Final Data Release Report

PHASE II LEACH PAD INVESTIGATION BEAL MOUNTAIN MINE

Beaverhead-Deerlodge National Forest
Silver Bow County, Montana

United States Department of Agriculture
Forest Service
Northern Region

February 2011

TETRA TECH

Final Data Release Report
Phase II Leach Pad Investigation
Beal Mountain Mine

Beaverhead-Deerlodge National Forest
Silver Bow County, Montana

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1.0 INTRODUCTION

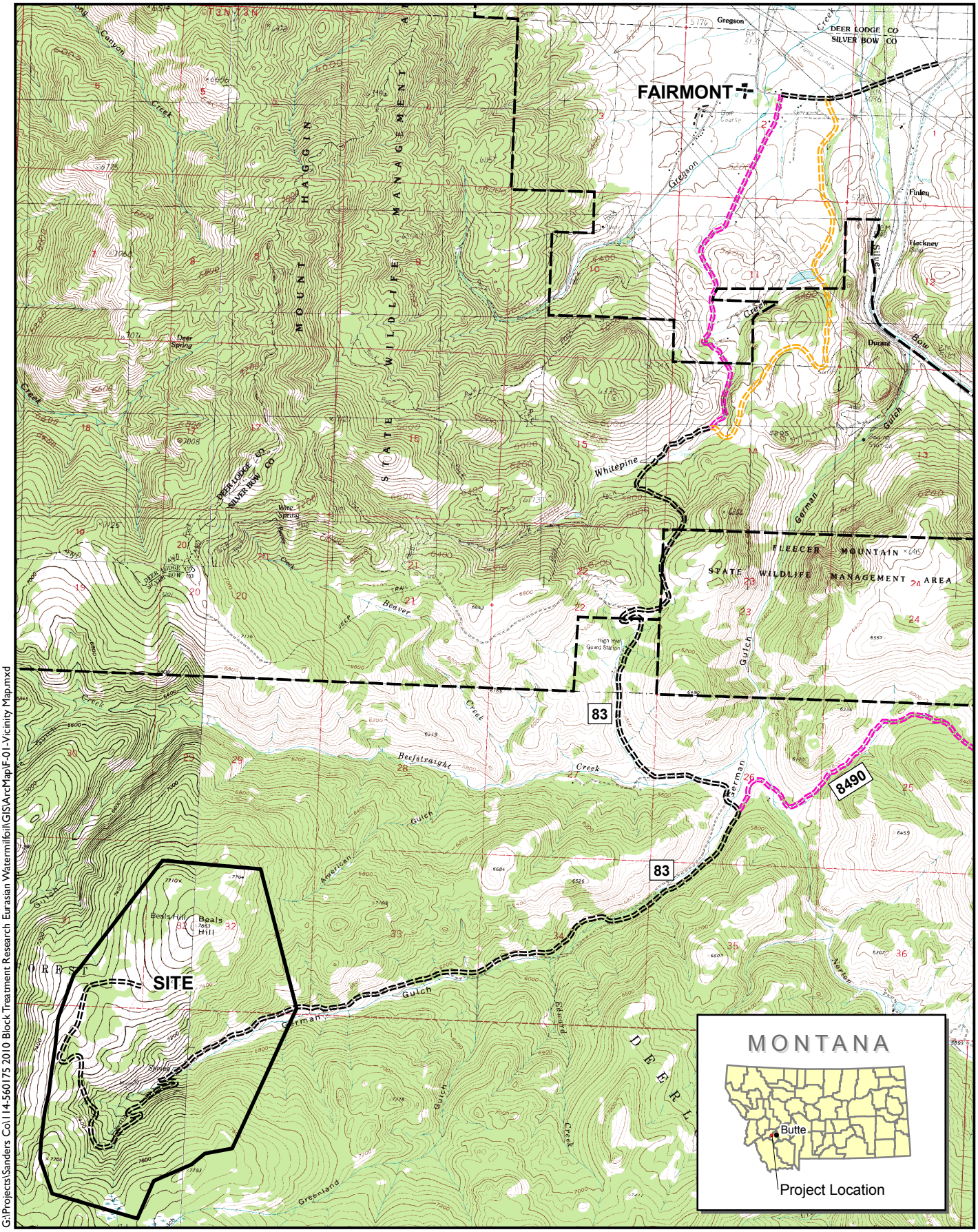
Tetra Tech, Inc. (Tetra Tech) is completing technical studies and conducting active water treatment of leach pad solution in conjunction with a reclamation and restoration project under contract GS-10F-0268K / AG-0356-D-08 with the USDA Forest Service, Region 1 for the Beal Mountain Mine property. The Beal Mountain Mine is located approximately 16 miles west-southwest of Butte, in Silver Bow County, Montana (**Figure 1**). The Mine occurs within the Beaverhead-Deerlodge National Forest near the headwaters of German Gulch.

This report provides data summary analysis and describes the Phase II program investigating the potential source(s) of water introduction to, and accumulation on the Beal Mountain Mine heap leach pad. Previously developed hypotheses for the accumulation of this water were related to either infiltration through a poorly designed or constructed cover, or lateral migration of shallow groundwater onto the leach pad along the northern and eastern edge containment dike, or both. It was the intent of Phase II to expand upon 2009 Phase I investigations. Both Phase I and Phase II investigations are described below.

1.1 LEACH PAD DESCRIPTION

The Beal Mountain Mine heap leach pad straddles the topographic divide between German and Minnesota Gulches (**Figure 2**). The leach pad was constructed in three stages in 1988 (Stage I), 1990 (Stage II), and 1992 (Stage III). The heap leach pad (see Figures 2 and 3 in Tetra Tech, 2010b) covers approximately 77 acres, stores an estimated 14,807,100 tons of spent ore, and has a capacity to hold about 106,000,000 gallons of solution. The foundation is constructed on unconsolidated and discontinuous glacial till overlying weathered bedrock. A constructed containment dike or embankment surrounds about 60% of the leach pad perimeter. The dike was constructed from approximately 3,000,000 tons of waste rock from portions of the first three years of mining from the main Beal Mountain pit. Along the southern side of the leach pad, the preexisting topography was a steep south-facing hill slope. Because of this topography, the dike along the south side was constructed to stabilize and hold ore on the side-hill pad construction site, and to act as a surface upon which to lay out the bottom composite liner. This southern portion of the dike is about 70 feet wide across its crest and about 350 feet wide at the base. It is also about 175 feet high and over 2,400 feet in length. Containment around the northern and northeastern portion of the leach pad was created by excavating glacial and weathered bedrock materials out of the containment basin.

On top of the foundation materials and beneath the base liner, a series of under-drains were installed to remove shallow groundwater and to provide a leak detection system (see Figure 12, in Tetra Tech, 2010a). The under-drain system drains to both the north and south as the topographic divide between German and Minnesota gulches occurs beneath the pad. The under-drains are a dendritic system of pipes that connect rock-filled basins (blanket collection drains or BCD) in the subsurface, with two ponds (BCD and BCD-A; **Figure 2**). The leach pad base constructed on top of the BCD under-drain is a composite liner that consists of two six- to nine-inch lifts of compacted clay as a bottom liner overlain by a 40-mil PVC geomembrane liner. Depth of spent ore on the pad is approximately 200 feet with the thickest section located in the southern part of the facility. Six sumps were constructed for recovering leachate solution from the heap leach pad (**Figure 2**).



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USGS 24K SERIES TOPOGRAPHIC MAP

N
W E
S

0 0.25 0.5 1 Miles

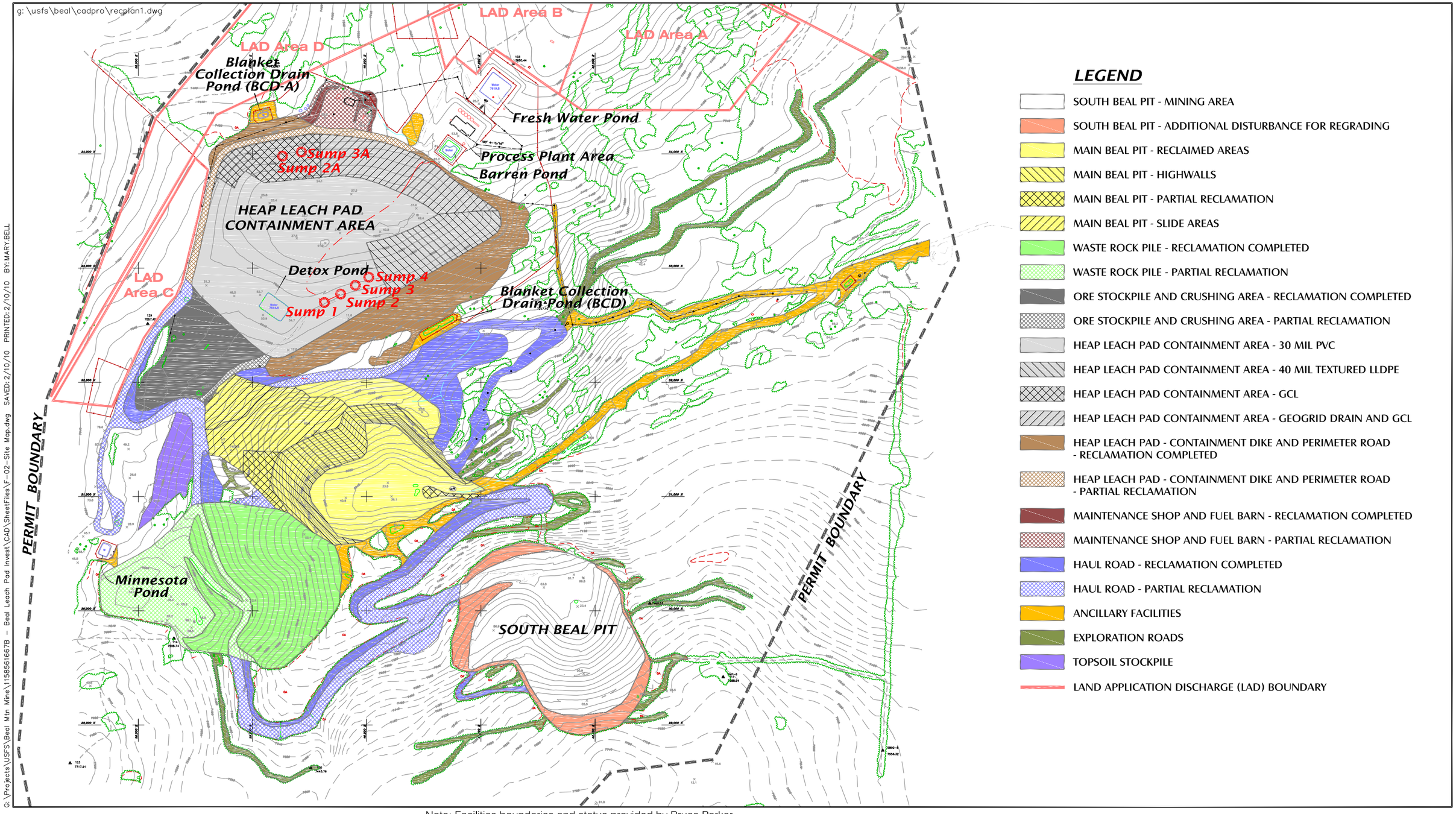
===: Common Access Route

===: Leased Access Route

===: USFS Access Route

83 USFS Road Route Number

Vicinity Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 1



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Note: Facilities boundaries and status provided by Bruce Parker,
Beal Mountain Mine, December 2003
Topography from Horizons Aerial Photogrammetry, September 2003

N

0 Feet 800

Site Map
Beal Mountain Mine
Silver Bow County, Montana
FIGURE 2

The heap leach pad was reclaimed during 2002 and 2003. Work completed included reclamation of the containment dike, drawing down solution contained within the pad, regrading the spent ore to a more stable configuration (perimeter ore slopes are 3H:1V or lower), and constructing a low permeability cap. The composite cap for the leach pad was constructed using various low permeability geosynthetic and soil covers. A 30-mil PVC geomembrane was installed over most of the leach pad, and variations in cover construction include the use of Geosynthetic Clay Liner (GCL) covers and geogrid drainage layers over other portions of the pad. **Figure 2** shows the geometry and materials used in construction of the cover over various portions of the leach pad. The existing conditions report (Maxim, 2004) describes in detail and illustrates the various geosynthetic composite covers used on the leach pad. Following placement of the geocomposite covers, an 18-inch thick layer of clayey and weathered quartzite South Beal waste and Beal shear zone material were placed as subsoil. An 18-inch soil cover was placed over the reclaimed pad and the containment dike. The soil was seeded with an approved seed mixture.

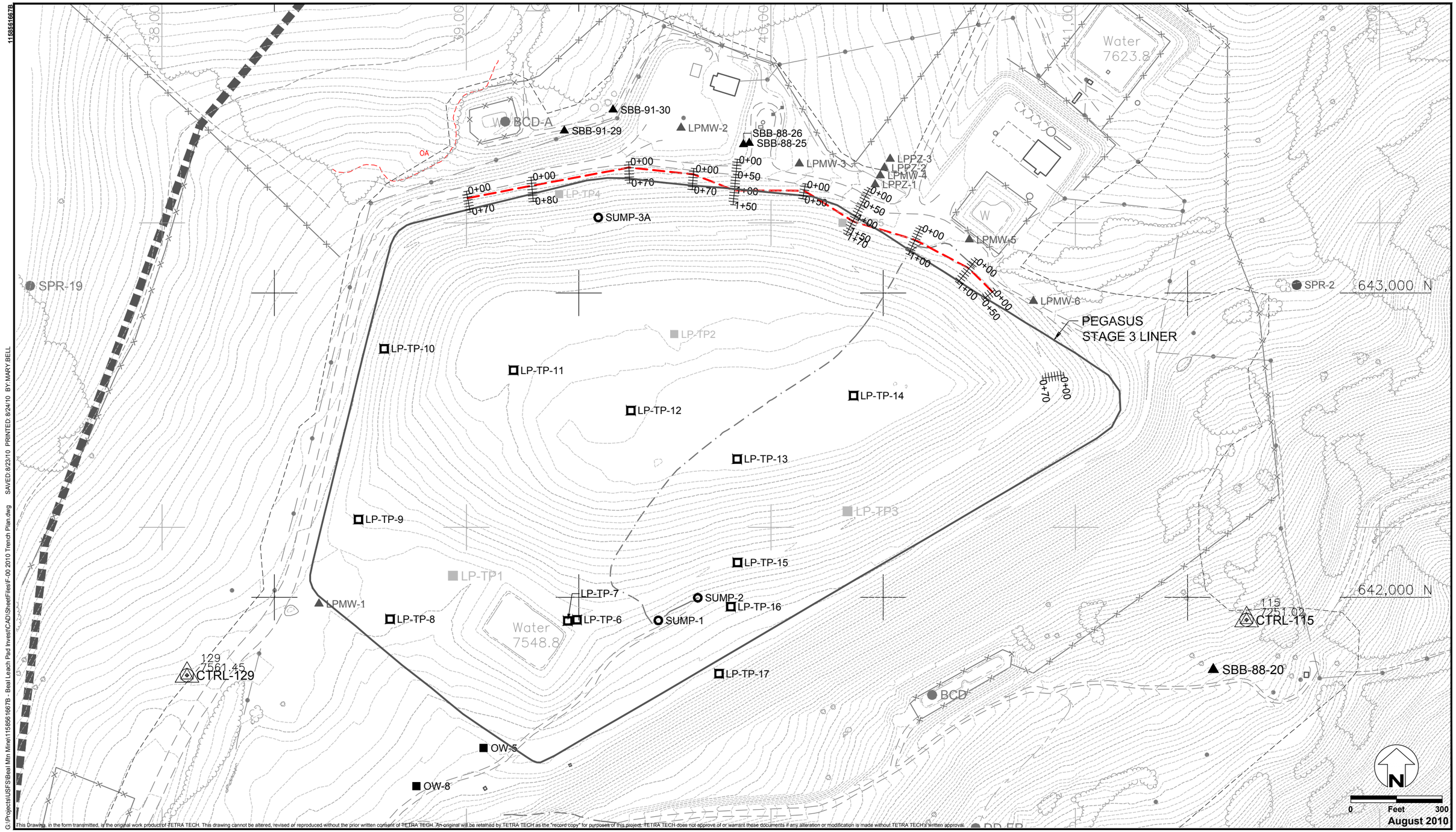
1.2 LEACH PAD INVESTIGATION PHASE I

The design and results of the Phase I Leach Pad Investigation are presented in the Final Preliminary Leach Pad Investigation Report (Tetra Tech, 2010b). Major objectives of the Phase I program included the following areas of investigation:

1. Compilation of existing information on leach pad design, as-built construction, reclamation and closure in order to produce accurate plan maps and cross-sections of the leach pad;
2. Water balance modeling of the leach pad and environs to identify and evaluate potential sources and volumes of water accumulating on the pad;
3. Installation of six (6) monitoring wells (LPMW-1 through 6, **Figure 3**) and three (3) piezometers (LPPZ-1 through 3, **Figure 3**) to determine groundwater elevations and flow direction outside of the pad in relation to the elevation of the geosynthetic bottom liner and cover on the leach pad. Continuous recording devices were installed in all nine newly installed wells during January 2010. Four additional wells were also instrumented in January 2010 with recording devices;
4. Two (2) trenches were excavated along the northern margin of the leach pad (2009 Leach Pad Trenches #1 and #2, **Figure 4)** to examine construction practices used in reclamation of the leach pad and geometric relations between the cover and bottom liner systems; and
5. Five (5) leach pad cover test pits (2009 LP-TP-1 through 5, **Figure 3**) were excavated to a depth sufficient to expose the top of the geosynthetic cover. Test pit locations were selected to encounter each of the various leach pad cover design scenarios used in construction of the overall leach pad cover.

In addition, the Final Leach Pad Investigation Report (Tetra Tech, 2010b) contains the following sections, only some of which are reproduced or summarized in this report:

Background
- Mining History
- Leach Pad Description
- Observations and Investigations of Water Accumulation on the Leach Pad



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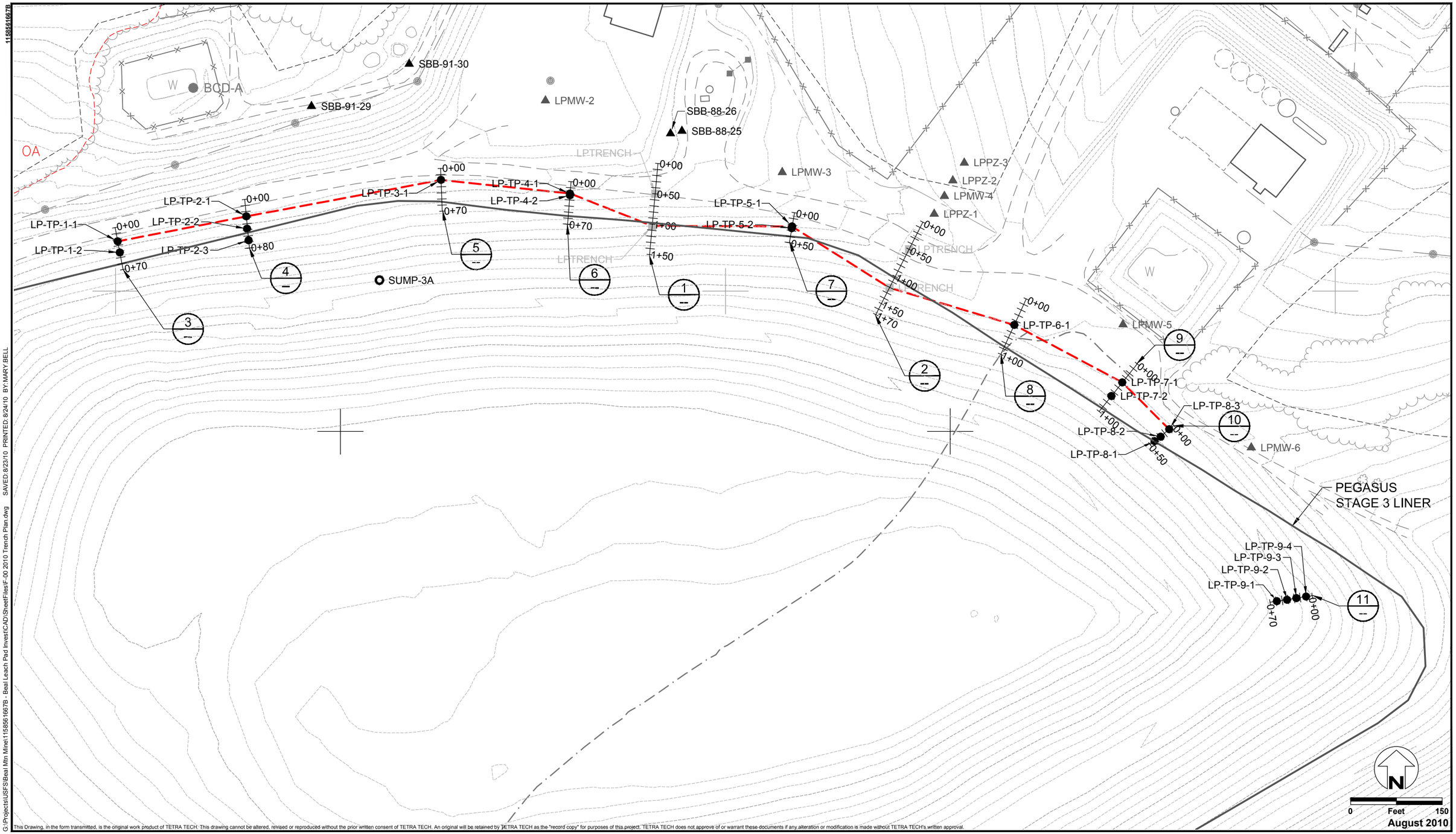
▲	Monitoring Well	▲ LPMW-2	2009 Leach Pad Investigation Monitoring Well
○	Leach Pad Sump	▲ LPPZ-2	2009 Leach Pad Investigation Piezometer Well
○	Abandoned Leach Pad Sump	◻ LP-TP-10	2010 Leach Pad Investigation Test Pit
△ 106 7437.07	Local Coordinate Control Point and Elevation (Feet)	■ LP-TP-1	2009 Leach Pad Investigation Test Pit
● 2010-LP-TP-1	2010 Leach Pad Cover Investigation Test Pit		
— — — —	Edge of Existing Cover		
———	Projection of Pegasus Stage 3 Bottom Liner		
0+00 0+50	2009 - 2010 Leach Pad Trenches		

Beal Mountain Mine
2010 Leach Pad Phase II Investigation
Plan View
Silver Bow County, Montana
FIGURE 3



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▲ Monitoring Well

Leach Pad Sump

Abandoned Leach Pad Sump

△106 7437.07 Local Coordinate Control Point and Elevation (Feet)

▲LPMW-2 2009 Leach Pad Investigation Monitoring Well

▲LPPZ-2 2009 Leach Pad Investigation Piezometer Well

0+00 0+50 1 -- 2009 - 2010 Leach Pad Trenches

●2010-LP-TP-1 2010 Leach Pad Trench Stake Locations

Edge of Existing Cover

Projection of Pegasus Stage 3 Bottom Liner

Beal Mountain Mine
2010 Leach Pad Phase II Investigation
Trench Plan View
Silver Bow County, Montana
FIGURE 4

Results
- Consolidation of Leach Pad Construction Information and Cross-sections
- Leach Pad Water Balance
- Monitor Well Installation and Monitoring
- Leach Pad Cover Investigation
  - Cover test pits
  - Trenching (Cover and bottom Liner relations)

1.3 LEACH PAD INVESTIGATION PHASE II

The Phase II Leach Pad Investigation was conducted in 2010 with the intent of confirming observations and laterally extending the area of investigation of the Phase I study. Both studies were designed to investigate the source of excess water introduced to, and accumulating on the leach pad, particularly along its northern edge. As such, the Phase II investigation sought to determine the construction characteristics of the cover, observe geometric relations between the cover and bottom liner, measure leach pad bottom liner elevations, measure groundwater elevations outside of the leach pad, evaluate the effectiveness of the as-built design to exclude water from the leach pad, and to identify the potential source(s) of introduction and continued accumulation of solution within the leach pad containment. It was anticipated that the results of these investigations would be used to identify construction remedies or solutions that would eliminate or minimize the accumulation of excess water on the leach pad.

Major elements of the Phase II investigative program were focused on the north side of the leach pad and included the following which are discussed in greater detail in Section 2:

- Periodic monitoring of depth to groundwater in 14 wells
- Excavation of nine new perimeter trenches
- Excavation of twelve (12) new cover test pits to investigate cover integrity, cap materials, and proper lapping of the geosynthetic material joints.

2.0 PHASE II INVESTIGATI0N – DATA AND RESULTS

This section of the report describes the elements of the Phase II investigation, the data generated by the investigation, and results. The Phase II investigation focused on the northern and eastern margins of the pad and attempted to further identify potential source(s) of water to the Beal Mountain Mine Heap Leach Pad and delineate the areas over which these sources might be contributing water to the pad. The investigation included: test pits examining the configuration and integrity of the leach pad cover; trenches exposing geometric relations of the historically implemented closure plan, particularly the relationship between the leach pad cover and bottom liner as a potential pathway for water introduction to the leach pad; and monitoring of groundwater levels in wells adjacent to the leach pad with respect to the elevation of the upper edge of the bottom liner.

2.1 LEACH PAD COVER INVESTIGATION – TEST PITS

Because only highly generalized "as-built" drawings of the leach pad cover were prepared during the historical closure, test pits in the leach pad cover were excavated to describe and confirm the actual construction components (soil, subsoil, and geosynthetics) of the cover at the test pit locations, with respect to the closure plan proposed and implemented by BMMI (**Figure 2)**. Geosynthetic liners in the test pits were also evaluated for proper lapping of joints and damage, which could have occurred during construction or placement of the soil cover material, and therefore could have provided a pathway for water entering the leach pad.

In all, seventeen test pits were excavated (five during the Phase I investigation, LP-TP-1 through 5; and twelve in the Phase II investigation, LP-TP-6 through 17, **Figure 3**) using a track-mounted excavator, to a depth sufficient to expose the top of the geosynthetic cover. Test pit locations were selected to encounter each of the various leach pad cover design scenarios used in construction of the overall leach pad cover (**Figure 2**). At each test pit location, the soil and geosynthetic covers were identified, described, and logged. Finally, each test pit was photographed, backfilled and marked with the test pit identification number on survey lath and surveyed. Test pit logs for the Phase I investigation are included as Appendix E of the preliminary Investigation Report (Tetra Tech, 2010b), and test pit logs for the Phase II investigation are included in **Appendix A** of this report.

As described in the test pit logs (**Appendix A**), various geosynthetic cover materials were encountered in each test pit with overlying cover soil that generally ranged from 29 to 49 inches in total depth. Typically the cover soil consisted of 15 to 18 inches of dark brown clayey sand with varying amounts of cobbles and gravels, which was overlying 12 to 31 inches of cobbles and gravels with sand and clay. Test Pit LP-TP-7 had 24 inches of cover soil, but was located on the margin of the detox pond; and in LP-TP- 8 through 10, located along the western side of the leach pad, soil thicknesses were somewhat thinner ranging from 27 to 35 inches. Test Pit LP-TP-17 was excavated off of the leach pad cover in order to determine if the geosynthetic cover in this area extended over the leach pad embankment.

The various combinations of geosynthetic liners and cover soil material generally matched the descriptions displayed in **Figure 2** and did not show evidence of damage from subsequent construction during placement of the cover soils. However, spent ore material below the geosynthetic liner was moist to wet in Test Pits 1, 2 and 4, and damp to moist in LP-TP-6 through 16, which brings into question the effectiveness of the low permeability geosynthetic and cover soil cap to exclude water. Two test pits also had standing water on top of the

geosynthetic cover indicating poor surface drainage conditions. Finally, a double layer of 30-mill PVC was encountered in Test Pits 3, 13, 14, and 16 indicating a lapped cover joint. Most joints were oriented north-south, and all were lapped properly with respect to the drainage slope angle. One excavated joint had a 1-foot overlap of PVC.

In summary, the test pits showed variable cover soil thickness from 29 to 49 inches, geosynthetic cover liners matched those described in conceptual closure diagrams, cover liners did not appear damaged by placement of cover soils, and PVC joints were lapped properly to shed water with a one foot overlap observed in one test pit. Test pit results showed only very minor and localized problems with the cover components (i.e., water standing on top of the cover, damp soils under the cover), and therefore, infiltration of precipitation, snowmelt and surface water though the cover is not expected to contribute a significant amount of water to the leach pad.

2.2 LEACH PAD LINERS INVESTIGATION – TRENCHES

Trenches along the northern and eastern margins of the leach pad were excavated to examine practices used in construction and reclamation of the leach pad, spatial relations between the cover and bottom liner systems, the elevation of the top of the bottom liner, and to evaluate the ability of the constructed closure design to prevent water from entering the leach pad.

In all, eleven (11) perimeter trenches were excavated. Two trenches were excavated during the Phase I investigation (Leach Pad Trenches 1 and 2, **Figure 4**) and nine (9) new perimeter trenches (Leach Pad Trenches 3 through 11, **Figure 4**) were excavated during Phase II of the investigation. All of the trenches were excavated at right angles to the slope of the reclaimed surface of the leach pad, and most trenches were relatively shallow excavations (4 to 8 feet) to determine the lateral extent of geogrid drain layer, GCL cover materials, and the nature of the material beneath the GCL cover. However, five of the leach pad trenches (1, 2, 4, 9, and 10) (**Figure 4**) were extended further into the reclaimed slope to be able to excavate through the cover soil and cover geotextile to expose the containment dike and upper edge of the bottom liner in the bottom of the trench. During excavation and logging of the trench materials, particular attention was paid to the relationship between the bottom liner and the cover system to determine if there was a potential pathway for infiltrated meteoric water from the leach pad or lateral migration of up-gradient groundwater from Beals Hill to enter the leach pad. Trenches were mapped, logged, liner and cover systems described, photographed, and trench locations surveyed. Both 2009 and 2010 leach pad trench cross-sections are presented in **Appendix B** of this report (**Figures B-1 through B-6**).

Observations from the trenching and cross-sections (**Appendix B**) combined with established mine sequencing of material placement on the pad, indicate that the leach pad basin was excavated into well-consolidated, poorly sorted glacial till or less commonly bedrock, and a compacted embankment was constructed to include a flat bench (or access-way) along the margin of the leach pad that slopes gently toward the leach pad basin. As can be seen from the trench cross-sections, on top of the basin portion of the excavated leach pad is a nominally 12-inch thick layer of compacted clay, overlain by a 40-mill PVC bottom liner with welded seams. The upper edge of the bottom liner was tucked into the top inner edge of the embankment where it was placed in a V-ditch with compacted embankment material overlying the liner. Ore was placed on the bottom liner on the leach pad, and stacked as high as 200 feet along the southern edge of the pad.

Upon decommissioning of the leach pad, the upper surface of the spent ore on the pad was regraded from its stacked and presumably benched configuration to a sloping contoured surface (see surface topography, **Figure 2**). Trenching observations and cross-sections (see cross-sections, **Appendix B**) indicate that during reclamation of the Beal leach pad, spent ore was regraded off of the leach pad's protective bottom liner, possibly to allow for a predetermined reclamation grade to the final leach pad surface. Grading of spent ore off of the leach pad has created a layer of well-sorted, highly permeable material that occurs between the leach pad bottom liner and its cover, and straddles the join between the interior of the leach pad; the planar, inward-sloping embankment margin; and materials outside of the leach pad, in this case glacial till, colluvium, or bedrock. In trenches, the spent ore layer varies between 3 and 13 feet in thickness (average 7.8 feet), between the bottom liner and the GCL cover (see cross-sections, **Appendix B**).

A composite low permeability cap or cover was constructed over the regraded spent ore surface on the leach pad. Along the north side of the leach pad, this cap consists of a "Geosynthetic Clay Liner" (GCL), overlain by a "Geogrid" drainage-net layer, which in turn was overlain by a 15 to 18-inch thick subsoil and a 12 to 18-inch soil cover (but see **Figures B-1 through B-6, Appendix B,** and test pit logs in **Appendix A** for variations). This surface was revegetated with grasses. The GCL is designed to eliminate or minimize infiltration thorough the cover, and the Geogrid creates a drainage layer that is designed to carry water infiltrated through the cover soil, off of the GCL surface.

Normally the GCL cover is designed such that the GCL and geogrid layers are placed far enough down the regraded heap leach pad surface to insure that water is removed from the vicinity of the heap leach pad. In addition, water draining through the soil cover and along GCL/Geogrid surface is typically delivered to a lined perimeter drainage ditch and diverted to a discharge point well away from the leach pad. Trench excavations and cross-sections (**Appendix B**) on the northern perimeter of the leach pad confirm that the GCL liner in many trenches terminates on spent ore that extends beyond the leach pad bottom liner, and is laterally continuous with spent ore on the leach pad. In at least two cases (Leach Pad Trenches 1 and 2), the GCL cover terminates in spent ore almost in the middle of the underlying compacted sloping planar top of the leach pad embankment. In these cases the cover liner is separated from the embankment and bottom liner by as much as 5 feet of highly transmissive spent ore. The Geogrid layer occasionally extends further down the regraded slope, but this layer is not a barrier to infiltrating water.

There are at least two major problems identified by trenching observations and depicted in the trench cross-sections (**Figures B-1 through B-6, Appendix B**). The first problem is that the geosynthetic cover fails to adequately transmit water away from the leach pad perimeter and instead delivers water that has infiltrated the soil cover to a zone where it can enter the leach pad below the geosynthetic cover. This can be illustrated by thinking of the regraded heap leach pad GCL cover, as a low permeability umbrella. In this analogy, a drip edge forms around the perimeter of the umbrella along the down-slope edge or termination of the GCL liner. The "umbrella" (GCL or PVC cover) collects precipitation and snowmelt from the entire 77 acre leach pad and delivers it to the down-slope margin of GCL (drip edge of the umbrella), where it infiltrates into permeable spent ore on the regraded pad at a location where there is some 3 to 13 feet of spent ore separating the geomembrane cover from the bottom liner. These relationships identify a delivery system and an open, highly transmissive conduit for surface water run-off that clearly define a pathway for water infiltrating through the cover soil to the geotextile, and draining off of the cover to reenter the leach pad.

The second problem identified during trench observations and illustrated on the cross-sections (**Figures B-1 through B-6, Appendix B**), is that this same conduit of highly transmissive spent ore, lying between the cover and the bottom liner, has the potential to allow shallow groundwater to migrate onto the pad from perimeter areas where the surface elevation of groundwater levels outside of the pad are higher than that of the top of the bottom liner (for example Beals Hill). In addition, these relations could provide snowmelt from drifts accumulating along the northern perimeter of the leach pad, a direct pathway onto the leach pad containment area.

Considerable evidence related to seasonal hydrograph variations in the rate of water accumulating on the pad, and observed relations between water levels in select monitor wells and the leach pad bottom liner elevation is presented in the following section (Section 2.3). These relations strongly suggest that this process at least locally operates to introduce groundwater to the leach pad along its northern and eastern perimeter.

2.3 MONITORING OF GROUNDWATER LEVELS IN WELLS

During the Phase I investigation in October 2009, one 4-inch diameter monitoring well (LPMW-1, **Figure 3**) was installed near the western most corner of the leach pad. Additionally, five 4-inch diameter monitoring wells (LPMW-2 through 6, **Figure 3**) and three 2-inch piezometers (LPPZ-1 through 3, **Figure 3**) were installed along, but outside of the north leach pad containment berm.

Monitoring wells installed along the northern and eastern embankment were evenly spaced to evaluate the potential for groundwater from the topographically higher Beals Hill area, located to the northeast of the leach pad, to exceed the embankment/bottom liner elevation and be a contributing source of water to the leach pad. In the event that groundwater would be identified as a contributor to leach pad solution volume, the new monitor wells were constructed (4-inch completions) with the capacity to be converted to dewatering wells during periods of elevated groundwater.

The six newly installed monitoring wells, three newly installed piezometers, and leach pad sumps #1 and #3A (**Figure 3**) were instrumented with pressure transducers and data loggers in January in order to continuously monitor rising hydrograph groundwater elevations during 2010. In addition, four other transducers were installed in wells OW-5, OW-8, SBB-88-25, and SBB-88-26 (**Figure 3**) during January of 2010. Tetra Tech's Phase I investigation report identifies monitoring locations instrumented with transducers and their objective (Table 8 in Tetra Tech, 2010b) and provides the location and measuring point elevation of newly installed leach pad monitoring wells (Table 9 in Tetra Tech, 2010b). Copies of these well logs were attached as Appendix D of the Phase I investigation report (Tetra Tech, 2010b).

During the Phase II investigation, periodic measurement of depth to groundwater was monitored in 14 wells: SBB-88-25, SBB-88-26, SBB-91-29, SBB-91-30, SBB-94-31, LPMW-1 through LPMW-6, and LPPZ-1 through LPPZ-3 (**Figure 3**). Groundwater levels were manually measured monthly from March 2010 through October 2010.

In addition, continuous water level recorders were downloaded in March, May, June, July and October during regularly scheduled surface and groundwater monitoring events. Water levels in

wells both with, and without transducers were also measured or checked manually using a sounding tape.

The complete set of data resulting from water level monitoring is presented graphically in **Appendix C**. **Table 1** presents maximum groundwater elevation data measured from monitor wells and compares it with the elevation of the top edge of the bottom liner as measured in the nearest excavated leach pad perimeter trench (and in one leach pad cover test pit). Since the leach pad bottom liner was not encountered in all trenches discussed above in Section 2.2, the Leach Pad Design Drawings were interpolated based on confirmed elevations. Due to uncertainties in this interpolation and potential for local liner elevation variations during construction, groundwater elevations within five feet of an interpolated liner elevation were assumed to have exceeded the bottom liner.

As can be seen from **Table 1** the maximum elevation of groundwater levels in LPMW-4 and LPPZ 1 through LPPZ-3 (shaded rows in **Table 1**) exceeds the elevation of the top of the bottom liner on the leach pad in Trench 2 excavated in 2009 (**Figure B-1, Appendix B**). Although these locations are topographically higher than the leach pad bottom liner they indicate that during periods of high groundwater, groundwater is likely entering the leach pad over the top of the bottom liner through the gap between the cover and bottom liners that is filled with regraded spent ore and cover soil (**Figure B-1, Appendix B**).

Additionally, continuous water level data for wells south and west of SBB-88-26 (i.e. OW-5, OW-6, LPMW-1, SBB-91-29, SBB-91-30, and LPMW-2) indicate that maximum groundwater elevations were at least 25 feet below the top of the nearest bottom liner elevation. Wells LPMW-5 and LPMW-6 along the northeast perimeter of the pad exhibited maximum groundwater elevations of at least 10 feet below the top of the nearest bottom liner elevation. These results indicate groundwater cannot be entering the leach pad in these areas by exceeding the bottom liner elevation and indicate the east and west extent of the area where groundwater elevations do exceed the bottom liner elevation.

Based on continuous water level data groundwater elevations exceeded the elevation of the top edge of the bottom liner from approximately mid-April through early-July during 2010. Therefore, it is likely that groundwater is contributing to leach pad solution volume. The area of likely groundwater contribution to leach pad solution volume extends from the vicinity of LPPZ-1 and leach pad Trench #2 and continues northwest to SBB-88-25 and leach pad Trench #1 (**Figures 3 and 4**) during periods of high groundwater especially during the spring snow-melt period. During the 2010 period of maximum groundwater elevations (June) a relatively consistent groundwater gradient of 0.06 foot per foot toward the south and west was observed along the northern edge of the leach pad.

TABLE 1
Beal Mountain Mine Leach Pad Monitoring Wells
Nearest Liner Elevation Compared to Groundwater Elevation

Well	MPE[1]	Nearest Trench	Elevation of Top Edge of Bottom Liner at Nearest Trench (Measured from Trench)	Max GWE[2]	Date[3]
LPMW-1	7556.98	LP-TP-10	--	7543.44	6/17/2010
LPMW-2	7509.54	Trench 6	7523.76**	7496.33	6/7/2010
LPMW-3	7539.22	Trench 7	7541.96**	7534.52	6/16/2010
LPMW-4	7557.40	Trench 2	7553.68	7555.28	6/17/2010
LPMW-5	7568.19	Trench 9	7565.73	7554.83	6/17/2010
LPMW-6	7555.16	Trench 10	7564.20	7547.25	6/17/2010
LPPZ-1	7555.16	Trench 2	7553.68	7553.36	6/16/2010
LPPZ-2	7559.36	Trench 2	7553.68	7556.86	6/17/2010
LPPZ-3	7562.65	Trench 2	7553.68	7559.04	6/17/2010
OW-5	7514.26	LP-TP-8	7505**	7399.83	6/18/2010
OW-8	7512.99	LP-Tp-8	7505**	7469.17	6/2/2010
SBB-88-25	7526.03	Trench 1	7531.81	7524.45	6/18/2010
SBB-88-26	7524.94	Trench 1	7531.81	7523.10	6/18/2010
SBB-91-29	7471.96	Trench 4	7521.30	7463.00*	6/17/2010
SBB-91-30	7480.05	Trench 5	7518.63**	7471.58*	7/1/2010
Sump-3A	7566.89	Trench 5	7518.63**	7516.17	8/2/2010

Notes:

1 MPE – Measuring point elevation is top of well PVC casing north side with a datum of NAD-83.

2 Max GWE – Maximum groundwater elevation recorded using dedicated pressure transducer for the period of January 14, 2010 through October 20, 2010.

3 Date Max GWE recorded.

* Manual measurements data.

** Top edge of Bottom Liner not encountered during excavation. Elevation presented based on corrected Leach Pad Stage 3 design drawings.

Shading indicates Max GWE within 5 feet or exceeds nearest Top Edge of Bottom Liner.

3.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and interpretations are a result of observations and measurements made during the Phase I and II leach pad investigations conducted between September 2009 and August 2010.

- During closure, ore from the leach pad was graded off the pad beyond the limits of the bottom liner to obtain the necessary slopes for leach pad cover liner installation.

- The regraded ore provides a highly transmissive zone along the northern pad perimeter from Trench 3 east to Trench 10 (**Figure 4**).

- The leach pad cover (GCL or PVC) does not extend beyond the highly transmissive regraded ore or the leach pad bottom liner along much of the northern pad perimeter. This relationship allows collected precipitation and snowmelt to report directly to the leach pad containment area at the down-slope extent of the cover GCL or PVC.

- The relationship between the GCL or PVC cover, regraded ore, and pad bottom liner likely provide snowmelt from drifts accumulating along the northern perimeter of the leach pad, a direct pathway onto the leach pad containment area.

- During periods of high groundwater elevations such as the spring snowmelt period, groundwater elevations exceed the top of the bottom liner elevation and groundwater is likely entering the leach pad through the gap between the cover and bottom liners that is filled with regraded spent ore and cover soil in the vicinity of Trench 1 east to Trench 2 (**Figure 4**).

Based on the above conclusions Tetra Tech recommends the following:

- Extend the leach pad cover material (GCL or PVC) beyond the limits of the leach pad liner where necessary.

- Construct a lined surface water diversion channel that is tied to the down slope extent of the cover GCL to transmit water away from the leach pad containment area.

- Construct an impermeable groundwater barrier along the northern pad perimeter to prevent elevated groundwater from entering the pad containment area.

- An alternative to the impermeable barrier may be to construct a french drain system of highly transmissive material to provide a preferential pathway in order to divert groundwater away from the leach pad perimeter during periods of high groundwater elevations. The bottom of this feature should be completed a minimum of five feet below the top of the nearest bottom liner elevation.

4.0 REFERENCES

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APPENDIX A

Test Pit Logs

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -6
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N641926.2 E1107994 Elev. 7558.64
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-22	Cover Soil, Sandy Silt with Cobbles and Gravel; damp; dark brown. Max rock size 8".
22-44	Subsoil; Silty Clay with Cobbles and Gravels; damp to moist; tan. Max Rock Size 8".
	Encountered Filter Fabric overlying PVC liner at 44".
Remarks:	Total Test Pit Depth: 44"

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -7
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N641922.3 E1107964 Elev. 7558.13
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-06	Cover Soil, Sandy Silt with Cobbles and Gravels; damp; dark brown. Max rock size 8".
06-24	Subsoil, Silty Clay with Cobbles and Gravel; damp to moist; tan. Max rock size 8".
	Encountered Filter Fabric overlying PVC liner at 24".
Remarks:	Total Test Pit Depth: 24"
	Test pit dug at edge of detox pond.

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -8
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N641928 E1107381 Elev. 7552.08
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-18	Cover Soil, Sandy Silt with Cobbles and Gravels; damp; dark brown. Max rock size 8".
18-30	Subsoil, Silty Clay with Cobbles and Gravels; damp to moist; tan. Max rock size 8".
	Encountered Filter Fabric overlying PVC liner at 30".
Remarks:	Total Test Pit Depth: 30"
	Material below PVC liner was damp to moist.

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -9
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N642255.6 E1107276 Elev. 7561.35
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-16	Cover Soil, Silty Sand with Gravel, damp, dark brown. Max rock size 3".
16-27	Subsoil, Cobbles and Gravels with Sandy Clay; damp to moist; tan. Max rock size 6".
	Encountered Filter Fabric overlying PVC liner at 27".
Remarks:	Total Test Pit Depth: 27"

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -10
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N642816.5 E1107361 Elev. 7568.28
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-18	Cover Soil, Silty Sand with Gravels; damp; dark brown. Max rock size 3".
18-35	Subsoil, Cobbles and Gravels with Sandy Clay; damp to moist; tan. Max rock size 10".
	Encountered Filter Fabric overlying PVC liner at 35".
	Crushed Ore beneath PVC Liner
Remarks:	Total Test Pit Depth: 35"

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -11
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N642746 E1107786 Elev. 7626.28
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-18	Cover Soil, Silty Sand with Gravels; dry to damp; brown. Max rock size 4".
18-36	Subsoil, Cobbles and Gravels with Sandy Clay; damp; reddish brown. Max rock size 6".
	Encountered Filter Fabric overlying PVC liner at 36".
	Crushed Ore beneath PVC Liner
Remarks:	Total Test Pit Depth: 36"

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -12
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N642613.7 E1108171 Elev. 7638.42
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-15	Cover Soil, Silty Sand with Gravels; damp; dark brown. Max rock size 2".
15-29	Subsoil, Cobbles and Gravels with Sandy Clay; damp to moist; tan to reddish brown. Max rock size 8".
	Encountered Filter Fabric overlying PVC liner at 29".
	Crushed Ore beneath PVC Liner
Remarks:	Total Test Pit Depth: 29"

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -13
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N642454.3 E1108520 Elev. 7642.34
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-21	Cover Soil, Silty Sand with Cobbles and Gravel; damp; dark brown. Max rock size 6".
21-36	Subsoil, Cobbles and Gravels with Sandy Clay; damp to moist; tan. Max rock size 12".
	Encountered Filter Fabric overlying PVC liner at 36".
	Crushed Ore beneath PVC Liner
Remarks:	Total Test Pit Depth: 36"
	Encountered seam on PVC liner running North/South

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -14
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N64266.2.7 E1108903 Elev. 7644.17
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-21	Cover Soil, Silty Sand with Gravels and Cobbles; damp; brown. Max rock size 4".
21-32	Subsoil, Cobbles and Gravels with Sandy Clay; damp; reddish brown. Max rock size 10".
	Encountered Filter Fabric overlying PVC liner at 32".
	Crushed Ore beneath PVC Liner
Remarks:	Total Test Pit Depth: 32"
	Encountered seam on PVC liner running approx. North/South. Seam overlap approx.1"

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -15
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N642114.2 E1108522 Elev. 7567.08
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-16	Cover Soil, Silty Sand with Gravels and Cobbles; dry to damp; dark brown. Max rock size 3".
16-43	Subsoil, Cobbles and Gravels with Sandy Clay; damp to moist; tan. Max rock size 8".
	Encountered Filter Fabric overlying PVC liner at 43".
	Crushed Ore beneath PVC Liner
Remarks:	Total Test Pit Depth: 43"

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -16
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N641959 E1108500 Elev. 7533.39
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-17	Cover Soil, Silty Sand with Gravels and Cobbles; dry to damp; brown. Max rock size 6".
17-38	Subsoil, Cobbles and Gravels with Sandy Clay; damp to moist; tan. Max rock size 8".
	Encountered Filter Fabric overlying PVC liner at 38".
	Did not tear Liner
Remarks:	Total Test Pit Depth: 38"
	Encountered Sep/stab fabric seam running North/South with the slope

Test Pit Photos

Tetra Tech, Inc
TEST PIT EXCAVATION LOG

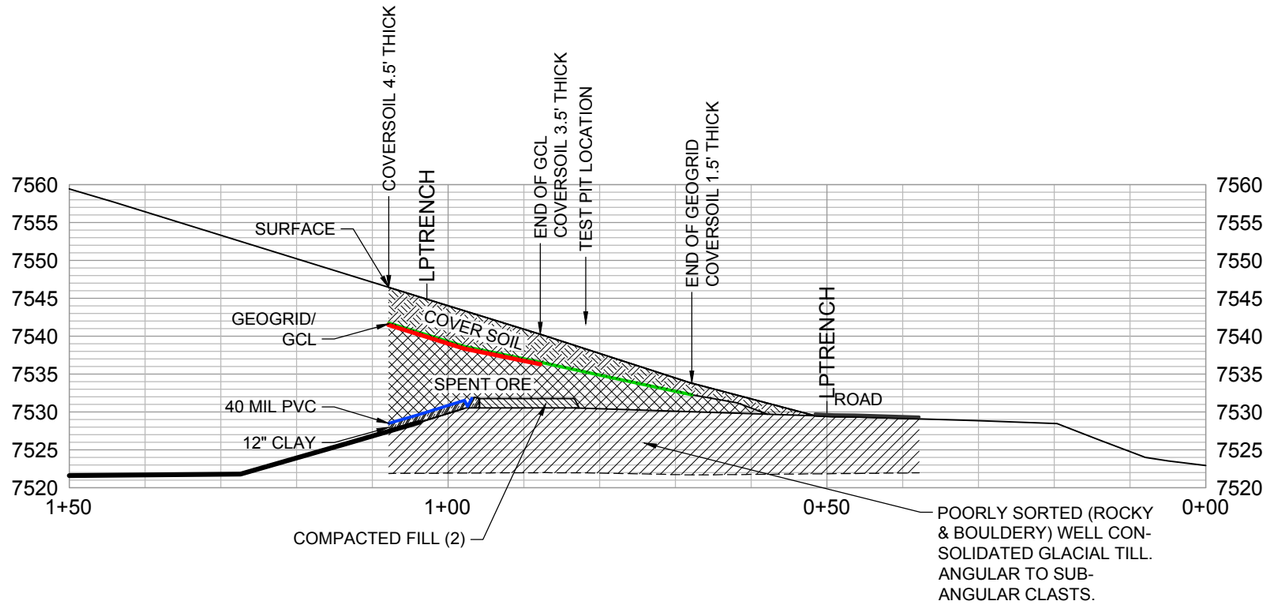
Project:	Beal Mountain Mine - Leach Pad Investigation
Test Pit No:	Test Pit -17
Date:	7/8/2010
Logged By:	M. Hatten
Surveyed Coordinates:	N641749 E1108461 Elev.7512.92
Excavator:	Case 305
Weather:	Clear to Partly Cloudy
Photo ID:	See Photo Log Below

Depth (in)	Soil Description
00-19	Cover Soil, Silty Sand with Cobbles and Gravels; dry to damp; dark brown. Max rock size 6".
19-232	Subsoil, Cobbles and Gravels with Sandy Clay; damp; reddish brown. Max rock size 8".
	Did not encounter Liner - Outside of leach pad.
Remarks:	Total Test Pit Depth: 9' 4"
	Test Pit outside of Leach Pad

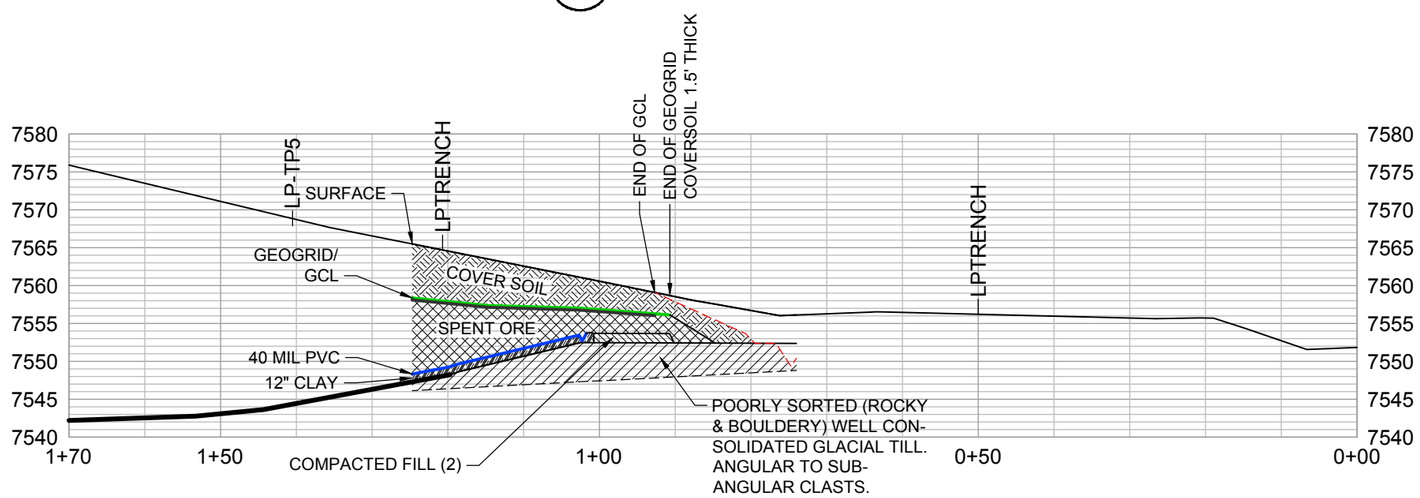
Test Pit Photos

APPENDIX B

Leach Pad Trench Cross Sections
FIGURES B-1 THROUGH B-6



1 / -- 2009 TRENCH 1 SECTION
1"=20'



2 / -- 2009 TRENCH 2 SECTION
1"=20'

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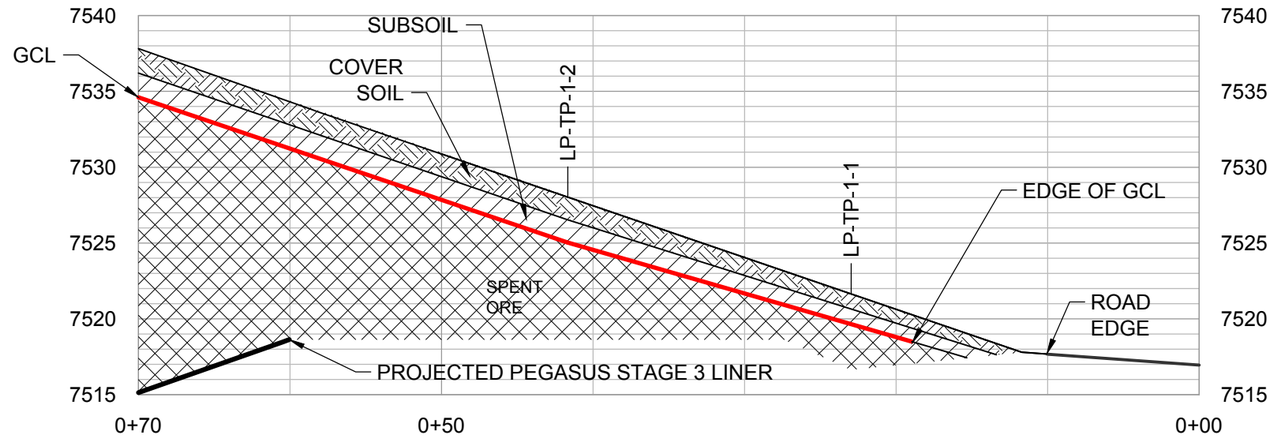
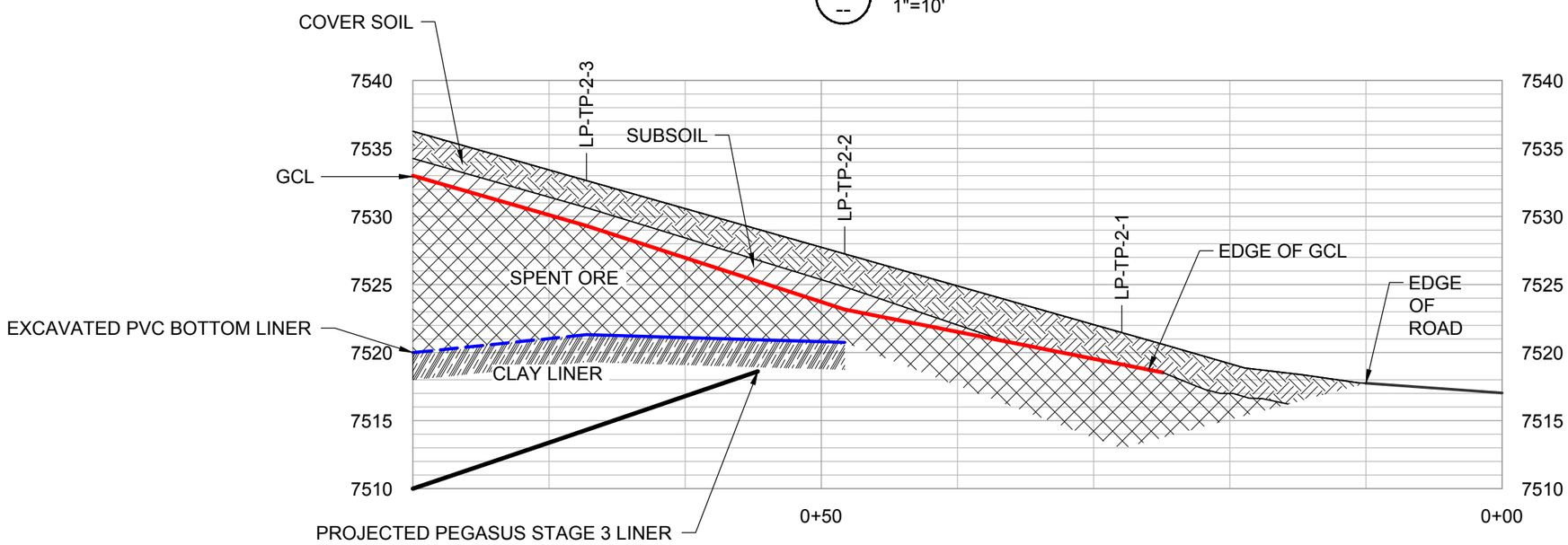
115856167B

Beal Mountain Mine
2010 Leach Pad Phase II Investigation
Trench Details
Silver Bow County, Montana
FIGURE B-1



3 -- TRENCH 1 SECTION
1"=10'



4 -- TRENCH 2 SECTION
1"=10'

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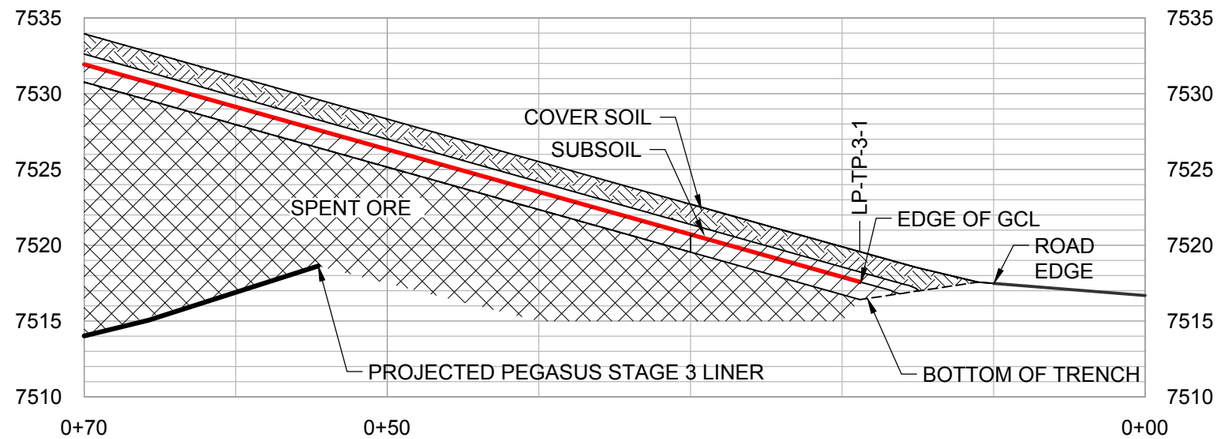
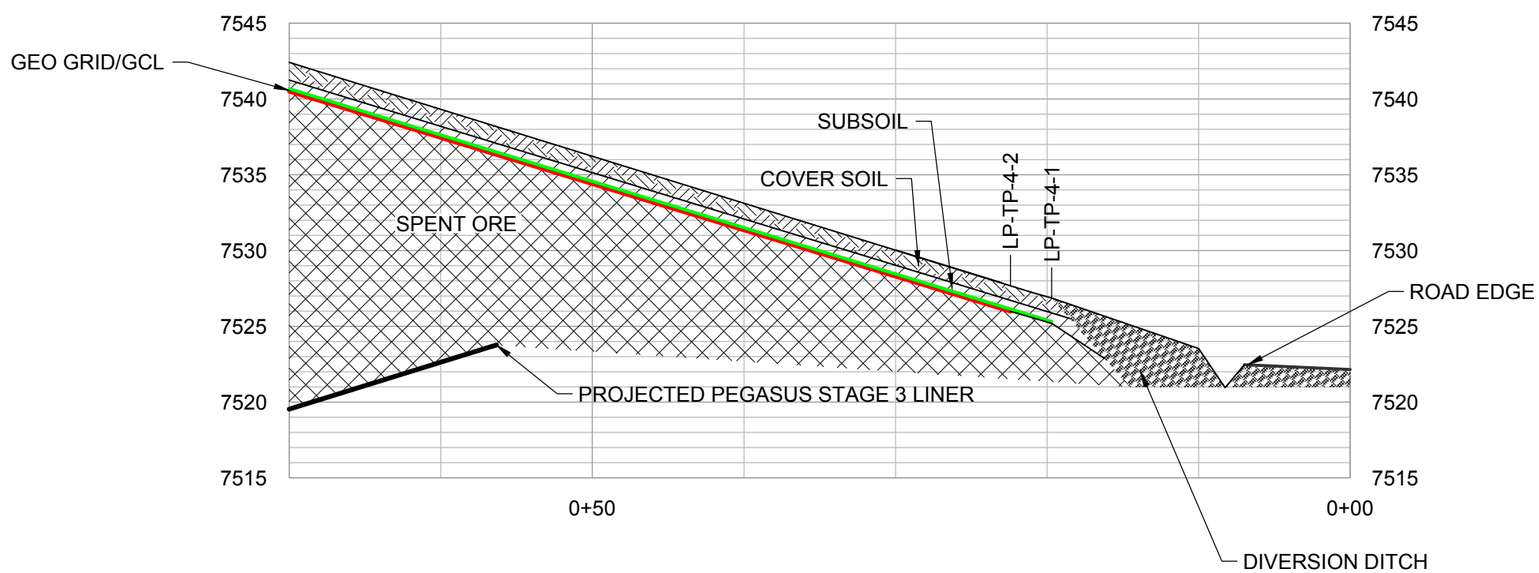
Beal Mountain Mine
2010 Leach Pad Phase II Investigation
Trench Details
Silver Bow County, Montana
FIGURE B-2



5 -- TRENCH 3 SECTION
1"=10'



6 -- TRENCH 4 SECTION
1"=10'

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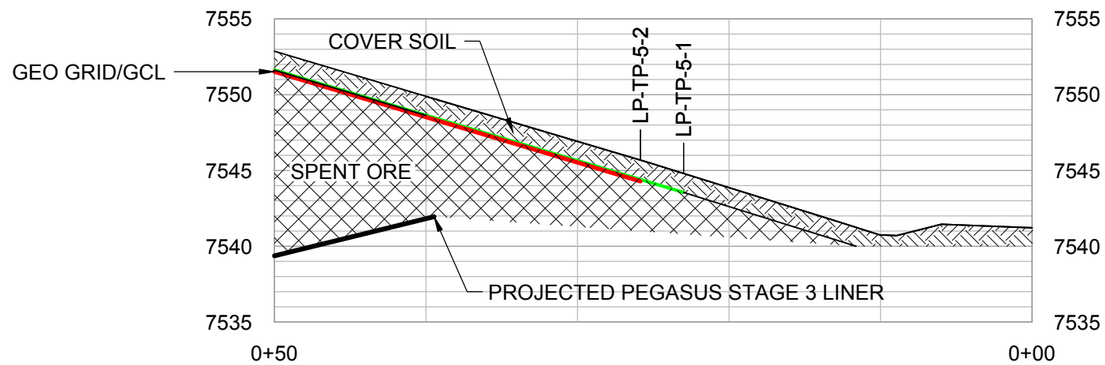
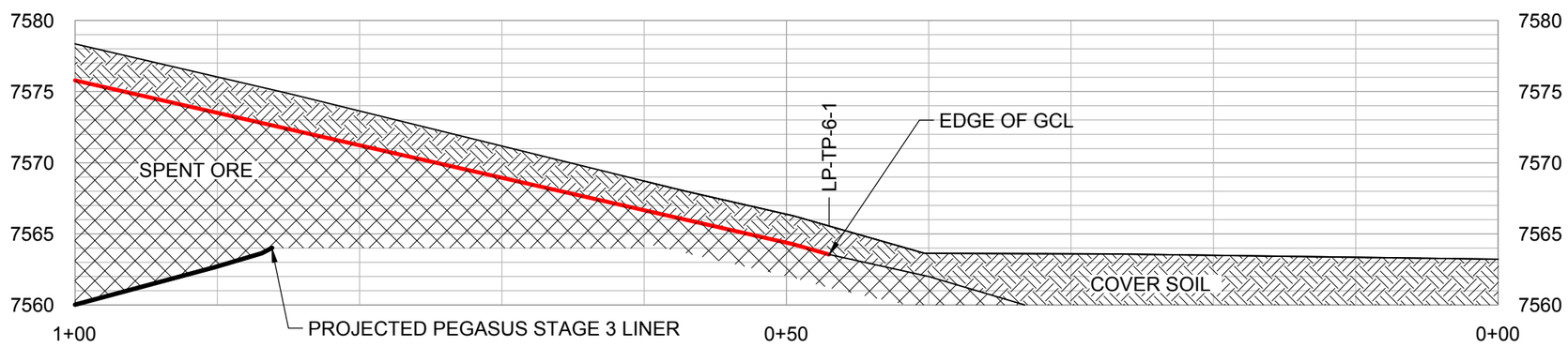
Beal Mountain Mine
2010 Leach Pad Phase II Investigation
Trench Details
Silver Bow County, Montana
FIGURE B-3



7 / -- TRENCH 5 SECTION
1"=10'



8 / -- TRENCH 6 SECTION
1"=10'

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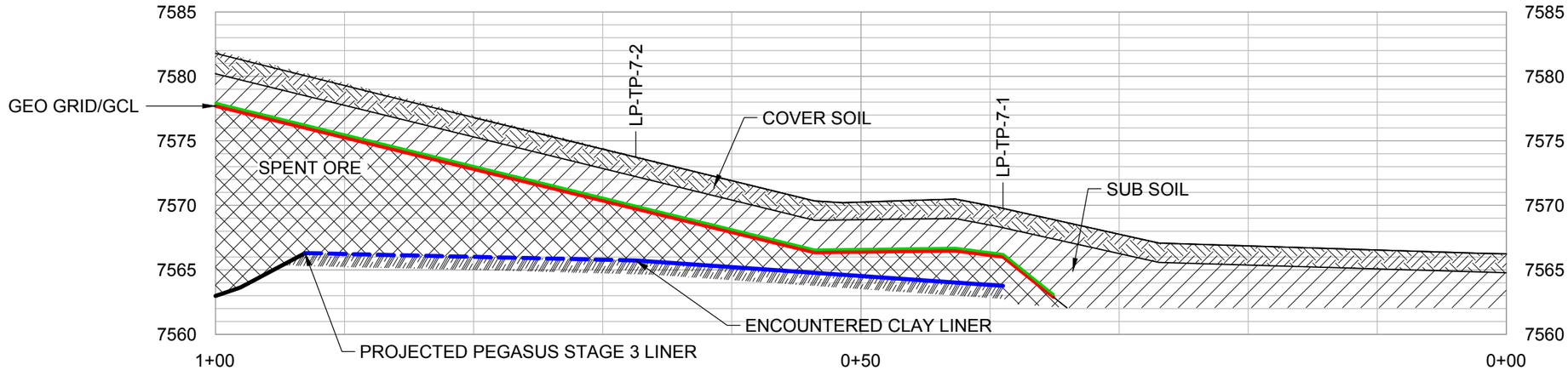
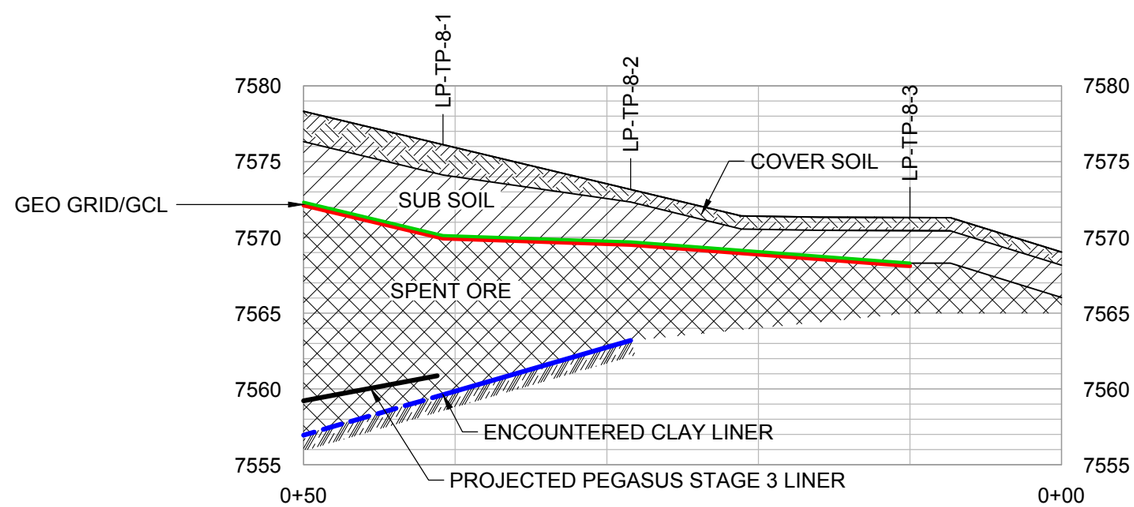
Beal Mountain Mine
2010 Leach Pad Phase II Investigation
Trench Details
Silver Bow County, Montana
FIGURE B-4



9 -- TRENCH 7 SECTION
1"=10'



10 -- TRENCH 8 SECTION
1"=10'

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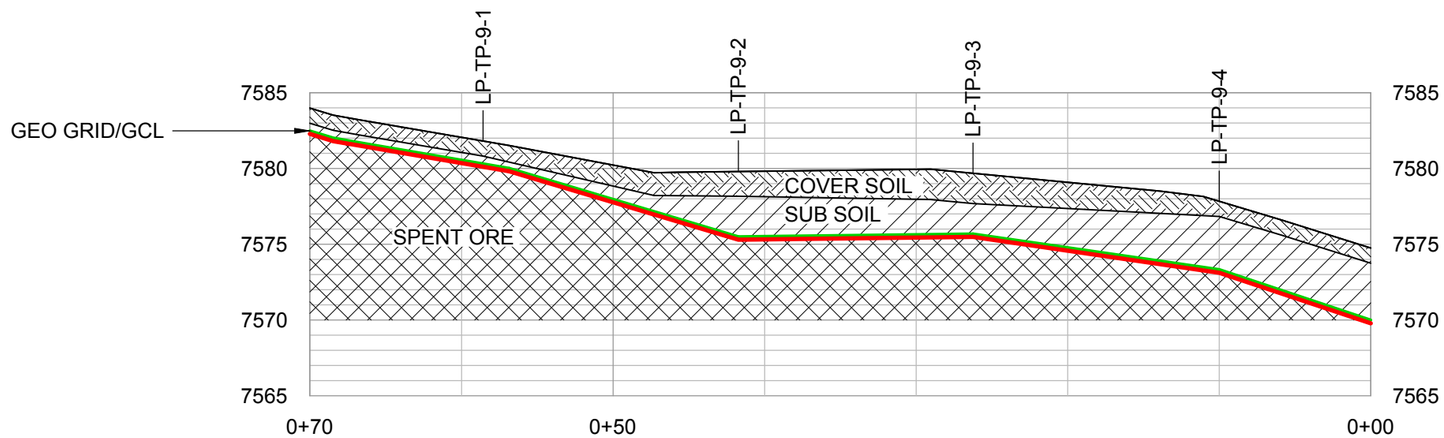
115856166 7B

Beal Mountain Mine
2010 Leach Pad Phase II Investigation
Trench Details
Silver Bow County, Montana
FIGURE B-5



11 -- TRENCH 9 SECTION
1"=10'

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August 2010

Beal Mountain Mine
2010 Leach Pad Phase II Investigation
Trench Details
Silver Bow County, Montana
FIGURE B-6

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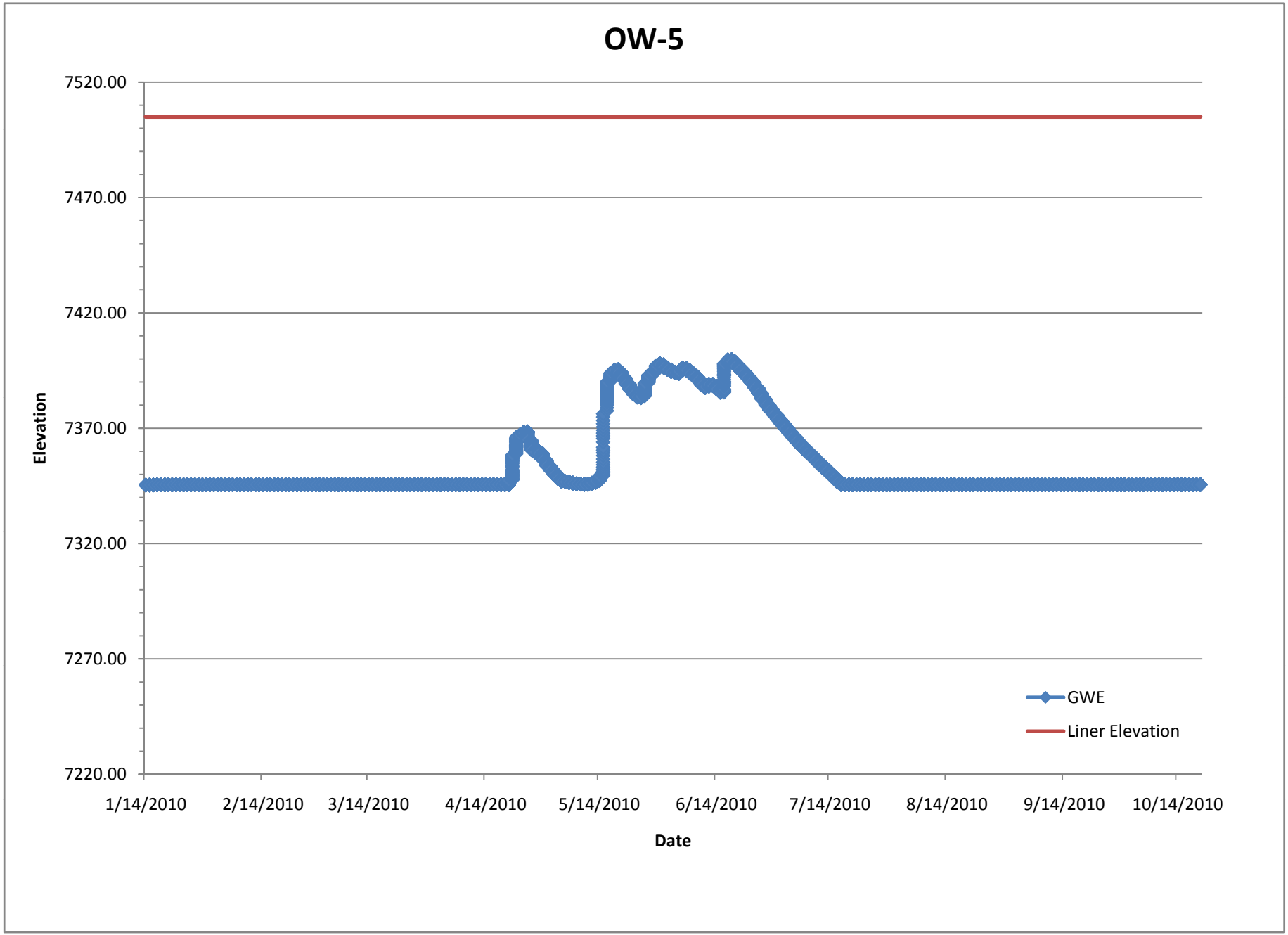
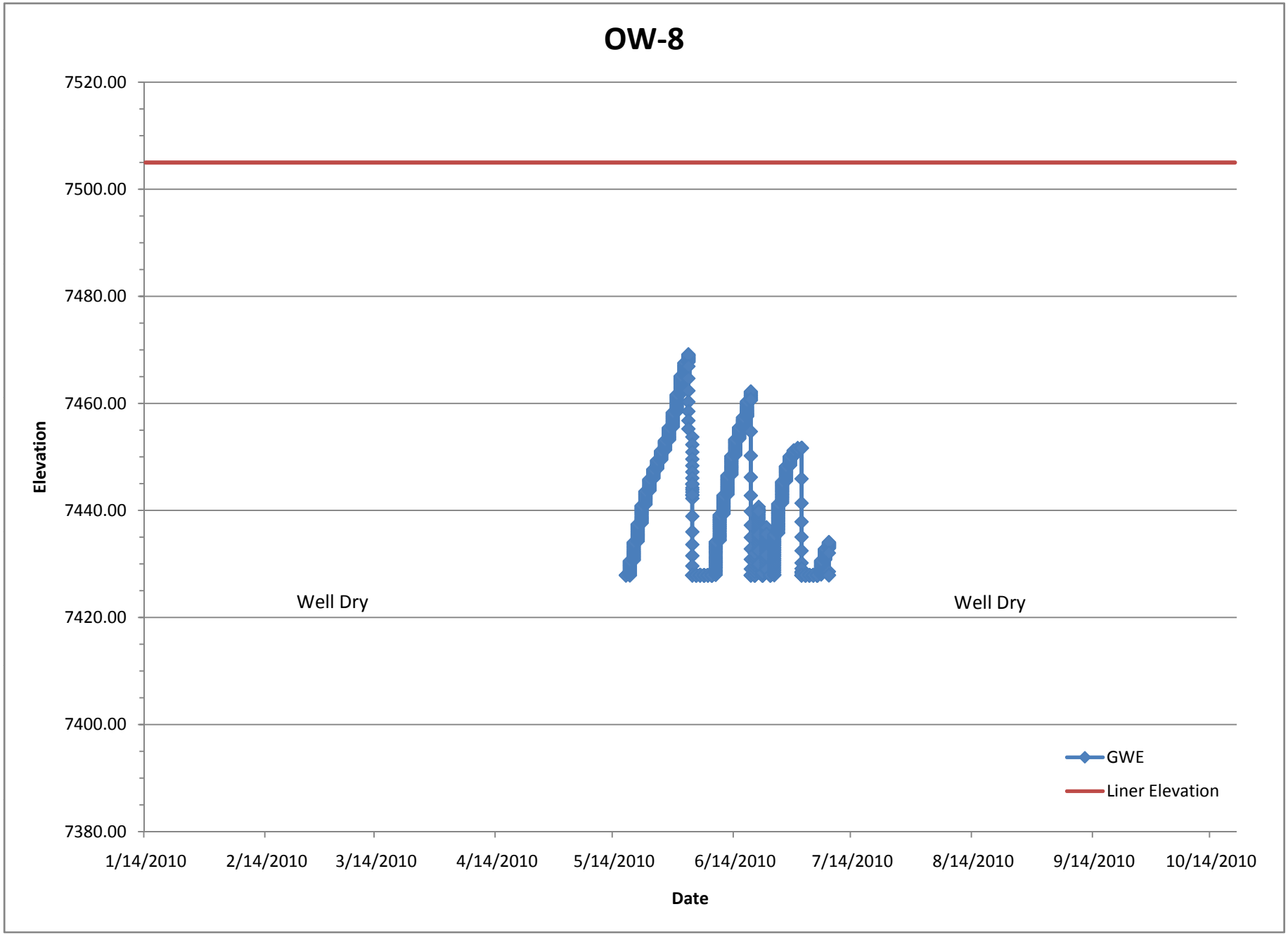
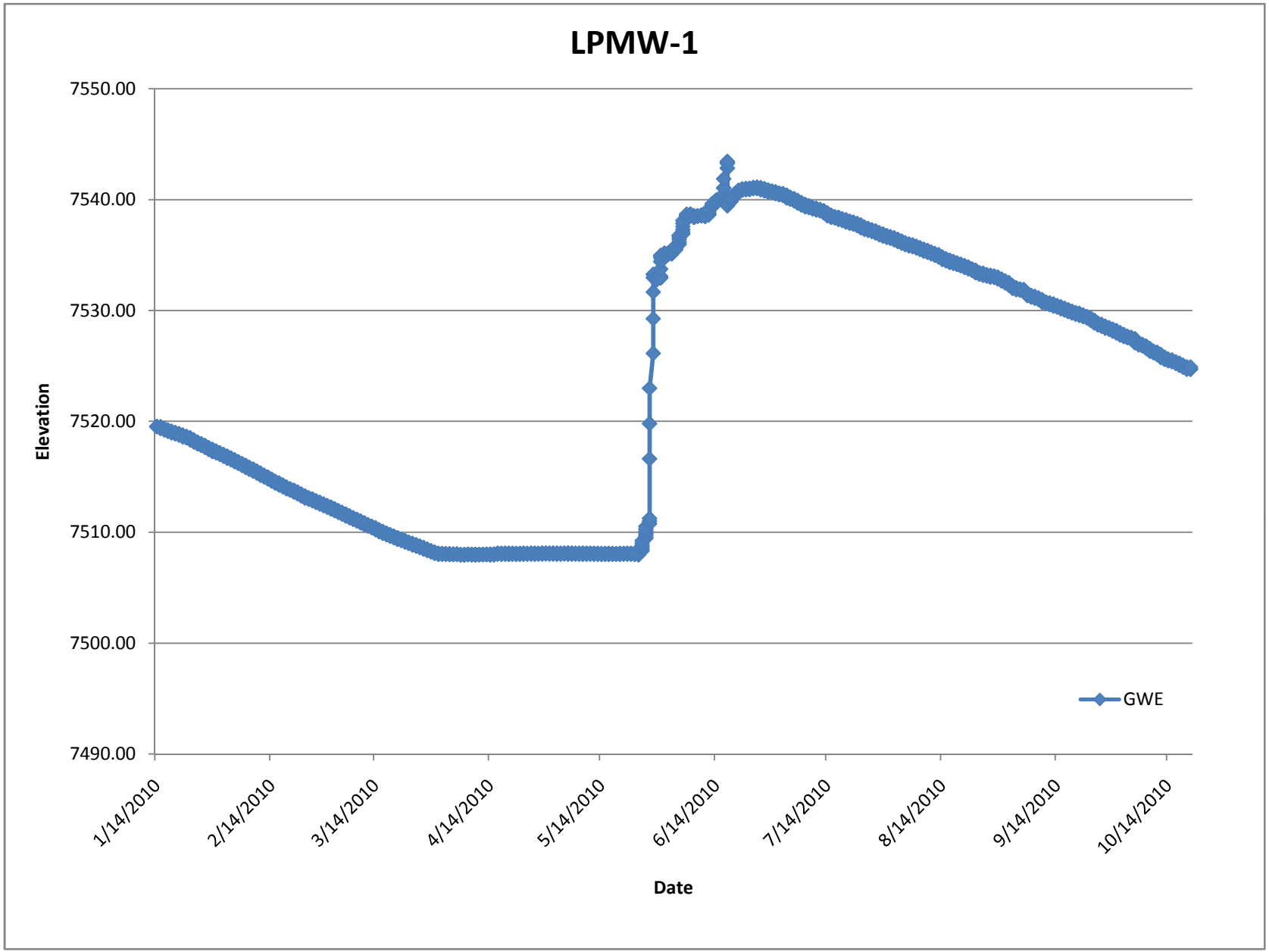
115856166 7B

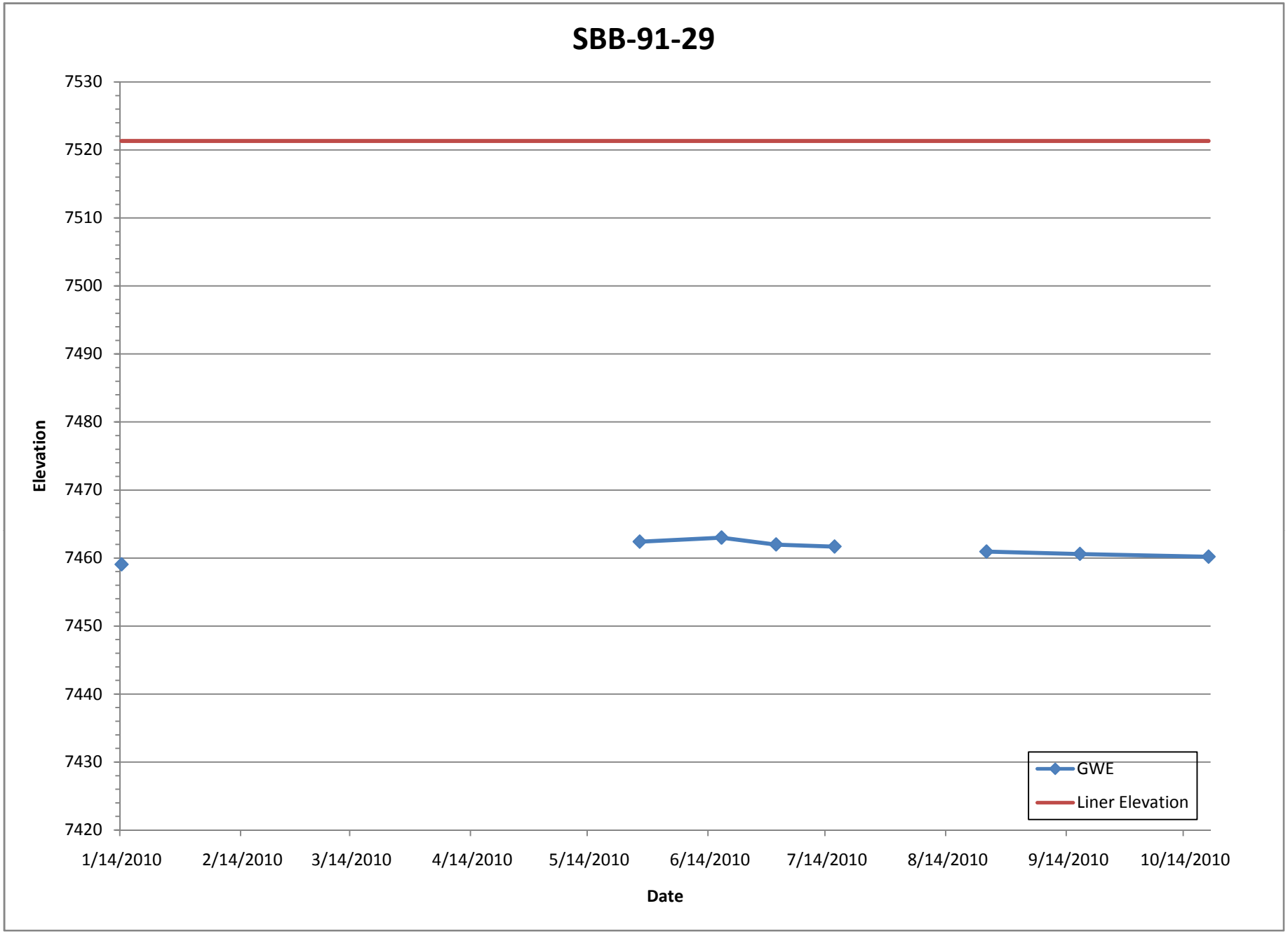
APPENDIX C

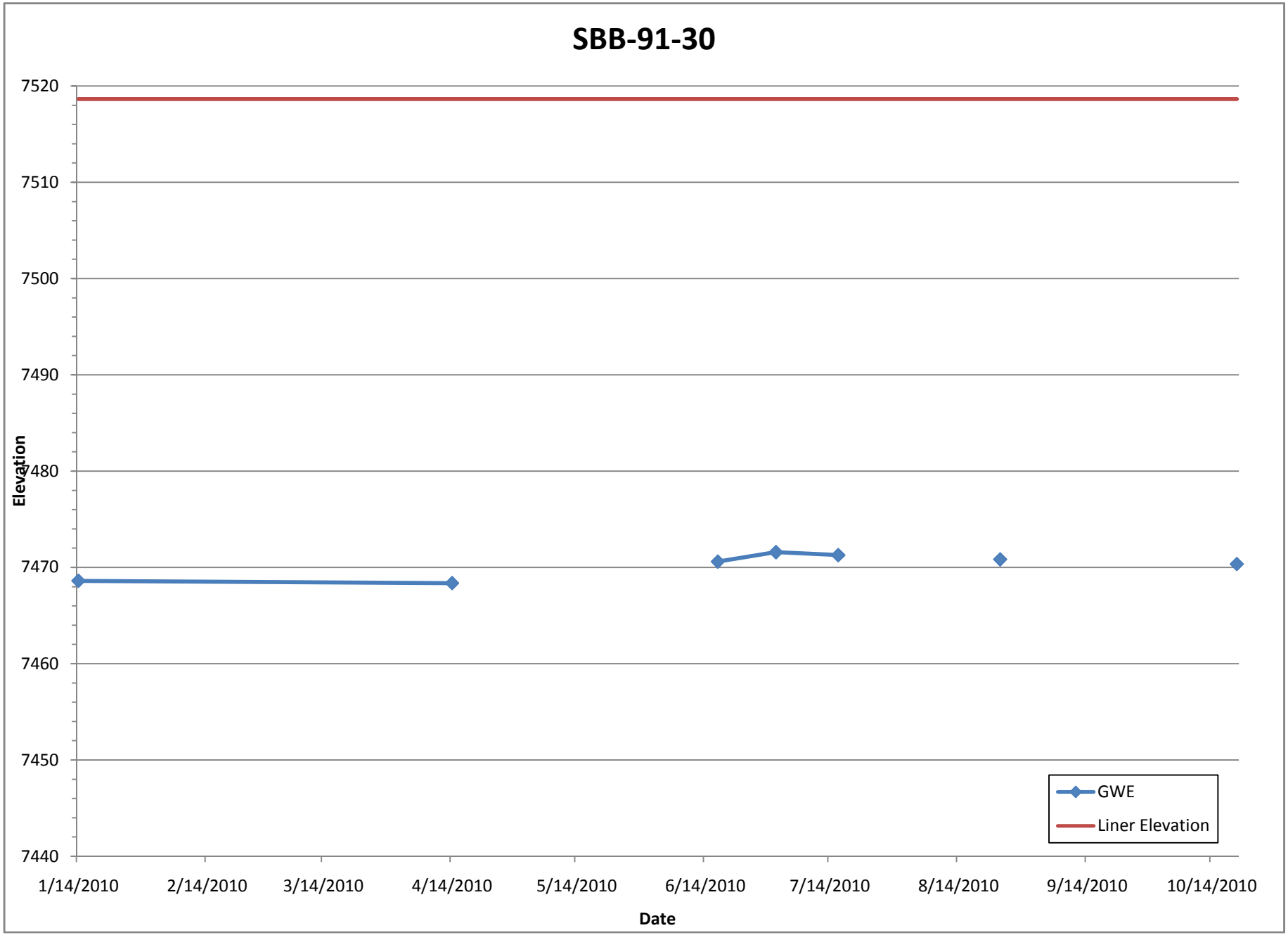
Graphs of Groundwater Elevations vs. Time

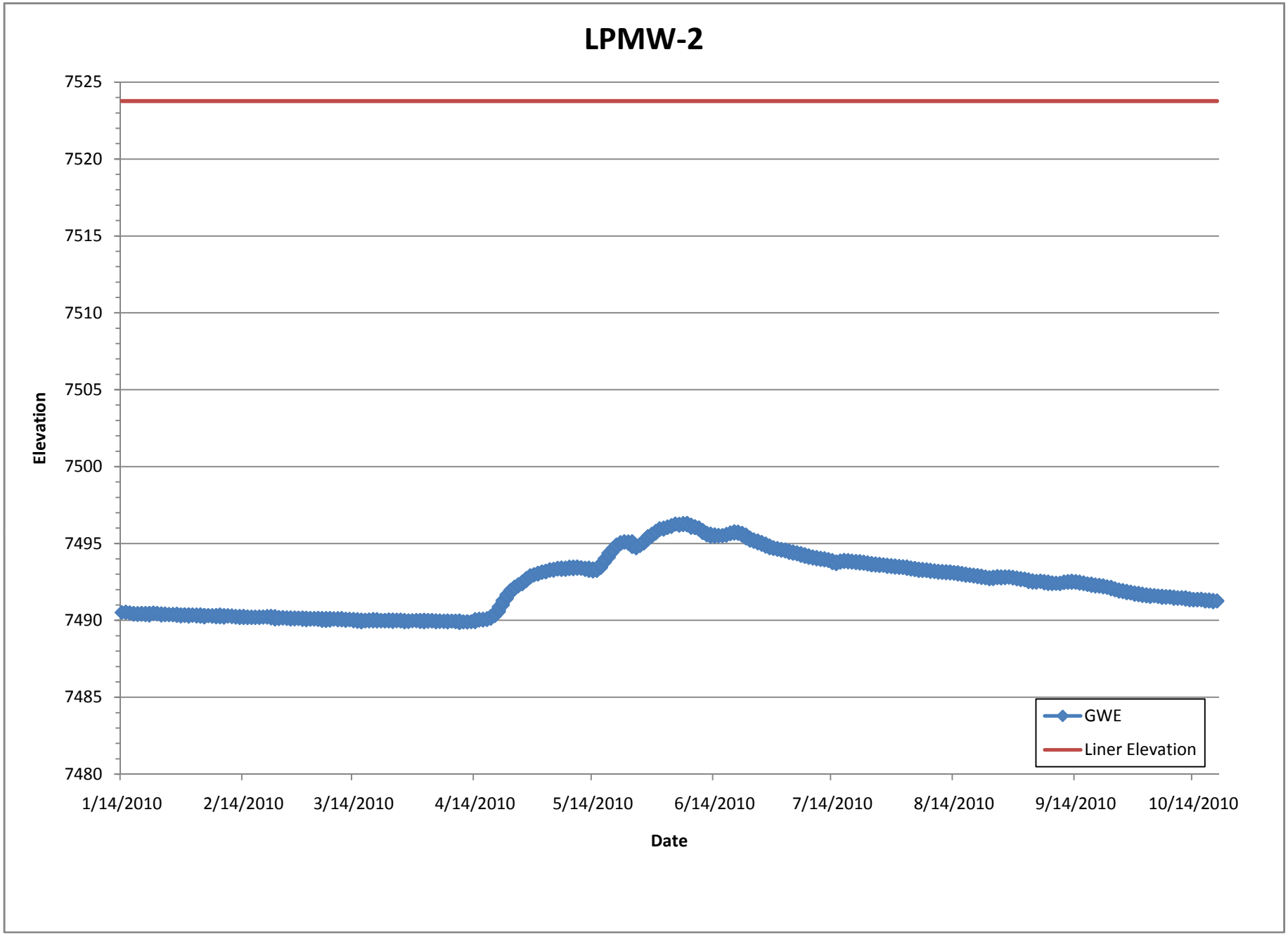

OW-5
7520.00
7470.00
7420.00
7370.00
7320.00
7270.00
7220.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

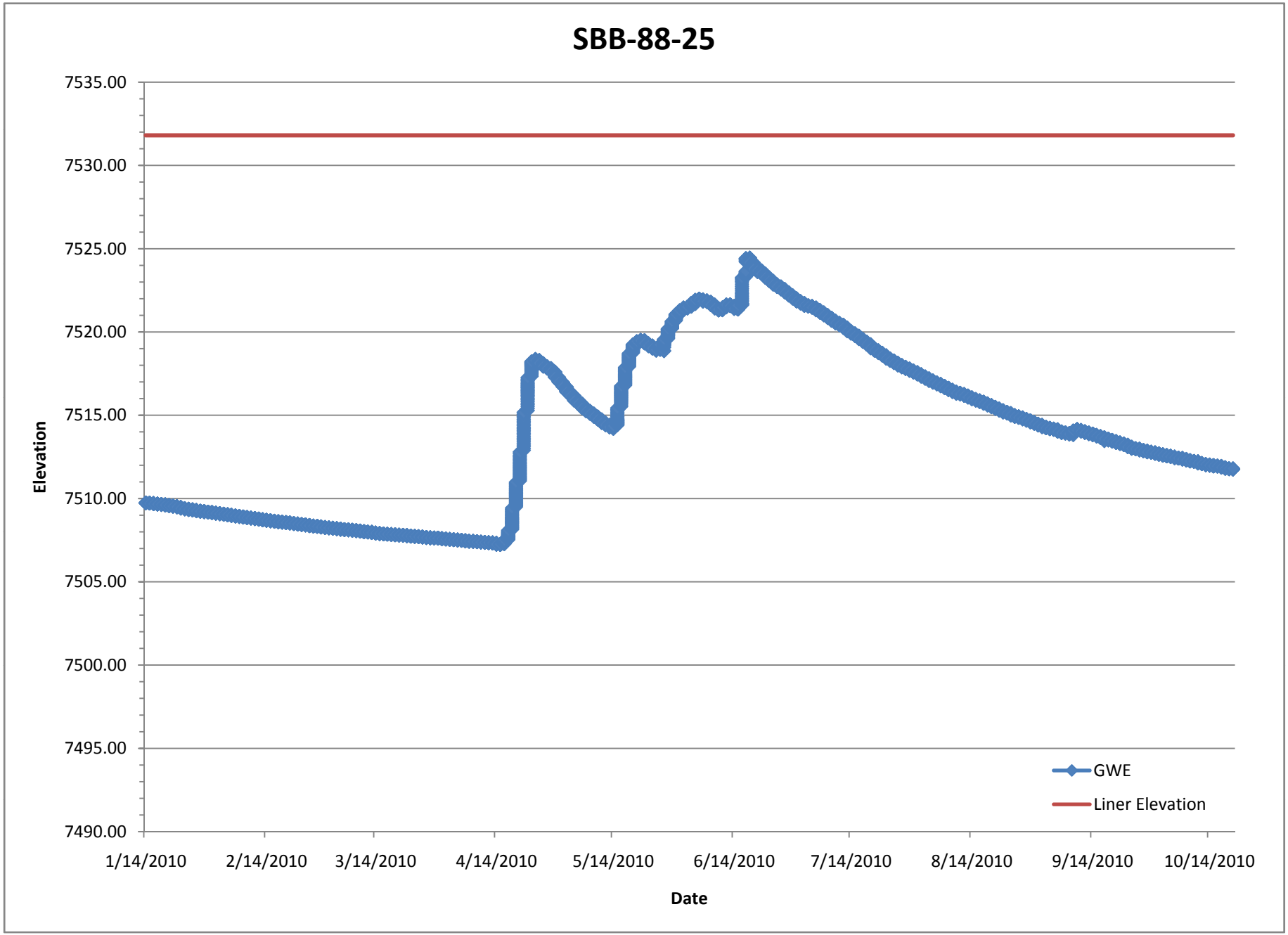

OW-8
7520.00
7500.00
7480.00
7460.00
7440.00
7420.00
7400.00
7380.00
Elevation
Well Dry
Well Dry
GWE
Liner Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date

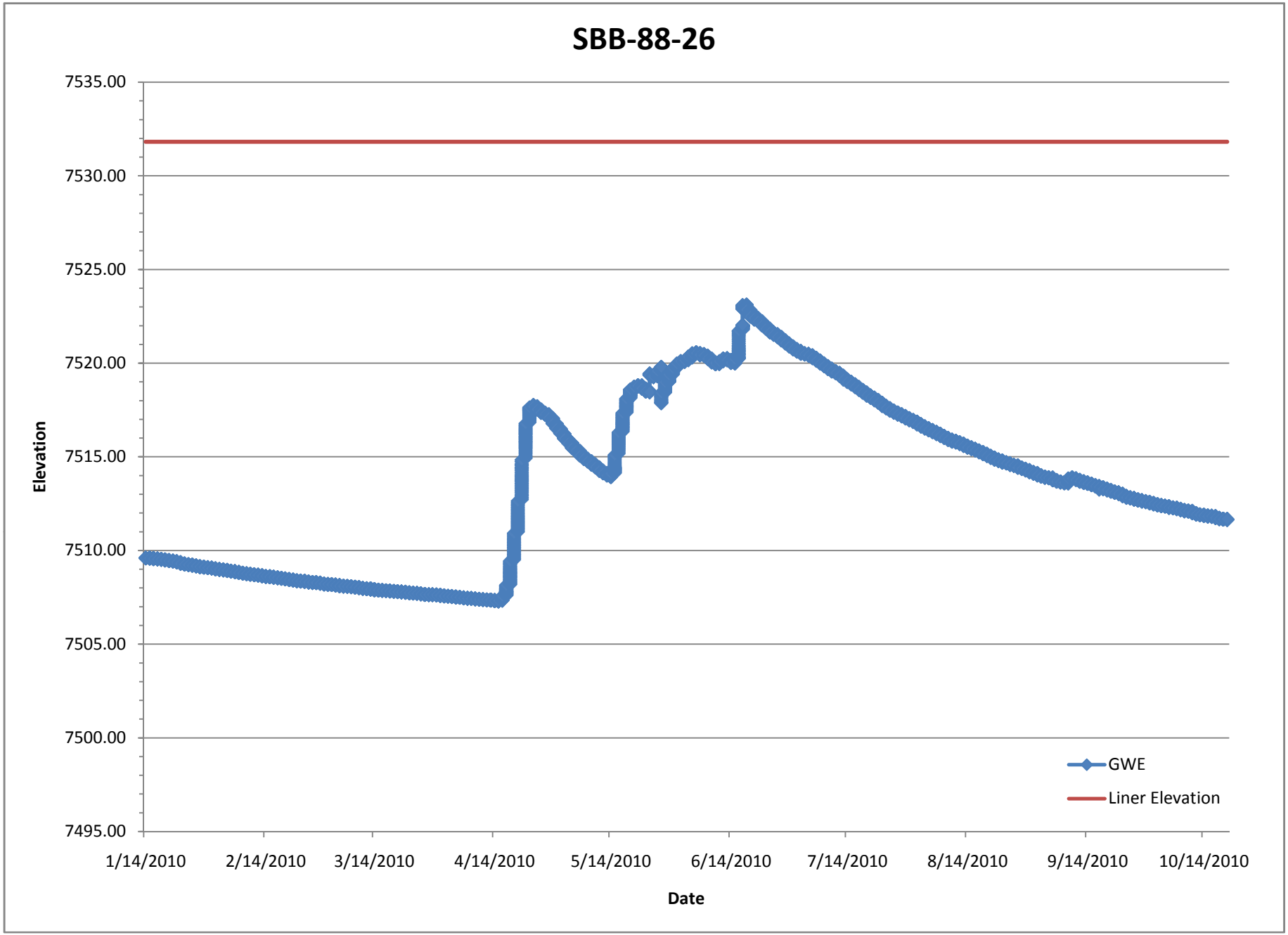

LPMW-1
7550.00
7540.00
7530.00
7520.00
7510.00
7500.00
7490.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE

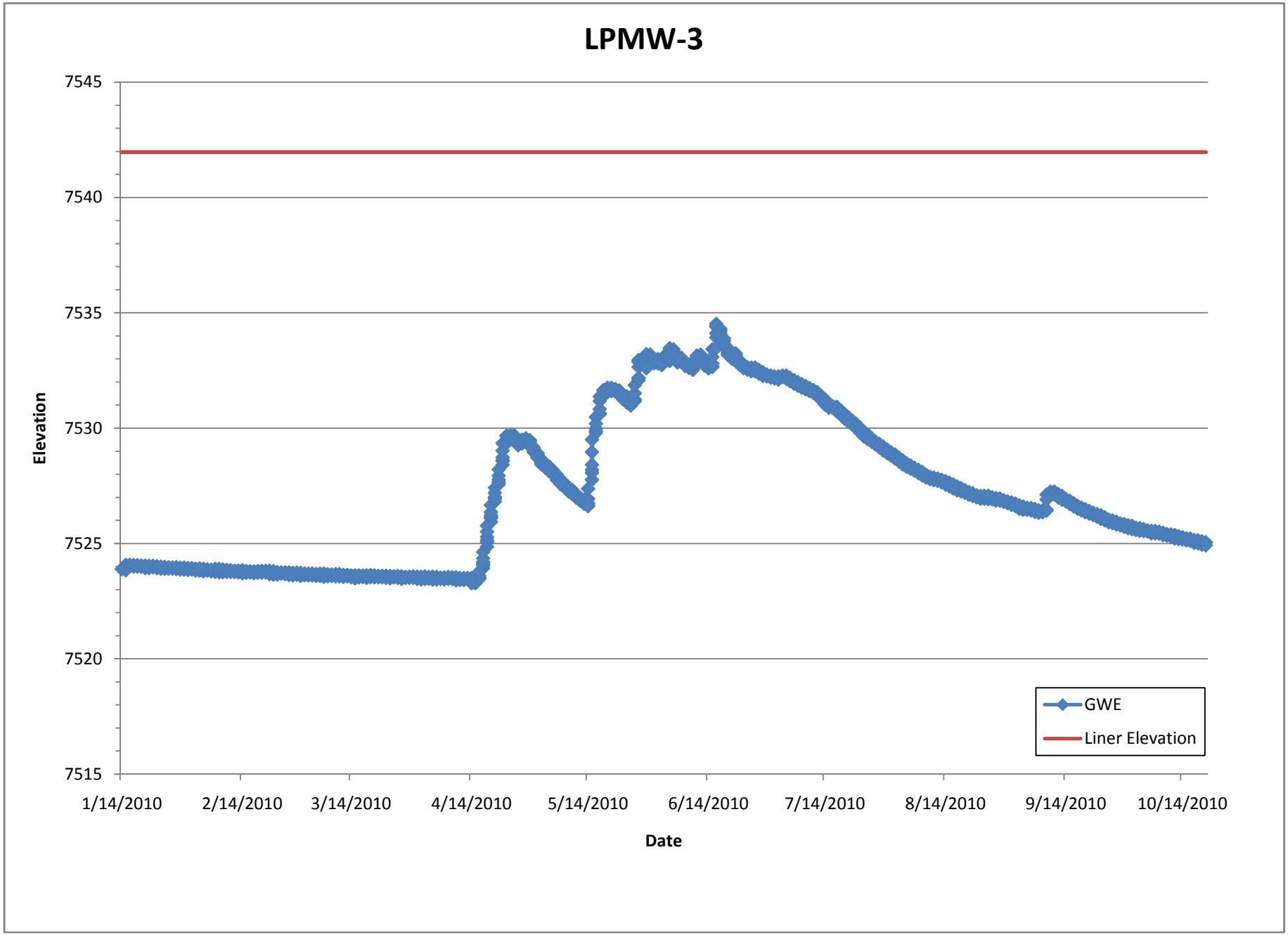

SBB-91-29
7530
7520
7510
7500
7490
7480
7470
7460
7450
7440
7430
7420
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

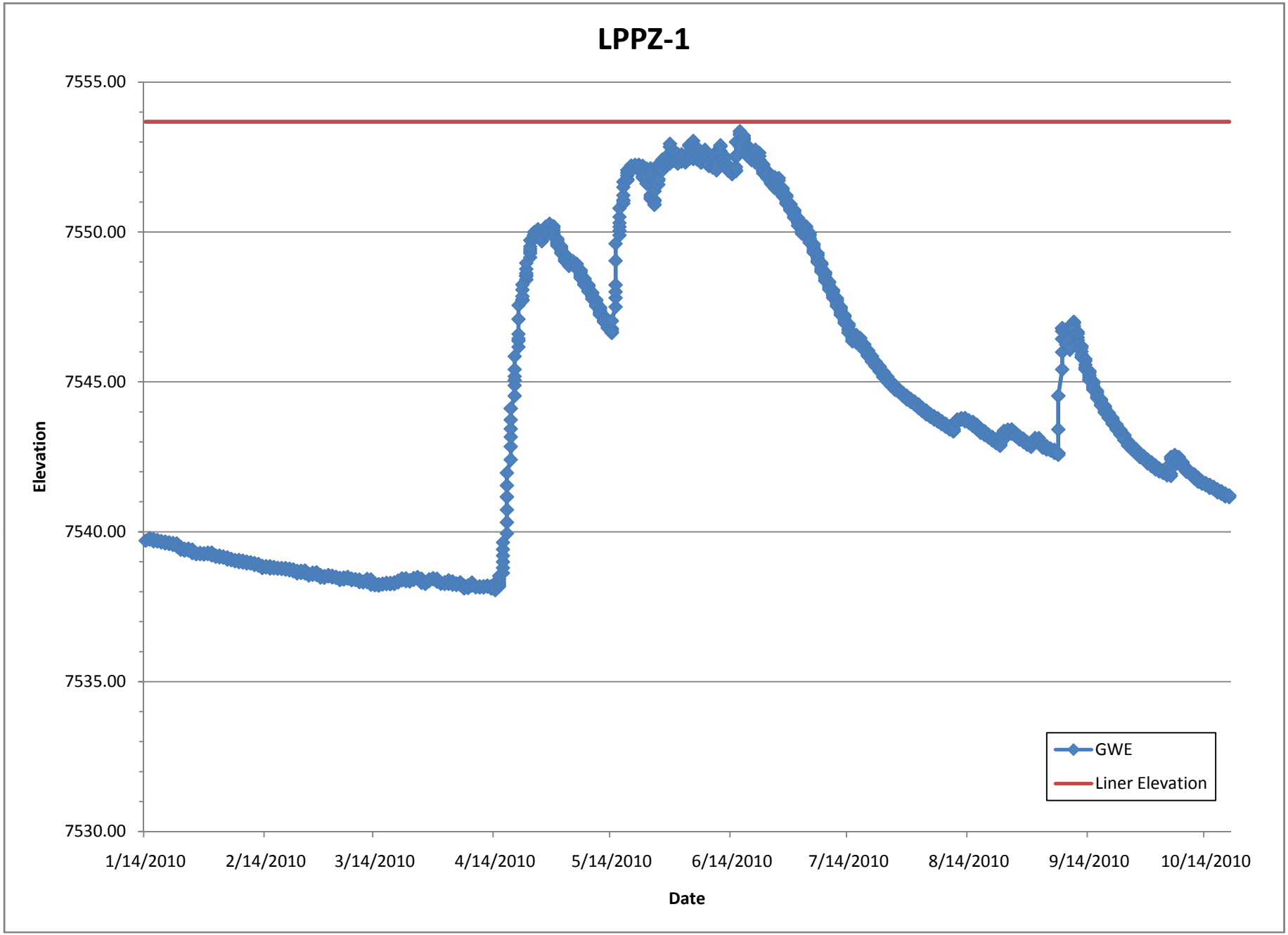

SBB-91-30
7520
7510
7500
7490
7480
7470
7460
7450
7440
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

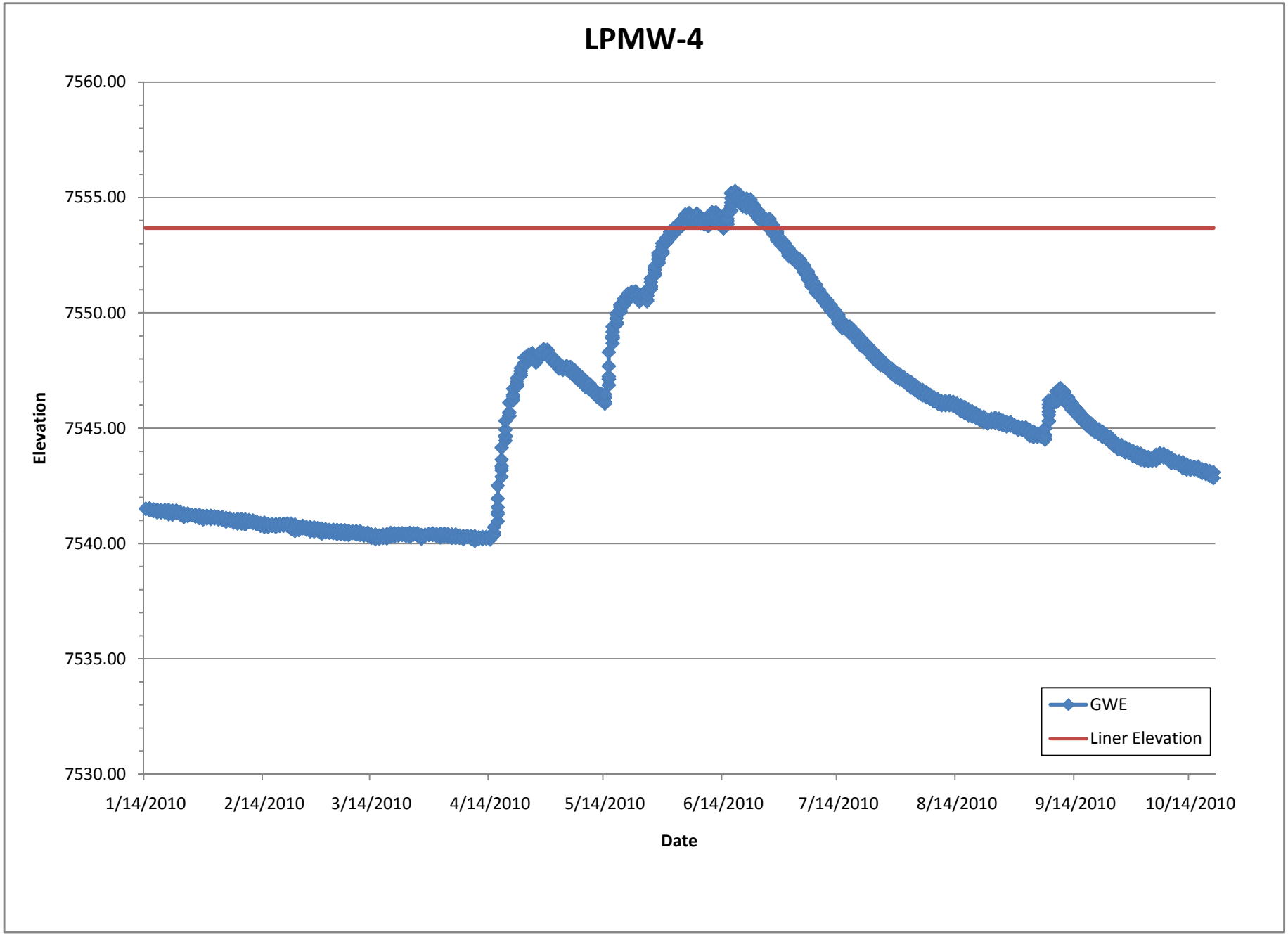

LPMW-2
7525
7520
7515
7510
7505
7500
7495
7490
7485
7480
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

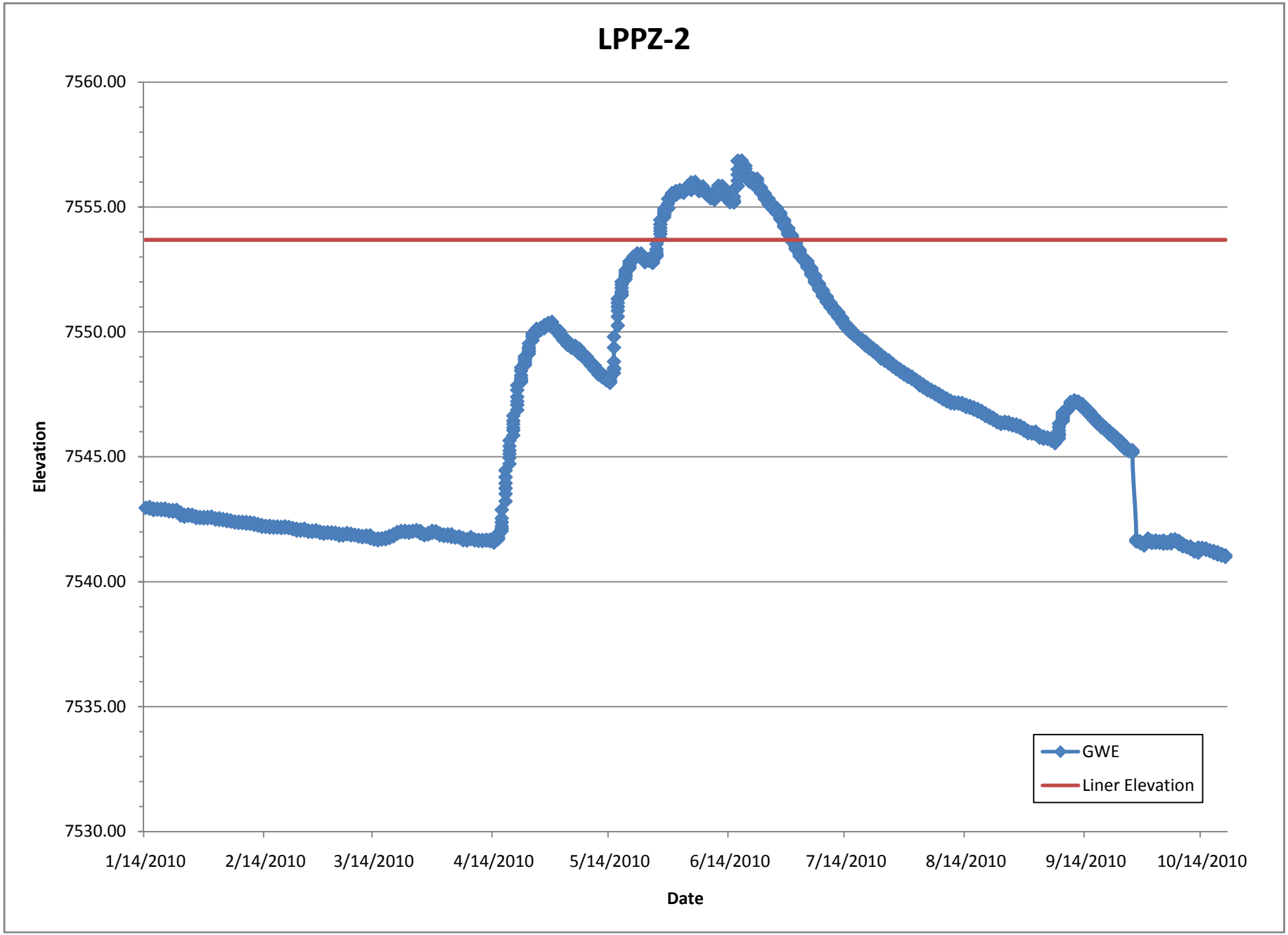

SBB-88-25
7535.00
7530.00
7525.00
7520.00
7515.00
7510.00
7505.00
7500.00
7495.00
7490.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

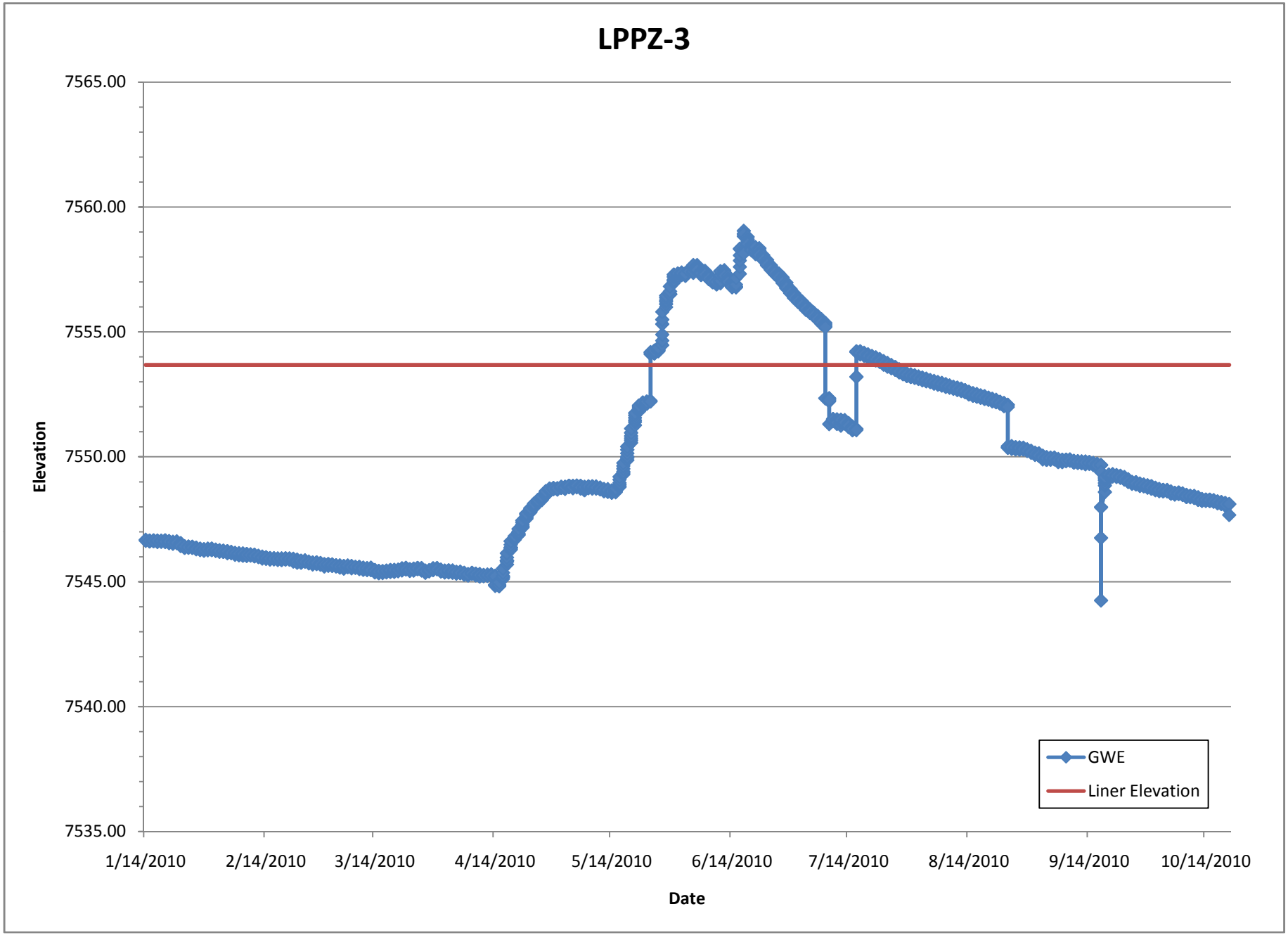

SBB-88-26
7535.00
7530.00
7525.00
7520.00
7515.00
7510.00
7505.00
7500.00
7495.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

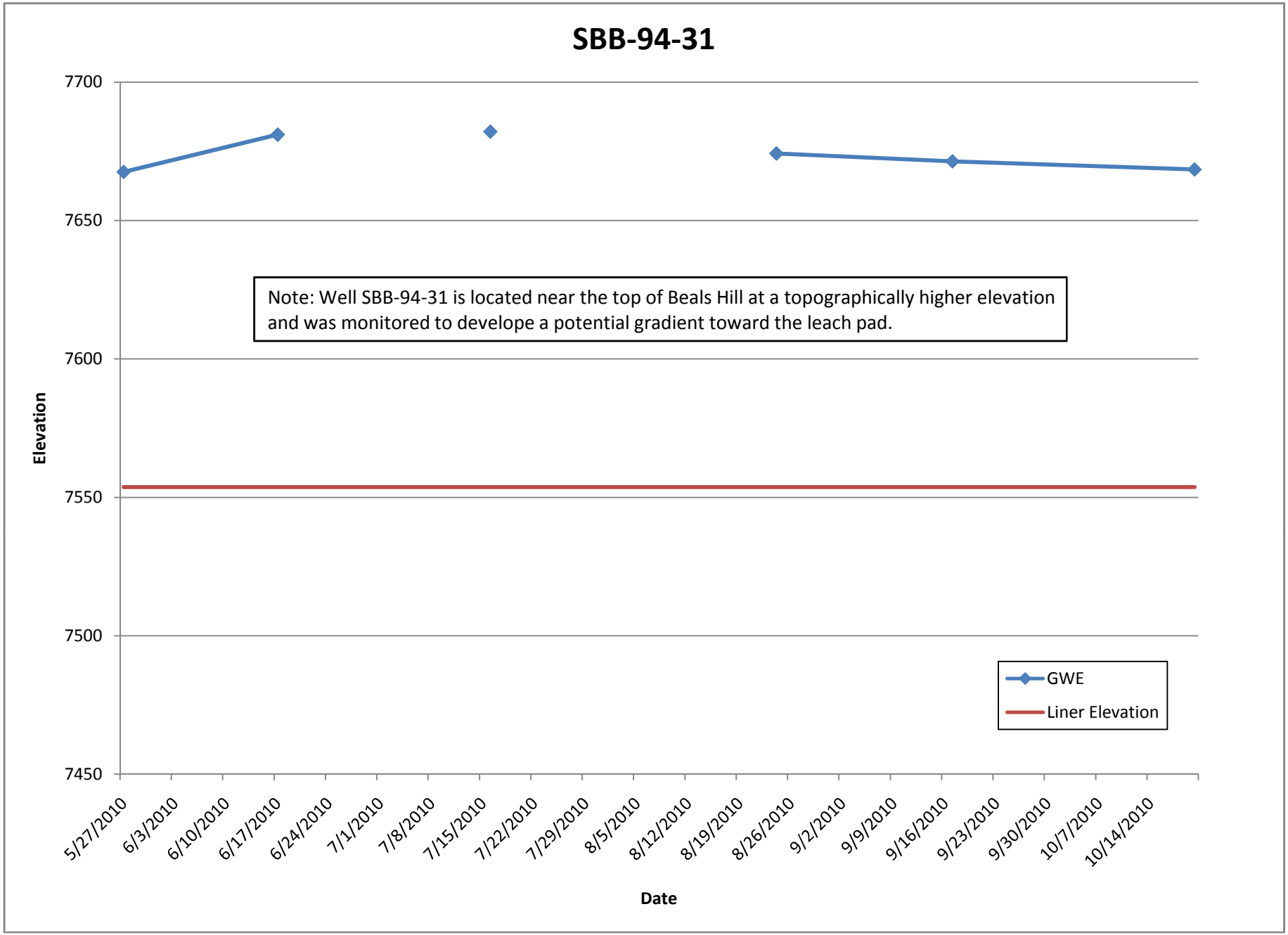

LPMW-3
7545
7540
7535
7530
7525
7520
7515
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

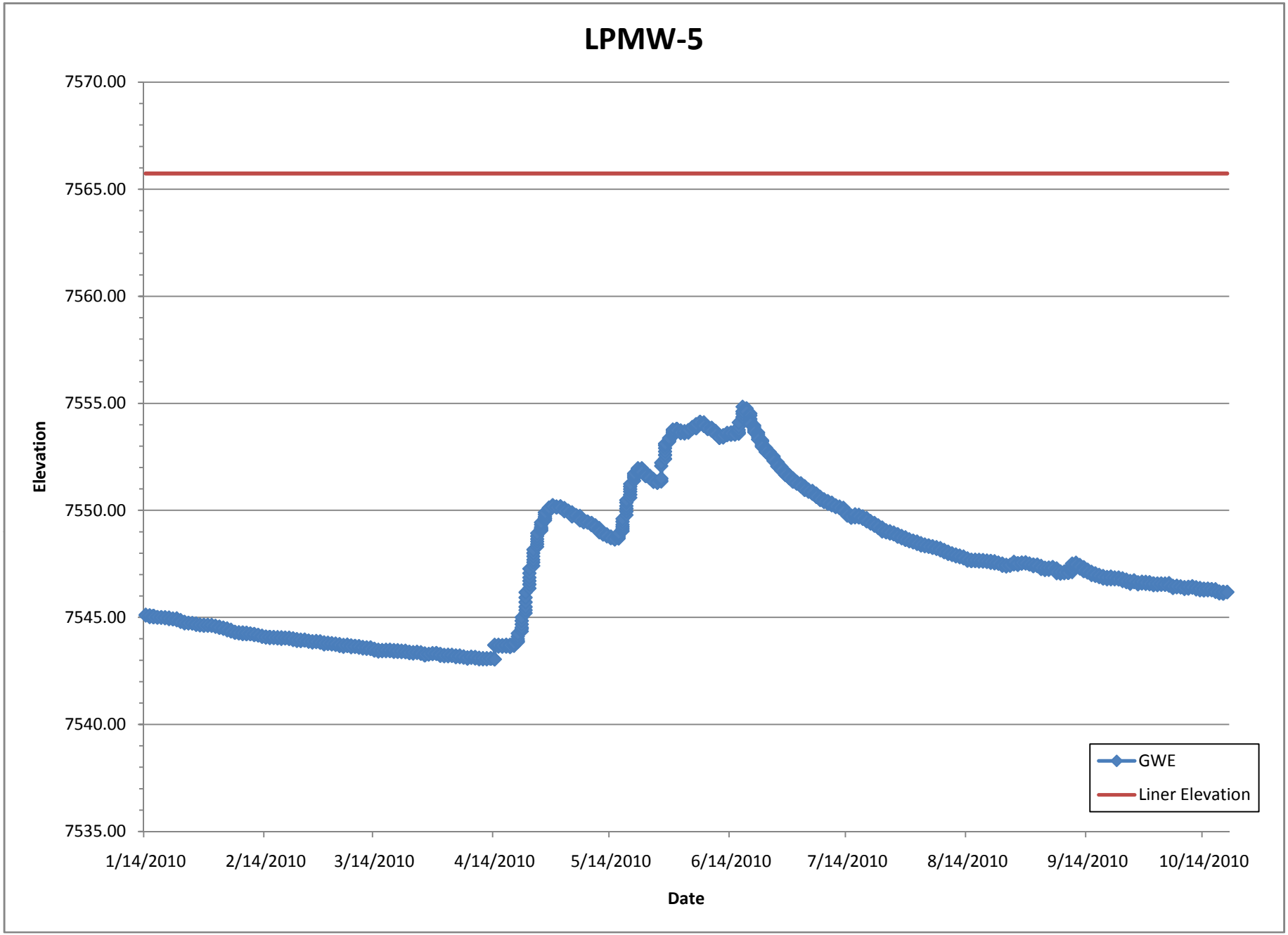

LPPZ-1
7555.00
7550.00
7545.00
7540.00
7535.00
7530.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

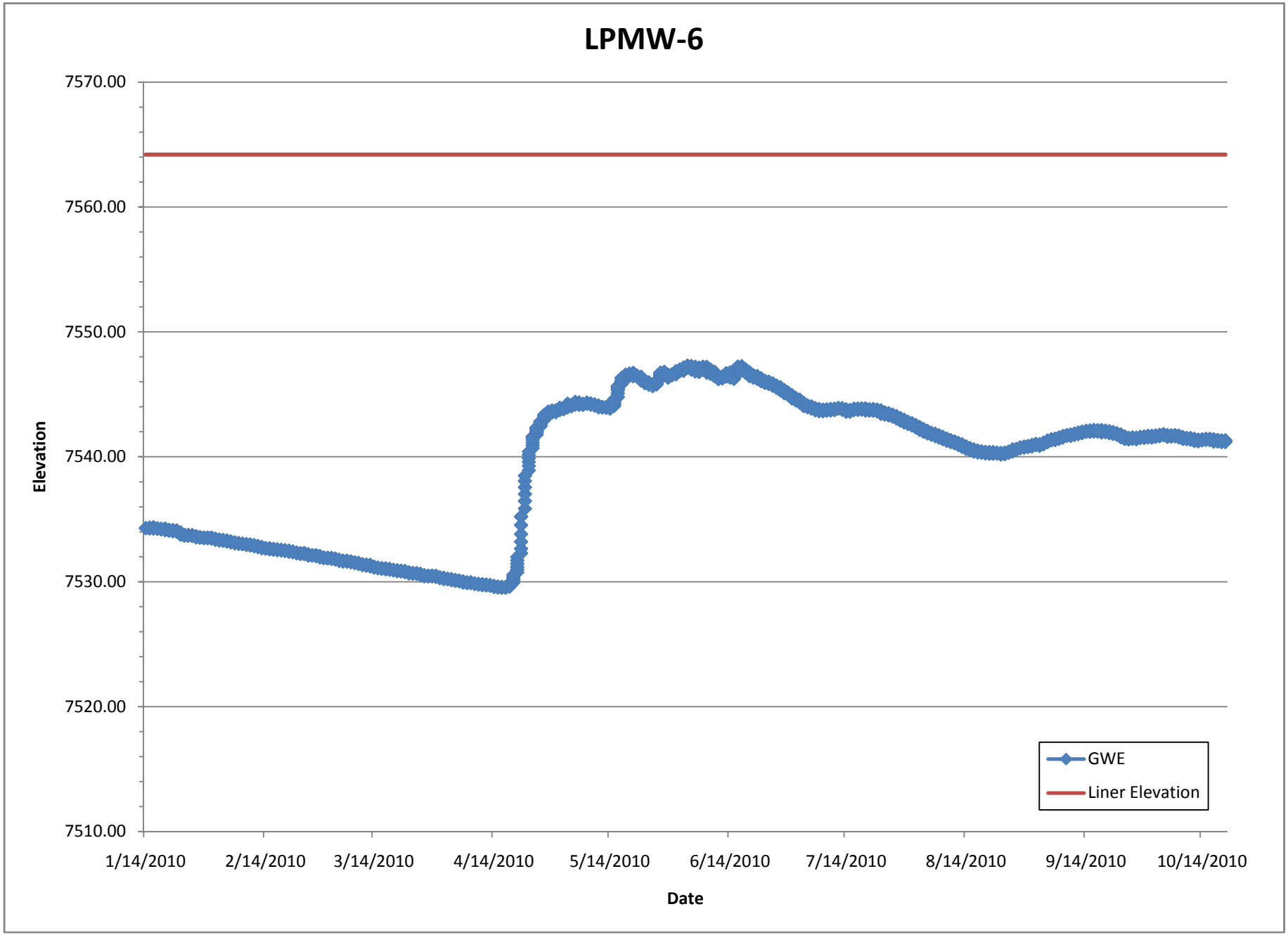

LPMW-4
7560.00
7555.00
7550.00
7545.00
7540.00
7535.00
7530.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation

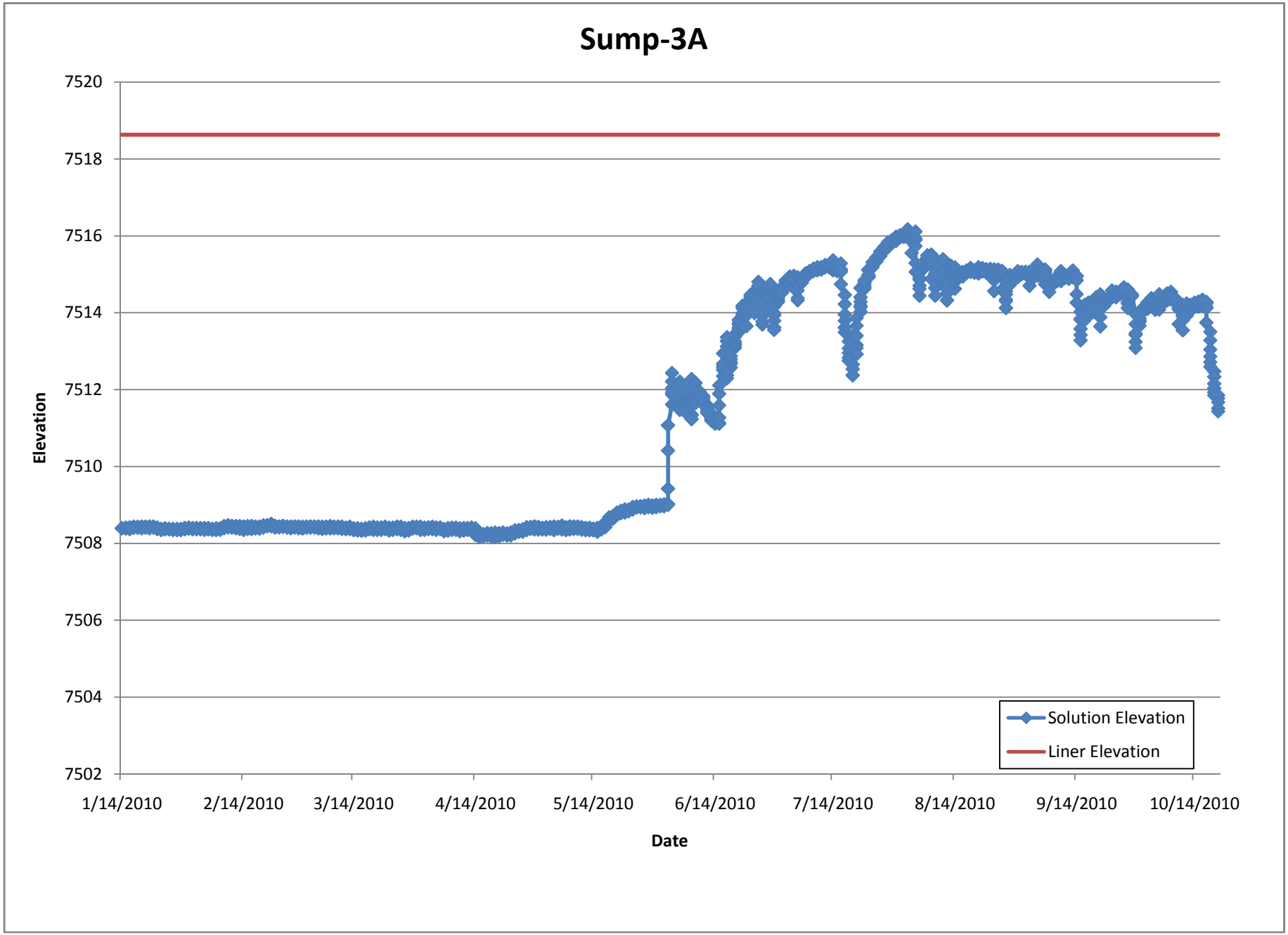

LPPZ-2
7560.00
7555.00
7550.00
7545.00
7540.00
7535.00
7530.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation


LPPZ-3
7565.00
7560.00
7555.00
7550.00
7545.00
7540.00
7535.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation


SBB-94-31
7700
7650
7600
7550
7500
7450
Elevation
Note: Well SBB-94-31 is located near the top of Beals Hill at a topographically higher elevation and was monitored to develope a potential gradient toward the leach pad.
GWE
Liner Elevation
5/27/2010
6/3/2010
6/10/2010
6/17/2010
6/24/2010
7/1/2010
7/8/2010
7/15/2010
7/22/2010
7/29/2010
8/5/2010
8/12/2010
8/19/2010
8/26/2010
9/2/2010
9/9/2010
9/16/2010
9/23/2010
9/30/2010
10/7/2010
10/14/2010
Date


LPMW-5
7570.00
7565.00
7560.00
7555.00
7550.00
7545.00
7540.00
7535.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation


LPMW-6
7570.00
7560.00
7550.00
7540.00
7530.00
7520.00
7510.00
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
GWE
Liner Elevation


Sump-3A
7520
7518
7516
7514
7512
7510
7508
7506
7504
7502
Elevation
1/14/2010
2/14/2010
3/14/2010
4/14/2010
5/14/2010
6/14/2010
7/14/2010
8/14/2010
9/14/2010
10/14/2010
Date
Solution Elevation
Liner Elevation