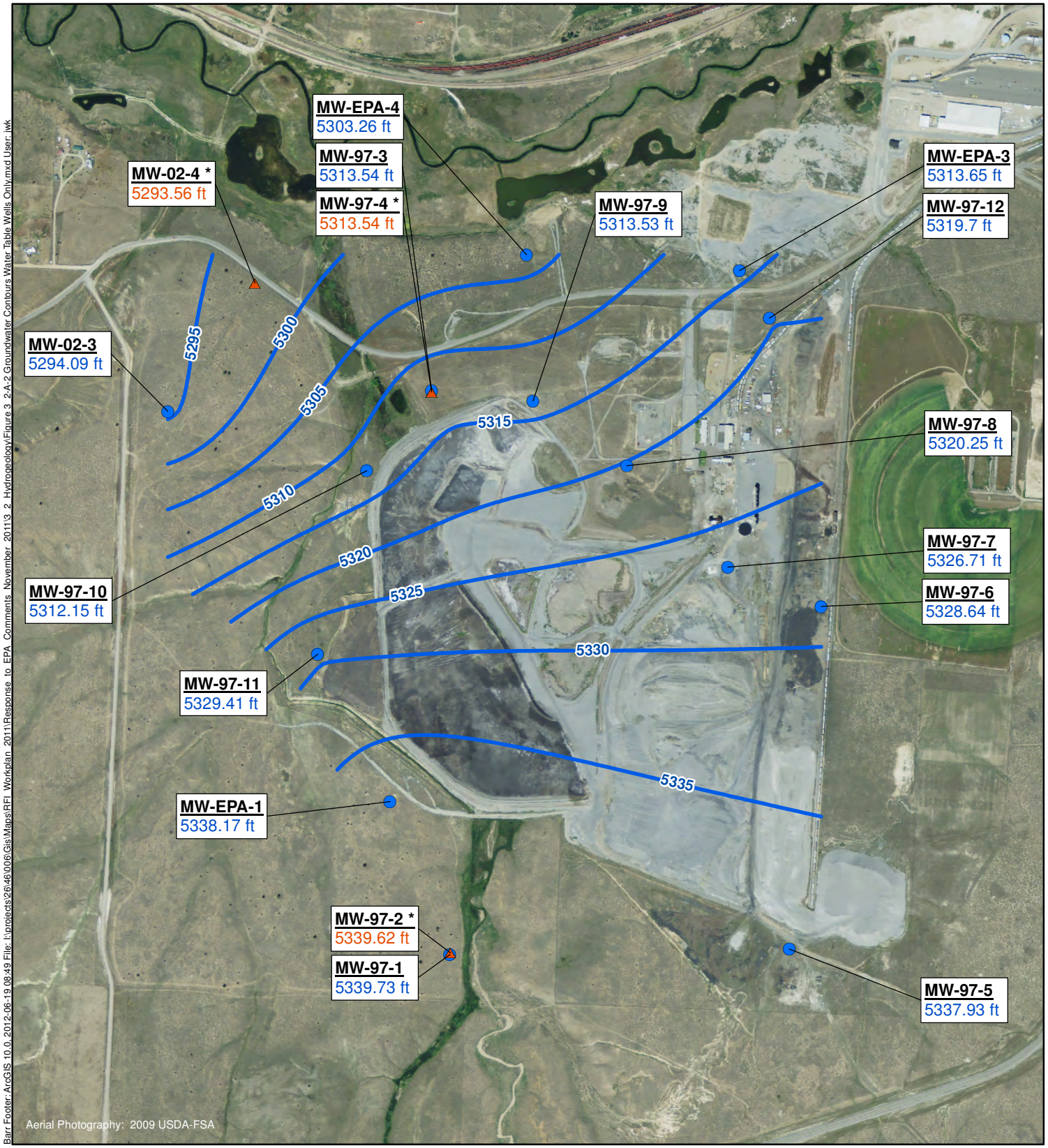
- Deep
- Water Table
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-1

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
10/31/2005 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



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Well Depth

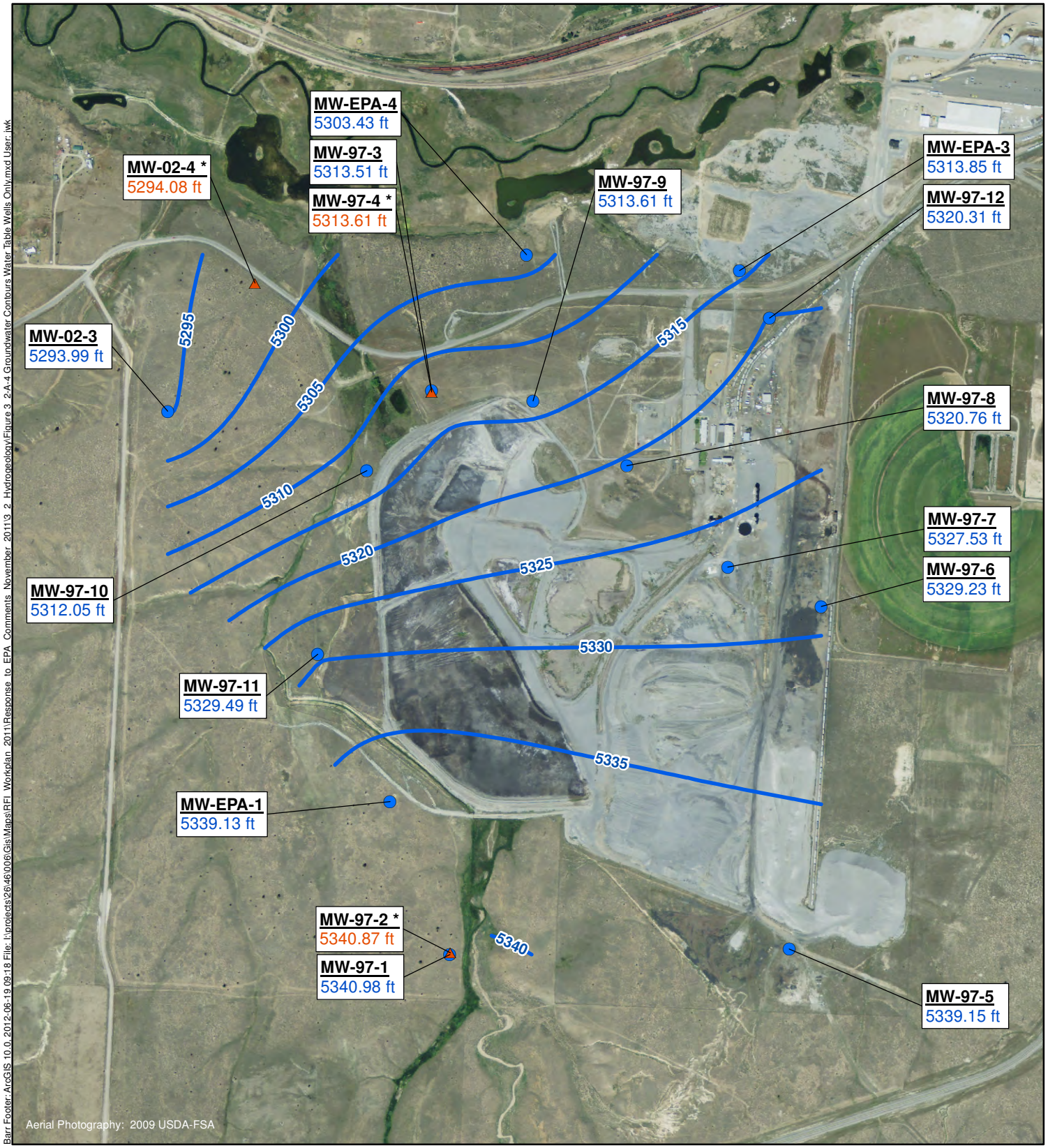
- Deep
- Water Table
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-2

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
03/27/2006 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Barr Footer: ArcGIS 10.0, 2012-06-19 09:18 File: I:\projects\26\46006\Gis\Maps\RFI Workplan 2011\Response to EPA Comments November 20113 2 Hydrogeology\Figure 3 2-A-4 Groundwater Contours Water Table Wells Only.mxd User: jwk

Well Depth

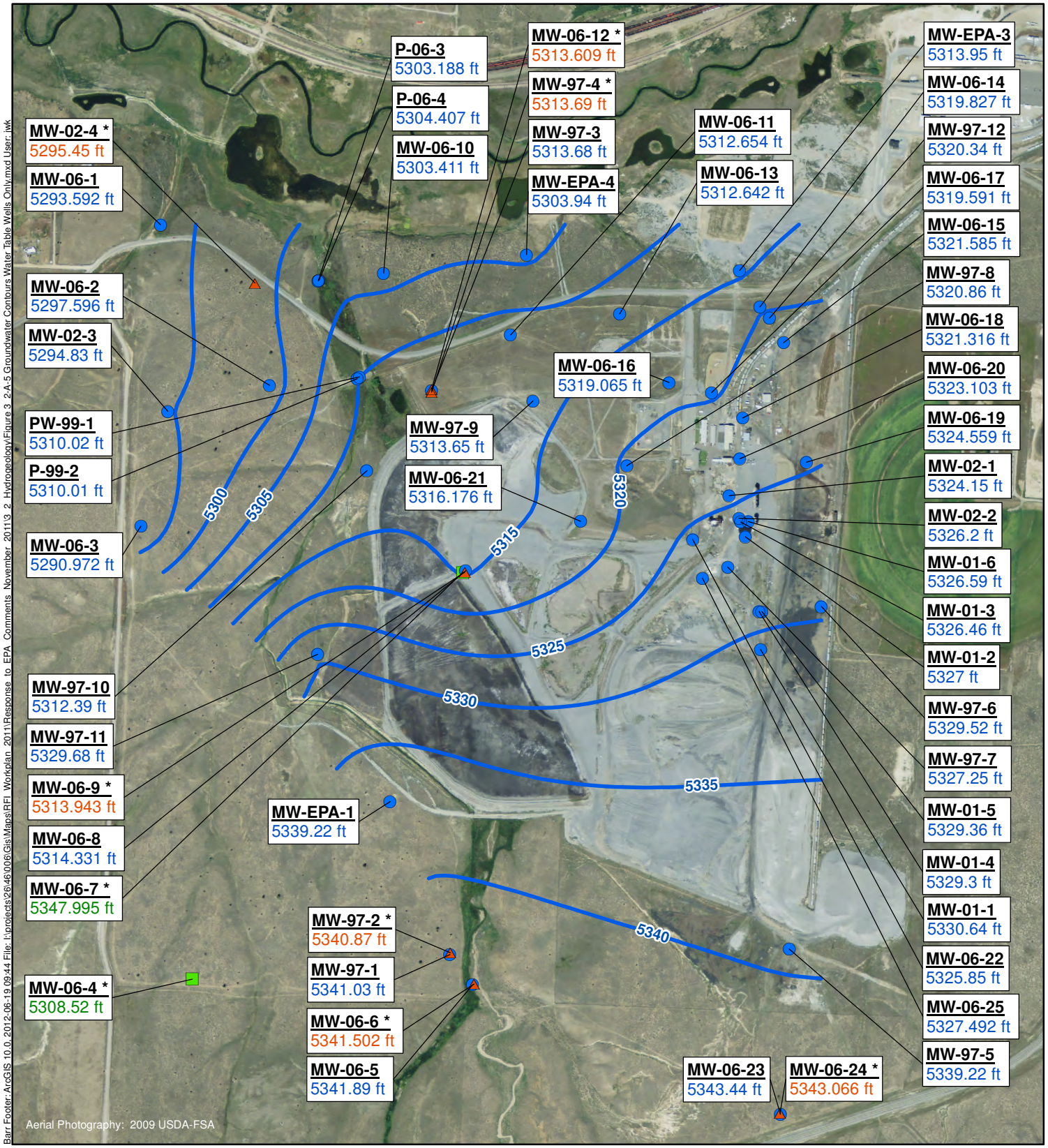
- Deep
- Water Table
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-4

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
08/31/2006 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

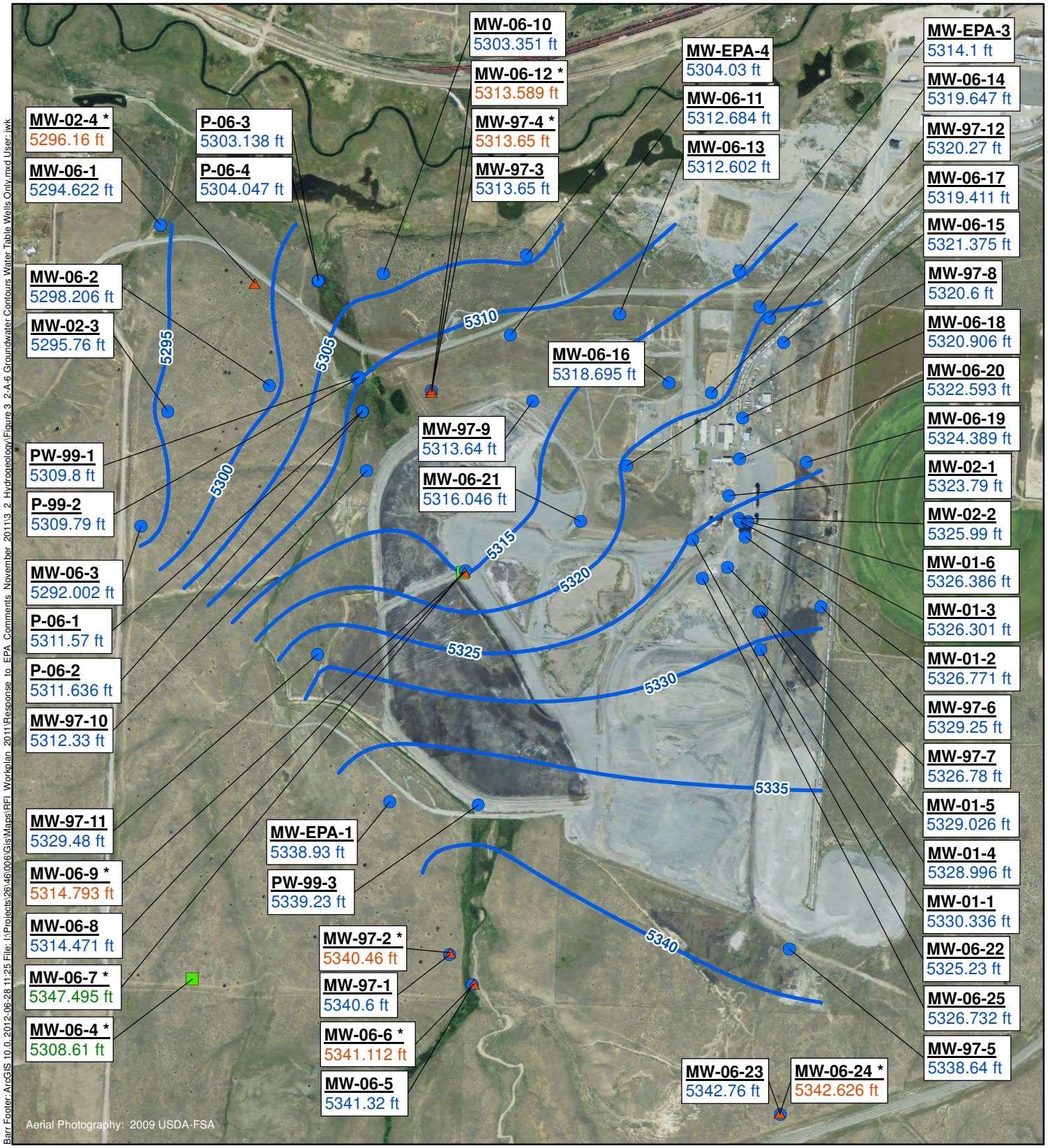
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-5

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
11/01/2006 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

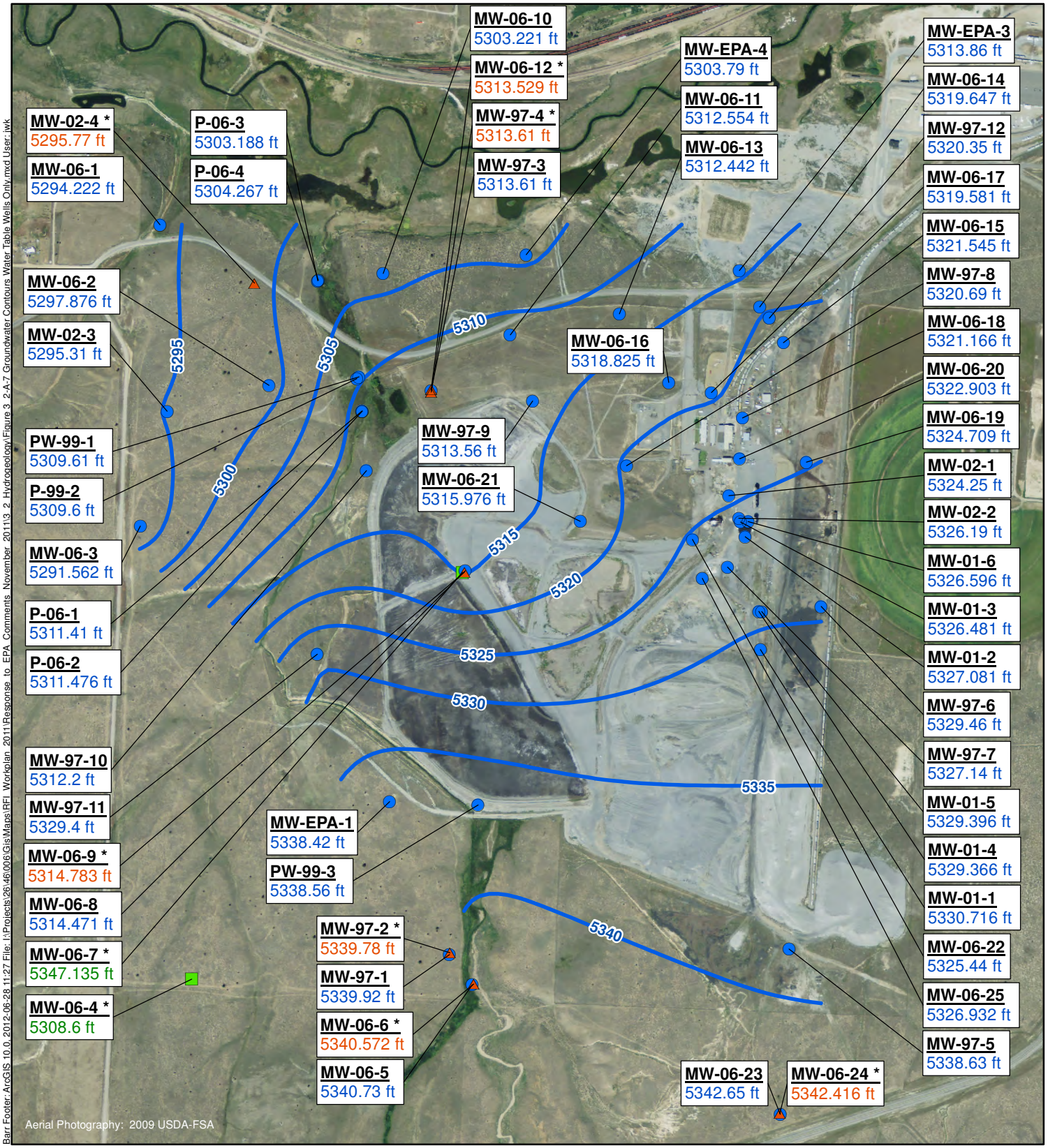
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-6

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
06/12/2007 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

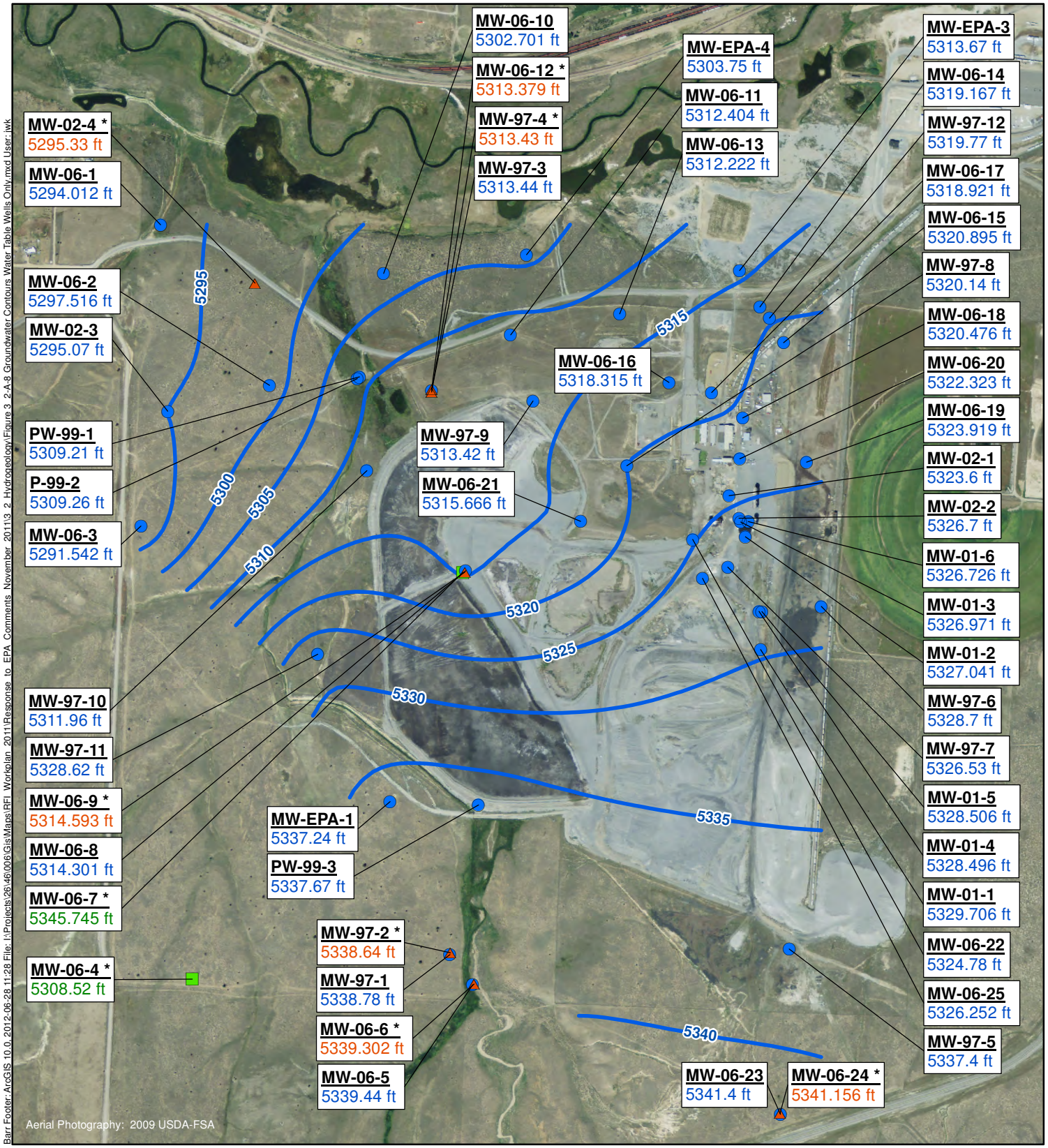
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-7

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
10/10/2007 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

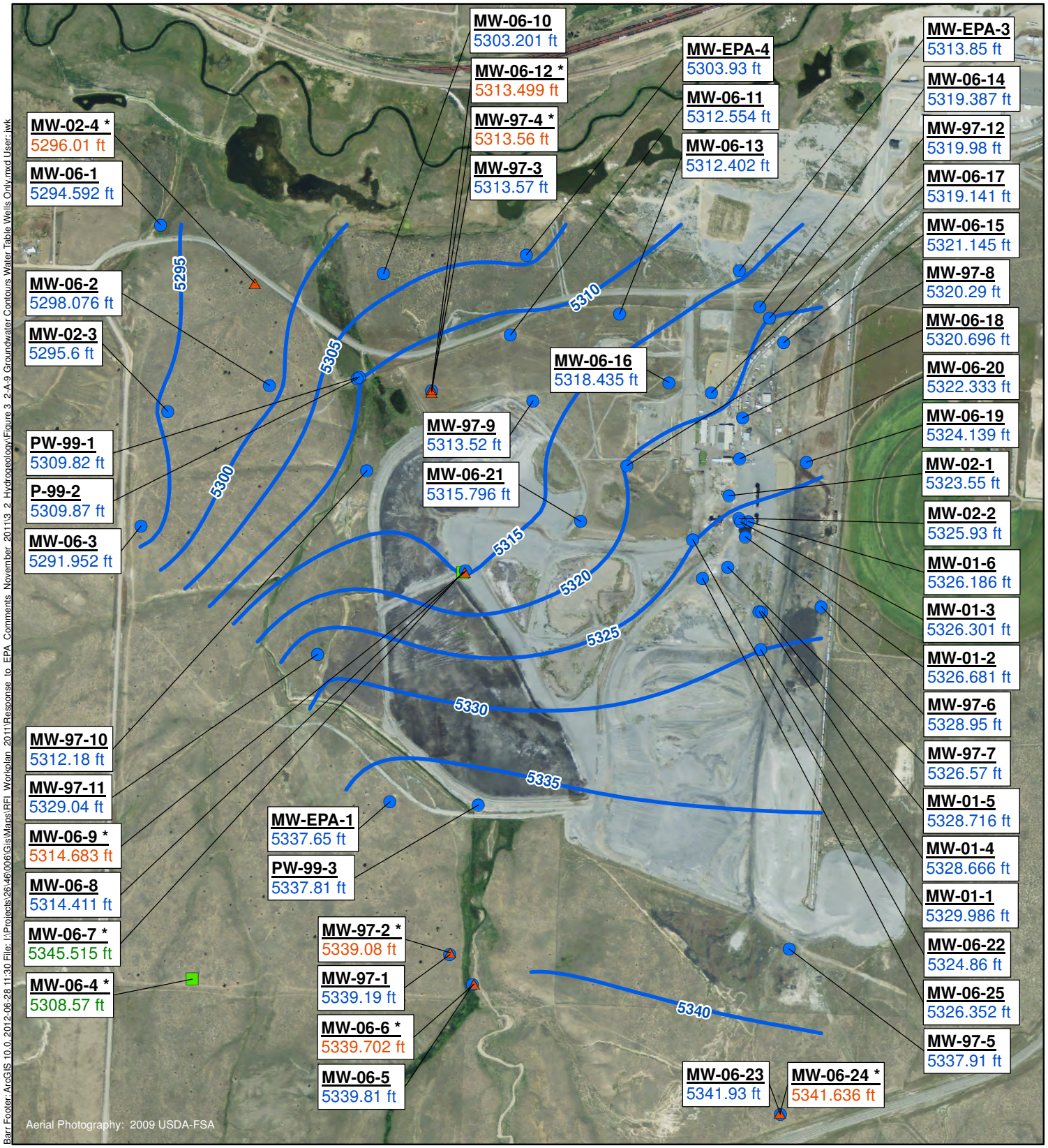
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-8

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
02/22/2008 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

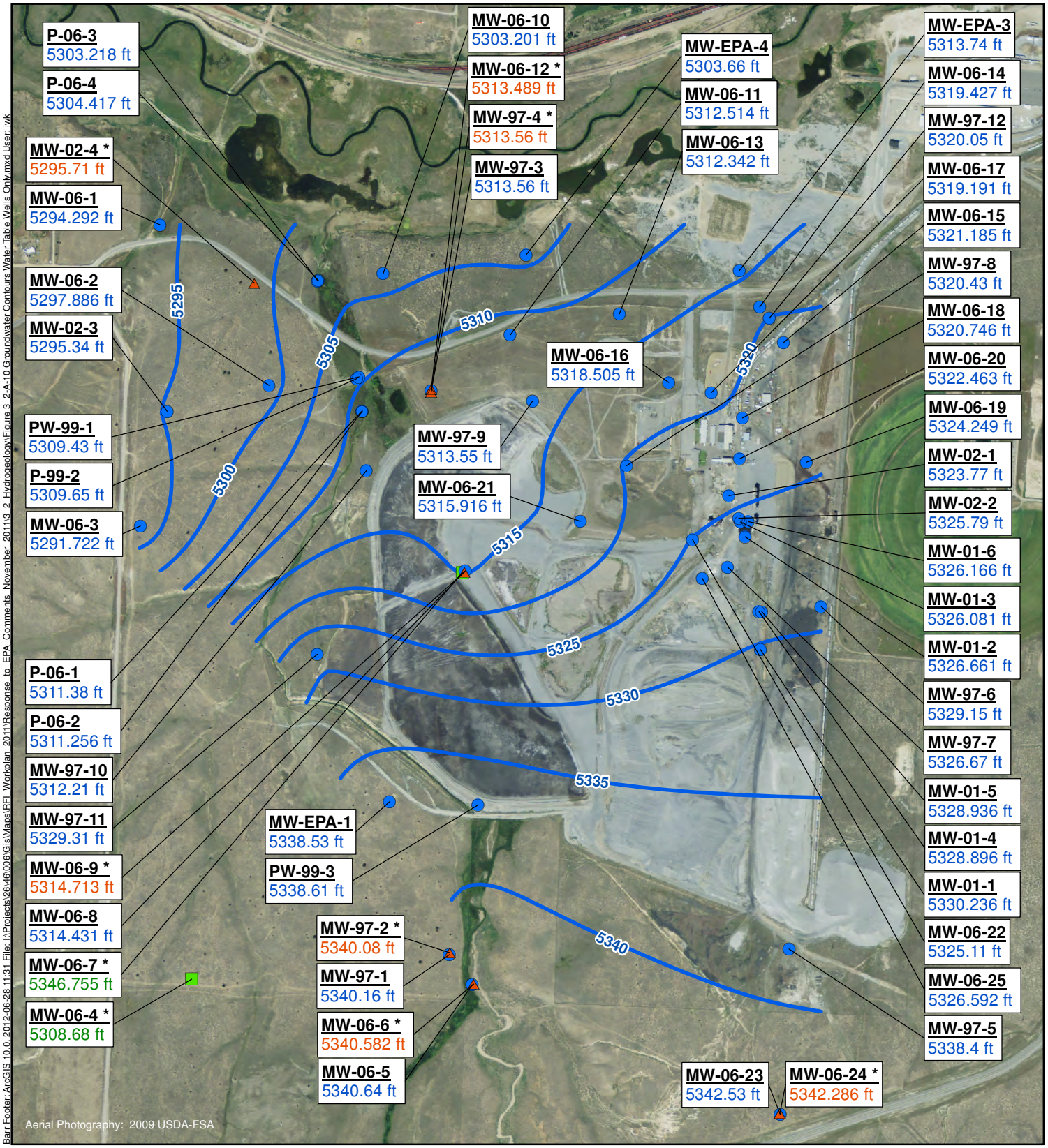
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-9

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
05/08/2008 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Barr Footer: ArcGIS 10.0, 2012-06-28 11:31 File: I:\Projects\26\46006\Gis\Maps\RFI Workplan 2011\Response to EPA Comments November 2011\3_2_Hydrogeology\Figure 3_2-A-10 Groundwater Contours Water Table Wells Only.mxd User: iwk

Well Depth

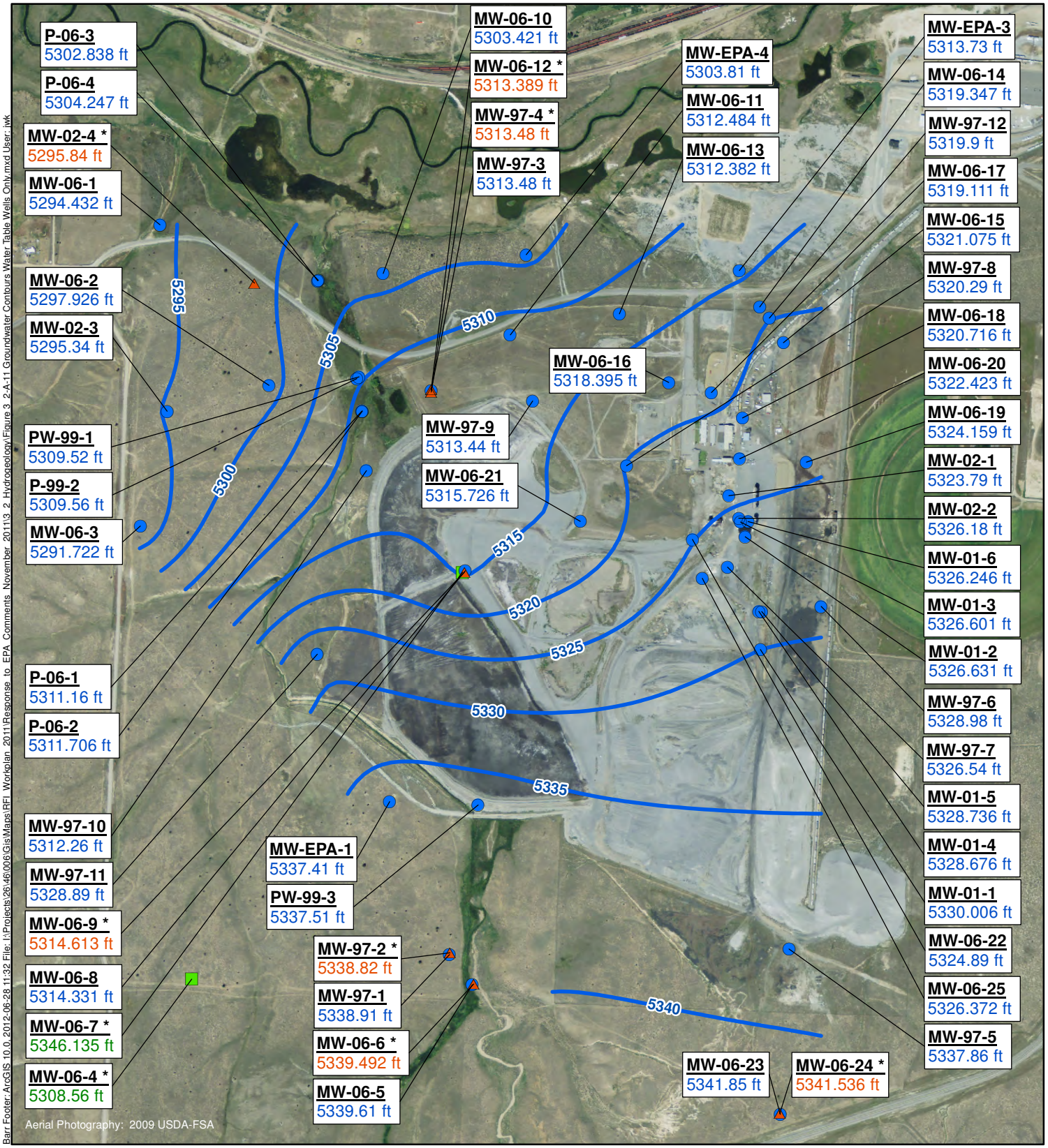
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-10

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
09/15/2008 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

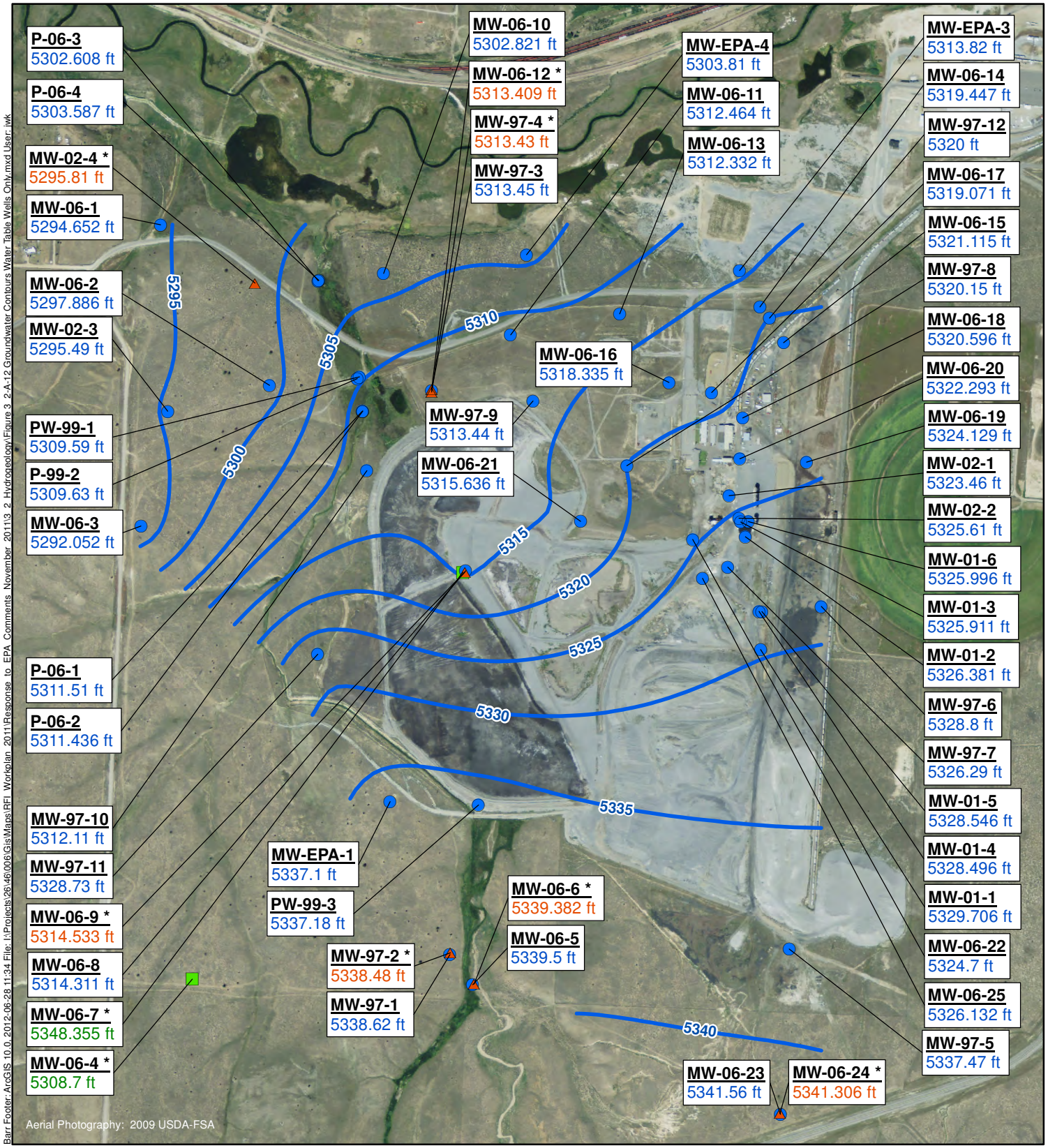
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-11

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
11/25/2008 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Barr Footer: ArcGIS 10.0, 2012-06-28 11:34 File: I:\Projects\26\46006\GIs\Maps\RFI Workplan 2011\Response to EPA Comments November 2011\3_2 Hydrogeology\Figure 3_2-A-12 Groundwater Contours Water Table Wells Only.mxd User: iwk

Well Depth

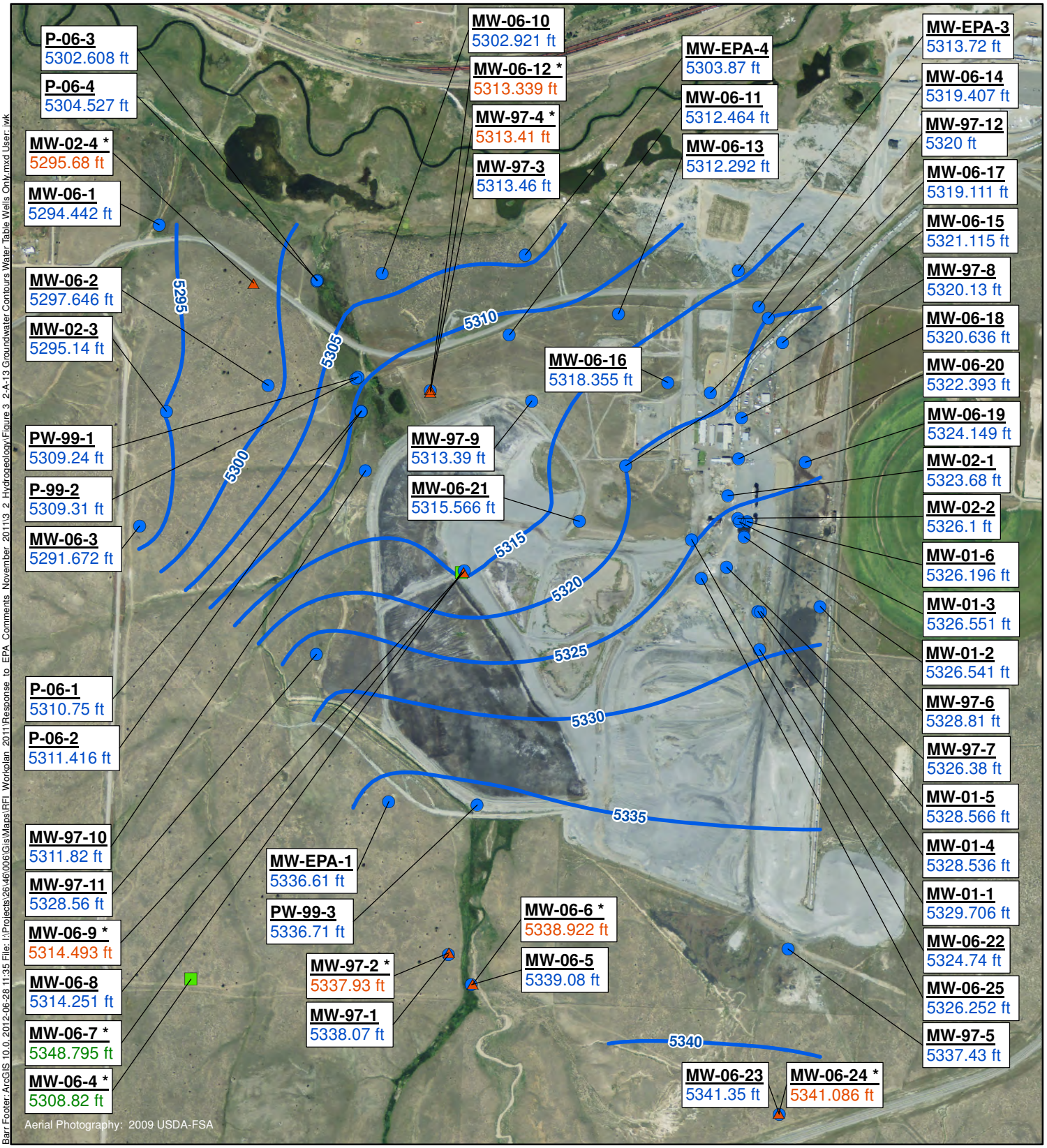
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-12

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
07/27/2009 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

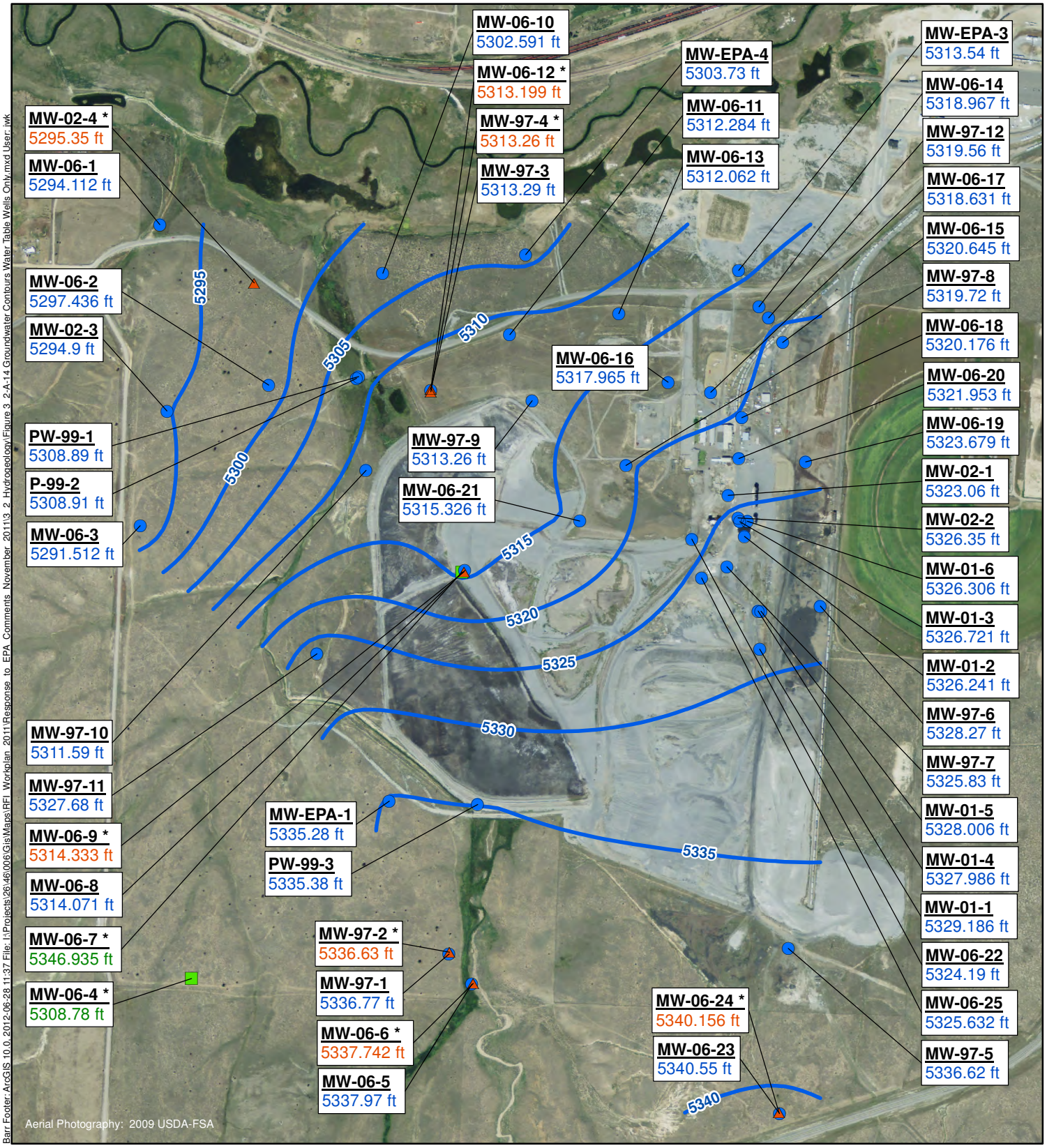
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-13

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
10/28/2009 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

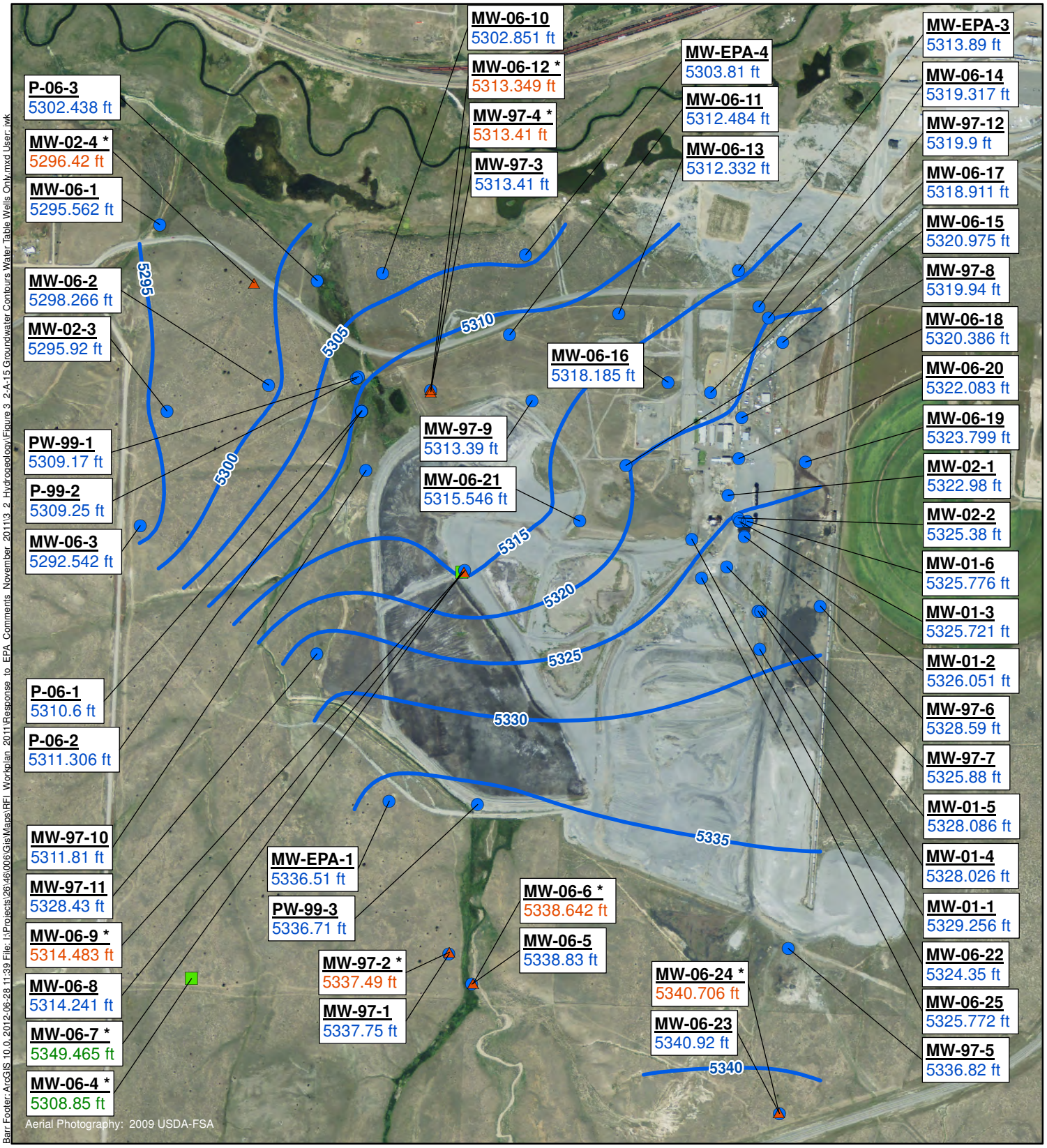
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-14

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
02/10/2010 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Barr Footer:ArcGIS 10.0, 2012-06-28 11:39 File: I:\Projects\26\46006\GIs\Maps\RFI Workplan 2011\Response to EPA Comments November 2011\3_2 Hydrogeology\Figure 3_2-A-15 Groundwater Contours Water Table Wells Only.mxd User: iwk

Well Depth

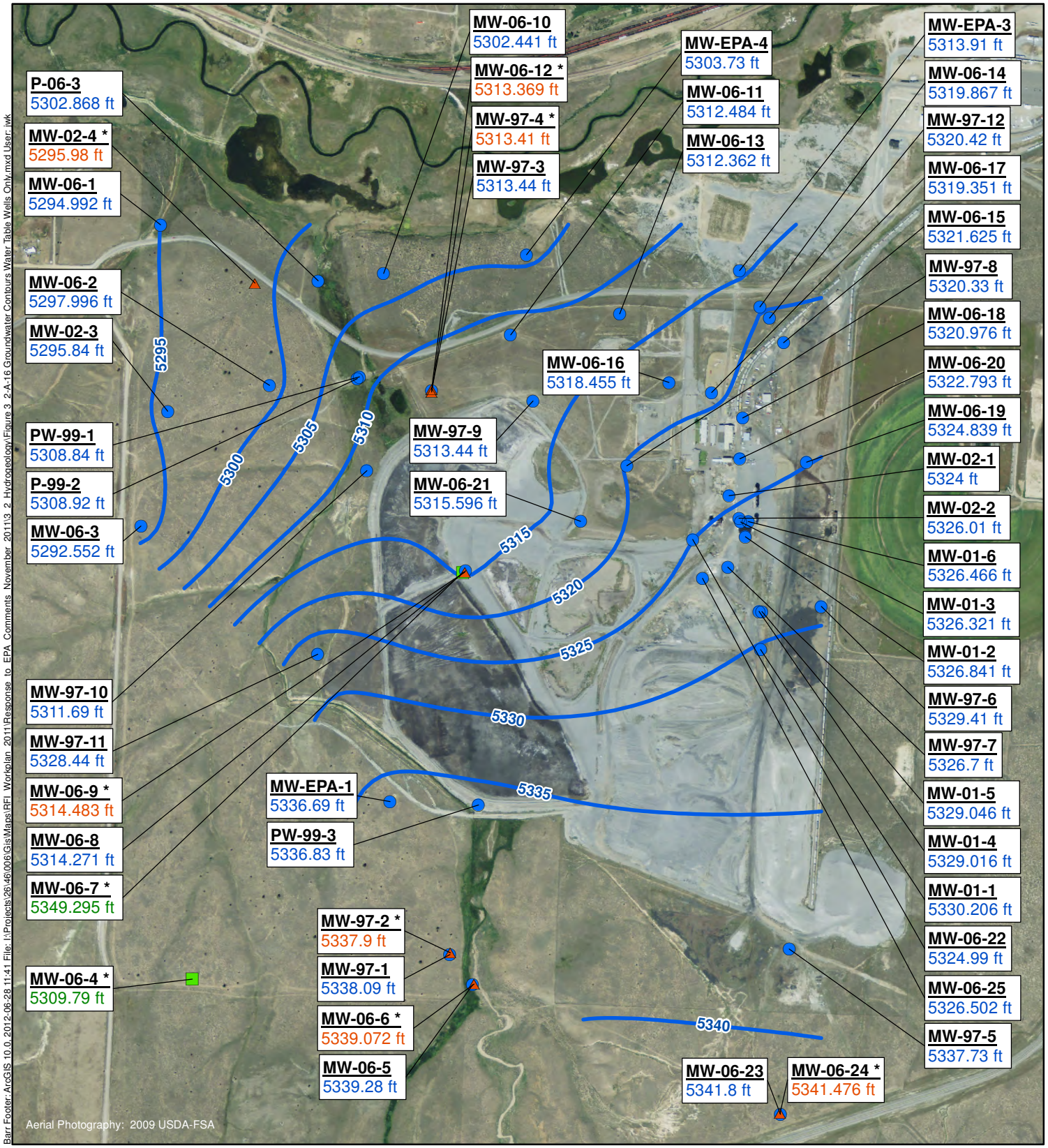
- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-15

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
07/15/2010 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Well Depth

- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

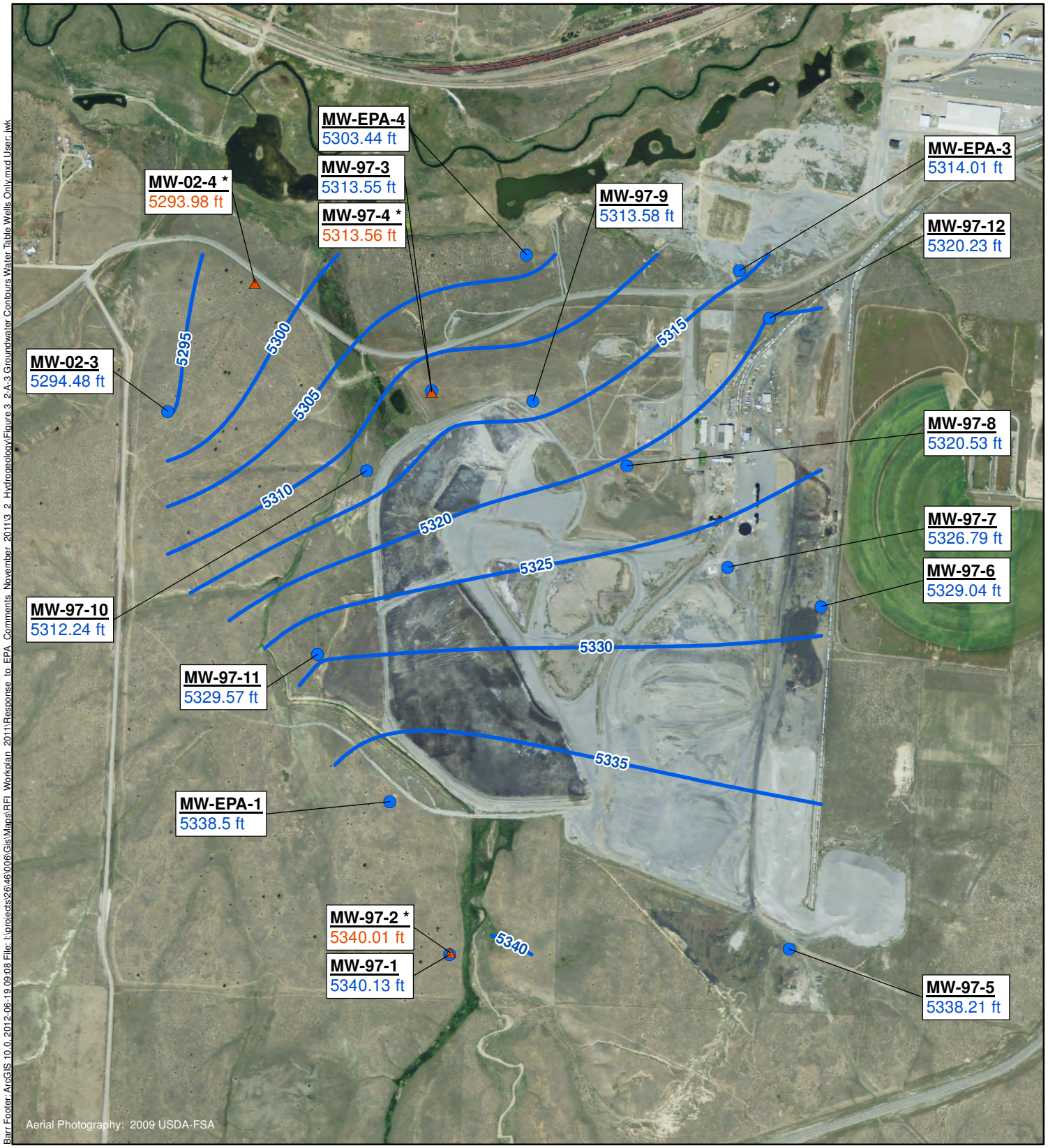
N

Feet

1,000 0 1,000

Figure 3.2-A-16

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
08/31/2011 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Barr Footer: ArcGIS 10.0, 2012-06-19 09:08 File: I:\projects\26\46006\Gis\Maps\RFI Workplan 2011\Response to EPA Comments November 20113 2 Hydrogeology\Figure 3 2-A-3 Groundwater Contours Water Table Wells Only.mxd User: jwk

Well Depth

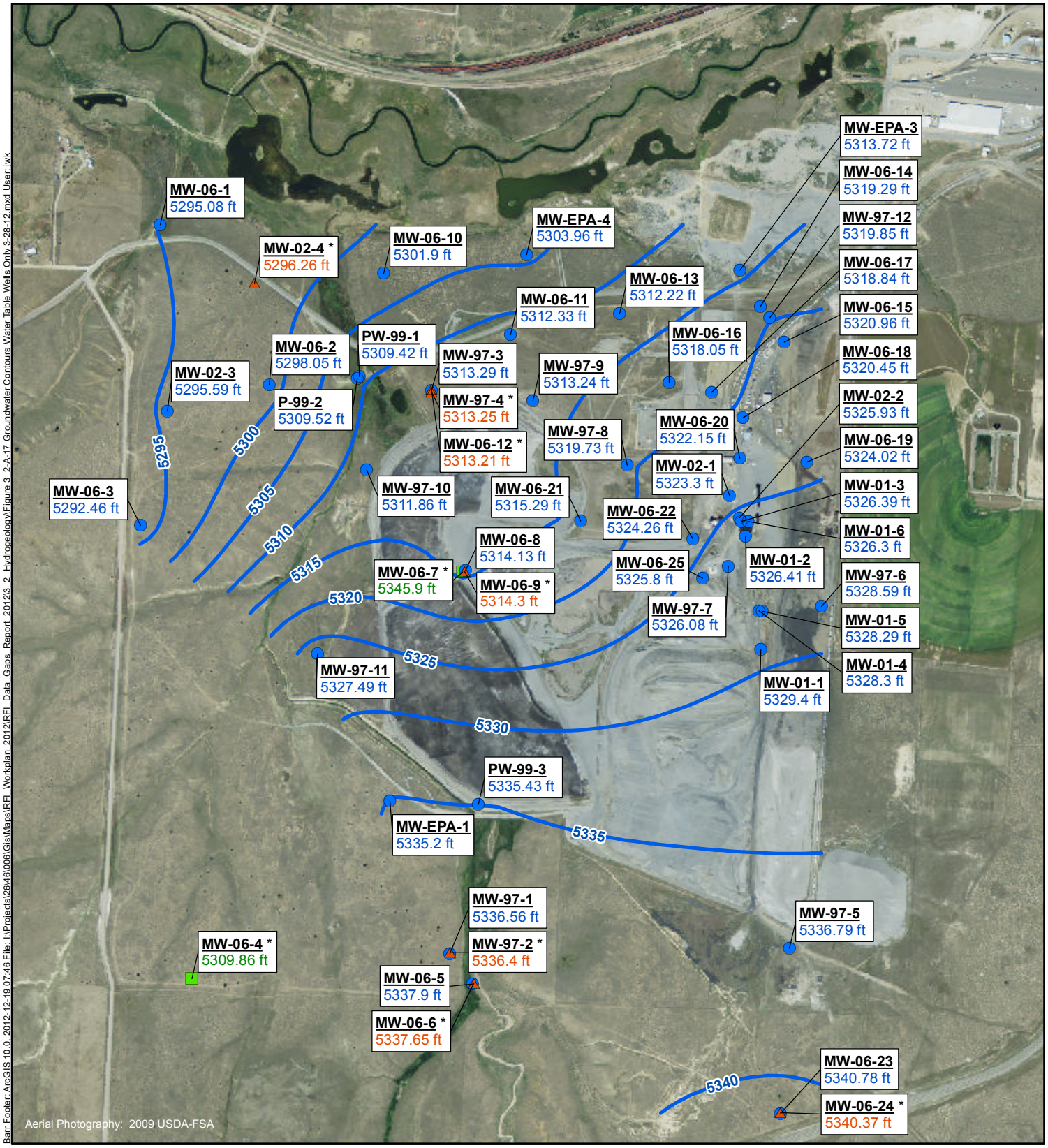
- Deep
- Water Table
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-3

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
05/09/2006 MEASUREMENTS
Rhodia Silver Bow Plant
Montana



Barr Footer: ArcGIS 10.0, 2012-12-19 07:46 File: I:\Projects\26\46\006\Gis\Maps\RFI Workplan 2012\RFI Data Gaps Report 2012\3 2 HydrogeologyFigure 3 2-A-17 Groundwater Contours Water Table Wells Only 3-28-12.mxd User: iwk

Well Depth

- Deep
- Water Table
- Other
- Groundwater Contour (ft MSL)

* Not used for contouring

Feet
1,000 0 1,000

Figure 3.2-A-17

GROUNDWATER CONTOURS
WATER TABLE WELLS ONLY
3/28/2012 MEASUREMENTS
Rhodia Silver Bow Plant
Montana

Appendix 3.2-B

Groundwater Contours (11/1997 – 3/2005)

Aerial Photographs from 2002

Barr Footer: Date: 1/27/2006 10:32:04 AM File: I:\Projects\26\46\006\Gis\Maps\Groundwater Contours\11-05-97.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-1

GROUNDWATER AND SURFACE WATER ELEVATIONS
November 5, 1997
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 12/5/2005 10:36:19 AM File: I:\Projects\26\46\006\Gis\Maps\Groundwater Contours\02-05-98b.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-2

GROUNDWATER AND SURFACE WATER ELEVATIONS
February 5, 1998
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 3:53:28 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\02-05-98.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-3

GROUNDWATER AND SURFACE WATER ELEVATIONS
March 31, 1998
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 7:08:25 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\05-26-98.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-4

GROUNDWATER AND SURFACE WATER ELEVATIONS
May 26, 1998
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 4:18:43 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\07-10-98.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-5

GROUNDWATER AND SURFACE WATER ELEVATIONS
July 10, 1998
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 4:18:43 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\07-10-98.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-6

GROUNDWATER AND SURFACE WATER ELEVATIONS
August 27, 1998
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 12/5/2005 10:31:10 AM File: I:\Projects\26\46\006\Gis\Maps\Groundwater Contours\10-10-98b.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-7

GROUNDWATER AND SURFACE WATER ELEVATIONS
October 10, 1998
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 2/1/2006 4:22:21 PM File: I:\Projects\26\46\006\Gis\Maps\Groundwater Contours\10-29-98.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-8

GROUNDWATER AND SURFACE WATER ELEVATIONS
October29, 1998
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 4:54:36 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\10-29-98.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-9

GROUNDWATER AND SURFACE WATER ELEVATIONS
January 14, 1999
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 5:19:17 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\01-10-02.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-10

GROUNDWATER AND SURFACE WATER ELEVATIONS
January 10, 2002
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 12/1/2005 9:07:50 AM File: i:\Projects\26\46\006\Gis\Maps\Groundwater Contours\08-19-02b.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-11

GROUNDWATER AND SURFACE WATER ELEVATIONS
August 19, 2002
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 5:19:17 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\01-10-02.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-12

GROUNDWATER AND SURFACE WATER ELEVATIONS
September 4, 2002
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 5:53:23 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\09-04-02.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-13

GROUNDWATER AND SURFACE WATER ELEVATIONS
May 3, 2004
Rhodia Silver Bow Plant
Montana

Barr Footer: Date: 11/27/2005 6:09:58 PM File: I:\Projects\26\46006\GisMaps\Groundwater Contours\05-03-04.mxd User: cdp

Aerial Photographs from 2002

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet

400 0 400 800

Meters

100 0 100 200

Figure Z-14

GROUNDWATER AND SURFACE WATER ELEVATIONS
September 16, 2004
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 6:20:11 PM File: I:\Projects\26\46\006\Gis\Maps\Groundwater Contours\09-16-04.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-15

GROUNDWATER AND SURFACE WATER ELEVATIONS
November 11, 2004
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 11/27/2005 6:20:11 PM File: I:\Projects\26\46\006\Gis\Maps\Groundwater Contours\09-16-04.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-16

GROUNDWATER AND SURFACE WATER ELEVATIONS
January 10, 2005
Rhodia Silver Bow Plant
Montana

Aerial Photographs from 2002

Barr Footer: Date: 12/5/2005 10:38:16 AM File: I:\Projects\26\46\006\Gis\Maps\Groundwater Contours\03-05-05b.mxd User: cdp

Monitoring Well or Surface Water Station with Reading

Other Monitoring Well

Rhodia Property Boundary

Water Elevations in Feet Mean Sea Level (Ft. MSL)

N

Feet
400 0 400 800

Meters
100 0 100 200

Figure Z-17

GROUNDWATER AND SURFACE WATER ELEVATIONS
March 5, 2005
Rhodia Silver Bow Plant
Montana

Appendix 3.2-C

Groundwater Receptor Survey

Barr Engineering Company
4700 West 77th Street • Minneapolis, MN 55435-4803
Phone: 952-832-2600 • Fax: 952-832-2601 • www.barr.com *An EEO Employer*

Minneapolis, MN • Hibbing, MN • Duluth, MN • Ann Arbor, MI • Jefferson City, MO

Memorandum

To: Project File

From: Tina Pint

Subject: Rhodia Groundwater Use Survey

Date: March 9, 2006

Project: 26/46-006

c: Jim Langseth, Tom Mattison

On February 8 through February 9, 2006 I conducted the site visit portion of the Groundwater Use Survey at the Rhodia Silver Bow Plant in accordance with the work plan dated September 16, 2005. This memorandum documents the results of this work. Figure 1 shows the well search area.

Site Visits

Five site visits were performed with residence located northwest of the Rhodia site (the Site), and one visit was performed with the Port of Montana, located northeast of the Site. At each property, a water well questionnaire was completed and all well locations were established using a global positioning system and photographed.

On February 8, Cam Balentine (Rhodia representative) and I met with Pat Baldry, Tom Tranmer, and Peter Banks. Each property has a single well that supplies water for household use. Completed well questionnaires and photographs are attached and well information is summarized in Table 1. The well locations are shown in Figure 2. None of the residents had well logs for the wells.

On February 9, Dan Bersanti (Rhodia representative) and I met with Tim Hess, Rob Dombroski and George Paul from the Port of Montana. Tim Hess's property had two wells. One well serves the residence and the other is used for stock watering. Rob Dombroski has a single well that supplies water for household use. One well is located at the Port of Montana facility and provides water for fire protection and sanitary purposes. George Paul reported that this facility supplies bottled water for drinking purposes.

Completed well questionnaires and photographs are attached. The well information is summarized in Table 1 and the well locations are shown in Figure 2. Neither Tim Hess nor Rob Dombroski had well logs for their wells. The Port of Montana supplied us with a copy of the well log and additional information on water usage. In addition, we were provided a copy of a water resources evaluation that was prepared for the Port of Montana.

Well Log Follow-up

Additional work was conducted to try and locate well logs for the residential wells identified as part of the groundwater use survey. The well logs for the new well on the Hess property and the Port of Montana well are in the Montana Bureau of Mines and Geology (MBMG) well database, and are attached. O'Keefe Drilling, Lindsay Drilling, and Dynamite Drilling were contacted to see if they could provide the well logs for the wells they drilled. All companies indicated that their logs are filed under the original well owner's name, and without that it is not possible to locate the logs.

Well information provided by the property owners was compared to the well information in the MBMG database. This comparison is summarized below:

Hess Property: The MBMG database shows two wells on the Hess property (#191148 and #164857). The #164857 is the new well (domestic well) on the property and matches the description provided by Mr. Hess. The #191148 well was drilled by O'Keefe drilling in 1975; Mr. Hess reported that the second well on his property (stock watering well) was drilled by Dynamite Drilling. A copy of the original well log for well #191148 was provided by O'Keefe drilling. The only well location information provided on the log is that the well is located in Silver Bow County.

Banks Property: The MBMG database shows two well on the Banks property (#50517 and #50516). Both of these wells were drilled by O'Keefe Drilling, which matches the well on the Banks property. The well depth reported by Mr. Banks does not match the well depth reported on either log (47ft verses 107 ft and 90 ft respectively).

Tranmer Property: The MBMG database shows one well on the Tranmer property (#50504). The actual well on the Tranmer property was drilled by O'Keefe drilling. Well #50504 does not list a

well driller. O'Keefe drilling did not have a log for the well from the MBMG database, indicating that they likely did not drill the well.

Baldry Property: The MBMG database shows one well on the Baldry property (#143518). Mr. Baldry did not know who drilled the well, but thought it was approximately 105 feet deep. The well from the MBMG database was drilled by Brazill to a depth of 160 feet. We were unable to locate a Brazill drilling to get the original well log.

Dombroski Property: The MBMG database shows one well on the Dombroski property (#50520). Mr. Dombroski indicated that the well on his property was drilled by Lindsay well drilling. The well from the MBMG database was drilled by O'Keefe Drilling.

Port of Montana Property: The information from the MBMG database matches the information provided by the Port of Montana.

Additional Well Locations

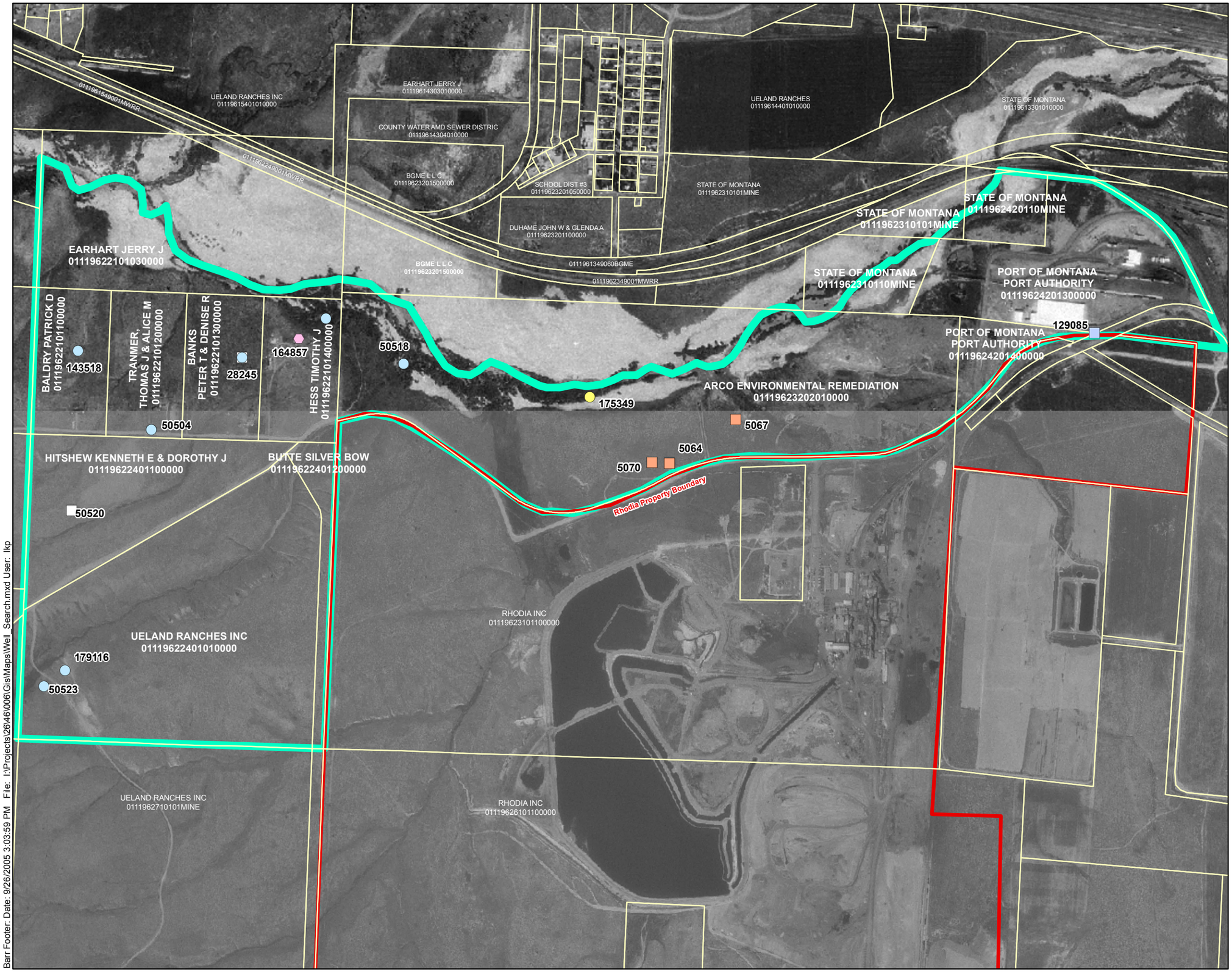
An attempt was made to locate the two wells on the Ueland Ranch property shown on Figure 1. Neither well could be located and there was no evidence that wells had ever been present. Three monitoring wells were located north of the Site near Silver Bow Creek (shown on Figure 2). These wells, located south of the current creek channel, were disturbed by the SSTOU remedy being implemented in the portion of Silver Bow Creek north of the Silver Bow Plant. A photograph of the wells is attached (Attachment A). It was not possible to try to locate well 50518 depicted on Figure 1 due to on-going tailings removal.

An old well was located on the Rhodia property, north of the tailing basin, near the beaver pond. The origin of this well is unknown. A photograph of the well is attached (Attachment A).

Table 1
Well Survey Results
Rhodia Silver Bow Site

Property	Owner	Well Location		Approximate Surface Elevation (ft MSL)	Estimated Well Depth (ft)	Estimated Screened Interval (ft)	Data drilled	Well driller
		Northing	Easting					
1119624201400000	Port of Montana	5095475	370636	5345	119*	101-119*	1988	Tri-Valley Drilling
Unknown	Robert Dombroski	5095052	368120	5370	200	Unknown	Unknown	Lindsay Well Drilling
1119622101400000	Timothy Hess (new)	5095416	368531	5325	59*	49-55*	1997	O'Keefe
1119622101400000	Timothy Hess (old)	5095425	368600	5320	47	Unknown	Unknown	Dynamite
1119622101300000	Peter Banks	5095214	368440	5335	47	Unknown	Unknown	O'Keefe
1119622101200000	Thomas Tranmer	5095253	368242	5350	160	Unknown	Unknown	O'Keefe
1119622101100000	Patrick Baldry	5095244	368002	5365	105	Unknown	Unknown	Unknown

* Well depth and screened interval from well log



LEGEND

- Area of Well Search
- Parcels
- Property Boundary

Well Use (from database)

- Domestic Well
- Irrigation Well
- Monitoring Well
- Industrial Well
- Public Water Supply Well

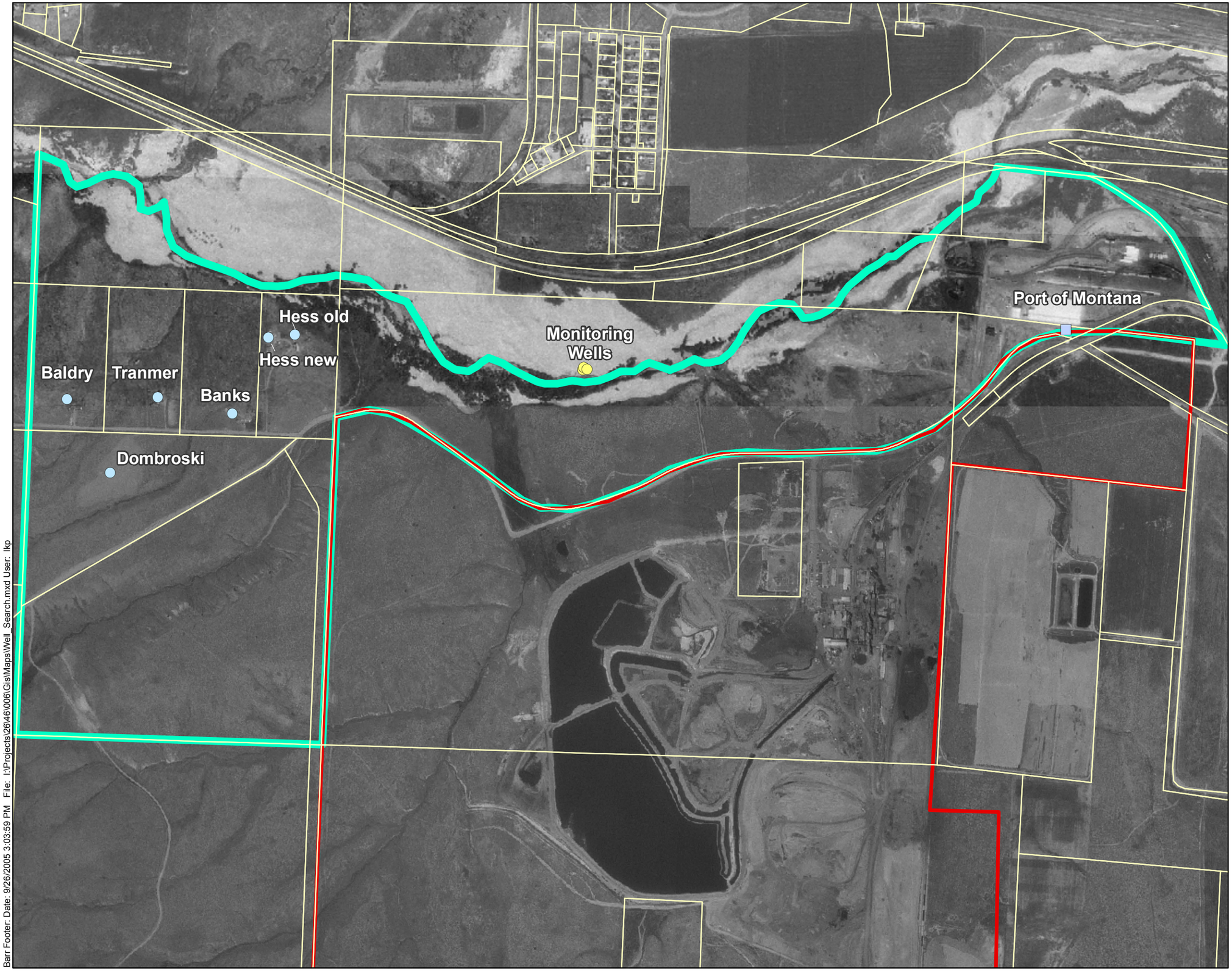
Feet
800 0 800

Meters
300 0 300

Figure 1

WELL SEARCH AREA
Northwest of
Silver Bow Plant

Barr Footer: Date: 9/26/2005 3:03:59 PM File: I:\Projects\26\46\006\GisMaps\Well_Search.mxd User: lkp



LEGEND

- Area of Well Search
- Parcels
- Property Boundary

Well Use (from database)

- Domestic Well
- Irrigation Well
- Monitoring Well
- Industrial Well
- Public Water Supply Well

Feet
800 0 800

Meters
300 0 300

Figure 2

WELL SEARCH RESULTS
Northwest of
Silver Bow Plant

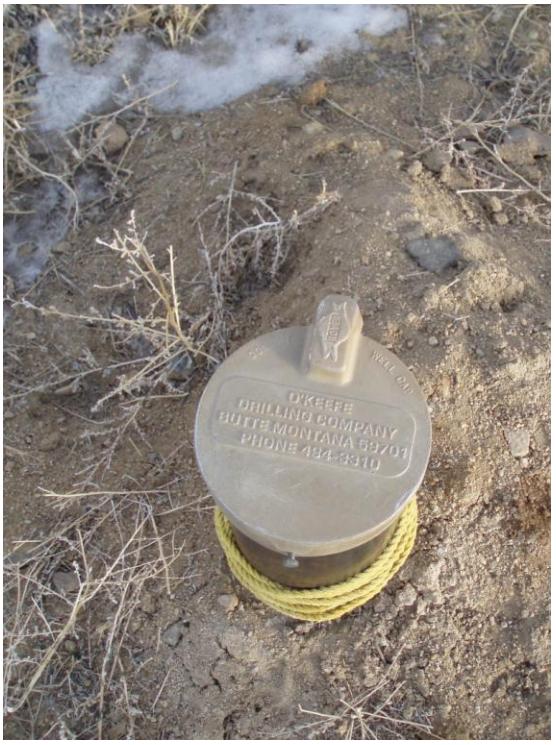
Barr Footer: Date: 9/26/2005 3:03:59 PM File: I:\Projects\26\46\006\Gis\Maps\Well_Search.mxd User: lkp

Baldry Well

Tranmer Well

Banks Well House

Hess New Well



Hess New Well

Hess Old Well (in barn)

Port of Montana Well

Dombroski Well

Monitoring wells south of Silver Bow Creek

Unknown well near beaver pond

Appendix 3.2-D

Residential Well Construction Logs

Butte Baldry 3N09W22 BD Silver Bow

Form No. 603 (R 2-89)

WELL LOG REPORT

76G-C091630-00 File No.

State law requires that the Bureau's copy be filed by the water well driller within 60 days after completion of the well. 105881

1. WELL OWNER
Name Curtis & Alice Stoltenberg

2. CURRENT MAILING ADDRESS
452 N Idaho
Butte MT. 59701

3. WELL LOCATION
W ¼ SE ¼ NW ¼ Section 22
Township 3 N/S Range 9 E/W County Silver Bow
Govn't Lot _____, or Lot _____, Block _____
Subdivision Name _____
Tract Number _____

4. PROPOSED USE: Domestic ☑ Stock ☐ Irrigation ☐
Other ☐ specify _____

5. TYPE OF WORK:
New well ☑ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☑ Jetted ☐

6. DIMENSIONS: Diameter of Hole
Dia. 6 in. from 0 ft. to 160 ft.
Dia. _____ in. from _____ ft. to _____ ft.
Dia. _____ in. from _____ ft. to _____ ft.

7. CONSTRUCTION DETAILS:
Casing; Steel Dia. 6 from 12 ft. to 18 ft.
Threaded ☐ Welded ☐ Dia. _____ from _____ ft. to _____ ft.
Type _____ Wall Thickness _____
Casing; Plastic Dia. 4 from 10 ft. to 160 ft.
Weight _____ Dia. _____ from _____ ft. to _____ ft.
PERFORATIONS: Yes ☑ No ☐
Type of perforator used saw
Size of perforations 1/8 in. by 4 in.
_____ perforations from 140 ft. to 160 ft.
_____ perforations from _____ ft. to _____ ft.
_____ perforations from _____ ft. to _____ ft.
SCREENS: Yes ☐ No ☑
Manufacturer's Name _____
Type _____ Model No. _____
Dia. _____ Slot size _____ from _____ ft. to _____ ft.
Dia. _____ Slot size _____ from _____ ft. to _____ ft.
GRAVEL PACKED: Yes ☐ No ☑ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
GROUTED: To what depth? 18 ft.
Material used in grouting Bentonite

8. WELL HEAD COMPLETION:
Pitless Adapter ☐ Yes ☐ No

9. PUMP (if installed)
Manufacturer's name _____
Type _____ Model No. _____ HP. _____

10. WELL TEST DATA
The information requested in this section is required for all wells. All depth measurements shall be from the top of the well casing.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air ✓ Pump _____ Bailer _____
b) Static water level immediately before testing 87 ft. If flowing; closed-in pressure _____ psi. _____ gpm. Flow controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test 155
d) The pumping rate: 15 gpm.
e) Pumping water level 135 ft. at 1 hrs. after pumping began.
f) Duration of test: Pumping time 1 hrs.
g) Recovery time 10 min hrs.
h) Recovery water level 87 ft. at 1 hrs. after pumping stopped.

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form.

NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

11. WAS WELL PLUGGED OR ABANDONED? _____ Yes ✓ No
If yes, how? _____

12. WELL LOG

Depth (ft.) From	To	Formation
0	2	Topsoil
2	8	Sandy Soil
8	15	Decomposed Rock
15	160	Rock

PA

ATTACH ADDITIONAL SHEETS IF NECESSARY

13. DATE COMPLETED 4-19-94

14. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

4-19-94
Date

Braill Drilling
Firm Name

Butte MT. 59702
Address

Bruce Braill 355
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6610

DNRC

DEPARTMENT—BUREAU COPY

M!143518

BUTTE 093 RECEIVED 03N 09W 22 AC Silver Bow File No. _____

Form No. 603 R9/82

Banks

SEP 08 1983

MONT. DEPT. of NATURAL RESOURCES & CONSERVATION

WELL LOG REPORT

State law requires that this form be filed by the water well driller within 60 days after completio

026510

1. WELL OWNER Name Brian Fladager Duane Saville

2. CURRENT MAILING ADDRESS
2900 Hanson Road
Butte, Montana 59701

3. WELL LOCATION
County Butte-Silver Bow
Township 3 NORTH N/S Range 9 WEST E/W
E/2 ¼ SW ¼ NE ¼ Section 22
Lot TRACT 9 Block
Subdivision Indian Wells

4. PROPOSED USE Domestic [X] Stock [ ] Irrigation [ ]
Other [ ] specify

5. DRILLING METHOD X cable, bored, forward rotary, reverse rotary, jetted, other (specify)

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations / Screen Kind Size	From (feet)	To (feet)
6"	6 5/8" od x .250	+18"	90'	Torch 1/8"	80'	90'

Was casing left open end? X Yes ___ No
Was a packer or seal used? ___ Yes X No
If so, what material
Was the well gravel packed? ___ Yes X No
Was the well grouted? ___ Yes X No
To what depth?
Material used in grouting
Well head completion: Pitless adapter ___ Yes ___ No
Top of casing 12 in. or greater above grade X Yes ___ No

7. WHAT IS THE TEMPERATURE OF THE WATER?
___ Degrees Fahrenheit
[ ] Measured [ ] Estimated

8. WATER LEVEL
Static water level 65 feet below land surface
If flowing; closed-in pressure ___ psi
___ gpm
Controlled by: ___ valve, ___ reducers, ___ other, (specify)

9. WELL TEST DATA ___ pump X bailer ___ other, (specify)
Pumping level below land surface:
___ ft. after ___ hrs. pumping 30 gpm
___ ft. after ___ hrs. pumping ___ gpm

10. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If yes, how?

11. DATE COMPLETED August 17, 1983

12. WELL LOG

Depth (ft.) From	To	Formation
0'	1'	Top soil
1'	30'	Sand and clay
30'	35'	Rocky with clay
35'	78'	Gravel and clay
78'	90'	Shale and clay
		Water

WFK/RB (use separate sheet if necessary)

13. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

8/19/83
Date

O'Keefe Drilling Company -4 Mile Road
Firm Name

P.O. Box 3810, Butte, Montana 59702
Address

Ed O'Keefe 287
Signature Ed O'Keefe License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION **DNRC**

32 SOUTH EWING HELENA, MONTANA 59620 449-3962

M: 50516

DEPARTMENT — BUREAU COPY

Butte 093 3N 9W 22 AC Silverbow

Form No. 603 R10/79

RECEIVED

File No. 055606

NOT CODED Banks APR 14 1980

Copy in File

WELL LOG REPORT

State law requires that this form be filed by the water well driller within 60 days after completion of the well.

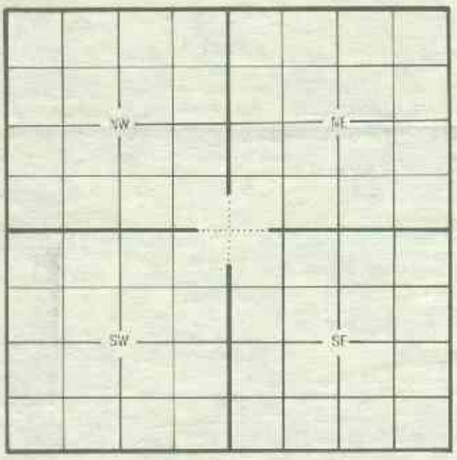
MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

CO28245-76b

1. WELL OWNER
Name David E. Dobb

2. CURRENT MAILING ADDRESS
402 Hamblin Heights
Butte, Montana 59701

3. WELL LOCATION



W2 ¼ SW ¼ NE ¼ Section 22
Township 3N N/S Range 9W E/W
County Butte-Silver Bow
Lot #10 Block
Subdivision Indian Wells
Well Elevation
Accuracy: ± 10'; ± 50'; ± 100';

4. DRILLING METHOD X cable, bored, forward rotary, reverse rotary, jetted, other (specify)

5. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations and/or Screen Kind	Size	From (feet)	To (feet)
6"	6 5/8" od x .250 4" PVC 200#	+2'	88'				
		85'	107'	Skill Saw		80'	107'

Was casing left open end? X Yes No
Was a packer or seal used? Yes X No
If so, what material
Was the well gravel packed? Yes X No
Was the well grouted? Yes X No
To what depth?
Material used in grouting
Well head completion: Pitless adapter
12 in. above grade , other
(if other, specify)
Pump horsepower , pump type
Pump intake level feet below land surface
Power (electric, diesel, etc.)

6. WATER LEVEL
Static water level 67 feet below land surface
If flowing, closed-in pressure psi
gpm flow through inch pipe
Controlled by: valve, reducers, other
(if other, specify)

7. WELL TEST DATA pump X bailer other
(if other, specify)
Pumping level below land surface:
ft. after hrs. pumping 30 gpm
ft. after hrs. pumping gpm

8. WAS WELL PLUGGED OR ABANDONED? Yes X No
If yes, how?

9. DATE STARTED 4/7/80
DATE COMPLETED 4/9/80

10. WELL LOG

Depth (ft.) From	To	Formation
0'	2'	Top soil
2'	40'	Gray clay
40'	80'	Gray clay with rock ledges
80'	107'	Rock with clay seams
		Water

W. F. Kentfield
(use separate sheet if necessary)

11. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date 4/10/80

O'Keefe Drilling Company
Firm Name

P.O. Box 3810, Butte, MT 59701
Address

Ed O'Keefe
Signature Ed O'Keefe

287
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC
32 SOUTH EWING HELENA, MONTANA 59601 449-3634

MW 50577

DEPARTMENT COPY

WL · 214

Form No. 603 R10/79

093 03N 09W 22CA SILVER BOW

File No. _____

BUTTE Dombrowski

WELL LOG REPORT

RECEIVED
SEP - 2 1982
MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

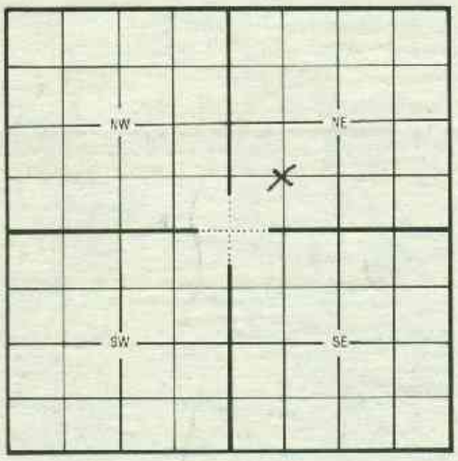
026512

State law requires that this form be filed by the water well driller within 60 days after compl

1. WELL OWNER
Name Dan O'Connor

2. CURRENT MAILING ADDRESS
Route 1, Box 204B
Butte, Montana 59702

3. WELL LOCATION INDIAN WELLS



E/2 ¼ NE ¼ SW ¼ Section 22
Township 3-NORTH N/S Range 9-WEST E/W
County Butte-Silver Bow
Lot TRACT 4 Block SURVEY 878
Subdivision Indian Wells
Well Elevation 5450
Accuracy: ✓ ±10'; ____ ±50'; ____ ±100';

4. DRILLING METHOD X cable, ____ bored, ____ forward rotary, ____ reverse rotary, ____ jetted, ____ other (specify)

5. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)	Perforations ____ and/or Screen ____ Kind Size	From (feet)	To (feet)
5"	5 5/8" od x .250 4" PVC 200#	+2' 80'	88' 120'	Skill Saw	80'	120'

Was casing left open end? X Yes ____ No
Was a packer or seal used? ____ Yes X No
If so, what material ____
Was the well gravel packed? ____ Yes X No
Was the well grouted? ____ Yes X No
To what depth? ____
Material used in grouting ____
Well head completion: Pitless adapter ____
12 in. above grade ____, other ____
(if other, specify) ____
Pump horsepower ____, pump type ____
Pump intake level ____ feet below land surface
Power (electric, diesel, etc.) ____

6. WATER LEVEL
Static water level 60 feet below land surface
If flowing, closed-in pressure ____ psi
____ gpm flow through ____ inch pipe
Controlled by: ____ valve, ____ reducers, ____ other
(if other, specify) ____

7. WELL TEST DATA ____ pump X bailer ____ other
(if other, specify) ____
Pumping level below land surface:
____ ft. after ____ hrs. pumping 20 gpm
____ ft. after ____ hrs. pumping ____ gpm

8. WAS WELL PLUGGED OR ABANDONED? ____ Yes X No
If yes, how? ____

9. DATE STARTED 5/3/82
DATE COMPLETED 5/5/82

10. WELL LOG

Depth (ft.) From	To	Formation
0'	1'	Top soil
1'	8'	Decomposed sand
8'	30'	Gravel, clay, rocky ledges
80'	100'	Sand and gravel
		Water 5 gpm
100'	120'	Rock
		Water

RECEIVED
SEP 08 1982
MONTANA BUREAU OF MINES & GEOLOGY

WFK (use separate sheet if necessary)

11. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

5/20/82
Date

O'Keefe Drilling Company
Firm Name

P.O. Box 3810, Butte, Montana 59702
Address

Ed O'Keefe
Signature Ed O'Keefe

287
License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION DNRC
32 SOUTH EWING HELENA, MONTANA 59601 449-3634

DEPARTMENT COPY M:50520 WL - 9558

T03N R09W 24 ABDC

Department of Natural Resources and Conservation

White-Department
Pink-Bureau
Yellow-Well owner
Gold-Driller

NOV 28 1975

MONT. DEPT. OF NATURAL RESOURCES CONSERVATION

Hess (old)

WELL LOG REPORT

1055-9766

Statute requires that this form be filed by the water well driller within 60 days after completion of the well; and Form 602, Notice of Completion of Groundwater Development, be filed by the well owner within 60 days after the water has been put to beneficial use.

1. WELL OWNER Name William Raugh Current address Silver Bow, Montana 59748

2. WELL LOCATION Lot ____, Block ____, Subdivision ____
County Silver Bow, or ____ ¼ ____ ¼ NE ¼ Sec. 24, T. 3 ⊗S, R. 9 E-⊗

3. PROPOSED USE X domestic (includes lawn and garden); ____ stock; ____ municipal; ____ industrial; ____ irrigation; ____ other (specify) ____

4. METHOD DRILLED X cable, ____ bored, ____ forward rotary, ____ reverse rotary, ____ jetted, ____ other (specify) ____

5. WELL CONSTRUCTION
Diameter of hole 6 in.; depth 49 ft.
Casing: X steel, ____ plastic, ____ concrete, ____ threaded, X welded, ____ other (specify)

Pipe weight:

	Dia.	From	To
53' XXXft	6 5/8 in.	+4 ft.	49 ft.
____ lb/ft	____ in.	____ ft.	____ ft.

Was casing left open end? X Yes ____ No
Was a well screen installed? ____ Yes X No
Material ____, dia. ____ in.
(stainless steel, bronze, etc.)
Was perforated pipe used? X Yes ____ No
Perforation type: X slots ____ holes
Size 1/8" set from 34 ft. to 39 ft.
Size ____ set from ____ ft. to ____ ft.
Was a packer or seal used? ____ Yes X No
If so, what material ____
Well type: ____ Straight screen ____ Graveled
Was the well grouted: ____ Yes X No
To what depth: ____ ft.
Material used in grouting ____
Well head completion: Pitless adapter ____
12 in. above grade ____, other ____
(if other, specify) ____
Was well disinfected? X Yes ____ No

6. WATER LEVEL
Static water level 26 ft. below land surface
If flowing: closed-in pressure ____ psi
gpm flow ____ through ____ inch pipe
Controlled by: ____ valve ____ reducers
____ other (specify) ____

7. WELL TEST DATA ____ Pump X Bailer ____ Other
(if other, specify) ____
Pumping level below land surface:
____ ft. after ____ hrs. pumping 45 gpm
____ ft. after ____ hrs. pumping ____ gpm

8. WELL LOG

Depth (ft) From	To	Formation
0'	8'	Pit
8'	14'	Gray shale
14'	26'	Red shale
26'	49'	Shale
		Water

PA

(use separate sheet if necessary)

9. DATE STARTED 9/7/75
DATE COMPLETED 9/9/75

10. WAS WELL PLUGGED OR ABANDONED? ____ Yes X No
If so, how? ____

11. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

O'Keefe Drilling Company 287
Driller's or firm name License No.

P.O. Box 3810, Butte, Montana 59701
Address

W. L. Penfield 9/15/75
Signed by date

M: 191148

03N 09W 22 ADAC

WELL LOG REPORT

File No. 125719

1. Well Owner Inv.# 97-130 Hess (new)

Name Tim Hess

2. Current Mailing Address

119007 Battle Ridge Indian Wells
Butte, MT 59701

3. Well Location

1/4 SE 1/4 NE 1/4 Section 22

Township 3N Range 9W County Silver Bow

Location Block

Subdivision Name

Tract Number

Latitude Longitude

4. Proposed Use: Domestic Stock Irrigatation ✓

Other (specify)

5. TYPE OF WORK

New Well ✓ Method Cable

Deepened

Reconditioned

6. DIMENSION: Diameter of hole

Dia. 6 in. from 0 ft. to 57 ft.

7. Construction Details:

Casing Steel Dia. 6 in. from 2.00 ft. to 59.00 ft.

Threaded Welded ✓

Type A53B Wall Thickness 0.256

Casing: Plastic Dia. in. from ft. to ft.

Threaded Welded ✓

Perforations ✓ Yes No

Type of perforations used Torched

Size of perferations 1/4

perforations from 49 ft. to 55 ft.

Screens Yes ✓ No

Manufacturer Name

Type Model No.

Dia. SlotSize from ft.to ft.

SlotSize from ft.to ft.

Gravel Packed Yes ✓ No Size of gravel

Gravel packed from Ft. to ft.

Grouted: To what depth? 25

Material used in grouting Casing Seal

8. Well Head Completion:

Pitless Adapter Yes ✓ No

9. Well Test Data

The information requested in this section is required for all wells. All depth measurements must be from the top or the well casing. All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:

a) Air Pump Bailer •

b) Static water level immediately before testing 13

c) Pumping level after one hour 40 ft.

d) Recovery level ft. 13 Time of recovery 2

e) Pumping Rate 20 min • hrs

Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more.

The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's Aquifer Test Data form. NOTE: All wells shall be equipped with an access port 1/2 inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removeable caps are acceptable as access ports.

10. Pumping Test Data

a) Static level immediately before testing ft.

b) Depth at which pump is set for test ft.

c) Pumping Rate gpm.

d) Maximum drawdown ft.

e) Duration of test pumping time • hrs ○ min

recovery time • hrs ○ min

f) Recovery level ft.

g) Duration of time in recovery level hrs.

11. PUMP INSTALLATION INFORMATION

Installation depth

Actual pumping rate

Manufacturer's name

Type HP

12. WAS WELL PLUGGED OR ABANDONED Yes ✓ No

If yes, how?

13. WELL LOG

DEPTH (FT.) PA

From	To	FORMATION
0	3	Top Soil
3	48	Sandy Clay
48	55	Shale, Gravel & Water
		Seepage @ 30'

ADDITIONAL SHEETS ATTACHED

14. YELLOWSTONE CLOSURE AREA: WATER TEM

15. Date Completed 10/ 1/97

16. DRILLER/CONTRACTOR CERTIFICATIO

This well was drilled under my jurisdiction and this report is true to the best of my

Date 10/ 1/97

O'Keefe Drilling Company, Inc.
Firm Name

P.O. Box 3810, Butte, MT 59702
Address

Lee Lock
Signature

WWD-029 Lee Lock
License No.

M: 164857

Butte

Form No. 603 (R 6-87)

3N09W24 BBDC

File No. _____

Silver Bow

Port of Montana

WELL LOG REPORT

089605

State law requires that this form be filed by the water well driller within 60 days after completion of the well.

1. WELL OWNER
Name Port of Montana

2. CURRENT MAILING ADDRESS
Silverbow, Hill B
Silverbow, Mt.

3. WELL LOCATION
County Silverbow
Township 3 (N)S Range 9 E(W)
NW ¼ NW ¼ Section 24
Lot _____ Block _____
Subdivision _____
Tract Number _____

4. PROPOSED USE Domestic X Stock ☐ Irrigation ☐
Other ☐ specify Public use

5. DRILLING METHOD X cable, _____ air rotary,
_____ forward rotary, _____ reverse rotary, _____ jetted,
_____ other (specify) _____

6. WELL LOG

Depth (ft.) From	To	Formation
0	14	Decomposed Diapiite
14	22	Sand + Some Gravel
22	60	Decomposed Granite
60	98	"
98	119	Sand + Gravel

PA

LOCATION VERIFIED
MBMG 9-8-92

ATTACH ADDITIONAL SHEETS IF NECESSARY

7. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and PSI Rating of casing	From (feet)	To (feet)
8"	8⅝	1½'	+1½'

Perforations X and/or
Screen _____

Kind Size	From (feet)	To (feet)
¼" & 3" Tank	119'	101'

Was casing left open end? X Yes _____ No
Was a packer or seal used? _____ Yes X No
If so, what material _____
Was the well gravel packed? _____ Yes X No
To what depth was the well grouted? 20' ft
Material used in grouting Concrete
Well head completion: Pitless adapter
X Yes _____ No
Top casing 18 in. or greater above grade
X Yes _____ No

8. WELL TEST DATA
The pump test information request in this section is required for all wells. All depth measurements shall be from the top of the well casing unless otherwise specified.
All wells under 100 gpm must be tested for a minimum of one hour and provide the following information:
a) Air _____ Pump 5-H.P. Bailer X
b) Static water level immediately before testing 12 ft. If flowing; closed-in pressure _____ psi 92 gpm
Controlled by: _____ valve, _____ reducers, _____ other, (specify) _____
c) Depth at which pump is set for test 84'
d) The pumping rate and means of discharge (i.e., bailing, airlift, pumping) 92 gpm
e) Maximum drawdown during the test To 41' ft
f) Duration of test: Pumping time 8 hrs
Recovery time _____ hrs
g) Recovery water level _____ ft
Amount of time after pumping recovery level water data was taken _____ hrs
Wells intended to yield 100 gpm or more shall be tested for a period of 8 hours or more. The test shall follow the development of the well, and shall be conducted continuously at a constant discharge at least as great as the intended appropriation. In addition to the above information, water level data shall be collected and recorded on the Department's "Aquifer Test Data" form included in each packet of well logs.
NOTE: All wells shall be equipped with an access port ½ inch minimum or a pressure gauge that will indicate the shut-in pressure of a flowing well. Removable caps are acceptable as access ports.

9. WAS WELL PLUGGED OR ABANDONED? _____ Yes X No
If yes, how? _____

10. DATE COMPLETED July 26 68

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date _____

Tri-Valley Drilling
Firm Name

Shelby Mt. 59474
Address

Robert L. Jackson 331
Signature License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

1520 EAST SIXTH AVENUE HELENA, MONTANA 59620-2301 444-6610

DNRC

DRILLER: Please give this copy to the well owner.
OWNER: Complete [illegible] side and send to DNRC when [illegible] and the water has been tested.

M: 129085

Butte

Form No. 603 R9/82

093 03N 09W 22 A

Silver Bow

File No. _____

Schlosser

RECEIVED
APR 16 1984
MONTANA DEPT. OF NATURAL RESOURCES & CONSERVATION

WELL LOG REPORT

State law requires that this form be filed by the water well driller within 60 days after completion

026498

1. WELL OWNER
Name Wayne Reed

2. CURRENT MAILING ADDRESS
Tract 11, Indian Wells
Butte, Montana 59701

3. WELL LOCATION
County Butte-Silver Bow County
Township 3 (N/S) Range 9 (E/W)
¼ ¼ ¼ Section 22 N½
Lot Tract 11 Block
Subdivision Indian Wells

4. PROPOSED USE Domestic [X] Stock [ ] Irrigation [ ]
Other [ ] specify

5. DRILLING METHOD X cable, bored,
forward rotary, reverse rotary, jetted,
other (specify)

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)
6"	6 5/8" o.d. x .250	+2'	78'
	4" PVC 200#	15'	155'

Perforations _____ and/or Screen _____

Kind Size	From (feet)	To (feet)
Skill Saw	100'	155'

Was casing left open end? X Yes ___ No
Was a packer or seal used? ___ Yes X No
If so, what material
Was the well gravel packed? ___ Yes X No
Was the well grouted? ___ Yes X No
To what depth?
Material used in grouting
Well head completion: Pitless adapter ___ Yes ___ No
Top of casing 12 in. or greater above grade X Yes ___ No

7. WHAT IS THE TEMPERATURE OF THE WATER?
_____ Degrees Fahrenheit
[ ] Measured [ ] Estimated

8. WATER LEVEL
Static water level 100 feet below land surface
If flowing; closed-in pressure _____ psi
_____ gpm
Controlled by: _____ valve, _____ reducers,
_____ other, (specify)

9. WELL TEST DATA _____ pump X bailer
_____ other, (specify)
Pumping level below land surface:
_____ ft. after _____ hrs. pumping 10 gpm
_____ ft. after _____ hrs. pumping _____ gpm

10. WAS WELL PLUGGED OR ABANDONED? ___ Yes X No
If yes, how?

11. DATE COMPLETED April 6, 1984

12. WELL LOG

Depth (ft.) From	To	Formation
0'	1'	Top soil
1'	3'	Brown clay
3'	97'	Grey sandy clay
97'	155'	Grey rock
		Water

WFK/BT (use separate sheet if necessary)

13. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

4/13/84
Date

O'Keefe Drilling Company 4 Mile Road
Firm Name

Butte, Montana - P.O. Box 3810 59702
Address

Ed O'Keefe 287
Signature Ed O'Keefe License No.

M: 50503

DEPARTMENT — BUREAU COPY

03N 09W 22 BDDC 01

REED, WAYNE MIKE
Tract 11, Indian Wells
Buxton 59701

April 3, 1984

DOMESTIC WELL -- DRY

Depth 215'
Cased 120'
6" drive shoe

~~DRY HOLE~~

GPM 1½ to 2 by bailing
SWL 110'

Driller: Frosty Kentfield, cable
Helper: Ben Thielen

This is not a dry hole, SWL measured on 10/30/01 -

Current owner: Ron Schlosser
119047 Battle Ridge Rd
Silver Bow, Mt 59750
(406) 782-3613

SWL
10/30/01
1610
95.28
STickup 2.4

50503

093 Butte RECEIVED 3N 9W 22 SW Silver Bow

Form No. 603 (R 6-84)

Tranmer

SEP 30 1986

File No. _____

WELL LOG REPORT

State law requires that this form be filed by the water well driller within 60 days after completion o

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

028048

1. WELL OWNER
Name Walt Falkowski

2. CURRENT MAILING ADDRESS
1939 Sampson
Butte, Montana 59701

3. WELL LOCATION
County Butte-Silver Bow
Township 3 North N/S Range 9 West E/W
¼ ¼ ¼ Section 22
Lot 5 Block
Subdivision Indian Wells Development

4. PROPOSED USE Domestic [X] Stock [ ] Irrigation [ ]
Other [ ] specify

5. DRILLING METHOD ____ cable, ____ bored,
X forward rotary, ____ reverse rotary, ____ jetted,
____ other (specify)

6. WELL CONSTRUCTION AND COMPLETION

Size of drilled hole	Size and weight of casing	From (feet)	To (feet)
6"	6 5/8" od x .250	+18"	58'
	4" PVC 200#	27'	127'

Perforations ____ and/or Screen ____

Kind Size	From (feet)	To (feet)
Skill Saw	87'	127'

Was casing left open end? X Yes ____ No
Was a packer or seal used? ____ Yes X No
If so, what material
Was the well gravel packed? ____ Yes X No
Was the well grouted? ____ Yes X No
To what depth?
Material used in grouting
Well head completion: Pitless adapter ____ Yes ____ No
Top of casing 12 in. or greater above grade X Yes ____ No

7. WHAT IS THE TEMPERATURE OF THE WATER?
____ Degrees Fahrenheit
[ ] Measured [ ] Estimated

8. WATER LEVEL
Static water level [ ] feet below land surface
If flowing; closed-in pressure ____ psi
[ ] gpm
Controlled by: ____ valve, ____ reducers,
____ other, (specify)

9. WELL TEST DATA ____ pump ____ bailer
X other, (specify) air compressor
Pumping water level below land surface:
____ ft. after ____ hrs. pumping 25 gpm
____ ft. after ____ hrs. pumping [ ] gpm

10. WAS WELL PLUGGED OR ABANDONED? ____ Yes X No
If yes, how?

11. DATE COMPLETED April 10, 1986

12. WELL LOG

Depth (ft.) From	To	Formation
0'	3'	Top soil
3'	45'	Decomposed granite
45'	127'	broken granite
		Seepage at 102'

(use separate sheet if necessary)

13. DRILLER'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
5/19/86
Date
O'Keefe Drilling Company 4 Mile Road
Firm Name
P.O. Box 3810 - Butte, MOntana 59702
Address
Daniel E. O'Keefe 459
Signature Daniel E. O'Keefe License No.

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
32 SOUTH EWING HELENA, MONTANA 59620 444-6610 **DNRC**

STATE PUBLISHING CO., HELENA, MONT.

DEPARTMENT - BUREAU COPY

M:50504

782-3013

3N09W22

Weir

114922

WELL LOG REPORT

1.WELL OWNER
Name WIER, GERALD WEIR

2.CURRENT MAILING ADDRESS
119295 GERMAN GULCH ROAD
BUTTE, MT 59701

3. WELL LOCATION INDIAN WELLS
County SILVER BOW
Township T 3 (N)/S Range 9 E/(W)
NW 1/4 ____ 1/4 SECTION 22
Lot ~~TRACT B~~ Block
Subdivision INDIAN WELLS
Tract Number TRACT B

4. PROPOSED USE Domestic X
Irrigation ____ Stock ____
Other:

5. DRILLING METHOD ____ Cable
Rotary: X Air ____ FWD ____ Reverse
____ Jetted ____ Other:

6. WELL LOG

From	To	Formation
0	100	RED CLAY
100	120	GRANITE
120	130	SAND
130	140	GRANITE

PA

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	20
4"	PVC	10	140

COMPLETIONS
perforations ____ screen ____

Kind	From feet	To feet
Skill Saw	80	140

Was casing left open? YES
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 20 FT
Grouting Material: Bentonite/ Hole Plug
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air X Pump ____ Bailer ____
B. Static Water Level before: ____ FT
If flowing closed in pressure ____ PSI ____ GPM
Controlled by:
C. Depth of Pump for Test ____ FT
D. Pumping Rate & Discharge 10 GPM
E. Maximum Drawdown for test ____ FT
F. Duration of test:
Pumping time: 1.5 HRS.
Recovery Time: ____ HRS.
G. Recovery Water Level ____ FT
Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED 0.0024291

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
Date: 6/26/95

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT. 59702

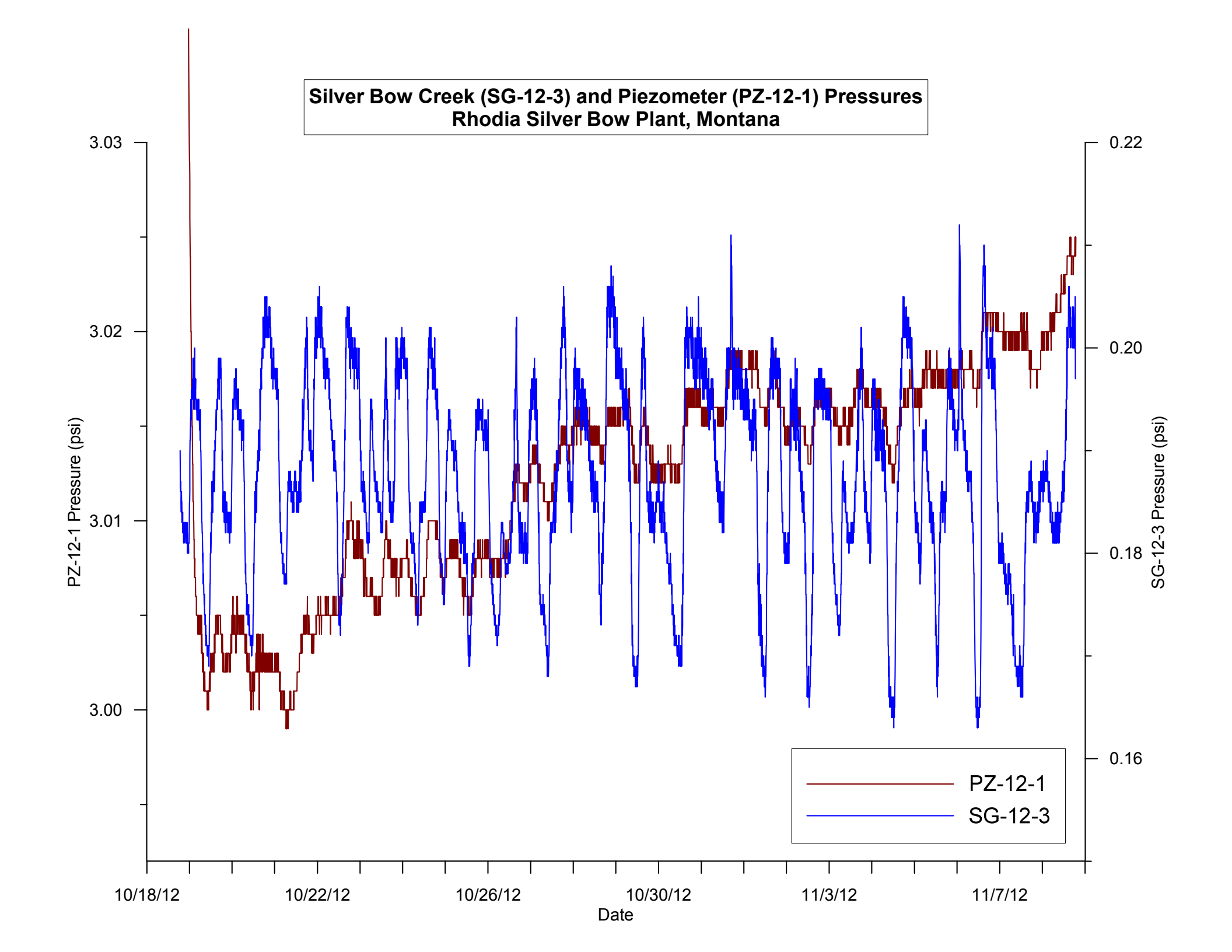
Dan O'Keefe 462
Signature License No.
Dan O'Keefe

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

M: 153520

Appendix 3.2-E

SG-12-3/PZ-12-1 Water Level Monitoring Data


Silver Bow Creek (SG-12-3) and Piezometer (PZ-12-1) Pressures
Rhodia Silver Bow Plant, Montana
PZ-12-1 Pressure (psi)
SG-12-3 Pressure (psi)
3.03
3.02
3.01
3.00
0.22
0.20
0.18
0.16
10/18/12
10/22/12
10/26/12
10/30/12
11/3/12
11/7/12
Date
PZ-12-1
SG-12-3