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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Executive Summary

Several *Resource Conservation and Recovery Act of 1976*[1] (RCRA) waste sites are located in the 200 East Area of the Hanford Site, and the groundwater flow direction at these waste sites is required to be periodically determined. Use of well water-level elevations to determine the groundwater flow rate and direction has been problematic in the 200 East Area because the magnitude of the hydraulic gradient is very low (i.e., the water table is very flat) and, therefore, difficult to measure accurately. For example, the regional hydraulic gradient magnitude between the 200 East Area and the Central Landfill (located 7.5 km [4.7 mi] southeast of the 200 East Area) was estimated to be 1.8×10^{-5} m/m. This equates to a 0.001 m (1 mm) change in the water table elevation over a horizontal distance of 55 m (180 ft), which is a very small gradient magnitude.

A study was conducted to evaluate the feasibility of reducing the error or variability in 200 East Area water-level measurements so the hydraulic gradients could be determined. Specific goals of the study were as follows:

- Improve the accuracy of the water-level elevation measurements at selected 200 East Area RCRA sites as much as is practicable.
- Determine the relative importance of the various factors affecting water-level measurement accuracy.
- Assess the feasibility of using the more accurate water-level measurements to determine hydraulic gradients.
- Assess the temporal variability of the hydraulic gradient at the study area sites.

This study was performed in four regions that included five RCRA sites within the 200 East Area: Low-Level Waste Management Area 1 (LLWMA-1), LLWMA-2, the Liquid Effluent Retention Facility (LERF), and the Integrated Disposal Facility (IDF) and the 216-A-36B Crib as a single area herein referred to as the IDF/Plutonium-Uranium Extraction (PUREX) Cribs.

Potential sources of error or variability in water-level measurements include (1) accuracy of well casing elevation surveys, (2) well verticality (i.e., plumbness of the wells),

[1] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq. Available at: http://www.epa.gov/epawaste/inforesources/online/index.htm.

(3) measuring device accuracy, (4) barometric pressure fluctuations, and (5) well construction. Measures were taken during this study to address all of these sources of error or variability. To address elevation survey accuracy, all of the monitoring wells were resurveyed to a higher degree of accuracy than is normally performed for geodetic surveys at the Hanford Site. Leveling surveys were performed for each well network using an infrared sighting device and a one-piece invar rod, and double runs were performed between wells and the results averaged. Each well network was referenced to a single benchmark. Wellbore deviation was addressed by performing gyroscope surveys in the wells. A gyroscope survey traces the position of the wellbore in three-dimensional space, which allows for the difference between the measured and true vertical depths to water to be determined. Water-level measurements were collected using measuring tapes dedicated to this study. The initial measuring tape used was calibrated by a standards laboratory and found to be accurate to within 0.001 m (1 mm) throughout its length. The water-level measurements were normalized to a constant barometric pressure using the multiple regression/deconvolution method. Finally, the wells used in this study were chosen to have relatively short screen lengths where possible. This minimized the chance that a vertical hydraulic gradient would occur within the screened interval, which would result in the well water-level elevation representing a composite head and not the water table elevation. The water-level measurements were analyzed by trend-surface analysis in which a plane was fit to the data by least-squares regression. The statistical significance of the results was assessed using an analysis of variance statistical test.

It was found that deviation of the wellbores from vertical was the largest source of error in the water-level measurements. Water-level measurements could not be used at all to determine hydraulic gradients unless this source of error was mitigated by performing gyroscope surveys in the wells. The magnitude of this error across all of the wells ranged from 0.000 to 0.472 m (0 to 472 mm), with a median of 0.018 m (18 mm) and an average of 0.056 m (56 mm).

It was found that accuracy of casing elevation surveys was not a substantial source of variability in the water-level measurements. Differences between the pre-existing casing surveys and the new highly accurate surveys ranged from 0.000 to 0.013 m (0 to 13 mm), with a median of 0.003 m (3 mm) and an average of 0.004 m (4 mm). Thus, the normal well casing elevation surveys performed in the 200 East Area were found to be quite accurate regardless of the survey method or benchmarks used. However, it is

recommended that resurveys of casing elevations should be performed when expanding this work to other sites to ensure that this potential source of variability is minimized.

Accounting for barometric pressure fluctuations resulted in some improvement of the trend-surface results, but this source of variability was also not substantial. Although a few individual wells exhibited water-level fluctuations of up to 0.032 m (32 mm) in response to barometric pressure changes, most wells exhibited water-level fluctuations of only up to approximately 0.011 m (11 mm) (95th percentile). The main effect of normalizing the water-level measurements to a constant barometric pressure was to reduce the uncertainty of the hydraulic gradient direction results. However, the potential remains for barometric pressure fluctuations to substantially affect well water levels, so an assessment of barometric effects should be performed when expanding this work to other sites.

During this study, a new characteristic shape for a water-level barometric response function was discovered. The new shape has response function coefficients less than zero (i.e., negative barometric efficiencies), indicating a direct relationship between water levels and barometric pressure changes (e.g., increases in barometric pressure causing *increases* in well water-level elevations) rather than the expected inverse relationship (e.g., increases in barometric pressure causing *decreases* in well water-level elevations). This was attributed to spatial variations in vadose zone transmission properties causing total head variations in the aquifer as air pressure changes propagate through the vadose zone at different rates. The total head variations cause water in the aquifer to displace from areas of high total head into areas of lower total head to maintain the total head equilibrium in the highly transmissive aquifer. This displacement effect was observed in two wells at LLWMA-1 and in all of the wells at the IDF/PUREX Cribs.

Water levels in all of the wells exhibited the same trends and responded to the same stressors. This study confirmed the hypothesis that large seasonal changes in Columbia River stage affect the water table in the 200 East Area. River-stage effects propagate to the 200 East Area from the north along a high-transmissivity paleochannel. Water levels in all of the wells also responded to discharges to the Treated Effluent Disposal Facility (TEDF), located 3 km (1.9 mi) east of the 200 East Area. Thus, stressors affect water levels over a large area in the highly transmissive aquifer beneath the 200 East Area and vicinity.

Results of determining the hydraulic gradient for each site are as described below and are summarized in Table E-1.

Table E-1. Summary of Hydraulic Gradient Determinations

RCRA Site	Date Range	Average Hydraulic Gradient Magnitude (m/m)	Average Hydraulic Gradient Direction (azimuth)
LLWMA-1	9/2005 to 1/2007	8.0×10^{-6} ($\pm 0.9 \times 10^{-6}$)	343 (±5)
	8/2008 to 9/2008	9.6×10^{-6}	184
	10/2008 to 6/2011	Indeterminate; hydraulic gradient too low to measure	
	7/2011 to 9/2012	2.5×10^{-5} ($\pm 0.4 \times 10^{-5}$)	175[a] (±8)
IDF/PUREX Cribs	6/2008 to 3/2011	2.2×10^{-5} ($\pm 0.3 \times 10^{-5}$)	64 (±12)
	6/2011 to 9/2012	2.3×10^{-5} ($\pm 0.2 \times 10^{-5}$)	96 (±6)
LLWMA-2	3/2009 to 9/2012	Indeterminate; hydraulic gradient too low to measure	
LERF	3 wells[b] (3/2009 to 11/2011)	9.3×10^{-5} ($\pm 7.4 \times 10^{-5}$)	187 (±34)
	4 wells[c] (12/2011 to 9/2012)	2.8×10^{-4} ($\pm 0.1 \times 10^{-4}$)	188 (±3)

a. Result is an average applicable to the entire region encompassed by the LLWMA-1 water-level network. Water table mapping indicates that the flow direction directly beneath LLWMA-1 is more toward the southeast.

b. Wells 299-E26-10, 299-E26-77, and 299-E26-79.

c. Wells 299-E26-10, 299-E26-14, 299-E26-77, and 299-E26-79.

IDF = Integrated Disposal Facility
LERF = Liquid Effluent Retention Facility
LLWMA = low-level waste management area
PUREX = Plutonium-Uranium Extraction
RCRA = *Resource Conservation and Recovery Act of 1976*

Low-Level Waste Management Area 1

The hydraulic gradient was successfully measured at LLWMA-1. Between September 2005 and January 2007, the average hydraulic gradient was 8.0×10^{-6} ($\pm 0.9 \times 10^{-6}$) m/m toward the north-northwest (343 [±5] degrees azimuth). During August and September 2008, the hydraulic gradient temporarily reversed. The average hydraulic gradient during these months was 9.6×10^{-6} m/m toward the south (184 degrees azimuth). This reversal was attributed to a high Columbia River stage during the summer of 2008 that propagated inland to the 200 East Area from the north through a high-transmissivity

paleochannel. From October 2008 through June 2011, the hydraulic gradient was indeterminate and groundwater flow was interpreted to be nearly stagnant, although the trend-surface results suggest that flow was slowly changing back to a north direction during this time. Beginning in the summer of 2011, the hydraulic gradient direction reversed again and remained toward the south through the end of the study period (September 2012). The average hydraulic gradient from July 2011 through September 2012 was 2.5×10^{-5} ($\pm 0.4 \times 10^{-5}$) m/m toward the south (175 [±8] degrees azimuth). The southward flow was attributed to high Columbia River stage during the summers of 2011 and 2012, combined with the lack of large volume discharges to the TEDF during this time. These hydraulic gradient determinations represent spatial averages across the entire LLWMA-1 well network. Mapping of water levels from August 2011 indicated that the flow direction directly beneath LLWMA-1 is more toward the southeast rather than toward the south. The estimated accuracy achieved in the water-level elevation measurements at LLWMA-1 was ±0.006 m (6 mm) (90 percent confidence interval).

Integrated Disposal Facility/Plutonium-Uranium Extraction Cribs

The hydraulic gradient was successfully measured at the IDF/PUREX Cribs, although the small size of the study area and variability in the water-level measurements required that wells with high residuals be removed from the trend-surface analyses. Between June 2008 and March 2011, the average hydraulic gradient was 2.2×10^{-5} ($\pm 0.3 \times 10^{-5}$) m/m with a direction of 64 (±12) degrees (east-northeast). Beginning in June 2011, the average direction of the hydraulic gradient changed to 96 (±6) degrees (east),[2] but the gradient magnitude remained essentially the same at 2.3×10^{-5} ($\pm 0.2 \times 10^{-5}$) m/m. This change in the hydraulic gradient direction correlated with the flow reversal observed at LLWMA-1 beginning in the summer of 2011. The estimated accuracy achieved in the water-level elevation measurements at IDF/PUREX Cribs was ±0.019 m (19 mm). This is higher than the error in the LLWMA-1 measurements for two reasons: (1) the wells are deviated from vertical to a greater extent; and (2) there is substantial air movement through the wellbores in response to barometric pressure changes as compared to the other wells in the 200 East Area. The latter results in substantial condensation inside the wells, which causes the measuring tapes to stick to

[2] During the first half of 2013, the hydraulic gradient had apparently shifted back toward the east-northeast, although additional measurements are needed for confirmation.

the casing. Both of these factors made it difficult to obtain accurate depth-to-water measurements in the IDF/PUREX Cribs wells.

Low-Level Waste Management Area 2

The hydraulic gradient magnitude at LLWMA-2 was too low to be measured. A factor contributing to this result was that many of the wells were located generally along a line, and this is a poor spatial distribution for trend-surface analyses. The spatial distribution of the wells is a consequence of having basalt bedrock above the water table beneath the northern portion of LLWMA-2. The estimated accuracy achieved in the water-level elevation measurements at LLWMA-2 was ±0.008 m (8 mm).

Liquid Effluent Retention Facility

The water-level monitoring well network at the LERF initially consisted of three wells until a fourth well was drilled and added to the network in December 2011. The average results for the initial three wells (March 2009 through November 2011) indicated a hydraulic gradient of 9.3×10^{-5} ($\pm 7.4 \times 10^{-5}$) m/m with a direction of 187 (±34) degrees (south). After including the fourth well, the gradient averaged 2.8×10^{-4} ($\pm 0.1 \times 10^{-4}$) m/m with a direction of 188 (±3) degrees. The water-level elevation is higher at the new well, 299-E26-14, which accounts for the higher gradient magnitude. Thus, the magnitude of the hydraulic gradient changes somewhere between 299-E26-14 located to the north of LERF and the other three wells located to the south and west of the facility. An estimate of the accuracy of the water-level measurements at LERF was not made due to the small number of wells in this network and because of the non-uniform hydraulic gradient magnitude at this site.

Conclusions

Overall, this study demonstrated that it is feasible to determine hydraulic gradients in the 10^{-6} to 10^{-5} m/m range for at least some locations in the 200 East Area using water-level measurements. This has improved the understanding of groundwater flow in this area, and expansion of this work into other portions of the 200 East Area should result in an even better conceptual model of groundwater flow in this region.

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Terms

ANOVA	analysis of variance
bls	below land surface
CCU	Cold Creek unit
DOE	U.S. Department of Energy
IDF	Integrated Disposal Facility
IQR	interquartile range
LERF	Liquid Effluent Retention Facility
LLWMA	low-level waste management area
N/A	not applicable
NAVD88	*North American Vertical Datum of 1988*
PUREX	Plutonium-Uranium Extraction
RCRA	*Resource Conservation and Recovery Act of 1976*
TEDF	Treated Effluent Disposal Facility

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1 Introduction

The U.S. Department of Energy's (DOE's) Hanford Site occupies 1,500 km^2 (580 mi^2) of land along the Columbia River in south-central Washington State (Figure 1-1). The site was established in 1943 with the primary mission of producing plutonium for national defense. Production continued through the Cold War era but ceased in the late 1980s. The current mission at the Hanford Site is environmental cleanup and waste management.

Groundwater quality monitoring is conducted at Hanford under several regulatory drivers, most notably the *Atomic Energy Act of 1954*; the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; and the *Resource Conservation and Recovery Act of 1976* (RCRA). At the Hanford Site, RCRA governs groundwater monitoring for dangerous waste constituents at 25 waste sites. Many of these sites are monitored under the interim status regulations (40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring"; as referenced by WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards") to detect impacts to groundwater quality. These regulations require that "...at least annually the owner or operator must evaluate the data on ground-water surface elevations…to determine whether the requirements…for locating the monitoring wells continues to be satisfied" (40 CFR 265.93[f], "Preparation, Evaluation, and Response"; as referenced by WAC 173-303-400). The groundwater elevations are used to determine the groundwater flow direction, which is then used to assess the suitability of the monitoring well network to detect impacts to groundwater quality from the waste site. A similar requirement also applies to sites under the final status regulations (WAC 173-303-645[9][e], "Releases from Regulated Units").

The groundwater flow direction is found by determining the hydraulic gradient using water-level measurements collected from monitoring wells. The hydraulic gradient is a measure of the driving force for groundwater movement. It is a vector quantity because it has a magnitude and direction. The direction of the hydraulic gradient can be expressed as the angle measured clockwise from true north (azimuth), and the magnitude is expressed as the change in water table (or potentiometric surface) elevation with horizontal distance:

$$i = \frac{\Delta h}{\Delta l} \qquad \textbf{(Equation 1-1)}$$

where:

i = spatial average hydraulic gradient magnitude (L/L)

Δh = change in water table elevation (L)

Δl = horizontal distance along the gradient direction in which the water table elevation change was determined (L)

Conceptually, the hydraulic gradient direction is the direction toward which the water table slopes, and the magnitude of the gradient is the steepness of the slope.

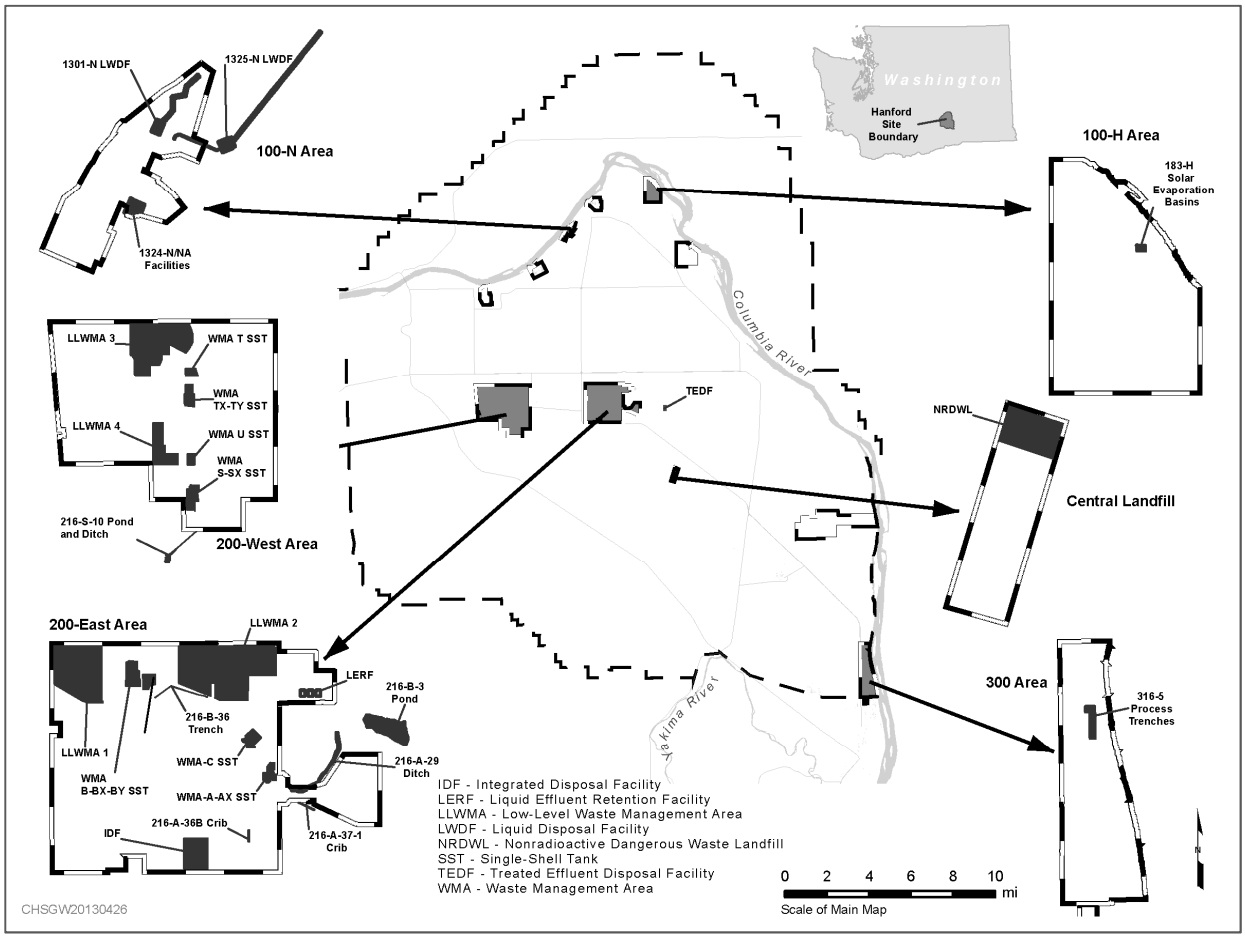

Figure 1-1. Hanford Site Map with Locations of the RCRA Waste Sites

The direction of the hydraulic gradient is generally a good approximation of the groundwater flow direction. The magnitude of the hydraulic gradient can be used to calculate the groundwater flow rate as follows (*Applied Hydrogeology* [Fetter, 1988]):

$$v = \frac{K \cdot i}{n_e} \qquad \textbf{(Equation 1-2)}$$

where:

v = groundwater flow rate or average linear velocity (L/T)

K = hydraulic conductivity of the aquifer (L/T)

n_e = effective porosity (i.e., the fraction of the cross-sectional area of the aquifer available for fluid flow) (unit-less)

The hydraulic conductivity is typically determined by hydrologic testing, such as pump tests or slug tests. The effective porosity can be determined from pump tests or other methods, or it can be estimated as ranging from 0.1 to 0.3.

Several of the RCRA waste sites requiring groundwater monitoring are located in the Hanford Site's 200 East Area (Figure 1-1). Use of the water-level approach to determine the groundwater flow rate and direction has been problematic in the 200 East Area because the magnitude of the hydraulic gradient is

very low (i.e., the water table is very flat) and, therefore, difficult to measure accurately. For example, the gradient magnitude in the 200 East Area was estimated by computing the regional hydraulic gradient magnitude for the central portion of the Hanford Site. This was done by comparing the average water table elevation in the 200 East Area to the average water table elevation at the Central Landfill (Figure 1-1), which is downgradient from the southeast portion of the 200 East Area. Using measurements collected during March 2004, the average water-level elevation in the 200 East Area was 122.282 m (NAVD88, *North American Vertical Datum of 1988*), and the average elevation at the Central Landfill was 122.145 m (NAVD88). This gives an elevation difference (Δh) of 0.137 m (137 mm). The distance from the center of the 200 East Area to the landfill (Δl) is about 7,500 m (4.7 mi). Using Equation 1-1, this gives a hydraulic gradient magnitude (i) of 1.8×10^{-5} m/m. This equates to a 0.001 m (1 mm) change in the water table elevation over a horizontal distance of 55 m (180 ft), which is a very small gradient magnitude.

The estimate of the regional gradient magnitude was used to estimate the change in water table elevation beneath the Low-Level Waste Management Area 1 (LLWMA-1) waste site as an example (location shown in Figure 1-1). The monitoring well network immediately surrounding this site spans 880 m (2,800 ft) along the presumed groundwater flow direction. If the regional gradient magnitude of 1.8×10^{-5} m/m is representative of local conditions at LLWMA-1, then the water table elevation would change spatially by approximately 0.016 m (16 mm) beneath the waste site.[3] During March 2004, the range of the water-level elevation measurements in the LLWMA-1 network monitoring wells was 0.060 m (60 mm). Thus, the variability of the water-level measurements was approximately four times larger than the expected actual change in the water table elevation (i.e., a low signal-to-noise ratio).

This higher level of variability in water-level elevation measurements compared to the expected true change in water table elevation was assumed to be due to inaccuracies in the water-level elevation measurements. Potential sources of error or variability include the following:

- Accuracy of well casing elevation surveys
- Well verticality (i.e., plumbness of the wells)
- Measuring device accuracy
- Barometric pressure fluctuations
- Well construction

Because of the high level of variability, existing water-level measurements at LLWMA-1 and elsewhere within the 200 East Area have not been useable for determining hydraulic gradients. Thus, the goals of this study were as follows:

- Improve the accuracy of the water-level elevation measurements at selected 200 East Area RCRA sites as much as is practicable
- Determine the relative importance of the various factors affecting water-level measurement accuracy
- Assess the feasibility of using the more accurate water-level measurements to determine hydraulic gradients
- Assess the temporal variability of the hydraulic gradient at the study area sites

[3] 1.8×10^{-5} m/m times 880 m equals 0.016 m.

This study was conducted first at LLWMA-1. It was later expanded to LLWMA-2, the area of the Integrated Disposal Facility (IDF) and Plutonium Uranium Extraction (PUREX) Plant Crib 216-A-36B, and the Liquid Effluent Retention Facility (LERF) (Figure 1-1). Measurement accuracy was improved by selecting a network of wells at each site that yielded water-level elevations representative of the water table, performing highly accurate casing elevation and wellbore deviation surveys, collecting water-level measurements with dedicated measuring tapes, and installing automated water-level monitoring equipment in the wells to allow for correction of barometric pressure fluctuations. If successful, the techniques employed for this study can be applied to other sites within the 200 East Area, thereby reducing the uncertainty in groundwater flow beneath this region.

The remainder of the discussion in this document includes the following:

- **Chapter 2:** Provides background information on the geology and hydrogeology of the Hanford Site and the 200 East Area.
- **Chapter 3:** Provides the detailed methodology used for this study.
- **Chapter 4:** Presents and discusses the results of this study.
- **Chapter 5:** Provides conclusions and recommendations.
- **Chapter 6:** Includes the references cited in this document

Supporting information is included in four appendices:

- **Appendix A:** Contains the casing elevation survey reports.
- **Appendix B:** Contains the wellbore deviation survey reports.
- **Appendix C:** Lists the manual water-level measurements and calculated well water-level elevations.
- **Appendix D:** Provides the results of an earlier study assessing stressors to the water table in the 200 East Area.

The calculations performed for this study are documented in detail in *Calculations in Support of the Low Hydraulic Gradient Evaluation Study for the 200 East Area Unconfined Aquifer* (ECF-200E-12-0086).

2 Background

This chapter briefly describes the geology and hydrogeology of the Hanford Site, with emphasis on the 200 East Area. A generalized conceptual model for groundwater flow in the 200 East Area is also presented. This information provides the context for the detailed discussion of water levels and groundwater flow in the following chapters.

2.1 Geologic Setting

The bedrock beneath the Hanford Site consists of numerous basalt lava flows laid down by fissure eruptions during Miocene time (RHO-BWI-ST-4, *Geologic Studies of the Columbia Plateau: A Status Report*) (Figure 2-1). The basalt formations are formally known as the Columbia River Basalt Group. Individual lava flows are separated by interflow zones and interbedded sediments, and the sediments are collectively referred to as the Ellensburg Formation. This sequence of basalt lava flows and interbedded sediments has been deformed into anticlinal ridges separated by synclinal basins trending northwest-southeast. The 200 East Area lies within the Cold Creek syncline on the south limb of the Umtanum Ridge-Gable Mountain anticline (Figure 2-2).

Clay, silt, sand, and gravel of the Miocene-Pliocene age Ringold Formation overlie basalt. These sediments were deposited in a fluvial-lacustrine environment by the ancestral Columbia River system (*The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-Central Washington and North-Central Oregon* [Lindsey, 1996]). They are overlain by the Cold Creek unit (CCU), which consists of alluvium, colluvium, and paleosol horizons (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin*).

Cataclysmic Ice Age floods swept across central Washington State during the Pleistocene (DOE/RL-2002-39). These floods removed much of the CCU and part of the Ringold Formation from the Hanford Site, although erosion of these units likely began prior to the Ice Age floods by the ancestral Columbia River. In the 200 East Area, much of the CCU and Ringold Formation member of Savage Island and member of Taylor Flat were removed by erosion or were not deposited (PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*). In addition, much of the member of Wooded Island was also removed by erosion, with only portions of Unit A remaining beneath the 200 East Area. The floods deposited silt, sand, and gravel of the Hanford formation. In the 200 East Area, the Hanford formation is comprised primarily of coarse sand and gravel.

2.2 Hydrogeology

General groundwater flow directions in the unconfined aquifer can be determined from the Hanford Site water table map (Figure 2-3). Groundwater generally flows from upland areas in the west toward the regional discharge area north and east along the Columbia River (DOE/RL-2011-01, *Hanford Site Groundwater Monitoring Report for 2010*). Steep gradients occur in the west, east, and north regions of the Hanford Site. Shallow gradients occur southeast of the 100-F Area and in a broad arc extending from west of the 100-BC Area toward the southeast between Gable Butte and Gable Mountain (Gable Gap) and the 200 East Area into the central portion of the Site.

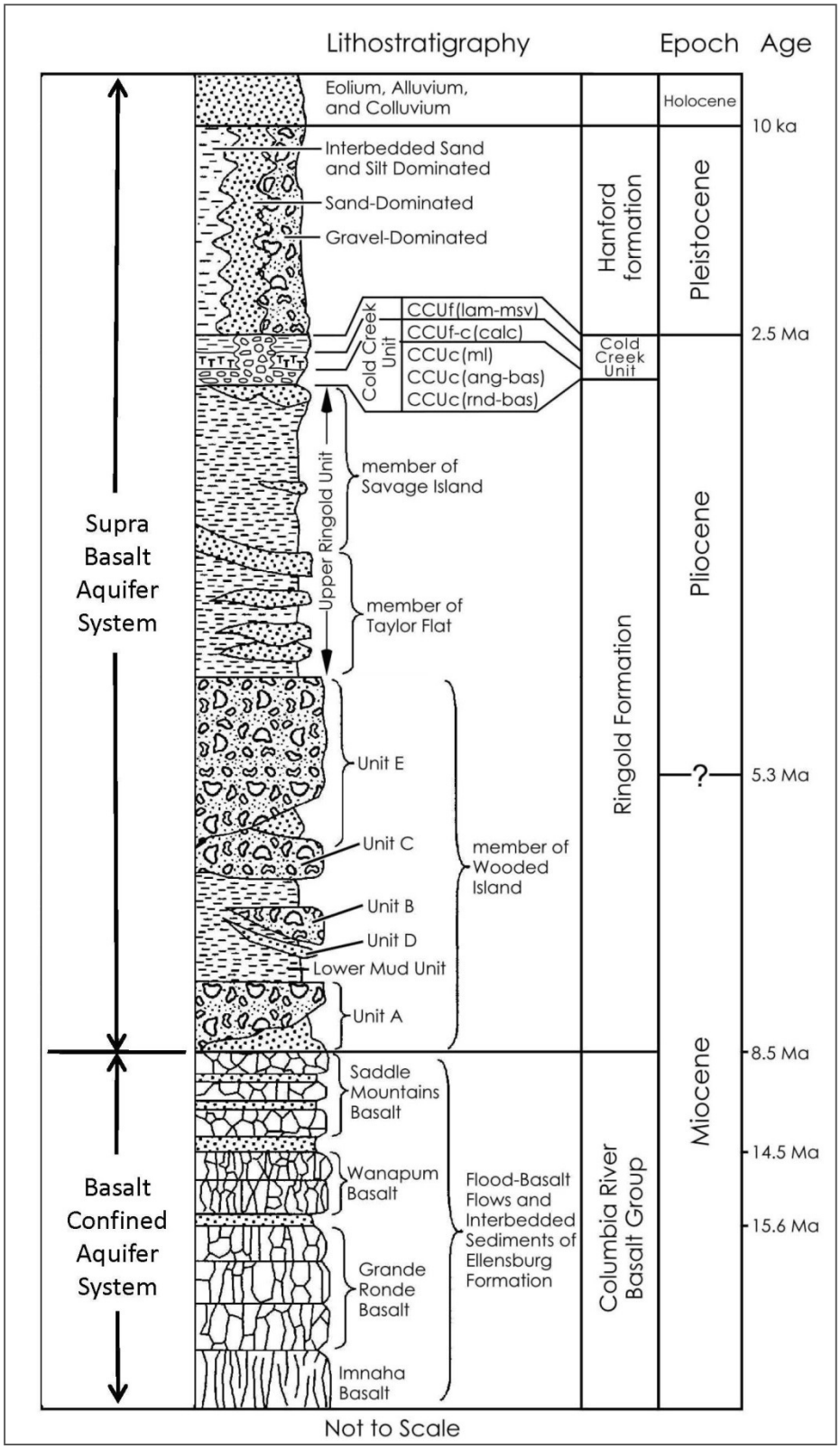

Figure 2-1. Generalized Stratigraphic Column for the Hanford Site

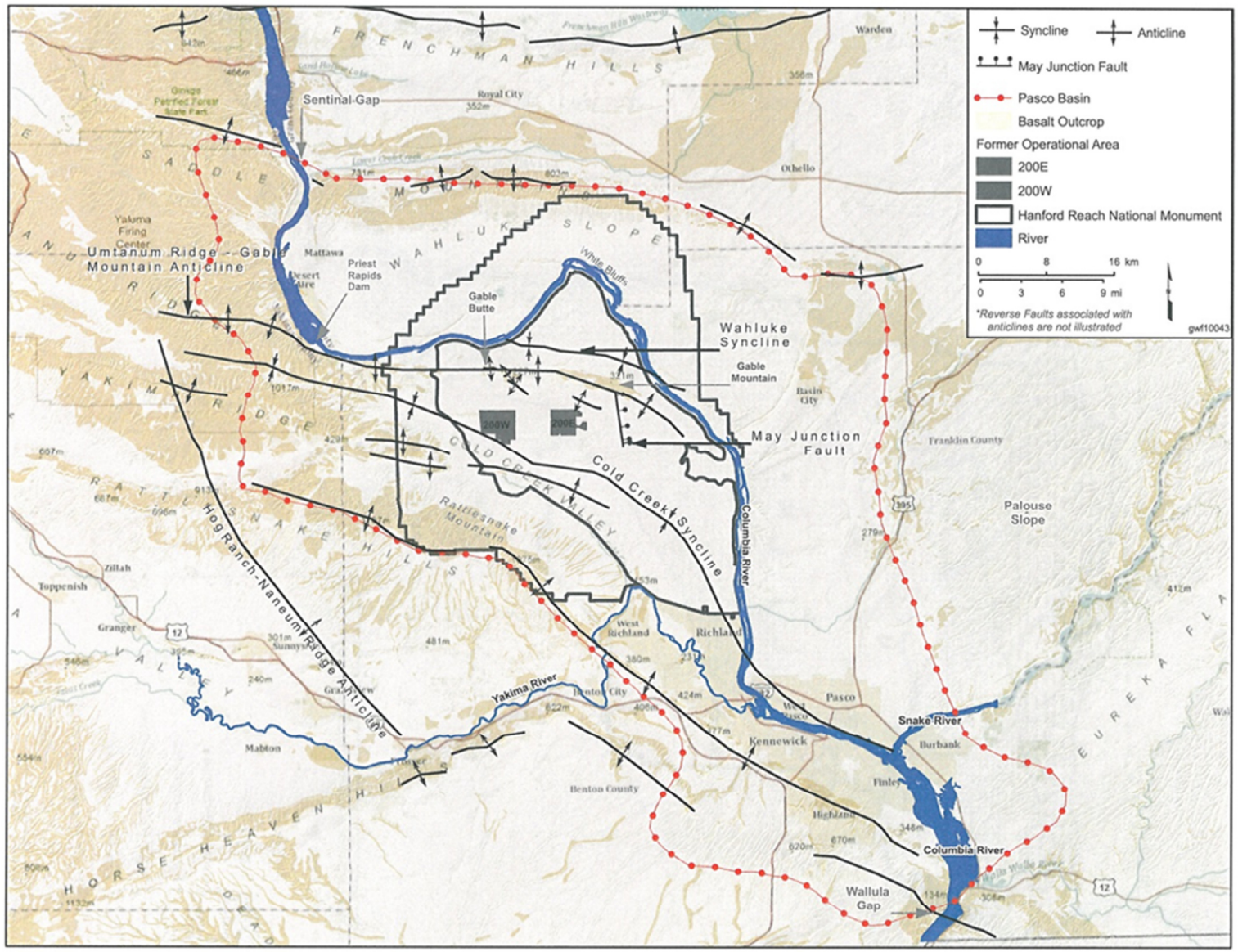

Figure 2-2. Generalized Geologic Structure of the Pasco Basin and the Hanford Site

High-energy floodwater from Ice Age floods flowed through Gable Gap and into the central portion of the Hanford Site. The result was a paleochannel filled with highly permeable sediment of the Hanford formation, which forms an aquifer of high hydraulic conductivity (i.e., high transmissivity) in this region (Figure 2-4). The paleochannel corresponds to the region of low hydraulic gradient on the water table map. The reason for this can be seen by examining Darcy's law for groundwater flow (Fetter, 1988):

$$\frac{Q}{A} = K \cdot i \qquad \textbf{(Equation 2-1)}$$

where:

Q = discharge (L^3/T)

A = cross-sectional area (L^2)

K = hydraulic conductivity (L/T)

i = hydraulic gradient magnitude (L/L)

The quantity Q/A is specific discharge, which is discharge per unit area. If specific discharge is constant, then an increase in hydraulic conductivity must be balanced by a decrease in hydraulic gradient, and vice versa. Thus, regions of high hydraulic conductivity are associated with low hydraulic gradients. On the water table map for the Hanford Site (Figure 2-3), steep hydraulic gradients in the west and east are associated with low-conductivity sediment of the Ringold Formation at the water table, while the low gradients are associated with the highly conductive sand and gravel of the Hanford formation at the water table. Because the unconfined aquifer in the 200 East Area occurs within the highly conductive Hanford formation sediments, the hydraulic gradient magnitude there is very low.

One characteristic of highly transmissive aquifers is that stressors to the aquifer can have effects at large distances from the source of the stress. For example, the discharge of effluent to the ground at the Treated Effluent Disposal Facility (TEDF), located 3 km (1.9 mi) east of the 200 East Area (Figure 2-3), affects the water table elevation throughout the 200 East Area (PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*). Further, it had previously been hypothesized that large seasonal changes in Columbia River stage also affect the water table elevation in the 200 East Area (PNNL-16346). Although the river is approximately 10 km (6.2 mi) from the 200 East Area, the highly transmissive paleochannel between the river and the 200 East Area allows for river-stage effects to be propagated large distances inland (Figure 2-4). This situation is described in more detail in Appendix D. This hypothesis was confirmed by the results of the present study, as described in Section 4.1.5.2.

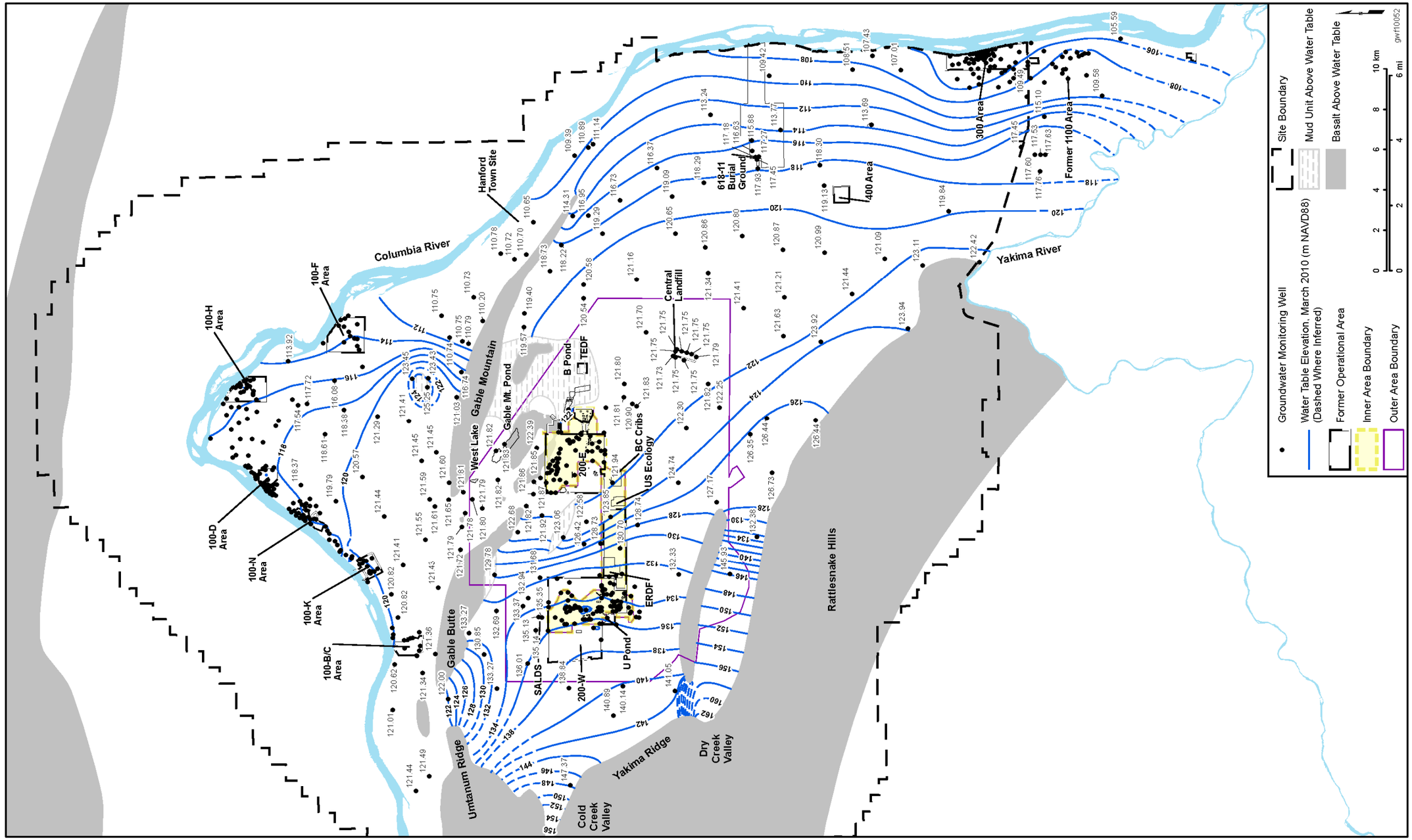

Figure 2-3. Hanford Site Water Table Map, March 2010

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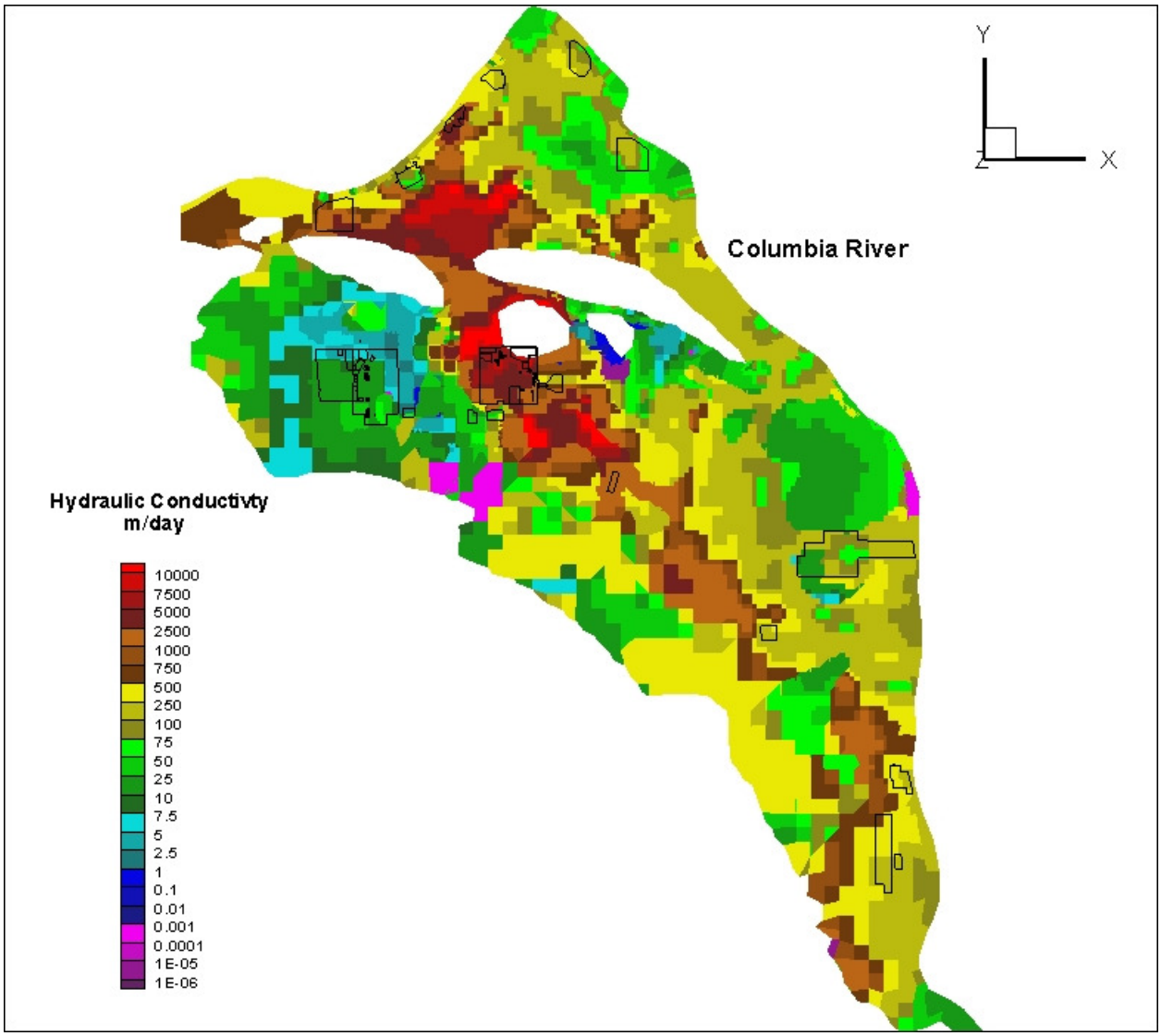

Source: PNNL-14753, Rev. 1, *Groundwater Data Package for Hanford Assessments*.

Figure 2-4. Hydraulic Conductivity Distribution in the Unconfined Aquifer at the Hanford Site

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3 Methodology

The methods used in this study consist of the techniques for data analysis and the actions taken to improve the accuracy of the water-level measurements. As listed in Chapter 1, potential sources of error or variability in water-level measurements include the following:

- Accuracy of well casing elevation surveys
- Well verticality (i.e., plumbness of the wells)
- Measuring device accuracy
- Barometric pressure fluctuations
- Well construction

Section 3.1 addresses issues associated with well construction. Sections 3.2 and 3.3 address the accuracy of reference point elevations and well verticality, respectively. The collection of manual water-level measurements is described in Section 3.4. Collection of automated water levels is discussed in Section 3.5, and the method of analyzing the automated data to determine barometric pressure effects is discussed in Section 3.6. The manual water-level measurements were analyzed by trend-surface analysis, which is described in Section 3.7. Section 3.7 also discusses the statistical test used to verify the validity of the trend-surface analysis results. Section 3.8 describes how the accuracy of the manual water-level measurements collected for this study was determined.

The discussions in the following sections are limited to the methods employed for this study. The results of this study are presented in Chapter 4.

3.1 Monitoring Well Construction

A screened monitoring well acts as a high hydraulic conductivity pathway connecting different horizons in an aquifer that would not otherwise be connected by such a pathway if the well had not been drilled. In an aquifer, there can be slight hydraulic head differences with depth. If present, these differences are driving forces for the vertical movement of water through a screened well under non-pumping conditions. Only small head differences are needed to induce flow (because the hydraulic conductivity of a wellbore is very high), so vertical flow may be common in screened wells ("Bias in Groundwater Samples Caused by Wellbore Flow" [Reilly et al., 1989]; "Implications of Observed and Simulated Ambient Flow in Monitoring Wells" [Elci et al., 2001).

Vertical flow in a well affects the water-level elevation within that well ("Detrimental Effects of Natural Vertical Head Gradients on Chemical and Water Level Measurements in Observation Wells: Identification and Control" [Elci et al., 2003]). Downward flow causes lower water-level elevations, while upward flow causes higher water-level elevations. Thus, wells experiencing vertical flow have a water-level elevation different from the water table. The difference is small enough to be negligible for most applications, but small differences may be significant under the low hydraulic gradient magnitude conditions in the 200 East Area. The amount of vertical flow in a well tends to be proportional to the length of the saturated screened interval, so vertical flow is less of a problem in wells of short screen lengths (Elci et al., 2001; Elci et al., 2003). To successfully measure the hydraulic gradient at sites within the 200 East Area, it was important that the water-level in the wells be representative of the water table elevation. Therefore, only wells having relatively short saturated screen intervals (i.e., less than 6.1 m [20 ft]) were chosen for use in this study, where available. In addition, wells having low hydraulic conductivity mud layers within the screened interval were avoided because these wells are more prone to vertical flow due to the potential for a hydraulic head difference across the mud layer.

The well networks selected for each site in this study are described in Chapter 4.

3.2 Reference Point Elevations

The water level in a well is expressed as the elevation of the water surface above mean sea level. All monitoring wells have a reference point (e.g., top of casing) at which the elevation is determined by geodetic survey. Field personnel measure the depth to water from this reference point using a measuring tape. The elevation of the water level is calculated by subtracting the depth to water from the reference point elevation (SGW-38815, *Water-Level Monitoring Plan for the Hanford Site Soil and Groundwater Remediation Project*). Thus, the accuracy of reference point elevation surveys affects the accuracy of calculated water-level elevations.

Existing reference point elevations for wells in the 200 East Area were determined over many years by different personnel using different survey techniques, different instruments, and different benchmarks. This has likely introduced some variability into the reference point elevations. To keep the variability to a minimum, the reference points for all wells used in this study were resurveyed by the same personnel using the same technique (differential leveling) and the same instruments, and all of the well surveys at a given site were referenced to a single benchmark.

With differential leveling, the difference in height between a point of known elevation (a benchmark or other surveyed point) and a point of unknown elevation (the well reference point) is measured. The elevation of the reference point is computed by applying this difference to the benchmark elevation. Height measurements are taken using a leveling instrument and a graduated rod. The leveling instrument is set up between a point of known elevation and the point being measured, and then leveled to the vertical. The rod is placed vertically on the point of known elevation, and the point on the rod at the same height as the leveling instrument is read by sighting through the leveling instrument (a backward sight). The rod is then placed on the point of unknown elevation, and a forward sight is taken through the leveling instrument. The difference between the two readings is the height difference between the two points. A series of sights between adjacent points is known as a leveling line. Leveling lines are typically constructed to close on the starting point or another point of known elevation which allows for a determination of the cumulative error in the leveling line. This is known as the misclosure.

The leveling instrument used in this study was the Trimble DiNi[4] 0.7 mm digital level, and the graduated rod was a one-piece invar[5] rod. Using infrared light, the digital level automatically reads a barcode on the invar rod to a stated accuracy of 0.7 mm/km (0.004 ft/mi) horizontal distance. Collimation tests were performed periodically during the survey to ensure instrument accuracy, and the difference between the backward and forward sight lengths were kept below 10 m (32.8 ft). All leveling lines between the benchmark and a well, or between wells, were double-surveyed and averaged. The leveling lines were closed to allow for misclosure determinations, and the misclosure values were pro-rated throughout each line. The largest misclosure during this study was 0.0019 m (i.e., less than 2 mm), indicating that high accuracy was achieved. Results of the elevation surveys are provided in Chapter 4, and Appendix A contains the survey data reports and diagrams of the leveling lines used in this study.

3.3 Wellbore Verticality

Calculating the water-level elevation in a well by subtracting the depth to water from the reference point elevation assumes that the wellbore is vertical (i.e., the depth-to-water measurement represents the true vertical depth to water). However, many wells deviate from vertical to some extent, particularly deeper

[4] Trimble® and DiNi® are registered trademarks of Trimble Navigation Limited, registered in the United States and in other countries.

[5] Invar is a particular iron-nickel alloy noted for its very low coefficient of thermal expansion (i.e., it is resistant to temperature-induced length changes).

wells. If a wellbore is out-of-plumb, the measured depth to water will be larger than the true vertical depth to water and the calculated water-level elevation will be lower than the true water-level elevation.

When selecting the network of wells used for this study, wells significantly deviated from vertical were avoided where possible. Such wells were easily identified because they had calculated water-level elevations much lower than surrounding wells. When this study began in 2005, the average water table elevation in the 200 East Area was approximately 122.1 m (NAVD88). Wells were considered significantly deviated from vertical if they yielded calculated water-level elevations less than 122.0 m (NAVD88).

To identify and correct for more subtle verticality errors, borehole path surveys were performed in the monitoring wells using a directional gyroscope (Model DG69-0901-4, manufactured by Humphrey, Inc.). This device was lowered down the well, and readings of inclination (i.e., angle from vertical) and bearing (i.e., direction of inclination) were taken at regular measured depth intervals. A software program (supplied by the gyroscope manufacturer) was then used to construct a three-dimensional model of the wellbore from the inclination and bearing readings. The software also provided the true vertical depth for each measurement station along the wellbore. This information was used to calculate the difference between the measured depth to water and the true vertical depth to water, which enabled the depth-to-water measurements to be corrected for verticality error.[6] Results of the gyroscope surveys are provided in Chapter 4, and Appendix B contains the gyroscope survey reports for all of the wells used in this study.

3.4 Manual Measurements

All manual water-level measurements collected during this study were taken with laminated-steel electric sounding tapes graduated in metric units (Model 3001, RST Instruments, Ltd.). All of the tapes were at least 100 m (328.1 ft) long and mounted on hand-cranked reels. Electrodes are contained in a weighted, stainless-steel probe at the end of each tape. When the probe electrodes contact water, an electric circuit is closed and a buzzer on the reel activates to indicate that water has been reached. The tape was held against the measuring point on the well casing at the depth that just causes the electric circuit to close. The depth to water from the measuring point was then read from the tape and recorded on a field record form. In many cases, the measuring point on the well casing (i.e., the actual point on the well casing from which the depth-to-water measurement was made) was not the same as the reference point. When this occurred, an adjustment to the measured depth to water was made so it reflected the depth to water from the reference point (SGW-38815).

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[6] Estimating the error in the verticality correction values is not straightforward. The gyroscope manufacturer states an accuracy of ±0.1 degree for the inclinometer, but the difference between a measured depth and a true vertical depth is not linear to the inclination angle. Instead, it varies as the cosine of the angle. Thus, the final error in a correction value depends on the depth and inclination of the borehole, as well as the interval between measured depth stations. However, the order of magnitude of the error can be estimated using a simple case, such as a straight borehole inclined at 2 degrees with gyroscope readings taken every 6.1 m (20 ft) to a total measured depth of 97.5 m (320 ft). In this case, the maximum error between the measured depth and true vertical depth over each 6.1 m (20 ft) interval is 0.0004 m (0.4 mm) (6.1 m times the cosine of 2.0 degrees less 6.1 m times the cosine of 2.1 degrees). This yields an error of 0.006 m (6 mm) at total depth (16 stations). This assumes that all of the inclinometer readings are 0.1 degrees too large, which would be an extreme case. More likely, the average error in the inclinometer readings would be normally distributed between -0.1 and +0.1 degree with a mean of zero, so the actual error in the correction factor would be much less. To account for this, assume all the readings are too large by 0.05 degree. In this case, the error at each 6.1 m station would be 0.0002 m (0.2 mm) for a total cumulative error of 0.003 m (3 mm). For this example, the true correction factor would be 0.059 m (59 mm) and an error of 0.003 m (3 mm) is 5 percent of this value. This example suggests that the probable error in many of the correction values in this study is only a few millimeters at most.

The measuring tapes used in this study were calibrated by the manufacturer. To verify this calibration and to assess measuring tape accuracy, the tape initially used for the water-level measurements at LLWMA-1 (between September 2005 and January 2007) was also calibrated by a standards laboratory and found to be accurate to within 0.001 m (1 mm) throughout its length. To reduce any variability that may be caused by use of different measuring tapes, all of the measurements collected for a site on a given day were collected using the same tape.

3.5 Automated Measurements

Automated water-level measurements were collected from the study area wells to allow for adjustments to the manual measurements for barometric pressure fluctuations (discussed in Section 3.6). Absolute pressure transducers were used for this purpose in accordance with the recommendations in *Comparison of Vented and Absolute Pressure Transducers for Water-Level Monitoring in Hanford Site Central Plateau Wells* (SGW-49700). Vented pressure transducers use a vent tube to supply atmospheric pressure to the transducer housing. Thus, the pressure returned by a vented transducer is gage pressure (i.e., total pressure less atmospheric pressure). However, this method of barometric compensation is not accurate if the air pressure inside the wellbore is not in equilibrium with atmospheric pressure. In SGW-49700, it was documented that vented pressure transducers installed in Central Plateau wells screened across the water table over-respond to barometric pressure fluctuations (i.e., the observed response in the pressure transducer readings to barometric pressure changes was greater than the actual water-level response in the wells). The cause was found to be air pressure differences between the wellbores and the atmosphere. This makes the data unusable for determining water-level response characteristics in the wells. Absolute pressure transducers are not subject to this problem because barometric compensation is achieved by direct measurement of the air pressure above the water surface in the well.

The absolute pressure transducers used were the Model 3001 Levelogger® Gold and Model 3001 Barologger™ Gold, both manufactured by Solinst, Inc.[7] These devices are a pressure transducer and data logger integrated into a single probe. The Levelogger is optimized to measure water pressure, while the Barologger is optimized to measure air pressure. The Levelogger had a range of 5 m (16.4 ft) of water (approximately 7.1 psi) above normal atmospheric pressure, and the Barologger had a range of 1.5 m (4.9 ft) of water (approximately 2.1 psi) above normal atmospheric pressure. Each installation consisted of a Levelogger submersed just below the water surface in the well and a Barologger in the air column just above the water surface. Barometric compensation was achieved by subtracting the Barologger readings from the Levelogger readings.

3.6 Barometric Pressure Fluctuations

Barometric pressure fluctuations affect the water level in a well. Under most conditions, the relationship is an inverse one: increases in barometric pressure cause a decline in the well water-level elevation, and vice versa (*Groundwater* [Freeze and Cherry, 1979]). A detailed explanation for why this occurs is provided in *Water-Level Barometric Response Analysis for the Liquid Effluent Retention Facility Monitoring Wells* (SGW-35756). A short summary is provided below.

Although hydraulic head is commonly used to determine groundwater flow, total head is the parameter that actually governs groundwater flow. The total head at a specific point of measurement within an unconfined aquifer is the sum of the hydraulic head (i.e., the pressure due to the water, plus the elevation of the point of measurement) and the atmospheric pressure in the pore space at the water table. At

[7] Levelogger® is a registered trademark and Barologger™ is a trademark of Solinst Canada Ltd., Georgetown, Ontario, Canada.

a specific measurement point within a well, the total head is the sum of the hydraulic head and atmospheric pressure at the water surface. At equilibrium, total head within a well equals total head in the aquifer adjacent to the well, and there is no flow of water across the well screen. Changes in atmospheric pressure are propagated instantaneously through the wellbore (if the well is open to the atmosphere), but there is a time lag before the pressure change propagates through the vadose zone to the water table. Thus, changes in barometric pressure result in an immediate change in total head within the well, but no immediate change in total head within the aquifer. This results in a total head imbalance between the well and the aquifer, and water moves through the well screen (i.e., the water level in the well changes) until an equilibrium is again established. Once the barometric pressure change propagates through the vadose zone to the water table, total head in the aquifer changes and the water level in the well returns to its initial position to maintain the equilibrium. By this mechanism, the water level in a well responds to changes in atmospheric pressure.

When hydraulic head is used to determine groundwater flow, the assumption is made that atmospheric pressure at the water table is the same everywhere in the study area. In that case, differences in hydraulic head are equal to differences in total head. However, this assumption is valid only if the vadose zone transmission properties are uniform throughout the study area ("Considering Barometric Pressure in Groundwater Flow Investigations" [Spane, 2002]). If not, water levels in wells will respond differently to changes in barometric pressure, which would affect the representativeness of hydraulic head as an indicator of groundwater flow.

3.6.1 Removal of Barometric Pressure Effects from Water-Level Measurements

Following the recommendation of Spane (2002) for low-gradient areas, barometric pressure effects were removed from the water-level measurements collected for this study. This yielded values for hydraulic head that would have occurred under constant barometric pressure conditions. These normalized hydraulic head values should be more representative of the long-term, average hydraulic gradient. In this study, the multiple regression/deconvolution method in "Identifying and Removing Barometric Pressure Effects in Confined and Unconfined Aquifers" (Rasmussen and Crawford, 1997) was used to remove barometric pressure effects from the manual measurements.

With multiple regression/deconvolution, the response of the well water level to a unit step change in barometric pressure (i.e., the response function[8]) is determined using multiple regression, and then barometric effects are removed from the water-level data by deconvolution. Detailed explanations of this method are provided in Rasmussen and Crawford (1997), Spane (2002), and SGW-35756. For this study, the multiple regression step to determine the response characteristics was performed using the MRCX software developed by Pacific Northwest National Laboratory (PNNL-19775, *Guide to Using Multiple Regression in Excel [MRCX v. 1.1] for Removal of River Stage Effects from Well Water Levels*),[9] and the deconvolution was accomplished in a separate spreadsheet. The following paragraphs describe this methodology along with the equations used.

To determine the barometric pressure/water-level response characteristics in the study area wells, absolute pressure transducers were installed in each well (see Section 3.5) for a period of one to several months to record a time series of well water-level elevations. The corresponding barometric pressure measurements

[8] Because barometric efficiency is defined as the ratio between the well water-level change and a barometric pressure change (in consistent units) and a barometric water-level response function gives the well water-level response to a unit step change in barometric pressure, the response function is essentially a plot of time-varying barometric efficiency.

[9] Although developed for river-stage effects, the MRCX software works equally well for barometric pressure effects because the mathematics are identical.

recorded at meteorology tower #6 in the 200 East Area were obtained from Pacific Northwest National Laboratory, and later from Mission Support Alliance, LLC. Barometric pressure measurements recorded at tower #21 in the 200 West Area were also obtained to fill in data gaps from tower #6 by interpolation. The measurements were reported as inches of mercury and were converted to meters of water (i.e., equivalent freshwater head) using a conversion factor of 0.345316 m H_2O/in Hg.

The water-level elevation and barometric pressure time series were detrended using linear regression, and then the quantitative relationship between the two data series was determined by multiple regression using MRCX. The regression was performed either using the "original data" or "first differences" options in the software, whichever yielded the best fit of predicted to actual water levels. The "original data" option corresponds to the following regression equation from Rasmussen and Crawford (1997):

$$h_O(t) = \beta_0 + \beta_1 t + \Delta u_0 B(t) + \Delta u_1 B(t-1) + \ldots + \Delta u_n B(t-n) \qquad \textbf{(Equation 3-1)}$$

where:

h_O = observed well water-level elevation (m) as a function of time t (hr)

β_0 = offset coefficient (m)

β_1 = linear trend coefficient (m/hr) (which was determined to be zero during the regression analysis because the data were detrended beforehand)

Δu_n = regression coefficients for time lags of 0 to n (m/m)

B = barometric pressure measurements (m of water) as a function of time

n = maximum time lag (hr)

The "first differences" option uses the same equation, except that changes in the water levels are related to changes in barometric pressure:

$$\Delta h_O(t) = \beta_0 + \beta_1 t + \Delta u_0 \Delta B(t) + \Delta u_1 \Delta B(t-1) + \ldots + \Delta u_n \Delta B(t-n) \qquad \textbf{(Equation 3-2)}$$

where:

Δh_O = change in observed well water-level elevation (m) between successive time steps

ΔB = change in barometric pressure (m of water) between successive time steps

When performing multiple regression in MRCX, the maximum time lag (n) was increased to a value at which a good fit was achieved between the predicted and measured water levels, and a further increase did not substantially improve the fit.

Using the coefficients in either Equation 3-1 or 3-2, an empirical response function of water-level change to a unit step change[10] in barometric pressure was determined using the following equation from Rasmussen and Crawford (1997):

$$u(\tau) = \sum_{i=0}^{\tau} \Delta u_i \qquad \textbf{(Equation 3-3)}$$

where:

u = water-level response to an instantaneous unit change in barometric pressure as a function of the time lag, τ (hr)

The net change in well water level in response to previous barometric pressure changes was then computed by applying the following numerical approximation of a convolution integral (modified from Rasmussen and Crawford, 1997):

$$\Delta h(t) = \sum_{\tau=0}^{n} u(\tau) \cdot \Delta B(t-\tau) \qquad \textbf{(Equation 3-4)}$$

where:

Δh = change in well water-level elevation (m) at some time t (hr) due to the cumulative effect of barometric pressure changes for the previous n timesteps

τ = time lag (hr) between an hourly barometric pressure change and the associated well water-level response

ΔB = change in barometric pressure (m of water) over successive hourly time steps

Finally, each hourly change in well water-level elevation (due to changes in barometric pressure) was added to the corresponding observed well water-level elevation (i.e., deconvolved) to produce a time series of adjusted well water-level elevations in which barometric pressure effects had been removed (i.e., the water-level measurements were normalized to a constant barometric pressure).

It should be noted that the equations presented in Rasmussen and Crawford (1997) are written in terms of total head (i.e., the sum of hydraulic head and barometric pressure head), whereas the equations presented in this section are in terms of hydraulic head (i.e., well water-level elevation). To normalize manual water-level measurements to a constant barometric pressure, well water-level response functions are needed instead of total head response functions. The use of well water-level elevations instead of total head is valid because convolution can be used on any pair of variables exhibiting a linear stress-response relationship ("Do a Bit More with Convolution" [Olsthoorn, 2008]).

3.6.2 Characteristic Barometric Water-Level Response Functions

The shape of a barometric water-level response function determined using Equation 3-3 can be used diagnostically to determine if an aquifer is confined or unconfined and to infer the presence of wellbore storage or skin effects (Rasumssen and Crawford, 1997; Spane, 2002). Each of these conditions imparts a characteristic shape on the response function, as shown in Figure 3-1. For an unconfined aquifer, a unit step change in barometric pressure ideally causes an instantaneous unit change in the well water level.

[10] A unit step change in a parameter is an instantaneous one unit change (increase or decrease) in its value after a long period of time in which the value was constant. The parameter is also assumed to be constant at the new value for a long period of time after the change.

For instance, a unit decrease in barometric pressure would cause a unit increase in well water level because of the time lag associated with the propagation of the pressure change through the vadose zone (see Section 3.6). Over time, as the air pressure at the water table equilibrates to the pressure change, the water in the well returns to its original level, causing the characteristic response function shape (decreasing with time) shown in Figure 3-1 for an unconfined aquifer.

The water level in a confined aquifer well responds differently to barometric pressure changes than in an unconfined aquifer well. A confined aquifer is under pressure due to the weight of the confining unit and all of the overlying materials, including the atmosphere. This is the total stress on the aquifer and it is borne partly by the aquifer matrix (i.e., the sediment grains) and partly by the aquifer water (which is why the water is under pressure). This division of total stress in a confined aquifer determines the barometric efficiency, which is the proportion of the total stress borne by the aquifer matrix. Thus, one minus the barometric efficiency is the proportion borne by the aquifer water (see discussion in SGW-35756).
A unit step change in barometric pressure is propagated instantaneously to the well water and it is also propagated instantaneously to the confined aquifer through the overlying soil matrix. However, the load on the aquifer water is different because some of the stress in the aquifer is carried by the aquifer matrix. Thus, to maintain the total head equilibrium between the well water and the aquifer water, the water level in a confined aquifer well changes in response to a unit step change in barometric pressure by an amount equal to the barometric efficiency (Figure 3-1). The water level would not return to its original level because the propagation of barometric pressure changes through the vadose zone does not alter the total stress on an underlying confined aquifer.

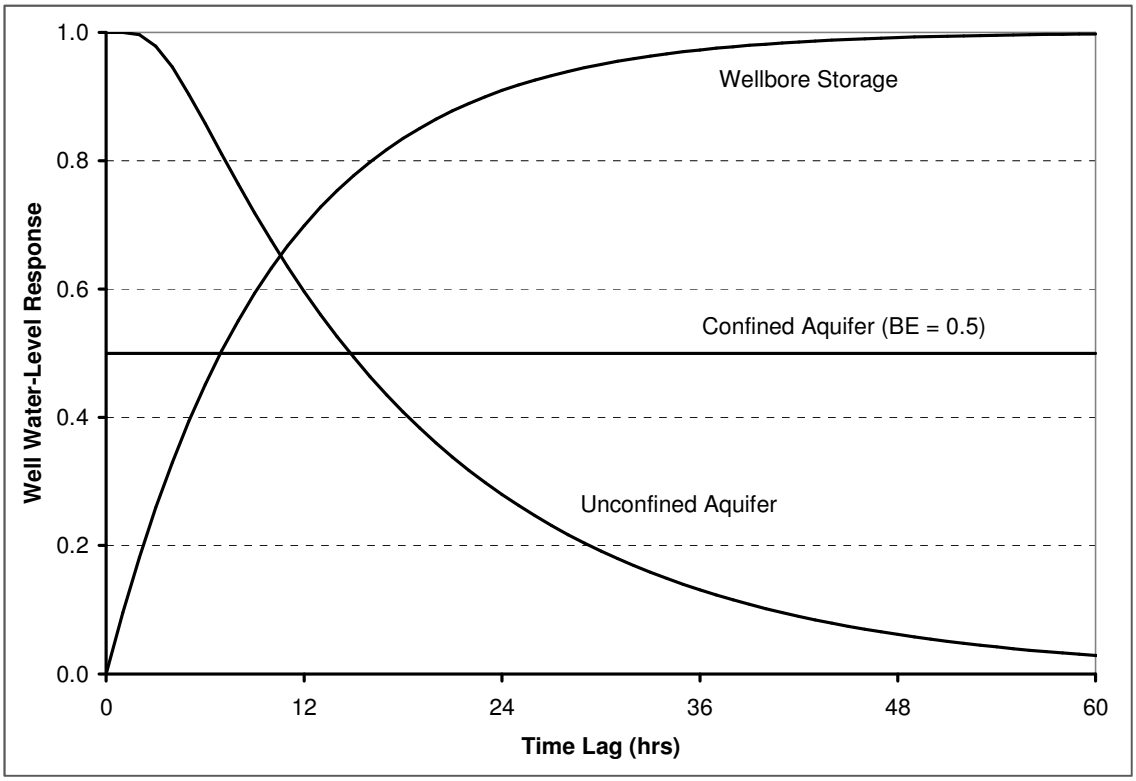

Figure 3-1. Characteristic Barometric Well Water-Level Response Functions

The response functions shown in Figure 3-1 for unconfined and confined aquifers assume that there is a good hydraulic connection between the wellbore and the aquifer so the well water level responds quickly to a total head imbalance between the well and the aquifer. If the well is subject to wellbore storage or skin effects, there will be a delay in the well water-level response, which is shown as a separate function in Figure 3-1. Note that this response function does not occur in isolation and is always superimposed on either the unconfined or confined response functions.

The characteristic response functions described above are best observed under ideal conditions, which consist of the following:

- The wellbore is fully open to the atmosphere, allowing the air inside the well to equilibrate instantaneously with atmospheric pressure changes.
- For a well within an unconfined aquifer, the screened interval is entirely below the water table (i.e., the screened interval does not include the lower vadose zone) so the wellbore is not a pathway for the movement of air between land surface and the deep vadose zone.

When these conditions are not met, barometric water-level response functions will deviate to some extent from their ideal characteristic shape.

The first condition above is rarely satisfied for Hanford Site wells. Most of the wells are equipped with a sampling pump at the end of a long discharge pipe, and the whole assembly is attached to a landing plate resting on the top of the well casing (Figure 3-2). There are normally one or two holes in the landing plate allowing access to the well (i.e., for measuring water levels), but the holes are small. Thus, the landing plate is a restriction on the free movement of air between the wellbore and the atmosphere. In addition, many of the well caps fit tightly around the casing, which further restricts air movement (Figure 3-3). The restriction of air movement results in a delayed water-level response, which has the same shape as the wellbore storage (or skin effects) response in Figure 3-1.

Figure 3-2. Sample Pump Landing Plate on a Typical Hanford Site Groundwater Monitoring Well

Figure 3-3. Typical Hanford Site Groundwater Monitoring Well with Well Cap in Place

The second condition above is also not normally satisfied for wells monitoring the water table. These wells typically have screened intervals that begin above the water table and extend to below the water table. The portion of the screen above the water table is open to the vadose zone. This allows for the movement of air between the land surface and the deep vadose zone without the air having to migrate through the full vadose zone thickness, at least in the vicinity of the wells. This causes empirically derived response functions for unconfined aquifer wells to peak at values much less than the ideal peak response of 1.0.

3.7 Data Analysis

The manual water-level measurements collected during this study were analyzed by trend-surface analysis, as described in *Statistics and Data Analysis in Geology* (Davis, 2002). A first-order, linear trend surface (i.e., a plane) was fitted to each set of water-level elevation measurements using least-squares regression. The slope of the fitted surface represented the hydraulic gradient magnitude, and the dip direction represented the hydraulic gradient direction. To determine if the fitted plane was representative of the hydraulic gradient, a statistical test was used to evaluate the goodness of fit of the plane to the water-level data. Both the trend-surface analysis and statistical test are described in the following subsections.

3.7.1 Trend-Surface Analysis

The following linear regression equation was used for the trend-surface analysis (from Davis, 2002):

$$z = b_0 + b_1 x + b_2 y \qquad \textbf{(Equation 3-5)}$$

where:

z = predicted water-level elevation (m NAVD88) at a location x,y, in which x is the easting geographic coordinate (m) and y is the northing geographic coordinate (m)

b_0 = offset (m)

b_1 = slope in the x direction (m/m)

b_2 = slope in the y direction (m/m)

Equation 3-5 can be rearranged as follows:

$$b_1 x + b_2 y - z + b_0 = 0 \qquad \textbf{(Equation 3-6)}$$

This equation has the same form as Equation 3-7:

$$Ax + By + Cz + D = 0 \qquad \textbf{(Equation 3-7)}$$

which is the familiar equation of a plane in standard form (where C = -1).

The least-squares regression for each set of water-level measurements was performed by solving the following matrix equation for the regression coefficients, b_0, b_1, and b_2 (from Davis, 2002):

$$\begin{bmatrix} k & \sum_{j=1}^{k} x_j & \sum_{j=1}^{k} y_j \\ \sum_{j=1}^{k} x_j & \sum_{j=1}^{k} x_j^2 & \sum_{j=1}^{k} x_j y_j \\ \sum_{j=1}^{k} y_j & \sum_{j=1}^{k} x_j y_j & \sum_{j=1}^{k} y_j^2 \end{bmatrix} \cdot \begin{bmatrix} b_0 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} \sum_{j=1}^{k} z_j \\ \sum_{j=1}^{k} x_j z_j \\ \sum_{j=1}^{k} y_j z_j \end{bmatrix} \qquad \textbf{(Equation 3-8)}$$

where:

k = number of wells

x_j = easting geographic coordinate of the jth well (m)

y_j = northing geographic coordinate of the jth well (m)

z_j = water-level elevation in the jth well (m NAVD88)

Equation 3-8 was solved in a spreadsheet modeled after the spreadsheet presented in "Spreadsheet Method of Estimating Best-Fit Hydraulic Gradients Using Head Data from Multiple Wells" (Devlin, 2003).

The hydraulic gradient magnitude is represented by the slope of the fitted plane. It follows from mathematics that vector $<A,B,C>$ is a normal vector to the plane (i.e., a vector perpendicular to the plane) in Equation 3-7; therefore, vector $<b_1,b_2,-1>$ is a normal vector to the plane represented in Equation 3-6. The slope of the fitted plane, which is the gradient magnitude, was calculated from the deviation of vector $<b_1,b_2,-1>$ from the vertical (i.e., its "tilt") using the Pythagorean theorem as follows:

$$i = \left(b_1^2 + b_2^2\right)^{1/2} \qquad \textbf{(Equation 3-9)}$$

Vector $<b_1,b_2,-1>$ begins at the origin of the coordinate system and points in the negative z direction (i.e., downward), because $c = -1$. Thus, the vector $<-b_1,-b_2,1>$ is also a normal vector to the fitted plane pointing in the positive z direction (i.e., upward). This vector can be projected onto the x,y plane by setting $c = 0$, and the direction of the resulting vector, $< -b_1, -b_2,0>$, is the direction of the hydraulic gradient. This direction was calculated from $-b_1$ and $-b_2$ using trigonometric functions.

Obvious outliers were excluded from the trend-surface analyses. Potential outliers in the hydraulic head measurements were identified using the interquartile range (IQR) approach described in *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance* (EPA 530/R-09-007). With this approach, the 25th and 75th percentiles of the residuals (i.e., the observed hydraulic head less the

predicted hydraulic head) are computed. The difference between these values is the IQR, and any residual less than the 25th percentile minus 1.5 times the IQR or greater than the 75th percentile plus 1.5 times the IQR was identified as a potential outlier. This method identifies potential outliers spatially (i.e., compared to the measurements collected in the other wells at the same time). However, potential outliers were removed from the analyses only if they were also temporal outliers (i.e., off-trend for that particular well) and no reason could be identified for the off-trend measurement (e.g., river-stage effects). Temporal outliers were identified by visual inspection of the well hydrographs.

Many of the hydraulic gradient results presented in this report are averages of several trend-surface analyses. Uncertainty in the results is given as a 90 percent confidence interval. Because a trend-surface result is a type of mean of the data, the average of several trend-surface results is a mean of means. In accordance with the central limits theorem of statistics, the standard error is used for the confidence interval calculation, rather than the standard deviation (Davis, 2002):

$$s_e = \sigma\sqrt{\frac{1}{n}} \qquad \textbf{(Equation 3-10)}$$

where:

s_e = standard error

σ = standard deviation of the trend-surface analyses results (either the magnitude or direction)

n = number of trend-surface analyses used to calculate the mean

The 90 percent confidence interval was calculated as 1.65 times the standard error.

3.7.2 Statistical Test

It is possible to use the equations presented in Section 3.7.1 to fit a plane to any set of x_j,y_j,z_j data, even random data, and calculate the slope and dip direction of the fitted plane. When applying these equations to water-level measurements, how can it be known that the results are representative of an actual trend in the measurements and not due to random error? In other words, how can it be known that the hydraulic gradient has been measured successfully? This question was answered by performing a statistical test.

In a statistical test, a null hypothesis and alternative hypothesis are established so if the null hypothesis can be shown to have a high probability of being false, then the alternative hypothesis will have a high probability of being true and, therefore, can be accepted as being true (Davis, 2002; *Understanding Statistics* [Ott and Mendenhall, 1985]). The test is designed so the null hypothesis will only be rejected and, thus, the alternative hypothesis will only be accepted, if the probability of obtaining the observed result or a result more contradictory to the null hypothesis, assuming the null hypothesis is true, is below some threshold value (i.e., it is presumed the null hypothesis is true unless it is shown otherwise to an acceptable level of confidence). In statistical testing, there is always a chance that the decision to reject or not reject the null hypothesis will be incorrect. A Type I error occurs when the null hypothesis is rejected when it is true (i.e., a false positive result), and a Type II error occurs when the null hypothesis is not rejected when it is false (i.e., a false negative result). The acceptable probability of committing a Type I error is denoted by α (alpha), and the probability of committing a Type II error is denoted by β (beta). The threshold value for rejecting or not rejecting the null hypothesis is α, and the probability of obtaining the observed result or a result more contradictory to the null hypothesis, assuming the null hypothesis is true, is referred to as the level of significance (denoted as the *p*-value). Thus, if the *p*-value is less than or equal to α, the null hypothesis will be rejected and the alternative hypothesis will be accepted. However, if the *p*-value is greater than α, it does not mean that the null hypothesis is true. Instead, it means that there is insufficient justification to reject the null hypothesis. To emphasize, a statistical test does not

choose between the null and alternative hypotheses; rather, it tests whether or not there is sufficient justification to accept the alternative hypothesis.

The statistical test for evaluating trend-surface analyses is known as analysis of variance (ANOVA). In this test, the variance (i.e., the variability) of the set of deviations of each measurement from a horizontal plane centered on the mean of the measurements is compared to the variance of the set of deviations of each measurement from the fitted plane. If the deviations from the fitted plane are much smaller than the deviations from the horizontal plane, it can be concluded that there is a linear trend in the data not explainable by random variability. Thus, the fitted plane would be deemed statistically significant.

A graphical depiction of an ANOVA statistical test for two-dimensional data is shown in Figure 3-4. Plots A and B show the same set of hypothetical measurements represented as x,y points. In plot A, the vertical lines show the deviation of each measurement from a horizontal line centered on the mean of the y values. Plot B shows the deviations of each measurement from a line fit to the measurements using least-squares regression. The variance of the deviations in plots A and B are nearly the same (i.e., they have a ratio of 1.04), which indicates that the variability of the measurements is not explained by a linear trend (i.e., there is no correlation between the x and y values). Plots C and D show another set of hypothetical measurements, along with the deviation of each measurement from a horizontal line centered on the mean of the y values (plot C) and the deviations from a best fit line (plot D). The variance of the deviations is much smaller for plot D than for plot C (i.e., they have a ratio of 22.0), indicating that much of the variability in the measurements is explained by a linear trend (i.e., there is a strong correlation between the x and y values). If the probability (i.e., the p-value) of obtaining the observed deviations in plot D (or another set of measurements with smaller deviations) by random sampling about a horizontal line is small (i.e., less than α), the fitted line in plot D would be considered statistically significant.

For the ANOVA analyses in this study, the specific null hypothesis was that both b_1 and b_2 in Equation 3-5 were equal to zero (i.e., the best fit plane is horizontal). The alternative hypothesis was that either b_1 was not equal to zero, b_2 was not equal to zero, or both b_1 and b_2 were not equal to zero (i.e., the best fit plane is distinguishable from a horizontal plane). To evaluate the null hypothesis, the ratio of the variance about the horizontal plane to the variance about the fitted plane was computed (this value is known as the test statistic), and then the probability of obtaining that ratio or a larger ratio when sampling from the same population (i.e., the p-value) was determined using the f probability distribution.[11] The acceptable probability of committing a Type I error (α) was chosen, a priori, to be 0.05 for this study. Thus, when the p-value for a given trend-surface analysis was less than or equal to 0.05, the null hypothesis (both coefficients are equal to zero) was rejected and the alternative hypothesis (one or both coefficients are nonzero) was accepted, and there was a 95 percent chance that this decision was correct. In other words, if the probability of obtaining the observed deviations about the fitted plane (or a set of smaller deviations) from a random sampling of deviations about a horizontal plane was less than or equal to 0.05, then there was high confidence that a spatial trend really exists in the water-level measurements and that the fitted trend-surface was representative of the hydraulic gradient.

[11] The f probability distribution is "…the theoretical distribution of values that would be expected by randomly sampling from a normal population and calculating, for all possible pairs of sample variances, the ratios…" of those variances (Davis, 2002).

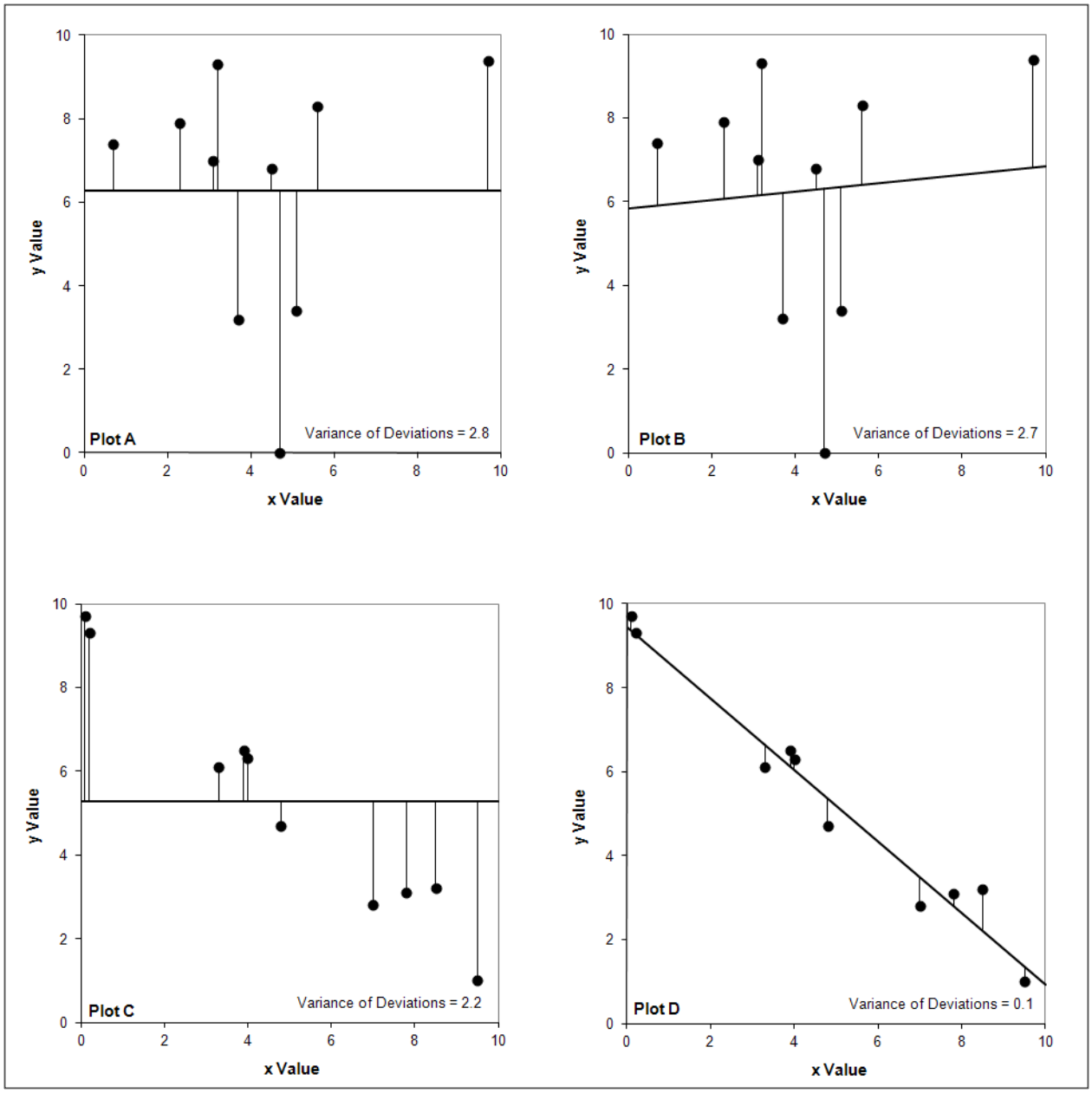

Figure 3-4. Analysis of Variance Demonstration — Hypothetical Linear Regression Results for Two-Dimensional Data without a Linear Trend (Plots A and B) and with a Linear Trend (Plots C and D)

The goodness of fit coefficient (R^2) was another statistic used in this study to ascertain whether the water-level measurements fit a plane. This statistic is the ratio of the sum of squares due to the regression (SS_R) to the total sum of squares (SS_T), as follows (Davis, 2002):

$$R^2 = \frac{SS_R}{SS_T} \qquad \textbf{(Equation 3-11)}$$

where the sum of squares due to the regression is given by:

$$SS_R = \sum_{j=1}^{k} (\hat{z}_j - Z)^2 \qquad \textbf{(Equation 3-12)}$$

and the total sum of squares is given by:

$$SS_T = \sum_{j=1}^{k} (z_j - Z)^2 \qquad \textbf{(Equation 3-13)}$$

where:

$\hat{z}_j$ = predicted water-level elevation for the jth well from the trend-surface regression equation

z_j = measured water-level elevation in the jth well (L)

Z = average water-level elevation in all k wells

If the measurements fit a plane closely, SS_R and SS_T will be approximately equal and their ratio, R^2, will be approximately unity. If the measurements do not fit a plane very well, the best fit plane will be nearly horizontal. In this case, SS_R will be small compared to SS_T and their ratio will be near zero. Thus, the more closely an R^2 value is to unity, the better the measurements fit a plane.

3.8 Determination of Water-Level Measurement Accuracy

The regression equation for the trend-surface analyses (Equation 3-5) provides the predicted value for hydraulic head at a given x,y location. Actual measurements of hydraulic head usually differ from the predicted value. Thus, the model representing the field measurements is:

$$z_j = b_0 + b_1 x_j + b_2 y_j + \varepsilon_j \qquad \textbf{(Equation 3-14)}$$

where:

ε_j = error term quantifying the difference between the predicted value of Equation 3-5 ($\hat{z}_j$) and the actual measured value (z_j) in the jth well

This difference is known as the residual, and it "takes into account all unpredictable and unknown factors" not included in the regression equation (Ott and Mendenhall, 1985). These factors consist of the experimental error (i.e., all of the variation inherent in the depth-to-water measurements and hydraulic head calculations) and error due to the regression model itself (i.e., deviations of the true water table from a plane). These two components are combined into a single error term and they cannot be separated (i.e., they are confounded) because we can never know the true hydraulic head values exactly (Davis, 2002).

The accuracy achieved in the water-level measurements was estimated for three of the four sites in this study. Because the experimental error and the regression model error are confounded, any estimate of measurement error must always involve an assumption regarding the true value being measured. The methods of determining the assumed true hydraulic head values for each site for which error estimates were made are discussed in Chapter 4.

A common assumption in statistics is that for multiple measurements of a physical parameter, the error term in Equation 3-14 is normally distributed with a mean of zero (Ott and Mendenhall, 1985). Thus, the standard deviation of the residuals is used to estimate measurement error as a confidence interval. For this study, estimates of the error in the hydraulic head measurements were made using a 90 percent confidence interval. This was calculated as follows:

$$\varepsilon = 1.65 \cdot \sigma \qquad \textbf{(Equation 3-15)}$$

where:

ε = error estimate (m)

σ = standard deviation (m) of all the differences between the measured hydraulic head and the assumed true hydraulic head for all of the measurements used in the error analysis

In addition to including the well verticality and casing elevation corrections, the error estimate (ε) was calculated after normalizing the hydraulic heads to a constant barometric pressure. This was done so variability caused by barometric effects would not be included as part of the error. Thus, the error estimate indicated the accuracy of the water-level elevation determinations in the wells (i.e., in terms of relative elevation between the wells). However, because measurement error is confounded with regression error, the error estimates in this study should be considered as upper bounds on the measurement error.

4 Results and Discussion

This chapter presents the results of this study. Each study site (i.e., LLWMA-1, IDF/PUREX Cribs, LLWMA-2, and LERF) is discussed in a separate section. The well network chosen for each site is described, and results of the well casing elevation resurveys, wellbore deviation surveys, barometric response analyses, and the trend-surface analyses are presented. This is followed by an estimation of the water-level measurement accuracy achieved at each site. To determine the relative importance of casing elevation surveys, wellbore verticality, and barometric pressure fluctuations on the results, these potential sources of variability were analyzed separately at LLWMA-1. For the remaining sites, only the effect of barometric pressure fluctuations was analyzed separately to obtain more information on the effect this source of variability had on the results.

4.1 Low-Level Waste Management Area 1

LLWMA-1 is a burial ground consisting of 19 unlined trenches located in the northwestern corner of the 200 East Area (DOE/RL-2009-75, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-1*). It began operating in 1955 and is used for the disposal of low-level radioactive waste and low-level mixed waste.

4.1.1 Monitoring Well Network

At LLWMA-1, a network of 10 wells was initially chosen for this study. The wells encompassed the burial grounds and adjacent areas to the north, east, and south (there were no available wells to the west) (Figure 4-1). These wells are referred to herein as the 10-well network. The goals for designing this network were to have a uniform spatial distribution of wells and to encompass a study area larger than LLWMA-1 itself. It was reasoned that a larger study area may have been necessary to discern water-level elevation differences between wells. To confirm the initial water-level results from the 10-well network, four additional wells were added to the network (two to the north and two to the south of LLWMA-1). The final network is referred to hereafter as the 14-well network (Figure 4-1).

Table 4-1 lists the construction details for the 14 wells used for LLWMA-1. Twelve of the 14 wells met the criterion of having saturated screened intervals less than 6.1 m (20 ft) in length. Two of the additional wells added to form the 14-well network, 299-E28-1 and 299-E28-17, had longer saturated screened intervals. These wells are located to the south of LLWMA-1, and there were no wells in this area that met the 6.1 m (20 ft) screen-length criterion at the time that the network was expanded. An examination of the borehole logs indicated that there were no mud units present within the screened intervals of wells 299-E28-1 and 299-E28-17 (as explained in Section 3.1, wells having mud units within the screened interval are more prone to vertical flow due to the potential for a head difference across the mud layer).

4.1.2 Casing Elevation Resurveys

Table 4-2 provides reference point (i.e., casing) elevations for the 14 wells used for LLWMA-1. This table shows the casing elevation values in use prior to the start of this study (the baseline surveys), the new casing elevation values determined for this study (see Appendix A for the survey data reports), and the difference between the two. The baseline surveys compare quite well to the new highly accurate surveys. The absolute value of the differences between the two surveys ranged from 0.002 m (2 mm) to 0.013 m (13 mm), with a median value of 0.005 m (5 mm). The upper portion of this range is similar to the water table elevation difference of approximately 0.016 m (16 mm) estimated to occur beneath LLWMA-1 (Chapter 1). Therefore, use of the new surveys was expected to improve the quality of the trend-surface analyses.

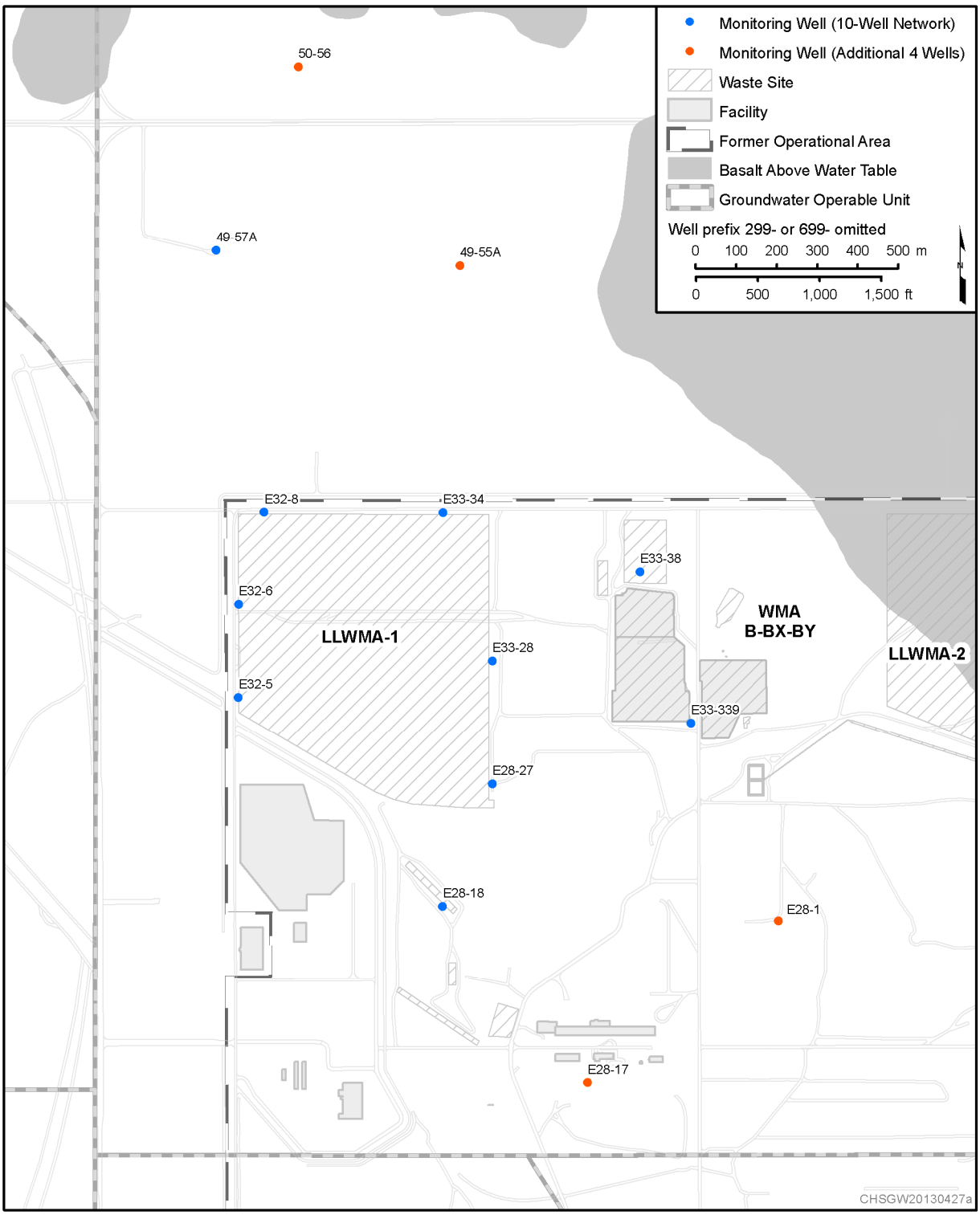

Figure 4-1. Water-Level Monitoring Well Network for LLWMA-1

Table 4-1. LLWMA-1 Water-Level Monitoring Well Network and Well Construction Details

Well Name	Screen Top (m bls)	Screen Bottom (m bls)	Water Level (m bls)*	Length of Saturated Screened Interval (m)
Original 10-Well Network				
299-E28-18	79.2	94.5	89.35	5.2
299-E28-27	82.2	88.3	85.88	2.4
299-E32-5	82.5	88.9	86.16	2.7
299-E32-6	77.6	83.9	81.45	2.5
299-E32-8	71.5	77.7	74.83	2.9
299-E33-28	77.9	84.0	81.13	2.9
299-E33-339	79.1	85.1	80.37	4.7
299-E33-34	66.8	72.9	71.30	1.6
299-E33-38	66.6	73.0	71.14	1.9
699-49-57A	43.9	51.2	47.02	4.2
Additional Wells Forming the 14-Well Network				
299-E28-1	84.4	98.8	87.35	11.5
299-E28-17	88.1	102.1	94.18	7.9
699-49-55A	38.1	41.1	40.13	1.0
699-50-56	46.1	49.1	46.40	2.7

* Measured on November 26, 2008.

Bls = below land surface

4.1.3 Gyroscope Surveys

The results of the wellbore deviation surveys for LLWMA-1 are shown in Table 4-3 (see Appendix B for the gyroscope survey reports). The values in Table 4-3 represent the difference between the measured depth to water and the true vertical depth to water (i.e., correction values). These values were determined by linear interpolation between depth stations measured by the gyroscope using the depth to water in the wells at the start of data collection in September 2005. Differences between the measured depth to water and the true vertical depth to water ranged from 0.000 to 0.168 m (168 mm), and the median difference was 0.014 m (14 mm). Six of the wells had correction values greater than the approximately 0.016 m (16 mm) water table elevation difference estimated to occur beneath LLWMA-1. Therefore, it was expected that wellbore deviation error would substantially affect the well water-level elevations and cause erroneous trend surface analysis results if this source of error was not accounted for.

Table 4-2. Reference Point Elevation Surveys for LLWMA-1 Wells

Well	Baseline Survey Date	Baseline Survey Source	Baseline Survey (m NAVD88)*	New Survey (m NAVD88)*	Difference (m)
Original 10-Well Network					
299-E28-18	7/15/1994	USACE(JECA)	212.111	212.104	-0.007
299-E28-27	1/15/1993	USACE(JECA)	208.473	208.463	-0.010
299-E32-5	1/14/1993	USACE(JECA)	209.013	209.005	-0.008
299-E32-6	9/24/1996	KEH	204.447	204.452	+0.005
299-E32-8	9/24/1996	KEH	197.790	197.795	+0.005
299-E33-28	9/24/1996	KEH	203.535	203.548	+0.013
299-E33-339	12/5/2001	Rogers Surveying	203.027	203.029	+0.002
299-E33-34	9/24/1996	KEH	194.133	194.141	+0.008
299-E33-38	9/24/1996	KEH	193.629	193.626	-0.003
699-49-57A	12/4/1992	USACE(JECA)	169.721	169.723	+0.002
Additional Wells Forming the 14-Well Network					
299-E28-1	5/12/1994	KEH	209.850	209.848	-0.002
299-E28-17	8/3/1994	USACE(JECA)	216.697	216.690	-0.007
699-49-55A	12/4/1992	USACE(JECA)	162.864	162.866	+0.002
699-50-56	2/26/2007	FGG	168.896	168.899	+0.003

* All elevations are for the top of the outermost casing.

FGG = Fluor Government Group
KEH = Kaiser Engineers Hanford
NAVD88 = *North American Vertical Datum of 1988*
USACE(JECA) = J.E. Chance and Associates for the U.S. Army Corps of Engineers

4.1.4 Barometric Response Analyses

Automated water-level measurements were collected from all 14 wells in the LLWMA-1 network using absolute pressure transducers. The data were analyzed to determine the characteristics of the well water-level responses to barometric pressure changes using the method described in Section 3.6. The barometric water-level response functions for all 14 wells are shown in Figures 4-2 through 4-5.

As expected, all of the wells in the LLWMA-1 network exhibited barometric water-level responses indicative of an unconfined aquifer. Most of the wells had peak response function values much less than the ideal value of 1.0. Ten of the 14 wells had peak response function values of approximately 0.1 or less, indicating that the water-level response in these wells will be no more than 10 percent of the barometric pressure change. As explained in Section 3.6.2, this is attributed to having a portion of the screened interval for each well open to the vadose zone above the water table.

Table 4-3. Wellbore Deviation Survey Results for the LLWMA-1 Well Network

Well	Correction Values*	
	(ft)	(m)
Original 10-Well Network		
299-E28-18	0.04	0.012
299-E28-27	0.12	0.037
299-E32-5	0.07	0.021
299-E32-6	0.05	0.015
299-E32-8	0.13	0.040
299-E33-28	0.02	0.006
299-E33-339	0.02	0.006
299-E33-34	0.02	0.006
299-E33-38	0.25	0.076
699-49-57A	0.00	0.000
Additional Wells Forming the 14-Well Network		
299-E28-1	0.03	0.009
299-E28-17	0.10	0.030
699-49-55A	0.03	0.009
699-50-56	0.55	0.168

* Difference between the measured depth to water and the true vertical depth to water.

A delayed water-level response to barometric pressure changes was noted for well 299-E33-28 (Figure 4-3) and wells 299-E33-38 and 699-49-55A (Figure 4-4). A slight delayed response may also have occurred at well 699-49-57A (Figure 4-5). It is not possible to determine if the delayed responses are due to wellbore storage/skin effects or to the restriction of air movement between the atmosphere and the wellbores (see discussion in Section 3.6.2).

4.1.4.1 Displacement Effect

The barometric water-level response functions for two of the wells, 299-E28-17 and 299-E28-18, had coefficients below zero during a portion of the response period (Figure 4-2). The response functions are derived with the sign convention that an inverse relationship exists between barometric pressure changes and well water-level elevations. Thus, a well water-level elevation decrease in response to a barometric pressure increase, and vice versa, manifests as a positive response (i.e., response function coefficients greater than zero). Therefore, coefficients less than zero indicate a direct (i.e., a non-inverse) correlation, such as an increase in barometric pressure resulting in a well water-level elevation increase instead of a decrease.

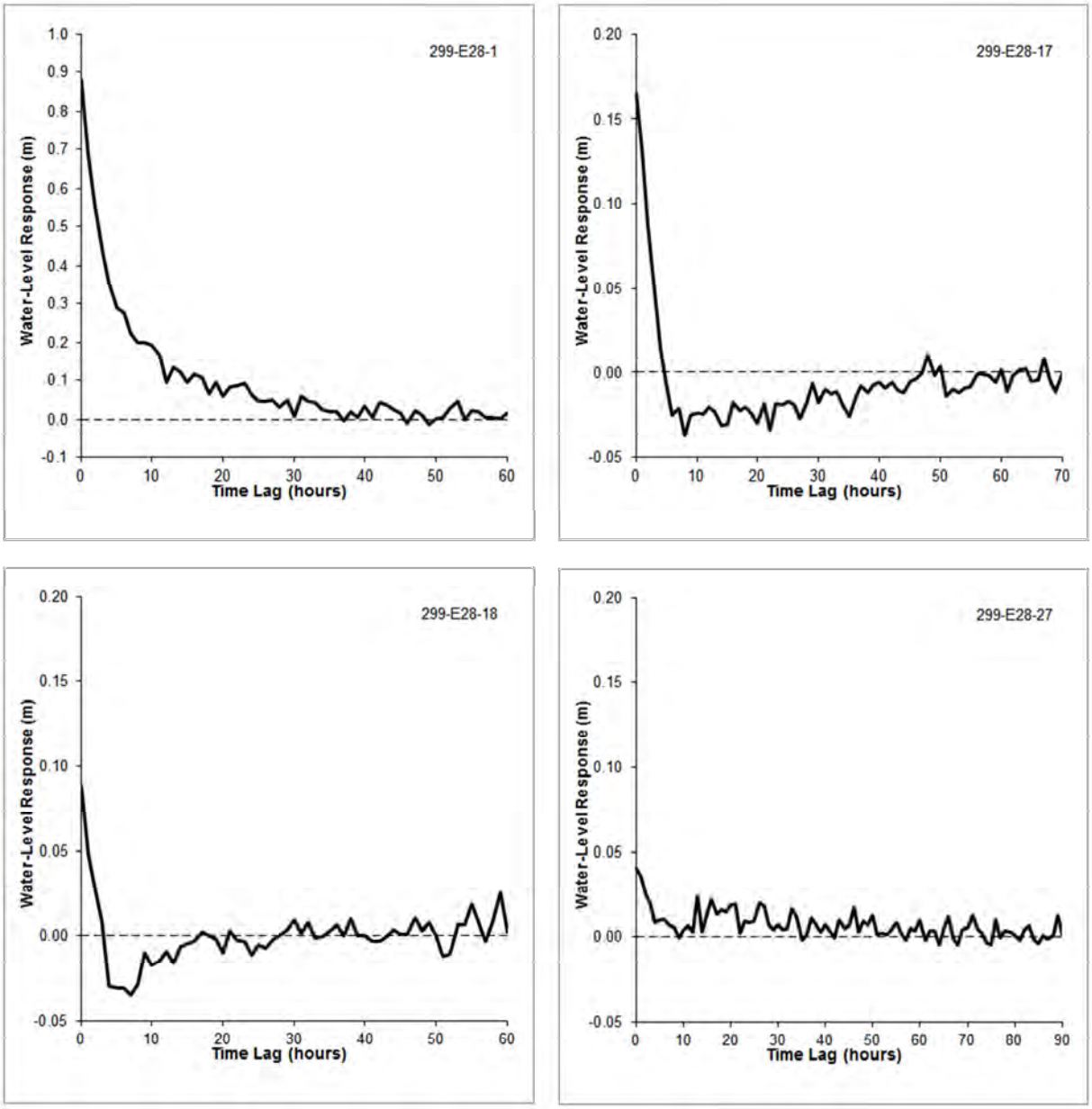

Figure 4-2. Barometric Water-Level Response Functions for Wells 299-E28-1, 299-E28-17, 299-E28-18, and 299-E28-27 (LLWMA-1)

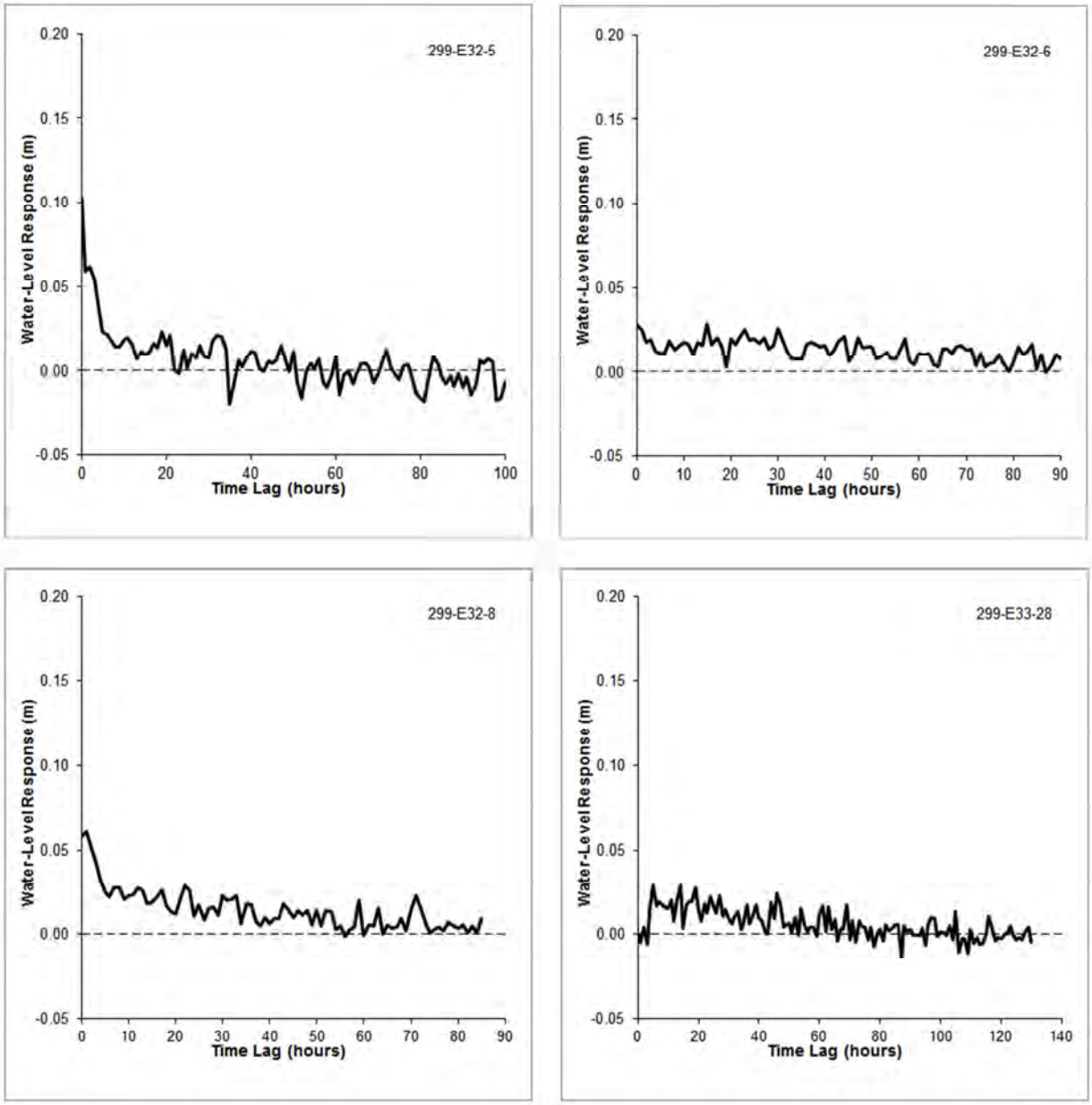

Figure 4-3. Barometric Water-Level Response Functions for Wells 299-E32-5, 299-E32-6, 299-E32-8, and 299-E33-28 (LLWMA-1)

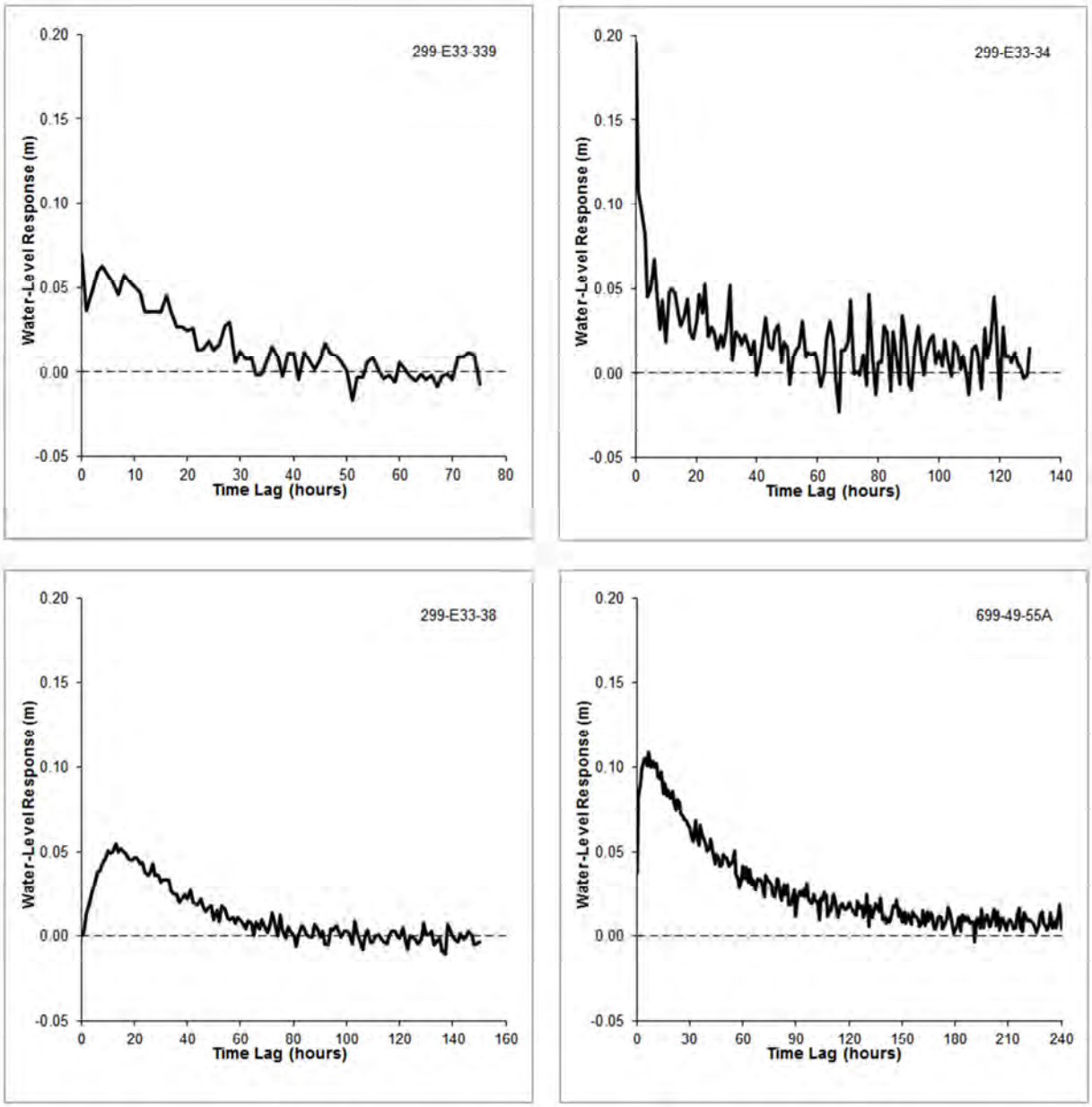

Figure 4-4. Barometric Water-Level Response Functions for Wells 299-E33-339, 299-E33-34, 299-E33-38, and 699-49-55A (LLWMA-1)

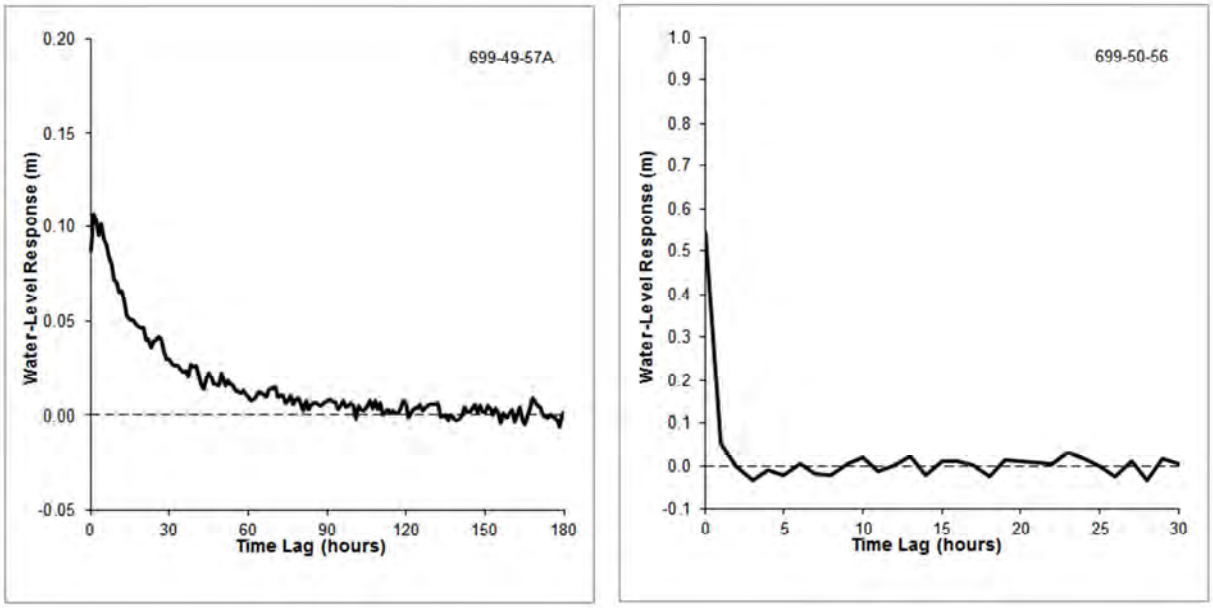

Figure 4-5. Barometric Water-Level Response Functions for Wells 699-49-57A and 699-50-56 (LLWMA-1)

The direct (i.e., non-inverse) correlation between well water-level elevations and barometric pressure changes is thought to be caused by lateral variations in vadose zone transmission properties in conjunction with a highly transmissive aquifer. In areas where the pneumatic diffusivity of the vadose zone is high (or the vadose zone thickness is small) so barometric pressure changes propagate quickly through the vadose zone, total head in the aquifer changes quickly. However, in areas where the pneumatic diffusivity is low (or the vadose zone thickness is large) so barometric pressure changes propagate slowly through the vadose zone, total head in the aquifer changes slowly. Thus, barometric pressure changes in the presence of lateral variations in vadose zone transmission properties cause lateral variations of total head in the aquifer. Because total head is the parameter that governs groundwater flow, water in a highly transmissive aquifer is temporarily displaced from areas of high total head into areas of low total head in order to maintain the total head equilibrium within the aquifer (i.e., a displacement effect). More simply, if the air pushes down on the water table in some areas and not in others, the water table will decrease where it is being pushed down and it will "pop up" where it is not being pushed down. Thus, in areas where the vadose zone pneumatic diffusivity is relatively low (or the vadose zone thickness is large), the water table elevation may temporarily increase in response to increases in barometric pressure. Once barometric pressure throughout the vadose zone equilibrates, the water table would return to its original position. This situation was described theoretically by Spane (2002) in terms of variations in groundwater flow direction caused by barometric pressure changes in combination with variable vadose zone properties. The data collected during the present study provides empirical evidence that this effect actually occurs. The displacement effect observed in wells 299-E28-17 and 299-E28-18 indicates that the vadose zone diffusivity in this area is relatively low compared to the remainder of the study area (the vadose zone thickness in these two wells is comparable to other nearby wells in the 200 East Area). This effect was observed in all of the wells at the IDF/PUREX study area, as discussed in Section 4.2.4.

4.1.4.2 Barometric Normalization of Water Levels

The manual water-level measurements for LLWMA-1 were normalized to a constant barometric pressure using deconvolution, as described in Section 3.6.1. The adjustment values (absolute values) across all of the wells and measurement dates for the 14-well network had a mean of 0.002 m (2 mm), a 90th percentile

of 0.005 m (5 mm), and a maximum of 0.032 m (32 mm). The adjustments for the set of measurements with the maximum single adjustment are shown in Table 4-4, which shows the observed hydraulic heads, the hydraulic heads normalized to a constant barometric pressure, and the difference for measurements collected on November 30, 2011. Well 299-E28-1 had a difference of 0.032 m (32 mm), but differences for the other wells were much less, ranging from no difference to 0.008 m (8 mm). The larger difference for well 299-E28-1 is consistent with this well having a much higher peak coefficient on its response function (approximately 0.9 [Figure 4-2]) compared to the other wells. The adjustments on this date reduced the range of the data by 0.004 m (4 mm).

Table 4-4. Example Comparison of Observed Hydraulic Heads and Hydraulic Heads Normalized to a Constant Barometric Pressure for LLWMA-1

Well	Observed Hydraulic Head (m)	Normalized Hydraulic Head (m)	Difference (m)
Original 10-Well Network			
299-E28-18	121.840	121.840	0.000
299-E28-27	121.835	121.836	+0.001
299-E32-5	121.841	121.841	0.000
299-E32-6	121.844	121.845	+0.001
299-E32-8	121.852	121.854	+0.002
299-E33-28	121.839	121.840	+0.001
299-E33-339	121.829	121.833	+0.004
299-E33-34	121.838	121.844	+0.006
299-E33-38	121.837	121.836	-0.001
699-49-57A	121.859	121.867	+0.008
Additional Wells Forming the 14-Well Network			
299-E28-1	121.794	121.826	+0.032
299-E28-17	121.798	121.801	+0.003
699-49-55A	121.859	121.866	+0.007
699-50-56	121.913	121.916	+0.003
Range (m)	**0.119**	**0.115**	

Note: Measurements were collected on November 30, 2011.

4.1.5 Trend-Surface Analyses

This section describes the trend-surface analyses performed for LLWMA-1. The results of the manual measurements from the 10-well network are discussed first, followed by the results from the 14-well network.

4.1.5.1 Trend-Surface Analysis Results for the 10-Well Network

Manual water-level measurements were periodically collected from the 10-well network between September 2005 and January 2007. To evaluate the effect that the casing elevation surveys and gyroscope

surveys had on reducing the error in the water-level measurements, four sets of well water-level elevations were calculated from this data: (1) a baseline set with no corrections, (2) a set using only the new casing elevation surveys, (3) a set using only the wellbore deviation corrections, and (4) a set with both corrections (see Appendix C for the water-level measurements and calculated well water-level elevations). Trend-surface analyses were performed on all four data sets.

The trend-surface analysis results on the baseline data (i.e., using the pre-existing well casing elevations and without correcting for wellbore deviation) are shown in Table 4-5. The results are very consistent. The range of the calculated well water-level elevations for each set of measurements was generally between 0.07 and 0.08 m (70 and 80 mm), the slope of the fitted planes ranged from 2.2×10^{-5} to 3.1×10^{-5} m/m, and the dip direction varied by only 7 degrees in a northeast direction. The highest goodness of fit value (R^2) was only 0.23, indicating that the data did not fit a plane very well. Further, the *p*-values were well above 0.05, ranging from 0.40 to 0.64. Thus, none of the trend surface results were statistically significant. This indicated that the baseline data were not useable for hydraulic gradient determinations.

Table 4-5. Trend-Surface Analysis Results for the Baseline Well Water-Level Elevations from the 10-Well Network at LLWMA-1 (Original Casing Elevation Surveys and No Corrections for Wellbore Deviation)

Measurement Date	Range (m)	Slope (m/m)	Dip Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
9/1/2005	0.071	2.2×10^{-5}	039	0.12	0.6292	No
9/12/2005	0.072	2.5×10^{-5}	039	0.15	0.5578	No
10/11/2005	0.073	2.8×10^{-5}	044	0.19	0.4703	No
10/25/2005	0.068	2.3×10^{-5}	043	0.14	0.5914	No
11/23/2005	0.074	2.5×10^{-5}	043	0.15	0.5729	No
12/29/2005	0.076	3.1×10^{-5}	045	0.23	0.3975	No
2/2/2006	0.071	2.8×10^{-5}	040	0.22	0.4255	No
3/8/2006	0.078	2.5×10^{-5}	041	0.14	0.5978	No
6/8/2006	0.073	2.9×10^{-5}	038	0.21	0.4420	No
1/25/2007	0.073	2.7×10^{-5}	041	0.16	0.6393	No
Averages	**0.073**	**2.6×10^{-5}**	**041**	**0.17**	**0.5324**	**N/A**

N/A = not applicable

Table 4-6 shows the trend-surface analysis results using the new casing elevation surveys to calculate the well water-level elevations, but still not correcting for wellbore deviation. The results were consistent and similar to the baseline results, except that the goodness of fit was even worse. The average range of the water-level elevations was the same as the baseline data, but the average slope decreased from 2.6×10^{-5} to 1.8×10^{-5} m/m. The average dip direction changed from 041 to 053 degrees azimuth, the goodness of fit (R^2) declined from 0.17 to 0.07, and the average *p*-value was substantially higher at 0.78. Therefore, ensuring that consistent and accurate well elevation surveys were used in calculating well water-level elevations, by itself, did not reduce the error enough to result in a valid hydraulic gradient determination.

Table 4-6. Trend-Surface Analysis Results for the 10-Well Network at LLWMA-1 (New Casing Elevation Surveys and No Corrections for Wellbore Deviation)

Measurement Date	Range (m)	Slope (m/m)	Dip Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
9/1/2005	0.076	1.4×10^{-5}	053	0.04	0.8673	No
9/12/2005	0.075	1.6×10^{-5}	051	0.05	0.8245	No
10/11/2005	0.070	2.0×10^{-5}	056	0.08	0.7328	No
10/25/2005	0.073	1.5×10^{-5}	058	0.05	0.8369	No
11/23/2005	0.075	1.7×10^{-5}	056	0.06	0.8130	No
12/29/2005	0.073	2.3×10^{-5}	056	0.12	0.6518	No
2/2/2006	0.070	2.0×10^{-5}	050	0.09	0.7238	No
3/8/2006	0.077	1.6×10^{-5}	053	0.05	0.8294	No
6/8/2006	0.072	2.0×10^{-5}	047	0.08	0.7376	No
1/25/2007	0.073	2.0×10^{-5}	052	0.09	0.7910	No
Averages	**0.073**	**1.8×10^{-5}**	**053**	**0.07**	**0.7808**	**N/A**

N/A = not applicable

Table 4-7 shows the trend-surface analysis results after applying the wellbore deviation corrections but using the baseline casing elevation surveys. Inclusion of the wellbore deviation corrections significantly improved the quality of the results. The average goodness of fit was 0.56, substantially higher than the previous results, and the average *p*-value was 0.06, substantially lower than the previous results. The highest *p*-value was only 0.11, and 4 of the 10 trend-surface analyses were statistically significant at the 95 percent confidence level (i.e., four of the *p*-values were less than 0.05). The average range of the calculated water-level elevations was 0.027 m (27 mm), substantially lower than the 0.073 m (73 mm) average for the baseline trend-surface analyses (Table 4-5). The average slope was 1.7×10^{-5} m/m, and the average dip direction was due north at 001 degrees azimuth.

The substantial improvement in the trend-surface analysis results when applying the wellbore deviation corrections, as compared to only applying the new casing elevation surveys, indicates that wellbore deviation was the most important source of error in the manual water-level measurements collected at LLWMA-1. This is also evident by the reduction in the range of the calculated water-level elevations from 0.073 to 0.027 m (73 to 27 mm), a decline of 0.046 m (46 mm). Thus, the total of all remaining sources of error in the water-level measurements cannot exceed 0.027 m (27 mm).

Table 4-7. Trend-Surface Analysis Results for the 10-Well Network at LLWMA-1 (Baseline Casing Elevation Surveys and Corrections for Wellbore Deviation)

Measurement Date	Range (m)	Slope (m/m)	Dip Direction (azimuth)	Goodness of Fit (R^2)	p-Value	Statistically Significant?
9/1/2005	0.026	1.4×10^{-5}	350	0.47	0.1079	No
9/12/2005	0.026	1.6×10^{-5}	357	0.59	0.0450	Yes
10/11/2005	0.025	1.7×10^{-5}	009	0.56	0.0563	No
10/25/2005	0.023	1.4×10^{-5}	357	0.52	0.0785	No
11/23/2005	0.026	1.6×10^{-5}	002	0.54	0.0670	No
12/29/2005	0.028	2.0×10^{-5}	016	0.55	0.0621	No
2/2/2006	0.029	1.9×10^{-5}	005	0.62	0.0339	Yes
3/8/2006	0.033	1.6×10^{-5}	359	0.47	0.1087	No
6/8/2006	0.031	1.9×10^{-5}	003	0.63	0.0316	Yes
1/25/2007	0.023	1.4×10^{-5}	356	0.70	0.0494	Yes
Averages	**0.027**	**1.7×10^{-5}**	**001**	**0.56**	**0.0640**	**N/A**

N/A = not applicable

Table 4-8 shows the trend-surface analysis results for the 10-well network using the resurveyed casing elevations and correcting for borehole deviation. This improved the results even more. The range of the calculated water-level elevations declined to 0.017 m (17 mm), compared to 0.027 m (27 mm) resulting from use of the wellbore deviation corrections alone. The average goodness of fit (R^2) increased from 0.56 to 0.69, and the average p-value declined from 0.06 to 0.02. Eight of the 10 trend-surface results were statistically significant at the 95 percent confidence level. The highest p-value was 0.07, indicating that all 10 trend-surface results would have been statistically significant at the 90 percent confidence level. The dip direction of the fitted planes ranged from 312 degrees (northwest) to 013 degrees (north-northeast), with an average value of 339 (±9) degrees (north-northwest). The slope of the fitted planes ranged from 6.4×10^{-6} to 1.0×10^{-5} m/m, with an average value of 8.3×10^{-6} ($\pm 0.7 \times 10^{-6}$) m/m.

Table 4-9 shows the trend-surface analysis results for the 10-well network with all corrections applied: using the resurveyed casing elevations, correcting for wellbore deviation, and normalizing all of the measurements to a constant barometric pressure. The addition of correcting for barometric pressure resulted in only a slight change to the results. The range and goodness of fit remained the same at 0.017 m (17 mm) and 0.69, respectively, and the average p-value increased slightly from 0.02 to 0.03. Nine of the 10 trend-surface results were statistically significant compared to 8 of the 10 without the barometric corrections. The average slope changed from 8.3×10^{-6} m/m to 8.0×10^{-6} m/m, and the average dip direction changed from 339 to 343 degrees azimuth. The main effect of normalizing the measurements to a constant barometric pressure was to reduce the uncertainty in the direction results slightly, from ±9 degrees to ±5 degrees.

Table 4-8. Trend-Surface Analysis Results for the 10-Well Network at LLWMA-1 (New Casing Elevation Surveys and Corrections for Wellbore Deviation)

Measurement Date	Range (m)	Slope (m/m)	Dip Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
9/1/2005	0.018	7.7×10^{-6}	312	0.67	0.0202	Yes
9/12/2005	0.018	8.2×10^{-6}	329	0.69	0.0174	Yes
10/11/2005	0.016	8.0×10^{-6}	356	0.78	0.0047	Yes
10/25/2005	0.016	6.4×10^{-6}	320	0.55	0.0599	No
11/23/2005	0.015	6.9×10^{-6}	336	0.69	0.0168	Yes
12/29/2005	0.017	1.0×10^{-5}	013	0.70	0.0143	Yes
2/2/2006	0.019	9.7×10^{-6}	350	0.72	0.0109	Yes
3/8/2006	0.018	7.8×10^{-6}	332	0.53	0.0703	No
6/8/2006	0.022	1.0×10^{-5}	347	0.74	0.0085	Yes
1/25/2007	0.014	7.3×10^{-6}	336	0.81	0.0149	Yes
Averages	**0.017**	**8.3×10^{-6} ($\pm 0.7 \times 10^{-6}$)**	**339 (±9)**	**0.69**	**0.0240**	**N/A**

N/A = not applicable

Table 4-9. Final Trend-Surface Analysis Results for the 10-Well Network at LLWMA-1 (All Corrections Applied and Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)	Gradient Magnitude (m/m)	Gradient Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
9/1/2005	0.018	8.6×10^{-6}	332	0.76	0.0068	Yes
9/12/2005	0.017	7.5×10^{-6}	323	0.67	0.0212	Yes
10/11/2005	0.014	7.2×10^{-6}	356	0.78	0.0051	Yes
10/25/2005	0.017	7.9×10^{-6}	339	0.65	0.0260	Yes
11/23/2005	0.017	8.5×10^{-6}	348	0.79	0.0042	Yes
12/29/2005	0.010	4.9×10^{-6}	353	0.40	0.1718	No
2/2/2006	0.014	6.5×10^{-6}	341	0.62	0.0330	Yes
3/8/2006	0.021	1.1×10^{-5}	348	0.70	0.0147	Yes
6/8/2006	0.020	1.0×10^{-5}	344	0.80	0.0038	Yes
1/25/2007	0.017	8.7×10^{-6}	348	0.76	0.0269	Yes
Averages	**0.017**	**8.0×10^{-6} ($\pm 0.9 \times 10^{-6}$)**	**343 (±5)**	**0.69**	**0.0314**	**N/A**

N/A = not applicable

The results in Table 4-9 represent the best determination of the long-term, average hydraulic gradient for LLWMA-1 between September 2005 and January 2007 based on the 10-well network. The hydraulic gradient was 8.0×10^{-6} ($\pm 0.9 \times 10^{-6}$) m/m toward the north-northwest (343 [±5] degrees azimuth). Figure 4-6 shows a vector diagram of the trend-surface analyses during this time.

4.1.5.2 Trend-Surface Analysis Results for the 14-Well Network

The sensitivity of the trend-surface analysis results in Table 4-9 (10-well network) to any particular well was assessed by removing each well in turn from the data set and repeating the trend-surface analyses. One well was found to have a substantial effect on the results: 699-49-57A, the most northern well in the 10-well network. The trend-surface analysis results when excluding this well from the analyses are shown in Table 4-10. While the average dip direction of 336 degrees was not substantially different from the average of 343 degrees with all 10 wells, none of the results were statistically significant. Well 699-49-57A, the most northerly well in the 10-well network (Figure 4-1), consistently had a lower water-level elevation than any other well in the network. Further, wells on the south or east sides of the study area, 299-E28-18 and 299-E33-339 (Figure 4-1), consistently had the highest water-level elevations during this study. While these conditions are expected if the hydraulic gradient was actually toward north-northwest, it did mean that the trend-surface results were dependent on measurements from a few wells.

To confirm that the water table elevation was lower in the north part of the study area and higher in the south and/or east part, four additional wells were added to the network in 2008: 699-49-55A and 699-50-56 to the north, and 299-E28-17 and 299-E28-1 to the south. The four additional wells are listed in Table 4-1 and are shown in Figure 4-1. Casing elevation surveys and wellbore deviation surveys were performed for the additional wells in the same manner as for the original 10 wells. The results of these surveys are shown in Tables 4-2 and 4-3.

Monthly water-level measurements were collected from the 14-well network beginning in June 2008, and the trend-surface analysis results are shown in Table 4-11 (all corrections were applied for casing elevation resurveys, gyroscope surveys, and barometric normalization). Although the results for June 2008 were not statistically significant, the *p*-value was reasonably low at 0.1321. Further, the hydraulic gradient was 5.9×10^{-6} m/m with a direction of 309 degrees, in reasonable agreement with the average values of 8.0×10^{-6} m/m and 343 degrees for the 10-well network. Thus, it was concluded that the June 2008 measurements were consistent with the results of the 10-well network.

The final trend-surface analysis results for the 10-well and 14-well networks combined are shown in Figure 4-7. The hydraulic gradient at LLWMA-1 changed after June 2008. The July 2008 results were far from being statistically significant (a goodness of fit [R^2] of 0.01 and a *p*-value of 0.96), whereas the results for the following 2 months, August and September 2008, were statistically significant and indicated a hydraulic gradient direction toward the south (Table 4-11). Thus, the groundwater flow direction changed from north to south between June and August 2008. This flow reversal was temporary because from October 2008 through June 2011, the hydraulic gradient at LLWMA-1 was indeterminate with only 3 of the 23 data sets yielding a statistically significant trend-surface result. During this time, groundwater flow was interpreted to be nearly stagnant, although the trend-surface results suggest a very slow change in the hydraulic gradient back toward the north (Figure 4-7).

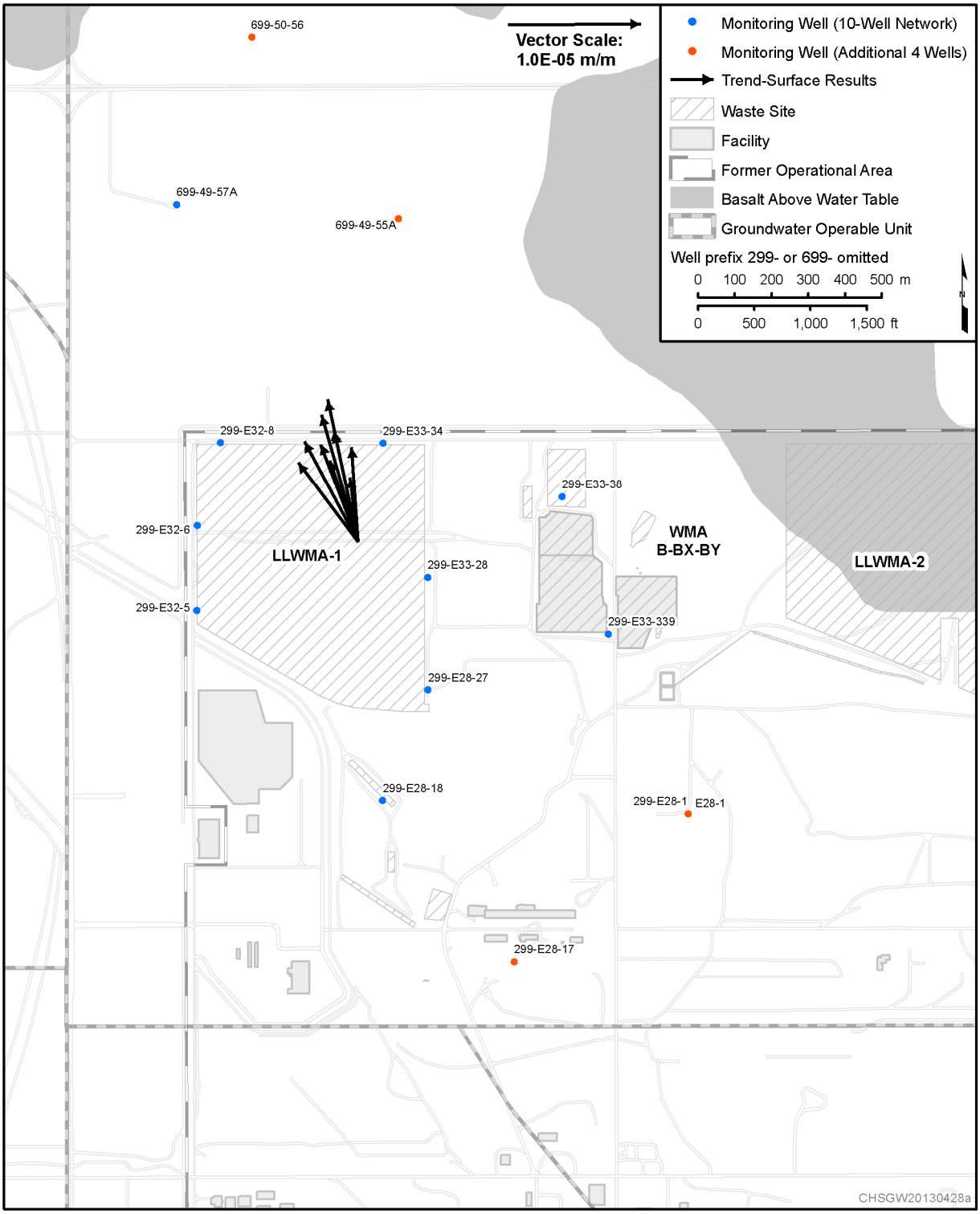

Figure 4-6. Hydraulic Gradient Determinations (Vectors) from September 2005 to January 2007 for LLWMA-1 (10-Well Network)

Table 4-10. Trend-Surface Analysis Results for the 10-Well Network, Excluding Well 699-49-57A (All Corrections Applied and Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)	Slope (m/m)	Dip Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
9/1/2005	0.010	6.0×10^{-6}	324	0.51	0.1159	No
9/12/2005	0.010	4.5×10^{-6}	303	0.39	0.2303	No
10/11/2005	0.007	4.8×10^{-6}	359	0.52	0.1093	No
10/25/2005	0.007	2.6×10^{-6}	318	0.27	0.3869	No
11/23/2005	0.009	5.7×10^{-6}	348	0.54	0.0967	No
12/29/2005	0.010	4.1×10^{-6}	354	0.17	0.5699	No
2/2/2006	0.005	2.1×10^{-6}	321	0.21	0.4989	No
3/8/2006	0.017	1.1×10^{-5}	348	0.55	0.0917	No
6/8/2006	0.008	5.9×10^{-6}	340	0.59	0.0695	No
1/25/2007	0.010	5.8×10^{-6}	347	0.48	0.2690	No
Averages	**0.009**	$\mathbf{5.3 \times 10^{-6}}$	**336**	**0.42**	**0.2438**	**N/A**

N/A = not applicable

Table 4-11. Final Trend-Surface Analysis Results for the 14-Well Network at LLWMA-1 (All Corrections Applied and Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)*	Gradient Magnitude (m/m)	Gradient Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
6/16/2008	0.031	5.9×10^{-6}	309	0.31	0.1321	No
7/21/2008	0.025	1.3×10^{-6}	264	0.01	0.9673	No
8/29/2008	0.028	9.1×10^{-6}	187	0.68	0.0018	Yes
9/11/2008	0.037	1.0×10^{-5}	180	0.69	0.0017	Yes
10/23/2008	0.021	5.9×10^{-6}	218	0.27	0.1803	No
11/26/2008	0.053	1.6×10^{-5}	237	0.24	0.2152	No
12/23/2008	0.036	7.7×10^{-6}	210	0.25	0.2794	No
1/12/2009	0.032	4.1×10^{-6}	219	0.06	0.7099	No
2/23/2009	0.027	7.5×10^{-6}	263	0.18	0.3812	No
3/24/2009	0.030	2.5×10^{-6}	224	0.03	0.8659	No
4/13/2009	0.030	4.8×10^{-6}	289	0.14	0.4408	No
5/28/2009	0.052	1.1×10^{-5}	300	0.30	0.1720	No
7/17/2009	0.079	1.9×10^{-5}	326	0.54	0.0198	Yes

Table 4-11. Final Trend-Surface Analysis Results for the 14-Well Network at LLWMA-1 (All Corrections Applied and Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)*	Gradient Magnitude (m/m)	Gradient Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
9/21/2009	0.032	5.6×10^{-6}	262	0.06	0.7241	No
10/27/2009	0.030	1.2×10^{-6}	176	0.01	0.9437	No
11/12/2009	0.035	3.5×10^{-6}	276	0.04	0.7905	No
1/21/2010	0.049	1.2×10^{-5}	258	0.14	0.4252	No
5/23/2010	0.057	7.6×10^{-6}	318	0.16	0.3782	No
6/30/2010	0.071	1.6×10^{-5}	348	0.41	0.0693	No
7/13/2010	0.077	1.2×10^{-5}	312	0.21	0.3140	No
9/15/2010	0.035	6.7×10^{-6}	338	0.31	0.1524	No
1/4/2011	0.060	1.1×10^{-5}	358	0.26	0.1841	No
2/11/2011	0.050	1.1×10^{-5}	339	0.48	0.0288	Yes
3/21/2011	0.044	8.1×10^{-6}	311	0.29	0.1573	No
4/25/2011	0.030	7.3×10^{-6}	326	0.49	0.0362	Yes
5/25/2011	0.015	4.7×10^{-6}	18	0.29	0.2147	No
6/20/2011	0.022	3.3×10^{-6}	191	0.16	0.4179	No
7/14/2011	0.036	1.2×10^{-5}	192	0.51	0.0278	Yes
8/15/2011	0.065	2.1×10^{-5}	161	0.79	0.0045	Yes
8/29/2011	0.085	2.7×10^{-5}	176	0.86	0.0001	Yes
11/30/2011	0.115	3.2×10^{-5}	171	0.83	0.0001	Yes
12/29/2011	0.074	2.6×10^{-5}	172	0.77	0.0006	Yes
1/25/2012	0.085	2.6×10^{-5}	144	0.68	0.0056	Yes
2/28/2012	0.060	2.0×10^{-5}	196	0.61	0.0056	Yes
4/18/2012	0.045	1.4×10^{-5}	172	0.79	0.0020	Yes
5/15/2012	0.046	1.6×10^{-5}	188	0.80	0.0003	Yes
6/14/2012	0.051	2.0×10^{-5}	200	0.82	0.0001	Yes
7/24/2012	0.094	3.0×10^{-5}	177	0.88	0.0000	Yes
8/16/2012	0.113	3.2×10^{-5}	151	0.75	0.0005	Yes
9/12/2012	0.139	4.5×10^{-5}	174	0.80	0.0007	Yes

Table 4-11. Final Trend-Surface Analysis Results for the 14-Well Network at LLWMA-1 (All Corrections Applied and Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)*	Gradient Magnitude (m/m)	Gradient Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
Averages for 7/14/2011 through 9/12/2012	0.078	2.5×10^{-5} ($\pm 0.4 \times 10^{-5}$)	175 (±8)	0.76	0.0037	N/A

* Range of hydraulic head (with all corrections applied); outliers excluded.

N/A = not applicable

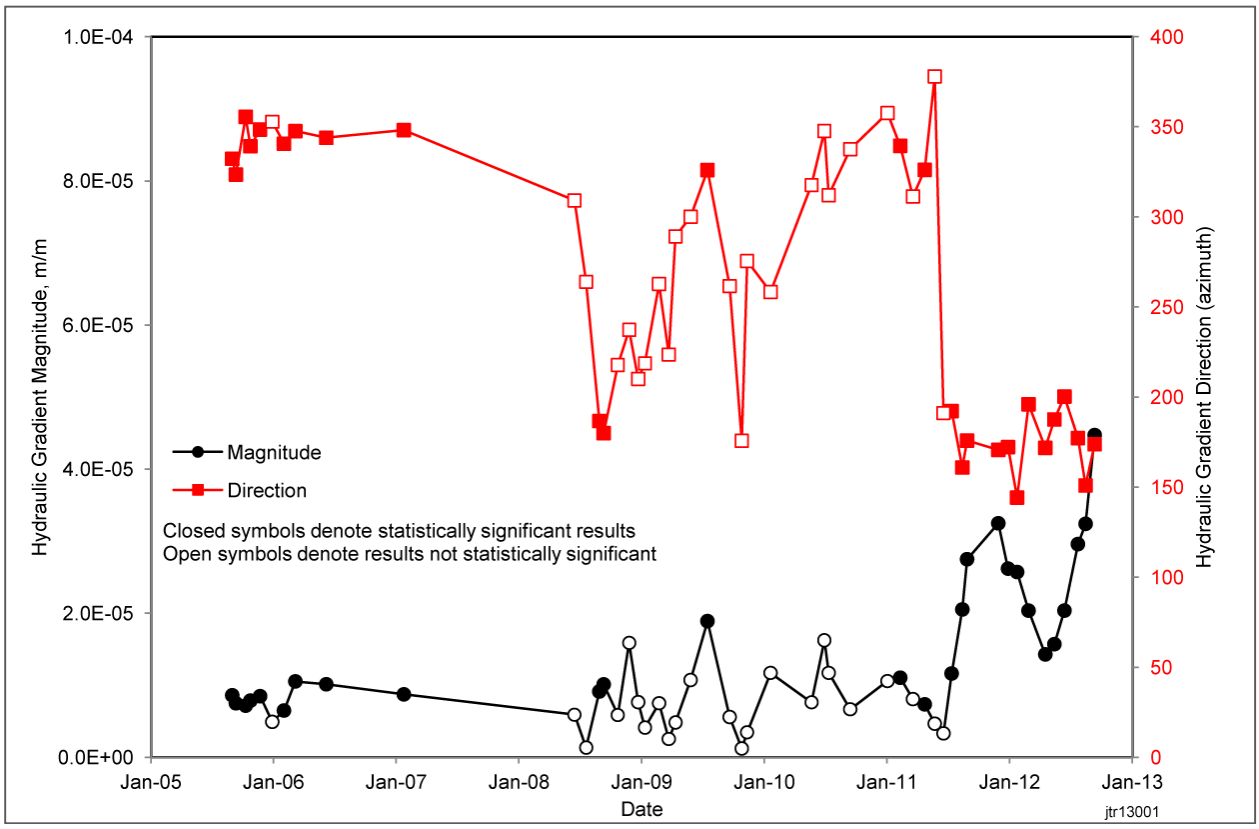

Figure 4-7. Hydraulic Gradient Determinations (Graph) for LLWMA-1

Beginning in the summer of 2011, the hydraulic gradient direction reversed again and remained toward the south through the end of the study period (September 2012).[12] Also during this time, the magnitude of the gradient increased and exhibited a seasonal fluctuation, being the highest in the fall and the lowest in the spring and early summer. All of the trend-surface analyses since July 2011 have been statistically significant. The mean hydraulic gradient from July 2011 to September 2012 was 2.5×10^{-5} ($\pm 0.4 \times 10^{-5}$) m/m toward the south (175 [±8] degrees azimuth).[13] The results since July 2011 are shown as a vector diagram in Figure 4-8.

As stated in Section 2.2, a characteristic of highly transmissive aquifers is that stressors to the aquifer can have effects at large distances from the source of the stress. Discharges to the TEDF (located 3 km [1.9 mi] east of the 200 East Area) are known to affect the water table beneath the 200 East Area, and it has been hypothesized that higher than normal stage in the Columbia River also affects the 200 East Area water table (see Appendix D). Because each of these stressors is located in a different direction from LLWMA-1, their effect on the hydraulic gradient at LLWMA-1 is different.

The effect of increased discharges from the TEDF propagates toward LLWMA-1 from the southeast, causing the hydraulic gradient direction to tend toward the northwest. The effects of high Columbia River stages propagate toward LLWMA-1 from the north through the highly transmissive paleochannel (see Figure 2-4), which would cause the hydraulic gradient direction to tend toward the south.

Monthly discharge volumes for the TEDF since January 2005 are shown in Figure 4-9. The discharges are episodic in nature. Months with large-volume discharges occur between periods of relatively low discharge volumes. The large-volume discharges are due to periodic operation of the 242-A evaporator.[14] The evaporator has not operated since September 2010, so there have been no large-volume discharges since that time. Thus, from shortly after September 2010 to the end of the study period, the TEDF has had no effect on the 200 East Area water table.

Monthly average discharges in the Columbia River since January 2005 are shown in Figure 4-10 (discharge is a surrogate for stage in that the higher the discharge, the higher the stage). During this period, discharge was highest during the summers of 2011 and 2012, and it was during 2011 that the latest flow reversal at LLWMA-1 began. Thus, it is concluded that the reversal in groundwater flow at LLWMA-1 was caused by higher than normal Columbia River stage during 2011 and 2012 in conjunction with the lack of large volume discharges to the TEDF.

The increased magnitude of the hydraulic gradient during the flow reversal allowed for a water table map to be prepared, which is shown in Figure 4-11 (generated by kriging) for the measurements collected on August 29, 2011 (corrected for sources of variability, as described in the preceding sections). The contour interval used was 0.006 m (6 mm). The map shows that the magnitude of the hydraulic gradient is larger to the north of LLWMA-1 than directly beneath LLWMA-1. This is consistent with a change in transmissivity as the aquifer thickness increases to the south. The trend-surface analysis for this data yielded a hydraulic gradient direction of 176 degrees (south) (Table 4-11), but this represents a spatial average across the entire study area. The water table map indicates that the hydraulic gradient directly beneath LLWMA-1 is more toward the southeast.

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[12] As of June 2013, the hydraulic gradient direction at LLWMA-1 was still toward the south.

[13] The average results for July 2011 through September 2012, without normalizing the measurements to a constant barometric pressure, was a magnitude of 2.6×10^{-5} ($\pm 0.4 \times 10^{-5}$) m/m with a direction of 172 (±11) degrees. Thus, the same as for the 10-well network, the main effect of normalizing to a constant barometric pressure was to reduce the uncertainty in the direction result only slightly (from ±11 degrees to ±8 degrees).

[14] The 242-A evaporator is a facility that reduces the volume of liquid waste by concentration allowing for more efficient use of space in underground storage tanks.

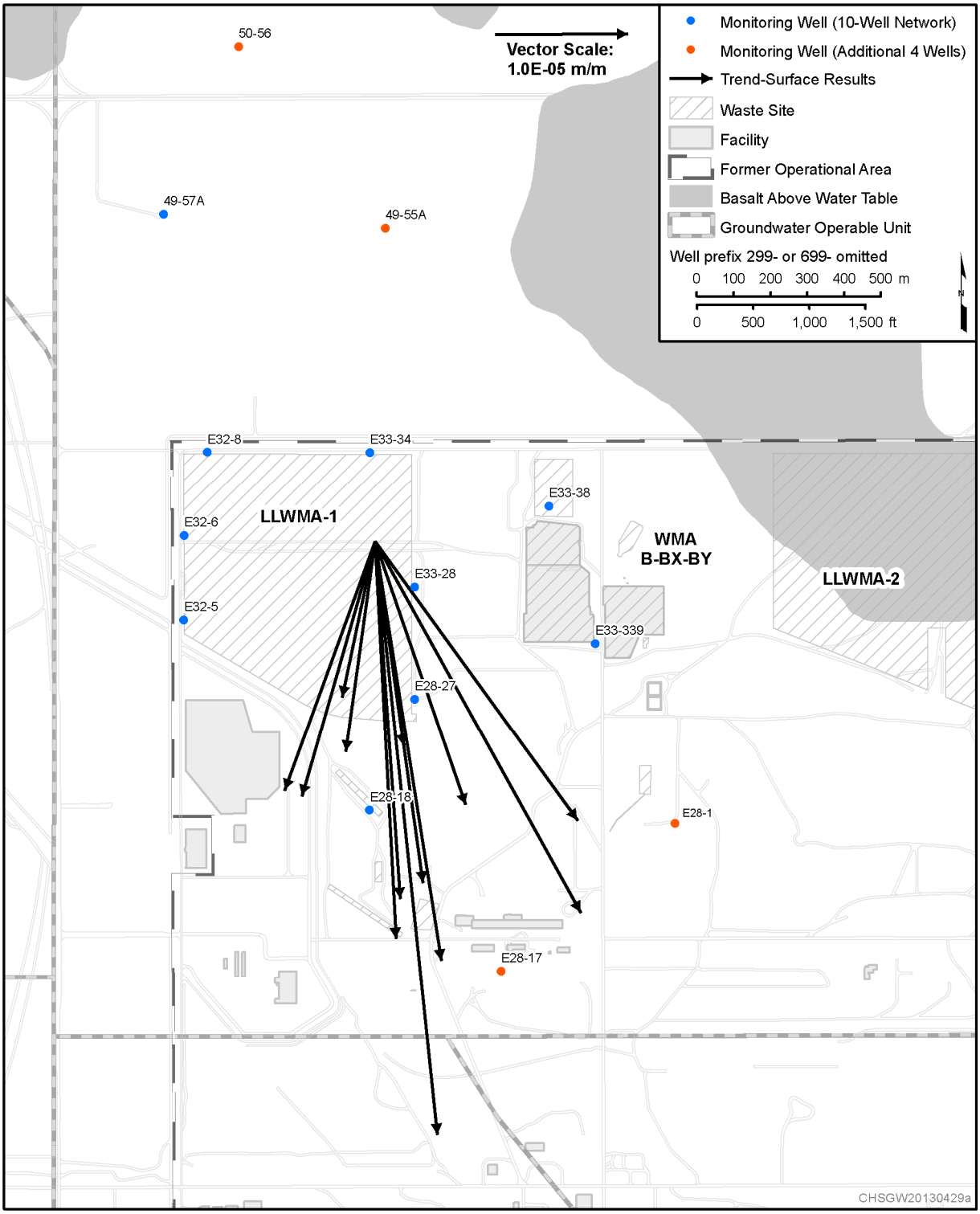


Figure 4-8. Hydraulic Gradient Determinations (Vectors) from July 2011 to September 2012 for LLWMA-1 (14-Well Network)

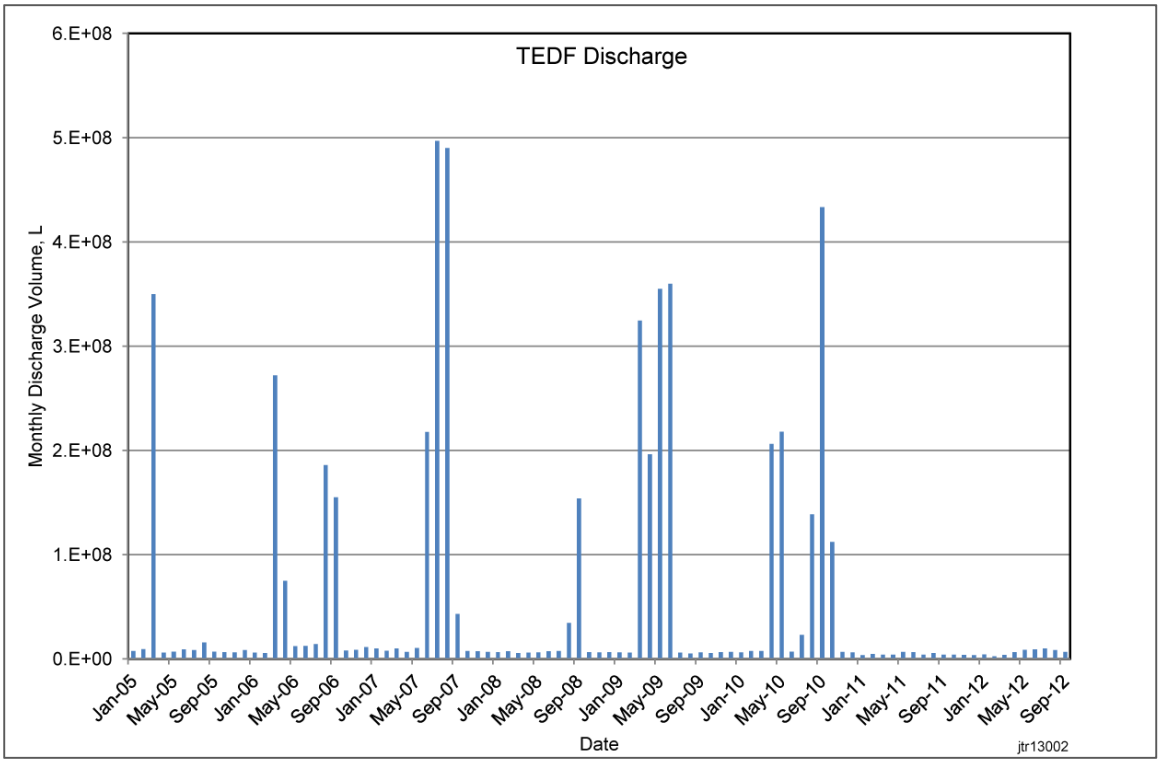
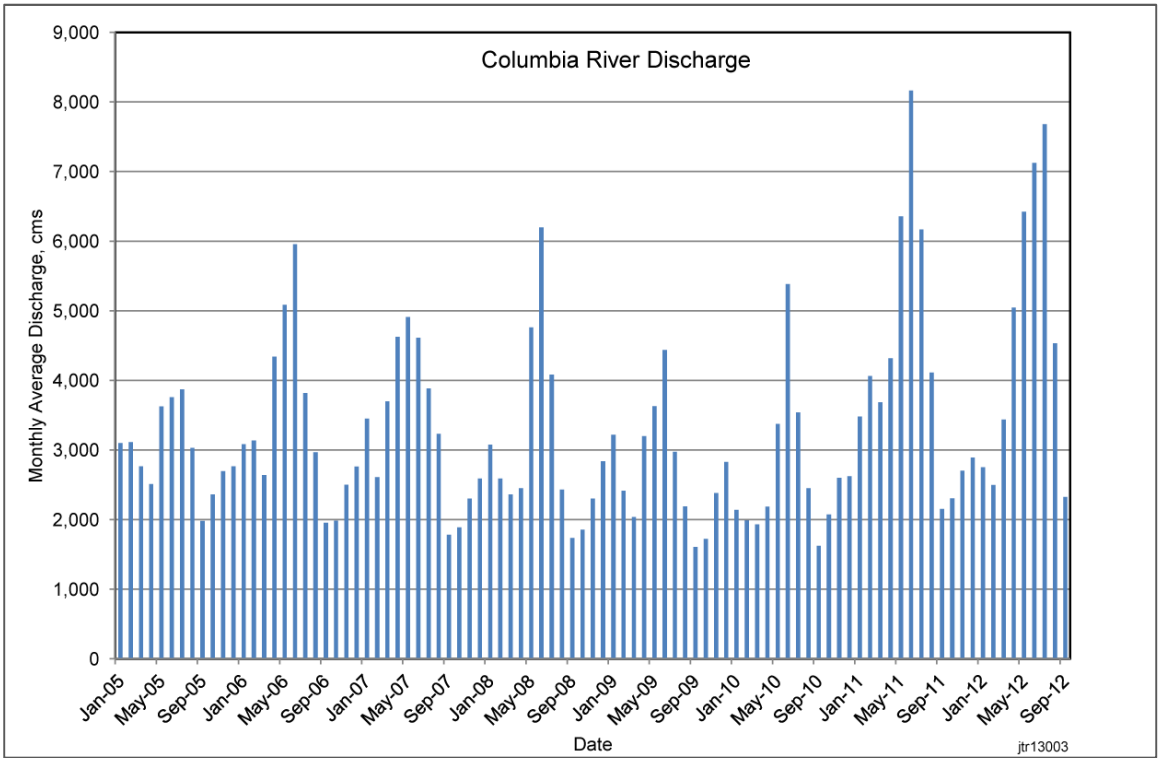


Figure 4-9. Monthly Discharge Volumes for the TEDF



Note: The location for these measurements was the U.S. Geological Survey Station 12472800.

Figure 4-10. Monthly Average Discharge in the Columbia River Below Priest Rapids Dam

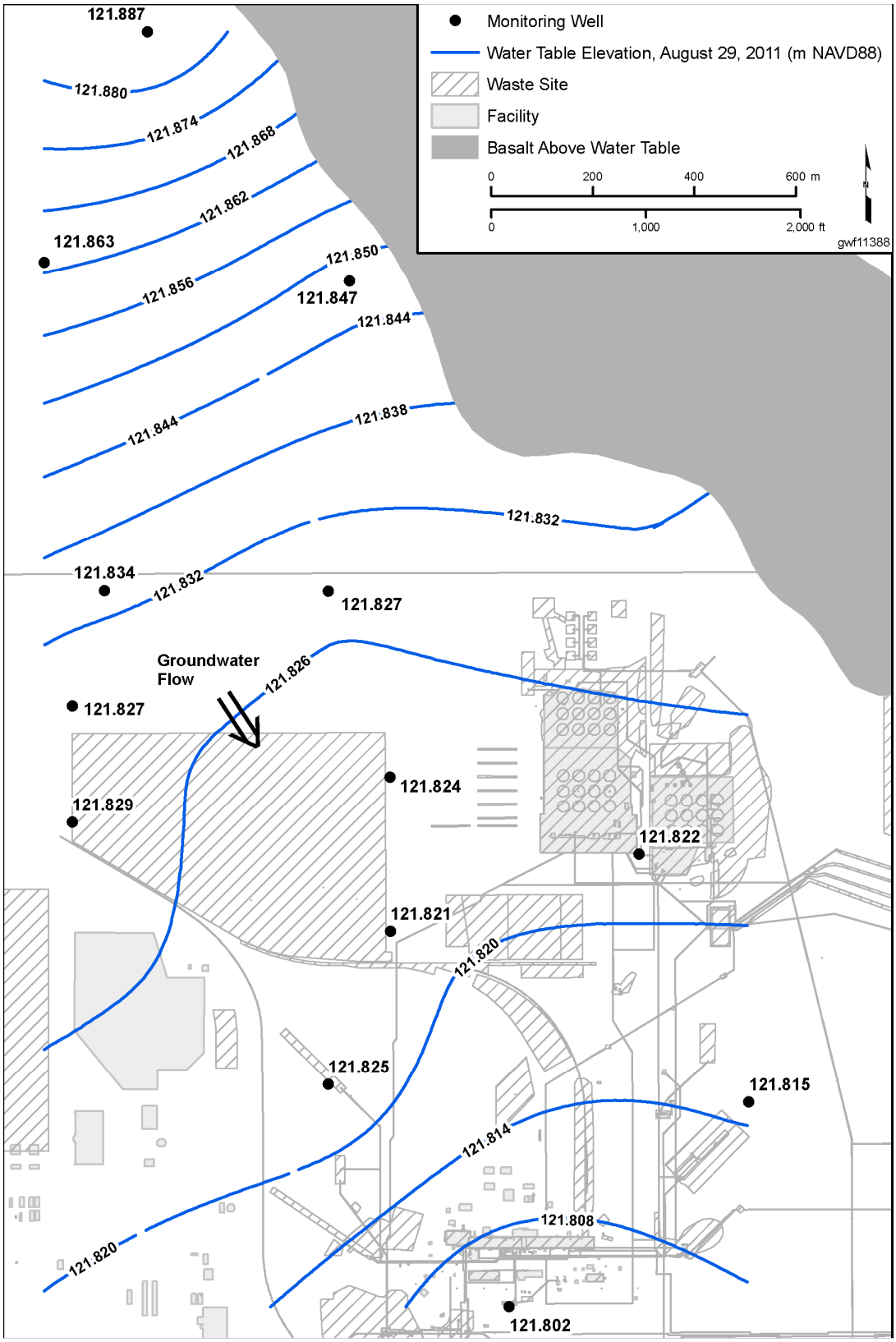


Figure 4-11. Water Table Map for LLWMA-1 and Vicinity, August 2011

4.1.6 Water-Level Trends

The manual water-level measurements collected for this study at LLWMA-1, with all corrections applied and the data normalized to a constant barometric pressure, are plotted in Figures 4-12 through 4-15. Overall, water levels declined by approximately 0.3 m (1 ft) between 2005 and 2012. This decline is a result of the substantial reduction of effluent discharges to the Hanford Site soil column in the mid-1990s. The water table elevation temporarily increased during 2009. This fluctuation was attributed to large-volume effluent discharges to the TEDF (Figure 4-9; DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009*). Similar large-volume discharges to the TEDF during 2010 caused the water table elevation to be relatively stable during 2010 (instead of declining). The water table increased during the latter half of 2011 and again during the latter half of 2012. As stated previously, there were no large volume TEDF discharges during this time (Figure 4-9), but discharge (and stage) in the Columbia River was higher than normal during the summers of 2011 and 2012 (Figure 4-10). Thus, increased Columbia River stage is the cause of the water table fluctuations in 2011 and 2012.

The magnitude of the water-level fluctuations in the wells provides further evidence that discharges to the TEDF caused the fluctuation in 2009 and increased Columbia River stage caused the fluctuation in 2011. The magnitude of the fluctuations will be larger in those wells located closer to the source of the stressor. The southern wells at LLWMA-1 are closer to the TEDF than the northern wells. In southern well 299-E28-1, the fluctuation in 2009 was about 0.06 m (6 cm) (Figure 4-12), whereas in the most northern well, 699-50-56, the fluctuation was only about 0.03 m (3 cm) (Figure 4-15). The situation was reversed when considering the 2011 fluctuation. Well 699-50-56 exhibited a water-level increase of 0.12 m (12 cm), whereas well 299-E28-1 exhibited an increase of only 0.02 m (2 cm). This observation is consistent with the source of the 2011 fluctuation, the Columbia River, occurring to the north.

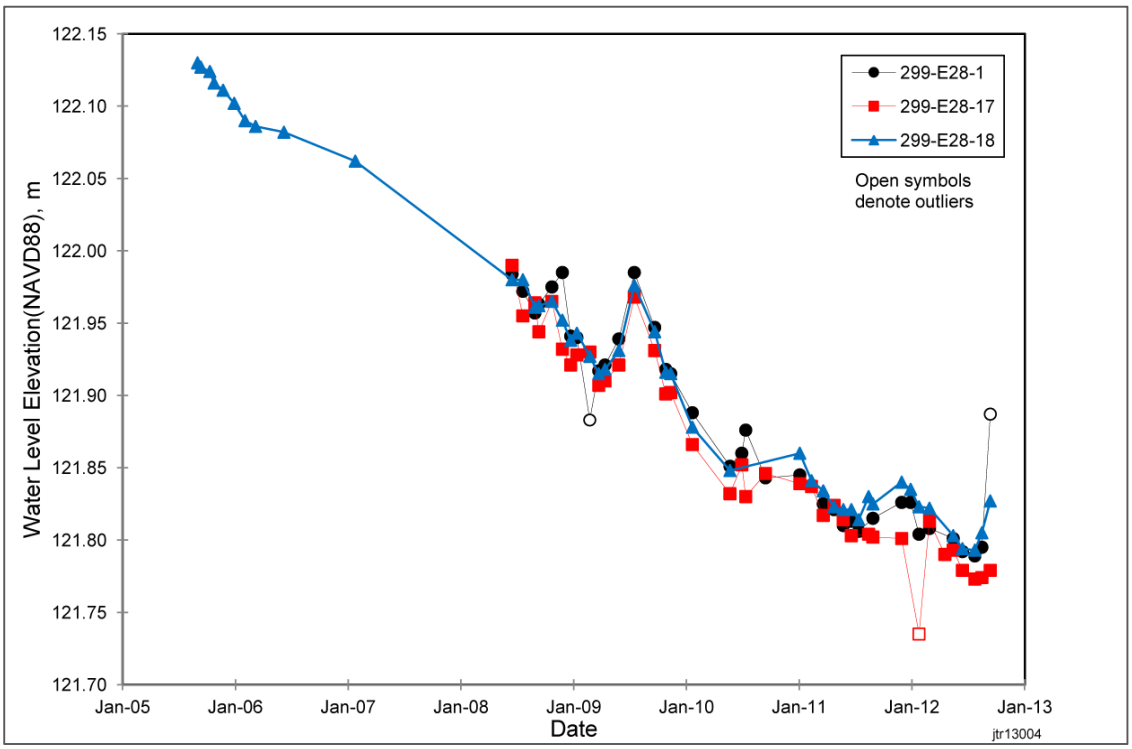


Figure 4-12. Hydrograph of Manual Water-Level Measurements for Wells 299-E28-1, 299-E28-17, and 299-E28-18 South of LLWMA-1

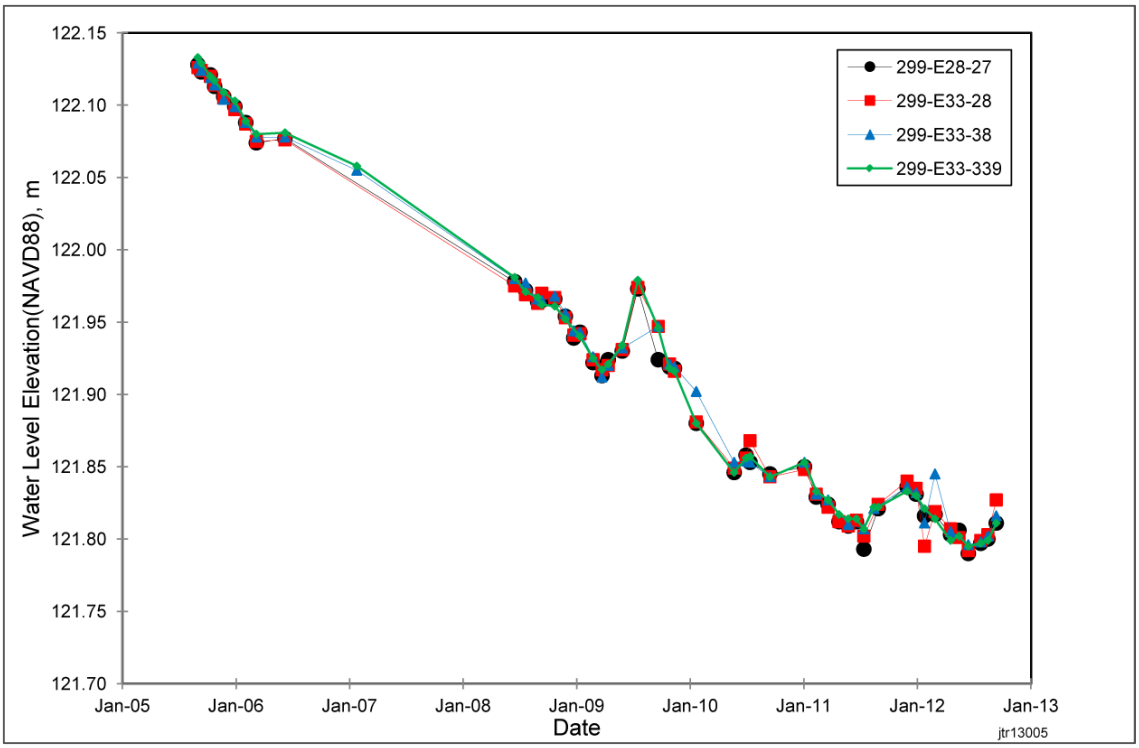


Figure 4-13. Hydrograph of Manual Water-Level Measurements for Wells 299-E28-27, 299-E33-28, 299-E33-38, and 299-E33-339 on the East Side of LLWMA-1

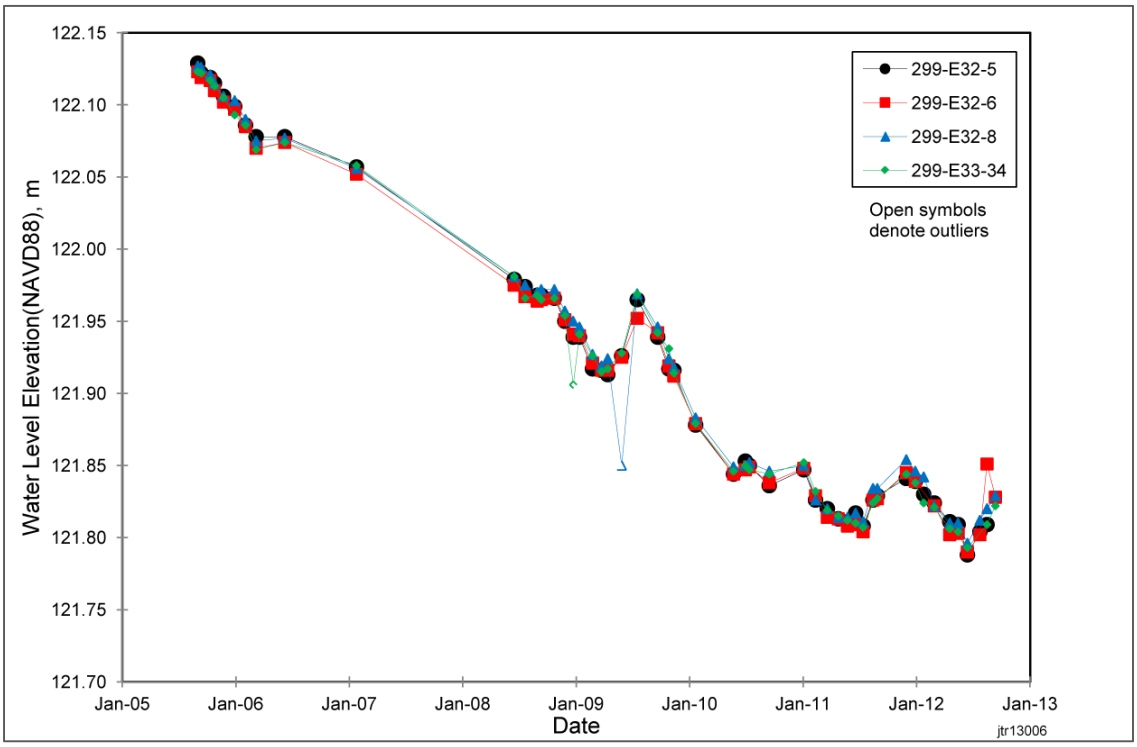


Figure 4-14. Hydrograph of Manual Water-Level Measurements for Wells 299-E32-5, 299-E32-6, 299-E32-8, and 299-E33-34 on the West and North Sides of LLWMA-1

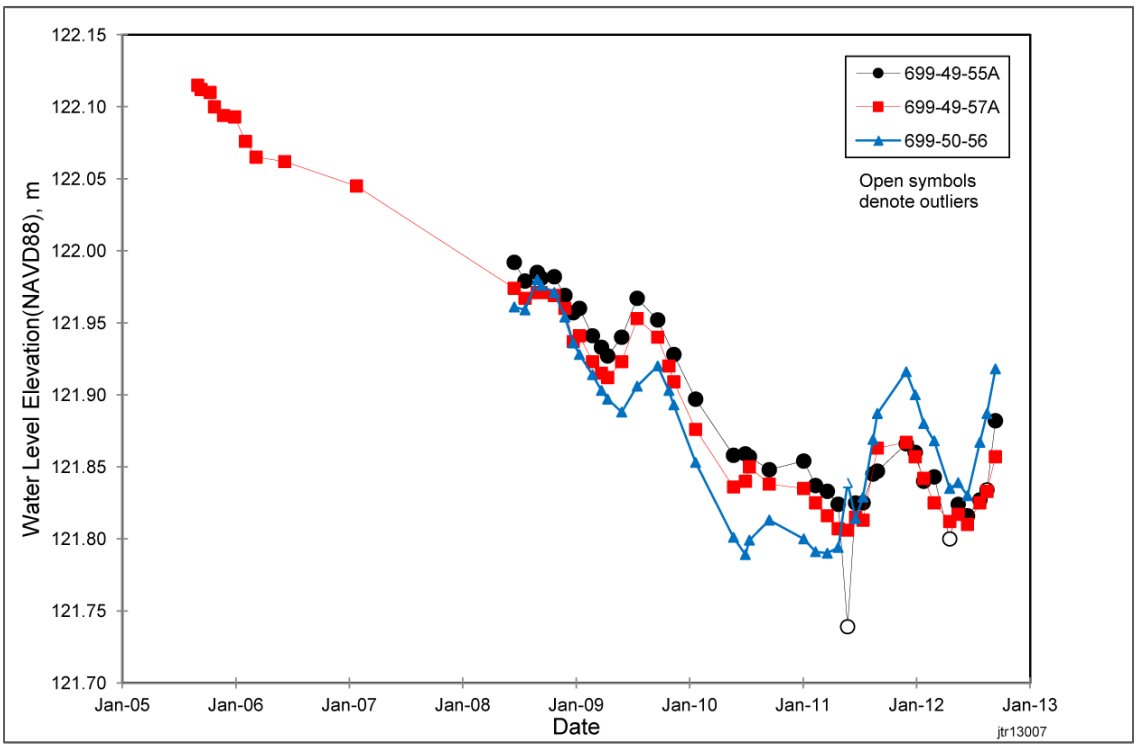


Figure 4-15. Hydrograph of Manual Water-Level Measurements for Wells 699-49-55A, 699-49-57A, and 699-50-56 North of LLWMA-1

4.1.7 Measurement Accuracy

As a measure of the accuracy achieved in the LLWMA-1 water-level measurements, the error remaining in the measurements after all corrections had been applied was estimated. Any estimate of measurement error must always involve an assumption regarding the true value being measured (see Section 3.8). As stated in Section 4.1.5, the hydraulic gradient at LLWMA-1 from October 2008 through June 2011 was too low to measure. Further, trend-surface analyses performed using only those wells located at the burial ground itself (299-E28-27, 299-E32-5, 299-E32-6, 299-E32-8, 299-E33-28, and 299-E-334) indicated that the water table was particularly flat directly beneath the burial ground compared to the remainder of the study area. This observation is consistent with the water table map for August 29, 2011 (Figure 4-11), which shows a lower hydraulic gradient magnitude beneath LLWMA-1 than elsewhere in the study area. Thus, during the October 2008 through June 2011 time period, it was assumed that all of the variability in the water-level measurements in wells adjacent to the burial ground was entirely due to error remaining in the hydraulic head determinations. For each set of measurements between January 2009 and June 2011, the average hydraulic head in the wells surrounding the burial ground was assumed to be the true water table elevation (i.e., the elevation of a horizontal plane fit by least-squares regression) and deviations from this average were assumed to be due to error (January 2009 was used as the start date instead of October 2008 to ensure that any residual gradient from the previous flow regime had dissipated). Months containing an outlier measurement, or for which one or more measurements were not collected, were excluded from the error estimate calculation. This ensured that the same number of measurements was used from each well which prevented introducing a bias into the error estimate by using more measurements from some wells than others. In effect, the error estimate represents the accuracy achieved when a “good” water-level measurement was collected.

The error estimate was calculated using Equation 3-14 (90 percent confidence interval). The result for LLWMA-1 was ±0.006 m (±6 mm) indicating that high accuracy was achieved.

4.2 Integrated Disposal Facility/PUREX Cribs

Following the initial success in measuring the hydraulic gradient at LLWMA-1, this study was expanded in 2008 to include the vicinity of the IDF/PUREX Cribs. The IDF is a RCRA-compliant landfill consisting of a lined trench with leachate collection and leak detection systems. It was designed to receive low-level radioactive waste and mixed waste from the Waste Treatment Plant. The landfill is not in operation and has not received any waste.

Groundwater monitoring under RCRA is required at two of the PUREX Cribs, 216-A-36B and 216-A-37-1. Only the 216-A-36B Crib was included in this study, and due to the proximity of this crib to the IDF, these two sites were evaluated as a single study area. These sites are located in the southeastern corner of the 200 East Area, and the study area extends from west of the IDF to the eastern boundary of the 200 East Area (Figure 4-16). The 216-A-36B Crib received effluent discharges from the PUREX Plant between 1965 and 1972 and again between 1982 and 1987.

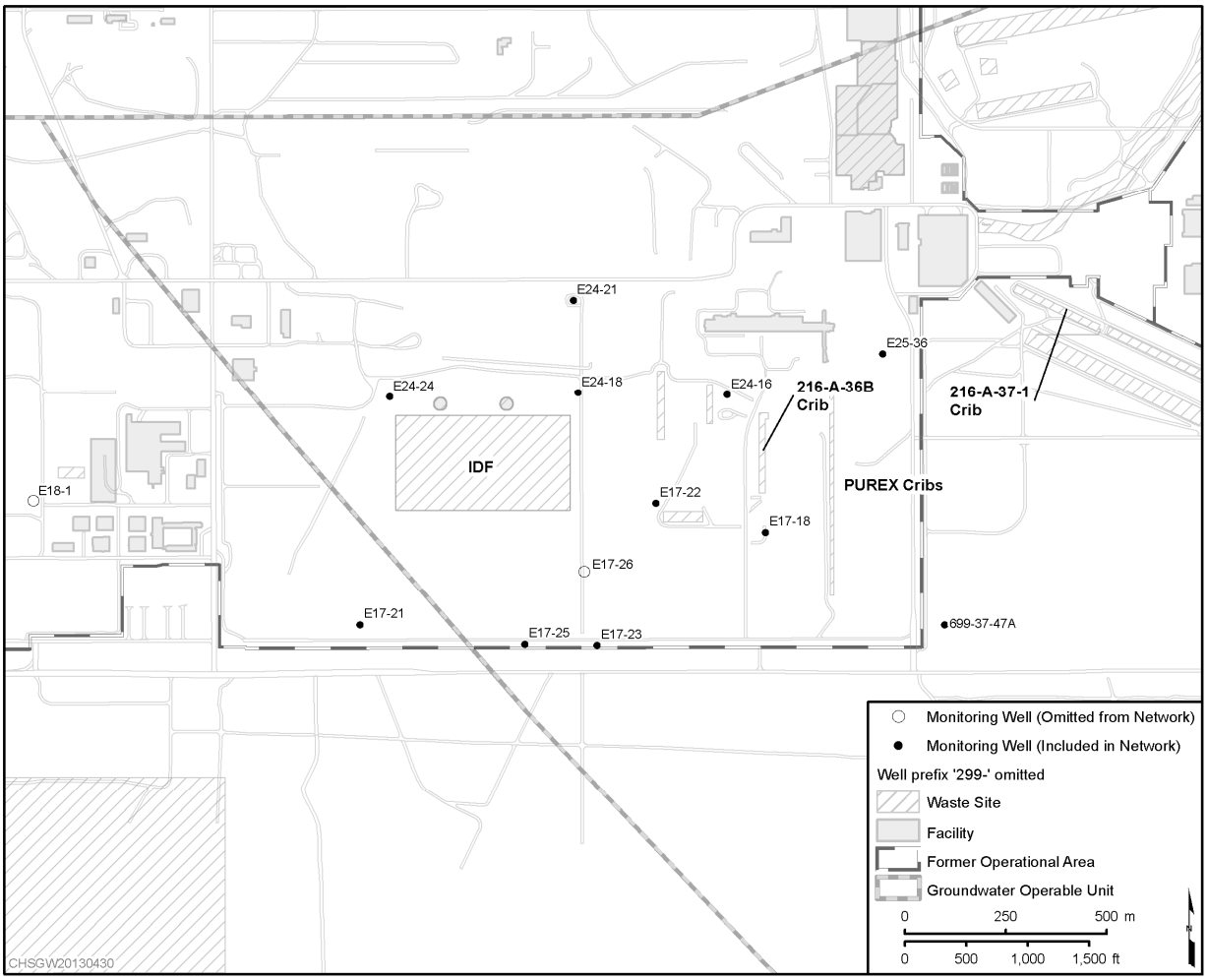


Figure 4-16. Water-Level Monitoring Well Network for the IDF/PUREX Cribs

4.2.1 Monitoring Well Network

A network of 13 wells was initially chosen for the IDF/PUREX Cribs area, but two wells were removed from the network: (1) well 299-E17-26 was removed because it was deviated from vertical to a much greater extent than the other wells (described in Section 4.2.3), and (2) well 299-E18-1 was removed because it was found to have a damaged casing so the gyroscope could not be lowered into the well.

Table 4-12 lists construction details for the 11 wells making up the network for IDF/PUREX Cribs. The saturated screen interval for 6 of the 11 wells exceeded the 6.1 m (20 ft) criterion, the largest at 10.4 m (34.1 ft) (299-E17-23). Inclusion of these wells could not be avoided because all of the IDF monitoring wells were included (except for 299-E17-26), and no other wells were available.
An examination of the borehole logs indicated that there were no mud units present within the screened intervals (as explained in Section 3.1, wells having mud units within the screened interval are more prone to vertical flow due to the potential for a head difference across the mud layer).

Table 4-12. IDF/PUREX Cribs Water-Level Monitoring Well Network and Well Construction Details

Well Name	Screen Top (m bls)	Screen Bottom (m bls)	Water Level (m bls)*	Length of Saturated Screened Interval (m)
299-E17-18	94.1	100.4	97.9	2.5
299-E17-21	100.0	109.1	102.3	6.8
299-E17-22	98.0	108.7	98.6	10.1
299-E17-23	101.5	112.2	101.8	10.4
299-E17-25	102.6	113.3	103.3	10.0
299-E24-16	92.8	99.4	97.1	2.3
299-E24-18	93.4	99.8	97.4	2.4
299-E24-21	95.2	101.3	96.2	5.1
299-E24-24	98.0	108.6	98.5	10.1
299-E25-36	90.4	96.8	93.8	3.0
699-37-47A	94.1	103.2	96.4	6.8

* Measured during 2007.

bls = below land surface

4.2.2 Casing Elevation Resurveys

Table 4-13 provides reference point (i.e., casing) elevations for the 11 wells in the IDF/PUREX Cribs network. This table shows the casing elevation values in use prior to the start of this study (the baseline surveys), the new casing elevation values determined for this study (see Appendix A for the survey data reports), and the difference between the two. The absolute value of the differences between the baseline surveys and the new surveys ranged from 0.000 to 0.007 m (7 mm), with a median value of 0.003 m (3 mm). These small differences indicate that the casing elevation surveys are not a substantial source of variability in the water-level measurements.

Table 4-13. Reference Point Elevation Surveys for the IDF/PUREX Wells

Well	Baseline Survey Date	Baseline Survey Source	Baseline Survey (m NAVD88)*	New Survey (m NAVD88)*	Difference (m)
299-E17-18	6/22/1994	USACE(JECA)	220.758	220.759	+0.001
299-E17-21	5/22/2001	Rogers Surveying	225.300	225.302	+0.002
299-E17-22	5/1/2002	Rogers Surveying	221.458	221.451	-0.007
299-E17-23	5/1/2002	Rogers Surveying	224.659	224.656	-0.003
299-E17-25	5/1/2002	Rogers Surveying	225.791	225.787	-0.004
299-E24-16	9/2/1994	USACE(JECA)	220.023	220.020	-0.003
299-E24-18	7/14/1994	USACE(JECA)	220.349	220.349	0.000
299-E24-21	5/22/2001	Rogers Surveying	218.643	218.645	+0.002
299-E24-24	7/13/2005	FGG	221.217	221.220	+0.003
299-E25-36	7/8/1994	USACE(JECA)	216.735	216.732	-0.003
699-37-47A	12/18/1996	FDNW	219.495	219.492	-0.003

* All elevations are for the top of the outermost casing.

FDNW = Fluor Daniel Northwest
FGG = Fluor Government Group
NAVD88 = *North American Vertical Datum of 1988*
USACE(JECA) = J.E. Chance and Associates for the U.S. Army Corps of Engineers

4.2.3 Gyroscope Surveys

The results of the wellbore deviation surveys for the IDF/PUREX Cribs wells are shown in Table 4-14 (see Appendix B for the gyroscope survey reports). The values in Table 4-14 represent the difference between the measured depth to water and the true vertical depth to water (i.e., correction values). These values were determined for the measured depth to water in each well by interpolation between depth stations measured using the gyroscope. The interpolation was performed using a third degree polynomial equation fitted to the gyroscope measurements using least-squares regression. For the wells used in this study, differences between the measured depth to water and the true vertical depth to water ranged from 0.003 to 0.366 m (3 to 366 mm), and the median difference was 0.024 m (24 mm). The maximum difference of 1.140 m occurred in well 299-E17-26, which was excluded from this study because of the large deviation. This source of variability was much larger than variability due to the casing elevation surveys.

As a group, the wells at IDF/PUREX Cribs are deviated from vertical to a greater extent than at LLWMA-1. The amount of deviation correlates with the drilling method. Wells drilled using the percussion hammer technique had a median deviation of 0.07 m (70 mm), whereas those drilled by cable tool or air rotary had a median deviation of 0.02 m (20 mm). The difference between the methods is more pronounced when considering the maximum deviations. The maximum deviation in a well drilled by percussion hammer was 1.140 m (3.74 ft) compared to 0.024 m (0.079 ft) in wells drilled by either cable tool or air rotary. In fact, the maximum deviation by cable tool or air rotary was less than the smallest deviation of 0.030 m (0.10 ft) by percussion hammer.

Table 4-14. Wellbore Deviation Survey Results for the IDF/PUREX Well Network

Well	Correction Values[a]		Drilling Method
	(ft)	(m)	
299-E17-18	0.08	0.024	Cable tool
299-E17-21	0.41	0.125	Percussion hammer
299-E17-22	0.10	0.030	Percussion hammer
299-E17-23	0.13	0.040	Percussion hammer
299-E17-25	1.20	0.366	Percussion hammer
299-E17-26[b]	3.78	1.140	Percussion hammer
299-E24-16	0.06	0.018	Cable tool
299-E24-18	0.07	0.021	Cable tool
299-E24-21	0.06	0.018	Percussion hammer
299-E24-24	0.22	0.067	Percussion hammer
299-E25-36	0.02	0.006	Cable tool
699-37-47A	0.01	0.003	Air rotary

a. Difference between the measured depth to water and the true vertical depth to water.

b. Not used in this study because of the large deviation from vertical.

4.2.4 Barometric Response Analyses

Automated water-level measurements were collected from all 11 wells in the IDF/PUREX Cribs network using absolute pressure transducers. The data were analyzed to determine the characteristics of the well water-level responses to barometric pressure changes using the method described in Section 3.6. The barometric water-level response functions for all 11 wells are shown in Figures 4-17 through 4-19.

As expected, all of the wells in the IDF/PUREX Cribs network exhibited barometric water-level responses indicative of an unconfined aquifer; the response function coefficients exhibit an initial decline from their starting values. A very slight delayed response may have occurred at well 299-E25-36 (Figure 4-19), but as explained in Section 3.6.2, it is not possible to distinguish if this is caused by wellbore storage/skin effects or the restriction of air movement between the atmosphere and the wellbore.

A portion of all of the response functions had coefficients that were less than zero, indicating a direct correlation between barometric pressure changes and well water-level elevation instead of the normal inverse relationship expected for a barometric response. This is thought to be caused by the displacement effect that was described in Section 4.1.4.1 for LLWMA-1. The displacement effect occurs when there are lateral variations in vadose zone transmission properties in conjunction with a highly transmissive aquifer. The response functions for the IDF/PUREX Cribs wells indicate that the vadose zone diffusivity in this area is low compared to elsewhere in the 200 East Area. This is also confirmed by field observations that show wells in this area experience more air movement through the wellbores in

response to barometric pressure changes than elsewhere in the 200 East Area.[15] Lateral variations in vadose zone properties cause lateral variations in total head in the aquifer in response to barometric pressure changes. Because the unconfined aquifer beneath the 200 East Area is highly transmissive, water is displaced in the aquifer from areas of high total head into areas to low total head to maintain the total head equilibrium. This effect is described in more detail in Section 4.1.4.1.

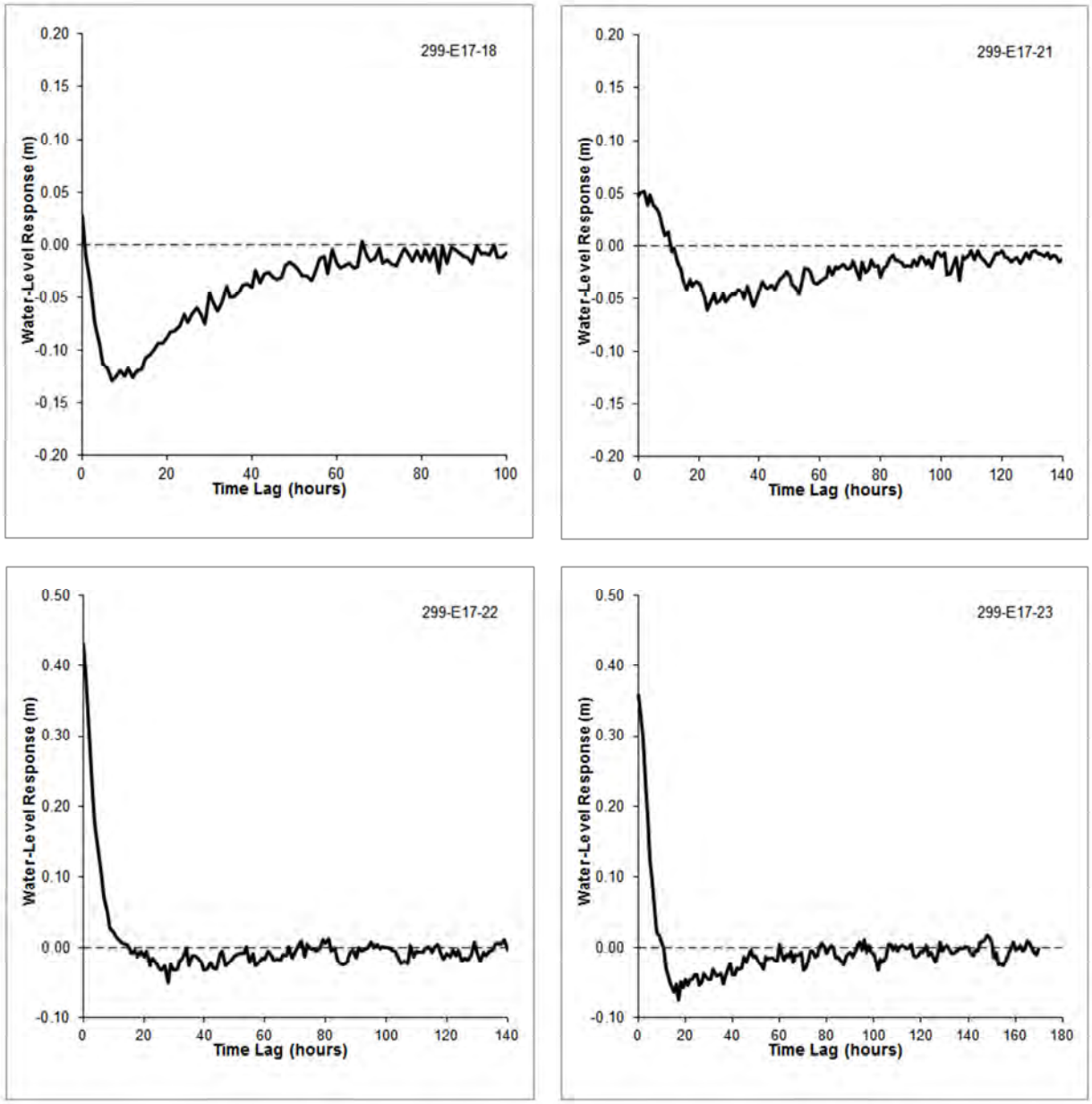


Figure 4-17. Barometric Water-Level Response Functions for Wells 299-E17-18, 299-E17-21, 299-E17-22, and 299-E17-23 (IDF/PUREX)

[15] In areas where the vadose zone has a relatively low pneumatic diffusivity, there will generally be a greater air pressure difference between the atmosphere and the deep vadose zone. This greater pressure differential causes more air movement through the wells.

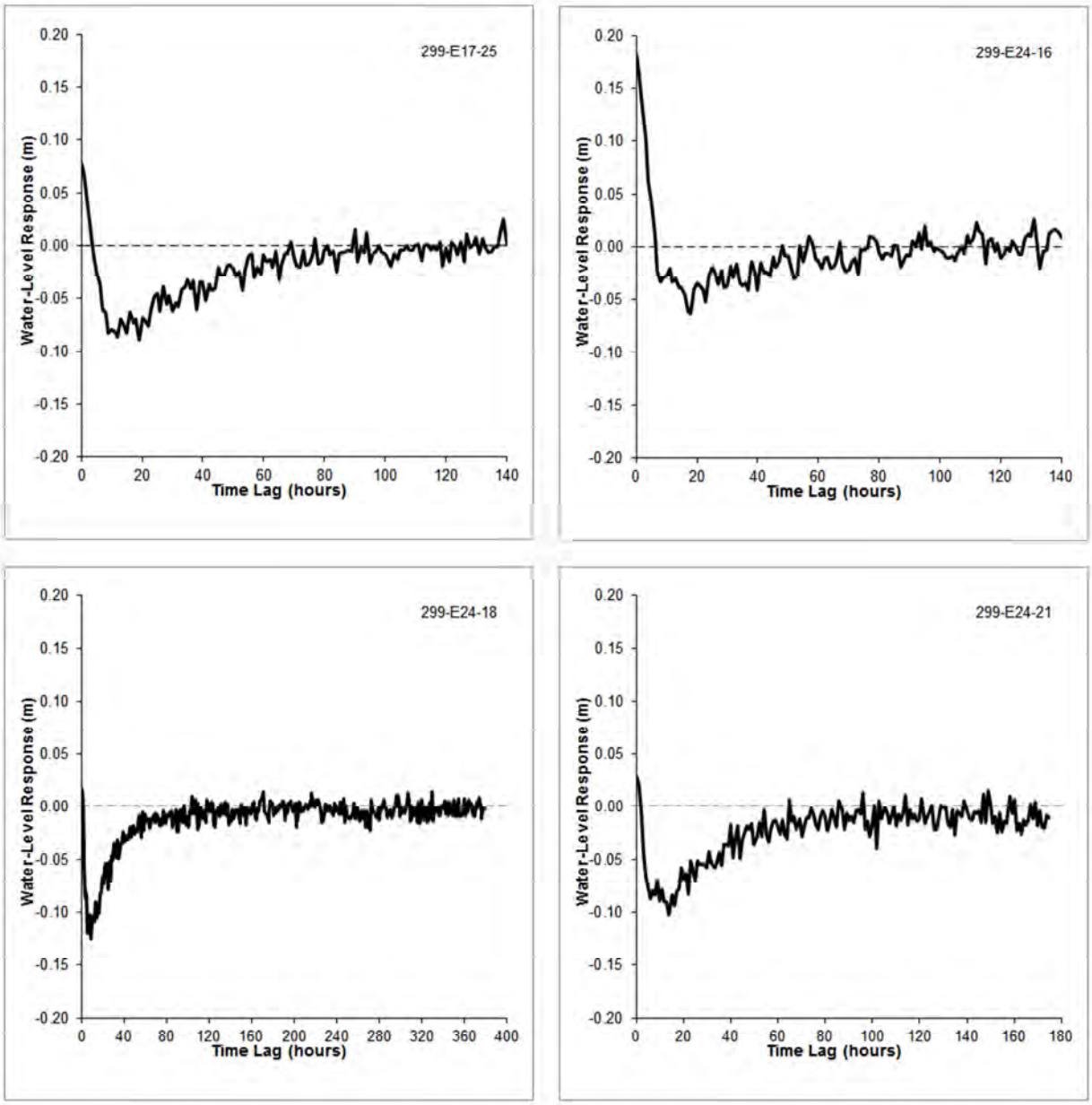


Figure 4-18. Barometric Water-Level Response Functions for Wells 299-E17-25, 299-E24-16, 299-E24-18, and 299-E24-21 (IDF/PUREX)

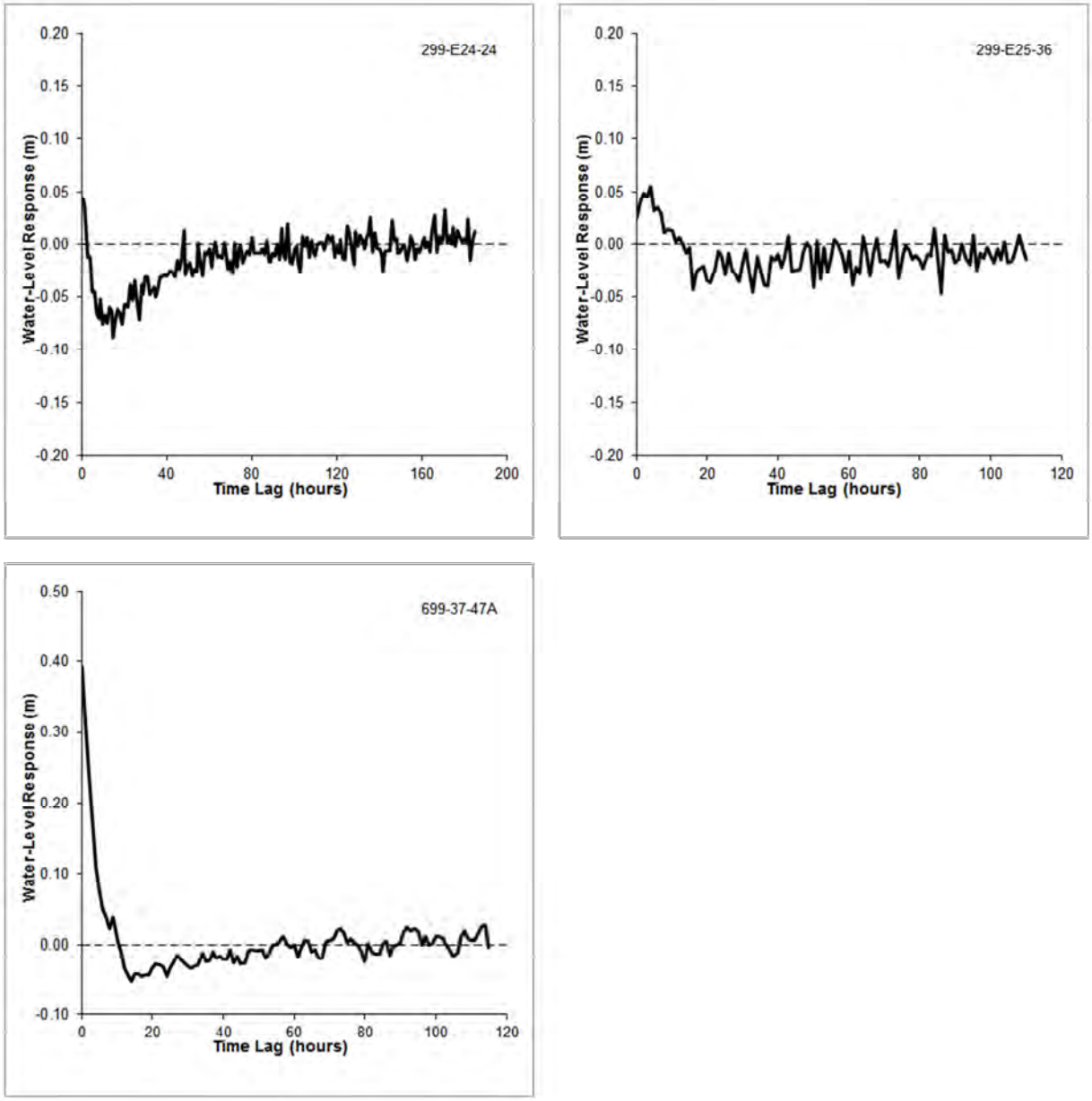


Figure 4-19. Barometric Water-Level Response Functions for Wells 299-E24-24, 299-E25-36, and 699-37-47A (IDF/PUREX)

The manual water-level measurements for IDF/PUREX Cribs were normalized to a constant barometric pressure using deconvolution, as described in Section 3.6.1. The adjustment values (absolute values) across all of the wells and measurement dates had a mean of 0.005 m (5 mm), a 90th percentile of 0.010 m (10 mm), and a maximum of 0.023 m (23 mm). The adjustments for the data set with second highest maximum adjustments are shown in Table 4-15, which shows the observed hydraulic heads, the hydraulic heads normalized to a constant barometric pressure, and the difference for measurements collected on December 30, 2009. The differences exhibit a range of 0.013 m (13 mm), and the adjustments on this date reduced the range of the hydraulic heads by 0.004 m (4 mm).

Table 4-15. Example Comparison of Observed Hydraulic Heads and Hydraulic Heads Normalized to a Constant Barometric Pressure for IDF/PUREX Cribs

Well	Observed Hydraulic Head (m)	Normalized Hydraulic Head (m)	Difference (m)
299-E17-18	121.864	121.872	+0.008
299-E17-21	121.904	121.912	+0.008
299-E17-22	121.877	121.887	+0.010
299-E17-23	121.885	121.898	+0.013
299-E17-25	121.895	121.903	+0.008
299-E24-16	121.893	121.900	+0.007
299-E24-18	121.870	121.877	+0.007
299-E24-21	121.884	121.891	+0.007
299-E24-24	121.889	121.897	+0.008
299-E25-36	121.872	121.876	+0.004
699-37-47A	121.856	121.868	+0.012
Range (m)	**0.048**	**0.044**	

Note: Water-level measurements were collected on December 30, 2009.

4.2.5 Trend-Surface Analyses

Collection of manual water-level measurements for the IDF/PUREX Cribs began in June 2008. Measurements were collected monthly through March 2009 and then quarterly thereafter. All corrections were applied to the measurements (i.e., correction for wellbore deviation from vertical, new casing elevation surveys, and normalization of the measurements to a constant barometric pressure).

The water-level measurements were analyzed by trend-surface analysis as described in Section 3.7. Of the 22 sets of water-level measurements collected between June 2008 and September 2012, only 3 sets yielded a statistically significant trend-surface result. The large number of nonstatistically significant results indicated that the variability remaining in the measurements after applying all of the corrections was still too large to allow for a statistically significant hydraulic gradient determination. This occurred for two reasons: (1) the site is smaller than the 14-well network at LLWMA-1, so the signal to noise ratio was smaller (i.e., the water-level change due to the hydraulic gradient magnitude was small compared to the variability in the measurements); and (2) the accuracy of the water-level elevations was not as good (discussed in Section 4.2.7).

To reduce the variability in the data at the IDF/PUREX Cribs, each set of measurements was repeatedly analyzed by removing the measurement with the highest residual until the trend-surface analysis results converged and were statistically significant. Specifically, the measurement with the highest residual was removed, and the trend-surface analysis was performed again, until (1) the result was statistically significant, (2) all residuals were less than 0.01 m (10 mm), and (3) the removal of the measurement with the next highest residual still resulted in a statistically significant result with residuals less than 0.01 m (10 mm) and the dip direction of the fitted plane changed by less than 10 degrees. Because three points

exactly define a plane, the trend-surface analyses were not performed on less than four wells. Also, because one additional trend-surface analysis was needed to confirm the results (i.e., criterion 3 identified above), no final trend-surface analysis result was based on less than five wells. This process produced statistically significant results for 18 of the 22 data sets. For the remaining four data sets, this method did not yield a result that converged, so no result was obtained. The final trend-surface analyses results are shown in Table 4-16.

Table 4-16. Final Trend-Surface Analysis Results for IDF/PUREX (All Corrections Applied and the Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)[a]	Gradient Magnitude (m/m)	Gradient Direction (azimuth)	Goodness of Fit (R^2)	p-Value[b]	Number of Wells[c]
6/16/2008	0.025	1.7×10^{-5}	58	0.81	0.0064	9
8/1/2008	0.028	1.9×10^{-5}	138	0.65	0.0411	9
8/29/2008	0.038	2.3×10^{-5}	63	0.78	0.0047	10
9/10/2008	No result					
10/23/2008	0.036	2.5×10^{-5}	52	0.81	0.0065	9
11/26/2008	0.017	1.2×10^{-5}	55	0.91	0.0283	6
12/22/2008	0.027	1.7×10^{-5}	108	0.92	0.0072	7
1/26/2009	No result					
2/5/2009	0.035	3.7×10^{-5}	47	0.95	0.0006	8
3/24/2009	0.025	1.9×10^{-5}	59	0.89	0.0039	8
6/29/2009	0.024	2.2×10^{-5}	36	0.95	0.0108	6
9/22/2009	0.036	2.6×10^{-5}	52	0.86	0.0069	8
12/30/2009	0.044	2.8×10^{-5}	73	0.88	0.0015	9
3/16/2010	0.030	2.0×10^{-5}	49	0.86	0.0071	8
6/30/2010	No result					
9/14/2010	0.015	1.4×10^{-5}	49	0.99	0.0001	7
3/18/2011	0.034	2.1×10^{-5}	57	0.78	0.0110	9
Averages for 6/16/2008 through 3/18/2011	**0.030**	**2.2×10^{-5} ($\pm 0.3 \times 10^{-5}$)**	**64 (±12)**	**0.86**	**0.0097**	**N/A**
6/20/2011	0.035	2.4×10^{-5}	89	0.84	0.0102	8
9/22/2011	0.029	2.1×10^{-5}	89	0.99	0.0001	7
12/29/2011	0.040	2.7×10^{-5}	104	0.90	0.0009	9
6/22/2012	No result					
9/12/2012	0.034	2.2×10^{-5}	101	0.91	0.0076	7
Averages for 6/20/2011 through 9/12/2012	**0.034**	**2.3×10^{-5} ($\pm 0.2 \times 10^{-5}$)**	**96 (±6)**	**0.91**	**0.0047**	**N/A**

Table 4-16. Final Trend-Surface Analysis Results for IDF/PUREX (All Corrections Applied and the Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)[a]	Gradient Magnitude (m/m)	Gradient Direction (azimuth)	Goodness of Fit (R^2)	p-Value[b]	Number of Wells[c]

a. Range of hydraulic head (with all corrections applied) for the wells retained in each analysis.

b. All valid results were statistically significant.

c. Number of wells included in the final trend-surface result.

N/A = not applicable

The trend-surface analysis results for the IDF/PUREX Cribs shown in Table 4-16 are plotted in Figure 4-20 and mapped in Figure 4-21. Between June 2008 and March 2011, individual trend-surface results ranged from a direction of 36 degrees (northeast) to 138 degrees (southeast), and the gradient magnitude ranged from 1.2×10^{-5} to 3.7×10^{-5} m/m. Average results during this time were 2.2×10^{-5} ($\pm 0.3 \times 10^{-5}$) m/m, with a direction of 64 (±12) degrees (east-northeast).[16]

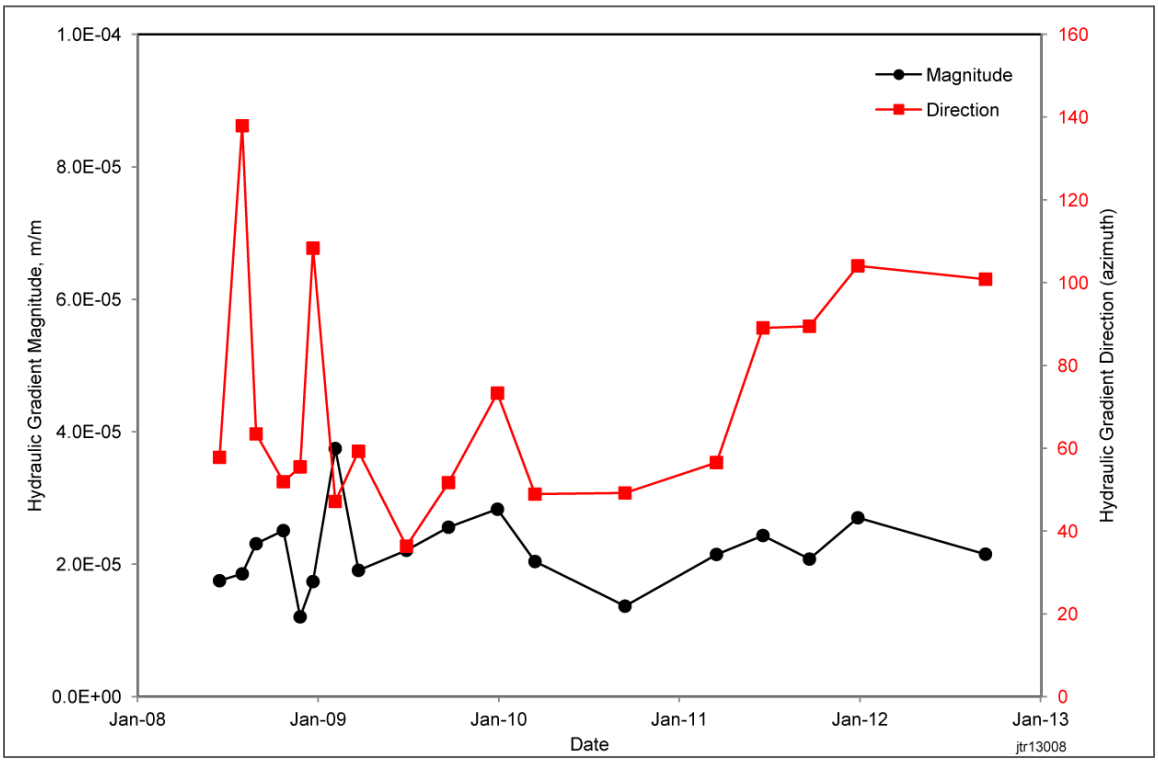


Figure 4-20. Hydraulic Gradient Determinations (Graph) for the IDF/PUREX Cribs

[16] Average results for June 2008 through March 2011 using measurements not normalized to a constant barometric pressure were 2.1×10^{-5} ($\pm 0.3 \times 10^{-5}$) m/m with a direction of 75 (±18) degrees. This is a difference in the mean gradient of 0.1×10^{-5} m/m and 11 degrees in direction compared to the results normalized to a constant barometric pressure. Thus, accounting for barometric pressure fluctuations had a larger effect on the results at IDF/PUREX Cribs than for LLWMA-1, likely due to the displacement effect that was observed in the IDF/PUREX Cribs wells.

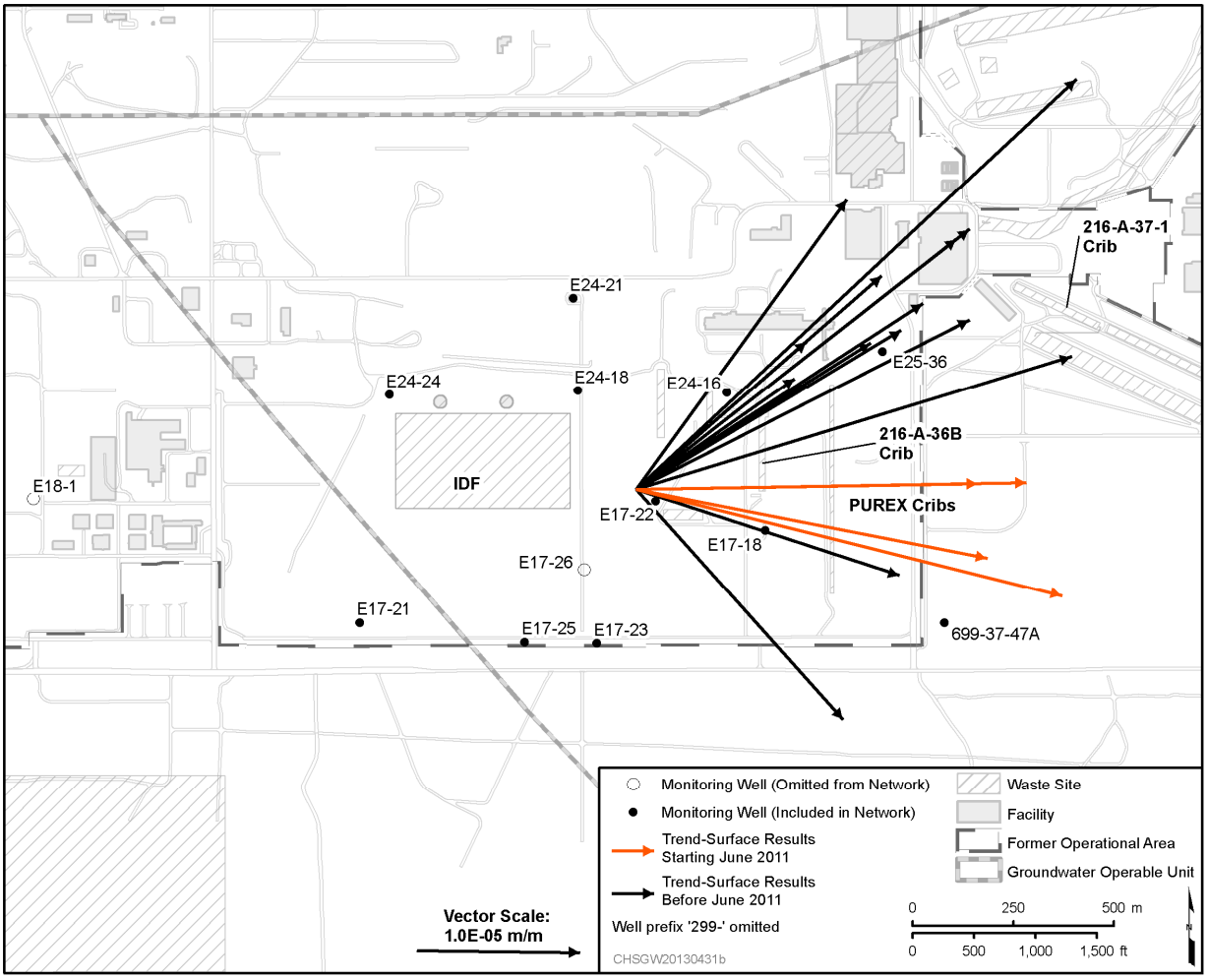


Figure 4-21. Hydraulic Gradient Determinations (Vectors) from June 2008 to September 2012 for the IDF/PUREX Cribs

Beginning in June 2011 and continuing through the end of the study period, the average direction of the hydraulic gradient at IDF/PUREX changed. Directions during this time averaged 96 (±6) degrees (east). The results of an ANOVA indicated that the change was statistically significant, at the 95 percent confidence level. This change in the hydraulic gradient direction correlated with the flow reversal observed at LLWMA-1 beginning in the summer of 2011. The flow reversal was attributed to higher than normal Columbia River stage in conjunction with the lack of large volume discharges to the TEDF (Section 4.1.5.2).[17]

The average hydraulic gradient direction of east-northeast prior to June 2011 is slightly different from the flow direction of east to southeast interpreted from the movement of nearby contaminant plumes at that time. Trend-surface analysis results represent a spatial average over the entire study area. The lowest water-level elevation used in the trend-surface analyses most frequently occurred in well 699-37-47A, the well at the southeast boundary of the study area. Thus, the groundwater flow direction is interpreted

[17] During the first half of 2013, the hydraulic gradient had apparently shifted back toward the east-northeast, although additional measurements are needed for confirmation.

to change across the study area from northeast in the western portion of the network to southeast in the eastern portion.

4.2.6 Water-Level Trends

The manual water-level measurements collected for this study at the IDF/PUREX Cribs, with all of the corrections applied and the data normalized to a constant barometric pressure, are plotted in Figures 4-22 through 4-24. Overall, the water table declined by approximately 0.15 m (0.50 ft) from 2008 to 2012. Similar to the trends at LLWMA-1, the water table elevation increased during 2009 and did not decline very much in 2010, both in response to effluent discharges at the TEDF in those years (Figure 4-9). Slight fluctuations are evident in the water-level trends during the second half of 2011 and the second half of 2012. These fluctuations were attributed to higher than normal Columbia River stage during the summers of 2011 and 2012 (Figure 4-10).

4.2.7 Measurement Accuracy

Accuracy of the water-level measurements collected for the IDF/PUREX Cribs was determined by analyzing the residuals of the trend-surface analyses. Thus, it was assumed that the predicted hydraulic heads (from Equation 3-5) represented the true hydraulic heads. This approach is different from the methodology used for LLWMA-1 in that it was not assumed that all of the variability in the measurements was due to error. This was because there was no region of the monitoring network for which it could be assumed the water table was too flat to measure. By analyzing the residuals, the variability attributed to the interpreted hydraulic gradient was accounted for. Note that the measurement error and the regression model error are still confounded, so the error estimate still represented an upper bound on the measurement error (see Section 3.8).

Measures were taken to prevent introducing a bias into the error estimate. As explained in Section 4.2.5, the trend-surface analyses were performed for the IDF/PUREX Cribs by successively removing the measurement with the highest residual until the results converged and the fitted plane was statistically significant. For the error estimate, however, the residuals for all of the measurements in a given month were used whether or not they were removed from the trend-surface analysis. Using only those measurements retained for the trend-surface analyses would have resulted in an error estimate that was biased low. Further, the conventions for handling outliers in the LLWMA-1 error estimation was also used for the IDF/PUREX Cribs error estimate. Months containing an outlier measurement, or for which one or more measurements were not collected, were excluded from the error calculations. This prevented any bias caused by using more measurements from some wells than others. Like for LLWMA-1, this approach resulted in an error estimate that represented the accuracy achieved when a “good” water-level measurement was collected.

The error estimate was calculated using Equation 3-15 (90 percent confidence interval). The result for the IDF/PUREX Cribs was ±0.019 m (±19 mm). This is larger than the estimated error for LLWMA-1, and this is thought to be due to three reasons:

- The depth to water is greater at the IDF/PUREX Cribs.
- The wells at the IDF/PUREX Cribs are deviated from vertical to a greater extent so the corrections for borehole deviation may not be as accurate.
- There is substantial air movement through the wellbores at the IDF/PUREX Cribs compared to other 200 East Area wells, which results in more condensation on the inside of the casings. This causes measuring tapes to frequently stick to the casing making it more difficult to obtain an accurate water-level measurement.

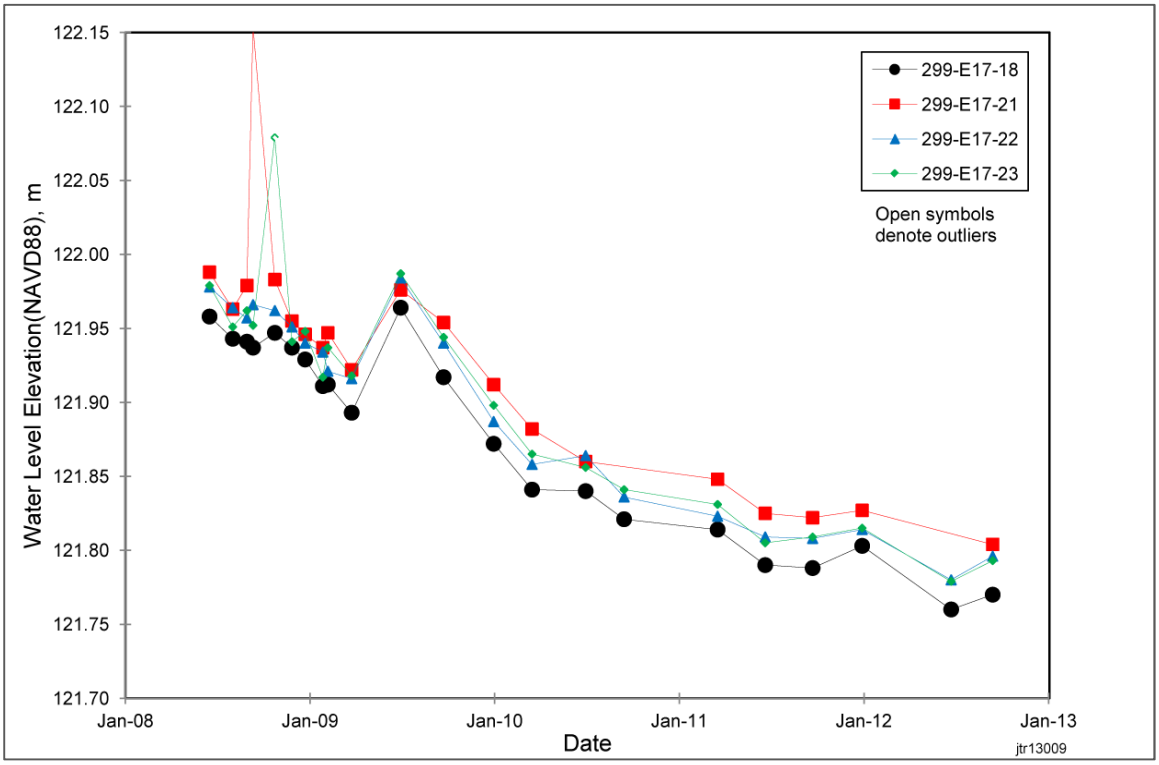


Figure 4-22. Hydrograph of Manual Water-Level Measurements for Wells 299-E17-18, 299-E17-21, 299-E17-22, and 299-E17-23 at the IDF/PUREX Cribs

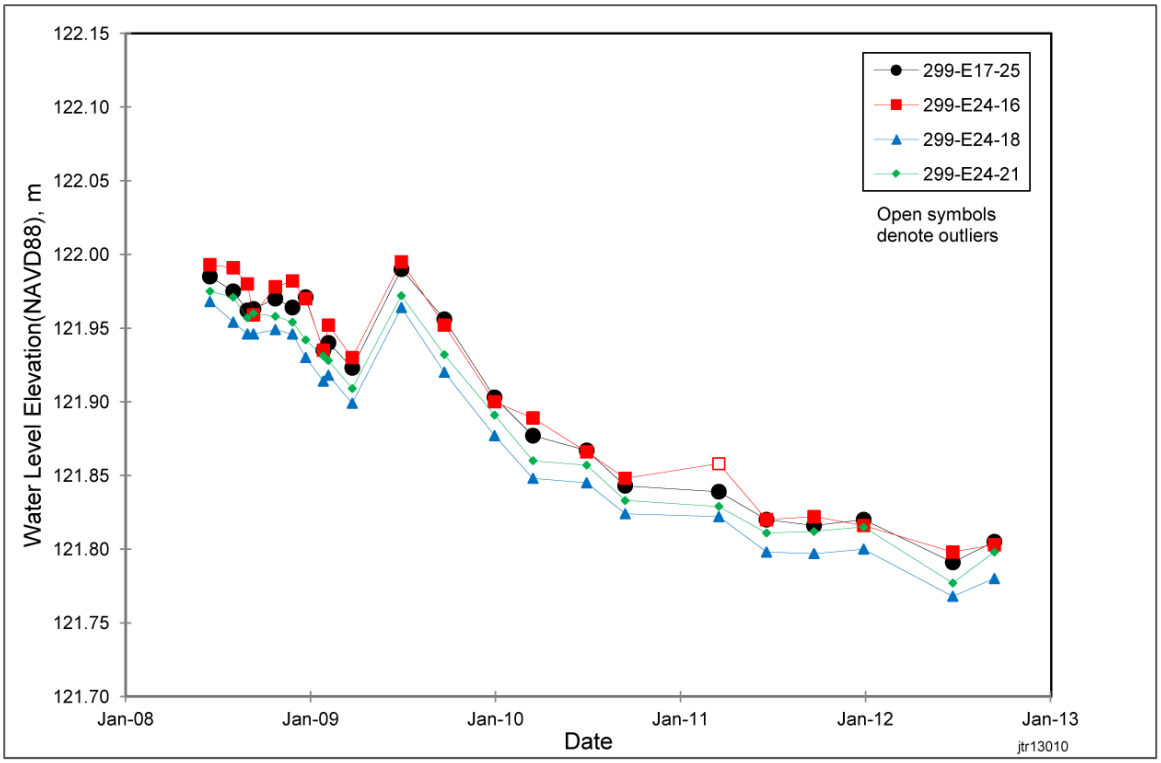


Figure 4-23. Hydrograph of Manual Water-Level Measurements for Wells 299-E17-25, 299-E24-16, 299-E24-18, and 299-E24-21 at the IDF/PUREX Cribs

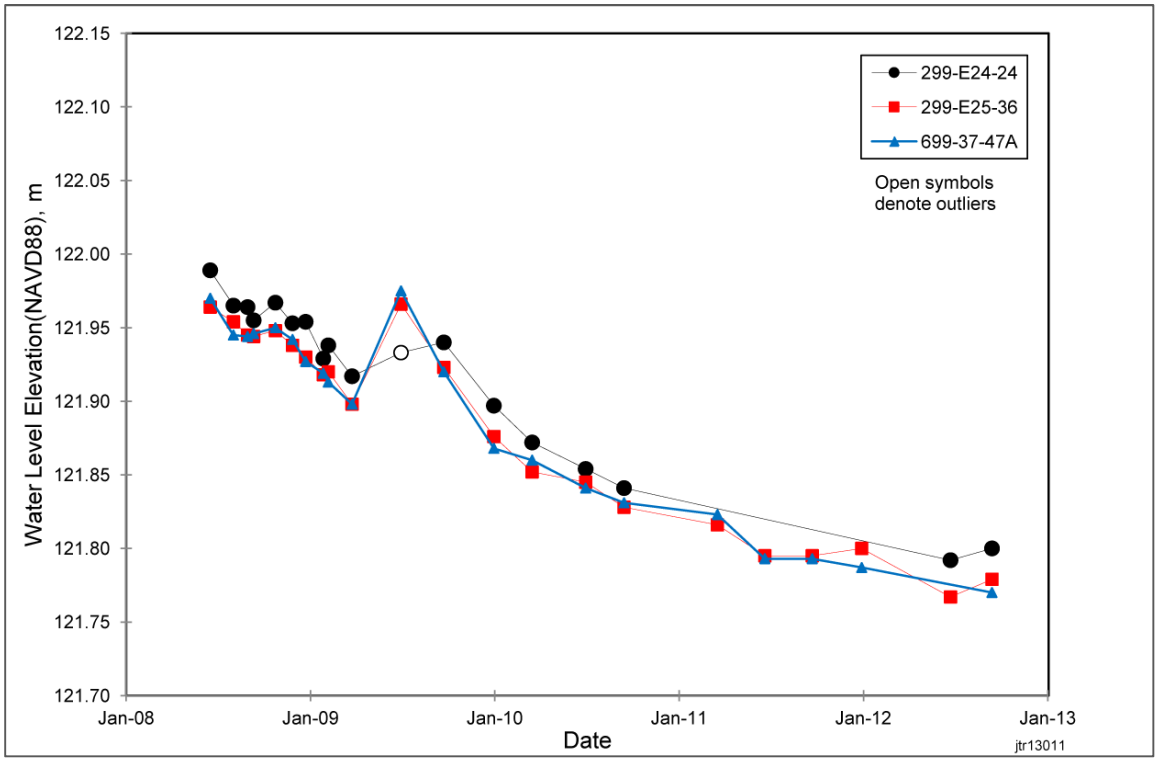


Figure 4-24. Hydrograph of Manual Water-Level Measurements for Wells 299-E24-24, 299-E25-36, and 699-37-47A at the IDF/PUREX Cribs

4.3 Low-Level Waste Management Area 2

This study was expanded to include LLWMA-2 in March 2009. This site is located in the northeastern corner of the 200 East Area and consists of a burial ground containing 39 unlined trenches (DOE/RL-2009-76, *Interim Status Groundwater Monitoring Plan for the LLBG WMA-2*). The site began operating in 1967 and receives low-level radioactive and low-level mixed waste. The site also receives U.S. Navy reactor vessel compartments.

4.3.1 Monitoring Well Network

At LLWMA-2, a network of eight wells was chosen. The wells occur on the south and east sides of LLWMA-2, generally along a line from southeast to northwest (Figure 4-25). The lack of spatial distribution in the north-south direction results in a poor geometry for trend-surface analyses. However, there were no other wells available at this site because there is basalt above the water table beneath much of the northern half of LLWMA-2 (Figure 4-25).

Table 4-17 lists construction details for the wells used for LLWMA-2. All eight wells met the criterion of having saturated screened intervals less than 6.1 m (20 ft) in length.

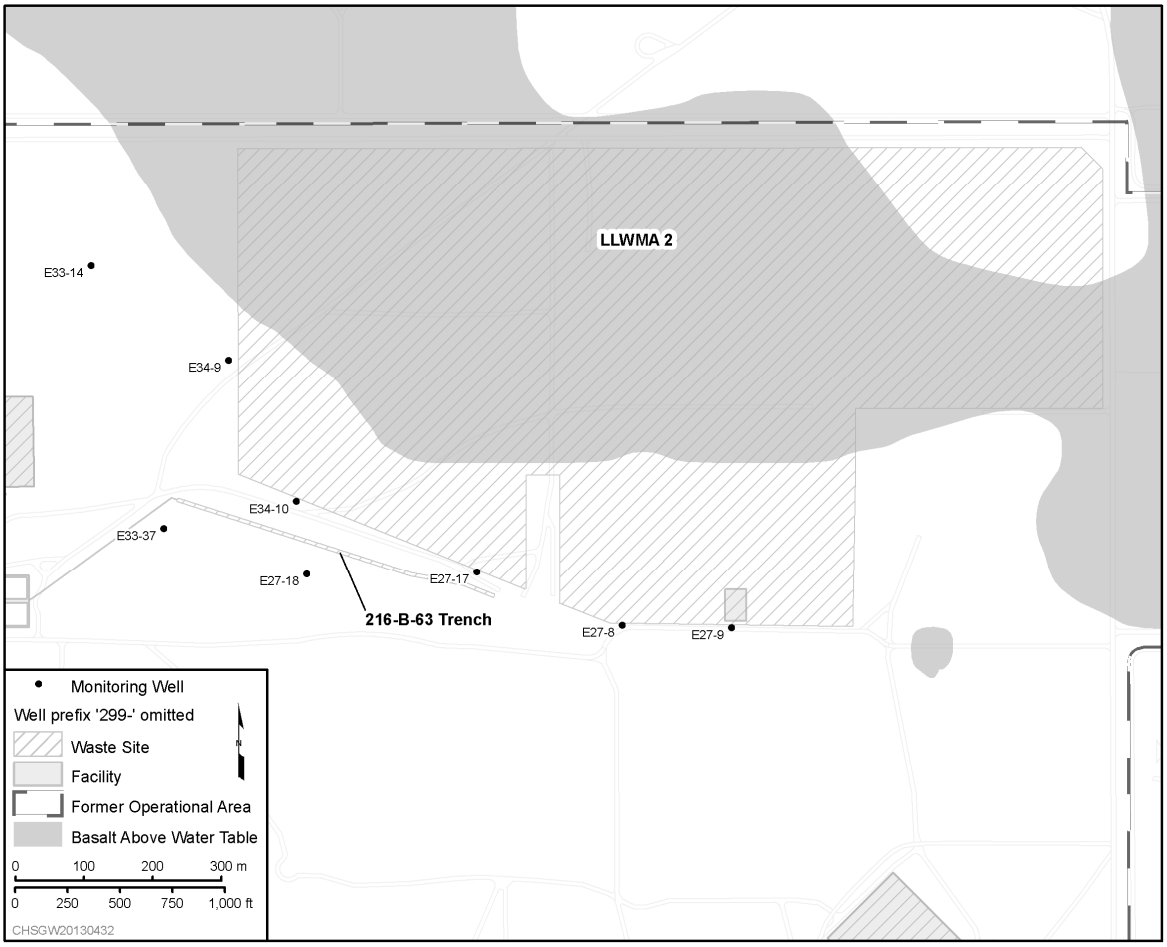


Figure 4-25. Water-Level Monitoring Well Network for LLWMA-2

Table 4-17. LLWMA-2 Water-Level Monitoring Well Network and Well Construction Details

Well Name	Screen Top (m bls)	Screen Bottom (m bls)	Water Level (m bls)*	Length of Saturated Screened Interval (m)
299-E27-17	68.0	74.4	71.5	2.9
299-E27-18	73.6	79.7	76.2	3.5
299-E27-8	68.7	74.8	71.9	2.9
299-E27-9	67.0	72.9	70.1	2.8
299-E33-14	64.6	69.2	67.9	1.3
299-E33-37	73.2	79.6	77.2	2.4
299-E34-10	68.6	75.1	73.2	1.9
299-E34-9	64.8	71.2	69.9	1.3

* Measured during 2008 except for 299-E27-18, which was measured during 2007

bls = below land surface

4.3.2 Casing Elevation Resurveys

Table 4-18 provides reference point (i.e., casing) elevations for the wells in the LLWMA-2 network. This table shows the casing elevation values in use prior to the start of this study (the baseline surveys), the new casing elevation values determined for this study (see Appendix A for the survey data reports), and the difference between the two. The absolute value of the differences between the baseline surveys and the new surveys ranged from 0.001 m (1 mm) to 0.006 m (6 mm), with a median value of 0.005 m (5 mm). These small differences indicate that casing elevation surveys are not a substantial source of variability in the water-level measurements.

Table 4-18. Reference Point Elevation Surveys for the LLWMA-2 Wells

Well	Baseline Survey Date	Baseline Survey Source	Baseline Survey (m NAVD88)*	New Survey (m NAVD88)*	Difference (m)
299-E27-17	9/24/1996	KEH	194.475	194.480	+0.005
299-E27-18	9/24/1996	KEH	199.175	199.180	+0.005
299-E27-8	6/30/1994	USACE(JECA)	195.503	195.499	-0.004
299-E27-9	6/30/1994	USACE(JECA)	192.874	192.872	-0.002
299-E33-14	1/11/1993	USACE(JECA)	190.625	190.619	-0.006
299-E33-37	9/24/1996	KEH	200.124	200.129	+0.005
299-E34-10	9/24/1996	KEH	196.016	196.022	+0.006
299-E34-9	9/24/1996	KEH	192.642	192.643	+0.001

* All elevations are for the top of the outermost casing.

KEH = Kaiser Engineers Hanford

NAVD88 = *North American Vertical Datum of 1988*

USACE(JECA) = J.E. Chance and Associates for the U.S. Army Corps of Engineers

4.3.3 Gyroscope Surveys

The results of the wellbore deviation surveys for LLWMA-2 are shown in Table 4-19 (see Appendix B for the gyroscope survey reports). The values in Table 4-19 represent the difference between the measured depth to water and the true vertical depth to water (i.e., correction values). These values were determined for the measured depth to water in each well by interpolation between depth stations measured by the gyroscope. The interpolation was performed using a third degree polynomial equation fitted to the gyroscope measurements using least-squares regression. Differences between the measured depth to water and the true vertical depth to water ranged from 0.003 m (3 mm) to 0.070 m (70 mm), and the median difference was 0.012 m (12 mm). Thus, wellbore deviation was a larger source of variability in water-level measurements than the casing elevation surveys.

4.3.4 Barometric Response Analyses

Automated water-level measurements were collected from all eight wells in the LLWMA-2 network using absolute pressure transducers. The data were analyzed to determine the characteristics of the well water-level responses to barometric pressure changes using the method described in Section 3.6. The barometric water-level response functions for all eight wells are shown in Figures 4-26 and 4-27.

Table 4-19. Wellbore Deviation Survey Results for the LLWMA-2 Well Network

Well	Correction Values*	
	(ft)	(m)
299-E27-17	0.03	0.009
299-E27-18	0.23	0.070
299-E27-8	0.04	0.012
299-E27-9	0.03	0.009
299-E33-14	0.01	0.003
299-E33-37	0.07	0.021
299-E34-10	0.04	0.012
299-E34-9	0.10	0.030

* Difference between the measured depth to water and the true vertical depth to water.

As expected, all of the wells in the LLWMA-2 network exhibited barometric water-level responses indicative of an unconfined aquifer. Most of the response function coefficients peaked between 0.1 and 0.2, although the peak value for well 299-E27-9 was much higher at 0.53. Delayed responses occurred in five of the wells, but (as explained in Section 3.6.2) it is not possible to distinguish if this is caused by wellbore storage/skin effects or the restriction of air movement between the atmosphere and the wellbore. The displacement effect response observed in two wells at LLWMA-1 (Section 4.1.4) and in all of the wells at the IDF/PUREX Cribs (Section 4.2.4) was not observed at LLWMA-2.

The manual water-level measurements for LLWMA-2 were normalized to a constant barometric pressure using deconvolution, as described in Section 3.6.1. The adjustment values (absolute values) across all of the wells and measurement dates had a mean of 0.005 m (5 mm), a 90th percentile of 0.011 m (11 mm), and a maximum of 0.027 m (27 mm). The adjustments for the data set with the maximum single adjustment are shown in Table 4-20, which shows the observed hydraulic heads, the hydraulic heads normalized to a constant barometric pressure, and the difference for the measurements collected on August 23, 2010. The differences exhibit a range of 0.010 to 0.027 m (10 to 27 mm). The adjustments on this date reduced the range of the data by 0.005 m (5 mm).

4.3.5 Trend-Surface Analyses

Manual water-level measurements were collected monthly from the LLWMA-2 wells beginning in March 2009. Thirty-seven sets of water-level measurements had been collected by the end of the study period in September 2012. After applying all corrections to the data, including normalization of the measurements to a constant barometric pressure, only two data sets yielded statistically significant trend-surface results. Thus, similar to the IDF/PUREX Cribs site, the variability remaining in the corrected measurements was too large compared to the change in the water table elevation across the site to determine the hydraulic gradient. Another factor was the spatial distribution of the wells generally along a southeast to northwest trending line, which is not an ideal arrangement for trend-surface analyses (Section 4.3.1).

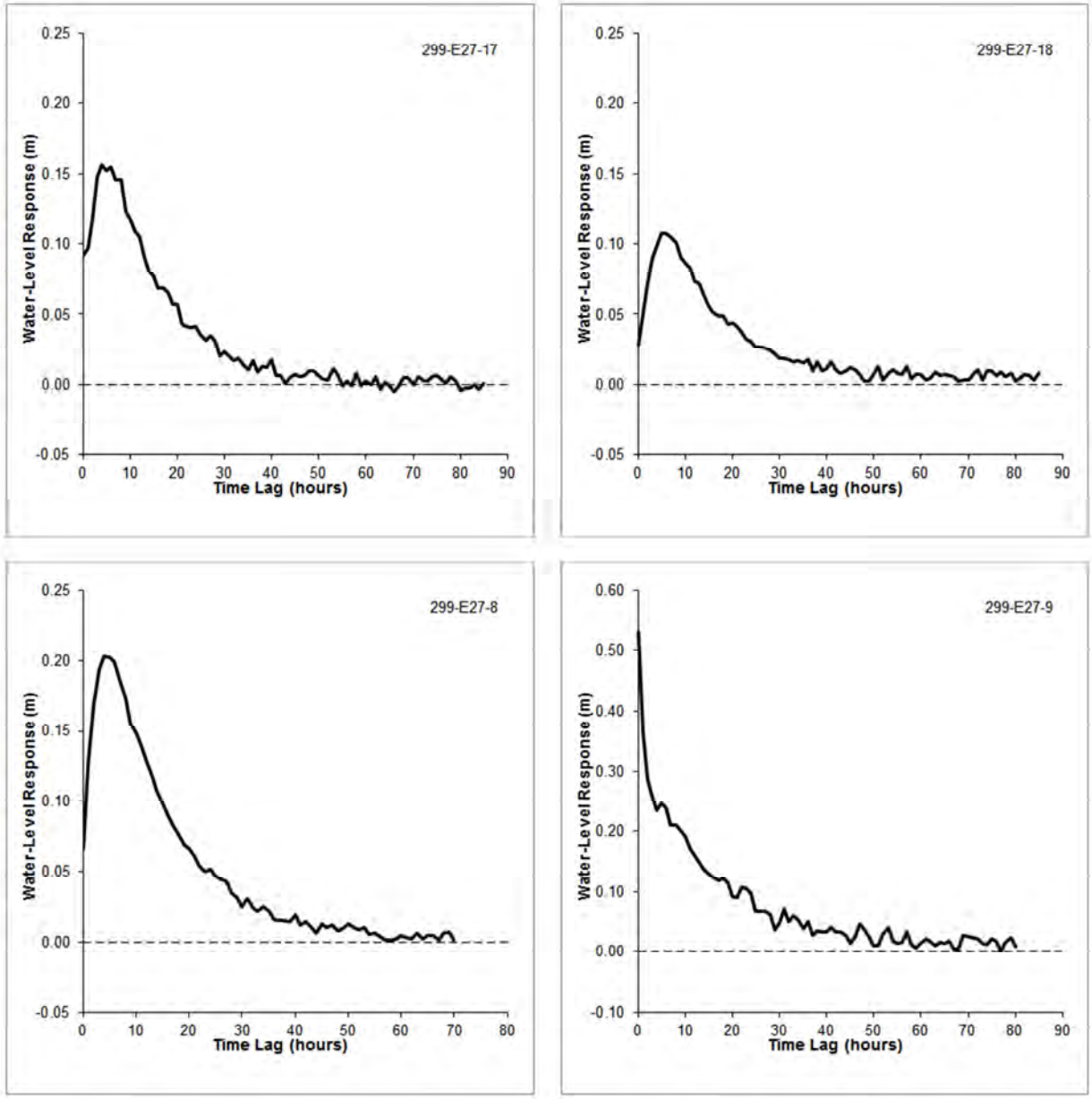


Figure 4-26. Barometric Water-Level Response Functions for Wells 299-E27-17, 299-E27-18, 299-E27-8, and 299-E27-9 (LLWMA-2)

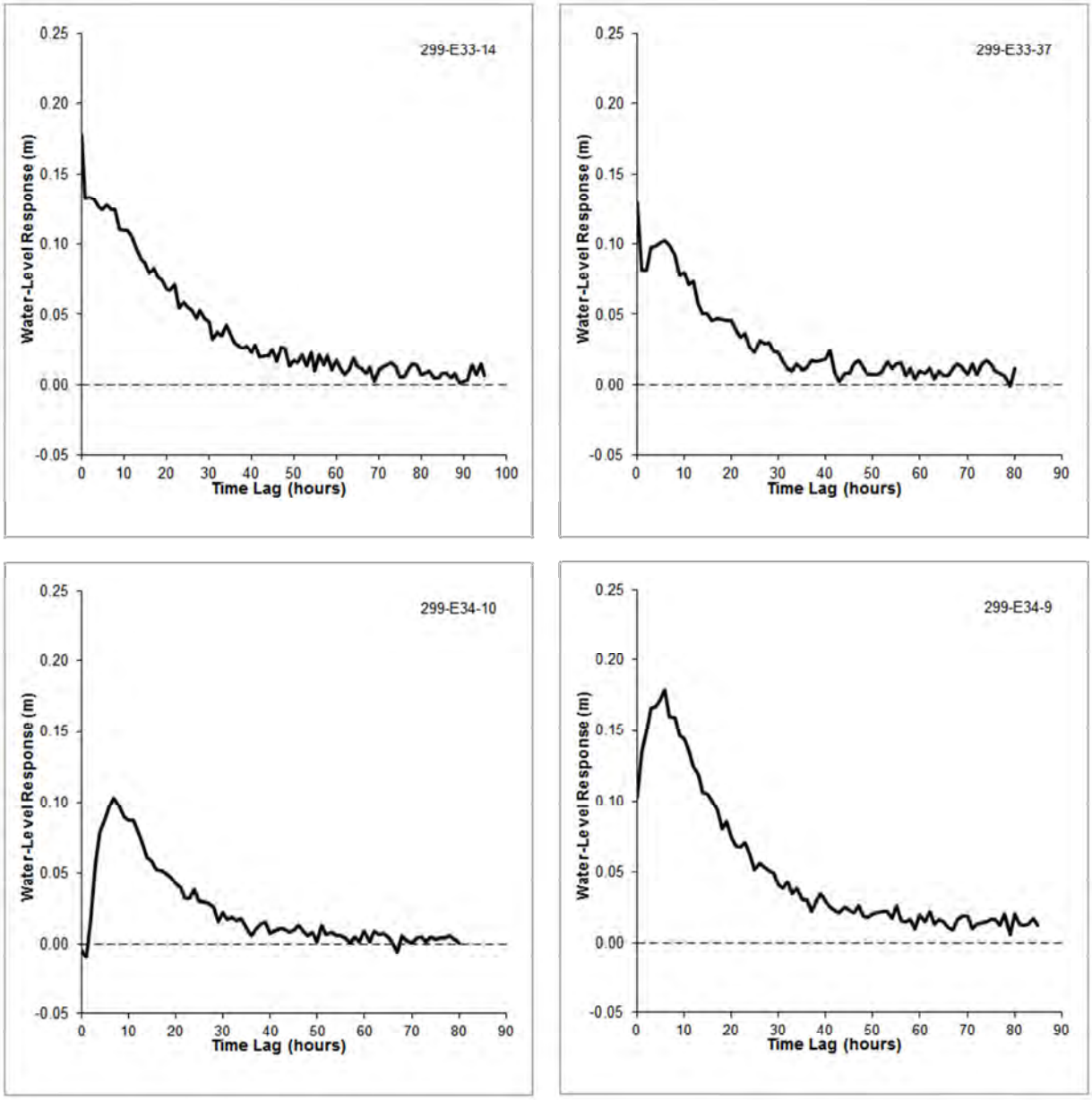


Figure 4-27. Barometric Water-Level Response Functions for Wells 299-E33-14, 299-E33-37, 299-E34-10, and 299-E34-9 (LLWMA-2)

Table 4-20. Example Comparison of Observed Hydraulic Heads and Hydraulic Heads Normalized to a Constant Barometric Pressure for the LLWMA-2

Well	Observed Hydraulic Head (m)	Normalized Hydraulic Head (m)	Difference (m)
299-E27-17	121.814	121.830	+0.016
299-E27-18	121.837	121.848	+0.011
299-E27-8	121.826	121.846	+0.020
299-E27-9	121.822	121.849	+0.027
299-E33-14	121.825	121.840	+0.015
299-E33-37	121.838	121.848	+0.010
299-E34-10	121.837	121.847	+0.010
299-E34-9	121.826	121.845	+0.019
Range (m)	**0.024**	**0.019**	

Note: Water-level measurements were collected on August 23, 2010.

To reduce the variability in the results, the same approach used for the trend-surface analyses at the IDF/PUREX Cribs was used for LLWMA-2. Each set of measurements was repeatedly analyzed by removing the measurement with the highest residual until the trend-surface analysis results converged and were statistically significant. Specifically, the measurement with the highest residual was removed, and the trend-surface analysis was performed again, until (1) the result was statistically significant, (2) all residuals were less than 0.01 m, and (3) the removal of the measurement with the next highest residual still resulted in a statistically significant result with residuals less than 0.01 m (10 mm) and the dip direction of the fitted plane changed by less than 10 degrees. Because three points exactly define a plane, the trend surface analyses were not performed on less than four wells. Also, because one additional trend surface analysis was needed to confirm the results, no final trend-surface analysis result was based on less than five wells. This process produced a statistically significant result for 21 of the 37 data sets. For the remaining 16 data sets, this method did not yield a result that converged; therefore, no result was obtained. The final trend-surface analysis results are shown in Table 4-21.

The results in Table 4-21 indicate that the hydraulic gradient at LLWMA-2 is too low to measure. Three observations support this conclusion. First, a large number of the data sets (43 percent) did not yield a statistically significant trend-surface result. Second, almost all of the data sets that did yield a statistically significant result had a dip direction toward the north or northeast, directly toward the subcrop of basalt above the water table (see Figure 4-25). This does not make sense hydrologically because the subcrop should generally act as a barrier to groundwater flow (although because of the declining water levels in the unconfined aquifer, water could possibly be flowing from the basalt into the alluvial aquifer). Third, the range of the water-level measurements within each data set, with all corrections applied and the data normalized to a constant barometric pressure, was usually similar to the estimated residual error in the water-level measurements for LLWMA-1 of ±0.006 m (±6 mm) (see the "Range" column in Table 4-21). Thus, it appears that all of the variability in the LLWMA-2 measurements can be attributed to residual error. These observations, in conjunction with the poor spatial distribution of the wells for trend-surface analyses, indicate that the hydraulic gradient at LLWMA-2 is too low to measure with the current monitoring well network and aquifer configuration.

Table 4-21. Final Trend-Surface Analysis Results for LLWMA-2 (All Corrections Applied and Data Normalized to Constant Barometric Pressure)

Measurement Date	Range (m)[a]	Slope (m/m)	Dip Direction (azimuth)	Goodness of Fit (R^2)	p-Value[b]	Number of Wells[c]
3/24/2009	No result					
4/30/2009	No result					
5/28/2009	0.007	1.8×10^{-5}	14	0.91	0.0272	6
6/29/2009	0.011	2.9×10^{-5}	18	0.89	0.0352	6
7/27/2009	0.011	2.5×10^{-5}	16	0.79	0.0459	7
8/6/2009	0.008	2.0×10^{-5}	18	0.85	0.0233	7
9/22/2009	0.008	1.2×10^{-5}	355	0.88	0.0412	6
10/29/2009	No result					
11/12/2009	No result					
1/4/2010	0.005	1.4×10^{-5}	7	0.89	0.0364	6
1/20/2010	0.007	1.2×10^{-5}	237	0.88	0.0424	6
2/18/2010	No result					
3/10/2010	No result					
5/23/2010	No result					
6/30/2010	0.015	3.0×10^{-5}	8	0.86	0.0210	7
7/13/2010	0.009	2.7×10^{-5}	17	0.91	0.0293	6
8/23/2010	0.009	1.7×10^{-5}	10	0.78	0.0472	7
9/17/2010	0.012	1.6×10^{-5}	347	0.97	0.0041	6
1/4/2011	0.009	2.1×10^{-5}	16	0.74	0.0348	8
2/11/2011	0.012	4.8×10^{-5}	33	0.94	0.0145	6
3/21/2011	No result					
4/25/2011	0.008	2.6×10^{-5}	23	0.92	0.0063	7
5/25/2011	0.005	1.5×10^{-5}	15	0.99	0.0001	7
6/20/2011	No result					
7/14/2011	0.009	2.7×10^{-5}	20	0.97	0.0043	6
8/15/2011	No result					
9/26/2011	No result					
11/30/2011	0.005	1.4×10^{-5}	38	0.80	0.0414	7
12/29/2011	No result					
1/25/2012	0.081	1.4×10^{-4}	237	0.97	0.0322	5
2/28/2012	0.006	2.5×10^{-5}	35	0.95	0.0098	6

Table 4-21. Final Trend-Surface Analysis Results for LLWMA-2 (All Corrections Applied and Data Normalized to Constant Barometric Pressure)

Measurement Date	Range (m)[a]	Slope (m/m)	Dip Direction (azimuth)	Goodness of Fit (R^2)	p-Value[b]	Number of Wells[c]
4/18/2012	No result					
5/15/2012	No result					
6/14/2012	0.201	5.2×10^{-4}	189	1.00	0.0050	5
7/30/2012	No result					
8/20/2012	No result					
9/11/2012	0.007	1.7×10^{-5}	42	0.92	0.0061	7

a. Range of hydraulic head (with all corrections applied) for the wells retained in each analysis.

b. All valid results were statistically significant.

c. Number of wells included in the final trend-surface result.

4.3.6 Water-Level Trends

The manual water-level measurements collected for this study at LLWMA-2, with all corrections applied and the data normalized to a constant barometric pressure, are plotted in Figures 4-28 and 4-29. Overall, the water table declined by approximately 0.10 m (0.30 ft) from 2009 to 2012. The water table elevation increased during 2009 and did not decline very much in 2010 in response to effluent discharges at the TEDF (Figure 4-9). Slight fluctuations occurred during the second half of 2011 and the second half of 2012 in response to higher than normal Columbia River stage during the summers of 2011 and 2012 (Figure 4-10). These trends are similar to those observed for LLWMA-1 and the IDF/PUREX Cribs. The similarity of the water-level trends between LLWMA-1, IDF/PUREX Cribs, and LLWMA-2 is consistent with the unconfined aquifer being highly transmissive. The effects of stressors migrate large lateral distances from the source of the stress so water levels throughout the high transmissivity region exhibit the same trends.

4.3.7 Measurement Accuracy

The approach to estimating the measurement error at LLWMA-2 was the same as employed for LLWMA-1. As stated in Section 4.3.5, it was concluded that the water table at LLWMA-2 was too flat to measure and all of the variability exhibited by the water-level measurements could be attributed to error. For each set of measurements, the average hydraulic head in the network wells was assumed to be the true water table elevation (i.e., the elevation of a horizontal plane fit by least-squares regression) and deviations from this average were assumed to be due to error. Months containing an outlier measurement, or for which one or more measurements were not collected, were excluded from the error calculations. This ensured that the same number of measurements was used from each well, which prevented introducing a bias into the error estimate by using more measurements from some wells than others. Like for LLWMA-1 and IDF/PUREX, the error estimate represents the accuracy achieved when a “good” water-level measurement was collected.

The error estimate was calculated using Equation 3-15 (90 percent confidence interval). The result for LLWMA-2 was ±0.008 m (±8 mm).

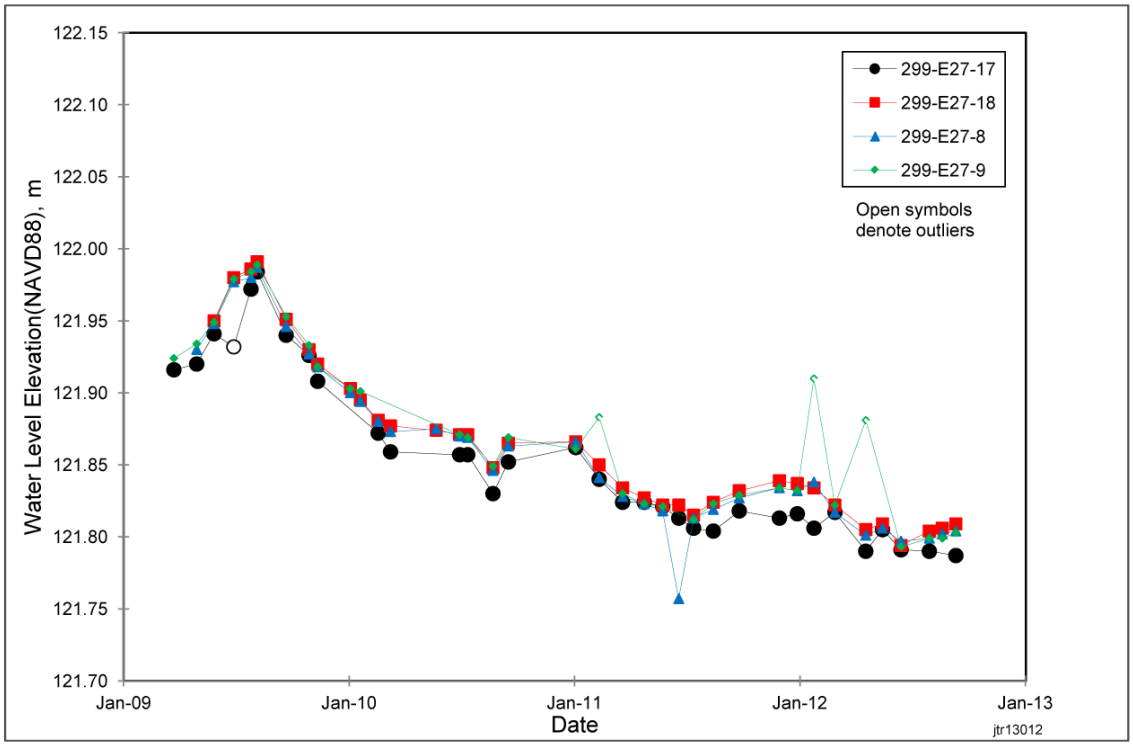


Figure 4-28. Hydrograph of Manual Water-Level Measurements for Wells 299-E27-17, 299-E27-18, 299-E27-8, and 299-E27-9 at LLWMA-2

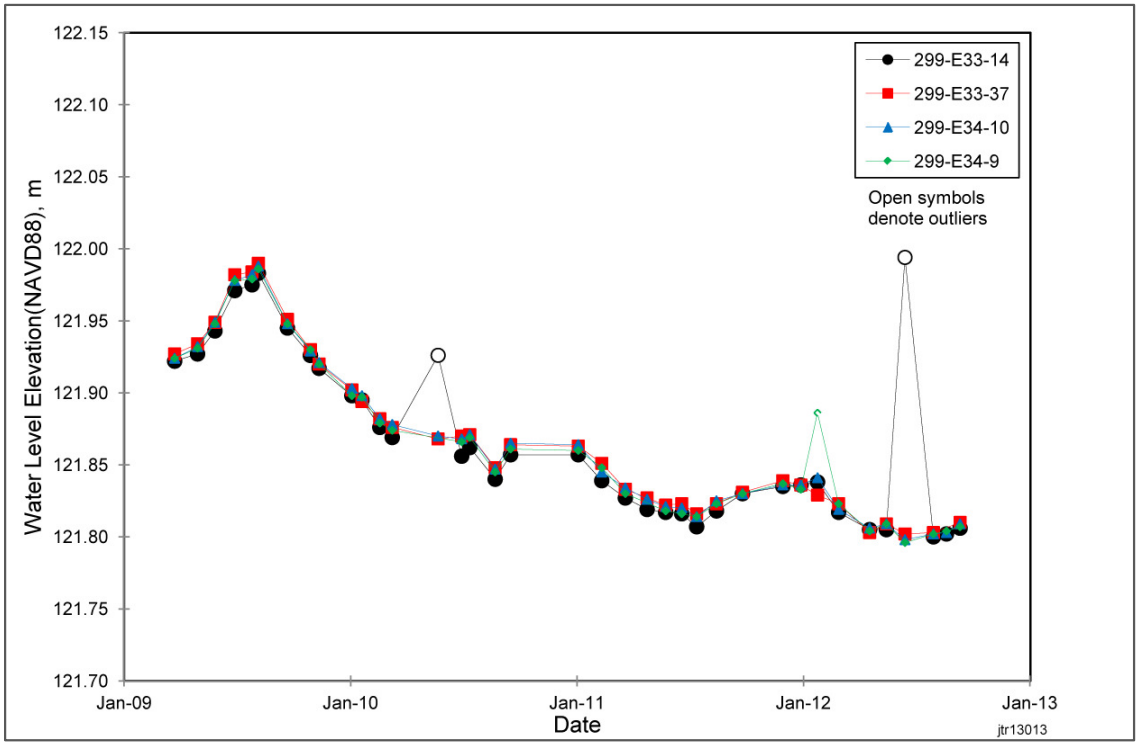


Figure 4-29. Hydrograph of Manual Water-Level Measurements for Wells 299-E33-14, 299-E33-37, 299-E34-10, and 299-E34-9 at LLWMA-2

4.4 Liquid Effluent Retention Facility

The LERF consists of three basins used as storage for the Effluent Treatment Facility (PNNL-11620, *Liquid Effluent Retention Facility Final-Status Groundwater Monitoring Plan*). The basins are lined and have leachate detection and collection systems. The facility is located just outside of the northeastern corner of the 200 East Area and began operating in 1994.

4.4.1 Monitoring Well Network

This study was implemented at LERF during 2008, and three wells were initially included: 299-E26-10, 299-E26-77, and 299-E26-79 (Figure 4-30). These were the only available wells at LERF open to the unconfined aquifer and that were not dry. LERF monitoring well 299-E26-11 was not included because it is open to a semiconfined aquifer (SGW-35756). Well 299-E26-14 was drilled during 2011 and was added to the network in December 2011.

Table 4-22 lists construction details for the LERF water-level well network. Two of the wells, 299-E26-10 and 299-E26-14, met the criterion of having saturated screened intervals less than 6.1 m (20 ft) in length. The other two wells exceeded this criterion, but only by 0.4 m (1.3 ft) for 299-E26-77 and by 0.2 m (0.7 ft) for 299-E26-79.

4.4.2 Casing Elevation Resurveys

Table 4-23 provides reference point (i.e., casing) elevations for the wells in the LERF network. The table shows the casing elevation values in use prior to the start of this study (the baseline surveys), the new casing elevation values determined for this study (see Appendix A for the survey data reports), and the difference between the two. The absolute value of the differences between the baseline surveys and the new surveys ranged from 0.001 m (1 mm) to 0.003 m (3 mm), with a median value of 0.002 m (2 mm). Similar to the other sites in this study, casing elevation surveys are not a substantial source of variability in water-level measurements.

4.4.3 Gyroscope Surveys

The results of the wellbore deviation surveys for LERF are shown in Table 4-24 (see Appendix B for the gyroscope survey reports). The values in Table 4-24 represent the difference between the measured depth to water and the true vertical depth to water (i.e., correction values). These values were determined for the measured depth to water in each well by interpolation between depth stations measured using the gyroscope. The interpolation was performed using a third degree polynomial equation fitted to the gyroscope measurements using least-squares regression. Differences between the measured depth to water and the true vertical depth to water were substantially lower for wells 299-E26-10 and 299-E26-14 (up to 0.012 m [12 mm]) than for wells 299-E26-77 and 299-E26-79 (up to 0.472 m [472 mm]). Wells 299-E26-10 and 299-E26-14 were drilled entirely by cable tool and did not penetrate very far into basalt, whereas wells 299-E26-77 and 299-E26-79 were drilled by cable tool until basalt was encountered, and then by air rotary into the basalt. Most of the saturated screened intervals for the latter two wells are within the basalt flow top. The values in Table 4-24 indicate that wellbore deviation was the largest source of variability in the LERF water-level measurements.

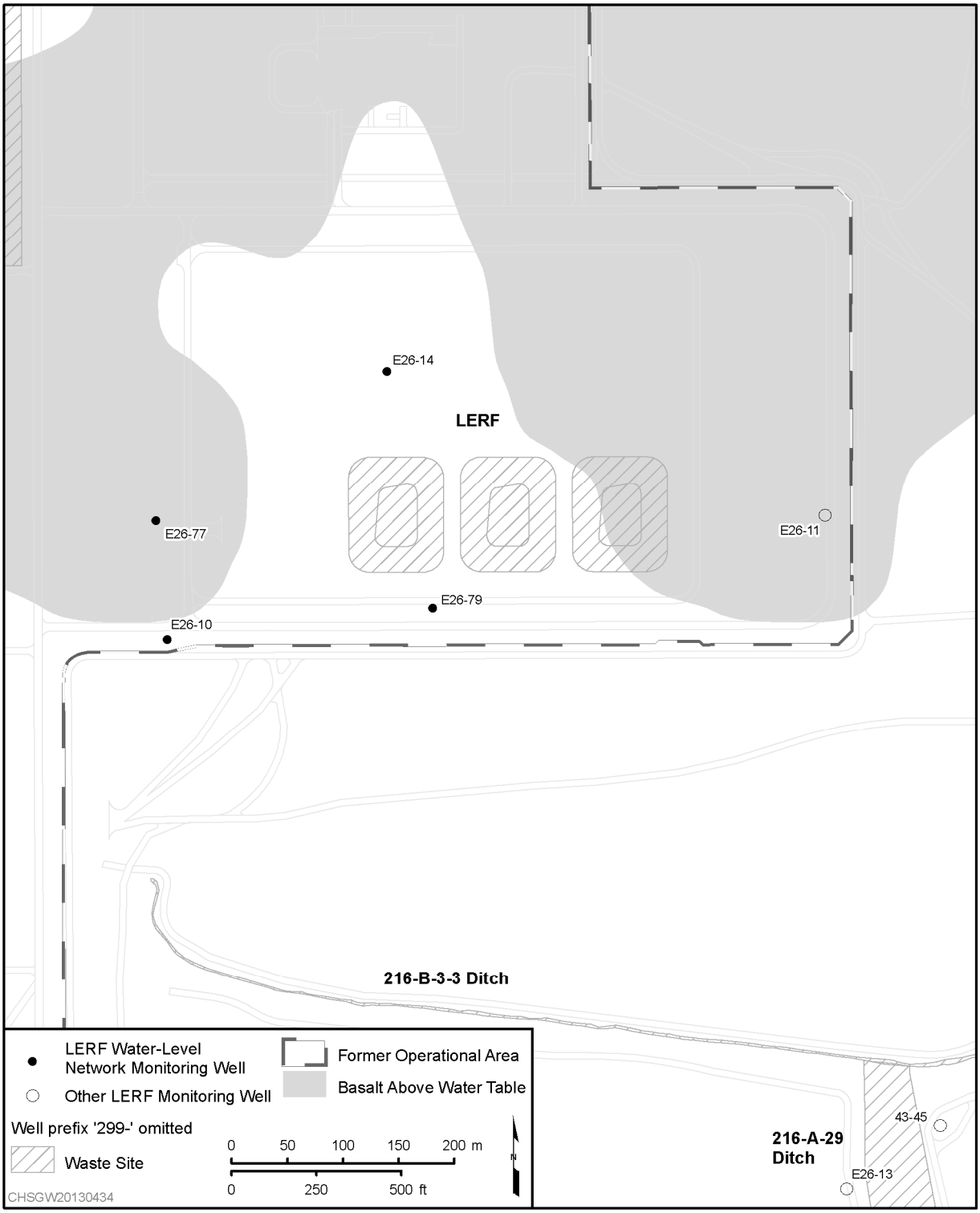


Figure 4-30. Water-Level Monitoring Well Network for the LERF

Table 4-22. LERF Water-Level Monitoring Well Network and Well Construction Details

Well Name	Screen Top (m bls)	Screen Bottom (m bls)	Water Level (m bls)*	Length of Saturated Screened Interval (m)
299-E26-10	58.1	62.8	61.5	1.3
299-E26-14	59.7	65.8	60.6	5.2
299-E26-77	61.2	68.8	62.3	6.5
299-E26-79	59.5	67.1	60.8	6.3

* Measured during 2008, except for 299-E26-14, which was measured during 2011.

bls = below land surface

Table 4-23. Reference Point Elevation Surveys for the LERF Wells

Well	Baseline Survey Date	Baseline Survey Source	Baseline Survey (m NAVD88)*	New Survey (m NAVD88)*	Difference (m)
299-E26-10	8/19/1994	USACE(JECA)	184.420	184.418	-0.002
299-E26-14	10/31/2011	Fluor	183.221	183.224	+0.003
299-E26-77	10/8/2008	Fluor	184.771	184.772	+0.001
299-E26-79	10/8/2008	Fluor	183.114	183.115	+0.001

* All elevations are for the top of the outermost casing.

NAVD88 = *North American Vertical Datum of 1988*

USACE(JECA) = J.E. Chance and Associates for the U.S. Army Corps of Engineers

Table 4-24. Wellbore Deviation Survey Results for the LERF Well Network

Well	Correction Values*	
	(ft)	(m)
299-E26-10	0.04	0.012
299-E26-14	0.02	0.006
299-E26-77	0.86	0.262
299-E26-79	1.55	0.472

* Difference between the measured depth to water and the true vertical depth to water.

4.4.4 Barometric Response Analyses

Automated water-level measurements were collected from all four wells in the LERF network using absolute pressure transducers. The data were analyzed to determine the characteristics of the well water-level responses to barometric pressure changes using the method described in Section 3.6. The barometric water-level response functions for all four wells are shown in Figure 4-31.

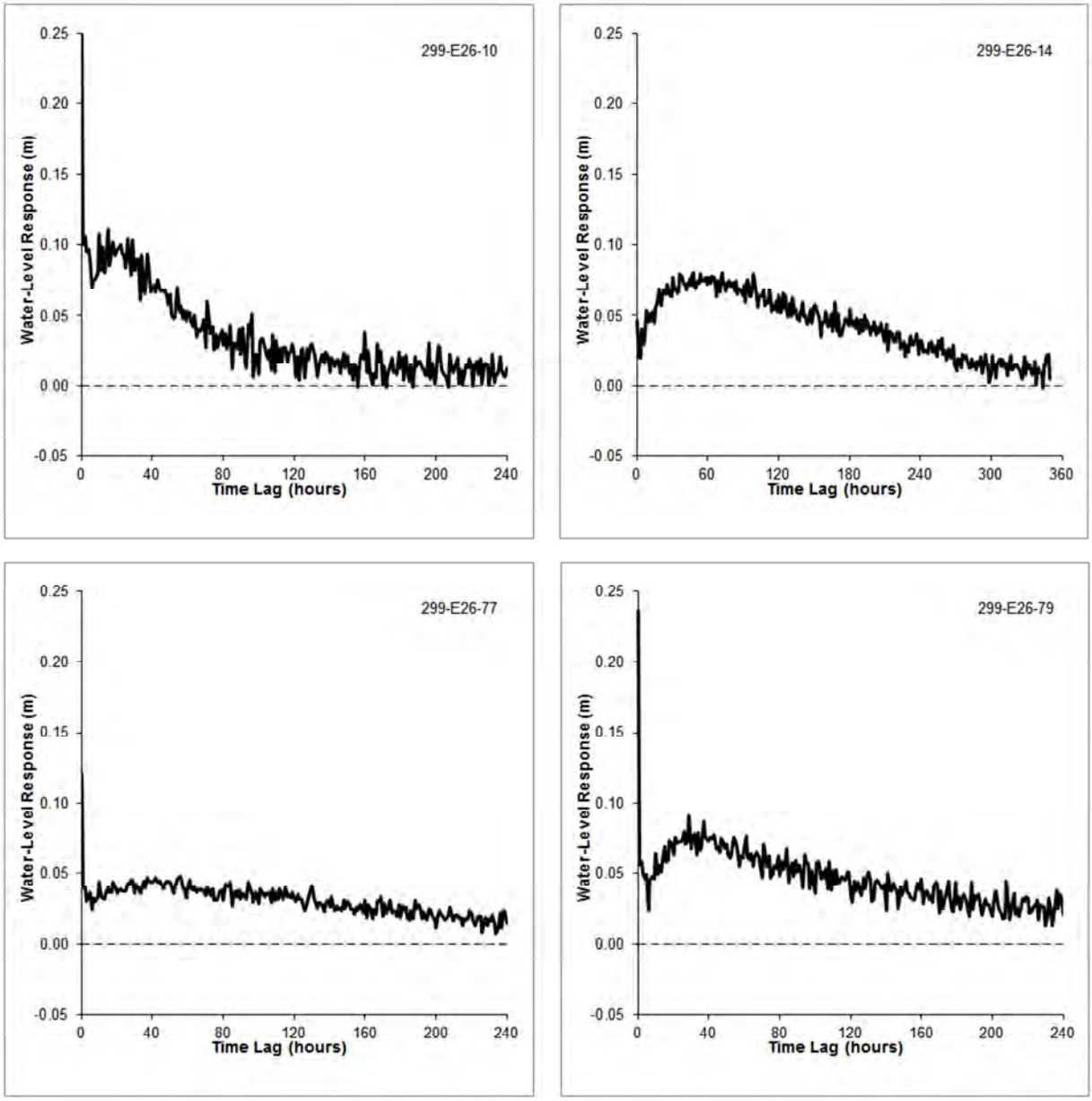


Figure 4-31. Barometric Water-Level Response Functions for Wells 299-E26-10, 299-E26-14, 299-E26-77, and 299-E26-79 (LERF)

As expected, all of the wells in the LERF water-level network exhibited barometric water-level responses indicative of an unconfined aquifer. Three of the four wells had relatively high initial response function coefficients followed immediately by a much lower value. The reason for this is not known. Delayed responses occurred in all of the wells, but as explained in Section 3.6.2, it is not possible to distinguish if this is caused by wellbore storage/skin effects or the restriction of air movement between the atmosphere and the wellbore. The displacement effect responses observed in two wells at LLWMA-1 (Section 4.1.4) and in all of the wells at the IDF/PUREX Cribs (Section 4.2.4) were not observed at the LERF.

The manual water-level measurements for IDF/PUREX Cribs were normalized to a constant barometric pressure using deconvolution, as described in Section 3.6.1. The adjustment values (absolute values) across all of the wells and measurement dates had a mean of 0.004 m (4 mm), a 90th percentile of 0.010 m (10 mm), and a maximum of 0.018 m (18 mm). The adjustments for the data set with the maximum adjustments after well 299-E26-14 was drilled are shown in Table 4-25, which shows the observed hydraulic heads, the hydraulic heads normalized to a constant barometric pressure, and the difference for the measurements collected on December 29, 2011. The differences exhibit a range of 0.005 to 0.011 m (5 to 11 mm). The adjustments on this date reduced the range of the data by 0.006 m (6 mm).

Table 4-25. Example Comparison of Observed Hydraulic Heads and Hydraulic Heads Normalized to a Constant Barometric Pressure for LERF

Well	Observed Hydraulic Head (m)	Normalized Hydraulic Head (m)	Difference (m)
299-E26-10	121.843	121.838	-0.005
299-E26-14	121.922	121.911	-0.011
299-E26-77	121.850	121.844	-0.006
299-E26-79	121.857	121.847	-0.010
Range (m)	**0.079**	**0.073**	

Note: Water-level measurements were collected on December 29, 2011.

4.4.5 Trend-Surface Analyses

Collection of water levels at LERF wells 299-E26-10, 299-E26-77, and 299-E26-79 began during November 2008. The fourth well, 299-E26-14, was added to the network beginning in December 2011. Results of the trend-surface analyses of the measurements are shown in Table 4-25. There are no results in Table 4-26 for those data sets that contained less than three measurements. This situation occurred when outliers were excluded from the analyses or when a well was missed when the field measurements were collected (this is why the first result in Table 4-26 is for March 2009). Also, when only three wells were used in the analysis, no statistics were possible because three wells fit a plane exactly.

Table 4-26. Final Trend-Surface Analysis Results for LERF (All Corrections Applied and the Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)	Gradient Magnitude (m/m)	Gradient Direction (azimuth)	Goodness of Fit (R^2)	p-Value	Statistically Significant?
Wells 299-E26-10, 299-E26-77, and 299-E26-79						
3/24/2009	0.016	1.5×10^{-4}	175	—	—	—
4/30/2009	0.007	3.3×10^{-5}	143	—	—	—
5/28/2009	0.006	2.5×10^{-5}	312	—	—	—
6/29/2009	0.013	5.5×10^{-5}	75	—	—	—
7/13/2009	0.002	2.0×10^{-5}	198	—	—	—
8/6/2009	0.006	5.7×10^{-5}	186	—	—	—
9/22/2009	0.010	9.4×10^{-5}	181	—	—	—
11/12/2009	0.020	9.1×10^{-5}	140	—	—	—
7/13/2010	0.005	4.9×10^{-5}	193	—	—	—
8/23/2010	0.011	1.1×10^{-4}	196	—	—	—
9/17/2010	0.009	8.5×10^{-5}	185	—	—	—
1/4/2011	0.008	8.1×10^{-5}	198	—	—	—
2/11/2011	0.017	1.6×10^{-4}	182	—	—	—
3/21/2011	0.017	1.7×10^{-4}	196	—	—	—
4/25/2011	0.019	1.5×10^{-4}	205	—	—	—
5/25/2011	0.012	6.8×10^{-5}	221	—	—	—
7/14/2011	0.007	4.8×10^{-5}	343	—	—	—
9/26/2011	0.008	8.1×10^{-5}	198	—	—	—
11/30/2011	0.009	9.0×10^{-5}	195	—	—	—
Averages	**0.011**[a]	**9.3×10^{-5} ($\pm 7.5 \times 10^{-5}$)**[a]	**187 (±34)**[a]	**N/A**	**N/A**	**N/A**
Wells 299-E26-10, 299-E26-14, 299-E26-77, and 299-E26-79						
12/29/2011	0.073	2.7×10^{-4}	195	0.92	0.2858	No
2/28/2012	0.061	2.5×10^{-4}	186	0.93	0.2670	No
4/18/2012	0.074	3.0×10^{-4}	188	0.91	0.2928	No
5/15/2012[b]	0.076	3.1×10^{-4}	181	—	—	—
8/20/2012	0.070	2.8×10^{-4}	188	0.94	0.2348	No
9/11/2012	0.069	2.7×10^{-4}	189	0.95	0.2132	No

Table 4-26. Final Trend-Surface Analysis Results for LERF (All Corrections Applied and the Data Normalized to a Constant Barometric Pressure)

Measurement Date	Range (m)	Gradient Magnitude (m/m)	Gradient Direction (azimuth)	Goodness of Fit (R^2)	*p*-Value	Statistically Significant?
Averages	**0.071**	**2.8×10^{-4} ($\pm 0.1 \times 10^{-4}$)**	**188 (±3)**	**0.93**	**0.2587**	**N/A**

a. Excludes 5/28/2009, 6/29/2009, and 7/14/2011

b. No statistics – one measurement was an outlier so result is based on 3 measurements.

N/A = not applicable

The trend-surface analyses results for wells 299-E26-10, 299-E26-77, and 299-E26-79 indicate a wide variation in magnitude and direction. Excluding the results for May 28, 2009; June 29, 2009; and July 14, 2011 (which appear substantially different from the other results and are discussed below), the gradient magnitude ranged over an order of magnitude from 2.0×10^{-5} to 1.7×10^{-4} m/m, and the direction ranged from 143 degrees (southeast) to 221 degrees (southwest). The average results were 9.3×10^{-5} ($\pm 7.5 \times 10^{-5}$) m/m with a direction of 187 (±34) degrees (south).[18,19] The mean range of the measurements was 0.011 m (11 mm) which is within the ±0.006 m (±6 mm) error estimated for the measurements at LLWMA-1. Thus, it could be argued that the results for the initial three wells were more indicative of remaining error in the measurements than indicative of the hydraulic gradient, but these results were confirmed when the fourth well was added.

The trend-surface results for May 28, 2009; June 29, 2009; and July 14, 2011, indicated gradient directions of northwest, east-northeast, and north-northwest, respectively (Table 4-26). The first two (May and June 2009) suggest the occurrence of a temporary flow reversal toward the north. This correlates with higher discharges to the TEDF between March and June 2009 (Figure 4-9). The July 2011 reversal appears to be an anomalous result. Columbia River stage was high during 2011, but the largest water-level response in the 200 East Area occurred later than July 2011.

The trend-surface analysis results were much less variable when the fourth well, 299-E26-14, was added to the network. Between December 2011 and September 2012, the gradient magnitude averaged 2.8×10^{-4} ($\pm 0.1 \times 10^{-4}$) m/m with a direction of 188 (±3) degrees. The water-level elevation at well 299-E26-14 is higher than in the other unconfined wells. For instance, the water-level elevation for December 2011 was 121.911 m (NAVD88) compared to a range of 121.838 to 121.847 m (NAVD88) for the other three wells. The higher water-level elevation at 299-E26-14 resulted in a higher gradient magnitude being calculated when including this well in the trend-surface analyses. Thus, the magnitude of the hydraulic gradient changes somewhere between 299-E26-14 and the other unconfined wells located to the south and southwest suggesting that the aquifer transmissivity is slightly lower at 299-E26-14. This means that there is some regression model error in the trend-surface analyses, which is consistent with the fact that none of the results after 299-E26-14 was included are statistically significant. The mean direction after

[18] The large uncertainty is a result of the variability in the results and the use of the standard deviation instead of the standard error to calculate the 90 percent confidence interval. The standard error, which is smaller than the standard deviation, is used to calculate a confidence interval on a mean of means. However, when only three measurements are used in a trend-surface analysis, the results are exact and cannot be considered to be a mean.

[19] The average results using measurements not normalized to a constant barometric pressure were 1.0×10^{-4} ($\pm 0.9 \times 10^{-4}$) m/m with a direction of 191 (±40) degrees azimuth. Thus, the main effect of accounting for barometric pressure changes was to slightly reduce the uncertainty in the results.

including 299-E26-14 (188 degrees) is only one degree different than the mean prior to including this well (187 degrees). This agreement suggests that the trend-surface results for LERF are indicative of the hydraulic gradient direction. Further, even though the gradient magnitude changes within the study area, the calculated magnitude when including well 299-E26-14 should still represent the average hydraulic gradient over the region encompassed by the well network. The trend-surface analyses results for LERF are shown as vectors in Figure 4-32.

4.4.6 Water-Level Trends

The manual water-level measurements collected for this study at LERF, with all corrections applied and the data normalized to a constant barometric pressure, are plotted in Figure 4-33. Overall, the trends are very similar to those observed at LLWMA-1, the IDF/PUREX Cribs, and LLWMA-2. The water table elevation increased during 2009 and did not decline very much in 2010 in response to effluent discharges at the TEDF (Figure 4-9). Slight fluctuations occurred during the second half of 2011 and the second half of 2012 in response to higher than normal Columbia River stage during the summers of 2011 and 2012 (Figure 4-10). Further, Figure 4-33 shows how the water-level elevation in well 299-E26-14 is higher than in the other three wells.

4.4.7 Measurement Accuracy

No attempt was made to estimate the accuracy of the water-level measurements at LERF. This was because the trend-surface results based on three wells were exact, so there were no residuals to use for an error estimate (i.e., ε_j in Equation 3-14 was zero). Also, because of the water-level elevation difference between 299-E26-14 and the other wells, regression model error probably accounts for a large component of the residuals when four wells were used in the trend-surface analyses. Thus, even though an error estimate represents an upper bound on measurement error because regression model error is always confounded with measurement error, it was thought that the model error component at LERF would be too large to result in a meaningful estimate of measurement accuracy. However, it is reasonable to assume that the measurement accuracy achieved was somewhere within the error range determined for the other sites in this study: ±0.006 m (±6 mm) at LLWMA-1, and ±0.019 m (±19 mm) for the IDF/PUREX Cribs.

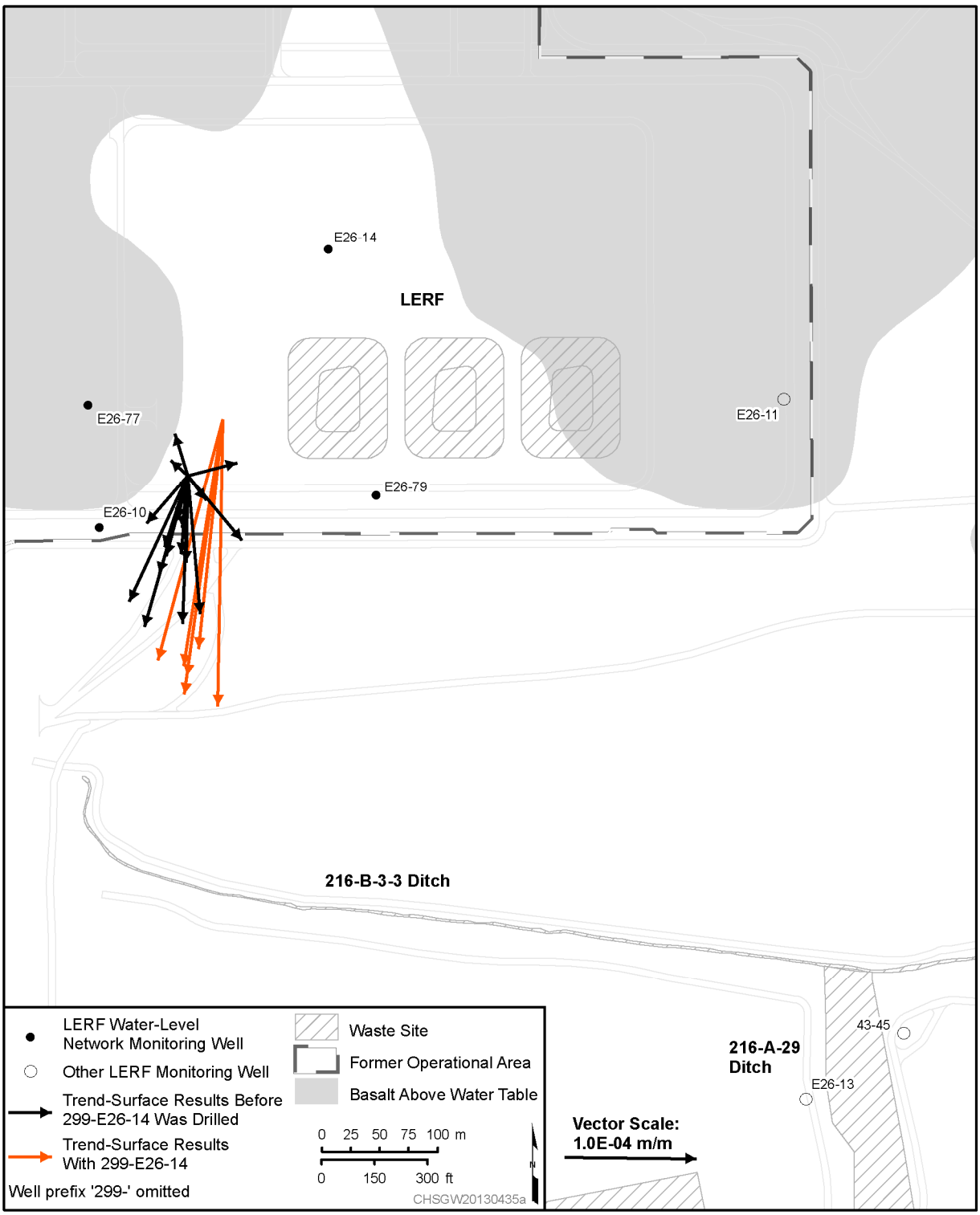


Figure 4-32. Hydraulic Gradient Determinations (Vectors) from March 2009 to September 2012 for the LERF

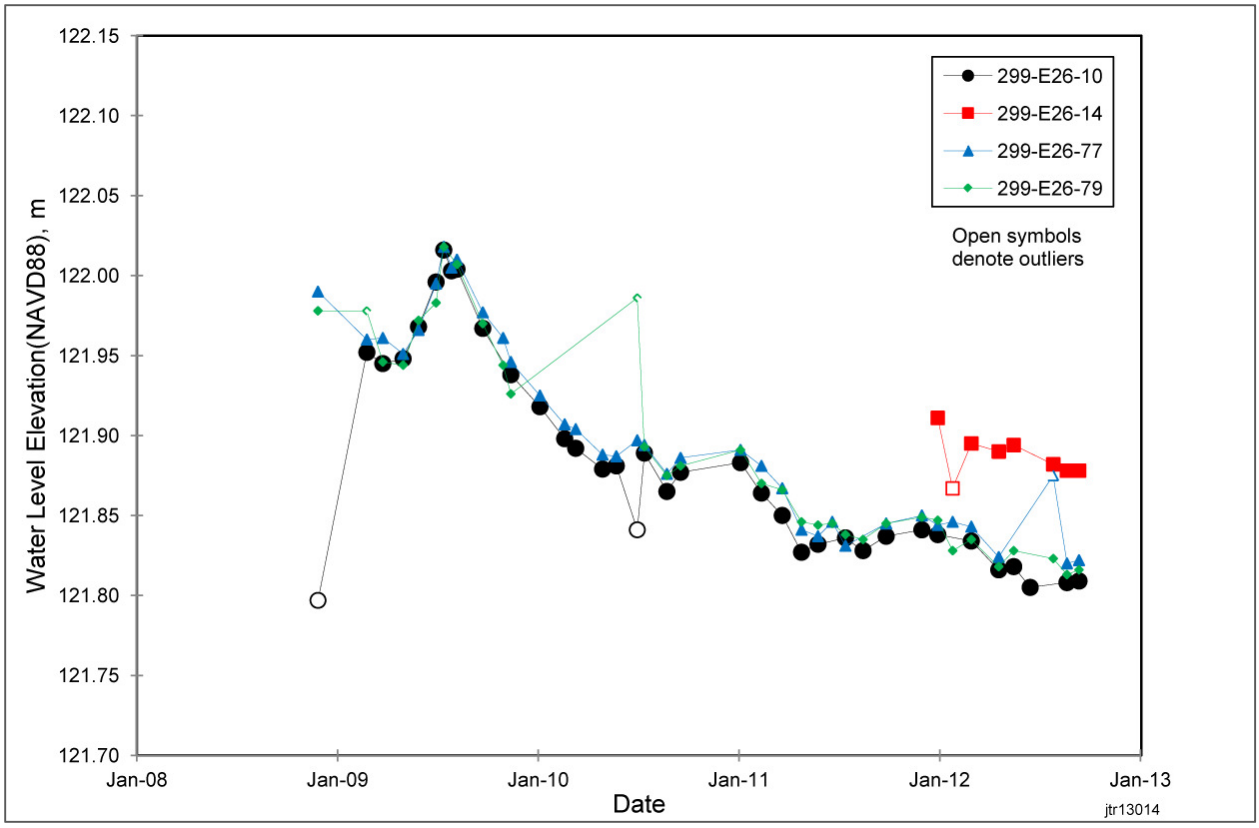


Figure 4-33. Hydrograph of Manual Water-Level Measurements for Wells 299-E26-10, 299-E26-14, 299-E26-77, and 299-E26-79 at the LERF

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5 Conclusions and Recommendations

This study demonstrated that it is feasible to determine hydraulic gradients in the 10^{-6} to 10^{-5} m/m range for at least some locations in the 200 East Area using water-level measurements. This was accomplished by mitigating sources of error or variability in water-level measurements. These sources of error or variability include accuracy of the casing elevation surveys, deviations of the wellbores from vertical, barometric pressure fluctuations, representativeness of the well water level to the water table elevation, and measurement device accuracy. The gradient was measured successfully at LLWMA-1, the IDF/PUREX Cribs, and LERF, but it was found that the gradient could not be measured at LLWMA-2 with the existing monitoring well network.

5.1 Conclusions

The following general conclusions resulted from this study:

- The largest source of error in water-level measurements in the 200 East Area was found to be deviations of the wellbores from vertical. In fact, water-level measurements could not be used at all to determine hydraulic gradients unless this source of error was mitigated by performing gyroscope surveys of the wells. The magnitude of this source of error across all of the wells ranged from 0.000 to 0.472 m (472 mm), with a median of 0.018 m (18 mm) and an average of 0.056 m (56 mm).

- The casing elevations for all of the wells in this study were determined using a highly accurate leveling technique. While this improved the accuracy of the hydraulic gradient determinations, the differences between the new surveys and the pre-existing (i.e., baseline) surveys were not very large. Differences between the baseline surveys and the new surveys ranged from 0.000 to 0.013 m (13 mm), with a median of 0.003 m (3 mm) and an average of 0.004 m (4 mm). These values indicate that the normal well casing elevation surveys performed in the 200 East Area are quite accurate regardless of the survey method or benchmarks used. Thus, addressing this source of variability in the water-level measurements is not sufficient to determine hydraulic gradients in the 200 East Area without also accounting for wellbore deviation.

- With only a few exceptions, water-level fluctuations in the wells in response to barometric pressure changes were found to be small. The maximum well water-level barometric response coefficients (i.e., barometric efficiencies) across all of the wells ranged from 0.02 to 0.88, with a median of 0.11 and an average of 0.17. However, 75 percent of the wells had maximum response function coefficients less than 0.20, and 92 percent of the wells had a maximum coefficient less than 0.50. While normalization of the water-level measurements to a constant barometric pressure generally improved the trend-surface results, the effect was not large. The main effect of accounting for barometric pressure fluctuations was to slightly reduce the uncertainty of the results.

- A new characteristic shape for water-level barometric response functions was discovered. The new shape has response function coefficients less than zero (i.e., negative barometric efficiencies) indicating a direct relationship between water levels and barometric pressure changes (e.g., increases in barometric pressure causing *increases* in well water-level elevations) rather than the expected inverse relationship (e.g., increases in barometric pressure causing *decreases* in well water-level elevations). This was attributed to spatial variations in vadose zone transmission properties. These variations result in barometric pressure changes being propagated from land surface to the aquifer faster in some areas than in others causing total head variations in the aquifer. The total head variations lead to the lateral displacement of water in the aquifer causing a reverse water-level response in areas where barometric pressure changes propagate more slowly through the vadose zone. Two of the wells at LLWMA-1 and all of the wells at IDF/PUREX Cribs exhibited the displacement

effect response. Because all of the wells at IDF/PUREX Cribs were affected, the vadose zone diffusivity in this area is lower than elsewhere in the 200 East Area.

- The hypothesis that large seasonal changes in Columbia River stage affect the water table in the 200 East Area was confirmed. There was a clear association between high Columbia River stages during the summers of 2011 and 2012 and the change in water-level elevations throughout the 200 East Area and changes in the groundwater flow direction at LLWMA-1.
- Water levels in all of the wells exhibited the same trends and responded to the same stressors: discharges to the TEDF and large seasonal changes in Columbia River stage. Thus, stressors affect water levels over a large area in the highly transmissive aquifer beneath the 200 East Area and vicinity.
- The accuracy achieved in the water-level measurements was estimated for three of the four sites in this study. The results were ±0.006 m (±6 mm) at LLWMA-1, ±0.019 m (±19 mm) for the IDF/PUREX Cribs, and ±0.008 m (±8 mm) for LLWMA-2.

The hydraulic gradient determinations for the specific RCRA sites in this study are described in the following paragraphs. The results are summarized in Table 5-1.

Table 5-1. Summary of Hydraulic Gradient Determinations

RCRA Site	Date Range	Average Hydraulic Gradient Magnitude (m/m)	Average Hydraulic Gradient Direction (azimuth)
LLWMA-1	9/2005 to 1/2007	8.0×10^{-6} ($\pm 0.9 \times 10^{-6}$)	343 (±5)
	8/2008 to 9/2008	9.6×10^{-6}	184
	10/2008 to 6/2011	Indeterminate; hydraulic gradient too low to measure	
	7/2011 to 9/2012	2.5×10^{-5} ($\pm 0.4 \times 10^{-5}$)	175[a] (±8)
IDF/PUREX Cribs	6/2008 to 3/2011	2.2×10^{-5} ($\pm 0.3 \times 10^{-5}$)	64 (±12)
	6/2011 to 9/2012	2.3×10^{-5} ($\pm 0.2 \times 10^{-5}$)	96 (±6)
LLWMA-2	3/2009 to 9/2012	Indeterminate; hydraulic gradient too low to measure	
LERF	3 wells[b] (3/2009 to 11/2011)	9.3×10^{-5} ($\pm 7.4 \times 10^{-5}$)	187 (±34)
	4 wells[c] (12/2011 to 9/2012)	2.8×10^{-4} ($\pm 0.1 \times 10^{-4}$)	188 (±3)

a. Result is an average applicable to the entire region encompassed by the LLWMA-1 water-level network. Water table mapping indicates that the flow direction directly beneath LLWMA-1 is more toward the southeast.

b. Wells 299-E26-10, 299-E26-77, and 299-E26-79.

c. Wells 299-E26-10, 299-E26-14, 299-E26-77, and 299-E26-79.

IDF = Integrated Disposal Facility
LERF = Liquid Effluent Retention Facility
LLWMA = low-level waste management area
PUREX = Plutonium-Uranium Extraction
RCRA = *Resource Conservation and Recovery Act of 1976*

5.1.1 Low-Level Waste Management Area 1

The hydraulic gradient in the LLWMA-1 vicinity was measured successfully. Between September 2005 and January 2007, the average hydraulic gradient was 8.0×10^{-6} ($\pm 0.9 \times 10^{-6}$) m/m toward the north-northwest (343 [±5] degrees azimuth). During August and September 2008, the hydraulic gradient temporarily reversed. The average hydraulic gradient during these months was 9.6×10^{-6} m/m toward the south (184 degrees azimuth). This reversal was attributed to a high Columbia River stage during the summer of 2008. From October 2008 through June 2011, the hydraulic gradient was indeterminate and groundwater flow was interpreted to be nearly stagnant, but the trend-surface analyses suggest that flow was slowly changing toward the north during this time. Beginning in the summer of 2011, the hydraulic gradient direction reversed again and remained toward the south through the end of the study period. The average hydraulic gradient from July 2011 through September 2012 was 2.5×10^{-5} ($\pm 0.4 \times 10^{-5}$) m/m toward the south (175 [±8] degrees azimuth). The southward flow was attributed to high Columbia River stage during the summers of 2011 and 2012 combined with the lack of large-volume discharges to the TEDF during this time. These hydraulic gradient determinations represent spatial averages across the entire LLWMA-1 well network. Mapping of water levels for August 2011 indicated that the flow direction directly beneath LLWMA-1 is more toward the southeast.

5.1.2 Integrated Disposal Facility/PUREX Cribs

The hydraulic gradient was successfully measured at the IDF/PUREX Cribs, although the small size of the study area and variability in the water-level measurements required that wells with high residuals be removed from the trend-surface analyses (see Section 4.2.5 for details). Between June 2008 and March 2011, the average hydraulic gradient was 2.2×10^{-5} ($\pm 0.3 \times 10^{-5}$) m/m with a direction of 64 (±12) degrees (east-northeast). Beginning in June 2011, the average direction of the hydraulic gradient changed to 96 (±6) degrees (east)[20], but the gradient magnitude remained essentially the same at 2.3×10^{-5} ($\pm 0.2 \times 10^{-5}$) m/m. This change in the hydraulic gradient direction correlated with the flow reversal observed at LLWMA-1 beginning in the summer of 2011. Based on the movement of contaminant plumes, the groundwater flow direction at the IDF/PUREX Cribs is interpreted to change across the study area from northeast in the western part of the network to southeast in the eastern portion.

5.1.3 Low-Level Waste Management Area 2

It was found that the hydraulic gradient magnitude at LLWMA-2 was too low to measure. A factor contributing to this result was that many of the wells were located generally along a line, which is a poor spatial distribution for trend-surface analyses.

5.1.4 Liquid Effluent Retention Facility

The water-level monitoring well network at LERF initially consisted of three wells until a fourth well was drilled and added to the network in December 2011. The average results for the initial three wells (November 2008 through November 2011) indicated a hydraulic gradient of 9.3×10^{-5} ($\pm 7.4 \times 10^{-5}$) m/m with a direction of 187 (±34) degrees (south). After including the fourth well, the gradient averaged 2.8×10^{-4} ($\pm 0.1 \times 10^{-4}$) m/m with a direction of 188 (±3) degrees. The water-level elevation is higher at the new well, 299-E26-14, which accounts for the higher gradient magnitude. Thus, the magnitude of the hydraulic gradient changes somewhere between 299-E26-14 located north of the LERF and the other three wells located to the south and west of the facility.

[20] During the first half of 2013, the hydraulic gradient had apparently shifted back toward the east-northeast, although additional measurements are needed for confirmation.

5.2 Recommendations

As a result of the findings presented in this report, the following recommendations are made:

- Because the magnitude of wellbore deviation error is often larger than water-level elevation differences between wells, gyroscope surveys must be performed in all wells used for hydraulic gradient determinations in the 200 East Area and vicinity. Under no circumstances should wells that have not been surveyed with a gyroscope be used for hydraulic gradient determinations in this area.
- Highly accurate casing elevation resurveys should continue to be performed whenever additional wells are included in the low-gradient water-level monitoring well network. Although it was found that the baseline casing elevation surveys for the wells in this study were quite accurate, the resurveys did improve both the quality of the results and their technical defensibility. Additional surveys should be performed in the same manner used for this study: survey to a common benchmark using an infrared leveling device, an invar rod, average of double runs between wells, and close on the starting point to evaluate the misclosure.
- Well water-level barometric response characteristics should continue to be determined for all wells used for hydraulic gradient determinations in the 200 East Area and vicinity. Although many wells exhibit only small water-level responses to barometric pressure changes, some wells in this study exhibited larger responses. For example, three wells had peak response function coefficients greater than 0.50.
- To further evaluate the effects of seasonal changes in Columbia River stage, water-level measurements should be periodically collected from wells along the high-conductivity paleochannel from north of the 200 East Area, through Gable Gap, to west of the 100-BC Area. The region southeast of the 200 East Area should also be monitored. These measurements can be used to determine the long-term flow direction through Gable Gap and will provide needed information for groundwater flow and transport model calibration.

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Appendix A

Monitoring Well Casing Elevation Survey Reports

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Appendix A

Monitoring Well Casing Elevation Survey Reports

This appendix contains reports for the casing elevation resurveys performed for this study. The casing elevations were resurveyed using a highly accurate, differential leveling method. The leveling instrument used was the Trimble DiNi 0.7 mm digital level, and a graduated one-piece invar rod was used for the sightings. The leveling instrument has a stated accuracy of 0.7 mm/km (0.004 ft/mi) horizontal distance. All leveling lines between the benchmark and a well, or between wells, were double surveyed and averaged. The leveling lines were closed to allow for misclosure determinations, and the misclosure values were pro-rated throughout each line.

The survey reports are presented in six packages. Surveys for the 10-well network at Low-Level Waste Management Area 1 (LLWMA-1) were performed in December 2007. This was followed by the surveys for the Integrated Disposal Facility (IDF)/Plutonium-Uranium Extraction (PUREX) Cribs well network, which were performed during February 2008. The additional four wells at LLWMA-1 (forming the 14-well network) were surveyed in July 2008. Surveys conducted for LLWMA-2 and the initial three wells at the Liquid Effluent Retention Facility (LERF) were performed during March 2009, and two additional wells were included in May 2009. Finally, the fourth well at LERF (299-E26-14) was resurveyed during January 2012. The survey report packages for IDF/PUREX Cribs and LLWMA-2 contain additional wells that were not included in this study. For example the IDF/PUREX Cribs package contains survey results for wells 299-E18-1 and 299-E17-26, both of which were not included in this study (a gyroscope survey could not be performed in 299-E18-1, and the 299-E17-26 wellbore was severely deviated from vertical). The additional wells included in the LLWMA-2 survey will be used in the future as part of a larger well network for the entire 200 East Area.

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SURVEY DATA REPORT

				Request No. 081-065
Project No.	Title: LLWMA-1 Wells Elevation Survey			File No. 2ET13R26
Job No. 65400811.1225430 CA10	Prepared By N.P. Fastabend	Date 12/31/07	Reviewer Tony Henty	Page 1 of 12

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtain elevations on 10 wells associated with the Low-Level Waste Management Area 1 (LLWMA-1) located in the northwest portion of 200E Area. Vertical network included Wells A4821, A4823, A4833, A4834, A4836, A4852, A4859, A4863, A5219 and C3392. All wells tied to a single control benchmark (HSWB-032) for NAVD88 Datum Reference.	Survey File	OR		
	J.P. McDonald	1		
	E.E. Oliver	1		
	G.G. Kelty	1		
Vertical Datum: NAVD88 (Meters)				

SURVEY RESULTS AND COMMENTS

See Attached Well Survey Data Report Sheets

The following field procedures were followed:

1) Equipment Used: Trimble DiNi 0.7mm Electronic Digital/Barcode Leveling System with Invar Rod
2) Leveled lines between wells were double run
3) Difference of forward and backward sight lengths per setup did not exceed ten meters.
4) Collimation tests to ensure accuracy of the equipment were done periodically during the course of the survey.
5) Misclosures of the three loops comprising the network did not exceed 0.002m.

NOTE: This Survey was performed under the supervision of a Licensed Professional Land Surveyor registered in the State of Washington.

E-NW-246 (09/04)

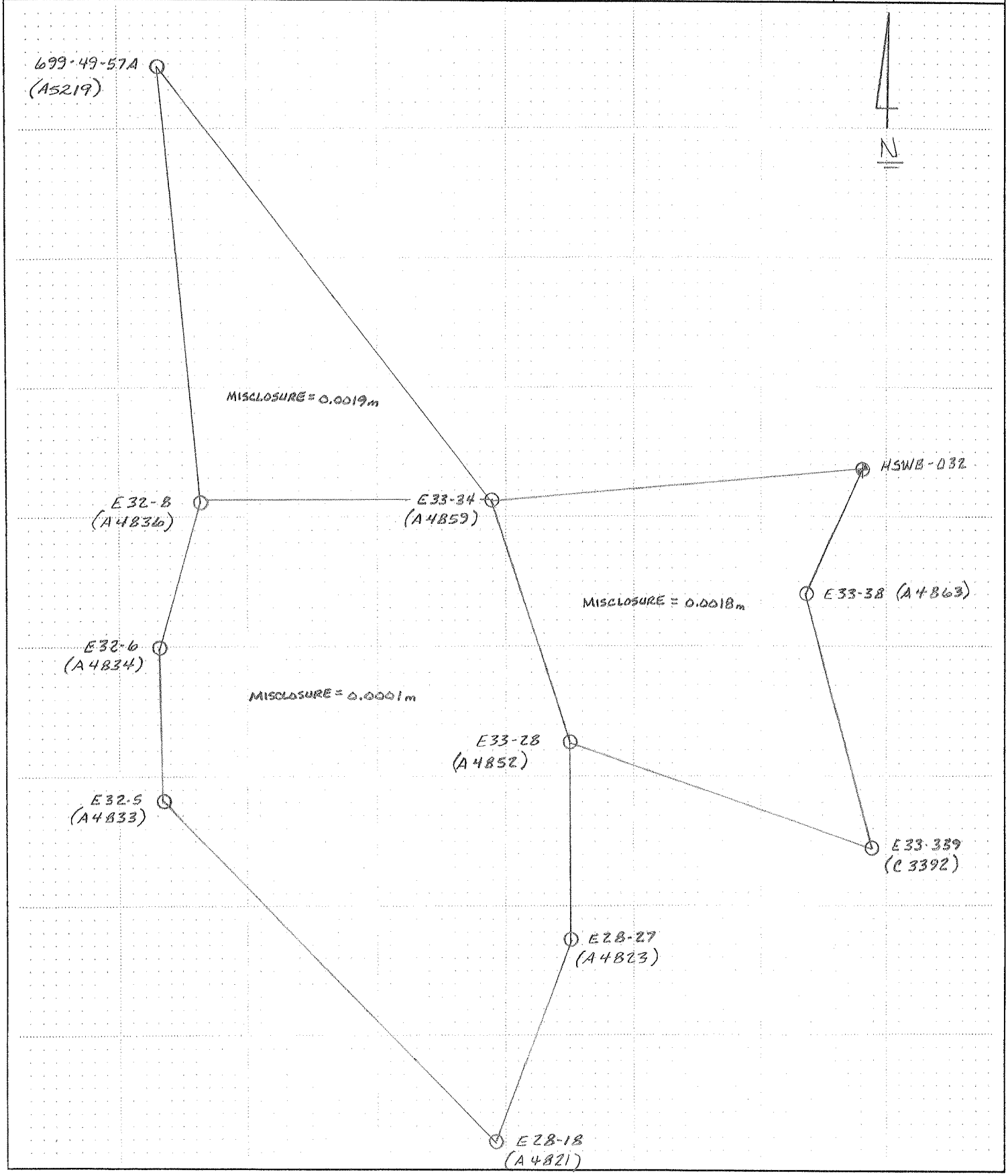
This information is PROPRIETARY and is provided solely for use in conjunction with work managed and controlled by Fluor Federal Services.

FLUOR FEDERAL SERVICES

FIELD SKETCH

Attachment to or Description: LLWMA-1 WELLS VERTICAL SURVEY

Sheet 2 of 12



KEH 0159.02 (03/94)

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4821 (299-E28-18) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

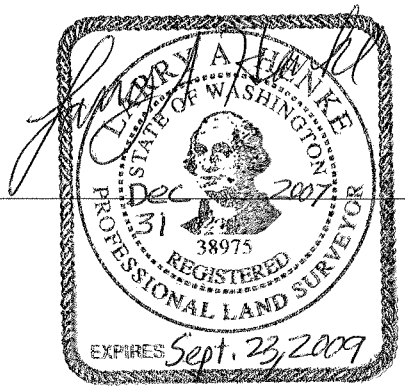
Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4821	299-E28-18				Center of Casing
				212.114	Top Pump Baseplate, N. Edge
				212.104	Top of Casing, N. Edge
				211.292	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod



Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4823 (299-E28-27) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4823	299-E28-27				Center of Casing
				208.468	Top Pump Baseplate, N. Edge
				208.463	Top of Casing, N. Edge
				Destroyed	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
DEC 31 2007
38975
REGISTERED PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4833 (299-E32-5) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4833	299-E32-5				Center of Casing
				209.010	Top Pump Baseplate, N. Edge
				209.005	Top of Casing, N. Edge
				208.086	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE STATE OF WASHINGTON DEC 31 2007 38975 REGISTERED PROFESSIONAL LAND SURVEYOR EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4834 (299-E32-6) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4834	299-E32-6				Center of Casing
				204.457	Top Pump Baseplate, N. Edge
				204.452	Top of Casing, N. Edge
				203.381	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
DEC 31 2007
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4836 (299-E32-8) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4836	299-E32-8				Center of Casing
				197.800	Top Pump Baseplate, N. Edge
				197.795	Top of Casing, N. Edge
				196.743	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009
DEC 31 2007

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4852 (299-E33-28) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4852	299-E33-28				Center of Casing
				203.561	Top Pump Baseplate, N. Edge
				203.548	Top of Casing, N. Edge
				203.070	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
DEC 31 2007
38975
REGISTERED PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4859 (299-E33-34) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4859	299-E33-34				Center of Casing
				194.146	Top Pump Baseplate, N. Edge
				194.141	Top of Casing, N. Edge
				193.246	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
DEC 31 2007
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4863 (299-E33-38) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4863	299-E33-38				Center of Casing
				193.631	Top Pump Baseplate, N. Edge
				193.626	Top of Casing, N. Edge
				193.025	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009
DEC 31 2007

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A5219 (699-49-57A) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A5219	699-49-57A				Center of Casing
				169.733	Top Pump Baseplate, N. Edge
				169.723	Top of Casing, N. Edge
				168.941	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

DEC 31 2007

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-1 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 12/31/07	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well C3392 (299-E33-339) as part of a network of 10 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C3392	299-E33-339				Center of Casing
				203.034	Top Pump Baseplate, N. Edge
				203.029	Top of Casing, N. Edge
				202.303	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in December, 2005 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

SURVEY DATA REPORT

				Request No. 081-066
Project No.	Title: IDF/PUREX Wells Elevation Survey			File No. 2ET12R26
Job No. MEH1NF122543 - 0010-CA10	Prepared By N.P. Fastabend	Date 2/23/08	Reviewer Larry Henke	Page 1 of 15

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtain elevations on 13 wells associated with the IDF/PUREX Wells Network located in the southeast portion of 200E Area. Vertical network included Wells A4736, A4743, A4751, A4753, A4784, B2822, B8500, C3177, C3826, C3827, C3926, C4647 and C4648. All wells tied to a single control benchmark (HSWB-033) for NAVD88 Datum Reference.	Survey File	OR		
	J.P. McDonald	1		
	E.E. Oliver	1		
	G.G. Kelty	1		
Vertical Datum: NAVD88 (Meters)				

SURVEY RESULTS AND COMMENTS

See Attached Sketch and Well Survey Data Report Sheets

The following field procedures were followed:

1) Equipment Used: Trimble DiNi 0.7mm Electronic Digital/Barcode Leveling System with Invar Rod.
2) Leveled lines between wells were double run.
3) Maximum sight length did not exceed 60 meters.
4) Difference of forward and backward sight lengths per setup did not exceed ten meters.
5) Collimation tests to ensure accuracy of the equipment were done periodically during the course of the survey.
6) Misclosures of the two loops comprising the network did not exceed 0.001m.

NOTE: This Survey was performed under the supervision of a Licensed Professional Land Surveyor registered in the State of Washington.

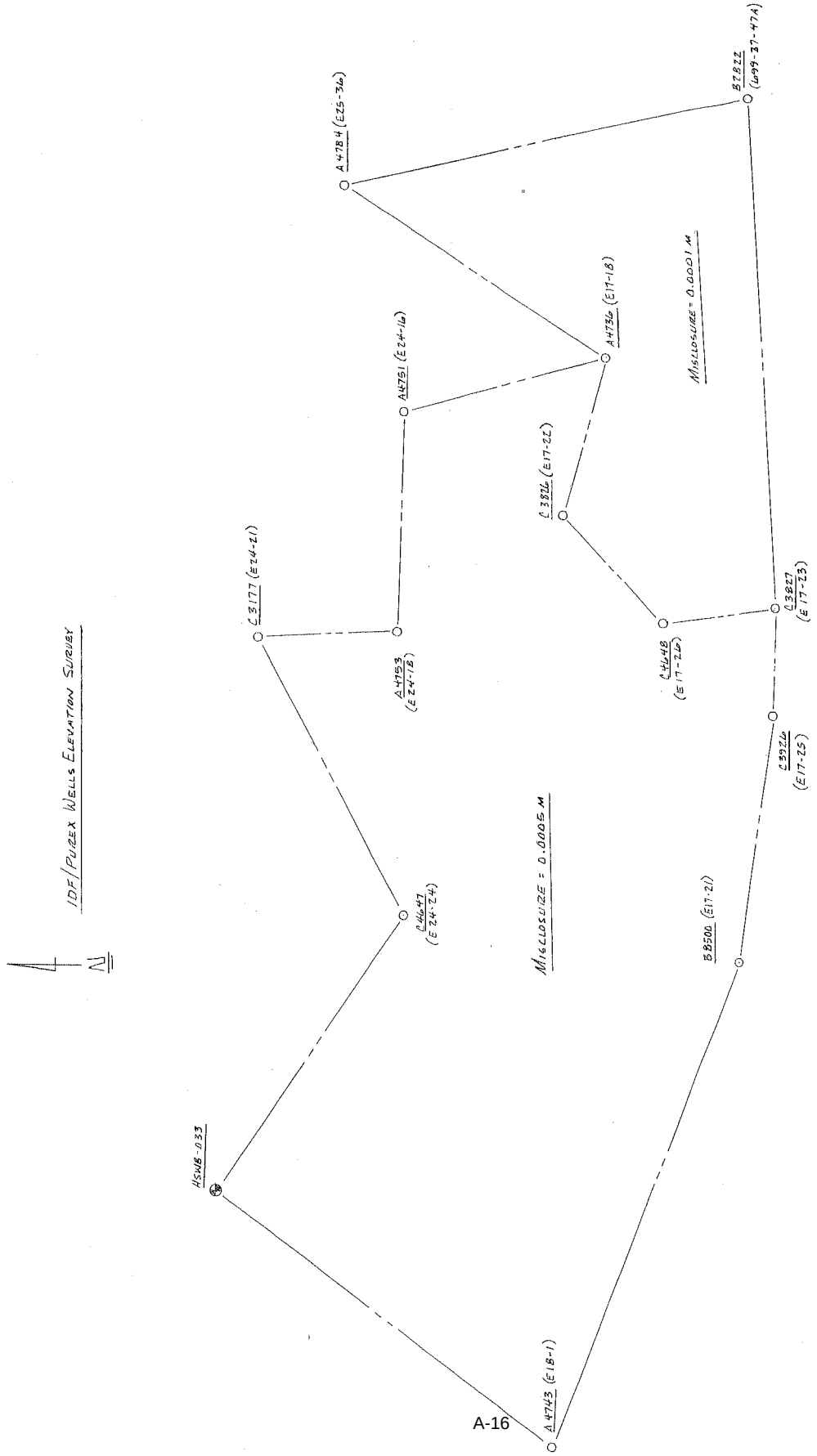
FLUOR FEDERAL SERVICES

FIELD SKETCH

Attachment to or Description:

IDF/PUREX WELLS ELEVATION SURVEY 081-066/2ET12R26 2/23/08

Sheet 2 of 15



WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4784 (299-E25-36) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4784	299-E25-36				Center of Casing
				216.732	Top 6" Outer Casing, N. Edge
				215.960	Top 4" InnerCasing, N. Edge
				215.813	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

LARRY A. HENKE
STATE OF WASHINGTON
Feb 25 2008
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4743 (299-E18-1) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4743	299-E18-1				Center of Casing
				220.648	Top Pumpbase Plate, N. Edge
				220.643	Top Outer Casing, N. Edge
				219.485	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009
Feb 25 2008

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well C3177 (299-E24-21) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C3177	299-E24-21				Center of Casing
				218.650	Top Pumpbase Plate, N. Edge
				218.645	Top Outer Casing, N. Edge
				217.852	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
Feb 25 2008
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well B8500 (299-E17-21) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
B8500	299-E17-21				Center of Casing
				225.302	Top Outer 7 ¾" Casing, N. Edge
				225.113	Top Inner 4" Casing, N. Edge
				224.257	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Feb 25 2008

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well C3926 (299-E17-25) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C3926	299-E17-25				Center of Casing
				225.793	Top Pumpbase Plate, N. Edge
				225.787	Top Outer Casing, N. Edge
				225.025	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
Feb 25 2008
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well C3827 (299-E17-23) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C3827	299-E17-23				Center of Casing
				224.662	Top Pumpbase Plate, N. Edge
				224.656	Top Outer Casing, N. Edge
				223.842	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well C4648 (299-E17-26) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C4648	299-E17-26				Center of Casing
				225.139	Top Pumpbase Plate, N. Edge
				225.132	Top Outer Casing, N. Edge
				224.436	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23, 2009
Feb 25 2008

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well C3826 (299-E17-22) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C3826	299-E17-22				Center of Casing
				221.458	Top Pumpbase Plate, N. Edge
				221.451	Top Outer Casing, N. Edge
				220.583	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
Feb 25 2008
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4736 (299-E17-18) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4736	299-E17-18				Center of Casing
				220.759	Top Outer 6" Casing, N. Edge
				220.002	Top Inner 4" Casing, N. Edge
				219.849	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23, 2009

Feb 25 2008

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4751 (299-E24-16) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4751	299-E24-16				Center of Casing
				220.033	Top Pumpbase Plate, SE. Edge
				220.020	Top Outer Casing, SE. Edge
				219.118	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23 2009

Feb 25 2008

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well C4647 (299-E24-24) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C4647	299-E24-24				Center of Casing
				221.226	Top Pumpbase Plate, N. Edge
				221.220	Top Outer Casing, N. Edge
				220.488	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well A4753 (299-E24-18) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4753	299-E24-18				Center of Casing
				220.349	Top Outer 6" Casing, S. Edge
				219.593	Top Inner 4" Casing, S. Edge
				219.440	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
Feb 25 2008
38975
REGISTERED PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: IDF/PUREX Wells Study	**Prepared By:** S. Wray **Company:** FGG
Date Requested: 11/8/07	**Requestor:** J.P. McDonald (FH)
Date of Survey: 2/23/08	**Surveyor:** L.A. Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FGG)
Description of Work: Obtain survey elevations on Well B2822 (699-E37-47A) as part of a network of 13 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-033 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
B2822	699-E37-47A				Center of Casing
				219.492	Top 6" Outer Casing, N. Edge
				218.726	Top 4" InnerCasing, N. Edge
				218.438	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 0.7mm Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
Feb 25 2008
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

SURVEY DATA REPORT

Request No. 083-297				
Project No.	Title: LLWMA-1 Wells Elevation Survey			File No. 2ET13R26
Job No. MEH1NF1225430-0010	Prepared By S. Wray	Date 7/16/08	Reviewer Larry Henke	Page 1 of 6

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtain elevations on 4 wells associated with the Low-Level Waste Management Area 1 (LLWMA-1) located in the northwest portion of 200E Area. Vertical network included Wells C5197, A5217, A6784 and A4820. All wells tied to a single control benchmark (HSWB-032) for NAVD88 Datum Reference.	Survey File	OR		
	J.P. McDonald	1		
	L.C. Sumner	1		
	G.G. Kelty	1		
Vertical Datum: NAVD88 (Meters)				

SURVEY RESULTS AND COMMENTS

See Attached Well Survey Data Report Sheets

The following field procedures were followed:

1) Equipment Used: Trimble DiNi 12 Electronic Digital/Barcode Leveling System with Invar Rod
2) Leveled lines between wells were double run
3) Difference of forward and backward sight lengths per setup did not exceed ten meters.
4) Collimation tests to ensure accuracy of the equipment were done periodically during the course of the survey.
5) Misclosures of the two loops comprising the network did not exceed 0.003m.

NOTE: This Survey was performed under the supervision of a Licensed Professional Land Surveyor registered in the State of Washington.

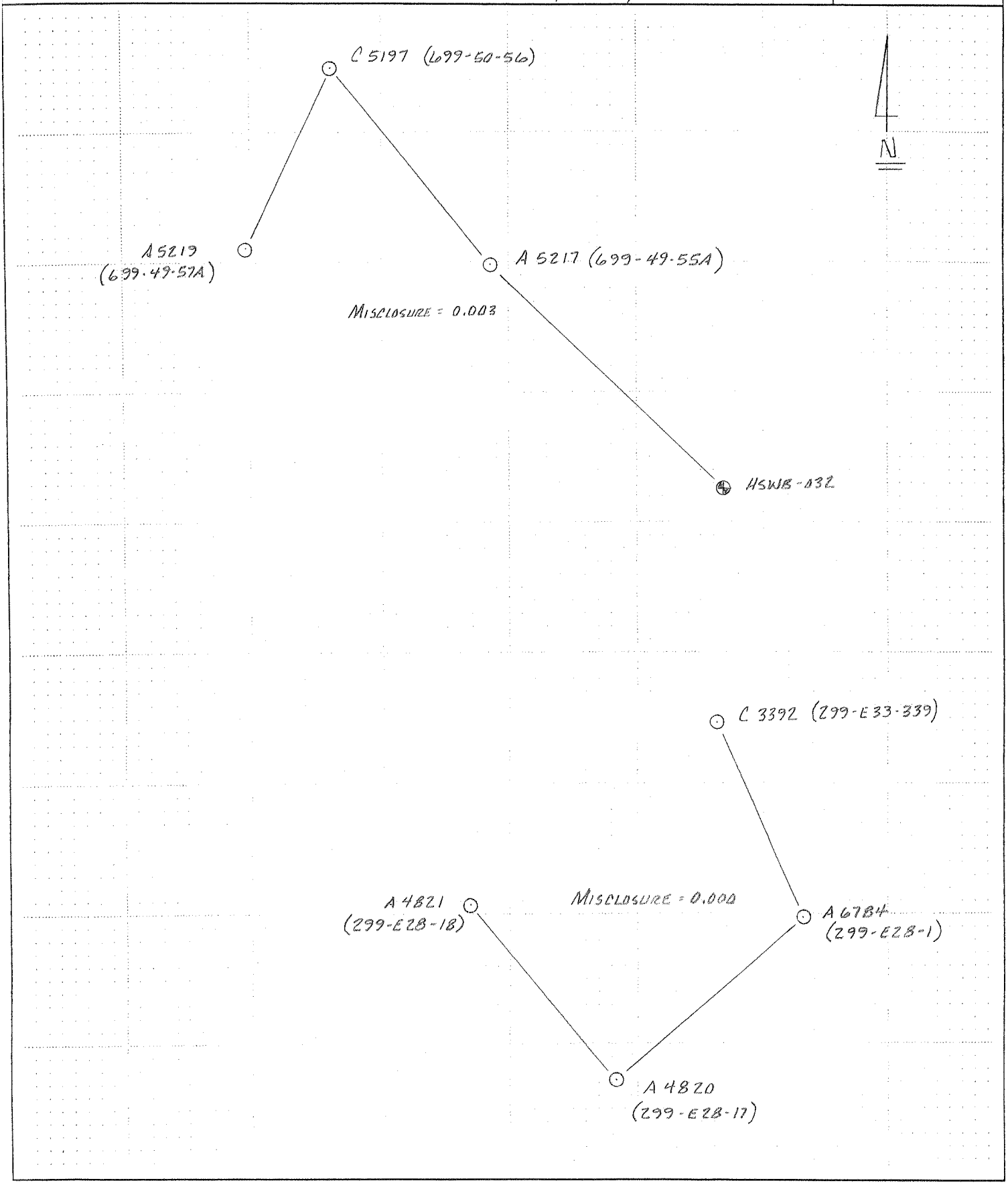
E-NW-246 (09/04)

This information is PROPRIETARY and is provided solely for use in conjunction with work managed and controlled by Fluor Federal Services.

FIELD SKETCH

Attachment to or Description:
LLWMA-1 VERTICAL NETWORK WELLS A4820, A6784, C5197 & C5217

Sheet 2 of 6



WELL SURVEY DATA REPORT

Project: **LLWMA-1 Wells Study**	**Prepared By:** Larry A Henke **Company:** FGG
Date Requested: 4/29/08	**Requestor:** J.P. McDonald(FH)
Date of Survey: 7/2/08	**Surveyor:** Larry A Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N. Fastabend
Description of Work: Obtain survey elevations on Well C5197 (699-50-56) as part of a network of 4 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** METERS **Hanford Area Designation:** 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
NA

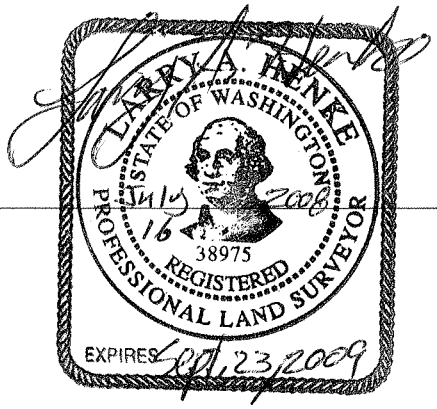
Vertical Control Monuments:
HSWB-032 (Held as single reference to NAVD88 Datum.)

Well ID	Well Name	Easting	Northing	Elevation	
C5197	699-50-56				Center of Casing
				168.909	Top Pump Baseplate, N. Edge
				168.899	Top Casing, N.Edge Stamped "^"on Face
				168.181	Brass Survey Marker

Notes:

EQUIPMENT USED: **TRIMBLE DiNi 12 LEVEL w/ Invar Rod**

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in July, 2008 under my direct supervision, and that the data contained here is true and correct.



Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: **LLWMA-1 Wells Study**	**Prepared By:** Larry A Henke **Company:** FGG
Date Requested: 4/29/08	**Requestor:** J.P. McDonald(FH)
Date of Survey: 7/2/08	**Surveyor:** Larry A Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N. Fastabend
Description of Work: Obtain survey elevations on Well A5217 (699-49-55A) as part of a network of 4 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** METERS **Hanford Area Designation:** 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
NA

Vertical Control Monuments:
HSWB-032 (Held as single reference to NAVD88 Datum.)

Well ID	Well Name	Easting	Northing	Elevation	
A5217	699-49-55A				Center of Casing
					Top Pump Baseplate, N. Edge
				162.866	Top Casing, N. Edge Stamped "X"
					Brass Survey Marker

Notes:

EQUIPMENT USED: **TRIMBLE DiNi 12 LEVEL w/ Invar Rod**

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in July, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
July 16 2008
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: **LLWMA-1 Wells Study**	**Prepared By:** Larry A Henke **Company:** FGG
Date Requested: 4/29/08	**Requestor:** J.P. McDonald(FH)
Date of Survey: 7/2/08	**Surveyor:** Larry A Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N. Fastabend
Description of Work: Obtain survey elevations on Well A6784 (299-E28-1) as part of a network of 4 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** METERS **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
NA

Vertical Control Monuments:
HSWB-032 (Held as single reference to NAVD88 Datum.)

Well ID	Well Name	Easting	Northing	Elevation	
A6784	299-E28-1				Center of Casing
					Top Pump Baseplate, N. Edge
				209.848	Top Casing, N. Edge Stamped "X"
					Brass Survey Marker

Notes:

EQUIPMENT USED: **TRIMBLE DiNi 12 LEVEL w/ Invar Rod**

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in July, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
July 16 2008
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23, 2009

Original to:
Distribution by DIS:

6/6

WELL SURVEY DATA REPORT

Project: **LLWMA-1 Wells Study**	**Prepared By:** Larry A Henke **Company:** FGG
Date Requested: 4/29/08	**Requestor:** J.P. McDonald(FH)
Date of Survey: 7/2/08	**Surveyor:** Larry A Henke FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N. Fastabend
Description of Work: Obtain survey elevations on Well A4820 (299-E28-17) as part of a network of 4 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** METERS **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
NA

Vertical Control Monuments:
HSWB-032 (Held as single reference to NAVD88 Datum.)

Well ID	Well Name	Easting	Northing	Elevation	
A4820	299-E28-17				Center of Casing
				216.699	Top Pump Baseplate, N. Edge
				216.690	Top Casing, N. Edge Stamped "^"on Face
				216.079	Brass Survey Marker

Notes:

EQUIPMENT USED: **TRIMBLE DiNi 12 LEVEL w/ Invar Rod**

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in July, 2008 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

July 16 2008

Original to:
Distribution by DIS:

SURVEY DATA REPORT				Request No. 091-107
Project No.	Title: LLWMA-2 Wells Elevation Survey			File No. 2ET12R26
Job No. PRC/ CACN: 300071-CA40	Prepared By N.P. Fastabend	Date 3/12/09	Reviewer Larry Hanks	Page 1 of 24

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtained elevations on 22 wells associated with the LLWMA-2 Wells Network located in the northeast portion of 200E Area as requested. All wells were tied to a single control benchmark (HSWB-032) for NAVD88 Datum Reference.	Survey File	OR		
	J.P. McDonald	1		
	S.H. Worley	1		
Vertical Datum: NAVD88 (Meters)				

SURVEY RESULTS AND COMMENTS

See Attached Sketch and Well Survey Data Report Sheets

The following field procedures were followed:

1) Equipment Used: Trimble DiNi 12 Electronic Digital/Barcode Leveling System with Invar Rod
2) Leveled lines between wells were double run.
3) Maximum sight length did not exceed 60 meters.
4) Difference of forward and backward sight lengths per setup did not exceed ten meters.
5) Collimation tests to ensure accuracy of the equipment were done periodically during the course of the survey.
6) Misclosures of the four loops comprising the network did not exceed 0.002 meters.

NOTE: This Survey was performed under the supervision of a Licensed Professional Land Surveyor registered in the State of Washington.

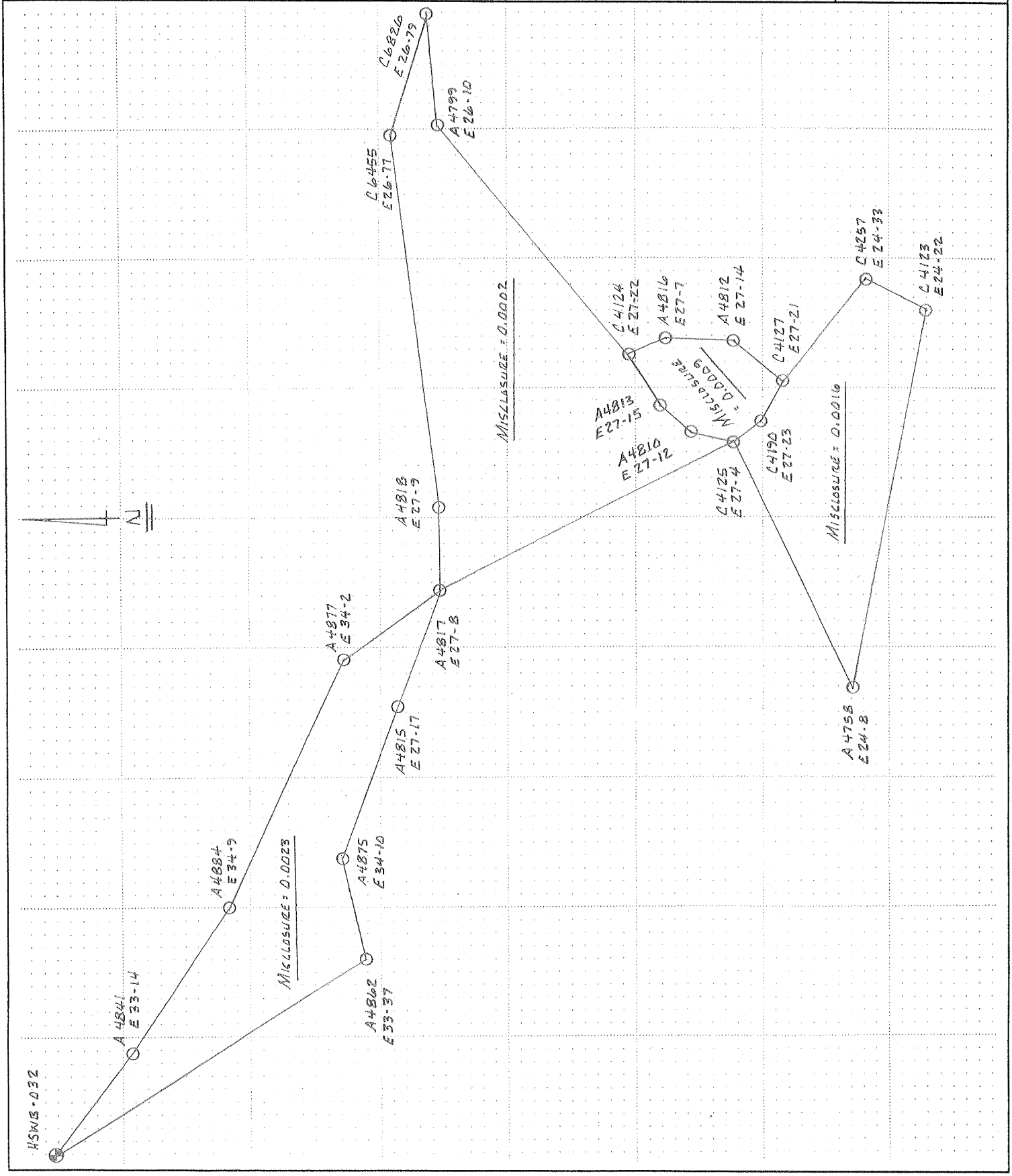
FLUOR FEDERAL SERVICES

FIELD SKETCH

Attachment to or Description:

LLWMA-2 WELLS ELEV. SURVEY 091-107/2ET12R26 3-12-09

Sheet 2 of 24



KEH 0159.02 (03/94)

WELL SURVEY DATA REPORT

Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4841 (299-E33-14) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4841	299-E33-14				Center of Casing
				190.625	Top Pump Baseplate, N. Edge
				190.619	Top of Casing, N. Edge
				189.859	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in March, 2009 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
MAR 12 2009
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4884 (299-E34-9) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4884	299-E34-9				Center of Casing
				192.650	Top Pump Baseplate, N. Edge
				192.643	Top of Casing, N. Edge
				191.818	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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WELL SURVEY DATA REPORT

Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4877 (299-E34-2) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
N/A

Vertical Control Monuments:
HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4877	299-E34-2				Center of Casing
				193.360	Top Pump Baseplate, N. Edge
				193.355	Top of Casing, N. Edge
				192.814	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

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WELL SURVEY DATA REPORT

Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4817 (299-E27-8) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4817	299-E27-8				Center of Casing
				195.513	Top Pump Baseplate, N. Edge
				195.499	Top of Casing, N. Edge
				194.528	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

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Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4815 (299-E27-17) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4815	299-E27-17				Center of Casing
				194.485	Top Pump Baseplate, N. Edge
				194.480	Top of Casing, N. Edge
				193.574	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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WELL SURVEY DATA REPORT

Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4875 (299-E34-10) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4875	299-E34-10				Center of Casing
				196.027	Top Pump Baseplate, N. Edge
				196.022	Top of Casing, N. Edge
				195.178	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4862 (299-E33-37) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4862	299-E33-37				Center of Casing
				200.134	Top Pump Baseplate, N. Edge
				200.129	Top of Casing, N. Edge
				199.185	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4818 (299-E27-9) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4818	299-E27-9				Center of Casing
				192.884	Top Pump Baseplate, N. Edge
				192.872	Top of Casing, N. Edge
				192.294	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well C6455 (299-E26-77) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C6455	299-E26-77				Center of Casing
				184.782	Top Pump Baseplate, N. Edge
				184.772	Top of Casing, N. Edge
				184.000	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

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Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well C6826 (299-E26-79) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C6826	299-E26-79				Center of Casing
				183.125	Top Pump Baseplate, N. Edge
				183.115	Top of Casing, N. Edge
				182.356	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4799 (299-E26-10) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4799	299-E26-10				Center of Casing
				184.423	Top Pump Baseplate, N. Edge
				184.418	Top of Casing, N. Edge
				183.512	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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WELL SURVEY DATA REPORT

Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well C4124 (299-E27-22) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C4124	299-E27-22				Center of Casing
				193.386	Top Pump Baseplate, N. Edge
				193.379	Top of Casing, N. Edge
				192.600	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4813 (299-E27-15) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4813	299-E27-15				Center of Casing
				200.028	Top Pump Baseplate, N. Edge
				200.024	Top of Casing, N. Edge
				199.160	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

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Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4810 (299-E27-12) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4810	299-E27-12				Center of Casing
				202.552	Top Pump Baseplate, N. Edge
				202.547	Top of Casing, N. Edge
				201.542	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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WELL SURVEY DATA REPORT

Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well C4125 (299-E27-4) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C4125	299-E27-4				Center of Casing
				205.574	Top Pump Baseplate, N. Edge
				205.567	Top of Casing, N. Edge
				204.685	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well C4190 (299-E27-23) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C4190	299-E27-23				Center of Casing
				206.567	Top Pump Baseplate, N. Edge
				206.561	Top of Casing, N. Edge
				205.659	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well C4127 (299-E27-21) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C4127	299-E27-21				Center of Casing
				205.731	Top Pump Baseplate, N. Edge
				205.724	Top of Casing, N. Edge
				204.993	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
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Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4812 (299-E27-14) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4812	299-E27-14				Center of Casing
				201.757	Top Pump Baseplate, N. Edge
				201.752	Top of Casing, N. Edge
				200.839	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

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38975
REGISTERED PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4816 (299-E27-7) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4816	299-E27-7				Center of Casing
				194.543	Top Pump Baseplate, N. Edge
				194.536	Top of Casing, N. Edge
				N/A	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in March, 2009 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
MAR 12 2009
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

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Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well C4257 (299-E24-33) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C4257	299-E24-33				Center of Casing
				206.807	Top Pump Baseplate, N. Edge
				206.800	Top of Casing, N. Edge
				206.032	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in March, 2009 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE STATE OF WASHINGTON 38975 REGISTERED PROFESSIONAL LAND SURVEYOR
MAR 12 2009
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well C4123 (299-E24-22) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C4123	299-E24-22				Center of Casing
				210.292	Top Pump Baseplate, N. Edge
				210.286	Top of Casing, N. Edge
				209.555	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in March, 2009 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
MAR 12 2009
38975
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PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

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Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 12/18/08	**Requestor:** J.P. McDonald (FH)
Date of Survey: 3/12/09	**Surveyor:** S. Wray FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A4758 (299-E24-8) as part of a network of 22 Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A4758	299-E24-8				Center of Casing
				210.910	Top Pump Baseplate, N. Edge
				210.897	Top of Casing, N. Edge
				Destroyed	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in March, 2009 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
MAR 12 2009
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

SURVEY DATA REPORT

				Request No. 093-316
Project No.	Title: LLWMA-2 Additional Wells Elevation Survey			File No. 2ET12R26
Job No. PRC/ CACN: 302066-CA40	Prepared By N.P. Fastabend	Date 5/27/09	Reviewer	Page 1 of 4

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtained elevations on 2 additional wells associated with the LLWMA-2 Wells Network located in the northeast portion of 200E Area as requested. Additional Wells: A6672 (299-E27-5) and A6674 (299-E27-18). Wells were referenced to a single control benchmark (HSWB-032) for NAVD88 Datum.	Survey File	OR		
	J.P. McDonald	1		
	S.H. Worley	1		
Vertical Datum: NAVD88 (Meters)				

SURVEY RESULTS AND COMMENTS

See Attached Sketch and Well Survey Data Report Sheets

The following field procedures were followed:

1) Equipment Used: Trimble DiNi 12 Electronic Digital/Barcode Leveling System with Invar Rod
2) Leveled lines between wells were double run.
3) Maximum sight length did not exceed 60 meters.
4) Difference of forward and backward sight lengths per setup did not exceed ten meters.
5) Collimation tests to ensure accuracy of the equipment were done periodically during the course of the survey.
6) Misclosures of the two loops comprising the network did not exceed 0.002 meters.

NOTE: This Survey was performed under the supervision of a Licensed Professional Land Surveyor registered in the State of Washington.

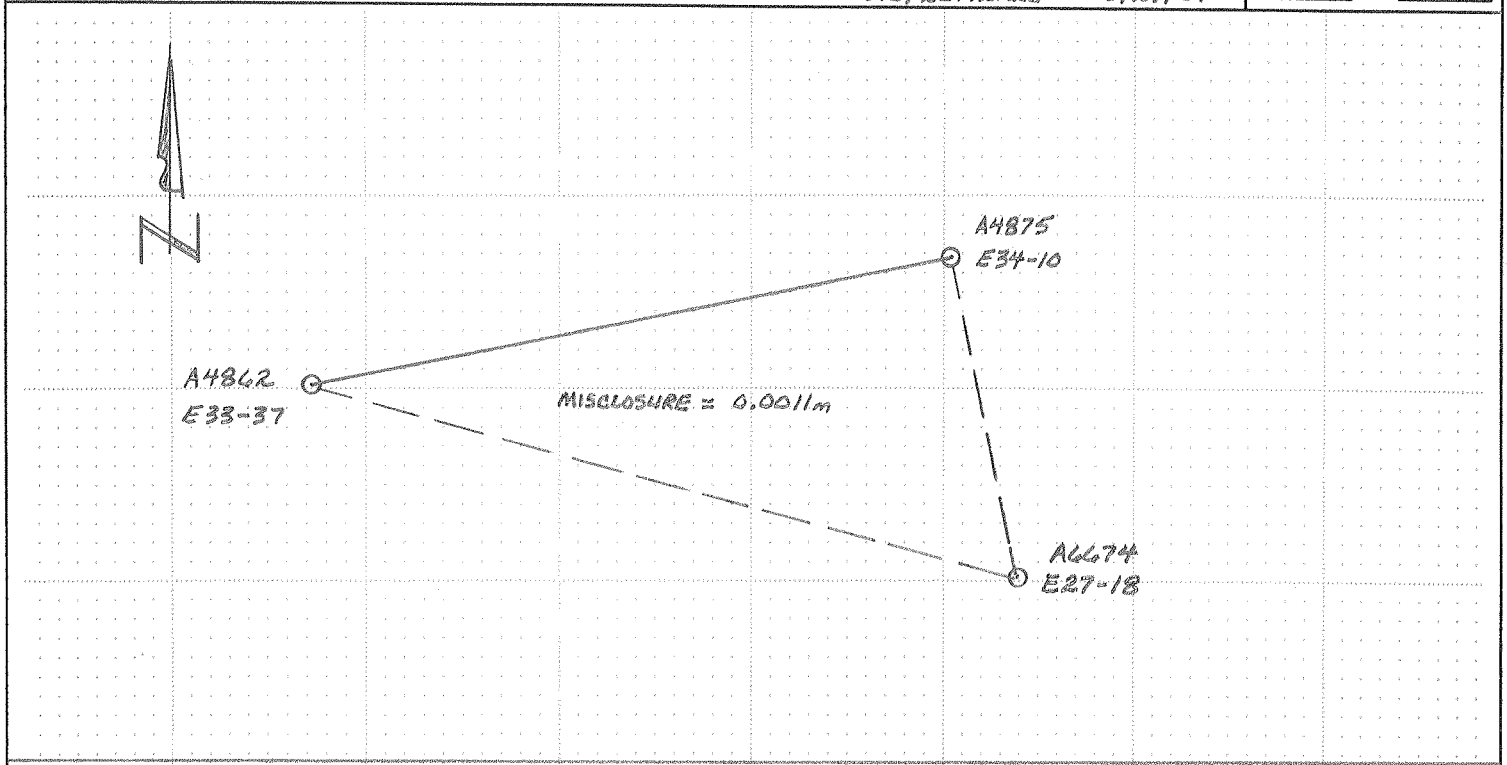
FLUOR FEDERAL SERVICES

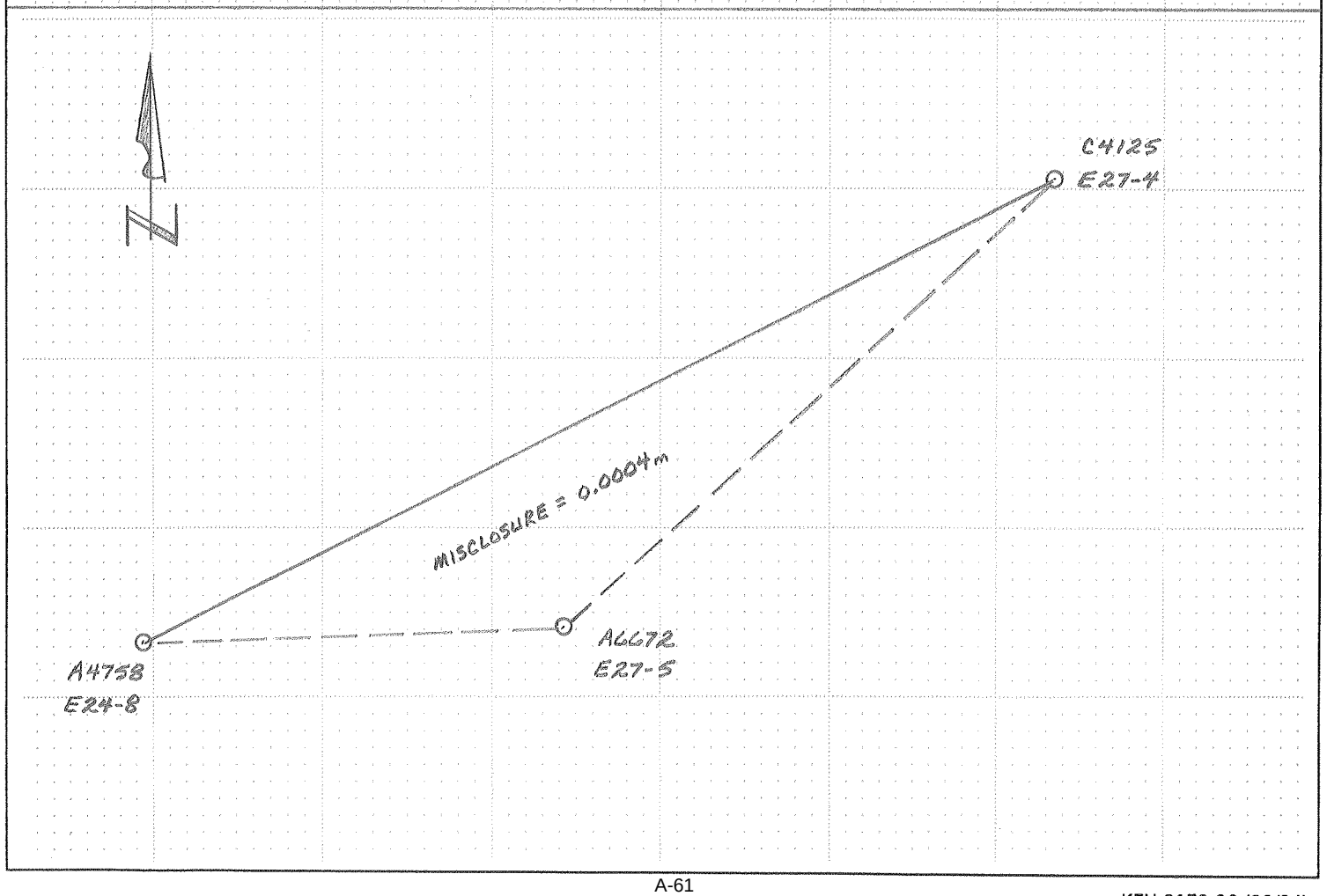
FIELD SKETCH

Attachment to or Description:

LLWMA-2 ADDITIONAL WELLS ELEVATION SURVEY 093-316/2ET12R26 5/27/09

Sheet 2 **of** 4





KEH 0159.02 (03/94)

WELL SURVEY DATA REPORT

Project: **LLWMA-2 Wells Study**	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 4/30/09	**Requestor:** J.P. McDonald (CHPRC)
Date of Survey: 5/27/09	**Surveyor:** L.A. Henke (PLS) FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A6672 (299-E27-5) as part of a network of Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A6672	299-E27-5				Center of Casing
					Top Pump Baseplate, N. Edge
				209.787	Top of Casing Flange, N.Edge stamped "X"
				209.030	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in May, 2009 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
May 27 2009
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

WELL SURVEY DATA REPORT

Project: LLWMA-2 Wells Study	**Prepared By:** N.P. Fastabend **Company:** FFS
Date Requested: 4/30/09	**Requestor:** J.P. McDonald (CHPRC)
Date of Survey: 5/27/09	**Surveyor:** L.A. Henke (PLS) FFS Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** N.P. Fastabend (FFS)
Description of Work: Obtain survey elevations on Well A6674 (299-E27-18) as part of a network of Wells for Groundwater Study.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: N/A

Vertical Control Monuments: HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
A6674	299-E27-18				Center of Casing
				199.185	Top Pump Baseplate, N. Edge
				199.180	Top of Casing, N. Edge
				198.265	Brass Survey Marker

Notes:

Equipment Used: Trimble DiNi 12 Level w/ Invar Rod

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in May, 2009 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
May 27 2009
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2009

Original to:
Distribution by DIS:

SURVEY DATA REPORT

				Request No. 122-053
Project No.	Title: LLWMA-2/ Additional Well C8204 (299-E26-14) Elevation Survey			File No. 2ET12R26
Job No. PRC/ CACN: 302896 - CA40	Prepared By Daniel A. Spaulding	Date 1/27/12	Reviewer Ryan Lomyde	Page 1 of 3

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtain elevations on Well C8204 (299-E26-14) tied to previous vertical network associated with the Low-Level Waste Management Area 2 (LLWMA-2) located in the northeast portion of 200E Area.	Survey File	OR		
	J.P. McDonald	1		
	F.H. Biebesheimer	1		
	D.C. Weekes	1		
Vertical Datum: NAVD88 (meters) [Tied to previous vertical network holding HSWB-032 as single reference to NAVD88]				

SURVEY RESULTS AND COMMENTS

See Attached Sketch and Well Survey Data Report Sheets

The following field procedures were followed:

1) Equipment Used: Trimble DiNi Electronic Digital/Barcode Leveling System with Invar Rod
2) Leveled lines between wells were double run.
3) Maximum sight length did not exceed 65 meters.
4) Difference of forward and backward sight lengths per setup did not exceed 5 meters.
5) Collimation tests to ensure accuracy of the equipment were done periodically during the course of the survey.
6) Misclosure of the loop comprising the network did not exceed 0.001 meters.

NOTE: This Survey was performed under the supervision of a Licensed Professional Land Surveyor registered in the State of Washington.

WELL SURVEY DATA REPORT

Project:	Prepared By: Daniel A. Spaulding Company: FFS
Date Requested: 01/16/2012	Requestor: John McDonald
Date of Survey: 01/25/2012	Surveyor: Daniel Spaulding
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain Elevations on Well C8204 (299-E26-14) tied to previous vertical network associated with the Low-Level Waste Management Area 2 (LLWMA-2).	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 200E Area

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
N/A

Vertical Control Monuments:
HSWB-032 (Held as single reference to NAVD88 Datum)

Well ID	Well Name	Easting	Northing	Elevation	
C8204	299-E26-14				Center of Casing
					"X" on Rim
				182.494	Brass Survey Marker

Notes:

183.231 Top Pump Base-plate, N.Edge
183.224 Top Rim,N.Edge

Elevations obtained on top of well casing taken on North side of casing. Marked with crows foot on side of casing. Top Base Plate at time of survey was 7mm in thickness.
Brass cap is domed. Found Brass Cap in concrete is loose.

Equipment Used: Trimble DiNi Level

Surveyor Statement:

I, Daniel A. Spaulding, a Professional Land Surveyor registered in the State of Washington (Registration No. 46899), hereby certify that this report is based on a field survey performed by me, or under my direct supervision.

DANIEL A. SPAULDING
STATE OF WASHINGTON
46899
REGISTERED
PROFESSIONAL LAND SURVEYOR

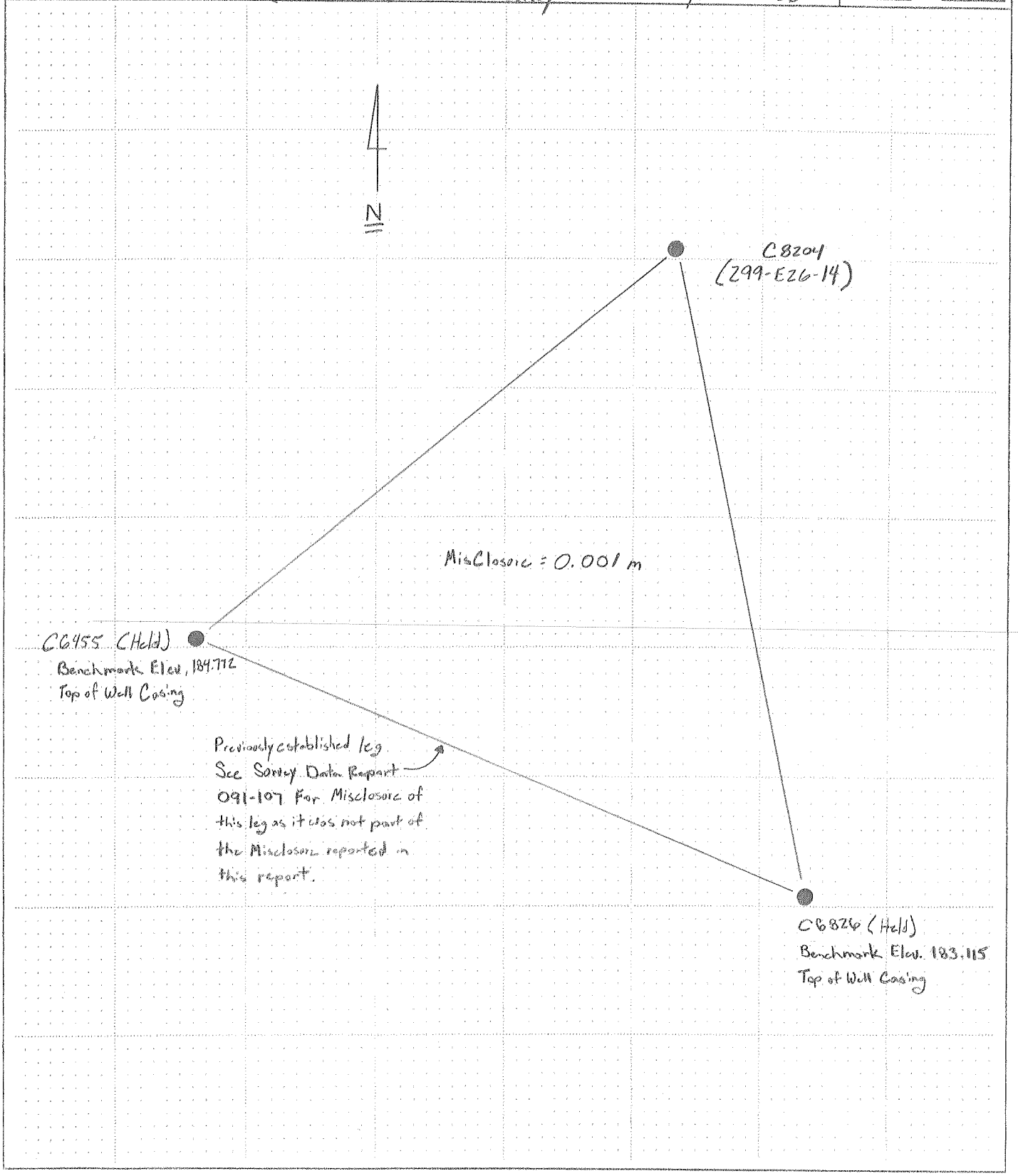
1-30-12

FLUOR FEDERAL SERVICES

FIELD SKETCH

Attachment to or Description:
LLWMA-2 Well C8204 (299-E26-14) Elevation Survey 122-053/ZET12226

Sheet 3 of 3



KEH 0159.02 (03/94)

Appendix B

Gyroscope Survey Reports

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Appendix B

Gyroscope Survey Reports

This appendix contains reports for the wellbore path surveys performed for this study. The surveys were performed in the monitoring wells using a directional gyroscope, which provided readings of inclination (i.e., angle from vertical) and bearing (i.e., direction of inclination) at regular measured depth intervals along a wellbore. The reports contain the true vertical depth for each measurement station along a wellbore, and for many of the reports, a diagram of the borehole path is provided. This information was used to calculate the difference between the measured depth to water and the true vertical depth to water, which enabled the depth to water measurements to be corrected for verticality error. The survey reports are listed in well name order.

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Stoller Hanford Office

HGLP-LDR-169, Rev. 0

299-E17-18 (A4736)
Log Data Report

Borehole Information:

Borehole:	299-E17-18	Well ID:	A4736	Site:	216-A-36B Crib
North	East	Elevation	Depth Reference		Total Depth (ft)
					327.92

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	1/15/2008	Engineer:	MJ Legler	Start File:	E17-18.raw.raw	Finish File:	299-E17-18.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.31	341.5	0	0	0	0	0	0	0
20	0.28	0.2	350.46	20	0.1	-0.02	0.5	0.1	0.1
40	0.59	1.8	356.97	40	0.25	-0.01	1.5	0.25	0.3
60	0.44	9.3	0.3	60	0.43	0	0.8	0.43	0.4
80	0.52	329	356.85	80	0.58	-0.03	1.7	0.58	0.6
100	0.93	341	350.82	100	0.81	-0.13	2.2	0.82	0.8
120	0.98	16	353.11	119.99	1.13	-0.14	2.9	1.14	1.1
140	1.03	25.1	359.48	139.99	1.46	-0.01	0.8	1.46	1.5
160	1.12	53.6	7.21	159.99	1.74	0.22	2.7	1.75	1.7
180	0.83	58.2	14.54	179.98	1.93	0.5	1.5	1.99	1.9
200	0.86	68.6	20.32	199.98	2.06	0.76	0.8	2.2	2.1
220	1.5	78	28.08	219.98	2.17	1.16	3.3	2.46	2.2
240	1.64	86.8	37.18	239.97	2.24	1.7	1.4	2.81	2.2
260	2.59	94.7	47.66	259.96	2.22	2.43	4.9	3.29	2.2
280	1.97	109.6	57.21	279.94	2.07	3.21	4.3	3.82	2.1
300	1.61	139.5	64.93	299.93	1.74	3.71	4.9	4.1	1.7
320	1.78	138.1	72.53	319.92	1.29	4.1	0.9	4.3	1.3
328	1.78	142.3	75.52	327.92	1.1	4.26	1.6	4.4	1.1

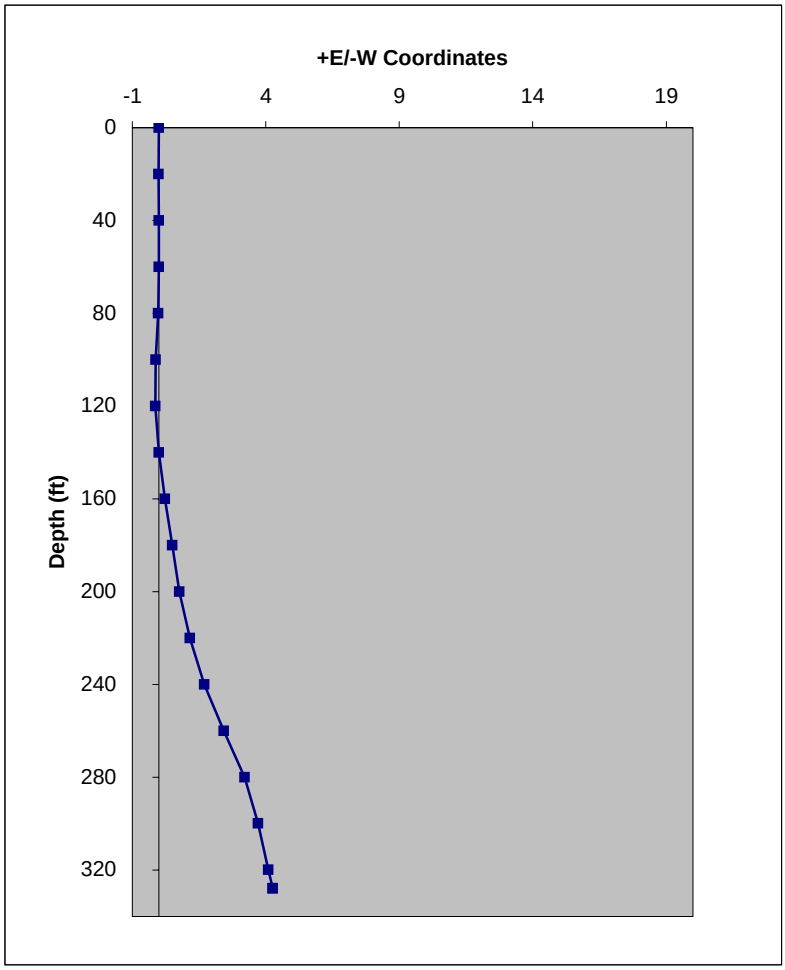
Analysis Notes:

Analyst:	Legler	Date:	2/6/2008

List of Log Plots:

Borehole Deviation

299-E17-18 (A4736)
Borehole Deviation



Water Level: 324.04

Stoller
Hanford Office

HGLP-LDR-168, Rev. 0

299-E17-21 (B8500)
Log Data Report

Borehole Information:

Borehole:	299-E17-21	Well ID:	B8500	Site:	200E
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
					358.48

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	1/15/2008	Engineer:	MJ Legler	Start File:	E17-21.raw	Finish File:	299-E17-21.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.05	314.1	0	0	0	0	0	0	0
20	0.2	2.4	353.69	20	0.04	0	0.9	0.04	0
40	0.28	103.4	35.62	40	0.06	0.05	1.9	0.08	0.1
60	0.46	107.2	80.75	60	0.03	0.17	0.9	0.17	0
80	1.32	91.9	90.45	80	0	0.48	4.4	0.48	0
100	1.28	79	88.08	99.99	0.03	0.93	1.5	0.93	0
120	1.67	85.8	86.21	119.99	0.09	1.44	2.1	1.44	0.1
140	2.33	90.4	86.96	139.97	0.11	2.13	3.4	2.14	0.1
160	2.56	87.9	87.57	159.95	0.13	2.99	1.3	2.99	0.1
180	3.2	89.5	87.88	179.93	0.15	3.99	3.2	3.99	0.1
200	3.13	94.2	88.75	199.9	0.11	5.1	1.3	5.1	0.1
220	3.05	101.8	90.35	219.87	-0.04	6.16	2.1	6.16	0
240	3.18	109.9	92.66	239.84	-0.34	7.2	2.3	7.21	-0.3
260	3.39	120.5	95.71	259.81	-0.82	8.23	3.2	8.28	-0.8
280	3.29	125.8	99.01	279.77	-1.46	9.21	1.6	9.32	-1.5
300	4.19	128.4	102.38	299.73	-2.25	10.25	4.6	10.49	-2.2
320	4.85	135.7	106.17	319.67	-3.31	11.41	4.4	11.88	-3.3
340	5.33	139.9	110.15	339.59	-4.62	12.6	3	13.42	-4.6
359	7.1	140.5	114.03	358.48	-6.21	13.92	9.3	15.24	-6.2

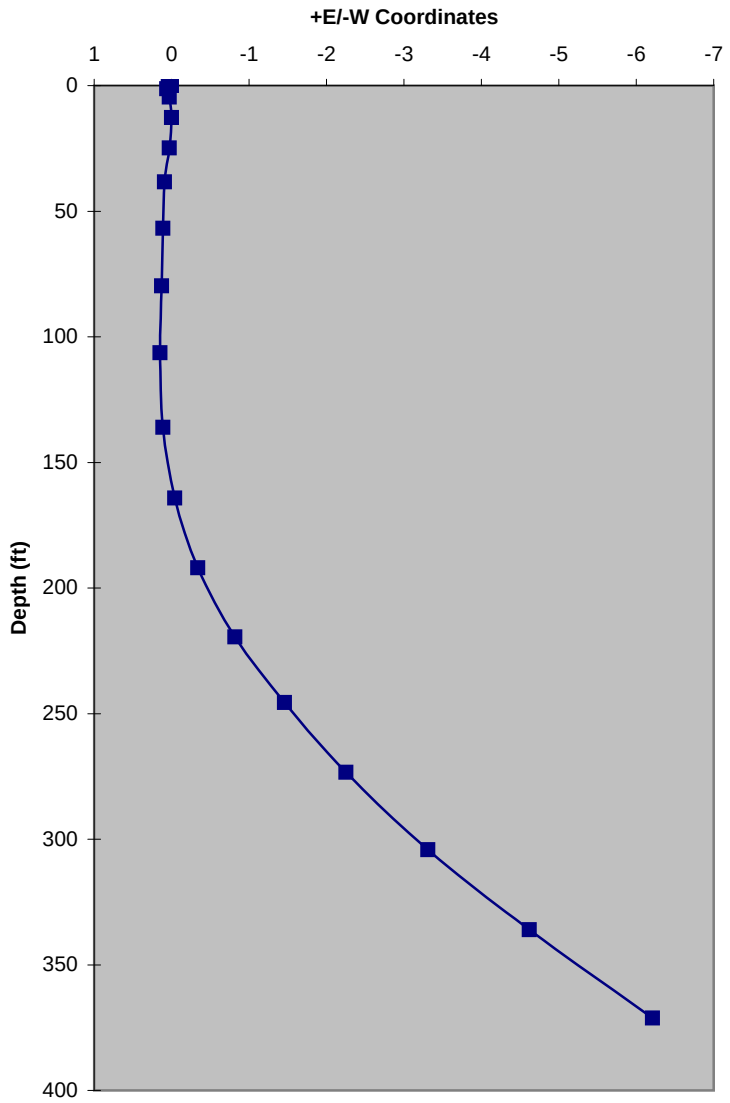
Analysis Notes:

Analyst:	Legler	Date:	2/6/2008

List of Log Plots:

Borehole Deviation

299-E17-21 (B8500)
Borehole Deviation



Water Level: 339.15

Stoller
Hanford Office

HGLP-LDR-185, Rev. 0

299-E17-22 (C3826)
Log Data Report

Borehole Information:

Borehole:	299-E17-22	Well ID:	C3826	Site:	200E S of PUREX near 216-A-45 Crib
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
N/A	N/A	N/A	Top of Casing		352.89

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	3/6/2008	Engineer:	LEGLER	Start File:	299-E17-22.raw	Finish File:	299-E17-22.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.40	259.3	0.00	0.00	0.00	0.00	0.0	0.00	0.0
20	1.10	292.5	283.71	20.00	0.06	-0.25	4.0	0.25	0.1
40	0.68	338.0	297.43	40.00	0.24	-0.47	3.9	0.53	0.2
60	1.00	318.1	307.51	59.99	0.48	-0.63	2.2	0.79	0.5
80	1.13	313.0	310.03	79.99	0.75	-0.89	0.8	1.16	0.7
100	1.19	321.4	311.91	99.99	1.04	-1.16	0.9	1.56	1.0
120	1.23	310.8	312.79	119.98	1.35	-1.46	1.1	1.98	1.3
140	1.29	316.4	312.95	139.98	1.65	-1.77	0.7	2.42	1.7
160	1.46	312.1	313.15	159.97	1.98	-2.12	1.0	2.90	2.0
180	1.77	319.8	313.67	179.96	2.39	-2.51	1.9	3.46	2.4
200	0.96	308.1	313.92	199.96	2.73	-2.84	4.3	3.94	2.7
220	1.12	286.1	312.46	219.95	2.89	-3.16	2.1	4.28	2.9
240	1.30	263.4	309.25	239.95	2.92	-3.57	2.5	4.61	2.9
260	1.99	246.5	303.79	259.94	2.75	-4.12	4.2	4.95	2.8
280	2.72	242.5	296.27	279.92	2.40	-4.85	3.8	5.41	2.4
300	2.01	236.5	289.61	299.91	1.98	-5.57	3.8	5.91	2.0
320	1.17	191.0	285.08	319.90	1.59	-5.90	7.3	6.11	1.6
340	1.34	132.2	282.05	339.90	1.23	-5.76	6.2	5.89	1.2
353	1.08	114.8	281.00	352.89	1.08	-5.54	3.4	5.64	1.1

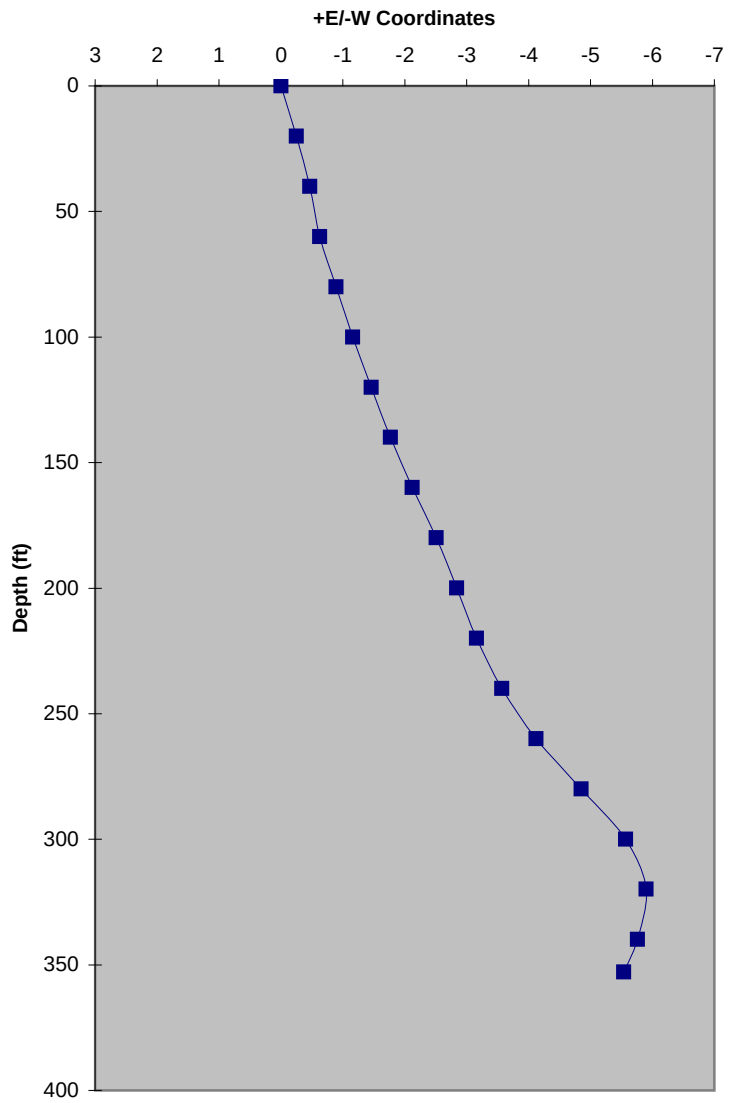
Analysis Notes:

Analyst:	Legler	Date:	3/6/2008

List of Log Plots:

Borehole Deviation

299-E17-22 (C3826)
Borehole Deviation



Water Level: 326.2

Stoller Hanford Office

HGLP-LDR-184, Rev. 0

299-E17-23 (C3827)
Log Data Report

Borehole Information:

Borehole:	299-E17-23	Well ID:	C3827	Site:	200E South of PUREX
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
N/A	N/A	N/A	N/A		363.86

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	3/5/2008	Engineer:	LEGLER	Start File:	299-E17-23.raw	Finish File:	299-E17-23.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.39	325.2	0.00	0.00	0.00	0.00	0.0	0.00	0.0
20	1.40	340.1	336.87	20.00	0.29	-0.12	5.1	0.31	0.3
40	1.54	343.0	339.83	39.99	0.77	-0.28	0.8	0.82	0.8
60	1.76	8.4	346.60	59.98	1.33	-0.32	3.8	1.37	1.3
80	1.48	30.7	355.66	79.97	1.86	-0.14	3.4	1.86	1.9
100	1.22	59.9	4.56	99.97	2.19	0.17	3.6	2.19	2.2
120	0.77	87.4	12.07	119.97	2.30	0.49	3.2	2.35	2.3
140	1.41	138.0	20.39	139.96	2.12	0.79	5.5	2.27	2.1
160	1.24	168.0	30.00	159.96	1.73	1.00	3.5	2.00	1.7
180	1.07	197.2	36.44	179.95	1.34	0.99	3.0	1.66	1.3
200	1.14	241.6	35.42	199.95	1.06	0.76	4.2	1.31	1.1
220	1.27	268.4	20.47	219.95	0.96	0.36	2.9	1.03	1.0
240	1.71	294.9	352.98	239.94	1.08	-0.13	4.0	1.09	1.1
260	1.84	311.7	335.66	259.93	1.42	-0.64	2.7	1.56	1.4
280	2.12	325.6	330.64	279.92	1.94	-1.09	2.8	2.23	1.9
300	2.14	337.9	330.92	299.91	2.59	-1.44	2.3	2.97	2.6
320	2.32	344.1	333.03	319.89	3.33	-1.69	1.5	3.73	3.3
340	2.11	349.1	335.33	339.87	4.08	-1.87	1.4	4.49	4.1
360	1.84	349.9	337.20	359.86	4.76	-2.00	1.4	5.16	4.8
364	1.95	350.0	337.51	363.86	4.89	-2.02	2.8	5.29	4.9

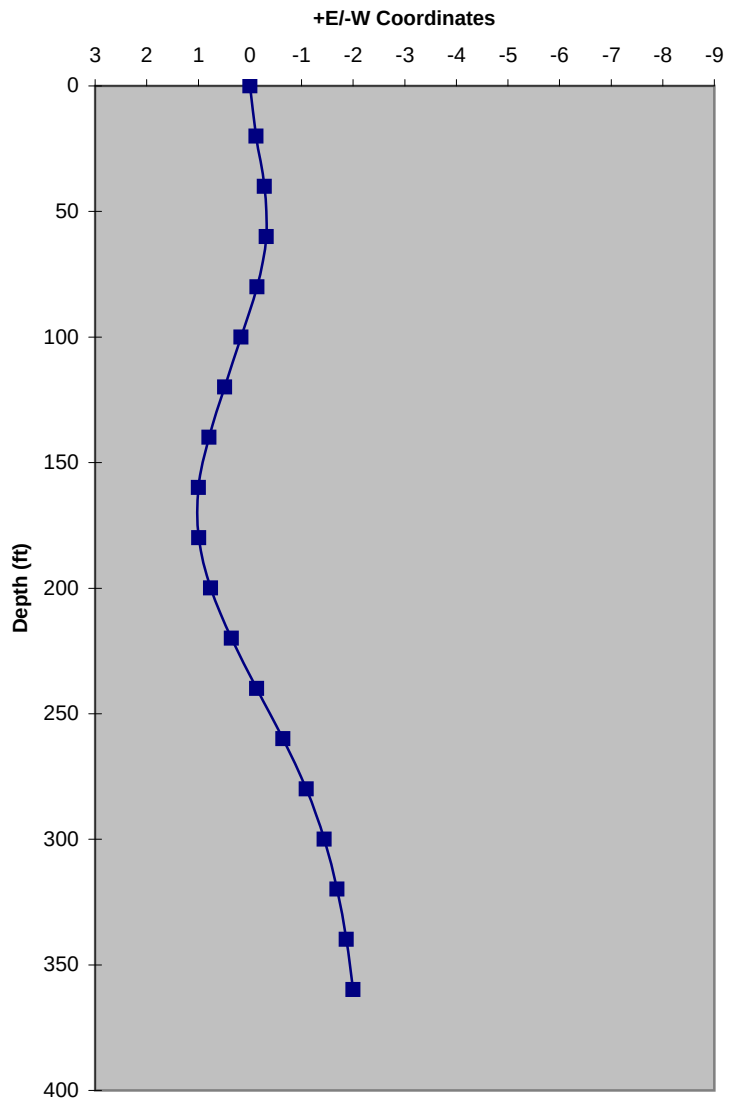
Analysis Notes:

Analyst:	Legler	Date:	3/5/2008

List of Log Plots:

Borehole Deviation

299-E17-23 (C3827)
Borehole Deviation



Water Level: 336.76

Stoller
Hanford Office

HGLP-LDR-186, Rev. 0

299-E17-25 (C3926)
Log Data Report

Borehole Information:

Borehole:	299-E17-25	Well ID:	C3926	Site:	200E along road South of PUREX
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
N/A	N/A	N/A	Top of Casing		366.66

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	3/6/2008	Engineer:	LEGLER	Start File:	299-E17-25.raw	Finish File:	299-E17-25.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.18	218.0	0.00	0.00	0.00	0.00	0.0	0.00	0.0
20	0.69	340.5	326.49	20.00	0.09	-0.06	4.0	0.11	0.1
40	1.00	6.6	348.00	40.00	0.38	-0.08	2.4	0.39	0.4
60	1.31	35.4	5.62	59.99	0.74	0.07	3.3	0.74	0.7
80	2.24	24.3	15.96	79.98	1.28	0.37	4.9	1.33	1.3
100	2.77	22.1	18.77	99.96	2.08	0.71	2.7	2.20	2.1
120	3.35	19.5	19.39	119.94	3.08	1.08	3.0	3.27	3.1
140	3.99	17.9	19.18	139.89	4.29	1.49	3.2	4.55	4.3
160	4.46	12.4	18.15	159.84	5.71	1.87	3.1	6.01	5.7
180	4.49	7.7	16.48	179.78	7.25	2.15	1.8	7.56	7.2
200	5.05	1.0	14.28	199.71	8.91	2.27	4.0	9.19	8.9
220	5.58	352.6	11.34	219.62	10.75	2.16	4.7	10.96	10.7
240	6.33	350.2	8.19	239.52	12.80	1.84	3.9	12.93	12.8
260	6.91	346.6	5.22	259.38	15.06	1.38	3.6	15.12	15.1
280	7.16	344.4	2.50	279.23	17.43	0.76	1.9	17.44	17.4
300	6.80	346.1	0.41	299.09	19.77	0.14	2.1	19.78	19.8
320	6.70	344.1	358.80	318.95	22.04	-0.46	1.3	22.05	22.0
340	6.46	341.8	357.32	338.81	24.24	-1.13	1.8	24.26	24.2
360	5.92	334.0	355.77	358.70	26.23	-1.94	5.0	26.30	26.2
368	6.01	331.6	355.09	366.66	26.97	-2.32	3.3	27.07	27.0

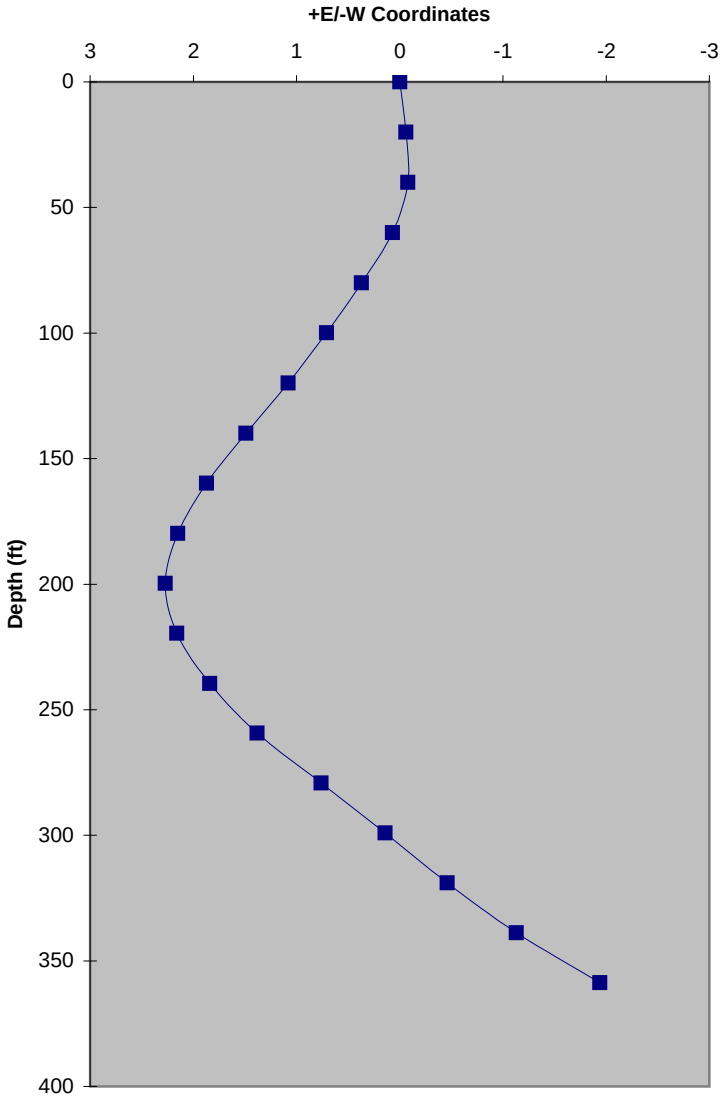
Analysis Notes:

Analyst:	Legler	Date:	3/6/2008

List of Log Plots:

Borehole Deviation

299-E17-25 (C3926)
Borehole Deviation



Water Level: 341.46

Survey File: C:\DSE\C4648.RAW
Date: Oct 05,2005
Time: 10:35
Description: Borehole Deviation Survey
LOCATION: 299-E17-26
CUSTOMER: Fluor
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 30.01 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
T Post
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 233 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.19	56.1	0.00	0.00	0.00	0.00	0.0
20.00	0.68	49.4	20.00	0.10	0.12	2.40	0.1
40.00	1.40	41.2	40.00	0.36	0.37	3.70	0.4
60.00	1.36	59.2	59.99	0.66	0.73	2.20	0.7
80.00	2.01	68.7	79.98	0.91	1.26	3.50	0.9
100.00	3.12	84.8	99.96	1.09	2.13	6.60	1.1
120.00	4.15	93.6	119.92	1.09	3.40	5.80	1.1
140.00	5.29	95.9	139.85	0.95	5.04	5.80	1.0
160.00	6.44	95.9	159.75	0.74	7.07	5.70	0.7
180.00	7.19	95.0	179.61	0.52	9.43	3.80	0.5
200.00	8.39	96.7	199.42	0.24	12.13	6.10	0.2
220.00	9.62	97.2	219.17	-0.14	15.24	6.20	-0.1
240.00	10.57	97.6	238.86	-0.60	18.71	4.70	-0.6
260.00	11.44	98.7	258.50	-1.14	22.49	4.50	-1.1
280.00	12.52	99.9	278.06	-1.82	26.59	5.50	-1.8
300.00	13.10	103.2	297.56	-2.71	30.93	4.70	-2.7
320.00	14.12	106.7	317.00	-3.92	35.47	6.50	-3.9
340.00	15.45	108.7	336.34	-5.48	40.33	7.20	-5.5
360.00	15.98	108.9	355.59	-7.22	45.46	2.70	-7.2
366.90	16.56	111.0	362.21	-7.88	47.28	12.10	-7.9

1

Bottom:

True Vertical Depth	362.21 feet
Closure Distance	47.9 feet
Closure Direction	99.5 deg.
Course Direction	111.0 deg.

DEFINITIONS:

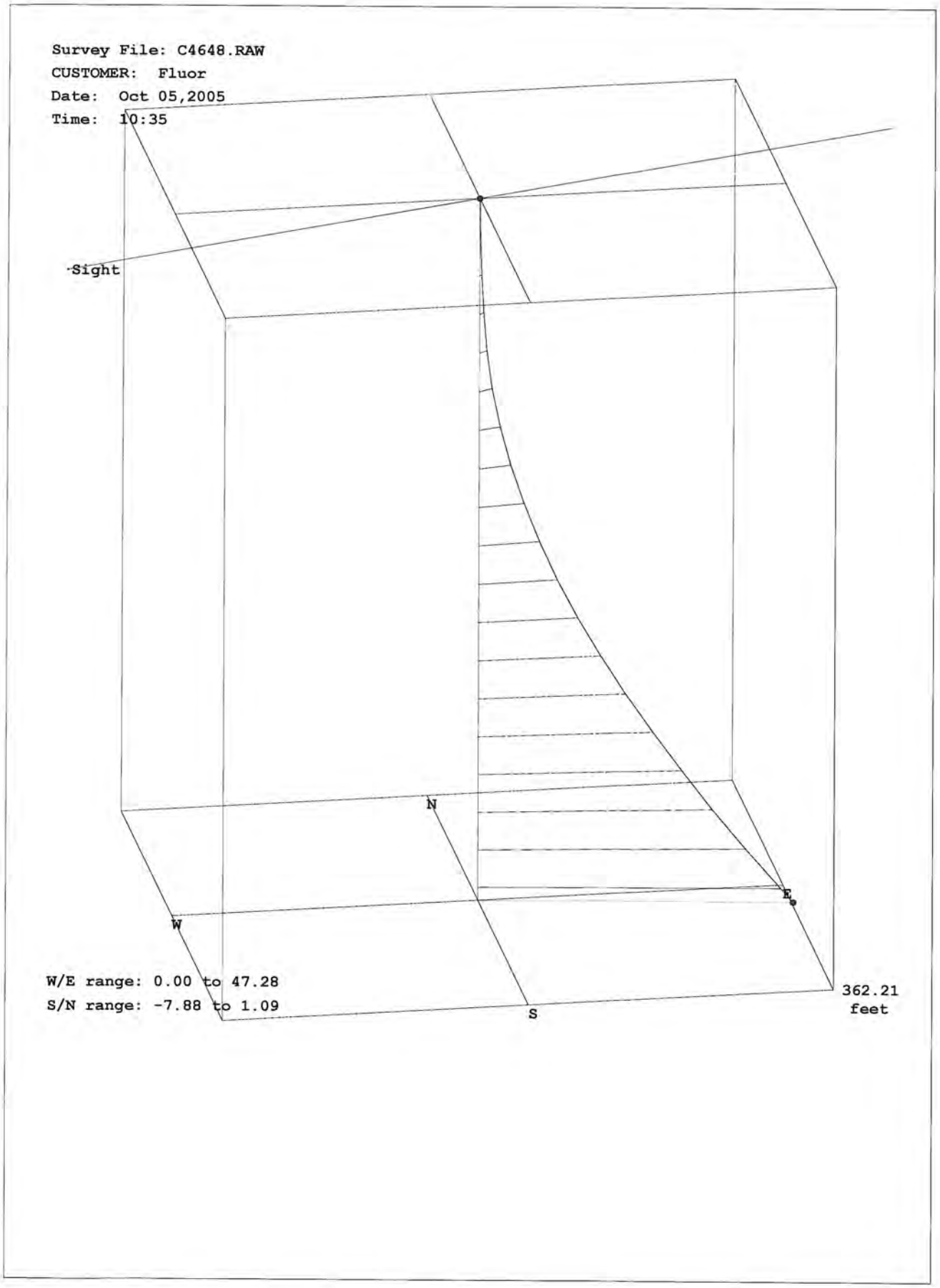
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.

Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: C4648.RAW
CUSTOMER: Fluor
Date: Oct 05,2005
Time: 10:35
Sight
N
E
W
S
W/E range: 0.00 to 47.28
S/N range: -7.88 to 1.09
362.21
feet

Stoller
Hanford Office

HGLP-LDR-175, Rev. 0

299-E24-16 (A4751)
Log Data Report

Borehole Information:

Borehole:	299-E24-16	Well ID:	A4751	Site:	200E 216-A10 CRIB
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
N/A	N/A	N/A	N/A		324.93

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	2/19/2008	Engineer:	LEGLER	Start File:	299-E24-16.raw	Finish File:	299-E24-16.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.28	69	0	0	0	0	0	0	0
20	0.55	35	46.41	20	0.1	0.1	1.8	0.14	0.1
40	0.8	69.8	52.09	40	0.22	0.29	2.3	0.36	0.2
60	0.64	32.3	52.48	60	0.37	0.48	2.4	0.6	0.4
80	0.36	343.3	44.9	80	0.52	0.52	2.5	0.74	0.5
100	0.49	78.6	44.42	100	0.6	0.59	3.2	0.84	0.6
120	0.9	81.9	52.38	119.99	0.64	0.83	2.1	1.04	0.6
140	0.58	101.1	59.41	139.99	0.64	1.08	2	1.26	0.6
160	0.51	189.1	65.48	159.99	0.53	1.17	3.8	1.28	0.5
180	0.27	177.3	71.04	179.99	0.4	1.16	1.2	1.22	0.4
200	0.78	40.7	70.06	199.99	0.45	1.25	5	1.33	0.5
220	1.29	15.8	61.07	219.99	0.77	1.4	3.4	1.6	0.8
240	1.6	358.2	48.82	239.98	1.27	1.45	2.7	1.93	1.3
260	1.61	26.3	41.04	259.97	1.8	1.57	3.9	2.39	1.8
280	1.94	50.8	40.77	279.96	2.27	1.95	4.1	2.99	2.3
300	2.29	64.2	44.15	299.95	2.65	2.58	3	3.7	2.7
320	2.27	92.7	49.86	319.94	2.81	3.33	5.6	4.36	2.8
325	2.41	102.7	51.78	324.93	2.78	3.53	8.7	4.5	2.8
325	2.41	103.2	51.78	324.93	2.78	3.53	8.7	4.5	2.8

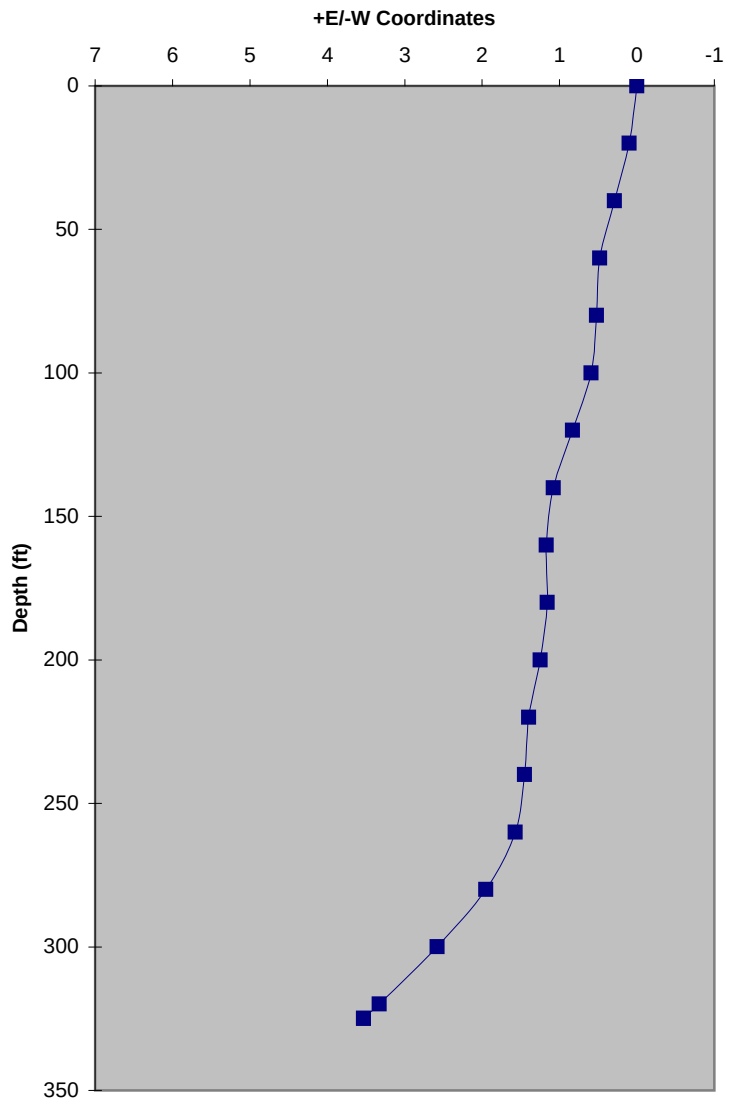
Analysis Notes:

Analyst:	Legler	Date:	2/19/2008

List of Log Plots:

Borehole Deviation

299-E24-16 (A4751)
Borehole Deviation



Water Level: 321.18

Stoller
Hanford Office

HGLP-LDR-183, Rev. 0

299-E24-18 (A4753)
Log Data Report

Borehole Information:

Borehole:	299-E24-18	Well ID:	A4753	Site:	200E near IDF
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
N/A	N/A	N/A	N/A		323.93

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	3/5/2008	Engineer:	LEGLER	Start File:	299-E24-18.raw	Finish File:	299-E24-18.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.38	124.9	0.00	0.00	0.00	0.00	0.0	0.00	0.0
20	0.43	122.6	123.69	20.00	-0.08	0.12	0.3	0.14	-0.1
40	0.34	96.8	117.71	40.00	-0.13	0.24	1.0	0.27	-0.1
60	0.52	93.0	109.48	60.00	-0.14	0.39	0.9	0.41	-0.1
80	0.51	86.6	103.57	80.00	-0.14	0.57	0.3	0.58	-0.1
100	0.39	73.6	98.85	100.00	-0.11	0.72	0.8	0.73	-0.1
120	0.34	45.1	93.47	120.00	-0.05	0.83	0.9	0.83	-0.1
140	0.21	58.3	89.26	140.00	0.01	0.90	0.7	0.90	0.0
160	0.06	204.7	88.68	160.00	0.02	0.93	1.3	0.93	0.0
180	0.73	237.3	94.02	180.00	-0.06	0.82	3.4	0.82	-0.1
200	1.72	227.7	124.03	199.99	-0.33	0.49	5.0	0.59	-0.3
220	2.03	216.4	176.20	219.98	-0.82	0.05	2.4	0.82	-0.8
240	1.99	208.5	192.89	239.97	-1.41	-0.32	1.4	1.44	-1.4
260	1.95	203.3	197.09	259.96	-2.02	-0.62	0.9	2.12	-2.0
280	1.41	194.4	197.63	279.95	-2.58	-0.82	3.0	2.70	-2.6
300	1.45	179.0	195.93	299.94	-3.07	-0.88	1.9	3.19	-3.1
320	1.69	177.4	193.35	319.93	-3.61	-0.86	1.2	3.71	-3.6
324	1.67	176.0	192.85	323.93	-3.73	-0.85	1.1	3.83	-3.7
324	1.65	176.5	192.85	323.93	-3.73	-0.85	1.1	3.83	-3.7

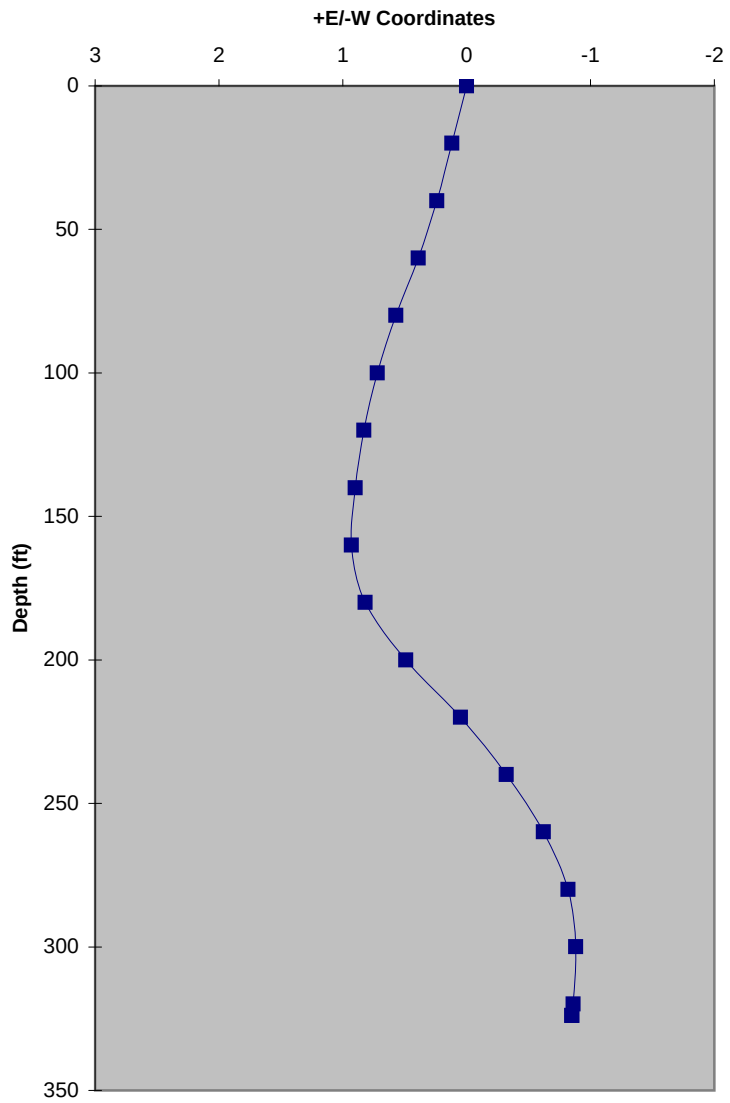
Analysis Notes:

Analyst:	Legler	Date:	3/5/2008

List of Log Plots:

Borehole Deviation

299-E24-18 (A4753)
Borehole Deviation



Water Level: 322.64

Stoller
Hanford Office

HGLP-LDR-188, Rev. 0

299-E24-21 (C3177)
Log Data Report

Borehole Information:

Borehole:	299-E24-21	Well ID:	C3177	Site:	218-E-1 Burial Ground
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
			Top of Casing		327.94

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	3/10/2008	Engineer:	LEGLER	Start File:	299-E24-21.raw	Finish File:	299-E24-21.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.05	89.1	0.00	0.00	0.00	0.00	0.0	0.00	0.0
20	0.62	76.5	77.36	20.00	0.03	0.11	2.9	0.12	0.0
40	0.36	74.4	76.38	40.00	0.07	0.28	1.3	0.29	0.1
60	0.50	35.7	68.25	60.00	0.16	0.39	1.6	0.42	0.2
80	0.48	41.1	59.71	80.00	0.29	0.50	0.3	0.58	0.3
100	0.70	17.6	51.43	100.00	0.47	0.59	1.6	0.75	0.5
120	1.08	39.7	45.60	119.99	0.73	0.75	2.5	1.04	0.7
140	1.02	29.0	42.73	139.99	1.03	0.95	1.0	1.40	1.0
160	1.46	37.7	40.71	159.99	1.39	1.20	2.4	1.83	1.4
180	1.71	50.3	41.58	179.98	1.78	1.58	2.1	2.38	1.8
200	1.65	49.0	43.17	199.97	2.16	2.03	0.4	2.96	2.2
220	1.35	58.6	44.69	219.96	2.47	2.45	1.9	3.48	2.5
240	1.47	71.1	47.18	239.96	2.68	2.89	1.6	3.94	2.7
260	1.09	77.3	49.81	259.95	2.80	3.32	2.0	4.34	2.8
280	0.78	109.7	52.39	279.95	2.80	3.63	3.0	4.58	2.8
300	0.94	126.2	55.71	299.95	2.65	3.89	1.5	4.71	2.7
320	1.22	132.7	60.02	319.94	2.41	4.18	1.5	4.83	2.4
328	1.15	135.1	61.89	327.94	2.30	4.30	1.1	4.88	2.3
328	1.15	135.0	61.89	327.94	2.30	4.30	1.1	4.88	2.3

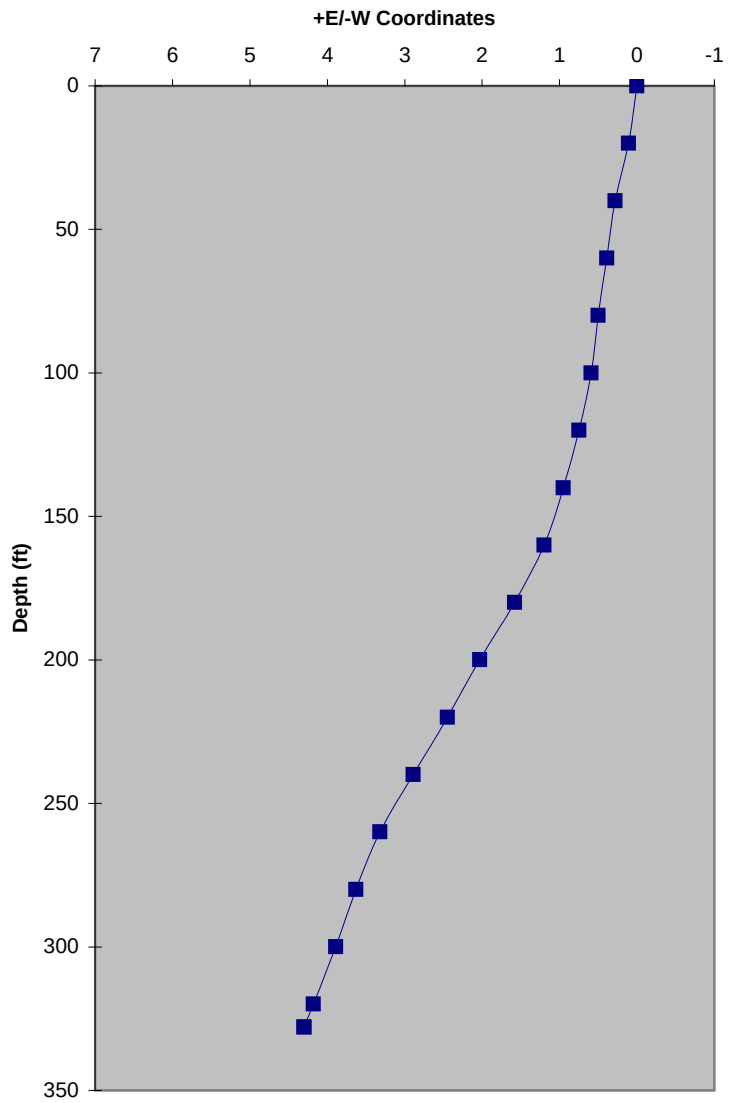
Analysis Notes:

Analyst:	Legler	Date:	3/10/2008

List of Log Plots:

Borehole Deviation

299-E24-21 (C3177)
Borehole Deviation



Water Level: 318.1

Survey File: C:\DSE\C4647.RAW
Date: Oct 05,2005
Time: 8:12
Description: Borehole Deviation Survey
LOCATION: 299-E24-24
CUSTOMER: Fluor
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 31.35 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
T Post
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 231 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.36	287.0	0.00	0.00	0.00	0.00	0.0
20.00	1.48	307.9	20.00	0.18	-0.26	5.80	0.2
40.00	1.14	318.6	39.99	0.48	-0.60	2.10	0.5
60.00	1.11	357.5	59.99	0.83	-0.74	3.80	0.8
80.00	1.38	40.3	79.98	1.21	-0.59	4.70	1.2
100.00	2.13	75.2	99.98	1.48	-0.08	6.30	1.5
120.00	2.70	97.9	119.96	1.51	0.75	5.50	1.5
140.00	3.44	117.0	139.93	1.18	1.75	6.30	1.2
160.00	3.68	138.1	159.89	0.43	2.72	6.60	0.4
180.00	3.21	154.0	179.86	-0.55	3.39	5.30	-0.6
200.00	2.36	164.9	199.83	-1.45	3.74	5.00	-1.5
220.00	1.89	168.2	219.82	-2.17	3.92	2.40	-2.2
240.00	0.59	182.7	239.81	-2.60	3.98	6.60	-2.6
260.00	0.90	75.7	259.81	-2.66	4.13	6.00	-2.7
280.00	1.98	74.9	279.81	-2.53	4.61	5.40	-2.5
300.00	1.95	84.2	299.79	-2.41	5.29	1.60	-2.4
320.00	2.35	96.3	319.78	-2.42	6.03	3.00	-2.4
360.00	2.53	104.4	359.74	-2.73	7.70	1.00	-2.7

Bottom:

1

True Vertical Depth	359.74 feet
Closure Distance	8.2 feet
Closure Direction	109.5 deg.
Course Direction	104.4 deg.

DEFINITIONS:

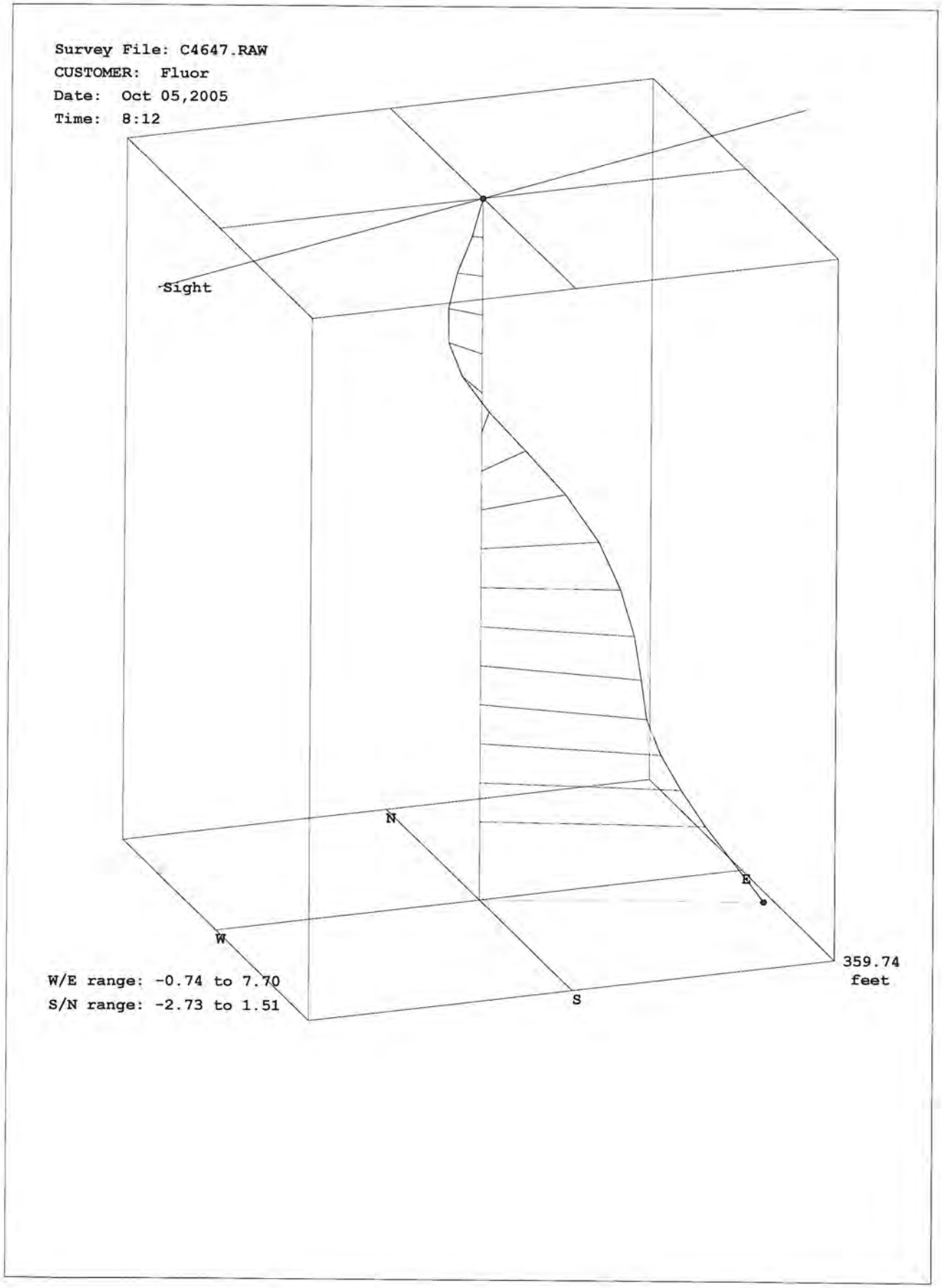
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.

Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: C4647.RAW
CUSTOMER: Fluor
Date: Oct 05,2005
Time: 8:12
Sight
N
E
W
S
359.74
feet
W/E range: -0.74 to 7.70
S/N range: -2.73 to 1.51

Stoller
Hanford Office

HGLP-LDR-167, Rev. 0

299-E25-36 (A4784)
Log Data Report

Borehole Information:

Borehole:	299-E25-36			Site:	200E
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
					316.97

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	1/17/2008	Engineer:	MJ Legler	Start File:	E25-36.raw	Finish File:	299-E25-36.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.38	326	0	0	0	0	0	0	0
20	0.58	302.6	311.8	20	0.11	-0.12	1.4	0.16	0.1
40	0.52	270.9	298.94	40	0.17	-0.3	1.5	0.34	0.2
60	0.38	225.5	285.37	60	0.12	-0.44	1.9	0.45	0.1
80	0.34	208.1	272.41	80	0.02	-0.51	0.6	0.51	0
100	0.51	171.5	257.21	100	-0.12	-0.53	1.6	0.54	-0.1
120	0.3	143.4	242.53	120	-0.25	-0.48	1.4	0.54	-0.3
140	0.5	161.6	228.38	140	-0.38	-0.42	1.2	0.57	-0.4
160	0.61	152.9	212.1	160	-0.55	-0.35	0.7	0.65	-0.6
180	0.38	124	199.62	179.99	-0.68	-0.24	1.7	0.73	-0.7
200	0.42	106.8	189.06	199.99	-0.74	-0.12	0.6	0.75	-0.7
220	0.7	95.2	174.54	219.99	-0.78	0.07	1.5	0.78	-0.8
240	0.93	84.3	155.14	239.99	-0.77	0.36	1.4	0.85	-0.8
260	1.02	66.8	135.15	259.99	-0.69	0.68	1.5	0.97	-0.7
280	1.12	53.6	116.5	279.98	-0.5	1	1.3	1.12	-0.5
300	1.46	42.8	98.42	299.98	-0.2	1.33	2.1	1.35	-0.2
317	1.37	51	86.88	316.97	0.09	1.64	1.3	1.64	0.1

Analysis Notes:

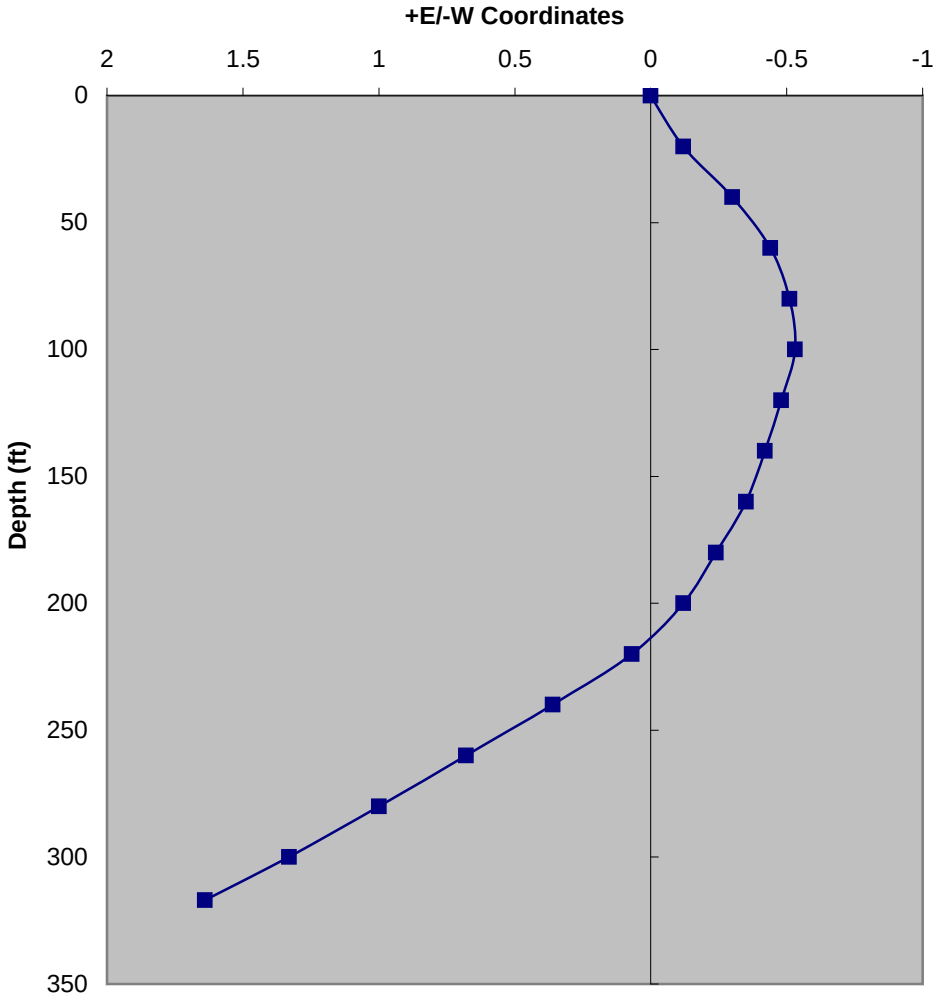
Analyst:	Legler	Date:	2/6/2008

List of Log Plots:

Borehole Deviation

HGLP-LDR-167, Rev. 0

299-E25-36 (A4784)
Borehole Deviation



Water Level: 310.74

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HGLP-LDR-352, Rev. 0

299-E26-10 (A4799)
Log Data Report

Borehole Information:

Borehole:	299-E26-10	Well ID:	A4799	Site:	South of LERF gate
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		205.96

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/6/2009	Engineer:	MJ LEGLER	Start File:	299-E26-10.raw	Finish File:	299-E26-10.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.39	138.4	0	0	0	0	0	0	0
20	0.59	246.4	208.45	20	-0.09	-0.05	4	0.1	-0.1
40	0.18	282.8	234.18	40	-0.13	-0.18	2.3	0.22	-0.1
60	0.26	273.7	245.05	60	-0.12	-0.25	0.4	0.28	-0.1
80	0.81	240.3	246.26	80	-0.18	-0.42	3.1	0.46	-0.2
100	1.1	249	245.84	100	-0.32	-0.72	1.6	0.79	-0.3
120	0.54	241.1	245.98	119.99	-0.44	-0.98	2.8	1.08	-0.4
140	0.73	178.6	240.11	139.99	-0.61	-1.06	3.4	1.22	-0.6
160	1.47	182.5	227.14	159.99	-0.99	-1.07	3.7	1.46	-1
180	1.62	169.6	214	179.98	-1.53	-1.03	1.9	1.84	-1.5
200	2.31	159.8	201.02	199.97	-2.18	-0.84	3.8	2.34	-2.2
206	2.5	161.1	197.32	205.96	-2.42	-0.75	3.2	2.54	-2.4
206	2.5	160.9	197.32	205.96	-2.42	-0.75	3.2	2.54	-2.4

Analysis Notes:

Analyst:	Legler	Date:	4/6/2009

List of Log Plots:

Borehole Deviation

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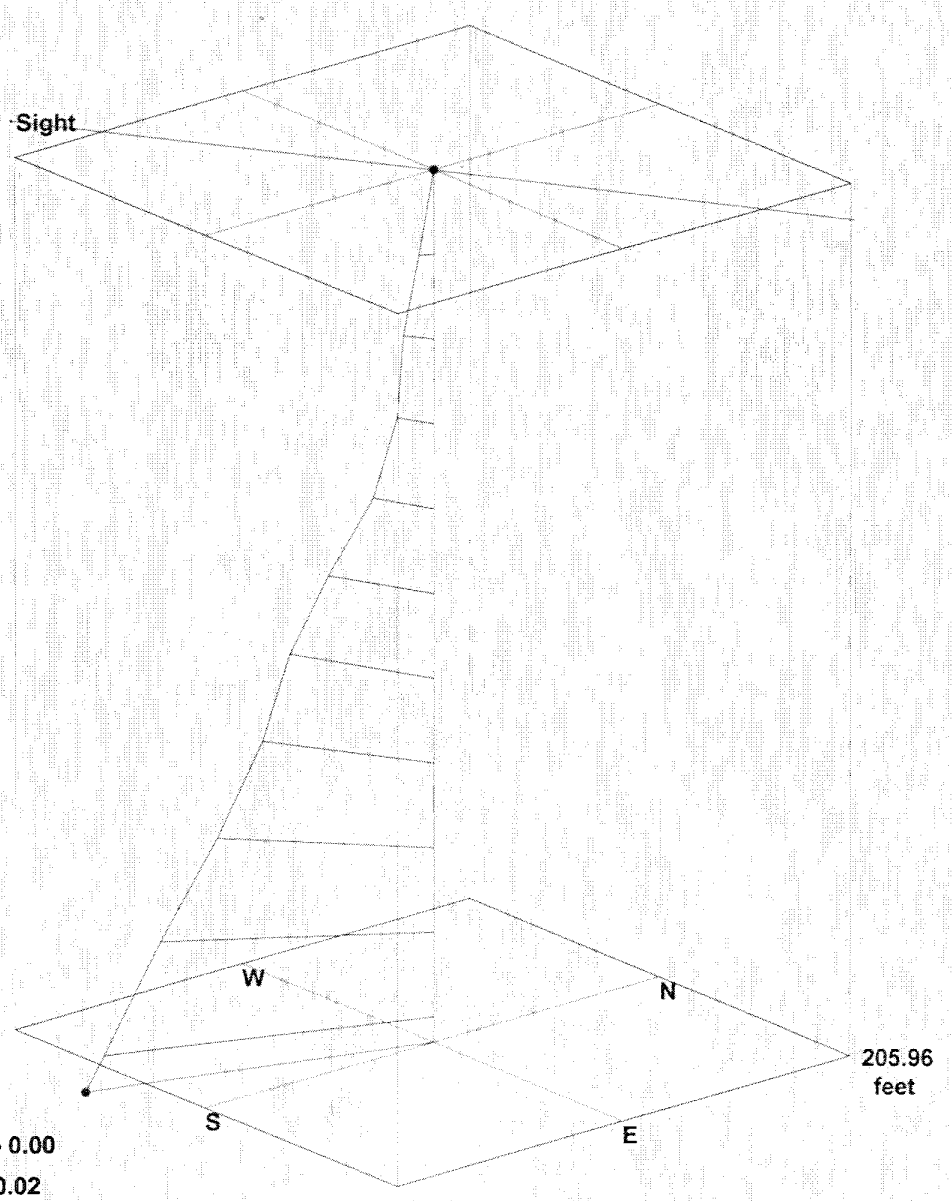
established 1959

HGLP-LDR-352, Rev. 0

Survey File: 299-E26-10.raw
Date: Apr 06,2009

299-E26-10 (A4799)



W/E range: -1.07 to 0.00
S/N range: -2.42 to 0.02

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HGLP-LDR-688, Rev. 0

299-E26-14 (C8204)
Log Data Report

Borehole Information:

Borehole:	299-E26-14	Well ID:	C8204	Site:	LERF
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		221.78

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	3/29/2011	Calibration Reference:	HGLP-CC-069, Rev. 0
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	Feb 01,2012	Engineer:	MJL	Start File:	299-E26-14.raw	Finish File:	299-E26-14.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.38	189.1	0	0	0	0	0	0	0
20	0.26	299.9	229.23	20	-0.04	-0.05	2.6	0.07	0
40	0.35	309.9	277.97	40	0.02	-0.14	0.5	0.14	0
60	0.43	325.2	298.08	60	0.12	-0.23	0.7	0.26	0.1
80	0.88	24.1	327.37	80	0.32	-0.21	3.8	0.38	0.3
100	0.88	42.5	356.07	100	0.58	-0.04	1.4	0.58	0.6
120	0.77	76.8	15.18	119.99	0.72	0.2	2.5	0.75	0.7
140	0.68	85	30.24	139.99	0.76	0.44	0.7	0.88	0.8
160	0.62	131.8	42.6	159.99	0.7	0.64	2.6	0.95	0.7
180	1.1	183.4	58.67	179.99	0.43	0.71	4.3	0.83	0.4
200	1.34	175.7	89.3	199.98	0.01	0.72	1.4	0.72	0
215	2.41	181.9	123.7	214.98	-0.48	0.72	7.3	0.87	-0.5
215	2.41	181	123.7	214.98	-0.48	0.72	7.3	0.87	-0.5

Analysis Notes:

Analyst:	Legler	Date:	2/1/2012

Plots are for illustrative purposes. Sight line graph is initial orientation of tool. Refer to table for N/S and E/W deviation in feet. The last station deviated 0.9 ft at azimuth 123.7°. Magnetic declination used was 15.57° East.

List of Log Plots:

Borehole Deviation

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HGLP-LDR-349, Rev. 0

299-E26-77 (C6455)
Log Data Report

Borehole Information:

Borehole:	299-E26-77	Well ID:	C6455	Site:	LERF
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		223.92

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/2/2009	Engineer:	MJ LEGLER	Start File:	299-E26-77.raw	Finish File:	299-E26-77.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.3	55.3	0	0	0	0	0	0	0
20	0.76	119.1	102.16	20	-0.03	0.16	3.4	0.16	0
40	1.39	90.2	100.94	40	-0.1	0.52	4	0.53	-0.1
60	1.86	95.7	97.03	59.99	-0.13	1.08	2.5	1.09	-0.1
80	3.17	99.8	97.59	79.97	-0.26	1.95	6.6	1.97	-0.3
100	4.17	90.2	96.32	99.93	-0.36	3.22	5.9	3.24	-0.4
120	5.09	87.6	93.81	119.86	-0.32	4.83	4.7	4.84	-0.3
140	6.07	95.3	93.22	139.77	-0.38	6.77	6.2	6.78	-0.4
160	7.13	104.7	95.02	159.63	-0.79	9.03	7.5	9.06	-0.8
180	8.31	111.1	97.99	179.45	-1.63	11.57	7.3	11.69	-1.6
200	8.83	119.3	101.47	199.23	-2.9	14.26	6.6	14.55	-2.9
220	9.28	117.4	104.44	218.98	-4.39	17.04	2.7	17.59	-4.4
225	9.36	117	105	223.92	-4.76	17.76	1.8	18.38	-4.8
225	9.35	116.7	105	223.92	-4.76	17.76	1.8	18.38	-4.8

Analysis Notes:

Analyst:	Legler	Date:	4/2/2009

List of Log Plots:

Borehole Deviation

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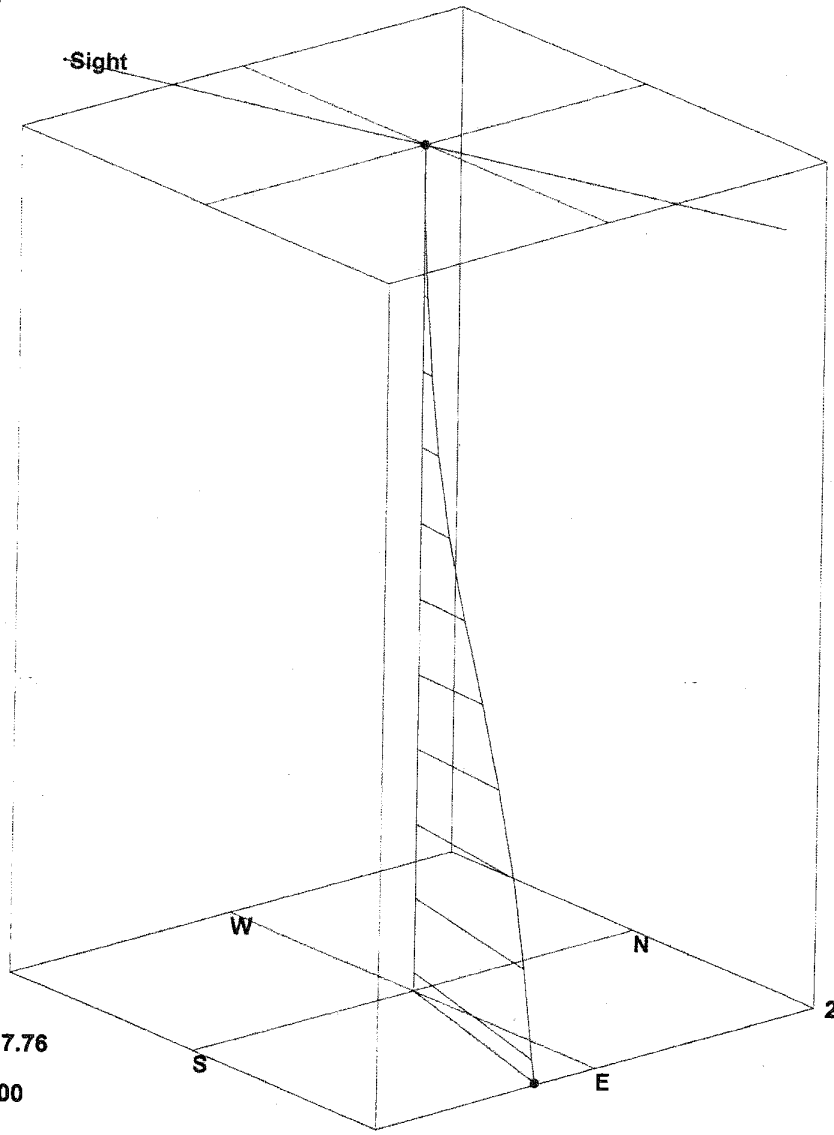
Hanford Office

established 1959

HGLP-LDR-349, Rev. 0

Survey File: 299-E26-77.raw
Date: Apr 02,2009

299-E26-77 (C6455)



223.92 feet

W/E range: 0.00 to 17.76

S/N range: -4.76 to 0.00

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HGLP-LDR-350, Rev. 0

299-E26-79 (C6826)
Log Data Report

Borehole Information:

Borehole:	299-E26-79	Well ID:	C6826	Site:	LERF (near road by fence)
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		218.04

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration Date:	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/2/2009	Engineer:	MJ LEGLER	Start File:	299-E26-79.raw	Finish File:	299-E26-79.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.48	99.5	0	0	0	0	0	0	0
20	0.55	73.3	85.48	20	0.01	0.18	1.2	0.18	0
40	1.39	87.6	84.2	40	0.05	0.51	4.3	0.51	0.1
60	2.39	102.9	91.53	59.99	-0.03	1.16	5.6	1.16	0
80	3.85	105.7	97.88	79.95	-0.31	2.21	7.3	2.23	-0.3
100	5.11	117.2	103.79	99.89	-0.9	3.65	7.7	3.76	-0.9
120	7.24	125.4	110.38	119.78	-2.03	5.47	11.5	5.84	-2
140	9.12	136	117.19	139.57	-3.9	7.6	12.1	8.54	-3.9
160	10.5	142.3	123.46	159.28	-6.49	9.82	8.7	11.77	-6.5
180	11.26	146	128.45	178.92	-9.55	12.02	5.1	15.35	-9.5
200	12.06	150	132.5	198.51	-12.98	14.16	5.7	19.21	-13
220	12.86	151.3	135.8	218.04	-16.74	16.28	4.2	23.35	-16.7
220	12.84	151.2	135.8	218.04	-16.74	16.28	4.2	23.35	-16.7

Analysis Notes:

Analyst:	Legler	Date:	4/2/2009

List of Log Plots:

Borehole Deviation

Stoller
Hanford Office

HGLP-LDR-356, Rev. 0

299-E27-17 (A4815)
Log Data Report

Borehole Information:

Borehole:	299-E27-17	Well ID:	A4815	Site:	218-E-12B burial ground
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		242.97

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	2/5/2009	Calibration Reference:	HGLP-CC-026, Rev. 1
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/9/2009	Engineer:	MJ LEGLER	Start File:	299-E27-17.raw	Finish File:	299-E27-17.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.37	318.5	0	0	0	0	0	0	0
20	0.33	136.2	339.4	20	0.01	0	3.5	0.01	0
40	0.22	57.1	102.27	40	-0.02	0.07	1.8	0.07	0
60	0.53	112.4	99.02	60	-0.03	0.19	2.2	0.19	0
80	0.93	149.3	119.93	80	-0.21	0.36	3	0.41	-0.2
100	0.26	170.8	131.15	100	-0.39	0.45	3.5	0.59	-0.4
120	0.32	15.8	129.07	120	-0.38	0.47	2.9	0.61	-0.4
140	0.75	92.7	118.42	140	-0.33	0.62	3.7	0.7	-0.3
160	0.65	87.8	111.29	159.99	-0.33	0.86	0.6	0.92	-0.3
180	0.71	102.1	108.05	179.99	-0.36	1.09	0.9	1.15	-0.4
200	1.25	93.1	105.38	199.99	-0.39	1.43	2.8	1.49	-0.4
220	1.71	115	105.48	219.98	-0.53	1.92	3.6	1.99	-0.5
240	2.15	125	109.26	239.97	-0.87	2.5	2.8	2.65	-0.9
243	2.25	116.6	109.74	242.97	-0.93	2.6	11.1	2.76	-0.9
243	2.25	116.2	109.74	242.97	-0.93	2.6	11.1	2.76	-0.9

Analysis Notes:

Analyst:	Legler	Date:	4/9/2009

List of Log Plots:

Borehole Deviation

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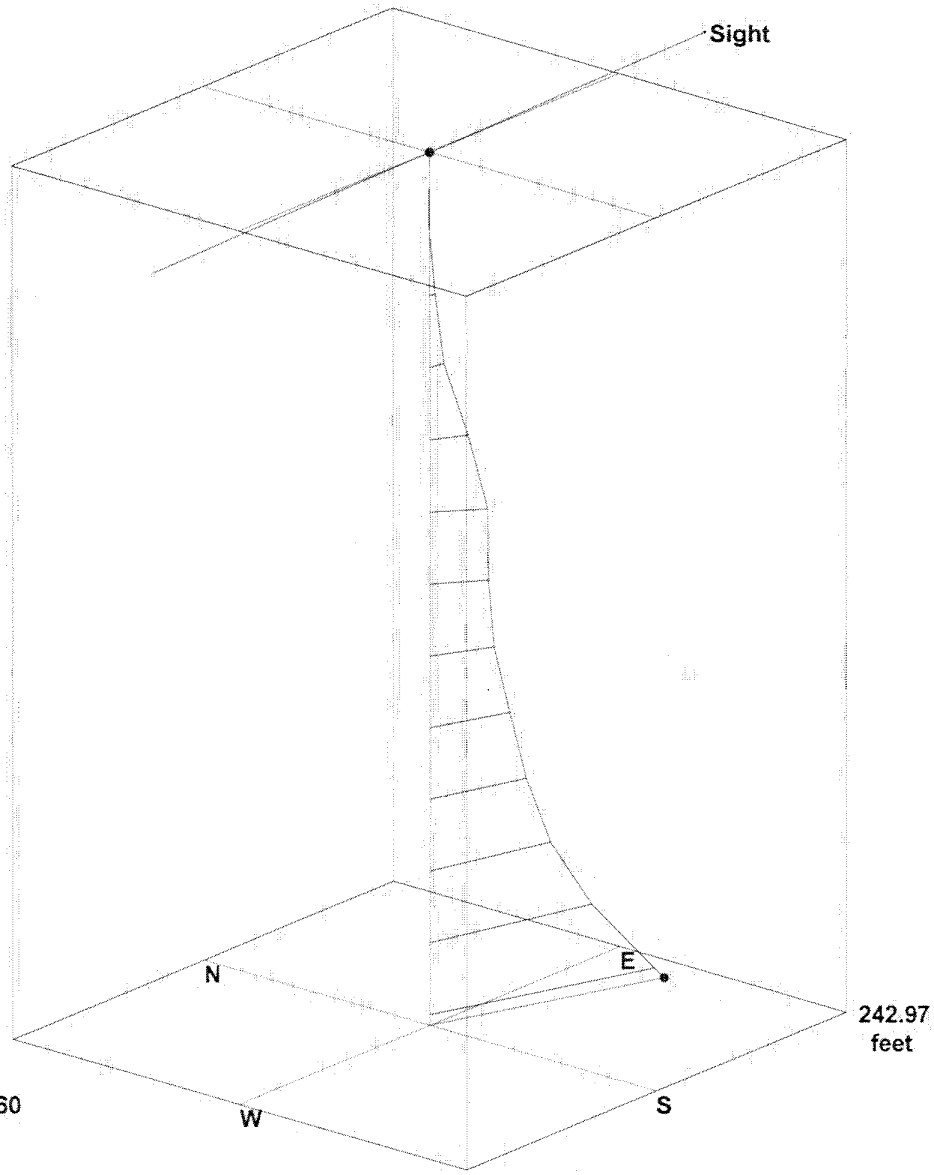
established 1959

HGLP-LDR-356, Rev. 0

299-E27-17 (A4815)

Survey File: 299-E27-17.raw
Date: Apr 09,2009



W/E range: -0.34 to 2.60
S/N range: -1.34 to 0.01

Stoller
Hanford Office

HGLP-LDR-363, Rev. 0

299-E27-18 (A6674)
Log Data Report

Borehole Information:

Borehole:	299-E27-18	Well ID:	A6674	Site:	216-B-2-2 Ditch
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		257.76

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	2/5/2009	Calibration Reference:	HGLP-CC-026, Rev. 1
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/15/2009	Engineer:	MJ LEGLER	Start File:	299-E27-18.raw	Finish File:	299-E27-18.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.35	329.4	0	0	0	0	0	0	0
20	1.74	191.4	200.37	20	-0.24	-0.09	10	0.26	-0.2
40	1.92	180.1	189.79	39.99	-0.88	-0.15	2	0.89	-0.9
60	2.21	175.9	184.46	59.97	-1.6	-0.12	1.7	1.6	-1.6
80	2.05	171.1	181.02	79.96	-2.33	-0.04	1.2	2.34	-2.3
100	2.21	172	178.74	99.95	-3.07	0.07	0.8	3.07	-3.1
120	2.5	177.4	177.91	119.93	-3.89	0.14	1.8	3.89	-3.9
140	2.65	169.3	177.04	139.91	-4.78	0.25	1.9	4.79	-4.8
160	2.94	168.5	175.67	159.89	-5.73	0.43	1.5	5.75	-5.7
180	2.81	164	174.29	179.86	-6.71	0.67	1.3	6.74	-6.7
200	2.72	162.3	172.9	199.84	-7.63	0.95	0.6	7.69	-7.6
220	2.45	161	171.72	219.82	-8.49	1.23	1.4	8.58	-8.5
240	3.09	163.7	170.79	239.79	-9.41	1.53	3.3	9.53	-9.4
258	3.8	162.7	170.01	257.76	-10.44	1.84	3.9	10.6	-10.4
258	3.8	162.9	170.01	257.76	-10.44	1.84	3.9	10.6	-10.4

Analysis Notes:

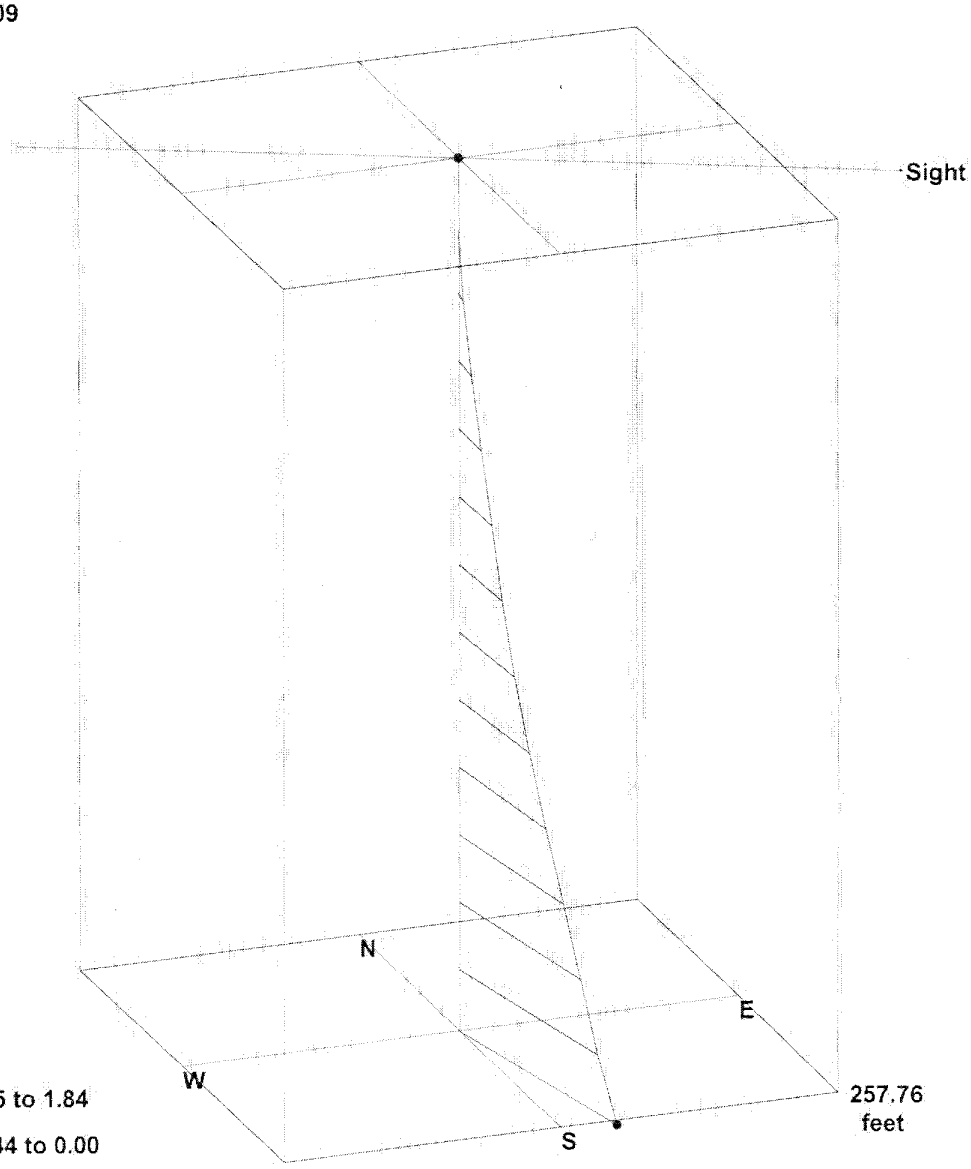
Analyst:	Legler	Date:	4/15/2009

List of Log Plots:

Borehole Deviation

Survey File: 299-E27-18.raw
Date: Apr 15,2009

299-E27-18 (A6674)



W/E range: -0.15 to 1.84

S/N range: -10.44 to 0.00

Stoller
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HGLP-LDR-360, Rev. 0

299-E27-8 (A4817)
Log Data Report

Borehole Information:

Borehole:	299-E27-8	Well ID:	A4817	Site:	218-E-12B Burial Ground
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		244.96

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	2/5/2009	Calibration Reference:	HGLP-CC-026, Rev. 1
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/10/2009	Engineer:	MJ LEGLER	Start File:	299-E27-8.raw	Finish File:	299-E27-8.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.37	107.4	0	0	0	0	0	0	0
20	0.78	114.9	112.53	20	-0.08	0.19	2.1	0.2	-0.1
40	0.36	72.1	107.29	40	-0.11	0.37	2.9	0.39	-0.1
60	1.01	81.1	96.43	60	-0.07	0.6	3.3	0.61	-0.1
80	0.53	37.2	87.75	79.99	0.03	0.83	3.6	0.83	0
100	0.8	48.7	78.72	99.99	0.2	0.99	1.5	1.01	0.2
120	1.06	58.4	72.87	119.99	0.39	1.26	1.5	1.31	0.4
140	1.13	43.3	67.95	139.99	0.63	1.55	1.5	1.67	0.6
160	1.21	17.2	60.88	159.98	0.97	1.75	2.7	2	1
180	1.66	18.1	52.63	179.98	1.45	1.9	2.2	2.39	1.5
200	1.13	13.4	46.71	199.97	1.92	2.04	2.7	2.8	1.9
220	0.68	0.5	43.07	219.97	2.23	2.08	2.4	3.05	2.2
240	1.43	13.9	39.62	239.96	2.59	2.14	3.9	3.36	2.6
245	1.63	26.2	38.9	244.96	2.71	2.19	7.7	3.49	2.7
245	1.63	26.1	38.9	244.96	2.71	2.19	7.7	3.49	2.7

Analysis Notes:

Analyst:	Legler	Date:	4/13/2009

List of Log Plots:

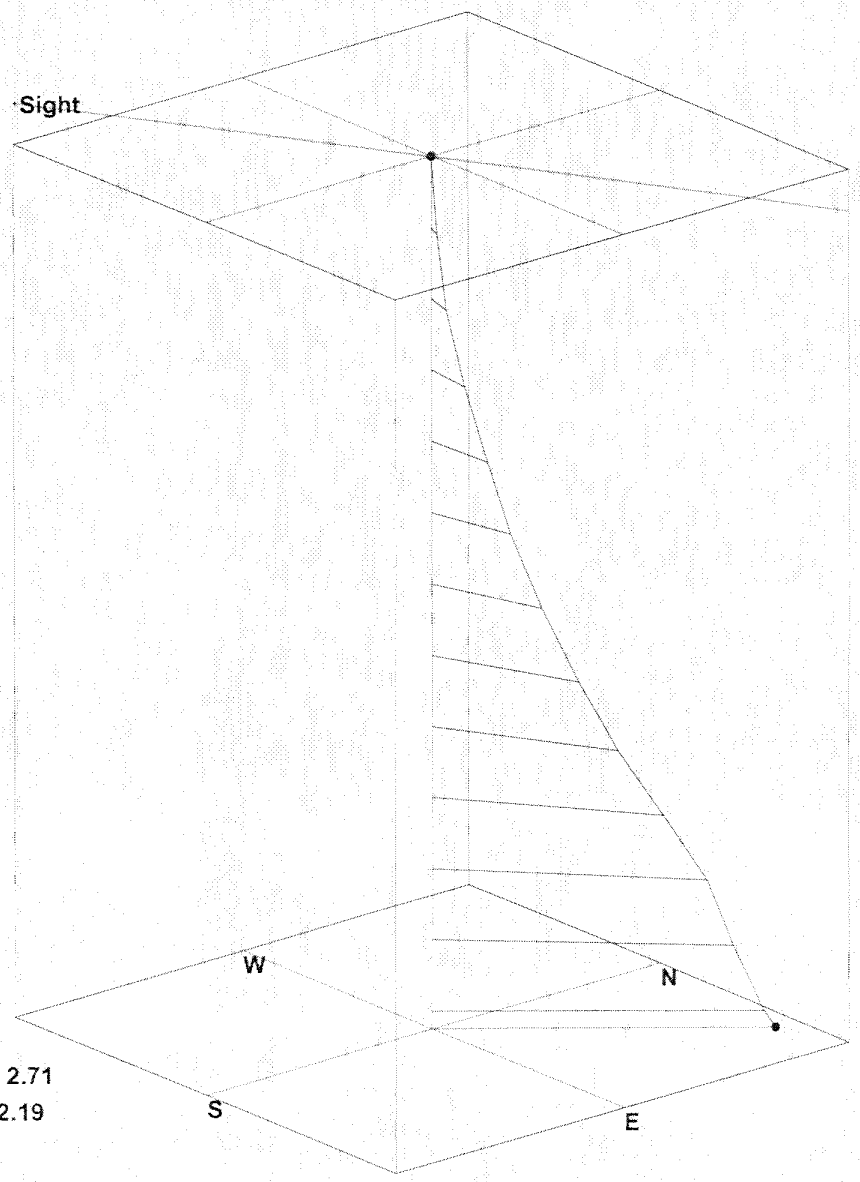
Borehole Deviation

Stoller
Hanford Office
established 1959

HGLP-LDR-360, Rev. 0

Survey File: 299-E27-8.raw
Date: Apr 10,2009

299-E27-8 (A4817)



244.96
feet

S/N range: -0.11 to 2.71
W/E range: 0.00 to 2.19

Stoller
Hanford Office

HGLP-LDR-359, Rev. 0

299-E27-9 (A4818)
Log Data Report

Borehole Information:

Borehole:	299-E27-9	Well ID:	A4818	Site:	218-E-12B Burial Ground
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		234.97

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	2/5/2009	Calibration Reference:	HGLP-CC-026, Rev. 1
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/13/2009	Engineer:	MJ LEGLER	Start File:	299-E27-9.raw	Finish File:	299-E27-9.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.59	281.2	0	0	0	0	0	0	0
20	0.74	236.6	256.15	20	-0.05	-0.21	2.6	0.21	-0.1
40	1.06	243.1	246.79	40	-0.21	-0.48	1.7	0.52	-0.2
60	1.5	248.5	246.54	59.99	-0.39	-0.89	2.3	0.97	-0.4
80	1.41	246	246.79	79.98	-0.58	-1.36	0.6	1.48	-0.6
100	1.85	246.8	246.69	99.98	-0.81	-1.88	2.2	2.05	-0.8
120	0.23	311.1	247.59	119.97	-0.91	-2.21	8.8	2.39	-0.9
140	1.03	257.4	249.06	139.97	-0.92	-2.41	4.5	2.58	-0.9
160	0.1	242.5	249.55	159.97	-0.97	-2.6	4.6	2.78	-1
180	0.59	165.1	247.4	179.97	-1.08	-2.59	2.9	2.81	-1.1
200	0.62	123.7	243.41	199.97	-1.24	-2.48	2.1	2.77	-1.2
220	0.76	136.2	238.69	219.97	-1.4	-2.29	1	2.69	-1.4
235	1.05	157.1	233.71	234.97	-1.59	-2.17	2.9	2.69	-1.6
235	1.07	157.9	233.71	234.97	-1.59	-2.17	2.9	2.69	-1.6

Analysis Notes:

Analyst:	Legler	Date:	4/13/2009

List of Log Plots:

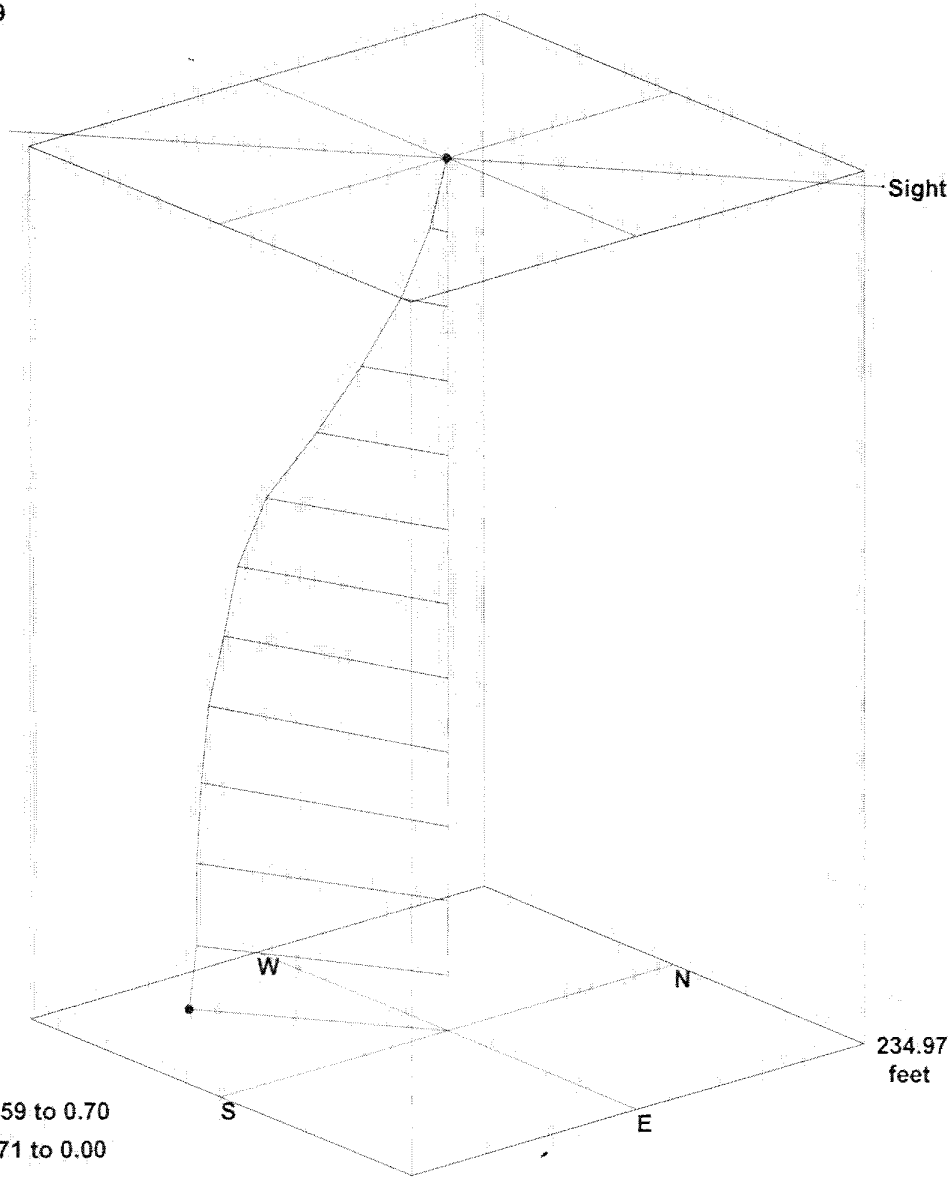
Borehole Deviation

Stoller
Hanford Office
established 1959

HGLP-LDR-359, Rev. 0

Survey File: 299-E27-9.raw
Date: Apr 13,2009

299-E27-9 (A4818)



S/N range: -1.59 to 0.70
W/E range: -2.71 to 0.00

Stoller
Hanford Office

HGLP-LDR-210, Rev. 0

299-E28-1 (A6784)
Log Data Report

Borehole Information:

Borehole:	299-E28-1	Well ID:	A6784	Site:	Near 216-B-56 trench
North	East	Elevation	Depth Reference		Total Depth (ft)
N/A*	N/A	N/A	Top of Casing		319.97

*N/A = Not Available

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	6/5/2008	Engineer:	MJ LEGLER	Start File:	299-E28-1.raw	Finish File:	299-E28-1.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.38	318.7	0	0	0	0	0	0	0
20	0.34	271.9	296.66	20	0.05	-0.1	1.4	0.11	0.1
40	0.34	275.5	285.02	40	0.06	-0.22	0.1	0.23	0.1
60	0.24	280.5	282.75	60	0.07	-0.32	0.5	0.33	0.1
80	0.22	206.8	276.77	80	0.04	-0.38	1.4	0.38	0
100	0.5	190.2	259.49	100	-0.08	-0.41	1.5	0.42	-0.1
120	0.94	190.1	234.54	120	-0.32	-0.46	2.2	0.56	-0.3
140	1.21	200.8	219.28	139.99	-0.68	-0.56	1.7	0.88	-0.7
160	1.33	210.4	214.81	159.99	-1.08	-0.75	1.2	1.32	-1.1
180	1.29	222.7	215.23	179.98	-1.45	-1.02	1.4	1.77	-1.4
200	0.96	232.3	217.31	199.98	-1.72	-1.31	1.9	2.16	-1.7
220	0.8	241.1	219.65	219.98	-1.89	-1.56	1	2.45	-1.9
240	0.53	234.6	221.27	239.98	-2.01	-1.76	1.4	2.67	-2
260	0.38	224.4	221.78	259.98	-2.11	-1.89	0.8	2.83	-2.1
300	0.71	174.9	218.57	299.97	-2.45	-1.96	1.4	3.14	-2.5
320	1.59	144.2	212.46	319.97	-2.8	-1.78	5.2	3.32	-2.8

Analysis Notes:

Analyst:	Legler	Date:	6/5/2008

Logged without centralizer. Skipped the 280 ft station to prevent erroneous reading caused by the tool being halfway into the telescoping screen.

List of Log Plots:

Borehole Deviation

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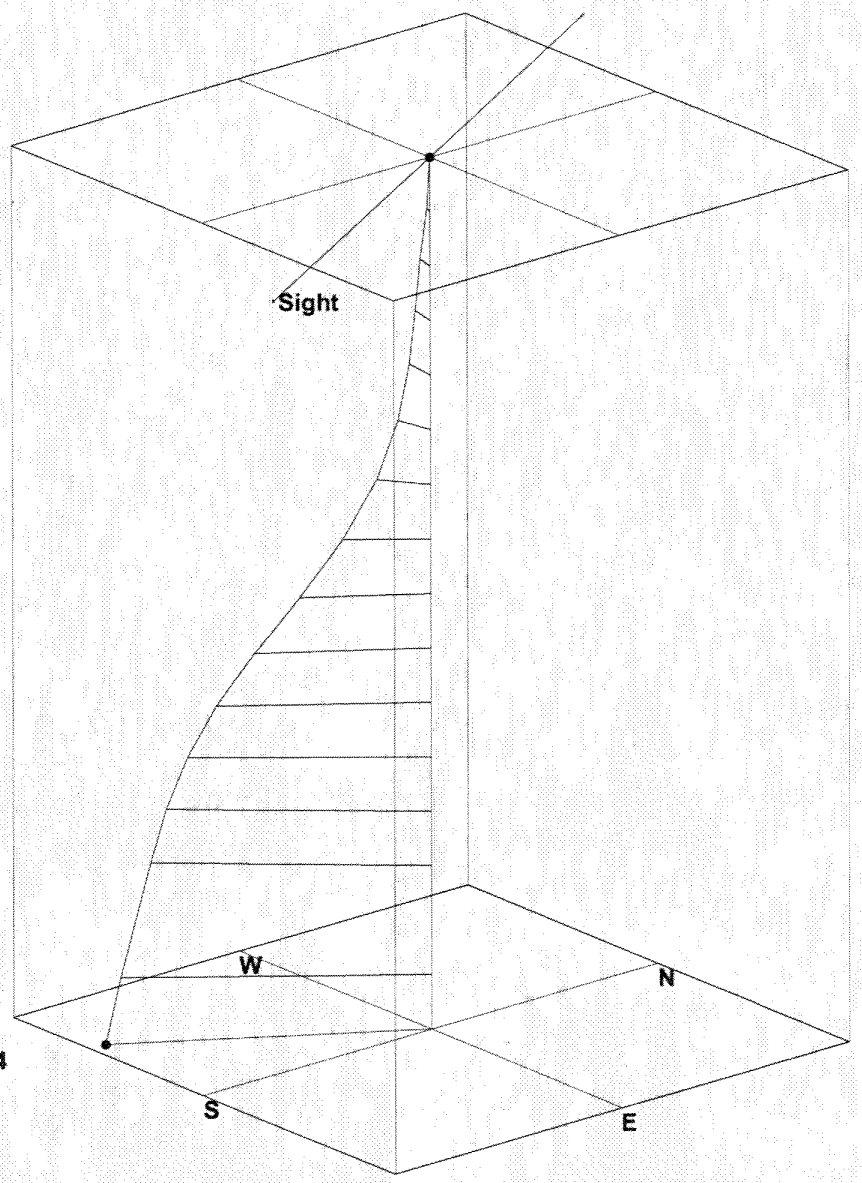
HGLP-LDR-210, Rev. 0

299-E28-1 (A6784)

Survey File: 299-E28-1.raw
Customer: Fluor
Date: Jun 05,2008
Time: 11:53



W/E range: -1.96 to 0.24
S/N range: -2.80 to 0.07

319.97
feet

Stoller Hanford Office

HGLP-LDR-226, Rev. 0

299-E28-17 (A4820)
Log Data Report

Borehole Information:

Borehole:	299-E28-17	Well ID:	A4820	Site:	Near 216-B-10 Crib
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
447333	2241410	706.6	Top of Casing		339.86

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	6/19/2008	Engineer:	MJ LEGLER	Start File:	299-E28-17.raw	Finish File:	299-E28-17.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.36	177.8	0	0	0	0	0	0	0
20	0.34	117.1	148.69	20	-0.09	0.05	1.8	0.1	-0.1
40	0.37	142.8	139.03	40	-0.17	0.15	0.8	0.22	-0.2
60	0.32	137.8	139.55	60	-0.26	0.22	0.3	0.34	-0.3
80	0.18	124.2	138.22	80	-0.32	0.29	0.8	0.43	-0.3
100	0.18	70.8	133.83	100	-0.33	0.34	0.8	0.47	-0.3
120	0.33	359.6	125.11	120	-0.26	0.37	1.6	0.45	-0.3
140	0.66	345.1	105.11	140	-0.09	0.34	1.8	0.35	-0.1
160	1.14	344	50.42	160	0.21	0.26	2.4	0.33	0.2
180	1.53	344.1	10.93	179.99	0.66	0.13	1.9	0.67	0.7
200	1.68	341.2	358.06	199.98	1.19	-0.04	0.9	1.2	1.2
220	1.78	333.3	351.07	219.97	1.75	-0.28	1.3	1.77	1.8
240	2.07	319.5	344.25	239.96	2.3	-0.65	2.7	2.39	2.3
260	2.28	308.5	337.07	259.95	2.83	-1.2	2.3	3.07	2.8
280	2.25	291.4	329.79	279.93	3.22	-1.87	3.4	3.72	3.2
300	2.53	267.2	321.26	299.91	3.34	-2.68	5.2	4.28	3.3
320	2.76	241.6	311.07	319.89	3.09	-3.54	6	4.7	3.1
340	4	210.4	297.59	339.86	2.26	-4.32	10.9	4.88	2.3
340	3.97	211.1	297.59	339.86	2.26	-4.32	10.9	4.88	2.3

Analysis Notes:

Analyst:	Legler	Date:	6/19/2008

A centralizer was not used.

List of Log Plots:

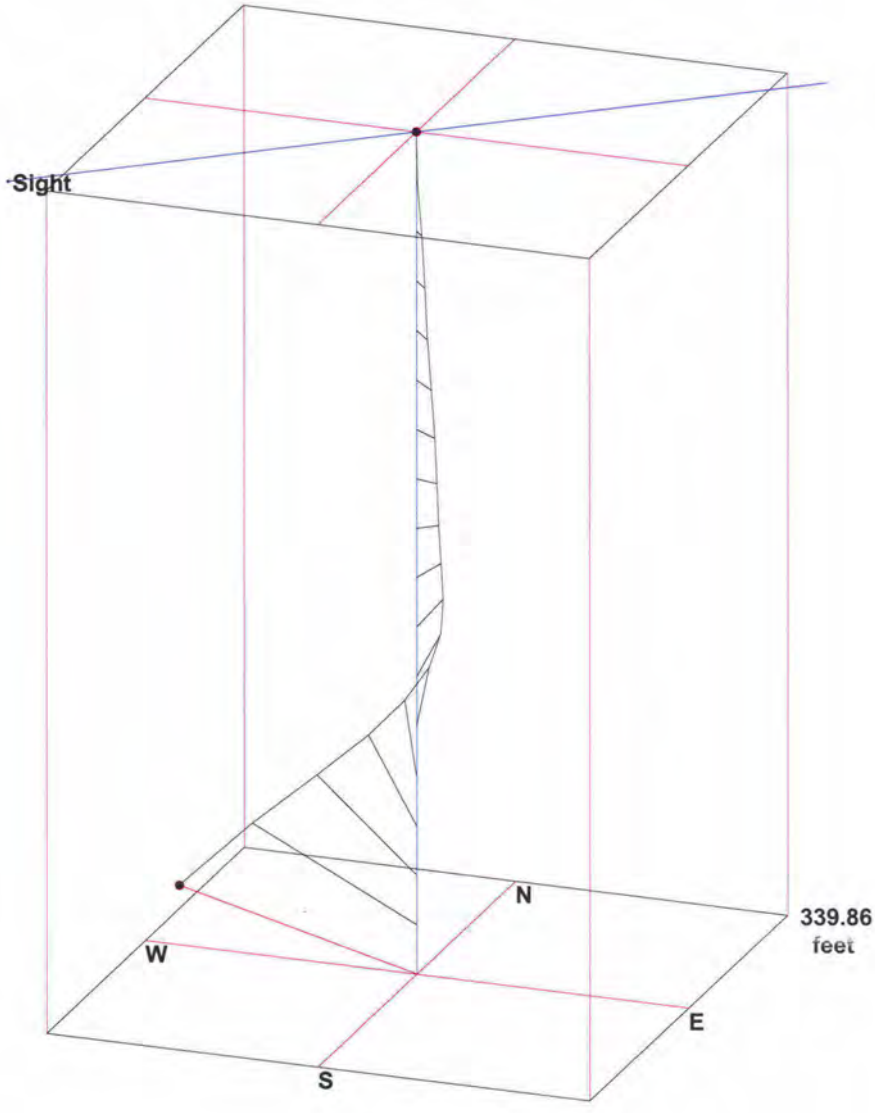
Borehole Deviation

Stoller
Hanford Office

HGLP-LDR-226, Rev. 0

Survey File: 299-E28-17.raw
Customer: Fluor
Date: Jun 19,2008
Time: 10:31
W/E range: -4.32 to 0.48
S/N range: -0.33 to 3.53

299-E28-17 (A4820)



Survey File: C:\DSE\A4821.RAW
Date: Aug 09,2005
Time: 0:57
Description: Borehole Survey
LOCATION: 299-E28-18
CUSTOMER: PNNL
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 0.61 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
212H Stack
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 239 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.18	292.3	0.00	0.00	0.00	0.00	0.0
20.00	0.34	28.6	20.00	0.06	0.00	2.00	0.1
40.00	1.04	57.0	40.00	0.22	0.18	3.80	0.2
60.00	1.34	72.2	59.99	0.39	0.56	2.20	0.4
80.00	1.30	91.1	79.99	0.45	1.01	2.20	0.5
100.00	0.82	122.2	99.99	0.37	1.35	3.60	0.4
120.00	0.62	164.7	119.98	0.19	1.50	2.80	0.2
140.00	0.50	220.3	139.98	0.02	1.48	2.70	0.0
160.00	0.92	271.4	159.98	-0.04	1.26	3.60	0.0
180.00	1.01	300.7	179.98	0.05	0.95	2.50	0.1
200.00	0.78	318.6	199.98	0.25	0.71	1.80	0.2
220.00	0.15	32.2	219.98	0.37	0.63	3.70	0.4
240.00	0.14	41.5	239.98	0.41	0.66	0.10	0.4
260.00	0.51	183.7	259.98	0.34	0.67	3.10	0.3
280.00	1.84	211.7	279.97	-0.02	0.50	7.00	0.0
300.00	2.64	234.4	299.96	-0.56	-0.05	5.90	-0.6
301.20	2.66	235.3	301.15	-0.59	-0.09	3.90	-0.6

Bottom:
True Vertical Depth 301.15 feet

1

Closure Distance	0.6 feet
Closure Direction	188.7 deg.
Course Direction	235.3 deg.

DEFINITIONS:

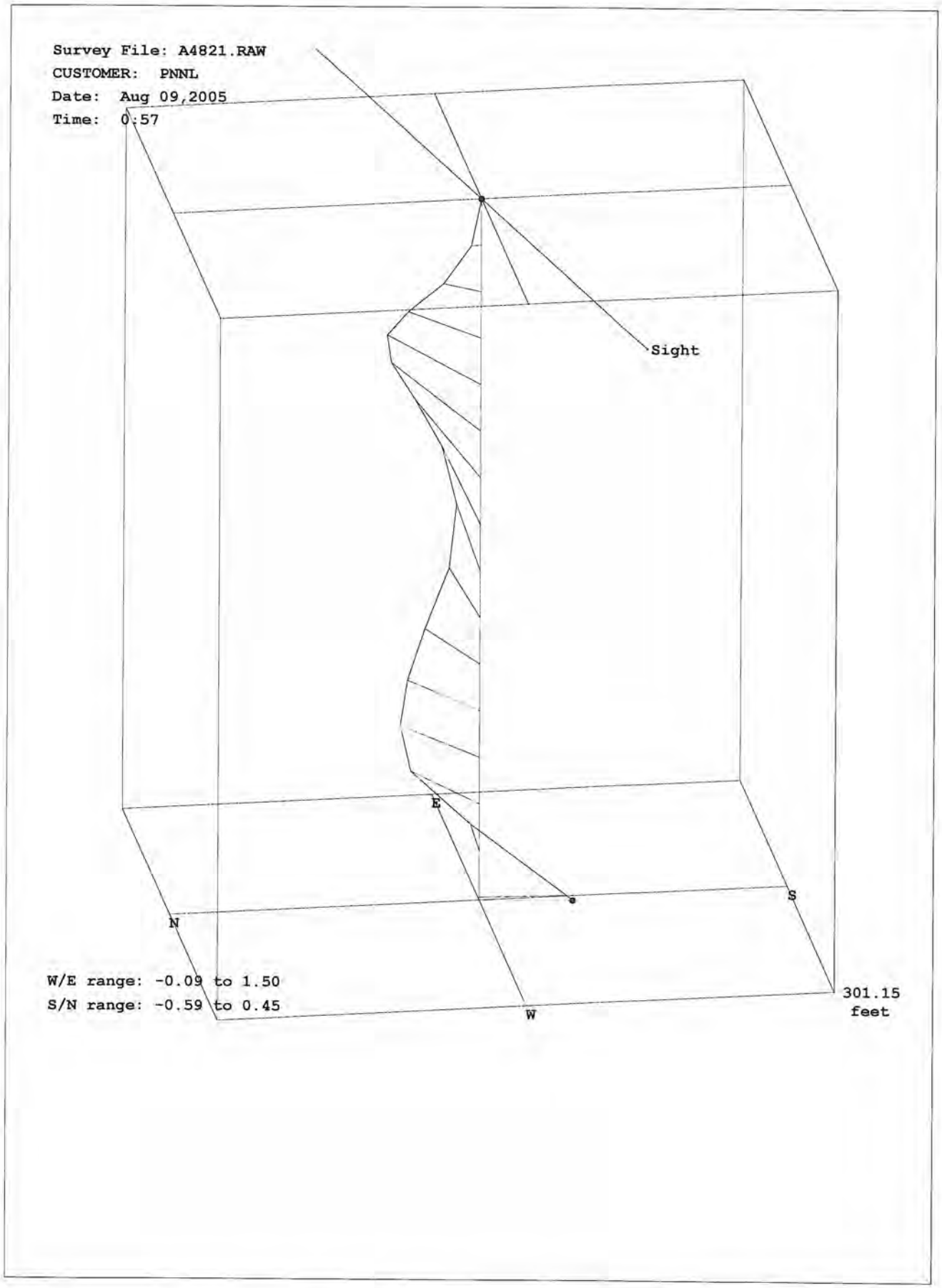
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.

Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: A4821.RAW
CUSTOMER: PNNL
Date: Aug 09,2005
Time: 0:57
Sight
E
S
N
W
W/E range: -0.09 to 1.50
S/N range: -0.59 to 0.45
301.15
feet

Survey File: C:\DSE\A4823.RAW
Date: Aug 08,2005
Time: 22:45
Description: Borehole Gyro
LOCATION: 299-E28-27
CUSTOMER: PNNL
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 30.39 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
T Post
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 187 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

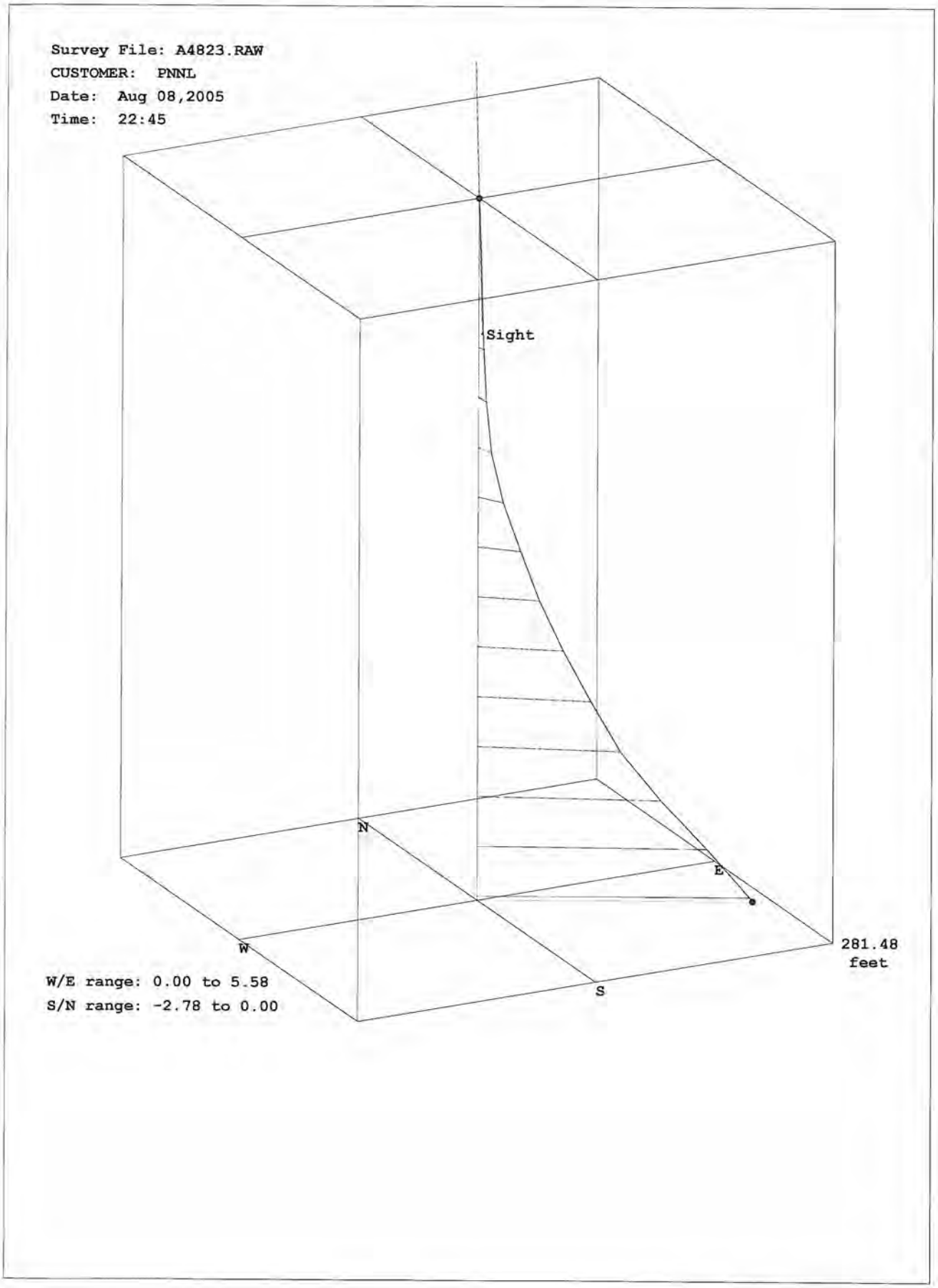
Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.27	67.3	0.00	0.00	0.00	0.00	0.0
20.00	0.14	157.7	20.00	0.00	0.05	1.50	0.0
40.00	0.14	180.0	40.00	-0.05	0.06	0.30	-0.1
60.00	0.48	190.6	60.00	-0.16	0.05	1.70	-0.2
80.00	0.62	186.7	80.00	-0.35	0.02	0.70	-0.3
100.00	0.48	118.9	100.00	-0.50	0.08	3.10	-0.5
120.00	1.09	106.0	120.00	-0.59	0.34	3.20	-0.6
140.00	1.22	103.2	139.99	-0.69	0.73	0.70	-0.7
160.00	1.24	116.3	159.99	-0.84	1.13	1.40	-0.8
180.00	1.88	118.5	179.98	-1.09	1.61	3.20	-1.1
200.00	1.74	123.0	199.97	-1.41	2.16	1.00	-1.4
220.00	2.11	110.9	219.96	-1.71	2.76	2.70	-1.7
240.00	3.15	112.8	239.94	-2.05	3.61	5.20	-2.1
260.00	2.91	108.4	259.91	-2.42	4.60	1.70	-2.4
280.00	2.67	111.5	279.89	-2.76	5.51	1.40	-2.8
281.60	2.56	112.1	281.48	-2.78	5.58	7.00	-2.8

Bottom:
True Vertical Depth 281.48 feet
Closure Distance 6.2 feet

1

Closure Direction 116.5 deg.
Course Direction 112.1 deg.

DEFINITIONS:
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.
Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.
Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.
ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.
ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: A4823.RAW
CUSTOMER: PNNL
Date: Aug 08,2005
Time: 22:45
Sight
N
E
W
S
281.48
feet
W/E range: 0.00 to 5.58
S/N range: -2.78 to 0.00

Survey File: C:\DSE\A4833A.RAW
Date: Aug 11,2005
Time: 10:07
Description: Boerhole Survey
LOCATION: 299-E32-5
CUSTOMER: PNNL
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 30.02 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
RR Xing sign
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 192 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.85	289.4	0.00	0.00	0.00	0.00	0.0
20.00	1.10	323.0	20.00	0.20	-0.26	3.00	0.2
40.00	1.30	330.3	39.99	0.55	-0.48	1.30	0.6
60.00	0.81	323.8	59.99	0.86	-0.68	2.60	0.9
80.00	1.45	316.3	79.99	1.16	-0.94	3.30	1.2
100.00	1.03	350.9	99.98	1.52	-1.14	4.20	1.5
120.00	0.64	358.6	119.98	1.81	-1.17	2.00	1.8
140.00	1.29	359.1	139.98	2.15	-1.18	3.30	2.1
160.00	1.26	8.0	159.97	2.59	-1.15	1.00	2.6
180.00	0.77	45.6	179.97	2.90	-1.02	4.00	2.9
200.00	0.68	67.7	199.97	3.04	-0.82	1.50	3.0
220.00	1.55	56.4	219.96	3.24	-0.48	4.50	3.2
240.00	1.90	56.0	239.95	3.57	0.02	1.70	3.6
260.00	1.94	88.4	259.94	3.77	0.63	5.40	3.8
280.00	1.62	97.5	279.93	3.74	1.25	2.20	3.7
284.30	1.67	102.7	284.23	3.72	1.37	3.70	3.7

Bottom:
True Vertical Depth 284.23 feet
Closure Distance 4.0 feet

1

Closure Direction	20.2 deg.
Course Direction	102.7 deg.

DEFINITIONS:

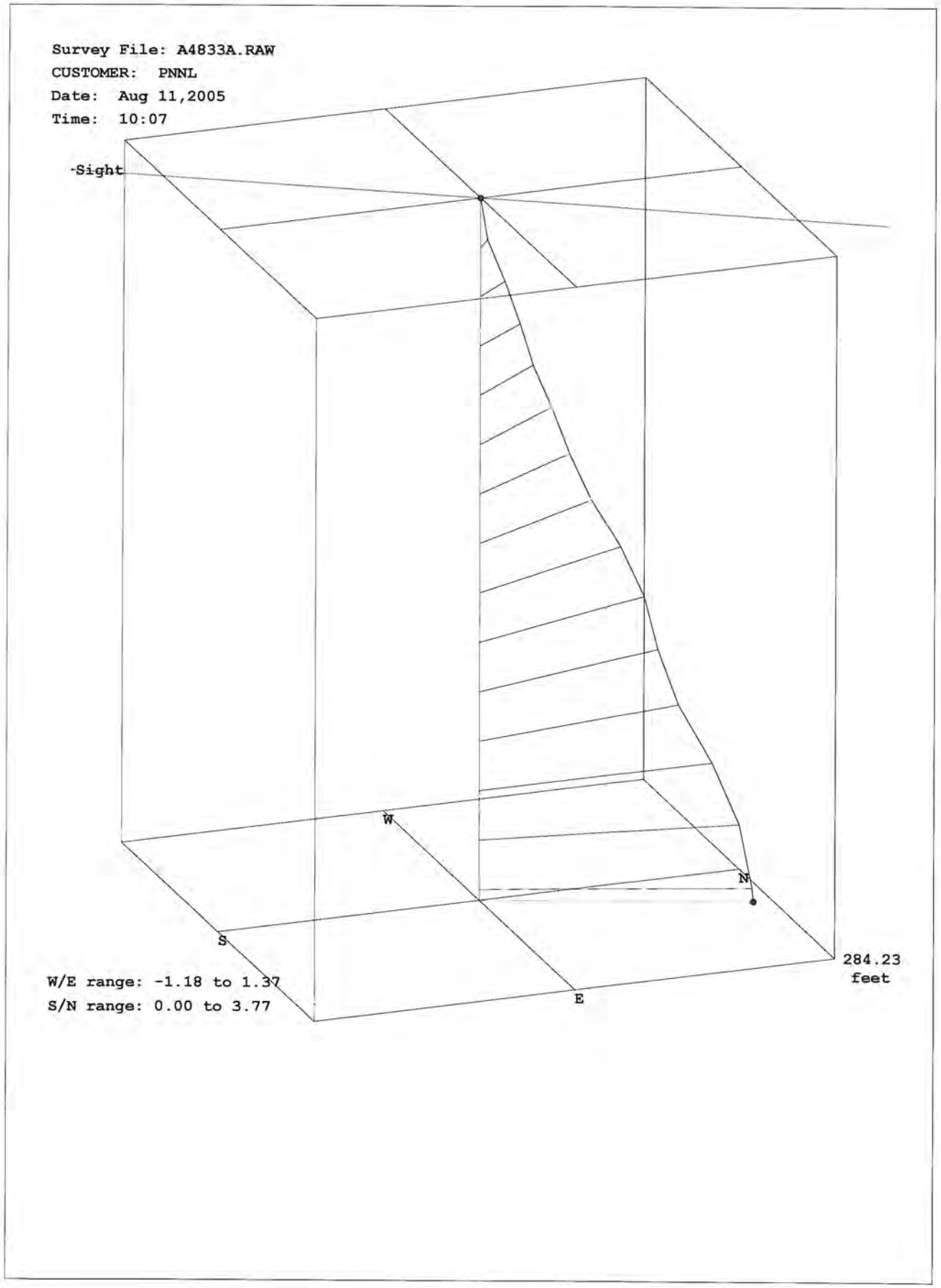
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.

Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: A4833A.RAW
CUSTOMER: PNNL
Date: Aug 11,2005
Time: 10:07
Sight
W
N
S
E
284.23
feet
W/E range: -1.18 to 1.37
S/N range: 0.00 to 3.77

Survey File: C:\DSE\A4834.RAW
Date: Jun 09,2005
Time: 13:00
Description:
LOCATION: 299-E32-6
CUSTOMER: PNNL
OPERATOR:
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #0001
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 0.03 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
t-post by power pole
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 152 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.15	232.3	0.00	0.00	0.00	0.00	0.0
20.00	0.40	105.7	20.00	-0.03	0.05	2.50	0.0
40.00	0.62	111.3	40.00	-0.09	0.22	1.10	-0.1
60.00	0.60	109.7	60.00	-0.17	0.42	0.10	-0.2
80.00	0.30	150.8	80.00	-0.25	0.54	2.10	-0.2
100.00	0.71	169.5	100.00	-0.42	0.59	2.20	-0.4
120.00	0.93	169.1	119.99	-0.70	0.64	1.10	-0.7
140.00	1.04	161.0	139.99	-1.03	0.73	0.90	-1.0
160.00	1.15	154.8	159.99	-1.38	0.88	0.80	-1.4
180.00	1.15	147.2	179.98	-1.73	1.07	0.80	-1.7
200.00	1.59	142.7	199.98	-2.12	1.35	2.20	-2.1
220.00	1.65	143.5	219.97	-2.57	1.69	0.30	-2.6
240.00	1.54	157.0	239.96	-3.05	1.96	1.90	-3.1
260.00	1.83	163.4	259.95	-3.60	2.16	1.70	-3.6
266.00	1.90	169.5	265.95	-3.79	2.20	3.50	-3.8

Bottom:
True Vertical Depth 265.95 feet
Closure Distance 4.4 feet
Closure Direction 149.9 deg.

1

Course Direction 169.5 deg.

DEFINITIONS:

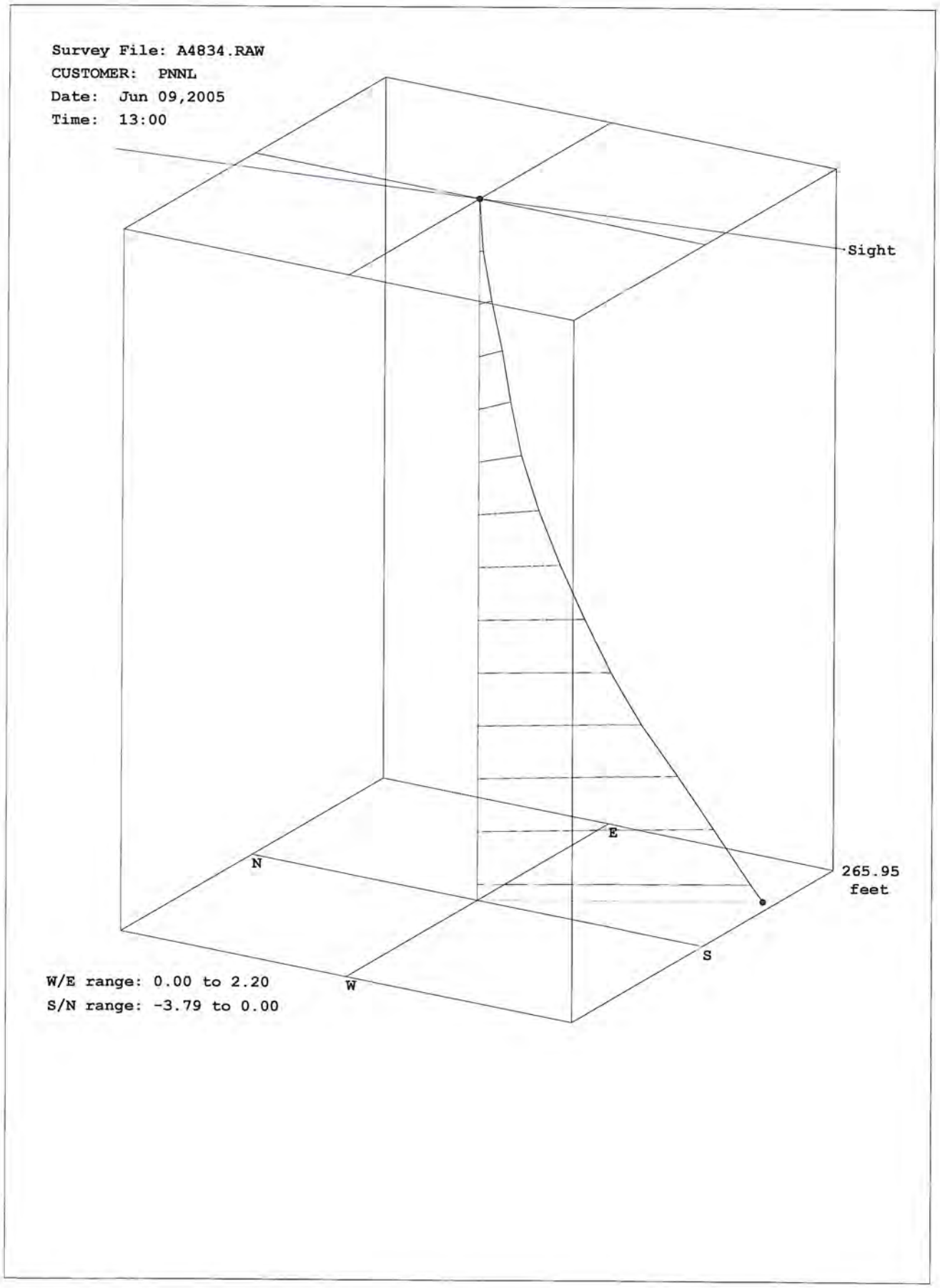
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.

Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: A4834.RAW
CUSTOMER: PNNL
Date: Jun 09,2005
Time: 13:00
Sight
E
N
265.95
feet
S
W
W/E range: 0.00 to 2.20
S/N range: -3.79 to 0.00

Survey File: C:\DSE\A4836.RAW
Date: Aug 05,2005
Time: 21:34
Description: Borehole Gyro
LOCATION: 299-E32-8
CUSTOMER: PNNL
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 30.08 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
T Post
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 304 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.42	115.5	0.00	0.00	0.00	0.00	0.0
20.00	0.14	13.4	20.00	-0.01	0.07	2.40	0.0
40.00	0.42	332.4	40.00	0.08	0.04	1.70	0.1
60.00	0.65	326.8	60.00	0.24	-0.05	1.10	0.2
80.00	0.83	307.3	80.00	0.42	-0.23	1.50	0.4
100.00	1.22	293.6	99.99	0.60	-0.54	2.30	0.6
120.00	1.98	286.2	119.99	0.78	-1.07	4.00	0.8
140.00	2.03	285.2	139.97	0.97	-1.74	0.30	1.0
160.00	1.83	299.4	159.96	1.22	-2.36	2.60	1.2
180.00	2.25	291.5	179.95	1.52	-3.00	2.50	1.5
200.00	2.64	293.6	199.93	1.85	-3.79	2.00	1.8
220.00	2.87	297.3	219.91	2.26	-4.66	1.50	2.3
240.00	3.08	295.4	239.88	2.72	-5.59	1.10	2.7
248.20	3.48	290.4	248.07	2.90	-6.02	6.00	2.9

Bottom:
True Vertical Depth 248.07 feet
Closure Distance 6.7 feet
Closure Direction 295.7 deg.
Course Direction 290.4 deg.

1

DEFINITIONS:

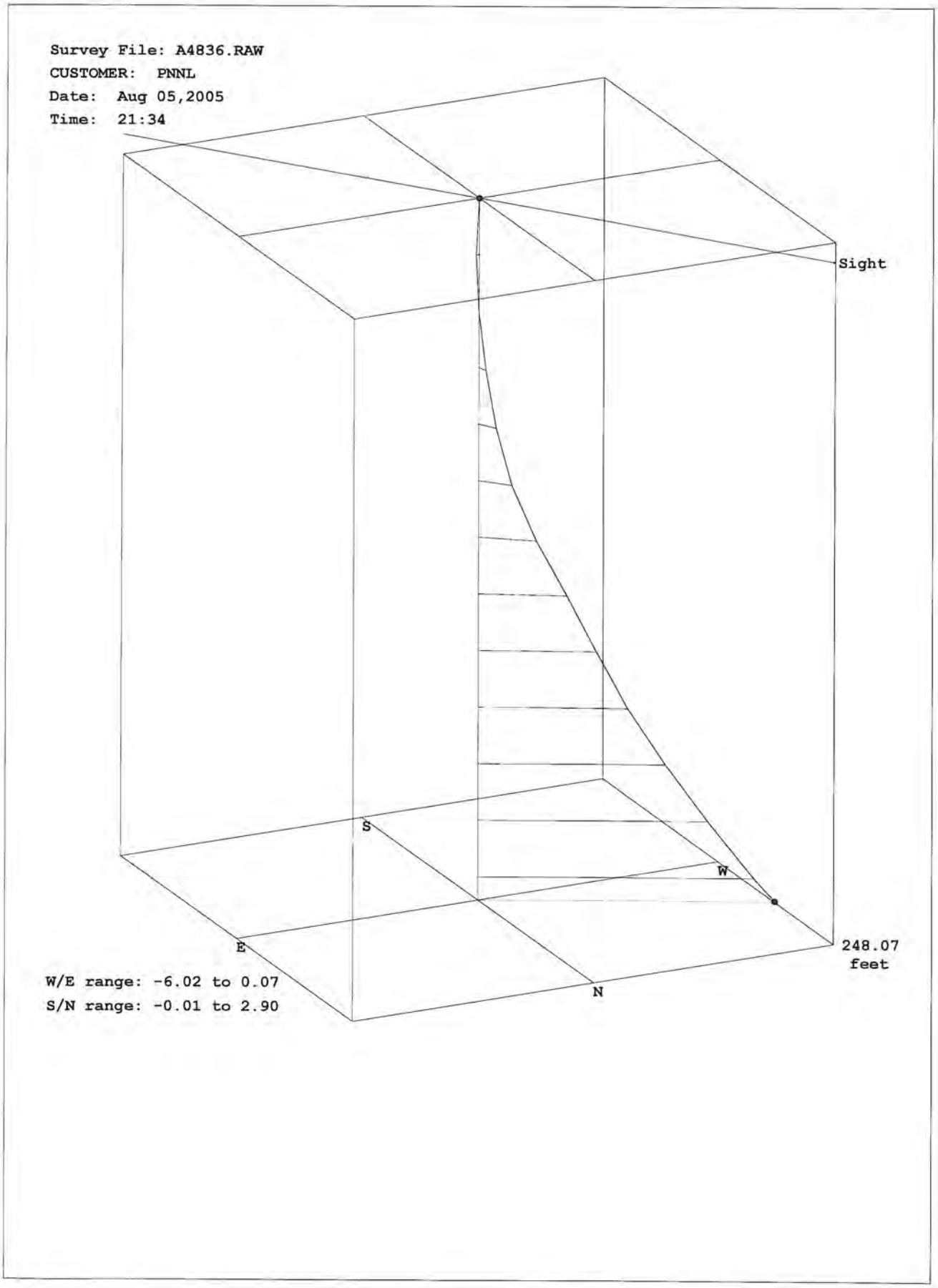
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.

Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: A4836.RAW
CUSTOMER: PNNL
Date: Aug 05,2005
Time: 21:34
Sight
S
W
E
N
248.07
feet
W/E range: -6.02 to 0.07
S/N range: -0.01 to 2.90

Stoller
Hanford Office

HGLP-LDR-358, Rev. 0

299-E33-14 (A4841)
Log Data Report

Borehole Information:

Borehole:	299-E33-14	Well ID:	A4841	Site:	218-E-12B Burial Ground
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		225.69

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	2/5/2009	Calibration Reference:	HGLP-CC-026, Rev. 1
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/13/2009	Engineer:	MJ LEGLER	Start File:	299-E33-14.raw	Finish File:	299-E33-14.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.37	62.6	0	0	0	0	0	0	0
20	0.41	47	54.41	20	0.08	0.11	0.6	0.13	0.1
40	0.41	91.8	61.81	40	0.12	0.23	1.5	0.26	0.1
60	0.41	135	78.49	60	0.07	0.35	1.5	0.36	0.1
80	0.27	191.8	93.67	80	-0.03	0.39	1.7	0.39	0
100	0.29	279.8	100.8	100	-0.06	0.33	2	0.34	-0.1
120	0.49	275.7	103.23	120	-0.05	0.2	1	0.2	0
140	0.41	259.6	142.21	140	-0.05	0.04	0.8	0.06	-0.1
160	0.52	265.8	240.18	160	-0.07	-0.12	0.6	0.14	-0.1
180	0.62	256.4	252.18	180	-0.1	-0.32	0.7	0.33	-0.1
200	1.11	277.1	260.43	199.99	-0.1	-0.61	2.9	0.62	-0.1
220	1.34	306.7	273.5	219.99	0.06	-0.99	3.3	0.99	0.1
225.7	2.26	334.4	280.45	225.69	0.2	-1.1	21.7	1.11	0.2

Analysis Notes:

Analyst:	Legler	Date:	4/13/2009

List of Log Plots:

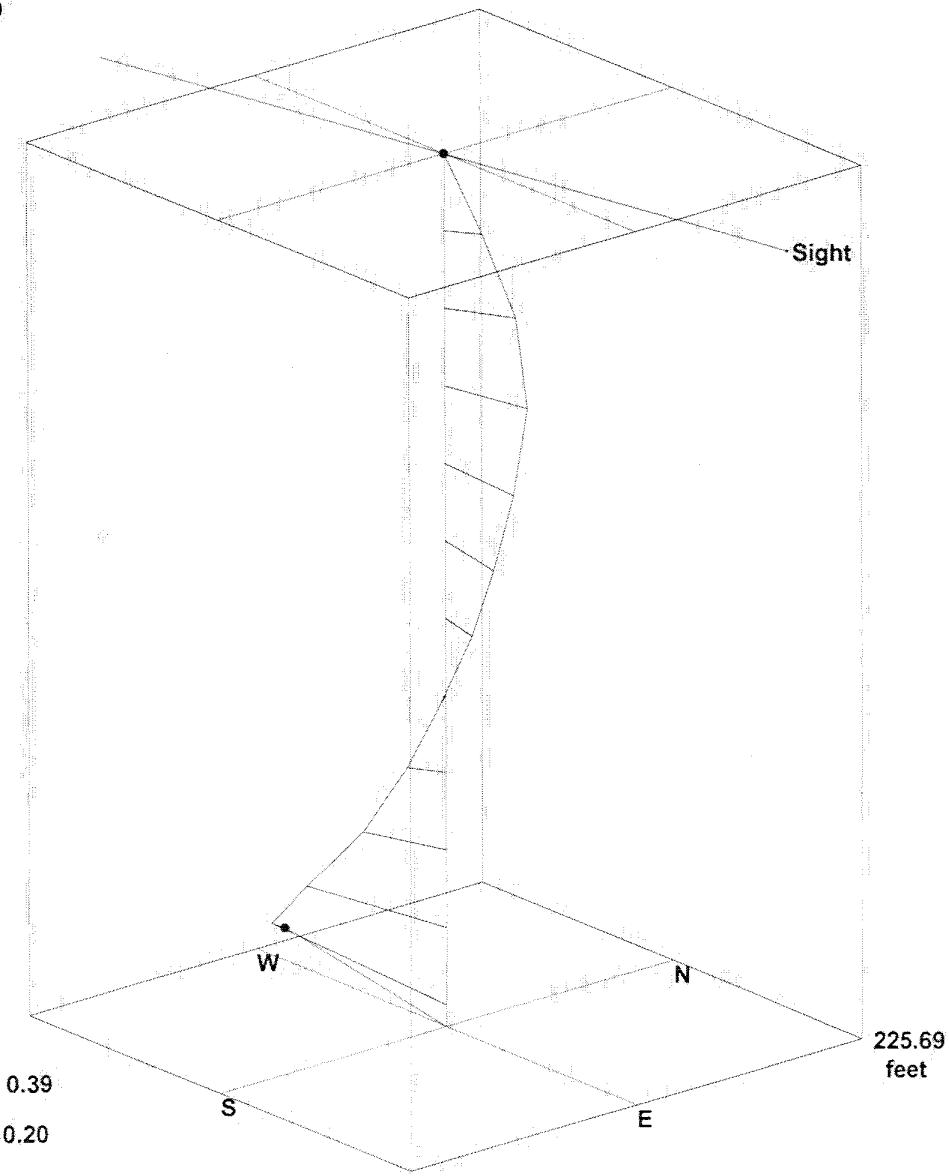
Borehole Deviation

Stoller
Hanford Office
established 1959

HGLP-LDR-358, Rev. 0

299-E33-14 (A4841)

Survey File: 299-E33-14.raw
Date: Apr 13,2009



W/E range: -1.10 to 0.39

S/N range: -0.36 to 0.20

A4852X.RPT

Survey File: C:\DSE\A4852.RAW
Date: Aug 08,2005
Time: 20:49
Description: Borehole Gyro
LOCATION: 299-E33-28
CUSTOMER: PNNL
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 30.09 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
T Post
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 183 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.14	344.3	0.00	0.00	0.00	0.00	0.0
20.00	0.32	305.1	20.00	0.06	-0.05	1.20	0.1
40.00	0.10	45.3	40.00	0.10	-0.09	1.80	0.1
60.00	0.14	87.4	60.00	0.11	-0.05	0.50	0.1
80.00	0.29	107.4	80.00	0.10	0.02	0.80	0.1
100.00	0.47	108.4	100.00	0.06	0.15	0.90	0.1
120.00	0.70	95.1	120.00	0.02	0.35	1.30	0.0
140.00	1.04	86.6	140.00	0.02	0.65	1.80	0.0
160.00	1.28	73.4	159.99	0.10	1.05	1.80	0.1
180.00	1.34	63.8	179.99	0.27	1.47	1.10	0.3
200.00	0.93	56.0	199.98	0.46	1.81	2.20	0.5
220.00	0.47	16.8	219.98	0.63	1.97	3.20	0.6
240.00	0.37	33.3	239.98	0.76	2.03	0.80	0.8
260.00	0.08	167.9	259.98	0.80	2.07	2.10	0.8
266.70	0.12	172.5	266.68	0.79	2.07	0.60	0.8

Bottom:
True Vertical Depth 266.68 feet
Closure Distance 2.2 feet
Closure Direction 69.1 deg.
Course Direction 172.5 deg.

DEFINITIONS:
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.
Closure Distance: A distance between coordinate origin and a horizontal

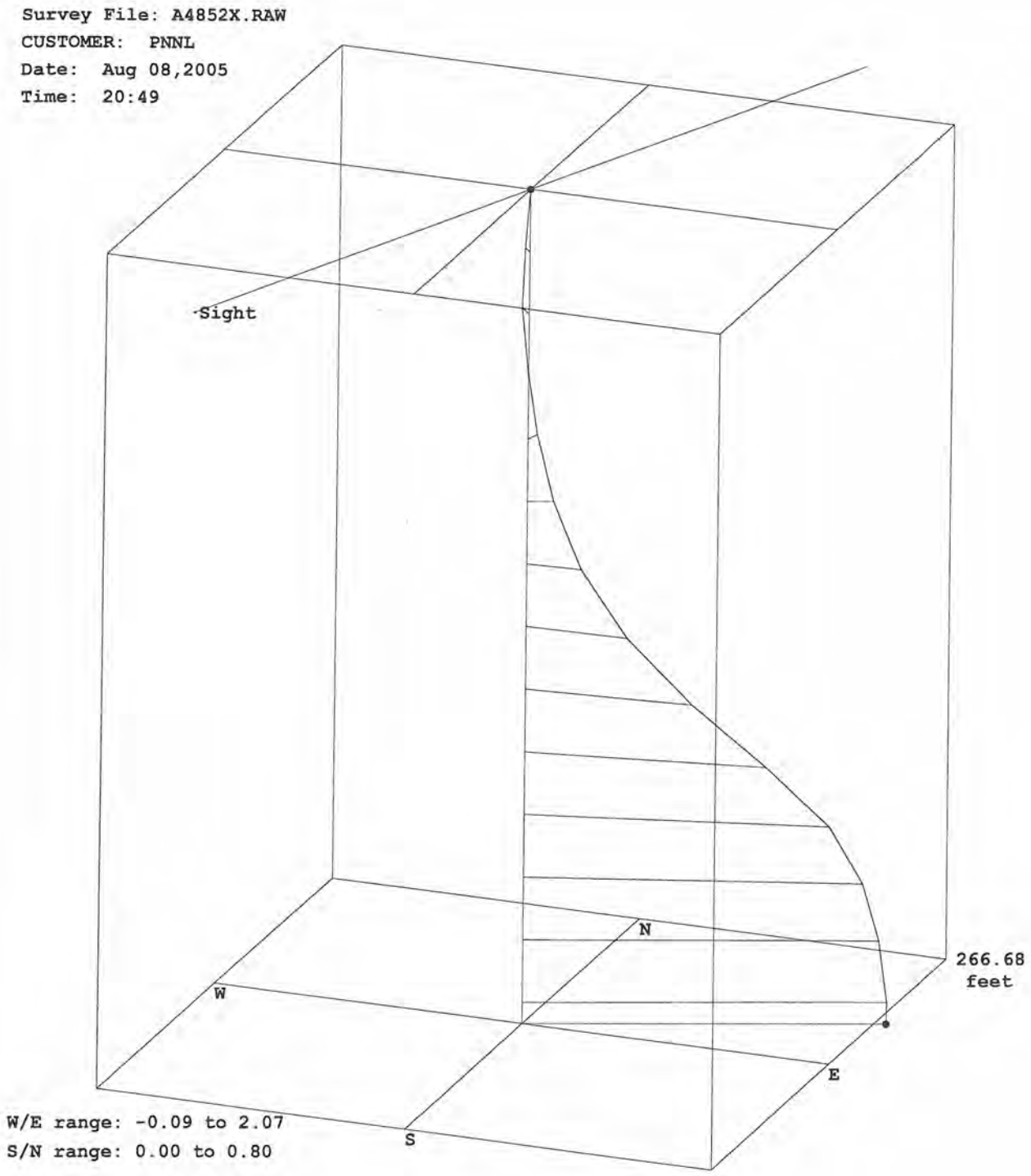
Page 1

projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: A4852X.RAW
CUSTOMER: PNNL
Date: Aug 08,2005
Time: 20:49
Sight
N
W
E
S
266.68
feet
W/E range: -0.09 to 2.07
S/N range: 0.00 to 0.80

Survey File: C:\DSE\A4859.RAW
Date: Aug 04,2005
Time: 22:04
Description: Gyro Survey
LOCATION: 299-E33-34
CUSTOMER: PNNL
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

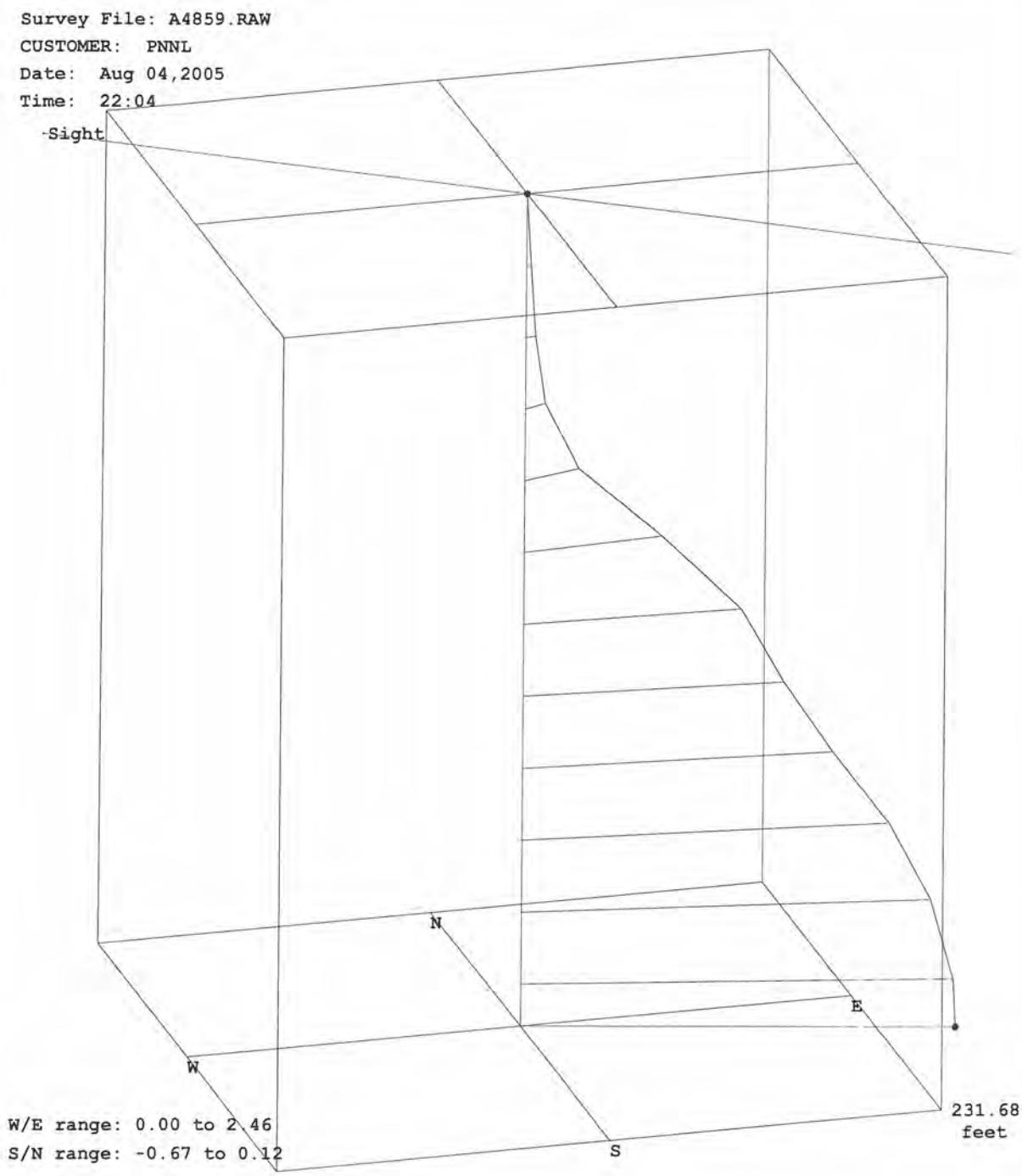
Warm-Up Duration: 30.01 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
T Post
Survey Reference Point: 305 deg.
Local Grid Offset: 0 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.12	76.9	0.00	0.00	0.00	0.00	0.0
20.00	0.06	134.0	20.00	0.00	0.03	0.50	0.0
40.00	0.18	55.9	40.00	0.01	0.06	0.90	0.0
60.00	0.35	51.3	60.00	0.07	0.14	0.90	0.1
80.00	1.01	85.4	80.00	0.12	0.36	3.70	0.1
100.00	1.84	102.9	99.99	0.06	0.85	4.70	0.1
120.00	0.85	116.7	119.99	-0.08	1.29	5.20	-0.1
140.00	0.62	98.2	139.98	-0.16	1.53	1.60	-0.2
160.00	1.07	97.5	159.98	-0.20	1.82	2.20	-0.2
180.00	0.84	109.4	179.98	-0.27	2.15	1.50	-0.3
200.00	0.68	138.9	199.98	-0.41	2.36	2.10	-0.4
220.00	0.40	164.5	219.98	-0.57	2.46	1.80	-0.6
231.70	0.65	200.5	231.68	-0.67	2.44	3.40	-0.7

Bottom:
True Vertical Depth 231.68 feet
Closure Distance 2.5 feet
Closure Direction 105.4 deg.
Course Direction 200.5 deg.

DEFINITIONS:
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.
Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.
Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.
ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.
ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: A4859.RAW
CUSTOMER: PNNL
Date: Aug 04,2005
Time: 22:04
Sight
N
E
W
S
231.68
feet
W/E range: 0.00 to 2.46
S/N range: -0.67 to 0.12

Stoller
Hanford Office

HGLP-LDR-361, Rev. 0

299-E33-37 (A4862)
Log Data Report

Borehole Information:

Borehole:	299-E33-37	Well ID:	A4862	Site:	216-B-2-1 Ditch
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		260.83

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	2/5/2009	Calibration Reference:	HGLP-CC-026, Rev. 1
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/8/2009	Engineer:	MJ LEGLER	Start File:	299-E33-37.raw	Finish File:	299-E33-37.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.44	134.8	0	0	0	0	0	0	0
20	0.68	348	25.92	20	0.06	0.03	5.4	0.07	0.1
40	0.46	146	24.29	40	0.11	0.05	5.6	0.12	0.1
60	0.43	348.1	34.11	60	0.12	0.08	4.4	0.14	0.1
80	1.39	289.7	328.9	80	0.27	-0.16	6.1	0.32	0.3
100	2.12	42.6	347.1	99.99	0.63	-0.14	14.8	0.64	0.6
120	1.39	4.1	6.21	119.98	1.14	0.12	6.7	1.15	1.1
140	1.33	353.9	4.15	139.98	1.61	0.12	1.2	1.62	1.6
160	1.72	20.6	5.33	159.97	2.13	0.2	4	2.14	2.1
180	1.82	28.3	9.6	179.96	2.69	0.45	1.3	2.72	2.7
200	0.88	10.6	11.48	199.95	3.12	0.63	5.1	3.18	3.1
220	1.99	50.1	14.89	219.95	3.49	0.93	7.1	3.61	3.5
240	1.44	30.8	18.62	239.94	3.93	1.32	4	4.15	3.9
260	1.86	45.2	21.05	259.93	4.38	1.68	2.9	4.69	4.4
260.9	1.86	45.9	21.19	260.83	4.4	1.7	2.5	4.71	4.4
260.9	1.86	45.9	21.19	260.83	4.4	1.7	2.5	4.71	4.4

Analysis Notes:

Analyst:	Legler	Date:	4/13/2009

List of Log Plots:

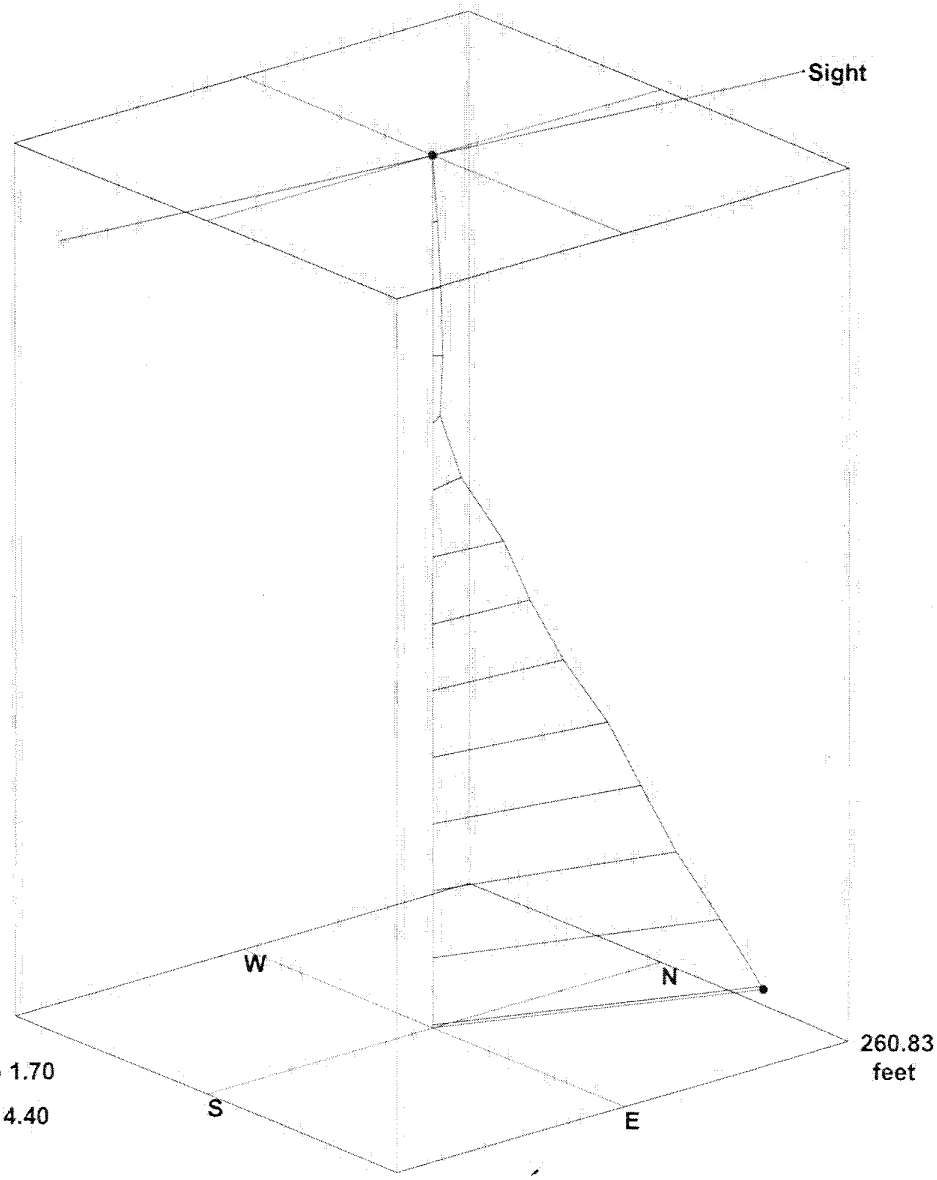
Borehole Deviation

Stoller
Hanford Office
established 1959

HGLP-LDR-361, Rev. 0

299-E33-37 (A4862)

Survey File: 299-E33-37.raw
Date: Apr 10,2009



W/E range: -1.34 to 1.70

S/N range: -0.37 to 4.40

Survey File: C:\DSE\A4863.RAW
Date: Dec 03,2002
Time: 12:03
Description: 299-E33-38
LOCATION: 200 EAST
CUSTOMER: PNNL
OPERATOR: DORSEY
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #4656
EI Series #4658
AC Series #4657
Accel.Voltage Limits: Xmax= 9.921 ; Xmin=-9.907 ; Ymax= 9.905 ; Ymin=-9.899
Comments:

Warm-Up Duration: 1.29 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading

Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 275 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.52	72.2	0.00	0.00	0.00	0.00	0.0
20.00	1.31	91.6	20.00	0.02	0.31	4.20	0.0
40.00	1.56	94.8	39.99	-0.01	0.81	1.30	0.0
60.00	1.65	108.7	59.98	-0.12	1.36	2.00	-0.1
80.00	1.45	132.8	79.98	-0.39	1.81	3.40	-0.4
100.00	2.12	152.3	99.97	-0.89	2.17	4.50	-0.9
120.00	2.71	166.5	119.95	-1.67	2.45	4.20	-1.7
140.00	2.96	186.3	139.92	-2.65	2.51	5.00	-2.6
160.00	3.42	200.8	159.89	-3.72	2.24	4.60	-3.7
180.00	3.79	206.4	179.85	-4.87	1.73	2.50	-4.9
200.00	3.64	215.9	199.81	-5.97	1.07	3.20	-6.0
220.00	3.59	215.2	219.77	-7.00	0.33	0.40	-7.0
230.40	3.92	216.7	230.15	-7.55	-0.06	3.30	-7.6

Bottom:
True Vertical Depth 230.15 feet
Closure Distance 7.6 feet
Closure Direction 180.5 deg.
Course Direction 216.7 deg.

DEFINITIONS:
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.
Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.
Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.
ToolFace Gravity: An angle between tool reference mark direction and

a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).

Survey File: C:\DSE\A4863.RAW
Date: Dec 03,2002
Time: 12:03
Description: 299-E33-38
LOCATION: 200 EAST
CUSTOMER: PNNL
OPERATOR: DORSEY
Comments:

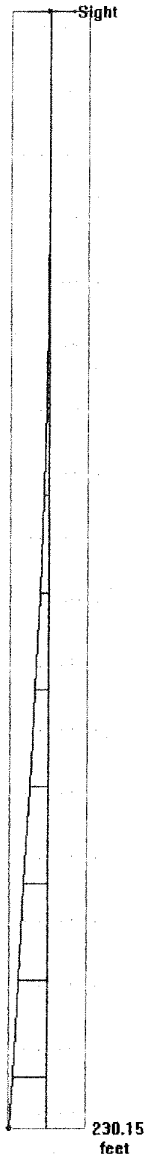
HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #4656
EI Series #4658
AC Series #4657
Accel.Voltage Limits: Xmax= 9.921 ; Xmin=-9.907 ; Ymax= 9.905 ; Ymin=-9.899
Comments:

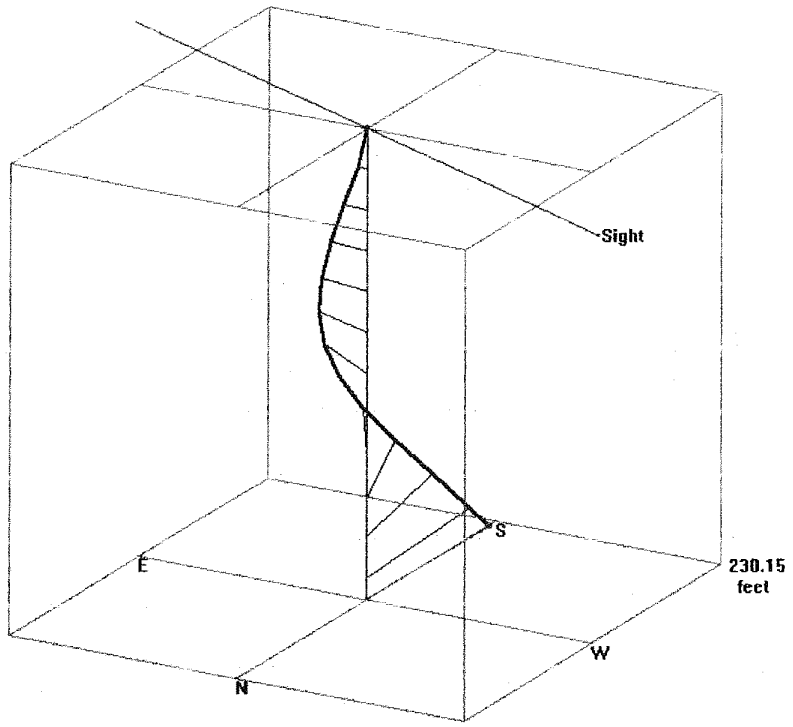
Warm-Up Duration: 1.29 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading

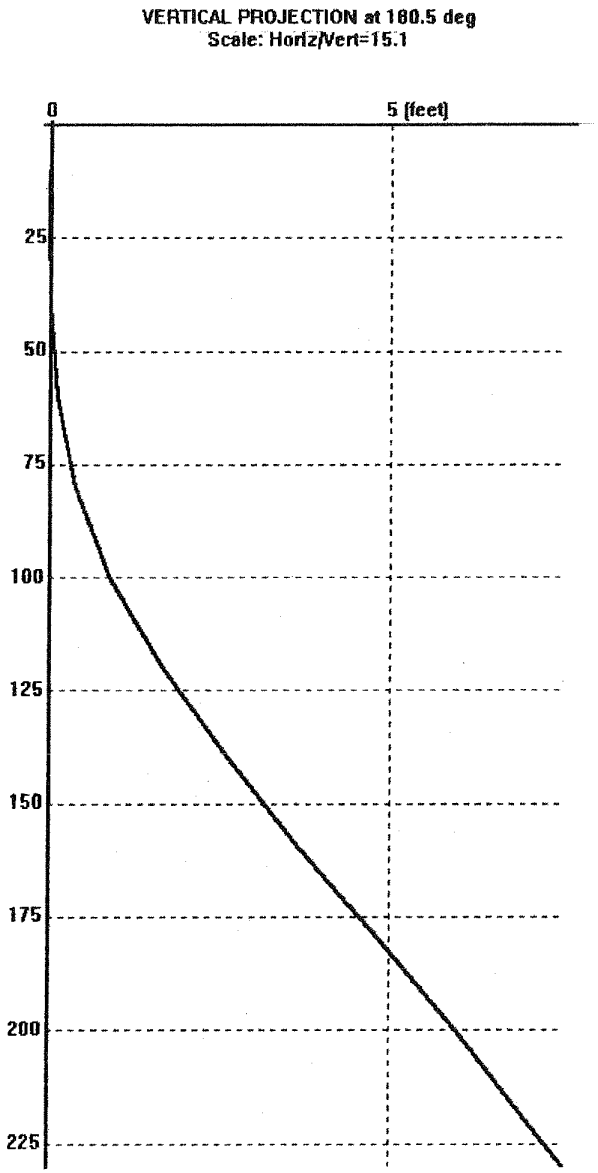
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 275 deg.
Local Grid Offset:-19 deg.

Stat	Minutes	Length	Sine	Cosine	XAccel	YAccel	Volts	Temperature
		feet				(deg.C)		
R 0	0.00	0.00	-0.664	9.878	0.047	-0.185	34.619	9.077
S 0	10.578	0.00	8.853	4.272	0.087	0.027	34.863	10.053
S 1	13.248	20.00	9.814	0.591	0.215	0.076	35.01	10.053
S 2	15.019	40.00	4.60	8.652	0.20	-0.185	35.059	10.541
S 3	16.277	60.00	-5.806	7.866	-0.15	-0.245	35.01	10.541
S 4	17.202	80.00	-3.364	9.219	-0.16	-0.195	35.059	11.03
S 5	18.10	100.00	1.431	9.688	-0.189	-0.319	35.059	11.518
S 6	18.845	120.00	6.118	7.637	-0.12	-0.457	35.107	11.518
S 7	19.538	140.00	4.849	8.511	-0.357	-0.373	35.156	11.518
S 8	20.411	160.00	7.437	6.338	-0.372	-0.467	35.156	12.006
S 9	21.284	180.00	6.948	-6.865	0.431	-0.501	35.205	12.495
S 10	22.003	200.00	4.15	8.848	-0.623	-0.126	35.205	12.495
S 11	22.85	220.00	9.79	-0.366	-0.12	-0.614	35.107	12.983
S 12	26.445	230.40	9.771	-0.645	-0.14	-0.669	35.254	14.448
D 13	29.602	240.80	9.731	-0.64	-0.145	-0.664	35.303	15.913
D 13	30.116	240.80	9.727	-0.64	-0.145	-0.664	35.254	16.401
D 13	30.373	240.80	9.746	-0.64	-0.145	-0.664	35.303	16.401
D 13	30.629	240.80	9.741	-0.64	-0.145	-0.664	35.352	16.401
D 13	30.887	240.80	9.727	-0.64	-0.145	-0.664	35.303	16.401
D 13	31.143	240.80	9.741	-0.64	-0.145	-0.659	35.352	16.401
D 13	31.40	240.80	9.731	-0.64	-0.145	-0.664	35.40	16.889
D 13	31.656	240.80	9.731	-0.645	-0.145	-0.664	35.303	16.889

D	13	31.914	240.80	9.741	-0.645	-0.145	-0.664	35.40	16.889
D	13	32.17	240.80	9.727	-0.64	-0.145	-0.664	35.352	17.377
D	13	32.427	240.80	9.731	-0.64	-0.145	-0.664	35.303	17.377
D	13	32.683	240.80	9.731	-0.64	-0.145	-0.664	35.40	17.377
D	13	32.94	240.80	9.722	-0.64	-0.15	-0.664	35.352	17.377
D	13	33.197	240.80	9.736	-0.64	-0.15	-0.664	35.40	17.377
D	13	33.453	240.80	9.717	-0.64	-0.15	-0.664	35.303	17.866
D	13	33.711	240.80	9.731	-0.64	-0.15	-0.664	35.40	17.866
D	13	33.967	240.80	9.727	-0.64	-0.15	-0.664	35.40	17.866
D	13	34.224	240.80	9.712	-0.64	-0.15	-0.664	35.40	17.866
D	13	34.48	240.80	9.727	-0.64	-0.15	-0.664	35.40	18.354
D	13	34.738	240.80	9.722	-0.64	-0.145	-0.664	35.352	18.354
D	13	34.994	240.80	9.727	-0.64	-0.15	-0.664	35.449	18.354
D	13	35.251	240.80	9.717	-0.64	-0.15	-0.664	35.352	18.842
D	13	35.507	240.80	9.717	-0.64	-0.145	-0.664	35.40	18.842
D	13	35.765	240.80	9.722	-0.64	-0.15	-0.664	35.352	18.842
D	13	36.021	240.80	9.717	-0.64	-0.15	-0.664	35.449	18.842
D	13	36.278	240.80	9.727	-0.645	-0.15	-0.664	35.449	18.842
R	13	45.572	240.80	1.309	9.619	0.052	0.031	35.449	20.795


Sight
230.15
feet


Sight
S
E
230.15
feet
W
N


VERTICAL PROJECTION at 180.5 deg
Scale: Horiz/Vert=15.1
0
5 (feet)
25
50
75
100
125
150
175
200
225

Survey File: C:\DSE\29933339.RAW
Date: Oct 05,2001
Time: 10:14
Description: WELL 299-E33-339
LOCATION: 200 EAST AREA, S.E. CORNER OF BX/BY TANK FARM.
CUSTOMER: PNNL
OPERATOR: RZ STEFFLER
Comments:
SURVEY STARTS WITH END OF CABLE EVEN WITH THE TOP OF CASING.

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #4656
EI Series #4658
AC Series #4657
Accel.Voltage Limits: Xmax= 9.921 ; Xmin=-9.907 ; Ymax= 9.905 ; Ymin=-9.899
Comments:
NEW WELL. 4 INCH STAINLESS STEEL

Warm-Up Duration: RZS 10-8-01 ~~0.24 min~~ 30+ minutes

----------SURVEY REFERENCE DATA----------

Sight Reference Description: Corresponding Magnetic Compass Reading
U.R.M. PIPLINE SIGN LOCATED SOUTH OF THE WELL.
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 168 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.69	90.0	0.00	0.00	0.00	0.00	0.0
20.00	0.78	70.3	20.00	0.05	0.25	1.30	0.0
40.00	0.62	67.5	40.00	0.13	0.48	0.80	0.1
60.00	0.32	93.4	60.00	0.17	0.63	1.80	0.2
80.00	0.32	50.3	80.00	0.20	0.73	1.20	0.2
100.00	0.08	114.5	100.00	0.23	0.79	1.50	0.2
120.00	0.14	101.5	120.00	0.22	0.83	0.30	0.2
140.00	0.70	95.6	140.00	0.21	0.97	2.80	0.2
160.00	0.99	96.4	159.99	0.18	1.27	1.50	0.2
180.00	0.22	61.6	179.99	0.17	1.47	4.10	0.2
200.00	0.46	80.6	199.99	0.21	1.58	1.30	0.2
220.00	1.04	89.6	219.99	0.22	1.85	3.00	0.2
240.00	1.13	92.6	239.99	0.21	2.22	0.50	0.2
260.00	1.48	85.4	259.98	0.22	2.68	1.90	0.2
271.40	2.05	97.0	271.38	0.21	3.03	5.90	0.2

Bottom:

True Vertical Depth	271.38 feet
Closure Distance	3.0 feet
Closure Direction	86.0 deg.
Course Direction	97.0 deg.

DEFINITIONS:

Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.

Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).

Survey File: C:\DSE\29933339.RAW
Date: Oct 05,2001
Time: 10:14
Description: WELL 299-E33-339
LOCATION: 200 EAST AREA, S.E. CORNER OF BX/BY TANK FARM.
CUSTOMER: PNNL
OPERATOR: RZ STEFFLER
Comments:
SURVEY STARTS WITH END OF CABLE EVEN WITH THE TOP OF CASING.

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #4656
EI Series #4658
AC Series #4657
Accel.Voltage Limits: Xmax= 9.921 ; Xmin=-9.907 ; Ymax= 9.905 ; Ymin=-9.899
Comments:
NEW WELL. 4 INCH STAINLESS STEEL

Warm-Up Duration: 0.24 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
J.R.M. PIPLINE SIGN LOCATED SOUTH OF THE WELL.
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 168 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

INRUN record set

Measured Depth (feet)	True Vert. Depth	Rectangular Coordinates +N/-S	+E/-W
0.00	0.00	0.00	0.00
20.00	20.00	0.05	0.25
40.00	40.00	0.13	0.48
60.00	60.00	0.17	0.63
80.00	80.00	0.20	0.73
100.00	100.00	0.23	0.79
120.00	120.00	0.22	0.83
140.00	140.00	0.21	0.97
160.00	159.99	0.18	1.27
180.00	179.99	0.17	1.47
200.00	199.99	0.21	1.58
220.00	219.99	0.22	1.85
240.00	239.99	0.21	2.22
260.00	259.98	0.22	2.68
271.40	271.38	0.21	3.03

Survey File: C:\DSE\29933339.RAW
Date: Oct 05,2001
Time: 10:14
Description: WELL 299-E33-339
LOCATION: 200 EAST AREA, S.E. CORNER OF BX/BY TANK FARM.
CUSTOMER: PNNL
OPERATOR: RZ STEFFLER
Comments:
SURVEY STARTS WITH END OF CABLE EVEN WITH THE TOP OF CASING.

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #4656
EI Series #4658
AC Series #4657
Accel.Voltage Limits: Xmax= 9.921 ; Xmin=-9.907 ; Ymax= 9.905 ; Ymin=-9.899
Comments:
NEW WELL. 4 INCH STAINLESS STEEL

Warm-Up Duration: 0.24 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
U.R.M. PIPLINE SIGN LOCATED SOUTH OF THE WELL.
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 168 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization

Time (min)	Cable (feet)	Inclination fromVert.	Course Direction	Gimbal Corr	Drift Corr
3.0	0.00	0.69	90.0	0.00	-0.36
5.0	20.00	0.78	70.3	0.00	-0.60
7.3	40.00	0.62	67.5	0.00	-0.88
8.7	60.00	0.32	93.4	0.00	-1.05
9.9	80.00	0.32	50.3	0.00	-1.20
10.9	100.00	0.08	114.5	0.00	-1.32
12.3	120.00	0.14	101.5	0.00	-1.49
14.1	140.00	0.70	95.6	0.00	-1.71
15.6	160.00	0.99	96.4	0.00	-1.89
17.3	180.00	0.22	61.6	0.00	-2.09
18.7	200.00	0.46	80.6	0.00	-2.27
21.0	220.00	1.04	89.6	0.00	-2.54
22.1	240.00	1.13	92.6	0.00	-2.67
24.1	260.00	1.48	85.4	0.00	-2.91
26.3	271.40	2.05	97.0	0.00	-3.18

Survey File: C:\DSE\29933339.RAW
Date: Oct 05,2001
Time: 10:14
Description: WELL 299-E33-339
LOCATION: 200 EAST AREA, S.E. CORNER OF BX/BY TANK FARM.
CUSTOMER: PNNL
OPERATOR: RZ STEFFLER
Comments:
SURVEY STARTS WITH END OF CABLE EVEN WITH THE TOP OF CASING.

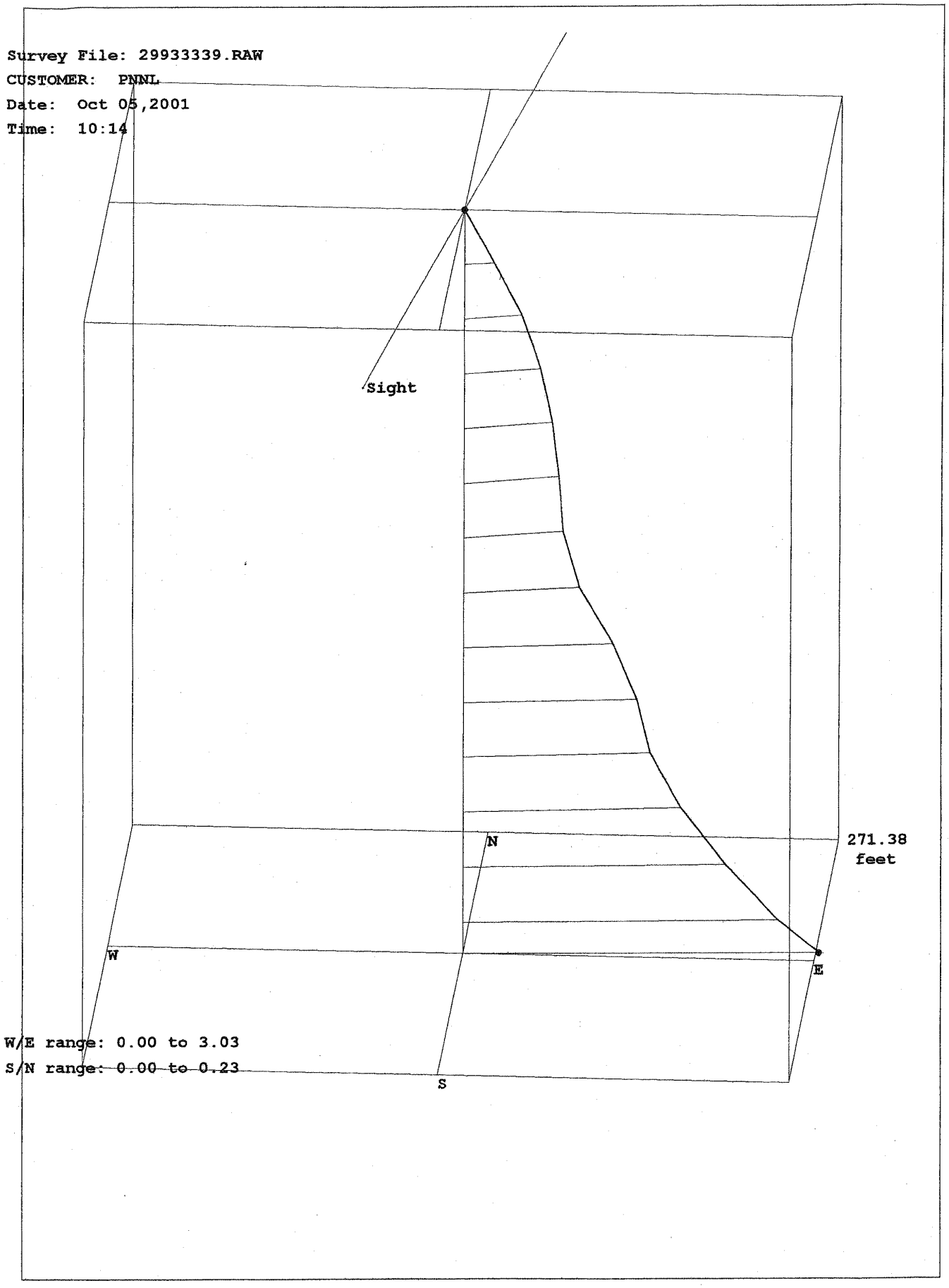
HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #4656
EI Series #4658
AC Series #4657
Accel.Voltage Limits: Xmax= 9.921 ; Xmin=-9.907 ; Ymax= 9.905 ; Ymin=-9.899
Comments:
NEW WELL. 4 INCH STAINLESS STEEL

Warm-Up Duration: 0.24 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
U.R.M. PIPLINE SIGN LOCATED SOUTH OF THE WELL.
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 168 deg.
Local Grid Offset:-19 deg.

Stat		Minutes	Length (feet)	Inclin	TFGyro	TFHighSide	CourseDir
R	0	0.00	0.00	0.740	358.848	300.735	246.267
S	0	3.00	0.00	0.692	243.615	342.165	89.603
S	1	4.95	20.00	0.782	106.223	224.703	69.674
S	2	7.29	40.00	0.621	49.425	170.972	66.606
S	3	8.70	60.00	0.324	256.083	351.870	92.365
S	4	9.91	80.00	0.323	303.812	82.875	49.089
S	5	10.91	100.00	0.080	344.765	59.744	113.174
S	6	12.30	120.00	0.142	48.496	136.637	100.012
S	7	14.15	140.00	0.700	77.746	172.003	93.896
S	8	15.64	160.00	0.992	95.334	188.973	94.513
S	9	17.31	180.00	0.217	129.107	257.800	59.460
S	10	18.72	200.00	0.459	176.110	285.945	78.318
S	11	21.03	220.00	1.042	219.222	320.356	87.020
S	12	22.06	240.00	1.129	278.329	16.504	89.978
S	13	24.08	260.00	1.481	293.961	39.664	82.454
S	14	26.27	271.40	2.052	269.970	4.325	93.800
D	14	26.78	271.40	2.052	269.970	4.325	93.800
D	14	27.04	271.40	2.052	269.970	4.325	93.800
D	14	27.29	271.40	2.052	269.970	4.325	93.800
D	14	27.55	271.40	2.052	269.970	4.325	93.800
D	14	27.81	271.40	2.050	269.970	3.526	94.598
D	14	28.06	271.40	2.050	269.970	3.526	94.598
D	14	28.32	271.40	2.050	269.970	3.526	94.598
D	14	28.58	271.40	2.050	269.970	3.526	94.598
D	14	28.83	271.40	2.052	269.941	4.325	93.771
D	14	29.09	271.40	2.050	269.970	3.526	94.598

2

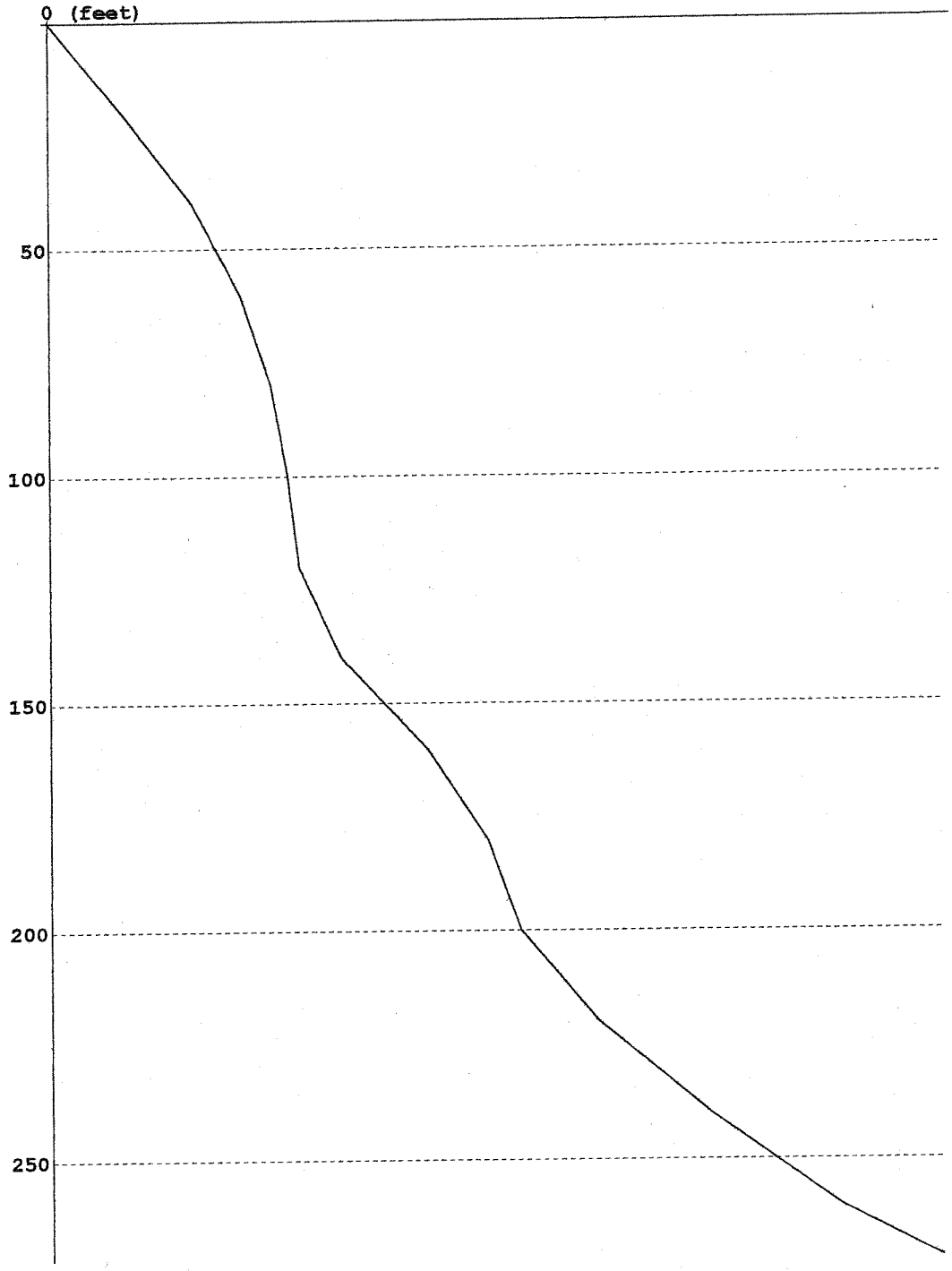
	Stat	Minutes	Length (feet)	Inclin	TFGyro	TFHighSide	CourseDir
D	14	29.35	271.40	2.052	270.000	4.325	93.830
D	14	29.60	271.40	2.052	269.970	4.325	93.800
D	14	29.86	271.40	2.052	269.970	4.325	93.800
R	15	37.41	0.00	0.326	354.321	246.140	296.333


Survey File: 29933339.RAW
CUSTOMER: PNNL
Date: Oct 05,2001
Time: 10:14
Sight
N
271.38
feet
W
E
W/E range: 0.00 to 3.03
S/N range: 0.00 to 0.23
S

VERTICAL PROJECTION at 86.0 deg
Scale: Horiz/Vert=64.2

Survey File: 29933339.RAW
CUSTOMER: PNNL

Date: Oct 05
Time: 10:14

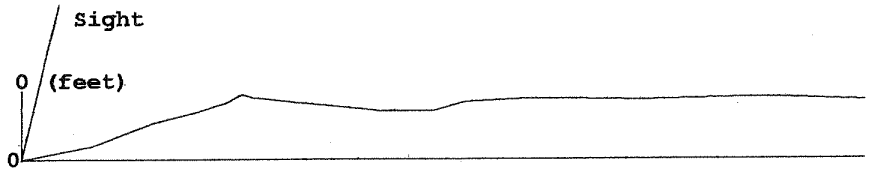


W/E range: 0.00 to 3.03
S/N range: 0.00 to 0.23

Survey File: 29933339.RAW
CUSTOMER: PNNL

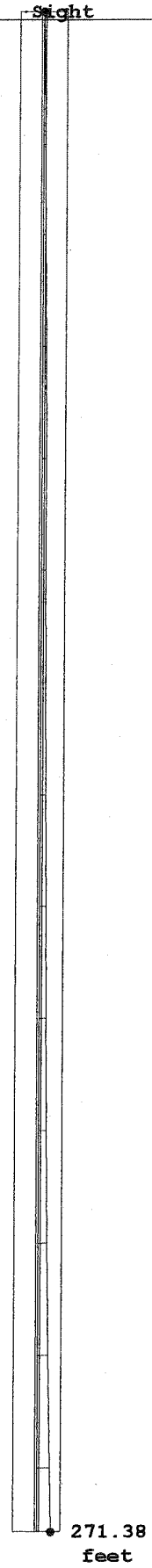
Date: Oct 05,2001
Time: 10:14

HORIZONTAL PROJECTION
Horiz Axis: 90.0 deg to Main Ref.



W/E range: 0.00 to 3.03
S/N range: 0.00 to 0.23

Survey File: 29933339.RAW
CUSTOMER: PNNL
Date: Oct 05,2001
Time: 10:14
W/E range: 0.00 to 3.03
S/N range: 0.00 to 0.23



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Hanford Office

HGLP-LDR-354, Rev. 0

299-E34-10 (A4875)
Log Data Report

Borehole Information:

Borehole:	299-E34-10	Well ID:	A4875	Site:	216-E12B Burial Ground
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		244.96

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	2/5/2009	Calibration Reference:	HGLP-CC-026, Rev. 1
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/8/2009	Engineer:	MJ LEGLER	Start File:	299-E34-10.raw	Finish File:	299-E34-10.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.52	351.1	0	0	0	0	0	0	0
20	0.85	352.1	351.72	20	0.24	-0.03	1.6	0.24	0.2
40	1.09	357.7	353.79	40	0.57	-0.06	1.3	0.58	0.6
60	1.27	329	349.05	59.99	0.95	-0.18	3.1	0.97	1
80	1.16	7.2	348.5	79.99	1.34	-0.27	4	1.37	1.3
100	0.44	28.7	352.51	99.99	1.61	-0.21	3.9	1.63	1.6
120	0.89	1.3	354.65	119.98	1.83	-0.17	2.7	1.84	1.8
140	1.16	356.2	355.26	139.98	2.19	-0.18	1.4	2.2	2.2
160	1.27	356.5	355.44	159.98	2.61	-0.21	0.5	2.62	2.6
180	0.71	46	357.41	179.97	2.92	-0.13	4.9	2.93	2.9
200	0.69	26.8	0.21	199.97	3.12	0.01	1.2	3.12	3.1
220	1.25	35.1	3.21	219.97	3.4	0.19	2.9	3.41	3.4
240	1.87	63.2	9.25	239.96	3.73	0.61	4.8	3.78	3.7
245	2.17	78.8	11.55	244.96	3.78	0.77	12.5	3.86	3.8
245	2.17	79	11.55	244.96	3.78	0.77	12.5	3.86	3.8

Analysis Notes:

Analyst:	Legler	Date:	4/8/2009

List of Log Plots:

Borehole Deviation

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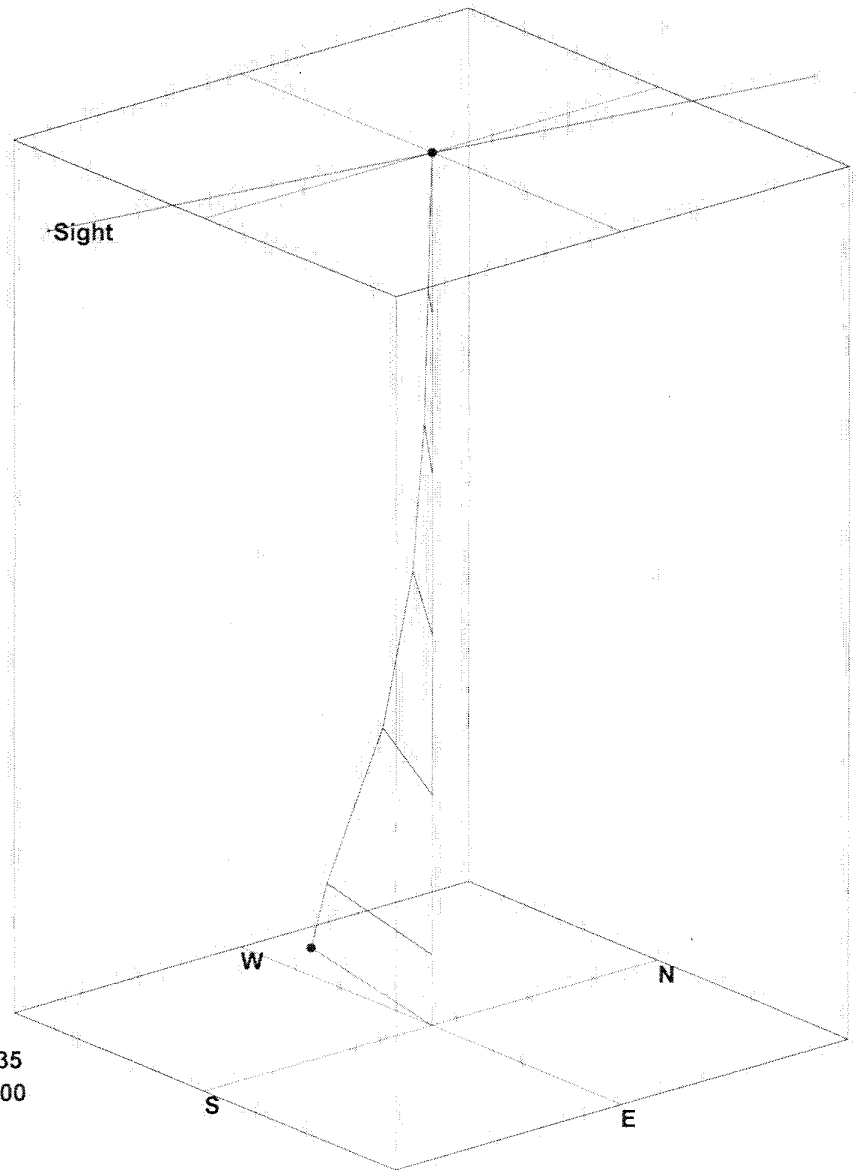
established 1959

HGLP-LDR-357, Rev. 0

Survey File: 299-E34-2.raw
Date: Apr 09,2009

299-E34-2 (A4877)



108.79
feet

S/N range: 0.00 to 0.35
W/E range: -0.84 to 0.00

Stoller
Hanford Office

HGLP-LDR-355, Rev. 0

299-E34-9 (A4884)
Log Data Report

Borehole Information:

Borehole:	299-E34-9	Well ID:	A4884	Site:	218-E-12B burial ground
North	East	Elevation	Depth Reference		Total Depth (ft)
			Top of Casing		232.9

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Effective Calibration	2/5/2009	Calibration Reference:	HGLP-CC-026, Rev. 1
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	4/8/2009	Engineer:	MJ LEGLER	Start File:	299-E34-9.raw	Finish File:	299-E34-9.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.06	265.2	0	0	0	0	0	0	0
20	1.22	301.4	299.68	20	0.11	-0.19	5.9	0.22	0.1
40	0.9	321.7	306.05	40	0.34	-0.47	2.5	0.58	0.3
60	0.77	12.1	317.8	59.99	0.6	-0.54	3.6	0.81	0.6
80	0.7	318.2	323.99	79.99	0.82	-0.6	3.3	1.01	0.8
100	1.25	323.3	323.35	99.99	1.09	-0.81	2.8	1.35	1.1
120	1.64	322.4	323.19	119.98	1.49	-1.11	1.9	1.86	1.5
140	1.95	315.1	321.99	139.97	1.95	-1.53	1.9	2.48	2
160	1.6	314.1	320.52	159.96	2.39	-1.97	1.8	3.1	2.4
180	2.48	312.3	319.11	179.95	2.87	-2.49	4.4	3.8	2.9
200	2.4	312.7	317.9	199.93	3.45	-3.12	0.4	4.65	3.4
220	2.42	323.1	317.9	219.91	4.07	-3.68	2.2	5.49	4.1
233	2.69	308.6	317.68	232.9	4.48	-4.08	5.4	6.06	4.5
233	2.69	308.5	317.68	232.9	4.48	-4.08	5.4	6.06	4.5

Analysis Notes:

Analyst:	Legler	Date:	4/8/2009

List of Log Plots:

Borehole Deviation

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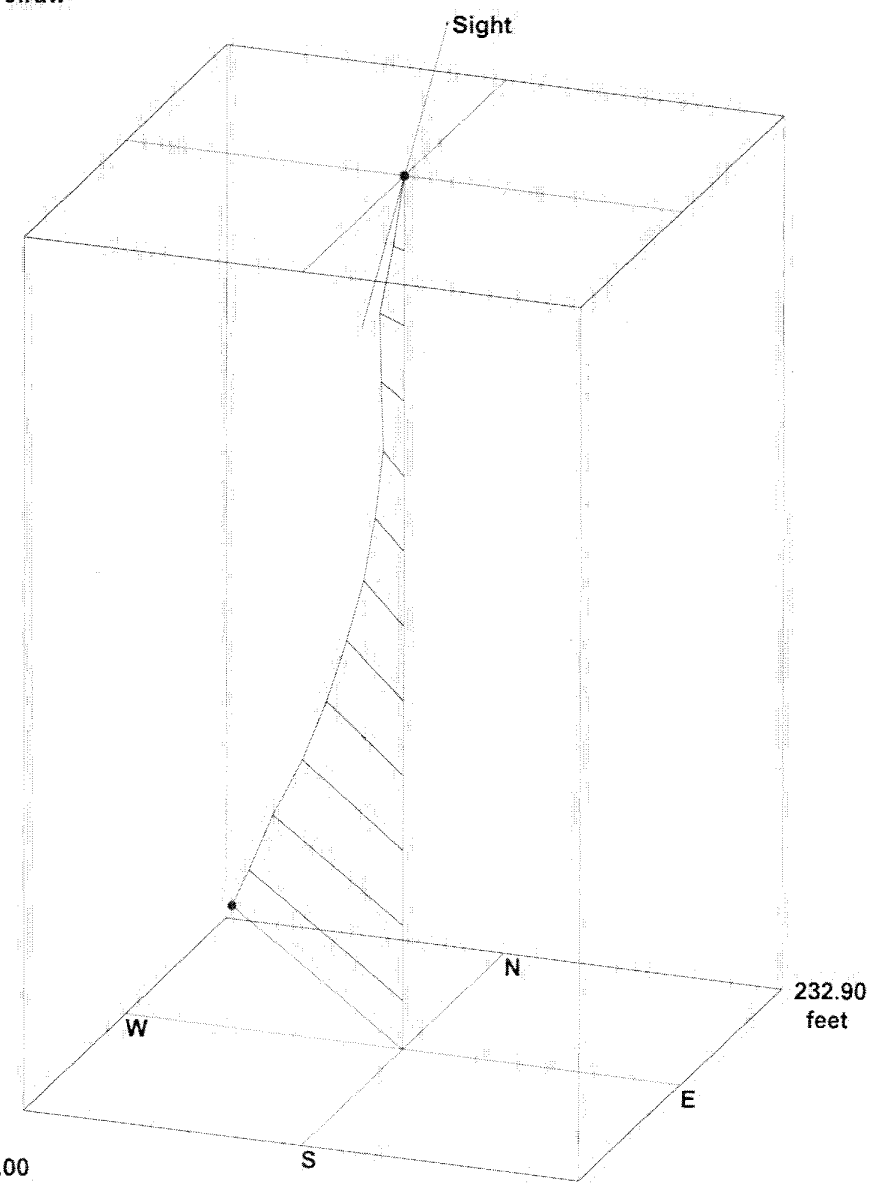
Hanford Office
established 1959

HGLP-LDR-355, Rev. 0

299-E34-9 (A4884)

Survey File: 299-E34-9.raw
Date: Apr 08,2009



W/E range: -4.08 to 0.00
S/N range: -0.21 to 4.48

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HGLP-LDR-166, Rev. 0

699-37-47A (B2822)
Log Data Report

Borehole Information:

Borehole:	699-37-47A			Site:	200E
North	East	Elevation	Depth Reference		Total Depth (ft)
					337.99

Log Run Information:

Logging System:	Borehole Deviation		Model:	DG69-0901-4 #4654
Effective Calibration	1/21/2008	Calibration Reference:		HGLP-CC-026
		Logging Procedure:		HGLP-PRO-005, Rev. 0

Log Date:	1/17/2008	Engineer:	MJ Legler	Start File:	37-47A.raw	Finish File:	699-37-47A.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.38	67.4	0	0	0	0	0	0	0
20	0.53	317.9	359.34	20	0.09	0	3.7	0.09	0.1
40	0.59	1.6	347.25	40	0.27	-0.06	2.1	0.27	0.3
60	0.24	303.6	346.69	60	0.39	-0.09	2.5	0.4	0.4
80	0.57	20.5	349.63	80	0.51	-0.09	2.8	0.52	0.5
100	0.28	72.9	358.96	100	0.62	-0.01	2.3	0.62	0.6
120	0.38	353.4	2.31	120	0.7	0.03	2.1	0.7	0.7
140	0.65	329.8	357.57	140	0.86	-0.04	1.7	0.86	0.9
160	0.24	315.2	352.89	160	0.99	-0.12	2.1	1	1
180	0.49	244	346.79	180	0.98	-0.23	2.4	1.01	1
200	0.9	299.4	336.46	199.99	1.02	-0.44	3.7	1.11	1
220	0.36	332.3	332.1	219.99	1.15	-0.61	3.1	1.3	1.2
240	0.27	321.8	331.78	239.99	1.24	-0.67	0.5	1.41	1.2
260	0.31	227	329.37	259.99	1.24	-0.74	2.1	1.44	1.2
280	0.37	265.5	325.03	279.99	1.2	-0.84	1.2	1.47	1.2
300	0.38	238.7	320.36	299.99	1.16	-0.96	0.9	1.51	1.2
320	0.55	183.9	315.13	319.99	1.03	-1.03	2.3	1.45	1
338	0.37	177.3	310.73	337.99	0.89	-1.03	1.1	1.36	0.9

Analysis Notes:

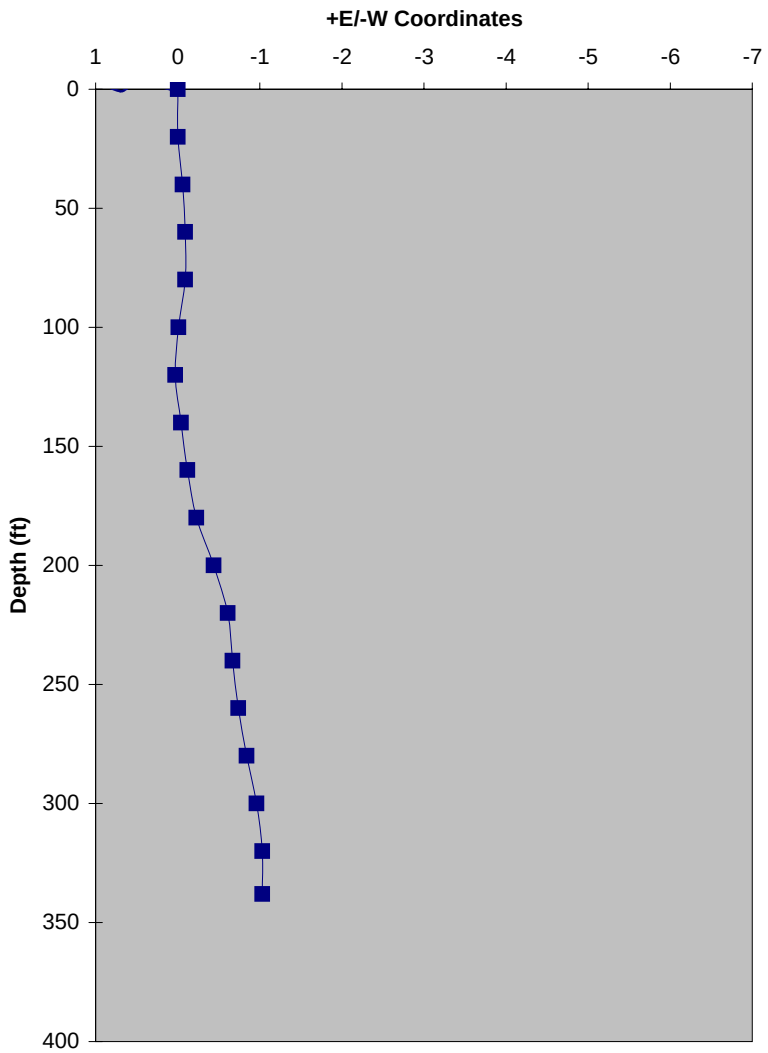
Analyst:	Legler	Date:	2/6/2008

List of Log Plots:

Borehole Deviation

HGLP-LDR-166, Rev. 0

699-37-47A (B2822)
Borehole Deviation



Water Level: 319.85

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Hanford Office

HGLP-LDR-234, Rev. 0

699-49-55A (A5217)
Log Data Report

Borehole Information:

Borehole:	699-49-55A	Well ID:	A5217	Site:	200E
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
453966.000	2240274.000	528.47	TOC		137.96

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #0001
Effective Calibration Date:	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	7/15/2008	Engineer:	MJ LEGLER	Start File:	699-49-55A.raw	Finish File:	699-49-55A.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	Rectangular Coordinates +E/-W	Dogleg Severety °/100 f	Closure Distance (feet)	Vertical Section (feet)
0	0.36	99.8	0	0	0	0	0	0	0
20	0.49	334	19.35	20	0.07	0.02	3.8	0.07	0.1
40	0.72	6.6	0.02	40	0.27	0	2	0.27	0.3
60	1.04	339.7	355.06	60	0.56	-0.05	2.6	0.57	0.6
80	1.04	348.5	350.77	79.99	0.91	-0.15	0.8	0.92	0.9
100	0.72	10.1	352.36	99.99	1.21	-0.16	2.3	1.22	1.2
120	1.79	349.5	353.13	119.99	1.64	-0.2	5.8	1.66	1.6
138	3.7	342	350.16	137.96	2.47	-0.43	10.7	2.51	2.5
138	3.7	341.5	350.16	137.96	2.47	-0.43	10.7	2.51	2.5

Analysis Notes:

Analyst:	Legler	Date:	7/15/2008

Centralizers were not installed

List of Log Plots:

Borehole Deviation

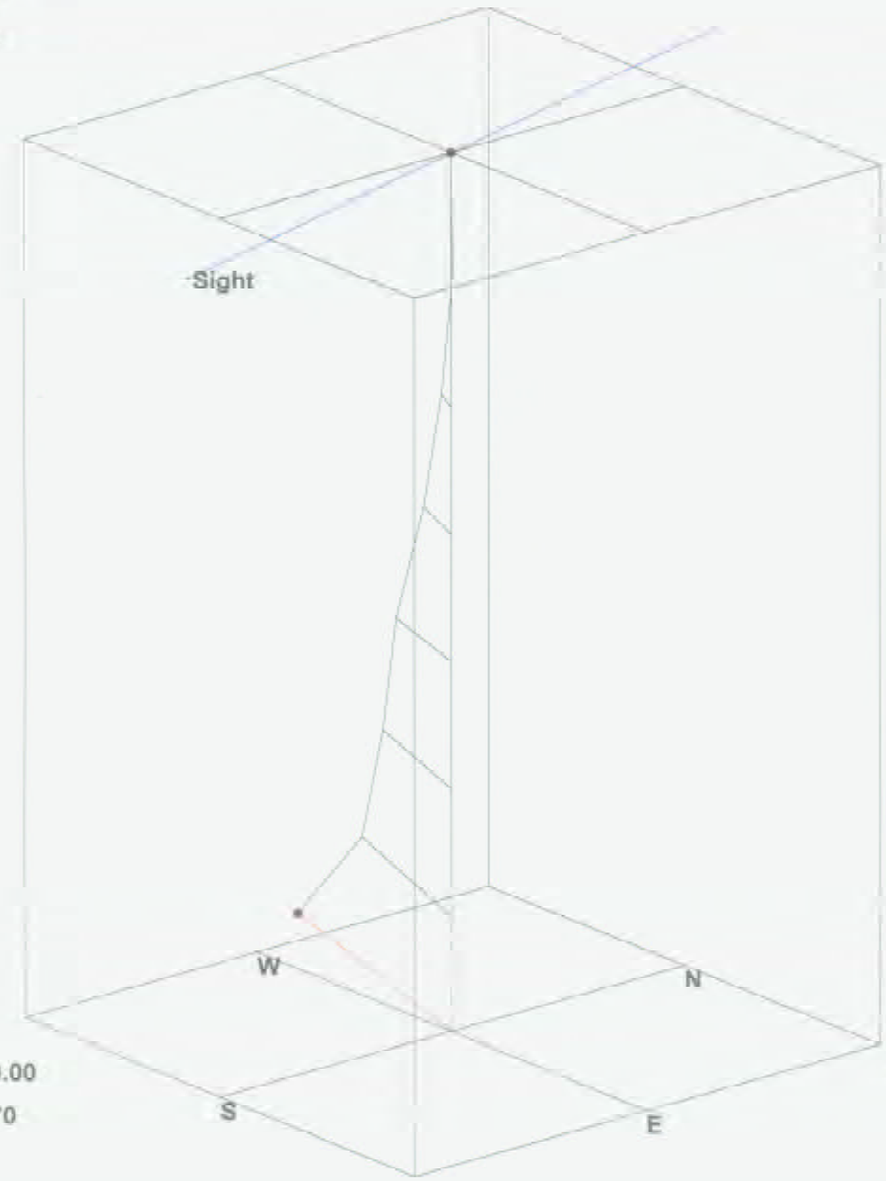
Stoller
Hanford Office

established 1959

HGLP-LDR-234, Rev. 0

Survey File: 699-49-55A.raw
Customer: Fluor
Date: Jul 15,2008

699-49-55A (A5217)



137.96
feet

W/E range: -2.41 to 0.00
S/N range: 0.00 to 0.70

Survey File: C:\DSE\A5219.RAW
Date: Aug 09,2005
Time: 20:13
Description: Borehole Gyro
LOCATION: 699-49-57A
CUSTOMER: PNNL
OPERATOR: Weakley
Comments:

HUMPHREY TOOL IDENTIFICATION
Gyroscope Model: DG69-0901-4 #4654
TX Series #0002
EI Series #0003
AC Series #0004
Accel.Voltage Limits: Xmax= 9.92 ; Xmin=-9.89 ; Ymax= 9.9 ; Ymin=-9.89
Comments:

Warm-Up Duration: 30.02 min
----------SURVEY REFERENCE DATA----------
Sight Reference Description: Corresponding Magnetic Compass Reading
Well A5220
Local Magnetic Declination: 19 deg.
REFERENCE SUMMARY
Survey Reference Point: 215 deg.
Local Grid Offset:-19 deg.
Drift Correction Method: Least Squares Drift Linearization
Computation Method: Minimum Curvature

Target Direction (deg): 0
INRUN record set

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates +N/-S	+E/-W	Dogleg Severety °/100 f	Vertical Section (feet)
0.00	0.16	325.8	0.00	0.00	0.00	0.00	0.0
20.00	0.14	233.5	20.00	0.01	-0.04	1.10	0.0
40.00	0.12	231.6	40.00	-0.02	-0.07	0.10	0.0
60.00	0.29	222.1	60.00	-0.07	-0.12	0.90	-0.1
80.00	0.35	212.1	80.00	-0.16	-0.19	0.40	-0.2
100.00	0.42	204.6	100.00	-0.28	-0.25	0.40	-0.3
120.00	0.45	194.9	120.00	-0.42	-0.30	0.40	-0.4
140.00	0.63	191.0	140.00	-0.60	-0.34	0.90	-0.6
153.20	0.86	192.2	153.20	-0.77	-0.38	1.80	-0.8

Bottom:
True Vertical Depth 153.2 feet
Closure Distance 0.9 feet
Closure Direction 206.3 deg.
Course Direction 192.2 deg.

DEFINITIONS:
Closure Direction: An angle between Main Reference direction (for example True North) and a line from coordinate origin to horizontal projection of current borehole point.

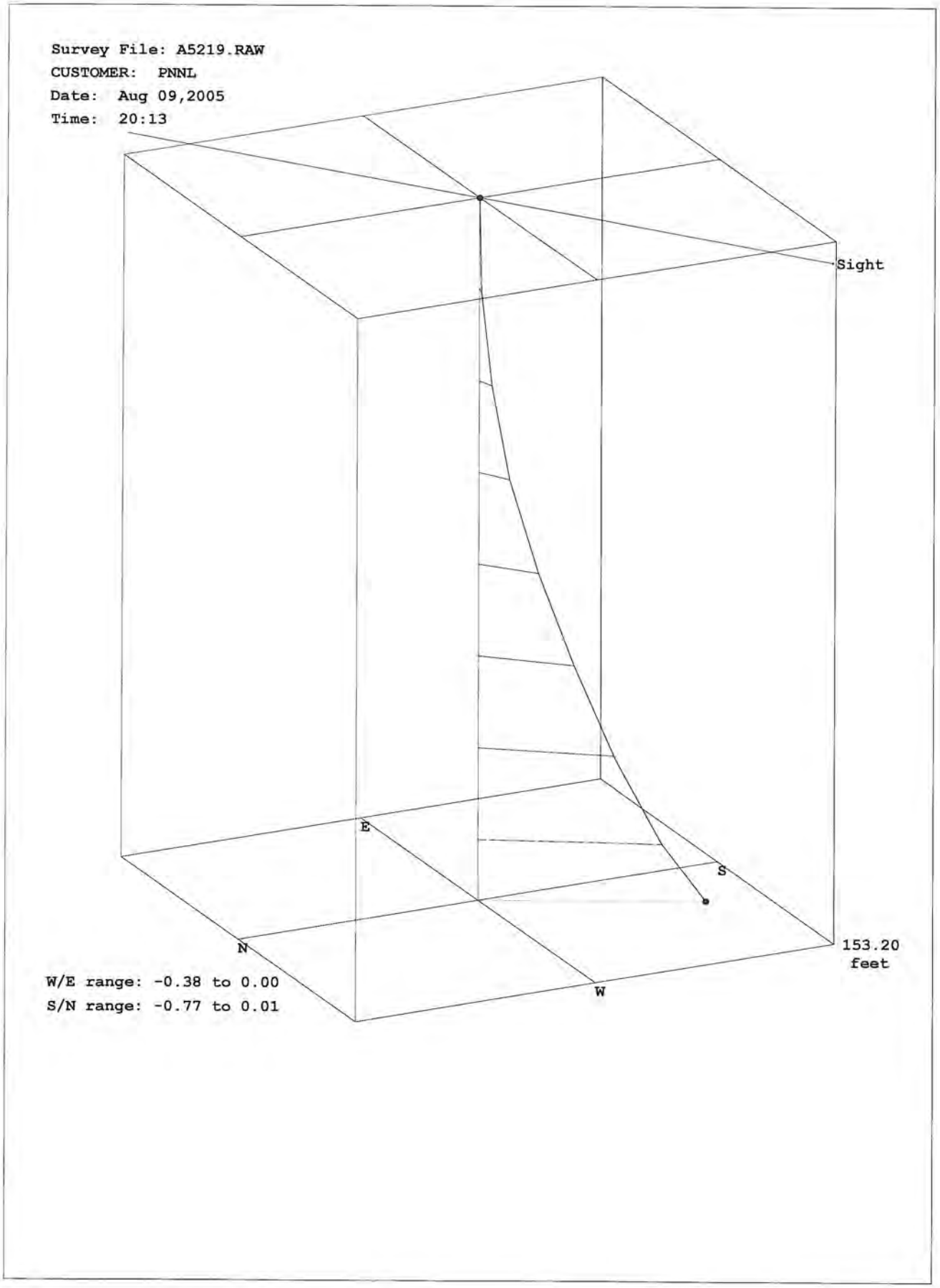
1

Closure Distance: A distance between coordinate origin and a horizontal projection of current borehole point.

Course Direction: An angle between Main Reference direction and a tangent to a horizontal projection of the borehole in current point.

ToolFace Gravity: An angle between tool reference mark direction and a tangent to a horizontal projection of the borehole.

ToolFace Gyro: An angle between tool reference mark direction and initial Survey Sight direction (which is gyroscope direction, if gyro drift =0).


Survey File: A5219.RAW
CUSTOMER: PNNL
Date: Aug 09,2005
Time: 20:13
Sight
E
S
N
W
153.20
feet
W/E range: -0.38 to 0.00
S/N range: -0.77 to 0.01

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HGLP-LDR-235, Rev. 0

699-50-56 (C5197)
Log Data Report

Borehole Information:

Borehole:	699-50-56	Well ID:	C5197	Site:	200E North Side
North	**East**	**Elevation**	**Depth Reference**		**Total Depth (ft)**
			TOC		159.4

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #0001
Effective Calibration	1/21/2008	Calibration Reference:	HGLP-CC-026
		Logging Procedure:	HGLP-PRO-005, Rev. 0

Log Date:	7/15/2008	Engineer:	MJ LEGLER	Start File:	699-50-56.raw	Finish File:	699-50-56.rpt

Measured Depth (feet)	Course Inclin. fromVert.	Course Direction (deg)	Closure Direction (deg)	TrueVert. Depth (feet)	Rectangular Coordinates		Dogleg Severity °/100 f	Closure Distance (feet)	Vertical Section (feet)
					+N/-S	+E/-W			
0	0.38	102.4	0	0	0	0	0	0	0
20	1.4	33.6	46.53	20	0.19	0.2	6.6	0.28	0.2
40	2.49	25.5	33.61	39.99	0.79	0.52	5.6	0.94	0.8
60	3.69	23.3	28.56	59.96	1.77	0.96	6	2.01	1.8
80	4.92	18.5	25.14	79.9	3.17	1.49	6.4	3.51	3.2
100	5.59	15.4	22.3	99.82	4.93	2.02	3.6	5.33	4.9
120	6.03	13	20.05	119.71	6.89	2.51	2.5	7.33	6.9
140	7.48	10.1	17.95	139.57	9.19	2.98	7.5	9.67	9.2
160	7.57	8.4	16.11	159.4	11.78	3.4	1.2	12.26	11.8
160	7.54	8.1	16.11	159.4	11.78	3.4	1.2	12.26	11.8

Analysis Notes:

Analyst:	Legler	Date:	7/15/2008

Centralizers were not installed

List of Log Plots:

Borehole Deviation

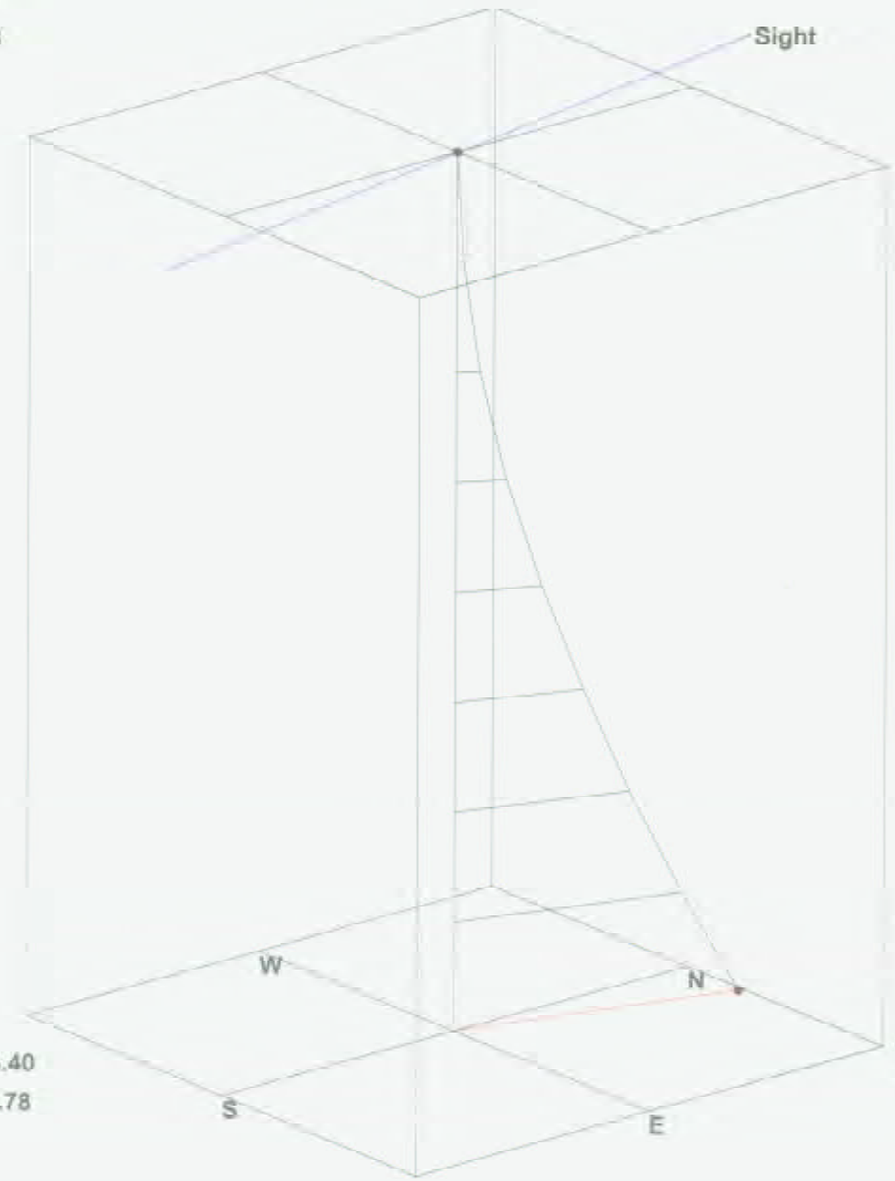
Stoller
Hanford Office

established 1959

HGLP-LDR-235, Rev. 0

Survey File: 699-50-56.raw
Customer: Fluor
Date: Jul 15,2008

699-50-56 (C5197)



W/E range: 0.00 to 3.40
S/N range: 0.00 to 11.78

159.40
feet

Appendix C

Water-Level Measurements and Trend-Surface Analysis Results

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Appendix C

Water-Level Measurements and Trend-Surface Analysis Results

This appendix provides all of the manual water-level measurements collected for this study. The measurements are presented by site, in date order, with the measurements for Low-Level Waste Management Area 1 (LLWMA-1) listed first, followed by measurements for the Integrated Disposal Facility (IDF)/Plutonium-Uranium Extraction (PUREX) Cribs, LLWMA-2, and the Liquid Effluent Retention Facility (LERF). Each set of synoptic measurements is provided in a separate table. Information provided includes the measurement date and time, measured depth to water, measurement point description, the vertical distance between the measurement point and the surveyed reference point, and the calculated hydraulic head (reference point elevations can be found on the survey reports in Appendix A). At the bottom of each table, the range of the hydraulic heads is provided along with the results of the trend-surface analyses including the slope (magnitude) and direction of the fitted plane, the goodness of fit coefficient (R^2), the p-value, and whether or not the result was statistically significant (at the 0.05 level of significance). Also provided are the hydraulic heads normalized to a constant barometric pressure. Measurements identified as potential outliers using the interquartile range (IQR) method (described in Section 3.7.1) that were retained for the analyses are highlighted in yellow. Those measurements highlighted in red were confirmed outliers removed from the analyses. For detailed explanations of all the calculations performed for this study see *Calculations in Support of the Low Hydraulic Gradient Evaluation Study for the 200 East Area Unconfined Aquifer* (ECF-200E-12-0086).

As explained in Sections 4.2.5 and 4.3.5, there was still too much variability in the water-level measurements for IDF/PUREX Cribs and LLWMA-2 to determine a hydraulic gradient after all of the corrections were applied to the measurements. The trend-surface analyses for these sites were performed by repeatedly removing the measurement with the highest residual until the trend-surface results converged. Specifically, the measurement with the highest residual was removed, and the trend-surface analysis was performed again, until (1) the result was statistically significant, (2) all residuals were less than 0.01 m (10 mm), and (3) the removal of the measurement with the next highest residual still resulted in a statistically significant result with residuals less than 0.01 m (10 mm) and the dip direction of the fitted plane changed by less than 10 degrees. Because three points exactly define a plane, the trend surface analyses were not performed on less than four wells. Also, because one additional trend surface analysis was needed to confirm the results (i.e., criteria 3 above), no final trend-surface analysis result was based on less than five wells. The tables for IDF/PUREX Cribs and LLWMA-2 show the results of all the trend-surface analysis iterations, including the residuals, with the residual removed from each iteration highlighted in red. Final trend-surface analysis results are shown in bold type.

Abbreviations used in the tables in this appendix include the following:

- BP: barometric pressure
- MP: measurement point
- RP: reference point
- MP-RP: vertical distance between the measurement point and the reference point (i.e., measurement point elevation less reference point elevation)
- NAVD88: *North American Vertical Datum of 1988*

- NM: no measurement
- PST: Pacific Standard Time
- TOC: top of casing
- TOPP: top of pump plate
- TOT: top of discharge tee

References

ECF-200E-12-0086, 2013, *Calculations in Support of the Low Hydraulic Gradient Evaluation Study for the 200 East Area Unconfined Aquifer*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0087502.

NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

Water-Level Measurements and Trend-Surface Analysis Results for LLWMA-1

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	9/1/2005 16:00	89.995	TOPP	0.010	122.126	122.119	122.138	122.131	122.130
299-E28-27	9/1/2005 15:10	86.376	TOPP	0.005	122.102	122.092	122.139	122.129	122.128
299-E32-5	9/1/2005 13:06	86.902	TOPP	0.005	122.116	122.108	122.137	122.129	122.129
299-E32-6	9/1/2005 13:22	82.349	TOPP	0.005	122.103	122.108	122.118	122.123	122.123
299-E32-8	9/1/2005 13:38	75.711	TOPP	0.005	122.084	122.089	122.124	122.129	122.127
299-E33-28	9/1/2005 15:25	81.441	TOPP	0.013	122.107	122.120	122.113	122.126	122.126
299-E33-339	9/1/2005 14:51	80.904	TOPP	0.005	122.128	122.130	122.134	122.136	122.133
299-E33-34	9/1/2005 13:54	72.023	TOPP	0.005	122.115	122.123	122.121	122.129	122.123
299-E33-38	9/1/2005 14:12	71.577	TOPP	0.005	122.057	122.054	122.133	122.130	122.129
699-49-57A	9/1/2005 12:44	47.615	TOPP	0.010	122.116	122.118	122.116	122.118	122.115
				Range (m):	0.071	0.076	0.026	0.018	0.018
				Gradient Magnitude (m/m):	2.24E-05	1.36E-05	1.45E-05	7.68E-06	8.60E-06
				Direction (azimuth):	39	53	350	312	332
				R^2:	0.12	0.04	0.47	0.67	0.76
				p-Value:	0.6292	0.8673	0.1079	0.0202	0.0068
				Statistically Significant?:	No	No	No	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	9/12/2005 10:20	89.999	TOPP	0.010	122.122	122.115	122.134	122.127	122.127
299-E28-27	9/12/2005 12:15	86.382	TOPP	0.005	122.096	122.086	122.133	122.123	122.123
299-E32-5	9/12/2005 11:45	86.909	TOPP	0.005	122.109	122.101	122.130	122.122	122.122
299-E32-6	9/12/2005 11:35	82.354	TOPP	0.005	122.098	122.103	122.113	122.118	122.119
299-E32-8	9/12/2005 11:15	75.715	TOPP	0.005	122.080	122.085	122.120	122.125	122.126
299-E33-28	9/12/2005 12:00	81.444	TOPP	0.013	122.104	122.117	122.110	122.123	122.124
299-E33-339	9/12/2005 10:40	80.912	TOPP	0.005	122.120	122.122	122.126	122.128	122.129
299-E33-34	9/12/2005 11:05	72.029	TOPP	0.005	122.109	122.117	122.115	122.123	122.122
299-E33-38	9/12/2005 10:55	71.584	TOPP	0.005	122.050	122.047	122.126	122.123	122.124
699-49-57A	9/12/2005 9:45	47.623	TOPP	0.010	122.108	122.110	122.108	122.110	122.112
				Range (m):	0.072	0.075	0.026	0.018	0.017
				Gradient Magnitude (m/m):	2.49E-05	1.60E-05	1.63E-05	8.24E-06	7.49E-06
				Direction (azimuth):	39	51	357	329	323
				R^2:	0.15	0.05	0.59	0.69	0.67
				p-Value:	0.5578	0.8245	0.0450	0.0174	0.0212
				Statistically Significant?:	No	No	Yes	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	10/11/2005 13:18	90.002	TOPP	0.010	122.119	122.112	122.131	122.124	122.124
299-E28-27	10/11/2005 12:53	86.384	TOPP	0.005	122.094	122.084	122.131	122.121	122.121
299-E32-5	10/11/2005 12:10	86.912	TOPP	0.005	122.106	122.098	122.127	122.119	122.119
299-E32-6	10/11/2005 12:18	82.355	TOPP	0.005	122.097	122.102	122.112	122.117	122.117
299-E32-8	10/11/2005 12:29	75.720	TOPP	0.005	122.075	122.080	122.115	122.120	122.121
299-E33-28	10/11/2005 12:46	81.448	TOPP	0.013	122.100	122.113	122.106	122.119	122.120
299-E33-339	10/11/2005 13:00	80.921	TOPP	0.005	122.111	122.113	122.117	122.119	122.120
299-E33-34	10/11/2005 12:39	72.034	TOPP	0.005	122.104	122.112	122.110	122.118	122.117
299-E33-38	10/11/2005 13:09	71.588	TOPP	0.005	122.046	122.043	122.122	122.119	122.119
699-49-57A	10/11/2005 11:45	47.625	TOPP	0.010	122.106	122.108	122.106	122.108	122.110
				Range (m):	0.073	0.070	0.025	0.016	0.014
				Gradient Magnitude (m/m):	2.81E-05	1.96E-05	1.74E-05	8.02E-06	7.16E-06
				Direction (azimuth):	44	56	9	356	356
				R^2:	0.19	0.08	0.56	0.78	0.78
				p-Value:	0.4703	0.7328	0.0563	0.0047	0.0051
				Statistically Significant?:	No	No	No	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	10/25/2005 8:58	90.010	TOPP	0.010	122.111	122.104	122.123	122.116	122.116
299-E28-27	10/25/2005 9:35	86.391	TOPP	0.005	122.087	122.077	122.124	122.114	122.113
299-E32-5	10/25/2005 11:10	86.916	TOPP	0.005	122.102	122.094	122.123	122.115	122.115
299-E32-6	10/25/2005 11:00	82.361	TOPP	0.005	122.091	122.096	122.106	122.111	122.110
299-E32-8	10/25/2005 10:46	75.723	TOPP	0.005	122.072	122.077	122.112	122.117	122.115
299-E33-28	10/25/2005 10:09	81.452	TOPP	0.013	122.096	122.109	122.102	122.115	122.114
299-E33-339	10/25/2005 9:16	80.921	TOPP	0.005	122.111	122.113	122.117	122.119	122.117
299-E33-34	10/25/2005 10:34	72.036	TOPP	0.005	122.102	122.110	122.108	122.116	122.113
299-E33-38	10/25/2005 10:22	71.591	TOPP	0.005	122.043	122.040	122.119	122.116	122.114
699-49-57A	10/25/2005 8:31	47.630	TOPP	0.010	122.101	122.103	122.101	122.103	122.100
				Range (m):	0.068	0.073	0.023	0.016	0.017
				Gradient Magnitude (m/m):	2.33E-05	1.48E-05	1.41E-05	6.38E-06	7.86E-06
				Direction (azimuth):	43	58	357	320	339
				R^2:	0.14	0.05	0.52	0.55	0.65
				p-Value:	0.5914	0.8369	0.0785	0.0599	0.0260
				Statistically Significant?:	No	No	No	No	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	11/23/2005 13:40	90.014	TOPP	0.010	122.107	122.100	122.119	122.112	122.111
299-E28-27	11/23/2005 14:45	86.398	TOPP	0.005	122.080	122.070	122.117	122.107	122.106
299-E32-5	11/23/2005 15:11	86.925	TOPP	0.005	122.093	122.085	122.114	122.106	122.106
299-E32-6	11/23/2005 15:22	82.369	TOPP	0.005	122.083	122.088	122.098	122.103	122.102
299-E32-8	11/23/2005 15:41	75.732	TOPP	0.005	122.063	122.068	122.103	122.108	122.106
299-E33-28	11/23/2005 15:00	81.461	TOPP	0.013	122.087	122.100	122.093	122.106	122.105
299-E33-339	11/23/2005 14:33	80.929	TOPP	0.005	122.103	122.105	122.109	122.111	122.109
299-E33-34	11/23/2005 15:48	72.044	TOPP	0.005	122.094	122.102	122.100	122.108	122.105
299-E33-38	11/23/2005 14:15	71.601	TOPP	0.005	122.033	122.030	122.109	122.106	122.104
699-49-57A	11/23/2005 13:03	47.636	TOPP	0.010	122.095	122.097	122.095	122.097	122.094
				Range (m):	0.074	0.075	0.026	0.015	0.017
				Gradient Magnitude (m/m):	2.52E-05	1.67E-05	1.55E-05	6.92E-06	8.48E-06
				Direction (azimuth):	43	56	2	336	348
				R^2:	0.15	0.06	0.54	0.69	0.79
				p-Value:	0.5729	0.8130	0.0670	0.0168	0.0042
				Statistically Significant?:	No	No	No	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	12/29/2005 9:41	90.023	TOPP	0.010	122.098	122.091	122.110	122.103	122.102
299-E28-27	12/29/2005 10:13	86.407	TOPP	0.005	122.071	122.061	122.108	122.098	122.099
299-E32-5	12/29/2005 11:21	86.932	TOPP	0.005	122.086	122.078	122.107	122.099	122.099
299-E32-6	12/29/2005 11:09	82.377	TOPP	0.005	122.075	122.080	122.090	122.095	122.097
299-E32-8	12/29/2005 10:59	75.739	TOPP	0.005	122.056	122.061	122.096	122.101	122.103
299-E33-28	12/29/2005 10:24	81.472	TOPP	0.013	122.076	122.089	122.082	122.095	122.097
299-E33-339	12/29/2005 9:58	80.942	TOPP	0.005	122.090	122.092	122.096	122.098	122.103
299-E33-34	12/29/2005 10:46	72.060	TOPP	0.005	122.078	122.086	122.084	122.092	122.093
299-E33-38	12/29/2005 10:37	71.612	TOPP	0.005	122.022	122.019	122.098	122.095	122.099
699-49-57A	12/29/2005 9:30	47.647	TOPP	0.010	122.084	122.086	122.084	122.086	122.093
				Range (m):	0.076	0.073	0.028	0.017	0.010
				Gradient Magnitude (m/m):	3.13E-05	2.29E-05	1.98E-05	1.01E-05	4.91E-06
				Direction (azimuth):	45	56	16	13	353
				R^2:	0.23	0.12	0.55	0.70	0.40
				p-Value:	0.3975	0.6518	0.0621	0.0143	0.1718
				Statistically Significant?:	No	No	No	Yes	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	2/2/2006 10:35	90.036	TOPP	0.010	122.085	122.078	122.097	122.090	122.090
299-E28-27	2/2/2006 11:40	86.417	TOPP	0.005	122.061	122.051	122.098	122.088	122.088
299-E32-5	2/2/2006 13:14	86.945	TOPP	0.005	122.073	122.065	122.094	122.086	122.086
299-E32-6	2/2/2006 12:58	82.388	TOPP	0.005	122.064	122.069	122.079	122.084	122.085
299-E32-8	2/2/2006 12:43	75.752	TOPP	0.005	122.043	122.048	122.083	122.088	122.090
299-E33-28	2/2/2006 12:10	81.480	TOPP	0.013	122.068	122.081	122.074	122.087	122.087
299-E33-339	2/2/2006 11:23	80.953	TOPP	0.005	122.079	122.081	122.085	122.087	122.089
299-E33-34	2/2/2006 12:30	72.069	TOPP	0.005	122.069	122.077	122.075	122.083	122.086
299-E33-38	2/2/2006 11:00	71.620	TOPP	0.005	122.014	122.011	122.090	122.087	122.088
699-49-57A	2/2/2006 9:57	47.662	TOPP	0.010	122.069	122.071	122.069	122.071	122.076
				Range (m):	0.071	0.070	0.029	0.019	0.014
				Gradient Magnitude (m/m):	2.85E-05	1.96E-05	1.88E-05	9.66E-06	6.48E-06
				Direction (azimuth):	40	50	5	350	341
				R^2:	0.22	0.09	0.62	0.72	0.62
				p-Value:	0.4255	0.7238	0.0339	0.0109	0.0330
				Statistically Significant?:	No	No	Yes	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	3/8/2006 13:27	90.038	TOPP	0.010	122.083	122.076	122.095	122.088	122.086
299-E28-27	3/8/2006 13:53	86.429	TOPP	0.005	122.049	122.039	122.086	122.076	122.074
299-E32-5	3/8/2006 14:46	86.953	TOPP	0.005	122.065	122.057	122.086	122.078	122.078
299-E32-6	3/8/2006 14:34	82.400	TOPP	0.005	122.052	122.057	122.067	122.072	122.070
299-E32-8	3/8/2006 14:26	75.761	TOPP	0.005	122.034	122.039	122.074	122.079	122.075
299-E33-28	3/8/2006 14:02	81.492	TOPP	0.013	122.056	122.069	122.062	122.075	122.075
299-E33-339	3/8/2006 13:43	80.955	TOPP	0.005	122.077	122.079	122.083	122.085	122.080
299-E33-34	3/8/2006 14:12	72.073	TOPP	0.005	122.065	122.073	122.071	122.079	122.069
299-E33-38	3/8/2006 15:14	71.629	TOPP	0.005	122.005	122.002	122.081	122.078	122.078
699-49-57A	3/8/2006 12:43	47.663	TOPP	0.010	122.068	122.070	122.068	122.070	122.065
				Range (m):	0.078	0.077	0.033	0.018	0.021
				Gradient Magnitude (m/m):	2.52E-05	1.64E-05	1.61E-05	7.78E-06	1.05E-05
				Direction (azimuth):	41	53	359	332	348
				R^2:	0.14	0.05	0.47	0.53	0.70
				p-Value:	0.5978	0.8294	0.1087	0.0703	0.0147
				Statistically Significant?:	No	No	No	No	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	6/8/2006 12:13	90.043	TOPP	0.010	122.078	122.071	122.090	122.083	122.082
299-E28-27	6/8/2006 12:52	86.428	TOPP	0.005	122.050	122.040	122.087	122.077	122.077
299-E32-5	6/8/2006 13:51	86.953	TOPP	0.005	122.065	122.057	122.086	122.078	122.078
299-E32-6	6/8/2006 13:38	82.398	TOPP	0.005	122.054	122.059	122.069	122.074	122.074
299-E32-8	6/8/2006 14:00	75.762	TOPP	0.005	122.033	122.038	122.073	122.078	122.077
299-E33-28	6/8/2006 13:20	81.491	TOPP	0.013	122.057	122.070	122.063	122.076	122.076
299-E33-339	6/8/2006 12:30	80.960	TOPP	0.005	122.072	122.074	122.078	122.080	122.081
299-E33-34	6/8/2006 14:14	72.076	TOPP	0.005	122.062	122.070	122.068	122.076	122.074
299-E33-38	6/8/2006 14:31	71.629	TOPP	0.005	122.005	122.002	122.081	122.078	122.078
699-49-57A	6/8/2006 11:36	47.672	TOPP	0.010	122.059	122.061	122.059	122.061	122.062
				Range (m):	0.073	0.072	0.031	0.022	0.020
				Gradient Magnitude (m/m):	2.86E-05	1.95E-05	1.95E-05	1.05E-05	1.01E-05
				Direction (azimuth):	38	47	3	347	344
				R^2:	0.21	0.08	0.63	0.74	0.80
				p-Value:	0.4420	0.7376	0.0316	0.0085	0.0038
				Statistically Significant?:	No	No	Yes	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)				
					No Corrections	New RP Only	Gyro Correction Only	New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-18	1/25/2007 15:57	90.064	TOPP	0.010	122.057	122.050	122.069	122.062	122.062
299-E28-27	NM	NM	NM	NM	NM	NM	NM	NM	NM
299-E32-5	1/25/2007 16:59	86.974	TOPP	0.005	122.044	122.036	122.065	122.057	122.057
299-E32-6	1/25/2007 16:49	82.419	TOPP	0.005	122.033	122.038	122.048	122.053	122.052
299-E32-8	1/25/2007 16:39	75.783	TOPP	0.005	122.012	122.017	122.052	122.057	122.056
299-E33-28	NM	NM	NM	NM	NM	NM	NM	NM	NM
299-E33-339	1/25/2007 16:08	80.980	TOPP	0.005	122.052	122.054	122.058	122.060	122.058
299-E33-34	1/25/2007 16:31	72.094	TOPP	0.005	122.044	122.052	122.050	122.058	122.058
299-E33-38	1/25/2007 16:21	71.650	TOPP	0.005	121.984	121.981	122.060	122.057	122.055
699-49-57A	1/25/2007 15:37	47.685	TOPP	0.010	122.046	122.048	122.046	122.048	122.045
				Range (m):	0.073	0.073	0.023	0.014	0.017
				Gradient Magnitude (m/m):	2.68E-05	2.00E-05	1.44E-05	7.27E-06	8.73E-06
				Direction (azimuth):	41	52	356	336	348
				R^2:	0.16	0.09	0.70	0.81	0.76
				p-Value:	0.6393	0.7910	0.0494	0.0149	0.0269
				Statistically Significant?:	No	No	Yes	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-1	6/16/2008 11:30	87.862	TOC	0.000	121.995	121.984
299-E28-17	6/16/2008 12:57	94.728	TOC	0.000	121.992	121.990
299-E28-18	6/16/2008 11:45	90.145	TOPP	0.010	121.981	121.980
299-E28-27	6/16/2008 12:30	86.526	TOPP	0.005	121.979	121.978
299-E32-5	6/16/2008 12:00	87.052	TOPP	0.005	121.979	121.979
299-E32-6	6/16/2008 12:05	82.496	TOPP	0.005	121.976	121.975
299-E32-8	6/16/2008 12:10	75.858	TOPP	0.005	121.982	121.981
299-E33-28	6/16/2008 12:24	81.591	TOPP	0.013	121.976	121.975
299-E33-339	6/16/2008 12:49	81.057	TOPP	0.005	121.983	121.981
299-E33-34	6/16/2008 12:15	72.168	TOPP	0.005	121.984	121.981
299-E33-38	6/16/2008 12:43	71.726	TOPP	0.005	121.981	121.980
699-49-55A	6/16/2008 13:30	40.884	TOPP	0.004	121.995	121.992
699-49-57A	6/16/2008 13:17	47.756	TOPP	0.010	121.977	121.974
699-50-56	6/16/2008 14:10	47.111	TOPP	0.009	121.965	121.961
				Range (m):	0.030	0.031
				Gradient Magnitude (m/m):	8.80E-06	5.91E-06
				Direction (azimuth):	287	309
				R^2:	0.38	0.31
				p-Value:	0.0744	0.1321
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E28-1	7/21/2008 8:41	87.893	TOC	0.000	121.964	121.972
299-E28-17	7/21/2008 8:12	94.777	TOPP	0.010	121.953	121.955
299-E28-18	7/21/2008 8:22	90.146	TOPP	0.010	121.980	121.980
299-E28-27	7/21/2008 8:50	86.533	TOPP	0.005	121.972	121.972
299-E32-5	7/21/2008 9:31	87.057	TOPP	0.005	121.974	121.974
299-E32-6	7/21/2008 9:36	82.504	TOPP	0.005	121.968	121.967
299-E32-8	7/21/2008 9:43	75.865	TOPP	0.005	121.975	121.975
299-E33-28	7/21/2008 8:57	81.598	TOPP	0.013	121.969	121.969
299-E33-339	7/21/2008 9:05	81.070	TOPP	0.005	121.970	121.971
299-E33-34	7/21/2008 9:51	72.185	TOPP	0.005	121.967	121.966
299-E33-38	7/21/2008 9:15	71.730	TOPP	0.005	121.977	121.977
699-49-55A	7/21/2008 7:50	40.896	TOC	0.000	121.979	121.979
699-49-57A	7/21/2008 7:58	47.768	TOPP	0.010	121.965	121.967
699-50-56	7/21/2008 7:41	47.109	TOC	0.000	121.958	121.959
				Range (m):	0.027	0.025
				Gradient Magnitude (m/m):	1.27E-06	1.35E-06
				Direction (azimuth):	97	264
				R^2:	0.01	0.01
				p-Value:	0.9639	0.9673
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	8/29/2008 9:47	87.882	TOC	0.000	121.975	121.957
299-E28-17	8/29/2008 9:37	94.754	TOC	0.000	121.966	121.964
299-E28-18	8/29/2008 10:32	90.164	TOPP	0.010	121.962	121.961
299-E28-27	8/29/2008 11:10	86.540	TOPP	0.005	121.965	121.964
299-E32-5	8/29/2008 10:24	87.063	TOPP	0.005	121.968	121.968
299-E32-6	8/29/2008 10:19	82.508	TOPP	0.005	121.964	121.964
299-E32-8	8/29/2008 10:14	75.868	TOPP	0.005	121.972	121.970
299-E33-28	8/29/2008 11:05	81.604	TOPP	0.013	121.963	121.963
299-E33-339	8/29/2008 9:54	81.071	TOPP	0.005	121.969	121.967
299-E33-34	8/29/2008 10:09	72.180	TOPP	0.005	121.972	121.968
299-E33-38	8/29/2008 10:02	71.740	TOPP	0.005	121.967	121.966
699-49-55A	8/29/2008 10:52	40.887	TOC	0.000	121.988	121.985
699-49-57A	8/29/2008 10:43	47.758	TOPP	0.010	121.975	121.971
699-50-56	8/29/2008 10:57	47.080	TOC	0.000	121.987	121.980
				Range (m):	0.026	0.028
				Gradient Magnitude (m/m):	1.32E-05	9.13E-06
				Direction (azimuth):	213	187
				R^2:	0.64	0.68
				p-Value:	0.0036	0.0018
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	9/11/2008 9:40	87.914	TOPP	0.013	121.956	121.963
299-E28-17	9/11/2008 9:12	94.785	TOPP	0.010	121.945	121.944
299-E28-18	9/11/2008 9:21	90.164	TOPP	0.010	121.962	121.962
299-E28-27	9/11/2008 11:05	86.540	TOPP	0.005	121.965	121.965
299-E32-5	9/11/2008 11:17	87.063	TOPP	0.005	121.968	121.968
299-E32-6	9/11/2008 11:23	82.507	TOPP	0.005	121.965	121.965
299-E32-8	9/11/2008 11:31	75.868	TOPP	0.005	121.972	121.972
299-E33-28	9/11/2008 10:58	81.598	TOPP	0.013	121.969	121.970
299-E33-339	9/11/2008 9:51	81.080	TOPP	0.005	121.960	121.962
299-E33-34	9/11/2008 11:36	72.186	TOPP	0.005	121.966	121.965
299-E33-38	9/11/2008 10:04	71.745	TOPP	0.005	121.962	121.965
699-49-55A	9/11/2008 9:56	40.899	TOC	0.000	121.976	121.981
699-49-57A	9/11/2008 8:25	47.766	TOPP	0.010	121.967	121.971
699-50-56	9/11/2008 8:47	47.099	TOPP	0.009	121.977	121.976
				Range (m):	0.032	0.037
				Gradient Magnitude (m/m):	9.30E-06	1.01E-05
				Direction (azimuth):	156	180
				R^2:	0.73	0.69
				p-Value:	0.0008	0.0017
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	10/23/2008 12:44	87.889	TOPP	0.013	121.981	121.975
299-E28-17	10/23/2008 12:54	94.767	TOPP	0.010	121.963	121.965
299-E28-18	10/23/2008 12:50	90.162	TOPP	0.010	121.964	121.965
299-E28-27	10/23/2008 12:32	86.538	TOPP	0.005	121.967	121.966
299-E32-5	10/23/2008 12:06	87.065	TOPP	0.005	121.966	121.966
299-E32-6	10/23/2008 12:10	82.505	TOPP	0.005	121.967	121.966
299-E32-8	10/23/2008 12:05	75.867	TOPP	0.005	121.973	121.972
299-E33-28	10/23/2008 12:36	81.599	TOPP	0.013	121.968	121.967
299-E33-339	10/23/2008 12:26	81.075	TOPP	0.005	121.965	121.961
299-E33-34	10/23/2008 12:18	72.183	TOPP	0.005	121.969	121.966
299-E33-38	10/23/2008 12:22	71.735	TOPP	0.005	121.972	121.968
699-49-55A	10/23/2008 11:54	40.888	TOC	0.000	121.987	121.982
699-49-57A	10/23/2008 12:00	47.761	TOPP	0.010	121.972	121.969
699-50-56	10/23/2008 11:50	47.102	TOPP	0.009	121.974	121.971
				Range (m):	0.024	0.021
				Gradient Magnitude (m/m):	1.11E-05	5.86E-06
				Direction (azimuth):	226	218
				R^2:	0.45	0.27
				p-Value:	0.0376	0.1803
				Statistically Significant?:	Yes	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	11/26/2008 10:38	87.901	TOPP	0.013	121.969	121.985
299-E28-17	11/26/2008 10:48	94.798	TOPP	0.010	121.932	121.932
299-E28-18	11/26/2008 9:52	90.173	TOPP	0.010	121.953	121.952
299-E28-27	11/26/2008 10:09	86.551	TOPP	0.005	121.954	121.954
299-E32-5	11/26/2008 9:40	87.081	TOPP	0.005	121.950	121.950
299-E32-6	11/26/2008 9:35	82.522	TOPP	0.005	121.950	121.951
299-E32-8	11/26/2008 9:28	75.884	TOPP	0.005	121.956	121.957
299-E33-28	11/26/2008 10:17	81.614	TOPP	0.013	121.953	121.953
299-E33-339	11/26/2008 8:48	81.091	TOPP	0.005	121.949	121.952
299-E33-34	11/26/2008 9:18	72.201	TOPP	0.005	121.951	121.954
299-E33-38	11/26/2008 8:59	71.752	TOPP	0.005	121.955	121.956
699-49-55A	11/26/2008 11:04	40.910	TOC	0.000	121.965	121.969
699-49-57A	11/26/2008 11:20	47.778	TOPP	0.010	121.955	121.960
699-50-56	11/26/2008 11:36	47.118	TOPP	0.009	121.958	121.954
				Range (m):	0.037	0.053
				Gradient Magnitude (m/m):	1.13E-05	1.59E-05
				Direction (azimuth):	225	237
				R^2:	0.31	0.24
				p-Value:	0.1268	0.2152
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	12/23/2008 9:39	87.942	TOPP	0.013	121.928	121.941
299-E28-17	12/23/2008 9:29	94.810	TOPP	0.010	121.920	121.921
299-E28-18	12/23/2008 9:19	90.187	TOPP	0.010	121.939	121.938
299-E28-27	12/23/2008 8:58	86.566	TOPP	0.005	121.939	121.939
299-E32-5	12/23/2008 9:09	87.092	TOPP	0.005	121.939	121.939
299-E32-6	12/23/2008 9:05	82.530	TOPP	0.005	121.942	121.941
299-E32-8	12/23/2008 8:41	75.890	TOPP	0.005	121.950	121.950
299-E33-28	12/23/2008 8:54	81.625	TOPP	0.013	121.942	121.941
299-E33-339	NM	NM	TOPP	0.005	NM	NM
299-E33-34	12/23/2008 8:48	72.249	TOPP	0.005	121.903	121.906
299-E33-38	12/23/2008 9:53	71.763	TOPP	0.005	121.944	121.944
699-49-55A	12/23/2008 10:03	40.920	TOC	0.000	121.955	121.957
699-49-57A	12/23/2008 10:10	47.798	TOPP	0.010	121.935	121.937
699-50-56	12/23/2008 10:20	47.142	TOPP	0.009	121.934	121.936
				Range (m):	0.052	0.036
				Gradient Magnitude (m/m):	5.70E-06	7.65E-06
				Direction (azimuth):	160	210
				R^2:	0.24	0.25
				p-Value:	0.2892	0.2794
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	1/12/2009 10:06	87.936	TOPP	0.013	121.934	121.940
299-E28-17	1/12/2009 10:13	94.802	TOPP	0.010	121.928	121.928
299-E28-18	1/12/2009 10:21	90.183	TOPP	0.010	121.943	121.943
299-E28-27	1/12/2009 10:33	86.563	TOPP	0.005	121.942	121.943
299-E32-5	1/12/2009 9:16	87.092	TOPP	0.005	121.939	121.939
299-E32-6	1/12/2009 9:24	82.534	TOPP	0.005	121.938	121.940
299-E32-8	1/12/2009 9:31	75.895	TOPP	0.005	121.945	121.946
299-E33-28	1/12/2009 10:39	81.626	TOPP	0.013	121.941	121.942
299-E33-339	1/12/2009 9:58	81.101	TOPP	0.005	121.939	121.940
299-E33-34	1/12/2009 9:37	72.214	TOPP	0.005	121.938	121.941
299-E33-38	1/12/2009 9:42	71.766	TOPP	0.005	121.941	121.943
699-49-55A	1/12/2009 9:02	40.925	TOC	0.000	121.950	121.960
699-49-57A	1/12/2009 9:08	47.796	TOPP	0.010	121.937	121.941
699-50-56	1/12/2009 8:56	47.149	TOPP	0.009	121.927	121.928
				Range (m):	0.023	0.032
				Gradient Magnitude (m/m):	8.86E-07	4.11E-06
				Direction (azimuth):	130	219
				R^2:	0.01	0.06
				p-Value:	0.9450	0.7099
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	2/23/2009 10:27	87.978	TOPP	0.013	121.892	121.883
299-E28-17	2/23/2009 12:01	94.799	TOPP	0.010	121.931	121.930
299-E28-18	2/23/2009 11:50	90.198	TOPP	0.010	121.928	121.927
299-E28-27	2/23/2009 11:16	86.582	TOPP	0.005	121.923	121.922
299-E32-5	2/23/2009 11:41	87.114	TOPP	0.005	121.917	121.917
299-E32-6	2/23/2009 11:25	82.549	TOPP	0.005	121.923	121.921
299-E32-8	2/23/2009 11:34	75.911	TOPP	0.005	121.929	121.927
299-E33-28	2/23/2009 11:10	81.642	TOPP	0.013	121.925	121.924
299-E33-339	2/23/2009 10:15	81.113	TOPP	0.005	121.927	121.925
299-E33-34	2/23/2009 10:55	72.223	TOPP	0.005	121.929	121.926
299-E33-38	2/23/2009 10:46	71.778	TOPP	0.005	121.929	121.926
699-49-55A	2/23/2009 12:40	40.928	TOC	0.000	121.947	121.941
699-49-57A	2/23/2009 12:12	47.806	TOPP	0.010	121.927	121.923
699-50-56	2/23/2009 12:30	47.156	TOPP	0.009	121.920	121.914
				Range (m):	0.055	0.027
				Gradient Magnitude (m/m):	9.88E-06	7.50E-06
				Direction (azimuth):	247	263
				R^2:	0.22	0.18
				p-Value:	0.2966	0.3812
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	3/24/2009 7:43	87.957	TOPP	0.013	121.913	121.917
299-E28-17	3/24/2009 7:54	94.822	TOPP	0.010	121.908	121.907
299-E28-18	3/24/2009 7:48	90.212	TOPP	0.010	121.914	121.915
299-E28-27	3/24/2009 7:33	86.593	TOPP	0.005	121.912	121.913
299-E32-5	3/24/2009 7:06	87.115	TOPP	0.005	121.916	121.916
299-E32-6	3/24/2009 7:10	82.558	TOPP	0.005	121.914	121.916
299-E32-8	3/24/2009 7:13	75.923	TOPP	0.005	121.917	121.919
299-E33-28	3/24/2009 7:37	81.652	TOPP	0.013	121.915	121.917
299-E33-339	3/24/2009 7:26	81.124	TOPP	0.005	121.916	121.917
299-E33-34	3/24/2009 7:16	72.239	TOPP	0.005	121.913	121.915
299-E33-38	3/24/2009 7:21	71.799	TOPP	0.005	121.908	121.912
699-49-55A	3/24/2009 6:56	40.949	TOC	0.000	121.926	121.933
699-49-57A	3/24/2009 6:59	47.821	TOPP	0.010	121.912	121.915
699-50-56	3/24/2009 6:52	47.172	TOPP	0.009	121.904	121.903
				Range (m):	0.022	0.030
				Gradient Magnitude (m/m):	6.34E-07	2.53E-06
				Direction (azimuth):	106	224
				R^2:	0.00	0.03
				p-Value:	0.9738	0.8659
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	4/13/2009 8:35	87.951	TOPP	0.013	121.919	121.921
299-E28-17	4/13/2009 8:44	94.819	TOPP	0.010	121.911	121.910
299-E28-18	4/13/2009 8:51	90.207	TOPP	0.010	121.919	121.918
299-E28-27	4/13/2009 9:01	86.581	TOPP	0.005	121.924	121.924
299-E32-5	4/13/2009 7:48	87.118	TOPP	0.005	121.913	121.913
299-E32-6	4/13/2009 7:56	82.557	TOPP	0.005	121.915	121.916
299-E32-8	4/13/2009 8:05	75.917	TOPP	0.005	121.923	121.924
299-E33-28	4/13/2009 9:07	81.647	TOPP	0.013	121.920	121.920
299-E33-339	4/13/2009 8:28	81.120	TOPP	0.005	121.920	121.921
299-E33-34	4/13/2009 8:11	72.237	TOPP	0.005	121.915	121.917
299-E33-38	4/13/2009 8:17	71.788	TOPP	0.005	121.919	121.920
699-49-55A	4/13/2009 7:28	40.952	TOC	0.000	121.923	121.927
699-49-57A	4/13/2009 7:38	47.824	TOPP	0.010	121.909	121.912
699-50-56	4/13/2009 7:13	47.180	TOPP	0.009	121.896	121.897
				Range (m):	0.028	0.030
				Gradient Magnitude (m/m):	4.72E-06	4.83E-06
				Direction (azimuth):	316	289
				R^2:	0.21	0.14
				p-Value:	0.2708	0.4408
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	5/28/2009 7:22	87.940	TOPP	0.013	121.930	121.939
299-E28-17	5/28/2009 6:55	94.810	TOPP	0.010	121.920	121.921
299-E28-18	5/28/2009 7:06	90.196	TOPP	0.010	121.930	121.931
299-E28-27	5/28/2009 8:00	86.575	TOPP	0.005	121.930	121.930
299-E32-5	5/28/2009 8:36	87.105	TOPP	0.005	121.926	121.926
299-E32-6	5/28/2009 8:30	82.547	TOPP	0.005	121.925	121.925
299-E32-8	5/28/2009 8:20	75.991	TOPP	0.005	121.849	121.850
299-E33-28	5/28/2009 7:52	81.636	TOPP	0.013	121.931	121.931
299-E33-339	5/28/2009 7:33	81.107	TOPP	0.005	121.933	121.934
299-E33-34	5/28/2009 8:10	72.226	TOPP	0.005	121.926	121.928
299-E33-38	5/28/2009 7:44	71.775	TOPP	0.005	121.932	121.932
699-49-55A	5/28/2009 8:57	40.938	TOC	0.000	121.937	121.940
699-49-57A	5/28/2009 8:47	47.812	TOPP	0.010	121.921	121.923
699-50-56	5/28/2009 9:05	47.186	TOPP	0.009	121.890	121.888
				Range (m):	0.088	0.052
				Gradient Magnitude (m/m):	8.23E-06	1.07E-05
				Direction (azimuth):	310	300
				R^2:	0.25	0.30
				p-Value:	0.2343	0.1720
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	7/17/2009 10:49	87.888	TOPP	0.013	121.982	121.985
299-E28-17	7/17/2009 10:41	94.761	TOPP	0.010	121.969	121.968
299-E28-18	7/17/2009 10:33	90.149	TOPP	0.010	121.977	121.976
299-E28-27	7/17/2009 10:09	86.532	TOPP	0.005	121.973	121.973
299-E32-5	7/17/2009 9:50	87.066	TOPP	0.005	121.965	121.965
299-E32-6	7/17/2009 9:42	82.520	TOPP	0.005	121.952	121.952
299-E32-8	7/17/2009 9:31	75.872	TOPP	0.005	121.968	121.969
299-E33-28	7/17/2009 10:04	81.593	TOPP	0.013	121.974	121.974
299-E33-339	7/17/2009 10:24	81.062	TOPP	0.005	121.978	121.979
299-E33-34	7/17/2009 7:29	72.186	TOPP	0.005	121.966	121.969
299-E33-38	NM	NM	TOPP	0.005	NM	NM
699-49-55A	7/17/2009 6:44	40.911	TOC	0.000	121.964	121.967
699-49-57A	7/17/2009 7:12	47.783	TOPP	0.010	121.950	121.953
699-50-56	7/17/2009 6:52	47.172	TOPP	0.009	121.904	121.906
				Range (m):	0.078	0.079
				Gradient Magnitude (m/m):	1.97E-05	1.89E-05
				Direction (azimuth):	335	326
				R^2:	0.58	0.54
				p-Value:	0.0127	0.0198
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	9/21/2009 9:35	87.933	TOPP	0.013	121.937	121.947
299-E28-17	9/21/2009 9:45	94.796	TOPP	0.010	121.934	121.931
299-E28-18	9/21/2009 9:49	90.181	TOPP	0.010	121.945	121.944
299-E28-27	9/21/2009 8:51	86.582	TOPP	0.005	121.923	121.924
299-E32-5	9/21/2009 8:27	87.092	TOPP	0.005	121.939	121.939
299-E32-6	9/21/2009 8:22	82.532	TOPP	0.005	121.940	121.942
299-E32-8	9/21/2009 8:18	75.897	TOPP	0.005	121.943	121.946
299-E33-28	9/21/2009 8:43	81.622	TOPP	0.013	121.945	121.947
299-E33-339	9/21/2009 9:11	81.098	TOPP	0.005	121.942	121.946
299-E33-34	9/21/2009 8:13	72.215	TOPP	0.005	121.937	121.942
299-E33-38	9/21/2009 9:03	71.766	TOPP	0.005	121.941	121.947
699-49-55A	9/21/2009 7:35	40.934	TOC	0.000	121.941	121.952
699-49-57A	9/21/2009 7:45	47.800	TOPP	0.010	121.933	121.940
699-50-56	9/21/2009 8:02	47.157	TOPP	0.009	121.919	121.920
				Range (m):	0.026	0.032
				Gradient Magnitude (m/m):	3.67E-06	5.57E-06
				Direction (azimuth):	8	262
				R^2:	0.10	0.06
				p-Value:	0.5734	0.7241
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	10/27/2009 7:49	87.971	TOPP	0.013	121.899	121.918
299-E28-17	10/27/2009 7:00	94.833	TOPP	0.010	121.897	121.901
299-E28-18	10/27/2009 8:55	90.210	TOPP	0.010	121.916	121.916
299-E28-27	10/27/2009 8:42	86.586	TOPP	0.005	121.919	121.919
299-E32-5	10/27/2009 8:26	87.114	TOPP	0.005	121.917	121.917
299-E32-6	10/27/2009 8:21	82.553	TOPP	0.005	121.919	121.919
299-E32-8	10/27/2009 8:15	75.917	TOPP	0.005	121.923	121.924
299-E33-28	10/27/2009 8:36	81.645	TOPP	0.013	121.922	121.921
299-E33-339	10/27/2009 7:55	81.125	TOPP	0.005	121.915	121.918
299-E33-34	10/27/2009 8:10	72.223	TOPP	0.005	121.929	121.931
299-E33-38	10/27/2009 8:02	71.784	TOPP	0.005	121.923	121.921
699-49-55A	10/27/2009 10:22	41.500	TOC	0.000	121.375	121.377
699-49-57A	10/27/2009 10:14	47.816	TOPP	0.010	121.917	121.920
699-50-56	10/27/2009 10:30	47.175	TOPP	0.009	121.901	121.903
				Range (m):	0.554	0.030
				Gradient Magnitude (m/m):	5.98E-06	1.22E-06
				Direction (azimuth):	100	176
				R^2:	0.10	0.01
				p-Value:	0.5781	0.9437
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	11/12/2009 8:43	87.958	TOPP	0.013	121.912	121.915
299-E28-17	11/12/2009 8:52	94.830	TOPP	0.010	121.900	121.902
299-E28-18	11/12/2009 9:21	90.212	TOPP	0.010	121.914	121.915
299-E28-27	11/12/2009 10:08	86.587	TOPP	0.005	121.918	121.918
299-E32-5	11/12/2009 9:33	87.115	TOPP	0.005	121.916	121.916
299-E32-6	11/12/2009 9:37	82.559	TOPP	0.005	121.913	121.912
299-E32-8	11/12/2009 9:41	75.921	TOPP	0.005	121.919	121.918
299-E33-28	11/12/2009 10:12	81.650	TOPP	0.013	121.917	121.916
299-E33-339	11/12/2009 9:57	81.123	TOPP	0.005	121.917	121.916
299-E33-34	11/12/2009 9:45	72.238	TOPP	0.005	121.914	121.914
299-E33-38	11/12/2009 9:52	71.786	TOPP	0.005	121.921	121.919
699-49-55A	11/12/2009 8:19	40.944	TOC	0.000	121.931	121.928
699-49-57A	11/12/2009 8:25	47.823	TOPP	0.010	121.910	121.909
699-50-56	11/12/2009 8:15	47.185	TOPP	0.009	121.891	121.893
				Range (m):	0.040	0.035
				Gradient Magnitude (m/m):	3.47E-06	3.46E-06
				Direction (azimuth):	259	276
				R^2:	0.02	0.04
				p-Value:	0.8933	0.7905
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	1/21/2010 10:21	87.994	TOPP	0.013	121.876	121.888
299-E28-17	1/21/2010 10:01	94.958	TOT	0.100	121.862	121.866
299-E28-18	1/21/2010 10:08	90.249	TOPP	0.010	121.877	121.878
299-E28-27	1/21/2010 9:37	86.625	TOPP	0.005	121.880	121.880
299-E32-5	1/21/2010 8:43	87.153	TOPP	0.005	121.878	121.878
299-E32-6	1/21/2010 8:51	82.592	TOPP	0.005	121.880	121.879
299-E32-8	1/21/2010 9:13	75.957	TOPP	0.005	121.883	121.883
299-E33-28	1/21/2010 9:28	81.684	TOPP	0.013	121.883	121.881
299-E33-339	1/21/2010 10:31	81.155	TOC	0.000	121.880	121.880
299-E33-34	1/21/2010 9:22	72.272	TOPP	0.005	121.880	121.879
299-E33-38	1/21/2010 10:42	71.803	TOPP	0.005	121.904	121.902
699-49-55A	1/21/2010 8:33	40.969	TOC	0.000	121.906	121.897
699-49-57A	1/21/2010 8:17	47.854	TOPP	0.010	121.879	121.876
699-50-56	1/21/2010 8:25	47.218	TOC	0.000	121.849	121.853
				Range (m):	0.057	0.049
				Gradient Magnitude (m/m):	1.07E-05	1.17E-05
				Direction (azimuth):	243	258
				R^2:	0.07	0.14
				p-Value:	0.6749	0.4252
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	5/23/2010 7:30	88.032	TOPP	0.013	121.838	121.851
299-E28-17	5/23/2010 7:18	94.898	TOPP	0.010	121.832	121.832
299-E28-18	5/23/2010 7:59	90.277	TOPP	0.010	121.849	121.848
299-E28-27	5/23/2010 8:48	86.659	TOPP	0.005	121.846	121.846
299-E32-5	5/23/2010 8:13	87.187	TOPP	0.005	121.844	121.844
299-E32-6	5/23/2010 8:20	82.628	TOPP	0.005	121.844	121.844
299-E32-8	5/23/2010 8:27	75.992	TOPP	0.005	121.848	121.849
299-E33-28	5/23/2010 8:42	81.718	TOPP	0.013	121.849	121.849
299-E33-339	5/23/2010 7:40	81.192	TOC	0.000	121.843	121.846
299-E33-34	5/23/2010 8:34	72.307	TOPP	0.005	121.845	121.846
299-E33-38	5/23/2010 8:58	71.855	TOPP	0.005	121.852	121.853
699-49-55A	5/23/2010 9:15	41.020	TOC	0.000	121.855	121.858
699-49-57A	5/23/2010 9:29	47.900	TOPP	0.010	121.833	121.836
699-50-56	5/23/2010 9:22	47.264	TOC	0.000	121.803	121.801
				Range (m):	0.052	0.057
				Gradient Magnitude (m/m):	6.29E-06	7.63E-06
				Direction (azimuth):	358	318
				R^2:	0.12	0.16
				p-Value:	0.5020	0.3782
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	6/30/2010 13:05	88.008	TOPP	0.013	121.862	121.860
299-E28-17	6/30/2010 13:14	94.874	TOPP	0.010	121.856	121.852
299-E28-18	NM	NM	TOPP	0.010	NM	NM
299-E28-27	6/30/2010 13:40	86.647	TOPP	0.005	121.858	121.858
299-E32-5	6/30/2010 12:26	87.178	TOPP	0.005	121.853	121.853
299-E32-6	6/30/2010 12:30	82.626	TOPP	0.005	121.846	121.847
299-E32-8	6/30/2010 12:36	75.990	TOPP	0.005	121.850	121.850
299-E33-28	6/30/2010 13:44	81.712	TOPP	0.013	121.855	121.856
299-E33-339	6/30/2010 12:53	81.181	TOC	0.000	121.854	121.856
299-E33-34	6/30/2010 12:41	72.302	TOPP	0.005	121.850	121.850
299-E33-38	6/30/2010 12:46	71.856	TOPP	0.005	121.851	121.854
699-49-55A	6/30/2010 12:17	41.022	TOC	0.000	121.853	121.859
699-49-57A	6/30/2010 12:07	47.896	TOPP	0.010	121.837	121.840
699-50-56	6/30/2010 12:12	47.275	TOC	0.000	121.792	121.789
				Range (m):	0.070	0.071
				Gradient Magnitude (m/m):	1.81E-05	1.62E-05
				Direction (azimuth):	353	348
				R^2:	0.54	0.41
				p-Value:	0.0212	0.0693
				Statistically Significant?:	Yes	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	7/13/2010 8:20	88.015	TOPP	0.013	121.855	121.876
299-E28-17	7/13/2010 8:10	94.899	TOPP	0.010	121.831	121.830
299-E28-18	NM	NM	TOPP	0.010	NM	NM
299-E28-27	7/13/2010 9:19	86.652	TOPP	0.005	121.853	121.853
299-E32-5	7/13/2010 10:36	87.181	TOPP	0.005	121.850	121.850
299-E32-6	7/13/2010 10:41	82.624	TOPP	0.005	121.848	121.849
299-E32-8	7/13/2010 10:46	75.990	TOPP	0.005	121.850	121.852
299-E33-28	7/13/2010 9:14	81.701	TOPP	0.013	121.866	121.868
299-E33-339	7/13/2010 8:42	81.182	TOC	0.000	121.853	121.857
299-E33-34	7/13/2010 9:06	72.308	TOPP	0.005	121.844	121.847
299-E33-38	7/13/2010 8:58	71.858	TOPP	0.005	121.849	121.853
699-49-55A	7/13/2010 10:10	41.025	TOC	0.000	121.850	121.857
699-49-57A	7/13/2010 10:17	47.889	TOPP	0.010	121.844	121.850
699-50-56	7/13/2010 10:25	47.269	TOC	0.000	121.798	121.799
				Range (m):	0.068	0.077
				Gradient Magnitude (m/m):	1.02E-05	1.17E-05
				Direction (azimuth):	357	312
				R^2:	0.20	0.21
				p-Value:	0.3377	0.3140
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	9/15/2010 10:42	88.018	TOPP	0.013	121.852	121.843
299-E28-17	9/15/2010 11:02	94.882	TOPP	0.010	121.848	121.846
299-E28-18	NM	NM	TOPP	0.010	NM	NM
299-E28-27	9/15/2010 10:18	86.659	TOPP	0.005	121.846	121.845
299-E32-5	9/15/2010 9:45	87.195	TOPP	0.005	121.836	121.836
299-E32-6	9/15/2010 9:51	82.633	TOPP	0.005	121.839	121.838
299-E32-8	9/15/2010 9:58	75.993	TOPP	0.005	121.847	121.846
299-E33-28	9/15/2010 10:13	81.724	TOPP	0.013	121.843	121.843
299-E33-339	9/15/2010 10:32	81.191	TOC	0.000	121.844	121.843
299-E33-34	9/15/2010 10:04	72.306	TOPP	0.005	121.846	121.844
299-E33-38	9/15/2010 10:25	71.863	TOPP	0.005	121.844	121.843
699-49-55A	9/15/2010 11:18	41.026	TOC	0.000	121.849	121.848
699-49-57A	9/15/2010 11:12	47.894	TOPP	0.010	121.839	121.838
699-50-56	9/15/2010 11:23	47.258	TOPP	0.009	121.818	121.813
				Range (m):	0.034	0.035
				Gradient Magnitude (m/m):	7.62E-06	6.66E-06
				Direction (azimuth):	315	338
				R^2:	0.42	0.31
				p-Value:	0.0646	0.1524
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	1/4/2011 9:56	88.026	TOPP	0.013	121.844	121.845
299-E28-17	1/4/2011 9:41	94.882	TOC	0.000	121.838	121.839
299-E28-18	1/4/2011 9:48	90.267	TOPP	0.010	121.859	121.860
299-E28-27	1/4/2011 10:51	86.655	TOPP	0.005	121.850	121.850
299-E32-5	1/4/2011 10:38	87.184	TOPP	0.005	121.847	121.847
299-E32-6	1/4/2011 10:32	82.624	TOPP	0.005	121.848	121.848
299-E32-8	1/4/2011 10:25	75.990	TOPP	0.005	121.850	121.850
299-E33-28	1/4/2011 10:45	81.719	TOPP	0.013	121.848	121.848
299-E33-339	1/4/2011 10:04	81.187	TOPP	0.005	121.853	121.853
299-E33-34	1/4/2011 10:20	72.302	TOPP	0.005	121.850	121.852
299-E33-38	1/4/2011 10:14	71.854	TOPP	0.005	121.853	121.853
699-49-55A	1/4/2011 9:23	41.026	TOC	0.000	121.849	121.854
699-49-57A	1/4/2011 9:28	47.899	TOPP	0.010	121.834	121.835
699-50-56	1/4/2011 9:17	47.275	TOPP	0.009	121.801	121.800
				Range (m):	0.058	0.060
				Gradient Magnitude (m/m):	1.12E-05	1.06E-05
				Direction (azimuth):	2	358
				R^2:	0.30	0.26
				p-Value:	0.1439	0.1841
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	2/11/2011 10:02	88.025	TOPP	0.013	121.845	121.838
299-E28-17	2/11/2011 10:24	94.895	TOPP	0.010	121.835	121.837
299-E28-18	2/11/2011 10:13	90.285	TOPP	0.010	121.841	121.841
299-E28-27	2/11/2011 9:23	86.675	TOPP	0.005	121.830	121.829
299-E32-5	2/11/2011 8:42	87.205	TOPP	0.005	121.826	121.826
299-E32-6	2/11/2011 8:53	82.643	TOPP	0.005	121.829	121.829
299-E32-8	2/11/2011 9:01	76.013	TOPP	0.005	121.827	121.826
299-E33-28	2/11/2011 9:15	81.735	TOPP	0.013	121.832	121.831
299-E33-339	2/11/2011 9:50	81.205	TOPP	0.005	121.835	121.833
299-E33-34	2/11/2011 9:08	72.317	TOPP	0.005	121.835	121.832
299-E33-38	2/11/2011 9:34	71.873	TOPP	0.005	121.834	121.831
699-49-55A	2/11/2011 8:22	41.033	TOC	0.000	121.842	121.837
699-49-57A	2/11/2011 8:32	47.905	TOPP	0.010	121.828	121.825
699-50-56	2/11/2011 8:12	47.275	TOC	0.000	121.792	121.791
				Range (m):	0.053	0.050
				Gradient Magnitude (m/m):	1.12E-05	1.10E-05
				Direction (azimuth):	316	339
				R^2:	0.41	0.48
				p-Value:	0.0532	0.0288
				Statistically Significant?:	No	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	3/21/2011 9:33	88.047	TOPP	0.013	121.823	121.825
299-E28-17	3/21/2011 9:40	94.916	TOPP	0.010	121.814	121.817
299-E28-18	3/21/2011 9:44	90.292	TOPP	0.010	121.834	121.834
299-E28-27	3/21/2011 10:20	86.680	TOPP	0.005	121.825	121.824
299-E32-5	3/21/2011 9:52	87.211	TOPP	0.005	121.820	121.820
299-E32-6	3/21/2011 9:56	82.656	TOPP	0.005	121.816	121.814
299-E32-8	3/21/2011 10:00	76.019	TOPP	0.005	121.821	121.820
299-E33-28	3/21/2011 10:25	81.743	TOPP	0.013	121.824	121.822
299-E33-339	3/21/2011 10:15	81.212	TOPP	0.005	121.828	121.827
299-E33-34	3/21/2011 10:04	72.331	TOPP	0.005	121.821	121.819
299-E33-38	3/21/2011 10:10	71.877	TOPP	0.005	121.830	121.827
699-49-55A	3/21/2011 7:44	41.034	TOC	0.000	121.841	121.833
699-49-57A	3/21/2011 7:34	47.914	TOPP	0.010	121.819	121.816
699-50-56	3/21/2011 7:41	47.280	TOC	0.000	121.787	121.790
				Range (m):	0.054	0.044
				Gradient Magnitude (m/m):	7.62E-06	8.07E-06
				Direction (azimuth):	296	311
				R^2:	0.15	0.29
				p-Value:	0.4063	0.1573
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	4/25/2011 11:35	88.034	TOPP	0.013	121.836	121.821
299-E28-17	4/25/2011 11:41	94.908	TOPP	0.010	121.822	121.824
299-E28-18	4/25/2011 11:48	90.305	TOPP	0.010	121.821	121.823
299-E28-27	4/25/2011 12:16	86.692	TOPP	0.005	121.813	121.812
299-E32-5	4/25/2011 12:42	87.218	TOPP	0.005	121.813	121.813
299-E32-6	4/25/2011 12:36	82.657	TOPP	0.005	121.815	121.813
299-E32-8	4/25/2011 12:28	76.023	TOPP	0.005	121.817	121.814
299-E33-28	4/25/2011 12:11	81.753	TOPP	0.013	121.814	121.812
299-E33-339	4/25/2011 11:56	81.220	TOPP	0.005	121.820	121.817
299-E33-34	4/25/2011 12:23	72.334	TOPP	0.005	121.818	121.815
299-E33-38	NM	NM	TOPP	0.005	NM	NM
699-49-55A	4/25/2011 9:49	41.041	TOC	0.000	121.834	121.824
699-49-57A	4/25/2011 9:47	47.918	TOPP	0.010	121.815	121.807
699-50-56	4/25/2011 9:48	47.269	TOC	0.000	121.798	121.794
				Range (m):	0.038	0.030
				Gradient Magnitude (m/m):	1.18E-05	7.34E-06
				Direction (azimuth):	275	326
				R^2:	0.36	0.49
				p-Value:	0.1046	0.0362
				Statistically Significant?:	No	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	5/25/2011 7:28	88.041	TOPP	0.013	121.829	121.810
299-E28-17	5/25/2011 7:38	94.914	TOPP	0.010	121.816	121.814
299-E28-18	5/25/2011 7:46	90.305	TOPP	0.010	121.821	121.821
299-E28-27	5/25/2011 8:20	86.695	TOPP	0.005	121.810	121.809
299-E32-5	5/25/2011 8:45	87.220	TOPP	0.005	121.811	121.811
299-E32-6	5/25/2011 8:40	82.663	TOPP	0.005	121.809	121.808
299-E32-8	5/25/2011 8:35	76.024	TOPP	0.005	121.816	121.814
299-E33-28	5/25/2011 8:14	81.758	TOPP	0.013	121.809	121.809
299-E33-339	5/25/2011 7:55	81.224	TOPP	0.005	121.816	121.814
299-E33-34	5/25/2011 8:29	72.337	TOPP	0.005	121.815	121.812
299-E33-38	5/25/2011 8:05	71.896	TOPP	0.005	121.811	121.810
699-49-55A	5/25/2011 9:06	41.133	TOC	0.000	121.742	121.739
699-49-57A	5/25/2011 8:54	47.923	TOPP	0.010	121.810	121.806
699-50-56	5/25/2011 9:00	47.226	TOC	0.000	121.841	121.839
				Range (m):	0.099	0.015
				Gradient Magnitude (m/m):	5.70E-06	4.67E-06
				Direction (azimuth):	306	18
				R^2:	0.37	0.29
				p-Value:	0.1274	0.2147
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	6/20/2011 11:50	88.054	TOPP	0.013	121.816	121.813
299-E28-17	6/20/2011 11:29	94.925	TOPP	0.010	121.805	121.803
299-E28-18	6/20/2011 11:22	90.304	TOPP	0.010	121.822	121.821
299-E28-27	6/20/2011 11:12	86.693	TOPP	0.005	121.812	121.812
299-E32-5	6/20/2011 11:58	87.214	TOPP	0.005	121.817	121.817
299-E32-6	6/20/2011 8:56	82.663	TOPP	0.005	121.809	121.809
299-E32-8	6/20/2011 9:00	76.024	TOPP	0.005	121.816	121.817
299-E33-28	6/20/2011 11:07	81.754	TOPP	0.013	121.813	121.813
299-E33-339	6/20/2011 10:59	81.227	TOPP	0.005	121.813	121.814
299-E33-34	6/20/2011 9:05	72.342	TOPP	0.005	121.810	121.810
299-E33-38	NM	NM	TOPP	0.005	NM	NM
699-49-55A	6/20/2011 8:42	41.053	TOC	0.000	121.822	121.825
699-49-57A	6/20/2011 8:32	47.921	TOPP	0.010	121.812	121.815
699-50-56	6/20/2011 8:37	47.252	TOC	0.000	121.815	121.814
				Range (m):	0.017	0.022
				Gradient Magnitude (m/m):	2.32E-06	3.30E-06
				Direction (azimuth):	212	191
				R^2:	0.06	0.16
				p-Value:	0.7300	0.4179
				Statistically Significant?:	No	No

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	7/14/2011 10:44	88.062	TOPP	0.013	121.808	121.806
299-E28-17	NM	NM	TOPP	0.010	NM	NM
299-E28-18	7/14/2011 10:57	90.311	TOPP	0.010	121.815	121.814
299-E28-27	7/14/2011 11:50	86.712	TOPP	0.005	121.793	121.793
299-E32-5	7/14/2011 11:24	87.223	TOPP	0.005	121.808	121.808
299-E32-6	7/14/2011 11:30	82.668	TOPP	0.005	121.804	121.804
299-E32-8	7/14/2011 11:36	76.029	TOPP	0.005	121.811	121.811
299-E33-28	7/14/2011 11:43	81.765	TOPP	0.013	121.802	121.802
299-E33-339	7/14/2011 11:08	81.233	TOPP	0.005	121.807	121.807
299-E33-34	7/14/2011 8:03	72.345	TOPP	0.005	121.807	121.807
299-E33-38	7/14/2011 8:11	71.901	TOPP	0.005	121.806	121.807
699-49-55A	7/14/2011 7:50	41.051	TOC	0.000	121.824	121.825
699-49-57A	7/14/2011 7:37	47.921	TOPP	0.010	121.812	121.813
699-50-56	7/14/2011 7:43	47.238	TOC	0.000	121.829	121.829
				Range (m):	0.036	0.036
				Gradient Magnitude (m/m):	1.08E-05	1.16E-05
				Direction (azimuth):	194	192
				R^2:	0.45	0.51
				p-Value:	0.0519	0.0278
				Statistically Significant?:	No	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1		NM	TOPP	0.013	NM	NM
299-E28-17	8/15/2011 11:14	94.926	TOPP	0.010	121.804	121.804
299-E28-18	8/15/2011 11:06	90.295	TOPP	0.010	121.831	121.830
299-E28-27		NM	TOPP	0.005	NM	NM
299-E32-5	8/15/2011 9:21	87.205	TOPP	0.005	121.826	121.826
299-E32-6	8/15/2011 9:27	82.646	TOPP	0.005	121.826	121.826
299-E32-8	8/15/2011 9:33	76.007	TOPP	0.005	121.833	121.834
299-E33-28		NM	TOPP	0.013	NM	NM
299-E33-339	8/15/2011 10:47	81.220	TOPP	0.005	121.820	121.822
299-E33-34	8/15/2011 9:39	72.330	TOPP	0.005	121.822	121.824
299-E33-38	8/15/2011 11:33	71.887	TOPP	0.005	121.820	121.821
699-49-55A	8/15/2011 8:59	41.034	TOC	0.000	121.841	121.845
699-49-57A		NM	TOPP	0.010	NM	NM
699-50-56	8/15/2011 8:51	47.199	TOC	0.000	121.868	121.869
				Range (m):	0.064	0.065
				Gradient Magnitude (m/m):	1.98E-05	2.05E-05
				Direction (azimuth):	154	161
				R^2:	0.75	0.79
				p-Value:	0.0076	0.0045
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	8/29/2011 7:56	88.062	TOPP	0.013	121.808	121.815
299-E28-17	8/29/2011 7:40	94.931	TOPP	0.010	121.799	121.802
299-E28-18	8/29/2011 8:06	90.302	TOPP	0.010	121.824	121.825
299-E28-27	8/29/2011 8:18	86.684	TOPP	0.005	121.821	121.821
299-E32-5	8/29/2011 8:18	87.202	TOPP	0.005	121.829	121.829
299-E32-6	8/29/2011 8:23	82.644	TOPP	0.005	121.828	121.827
299-E32-8	8/29/2011 8:28	76.006	TOPP	0.005	121.834	121.834
299-E33-28	8/29/2011 8:48	81.742	TOPP	0.013	121.825	121.824
299-E33-339	8/29/2011 9:10	81.218	TOPP	0.005	121.822	121.822
299-E33-34	8/29/2011 8:36	72.325	TOPP	0.005	121.827	121.827
299-E33-38	NM	NM	TOPP	0.005	NM	NM
699-49-55A	8/29/2011 9:38	41.026	TOC	0.000	121.849	121.847
699-49-57A	8/29/2011 9:46	47.870	TOPP	0.010	121.863	121.863
699-50-56	8/29/2011 9:27	47.181	TOC	0.000	121.886	121.887
				Range (m):	0.087	0.085
				Gradient Magnitude (m/m):	2.85E-05	2.75E-05
				Direction (azimuth):	171	176
				R^2:	0.89	0.86
				p-Value:	0.0000	0.0001
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	11/30/2011 11:41	88.076	TOPP	0.013	121.794	121.826
299-E28-17	11/30/2011 11:51	94.932	TOPP	0.010	121.798	121.801
299-E28-18	11/30/2011 11:58	90.286	TOPP	0.010	121.840	121.840
299-E28-27	11/30/2011 12:08	86.670	TOPP	0.005	121.835	121.836
299-E32-5	11/30/2011 11:14	87.190	TOPP	0.005	121.841	121.841
299-E32-6	11/30/2011 11:19	82.628	TOPP	0.005	121.844	121.845
299-E32-8	11/30/2011 11:24	75.988	TOPP	0.005	121.852	121.854
299-E33-28	11/30/2011 12:13	81.728	TOPP	0.013	121.839	121.840
299-E33-339	11/30/2011 11:36	81.211	TOPP	0.005	121.829	121.833
299-E33-34	11/30/2011 11:30	72.314	TOPP	0.005	121.838	121.844
299-E33-38	11/30/2011 8:52	71.870	TOPP	0.005	121.837	121.836
699-49-55A	11/30/2011 11:00	41.016	TOC	0.000	121.859	121.866
699-49-57A	11/30/2011 11:06	47.874	TOPP	0.010	121.859	121.867
699-50-56	11/30/2011 10:55	47.154	TOC	0.000	121.913	121.916
				Range (m):	0.119	0.115
				Gradient Magnitude (m/m):	3.38E-05	3.25E-05
				Direction (azimuth):	153	171
				R^2:	0.82	0.83
				p-Value:	0.0001	0.0001
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	12/29/2011 11:38	88.057	TOPP	0.013	121.813	121.826
299-E28-17	NM	NM	TOPP	0.010	NM	NM
299-E28-18	12/29/2011 12:16	90.288	TOPP	0.010	121.838	121.835
299-E28-27	12/29/2011 12:33	86.673	TOPP	0.005	121.832	121.831
299-E32-5	12/29/2011 12:53	87.192	TOPP	0.005	121.839	121.839
299-E32-6	12/29/2011 13:00	82.631	TOPP	0.005	121.841	121.839
299-E32-8	12/29/2011 13:08	75.994	TOPP	0.005	121.846	121.846
299-E33-28	12/29/2011 12:44	81.732	TOPP	0.013	121.835	121.835
299-E33-339	12/29/2011 13:46	81.213	TOPP	0.005	121.827	121.830
299-E33-34	12/29/2011 13:14	72.312	TOPP	0.005	121.840	121.838
299-E33-38	12/29/2011 13:41	71.875	TOPP	0.005	121.832	121.832
699-49-55A	12/29/2011 8:11	41.010	TOC	0.000	121.865	121.860
699-49-57A	12/29/2011 8:19	47.878	TOPP	0.010	121.855	121.857
699-50-56	12/29/2011 8:05	47.170	TOC	0.000	121.897	121.900
				Range (m):	0.084	0.074
				Gradient Magnitude (m/m):	2.71E-05	2.62E-05
				Direction (azimuth):	163	172
				R^2:	0.81	0.77
				p-Value:	0.0002	0.0006
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	1/25/2012 13:05	88.089	TOPP	0.013	121.781	121.804
299-E28-17	1/25/2012 13:15	94.994	TOPP	0.010	121.736	121.735
299-E28-18	1/25/2012 13:22	90.301	TOPP	0.010	121.825	121.823
299-E28-27	1/25/2012 13:31	86.689	TOPP	0.005	121.816	121.816
299-E32-5	1/25/2012 12:33	87.201	TOPP	0.005	121.830	121.830
299-E32-6	1/25/2012 12:38	82.864	TOPP	0.005	121.608	121.610
299-E32-8	1/25/2012 12:45	76.000	TOPP	0.005	121.840	121.842
299-E33-28	1/25/2012 13:36	81.774	TOPP	0.013	121.793	121.795
299-E33-339	1/25/2012 12:56	81.223	TOPP	0.005	121.817	121.821
299-E33-34	1/25/2012 12:50	72.332	TOPP	0.005	121.820	121.824
299-E33-38	1/25/2012 8:44	71.897	TOPP	0.005	121.810	121.811
699-49-55A	1/25/2012 12:17	41.045	TOC	0.000	121.830	121.840
699-49-57A	1/25/2012 12:23	47.899	TOPP	0.010	121.834	121.842
699-50-56	1/25/2012 12:12	47.185	TOC	0.000	121.882	121.880
				Range (m):	0.274	0.085
				Gradient Magnitude (m/m):	3.06E-05	2.57E-05
				Direction (azimuth):	129	144
				R^2:	0.67	0.68
				p-Value:	0.0065	0.0056
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	2/28/2012 12:46	88.038	TOPP	0.013	121.832	121.808
299-E28-17	2/28/2012 12:53	94.915	TOPP	0.010	121.815	121.813
299-E28-18	2/28/2012 12:58	90.303	TOPP	0.010	121.823	121.822
299-E28-27	2/28/2012 13:07	86.687	TOPP	0.005	121.818	121.817
299-E32-5	2/28/2012 12:24	87.207	TOPP	0.005	121.824	121.824
299-E32-6	2/28/2012 12:28	82.650	TOPP	0.005	121.822	121.822
299-E32-8	2/28/2012 12:32	76.017	TOPP	0.005	121.823	121.822
299-E33-28	2/28/2012 13:10	81.747	TOPP	0.013	121.820	121.819
299-E33-339	2/28/2012 12:40	81.223	TOPP	0.005	121.817	121.814
299-E33-34	2/28/2012 12:35	72.325	TOPP	0.005	121.827	121.821
299-E33-38	2/28/2012 8:22	71.861	TOPP	0.005	121.846	121.845
699-49-55A	2/28/2012 12:12	41.028	TOC	0.000	121.847	121.843
699-49-57A	2/28/2012 12:17	47.904	TOPP	0.010	121.829	121.825
699-50-56	2/28/2012 12:08	47.195	TOC	0.000	121.872	121.868
				Range (m):	0.057	0.060
				Gradient Magnitude (m/m):	2.54E-05	2.04E-05
				Direction (azimuth):	213	196
				R^2:	0.63	0.61
				p-Value:	0.0040	0.0056
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	NM	NM	TOPP	0.013	NM	NM
299-E28-17	4/18/2012 10:30	94.940	TOPP	0.010	121.790	121.790
299-E28-18	NM	NM	TOPP	0.010	NM	NM
299-E28-27	4/18/2012 10:40	86.701	TOPP	0.005	121.804	121.803
299-E32-5	4/18/2012 9:52	87.220	TOPP	0.005	121.811	121.811
299-E32-6	4/18/2012 9:58	82.670	TOPP	0.005	121.802	121.802
299-E32-8	4/18/2012 10:06	76.030	TOPP	0.005	121.810	121.810
299-E33-28	4/18/2012 10:44	81.760	TOPP	0.013	121.807	121.807
299-E33-339	4/18/2012 10:17	81.240	TOPP	0.005	121.800	121.799
299-E33-34	4/18/2012 10:11	72.345	TOPP	0.005	121.807	121.806
299-E33-38	4/18/2012 7:56	71.901	TOPP	0.005	121.806	121.805
699-49-55A	4/18/2012 9:38	41.075	TOC	0.000	121.800	121.800
699-49-57A	4/18/2012 9:43	47.920	TOPP	0.010	121.813	121.812
699-50-56	4/18/2012 9:33	47.230	TOC	0.000	121.837	121.835
				Range (m):	0.047	0.045
				Gradient Magnitude (m/m):	1.52E-05	1.43E-05
				Direction (azimuth):	176	172
				R^2:	0.80	0.79
				p-Value:	0.0018	0.0020
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	5/15/2012 10:20	88.065	TOPP	0.013	121.805	121.801
299-E28-17	5/15/2012 10:07	95.028	TOT	0.100	121.792	121.793
299-E28-18	5/15/2012 8:49	90.323	TOPP	0.010	121.803	121.803
299-E28-27	5/15/2012 9:23	86.698	TOPP	0.005	121.807	121.806
299-E32-5	5/15/2012 9:08	87.222	TOPP	0.005	121.809	121.809
299-E32-6	5/15/2012 9:13	82.667	TOPP	0.005	121.805	121.803
299-E32-8	5/15/2012 9:37	76.028	TOPP	0.005	121.812	121.810
299-E33-28	5/15/2012 9:44	81.765	TOPP	0.013	121.802	121.801
299-E33-339	5/15/2012 9:54	81.237	TOPP	0.005	121.803	121.802
299-E33-34	5/15/2012 9:30	72.345	TOPP	0.005	121.807	121.804
299-E33-38	NM	NM	TOPP	0.005	NM	NM
699-49-55A	5/15/2012 12:18	41.044	TOC	0.000	121.831	121.824
699-49-57A	5/15/2012 12:25	47.912	TOPP	0.010	121.821	121.817
699-50-56	5/15/2012 12:30	47.224	TOC	0.000	121.843	121.839
				Range (m):	0.051	0.046
				Gradient Magnitude (m/m):	1.93E-05	1.57E-05
				Direction (azimuth):	194	188
				R^2:	0.84	0.80
				p-Value:	0.0001	0.0003
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	6/14/2012 8:27	88.085	TOPP	0.013	121.785	121.792
299-E28-17	6/14/2012 8:06	94.951	TOPP	0.010	121.779	121.779
299-E28-18	6/14/2012 8:14	90.332	TOPP	0.010	121.794	121.794
299-E28-27	6/14/2012 8:44	86.715	TOPP	0.005	121.790	121.790
299-E32-5	6/14/2012 7:54	87.243	TOPP	0.005	121.788	121.788
299-E32-6	6/14/2012 7:47	82.682	TOPP	0.005	121.790	121.790
299-E32-8	6/14/2012 7:42	76.045	TOPP	0.005	121.795	121.796
299-E33-28	6/14/2012 8:52	81.775	TOPP	0.013	121.792	121.792
299-E33-339	6/14/2012 8:35	81.246	TOPP	0.005	121.794	121.795
299-E33-34	6/14/2012 7:38	72.361	TOPP	0.005	121.791	121.793
299-E33-38	6/14/2012 7:31	71.912	TOPP	0.005	121.795	121.796
699-49-55A	6/14/2012 9:11	41.062	TOC	0.000	121.813	121.816
699-49-57A	6/14/2012 9:03	47.924	TOPP	0.010	121.809	121.810
699-50-56	6/14/2012 9:15	47.235	TOC	0.000	121.832	121.830
				Range (m):	0.053	0.051
				Gradient Magnitude (m/m):	1.92E-05	2.04E-05
				Direction (azimuth):	193	200
				R^2:	0.81	0.82
				p-Value:	0.0001	0.0001
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	7/24/2012 8:55	88.079	TOPP	0.013	121.791	121.789
299-E28-17	7/24/2012 8:39	94.956	TOPP	0.010	121.774	121.773
299-E28-18	7/24/2012 8:30	90.333	TOPP	0.010	121.793	121.793
299-E28-27	7/24/2012 9:10	86.708	TOPP	0.005	121.797	121.797
299-E32-5	7/24/2012 9:30	87.227	TOPP	0.005	121.804	121.804
299-E32-6	7/24/2012 9:40	82.670	TOPP	0.005	121.802	121.802
299-E32-8	7/24/2012 10:00	76.028	TOPP	0.005	121.812	121.812
299-E33-28	7/24/2012 9:16	81.768	TOPP	0.013	121.799	121.799
299-E33-339	7/24/2012 9:02	81.243	TOPP	0.005	121.797	121.797
299-E33-34	7/24/2012 11:56	73.354	TOPP	0.005	120.798	120.795
299-E33-38	7/24/2012 12:07	71.909	TOPP	0.005	121.798	121.798
699-49-55A	7/24/2012 12:47	41.048	TOC	0.000	121.827	121.827
699-49-57A	7/24/2012 12:53	47.906	TOPP	0.010	121.827	121.825
699-50-56	7/24/2012 12:41	47.196	TOC	0.000	121.871	121.867
				Range (m):	1.073	0.094
				Gradient Magnitude (m/m):	3.05E-05	2.96E-05
				Direction (azimuth):	178	177
				R^2:	0.86	0.88
				p-Value:	0.0001	0.0000
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	8/16/2012 7:50	88.089	TOPP	0.013	121.781	121.795
299-E28-17	8/16/2012 7:21	94.957	TOPP	0.010	121.773	121.774
299-E28-18	8/16/2012 7:30	90.321	TOPP	0.010	121.805	121.805
299-E28-27	8/16/2012 9:33	86.705	TOPP	0.005	121.800	121.800
299-E32-5	8/16/2012 8:56	87.222	TOPP	0.005	121.809	121.809
299-E32-6	8/16/2012 9:04	82.622	TOPP	0.005	121.850	121.851
299-E32-8	8/16/2012 9:12	76.022	TOPP	0.005	121.818	121.820
299-E33-28	8/16/2012 9:45	81.765	TOPP	0.013	121.802	121.803
299-E33-339	8/16/2012 8:00	81.243	TOPP	0.005	121.797	121.799
299-E33-34	8/16/2012 9:20	72.345	TOPP	0.005	121.807	121.809
299-E33-38	8/16/2012 8:18	71.907	TOPP	0.005	121.800	121.802
699-49-55A	8/16/2012 7:01	41.045	TOC	0.000	121.830	121.834
699-49-57A	8/16/2012 6:42	47.904	TOPP	0.010	121.829	121.833
699-50-56	8/16/2012 6:52	47.182	TOC	0.000	121.885	121.887
				Range (m):	0.112	0.113
				Gradient Magnitude (m/m):	3.39E-05	3.24E-05
				Direction (azimuth):	142	151
				R^2:	0.76	0.75
				p-Value:	0.0003	0.0005
				Statistically Significant?:	Yes	Yes

Low-Level Waste Management Area 1

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E28-1	9/12/2012 8:52	88.008	TOPP	0.013	121.862	121.887
299-E28-17	9/12/2012 9:02	94.952	TOPP	0.010	121.778	121.779
299-E28-18	9/12/2012 9:10	90.299	TOPP	0.010	121.827	121.827
299-E28-27	9/12/2012 8:36	86.696	TOPP	0.005	121.809	121.811
299-E32-5	NM	NM	TOPP	0.005	NM	NM
299-E32-6	9/12/2012 8:08	82.646	TOPP	0.005	121.826	121.828
299-E32-8	9/12/2012 8:00	76.015	TOPP	0.005	121.825	121.829
299-E33-28	9/12/2012 8:24	81.742	TOPP	0.013	121.825	121.827
299-E33-339	9/12/2012 8:42	81.233	TOPP	0.005	121.807	121.811
299-E33-34	9/12/2012 7:55	72.337	TOPP	0.005	121.815	121.822
299-E33-38	9/12/2012 7:43	71.895	TOPP	0.005	121.812	121.816
699-49-55A	9/12/2012 9:25	41.004	TOC	0.000	121.871	121.882
699-49-57A	9/12/2012 9:33	47.884	TOPP	0.010	121.849	121.857
699-50-56	9/12/2012 9:42	47.148	TOC	0.000	121.919	121.918
				Range (m):	0.141	0.139
				Gradient Magnitude (m/m):	4.23E-05	4.47E-05
				Direction (azimuth):	170	174
				R^2:	0.75	0.80
				p-Value:	0.0018	0.0007
				Statistically Significant?:	Yes	Yes

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Water-Level Measurements and Trend-Surface Analysis Results for IDF/PUREX Cribs

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	6/16/2008 9:13	98.831	TOPP	0.003	121.956	121.958	-0.0145	-0.0121						
299-E17-21	6/16/2008 8:38	103.439	TOC	0.000	121.987	121.988	-0.0001	-0.0013	-0.0015	-0.0021				
299-E17-22	6/16/2008 9:25	99.512	TOPP	0.007	121.976	121.978	0.0017	0.0038	0.0022	0.0012				
299-E17-23	6/16/2008 9:00	102.724	TOPP	0.005	121.976	121.979	-0.0005	-0.0006	-0.0023	-0.0024				
299-E17-25	6/16/2008 8:48	104.176	TOPP	0.006	121.983	121.985	0.0029	0.0023	0.0011	0.0009				
299-E24-16	6/16/2008 9:35	98.062	TOPP	0.016	121.992	121.993	0.0200							
299-E24-18	6/16/2008 10:50	98.408	TOPP	0.005	121.967	121.968	-0.0105	-0.0073	-0.0081					
299-E24-21	6/16/2008 11:07	96.693	?	0.004	121.974	121.975	-0.0030	0.0014	0.0008	-0.0017				
299-E24-24	6/16/2008 10:27	99.299	TOC	0.000	121.989	121.989	0.0035	0.0055	0.0059	0.0038				
299-E25-36	6/16/2008 10:10	94.780	TOPP	0.004	121.963	121.964	-0.0030	0.0025	0.0000	-0.0018				
699-37-47A	6/16/2008 9:53	97.529	TOPP	0.004	121.970	121.970	0.0035	0.0057	0.0020	0.0022				
				Range (m):	0.036	0.035			0.025					
				Gradient Magnitude (m/m):			1.51E-05	1.91E-05	**1.75E-05**	1.67E-05				
				Direction (azimuth):			80	65	**58**	67				
				R^2:			0.38	0.70	**0.81**	0.93				
				p-Value:			0.1456	0.0151	**0.0064**	0.0012				
				Statistically Significant?:			No	Yes	**Yes**	Yes				

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	8/1/2008 8:03	98.846	TOPP	0.003	121.941	121.943	-0.0134	-0.0099	-0.0082	-0.0070				
299-E17-21	8/1/2008 7:30	103.468	TOC	0.000	121.958	121.963	-0.0016	-0.0033	0.0025	0.0036				
299-E17-22	8/1/2008 8:12	99.534	TOPP	0.007	121.954	121.964	0.0035	0.0066	0.0085					
299-E17-23	8/1/2008 7:40	102.762	TOPP	0.005	121.938	121.951	-0.0062	-0.0063	-0.0015	-0.0003				
299-E17-25	8/1/2008 7:21	104.189	TOPP	0.006	121.970	121.975	0.0157	0.0150						
299-E24-16	8/1/2008 8:37	98.068	TOPP	0.016	121.986	121.991	0.0287							
299-E24-18	8/1/2008 8:52	98.422	TOPP	0.005	121.953	121.954	-0.0126	-0.0081	-0.0077	-0.0068				
299-E24-21	8/1/2008 8:47	96.698	TOPP	0.004	121.969	121.971	0.0010	0.0073	0.0060	0.0068				
299-E24-24	8/1/2008 9:08	99.331	TOPP	0.006	121.963	121.965	-0.0068	-0.0039	-0.0024	-0.0015				
299-E25-36	8/1/2008 8:24	94.793	TOPP	0.004	121.950	121.954	-0.0053	0.0025	0.0003	0.0014				
699-37-47A	8/1/2008 7:51	97.564	TOPP	0.004	121.935	121.945	-0.0030	0.0002	0.0025	0.0039				
				Range (m):	0.051	0.048			0.028					
				Gradient Magnitude (m/m):			1.83E-05	1.62E-05	**1.85E-05**	1.90E-05				
				Direction (azimuth):			141	114	**138**	138				
				R^2:			0.23	0.46	**0.65**	0.74				
				p-Value:			0.3578	0.1132	**0.0411**	0.0334				
				Statistically Significant?:			No	No	**Yes**	Yes				

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	8/29/2008 9:03	98.848	TOPP	0.003	121.939	121.941	-0.0116	-0.0084	-0.0090					
299-E17-21	8/29/2008 7:36	103.446	TOC	0.000	121.980	121.979	0.0081	0.0065	0.0058					
299-E17-22	8/29/2008 9:10	99.525	TOPP	0.007	121.963	121.957	-0.0001	0.0027	0.0017					
299-E17-23	8/29/2008 8:03	102.735	TOPP	0.005	121.965	121.962	0.0012	0.0011	0.0010					
299-E17-25	8/29/2008 7:48	104.197	TOPP	0.006	121.962	121.962	-0.0019	-0.0026	-0.0028					
299-E24-16	8/29/2008 8:55	98.072	TOPP	0.016	121.982	121.980	0.0268							
299-E24-18	8/29/2008 8:39	98.431	TOPP	0.005	121.944	121.946	-0.0137	-0.0094						
299-E24-21	8/29/2008 8:30	96.712	TOPP	0.004	121.955	121.957	-0.0022	0.0037	0.0008					
299-E24-24	8/29/2008 9:25	99.331	TOPP	0.006	121.963	121.964	-0.0039	-0.0012	-0.0036					
299-E25-36	8/29/2008 8:21	94.797	TOPP	0.004	121.946	121.945	-0.0012	0.0062	0.0043					
699-37-47A	8/29/2008 8:13	97.553	TOPP	0.004	121.946	121.944	-0.0015	0.0014	0.0018					
				Range (m):	0.043	0.039		0.038						
				Gradient Magnitude (m/m):			1.78E-05	**2.31E-05**	2.25E-05					
				Direction (azimuth):			80	**63**	72					
				R^2:			0.37	**0.78**	0.86					
				p-Value:			0.1597	**0.0047**	0.0028					
				Statistically Significant?:			No	**Yes**	Yes					

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	9/10/2008 9:27	98.843	TOPP	0.003	121.944	121.937	-0.0167	-0.0131						
299-E17-21	9/10/2008 9:01	103.278	TOC	0.000	122.147	122.154	0.1148							
299-E17-22	9/10/2008 9:25	99.535	TOPP	0.007	121.953	121.966	-0.0031	0.0129	0.0113					
299-E17-23	9/10/2008 9:18	102.760	TOPP	0.005	121.940	121.952	-0.0478	-0.0032	-0.0051	-0.0033	-0.0038	-0.0037	-0.0041	-0.0006
299-E17-25	9/10/2008 9:11	104.195	TOPP	0.006	121.964	121.963	-0.0495	0.0057	0.0042	0.0061	0.0054	0.0053	0.0050	
299-E24-16	9/10/2008 9:46	98.100	TOPP	0.016	121.955	121.959	0.0179	0.0083	0.0067	0.0080	0.0065			
299-E24-18	9/10/2008 10:34	98.421	TOPP	0.005	121.954	121.946	-0.0214	-0.0090	-0.0096	-0.0084				
299-E24-21	9/10/2008 10:50	96.702	TOPP	0.004	121.965	121.960	0.0048	0.0052	0.0050	0.0059	0.0036	0.0055		
299-E24-24	9/10/2008 10:22	99.336	TOPP	0.006	121.958	121.955	-0.0466	-0.0053	-0.0049	-0.0037	-0.0061	-0.0052	-0.0014	0.0004
299-E25-36	9/10/2008 10:07	94.803	TOPP	0.004	121.940	121.944	0.0365	-0.0022	-0.0044	-0.0033	-0.0046	-0.0021	0.0012	-0.0004
699-37-47A	9/10/2008 9:58	97.560	TOPP	0.004	121.939	121.946	0.0111	0.0007	-0.0031	-0.0013	-0.0010	0.0002	-0.0008	0.0005
				Range (m):	0.208	0.217								
				Gradient Magnitude (m/m):			9.18E-05	1.15E-05	9.67E-06	9.37E-06	1.02E-05	1.15E-05	1.32E-05	8.75E-06
				Direction (azimuth):			52	84	71	78	90	79	52	67
				R^2:			0.40	0.26	0.25	0.34	0.50	0.64	0.80	0.99
				p-Value:			0.1317	0.3549	0.4253	0.3550	0.2548	0.2194	0.2015	0.1086
				Statistically Significant?:			No	No	No	No	No	No	No	No

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	10/23/2008 13:58	98.848	TOPP	0.003	121.939	121.947	-0.0233	-0.0102	-0.0075	-0.0082				
299-E17-21	10/23/2008 13:10	103.443	TOC	0.000	121.983	121.983	-0.0195	0.0065	0.0051	0.0044				
299-E17-22	10/23/2008 13:38	99.526	TOPP	0.007	121.962	121.962	-0.0103	0.0009	0.0033	0.0022				
299-E17-23	10/23/2008 14:05	102.625	TOPP	0.005	122.074	122.079	0.0860							
299-E17-25	10/23/2008 13:05	104.195	TOPP	0.006	121.964	121.970	-0.0266	0.0000	-0.0006	-0.0008				
299-E24-16	10/23/2008 13:47	98.079	TOPP	0.016	121.975	121.978	0.0229	0.0224						
299-E24-18	10/23/2008 13:22	98.433	TOPP	0.005	121.942	121.949	-0.0135	-0.0129	-0.0093					
299-E24-21	10/23/2008 13:32	96.714	TOPP	0.004	121.953	121.958	0.0068	-0.0019	0.0030	0.0001				
299-E24-24	10/23/2008 13:25	99.333	TOPP	0.006	121.961	121.967	-0.0056	-0.0030	-0.0007	-0.0031				
299-E25-36	10/23/2008 14:17	94.796	TOPP	0.004	121.947	121.948	0.0059	-0.0001	0.0061	0.0042				
699-37-47A	10/23/2008 14:12	97.553	TOPP	0.004	121.946	121.950	-0.0228	-0.0017	0.0007	0.0011				
				Range (m):	0.135	0.132			0.036					
				Gradient Magnitude (m/m):			5.43E-05	1.95E-05	**2.51E-05**	2.39E-05				
				Direction (azimuth):			22	61	**52**	59				
				R^2:			0.26	0.46	**0.81**	0.89				
				p-Value:			0.2992	0.1175	**0.0065**	0.0040				
				Statistically Significant?:			No	No	**Yes**	Yes				

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	11/26/2008 10:25	98.845	TOPP	0.003	121.942	121.937	-0.0106	-0.0068	-0.0055					
299-E17-21	11/26/2008 8:56	103.474	TOC	0.000	121.952	121.955	-0.0004	-0.0023	0.0023	0.0020	-0.0010	-0.0017	-0.0008	
299-E17-22	11/26/2008 10:32	99.544	TOPP	0.007	121.944	121.951	0.0004	0.0038	0.0053	0.0045	0.0031	0.0037		
299-E17-23	11/26/2008 9:24	102.769	TOPP	0.005	121.931	121.941	-0.0087	-0.0089	-0.0051	-0.0060				
299-E17-25	11/26/2008 9:08	104.195	TOPP	0.006	121.964	121.964	0.0126	0.0118						
299-E24-16	11/26/2008 10:15	98.076	TOPP	0.016	121.978	121.982	0.0314							
299-E24-18	11/26/2008 9:48	98.426	TOPP	0.005	121.949	121.946	-0.0081	-0.0031	-0.0028	-0.0032	-0.0034	-0.0014	-0.0008	
299-E24-21	11/26/2008 9:55	96.711	TOPP	0.004	121.956	121.954	-0.0016	0.0053	0.0043	0.0041	0.0049			
299-E24-24	11/26/2008 8:44	99.341	TOPP	0.006	121.953	121.953	-0.0053	-0.0021	-0.0009	-0.0008	-0.0012	0.0009	0.0015	
299-E25-36	11/26/2008 10:50	94.806	TOPP	0.004	121.937	121.938	-0.0097	-0.0011	-0.0028	-0.0039	-0.0034	-0.0012	-0.0006	
699-37-47A	11/26/2008 11:03	97.562	TOPP	0.004	121.937	121.942	-0.0001	0.0034	0.0052	0.0034	0.0010	-0.0003	0.0007	
				Range (m):	0.047	0.045						0.017		
				Gradient Magnitude (m/m):			1.11E-05	1.31E-05	1.15E-05	1.03E-05	1.05E-05	**1.20E-05**	1.19E-05	
				Direction (azimuth):			124	80	108	105	80	**55**	58	
				R^2:			0.12	0.50	0.63	0.62	0.77	**0.91**	0.98	
				p-Value:			0.6009	0.0861	0.0524	0.0864	0.0548	**0.0283**	0.0208	
				Statistically Significant?:			No	No	No	No	No	**Yes**	Yes	

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	12/22/2008 12:31	98.870	TOPP	0.003	121.917	121.929	-0.0106	-0.0069	-0.0046	-0.0054	-0.00394			
299-E17-21	12/22/2008 12:54	103.488	TOC	0.000	121.938	121.946	-0.0106	-0.0124	-0.0046	-0.0054	-0.0022	-0.0028		
299-E17-22	12/22/2008 12:36	99.552	TOPP	0.007	121.936	121.940	-0.0036	-0.0003	0.0022	0.0009	0.0022	0.0014		
299-E17-23	12/22/2008 12:43	102.762	TOPP	0.005	121.938	121.948	0.0006	0.0004	0.0068	0.0067				
299-E17-25	12/22/2008 12:50	104.199	TOPP	0.006	121.960	121.971	0.0208	0.0200						
299-E24-16	12/22/2008 12:21	98.091	TOPP	0.016	121.963	121.970	0.0303							
299-E24-18	12/22/2008 12:05	98.456	TOPP	0.005	121.919	121.930	-0.0156	-0.0107	-0.0103					
299-E24-21	12/22/2008 12:08	96.736	TOPP	0.004	121.931	121.942	-0.0028	0.0038	0.0021	-0.0010	-0.0019	-0.0021		
299-E24-24	12/22/2008 12:00	99.350	TOPP	0.006	121.944	121.954	0.0009	0.0040	0.0061	0.0034	0.00386	0.0038		
299-E25-36	12/22/2008 13:21	94.816	TOPP	0.004	121.927	121.930	-0.0031	0.0052	0.0023	0.0003	-0.0006	-0.0014		
699-37-47A	12/22/2008 13:26	97.579	TOPP	0.004	121.920	121.927	-0.0064	-0.0031	0.0000	0.0005	0.0026	0.0011		
				Range (m):	0.046	0.044					0.027			
				Gradient Magnitude (m/m):			1.65E-05	2.31E-05	1.65E-05	1.72E-05	**1.74E-05**	1.64E-05		
				Direction (azimuth):			75	58	81	93	**108**	106		
				R^2:			0.23	0.54	0.68	0.83	**0.92**	0.94		
				p-Value:			0.3532	0.0638	0.0330	0.0118	**0.0072**	0.0157		
				Statistically Significant?:			No	No	Yes	Yes	**Yes**	Yes		

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	1/26/2009 10:27	98.869	TOPP	0.003	121.918	121.911	-0.0109	-0.0116						
299-E17-21	1/26/2009 9:29	103.494	TOC	0.000	121.933	121.937	0.0043	0.0033	0.0030	-0.0005	-0.0008	0.0000	-0.0019	
299-E17-22	1/26/2009 10:21	99.566	TOPP	0.007	121.922	121.934	0.0091	0.0078	0.0064	0.0047	0.0059			
299-E17-23	1/26/2009 9:41	102.794	TOPP	0.005	121.906	121.917	-0.0093	-0.0094	-0.0110					
299-E17-25	1/26/2009 9:34	104.222	TOPP	0.006	121.937	121.935	0.0067	0.0064	0.0052	0.0015	0.0015	0.0025	0.0017	-0.0004
299-E24-16	1/26/2009 10:14	98.123	TOPP	0.016	121.932	121.935	0.0119	0.0098	0.0083	0.0082				
299-E24-18	1/26/2009 9:54	98.455	TOPP	0.005	121.920	121.914	-0.0132							
299-E24-21	1/26/2009 9:59	96.733	TOPP	0.004	121.934	121.931	0.0036	0.0001	-0.0002	0.0009	0.0031	0.0039	0.0012	0.0005
299-E24-24	1/26/2009 10:06	99.362	TOPP	0.006	121.932	121.929	-0.0032	-0.0063	-0.0060	-0.0063	-0.0052	-0.0045		
299-E25-36	1/26/2009 10:34	94.827	TOPP	0.004	121.916	121.918	-0.0010	-0.0030	-0.0051	-0.0047	-0.0019	-0.0008	-0.0014	-0.0006
699-37-47A	1/26/2009 10:39	97.586	TOPP	0.004	121.913	121.919	0.0020	0.0028	-0.0005	-0.0038	-0.0026	-0.0012	0.0003	0.0005
				Range (m):	0.031	0.026								
				Gradient Magnitude (m/m):			1.09E-05	1.29E-05	1.05E-05	1.05E-05	1.23E-05	1.25E-05	1.41E-05	1.64E-05
				Direction (azimuth):			93	110	107	76	66	68	81	78
				R^2:			0.26	0.39	0.37	0.56	0.76	0.86	0.97	1.00
				p-Value:			0.2977	0.1803	0.2468	0.1297	0.0588	0.0506	0.0309	0.0692
				Statistically Significant?:			No	No	No	No	No	No	Yes	No

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	2/5/2009 9:41	98.885	TOPP	0.003	121.902	121.912	-0.0121	-0.0088	-0.0057	-0.0043	-0.0039			
299-E17-21	2/5/2009 9:18	103.482	TOC	0.000	121.944	121.947	0.0040	0.0023	-0.0014	-0.0027	-0.0013			
299-E17-22	2/5/2009 9:47	99.562	TOPP	0.007	121.926	121.921	-0.0078	-0.0049	-0.0028	-0.0009	0.0006			
299-E17-23	2/5/2009 9:32	102.762	TOPP	0.005	121.938	121.937	0.0045	0.0044	0.0035	0.0021	0.0018			
299-E17-25	2/5/2009 9:26	104.225	TOPP	0.006	121.934	121.940	0.0043	0.0036	0.0017	0.0003	0.0004			
299-E24-16	2/5/2009 9:58	98.105	TOPP	0.016	121.950	121.952	0.0271							
299-E24-18	2/5/2009 8:59	98.466	TOPP	0.005	121.909	121.918	-0.0136	-0.0093	-0.0065	-0.0022	0.0014			
299-E24-21	2/5/2009 9:05	96.747	TOPP	0.004	121.920	121.928	-0.0032	0.0028	0.0070					
299-E24-24	2/5/2009 8:50	99.362	TOPP	0.006	121.932	121.938	-0.0021	0.0006	0.0009	0.0047				
299-E25-36	2/5/2009 10:13	94.824	TOPP	0.004	121.919	121.920	0.0025	0.0099						
699-37-47A	2/5/2009 10:06	97.585	TOPP	0.004	121.914	121.913	-0.0036	-0.0006	0.0033	0.0031	0.0010			
				Range (m):	0.048	0.040				0.035				
				Gradient Magnitude (m/m):			1.84E-05	2.37E-05	3.14E-05	**3.75E-05**	4.03E-05			
				Direction (azimuth):			81	65	58	**47**	38			
				R^2:			0.37	0.76	0.88	**0.95**	0.98			
				p-Value:			0.1590	0.0069	0.0018	**0.0006**	0.0004			
				Statistically Significant?:			No	Yes	Yes	**Yes**	Yes			

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	3/24/2009 12:21	98.889	TOPP	0.003	121.898	121.893	-0.0139	-0.0110						
299-E17-21	3/24/2009 12:55	103.500	TOC	0.000	121.927	121.922	-0.0015	-0.0029	-0.0031	-0.0038	-0.0032			
299-E17-22	3/24/2009 12:35	99.562	TOPP	0.007	121.926	121.916	0.0054	0.0080	0.0065	0.0052				
299-E17-23	3/24/2009 12:15	102.774	TOPP	0.005	121.926	121.918	0.0032	0.0031	0.0015	0.0014	0.0021			
299-E17-25	3/24/2009 12:09	104.231	TOPP	0.006	121.929	121.923	0.0055	0.0049	0.0037	0.0035	0.0041			
299-E24-16	3/24/2009 12:28	98.119	TOPP	0.016	121.936	121.930	0.0236							
299-E24-18	3/24/2009 11:40	98.472	TOPP	0.005	121.903	121.899	-0.0130	-0.0092	-0.0100					
299-E24-21	3/24/2009 11:35	96.753	TOPP	0.004	121.914	121.909	-0.0019	0.0033	0.0028	-0.0003	0.0005			
299-E24-24	3/24/2009 11:20	99.373	TOPP	0.006	121.921	121.917	-0.0021	0.0002	0.0005	-0.0021	-0.0014			
299-E25-36	3/24/2009 12:50	94.842	TOPP	0.004	121.901	121.898	-0.0019	0.0045	0.0022	0.0000	0.0010			
699-37-47A	3/24/2009 12:43	97.591	TOPP	0.004	121.908	121.898	-0.0034	-0.0008	-0.0042	-0.0040	-0.0030			
				Range (m):	0.038	0.037				0.025				
				Gradient Magnitude (m/m):			1.62E-05	2.16E-05	2.05E-05	**1.91E-05**	1.94E-05			
				Direction (azimuth):			70	56	50	**59**	59			
				R^2:			0.34	0.70	0.77	**0.89**	0.94			
				p-Value:			0.1851	0.0144	0.0122	**0.0039**	0.0042			
				Statistically Significant?:			No	Yes	Yes	**Yes**	Yes			

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	6/29/2009 11:50	98.823	TOPP	0.003	121.964	121.964	-0.0145	-0.0131	-0.0106					
299-E17-21	6/29/2009 12:37	103.449	TOC	0.000	121.977	121.976	0.0019	-0.0076	-0.0082	-0.0083				
299-E17-22	6/29/2009 11:41	99.498	TOPP	0.007	121.990	121.984	0.0097	0.0066	0.0092	0.0078	0.0061	0.0041		
299-E17-23	6/29/2009 12:15	102.708	TOPP	0.005	121.992	121.987	0.0062	0.0052	0.0052	0.0037	-0.0001	-0.0011	-0.0002	
299-E17-25	6/29/2009 12:22	104.168	TOPP	0.006	121.991	121.990	0.0110	0.0075	0.0072	0.0062	0.0012	-0.0004	0.0006	
299-E24-16	6/29/2009 11:33	98.056	TOPP	0.016	121.998	121.995	0.0249	0.0212						
299-E24-18	6/29/2009 11:19	98.410	TOPP	0.005	121.965	121.964	-0.0024	-0.0112	-0.0071	-0.0077	-0.0097			
299-E24-21	6/29/2009 11:26	96.694	TOPP	0.004	121.973	121.972	0.0107	-0.0007	0.0048	0.0045	0.0032	-0.0017	-0.0006	
299-E24-24	6/29/2009 11:03	99.361	TOPP	0.006	121.933	121.933	-0.0293							
299-E25-36	6/29/2009 12:07	94.776	TOPP	0.004	121.967	121.966	-0.0054	-0.0051	0.0008	-0.0015	0.0018	0.0000	0.0007	
699-37-47A	6/29/2009 12:00	97.520	TOPP	0.004	121.979	121.975	-0.0128	-0.0028	-0.0012	-0.0046	-0.0026	-0.0009	-0.0005	
				Range (m):	0.065	0.062						0.024		
				Gradient Magnitude (m/m):			2.41E-05	1.16E-05	1.84E-05	1.90E-05	2.41E-05	**2.21E-05**	2.19E-05	
				Direction (azimuth):			337	20	18	10	24	**36**	35	
				R^2:			0.22	0.14	0.47	0.56	0.76	**0.95**	1.00	
				p-Value:			0.3611	0.5791	0.1529	0.1317	0.0581	**0.0108**	0.0035	
				Statistically Significant?:			No	No	No	No	No	**Yes**	Yes	

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	9/22/2009 7:50	98.870	TOPP	0.003	121.917	121.917	-0.0144	-0.0116	-0.0125					
299-E17-21	9/22/2009 7:58	103.468	TOC	0.000	121.958	121.954	0.0007	-0.0007	-0.0016	-0.0018	0.0012			
299-E17-22	9/22/2009 7:43	99.548	TOPP	0.007	121.940	121.940	0.0044	0.0069	0.0055	0.0037	0.0048			
299-E17-23	9/22/2009 8:09	102.757	TOPP	0.005	121.943	121.944	0.0011	0.0010	0.0009	-0.0008	0.0018			
299-E17-25	9/22/2009 8:05	104.202	TOPP	0.006	121.957	121.956	0.0098	0.0092	0.0089	0.0076				
299-E24-16	9/22/2009 7:33	98.103	TOPP	0.016	121.952	121.952	0.0232							
299-E24-18	9/22/2009 7:15	98.456	TOPP	0.005	121.919	121.920	-0.0158	-0.0121						
299-E24-21	9/22/2009 7:27	96.734	TOPP	0.004	121.933	121.932	-0.0010	0.0040	0.0004	-0.0004	-0.0010			
299-E24-24	9/22/2009 7:06	99.355	TOPP	0.006	121.939	121.940	-0.0047	-0.0024	-0.0055	-0.0054	-0.0046			
299-E25-36	9/22/2009 8:23	94.819	TOPP	0.004	121.924	121.923	0.0028	0.0091	0.0067	0.0039	0.0030			
699-37-47A	9/22/2009 8:14	97.581	TOPP	0.004	121.918	121.920	-0.0060	-0.0034	-0.0029	-0.0067	-0.0052			
				Range (m):	0.041	0.039				0.036				
				Gradient Magnitude (m/m):			2.28E-05	2.88E-05	2.70E-05	**2.56E-05**	2.25E-05			
				Direction (azimuth):			56	49	57	**52**	58			
				R^2:			0.45	0.71	0.78	**0.86**	0.90			
				p-Value:			0.0921	0.0124	0.0102	**0.0069**	0.0100			
				Statistically Significant?:			No	Yes	Yes	**Yes**	Yes			

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	12/30/2009 8:53	98.923	TOPP	0.003	121.864	121.872	-0.0102	-0.0080	-0.0088					
299-E17-21	12/30/2009 10:10	103.523	TOC	0.000	121.904	121.912	0.0040	0.0029	0.0021	0.0019				
299-E17-22	12/30/2009 9:13	99.611	TOPP	0.007	121.877	121.887	-0.0012	0.0007	-0.0005	-0.0018				
299-E17-23	12/30/2009 8:39	102.815	TOPP	0.005	121.885	121.898	0.0038	0.0037	0.0036	0.0024				
299-E17-25	12/30/2009 8:23	104.265	TOPP	0.006	121.895	121.903	0.0045	0.0040	0.0038	0.0029				
299-E24-16	12/30/2009 9:02	98.162	TOPP	0.016	121.893	121.900	0.0180							
299-E24-18	12/30/2009 9:33	98.505	TOPP	0.005	121.870	121.877	-0.0139	-0.0111						
299-E24-21	12/30/2009 9:26	96.783	TOPP	0.004	121.884	121.891	0.0014	0.0054	0.0020	0.0014				
299-E24-24	12/30/2009 9:56	99.405	TOPP	0.006	121.889	121.897	-0.0053	-0.0034	-0.0063	-0.0062				
299-E25-36	12/30/2009 11:12	94.871	TOPP	0.004	121.872	121.876	0.0040	0.0089	0.0067	0.0047				
699-37-47A	12/30/2009 10:25	97.643	TOPP	0.004	121.856	121.868	-0.0051	-0.0031	-0.0026	-0.0053				
				Range (m):	0.048	0.044			0.044					
				Gradient Magnitude (m/m):			2.51E-05	2.88E-05	**2.83E-05**	2.68E-05				
				Direction (azimuth):			74	66	**73**	71				
				R^2:			0.64	0.81	**0.88**	0.92				
				p-Value:			0.0175	0.0028	**0.0015**	0.0017				
				Statistically Significant?:			Yes	Yes	**Yes**	Yes				

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	3/16/2010 7:41	98.949	TOPP	0.003	121.838	121.841	-0.0192	-0.0156						
299-E17-21	3/16/2010 7:10	103.541	TOC	0.000	121.886	121.882	0.0057	0.0038	0.0036	0.0027	0.0021			
299-E17-22	3/16/2010 8:54	99.628	TOPP	0.007	121.860	121.858	-0.0055	-0.0023	-0.0044	-0.0059				
299-E17-23	3/16/2010 7:31	102.833	TOPP	0.005	121.867	121.865	-0.0034	-0.0035	-0.0057	-0.0059	-0.0067			
299-E17-25	3/16/2010 7:22	104.284	TOPP	0.006	121.876	121.877	0.0061	0.0053	0.0037	0.0034	0.0026			
299-E24-16	3/16/2010 7:53	98.166	TOPP	0.016	121.889	121.889	0.0301							
299-E24-18	3/16/2010 9:09	98.529	TOPP	0.005	121.846	121.848	-0.0161	-0.0113	-0.0124					
299-E24-21	3/16/2010 8:40	96.810	TOPP	0.004	121.857	121.860	-0.0025	0.0041	0.0035	-0.0004	-0.0012			
299-E24-24	3/16/2010 8:30	99.424	TOPP	0.006	121.870	121.872	0.0012	0.0042	0.0046	0.0014	0.0007			
299-E25-36	3/16/2010 8:16	94.889	TOPP	0.004	121.854	121.852	-0.0006	0.0077	0.0043	0.0017	0.0005			
699-37-47A	3/16/2010 8:06	97.638	TOPP	0.004	121.861	121.860	0.0042	0.0076	0.0027	0.0030	0.0019			
				Range (m):	0.051	0.048				0.030				
				Gradient Magnitude (m/m):			1.63E-05	2.39E-05	2.29E-05	**2.04E-05**	2.00E-05			
				Direction (azimuth):			61	48	40	**49**	49			
				R^2:			0.23	0.61	0.72	**0.86**	0.91			
				p-Value:			0.3470	0.0374	0.0230	**0.0071**	0.0086			
				Statistically Significant?:			No	Yes	Yes	**Yes**	Yes			

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	6/30/2010 8:55	98.937	TOPP	0.003	121.850	121.840	-0.0107	-0.0089	-0.0074	-0.0061	-0.0066			
299-E17-21	6/30/2010 10:01	103.568	TOC	0.000	121.859	121.860	-0.0025	-0.0034	-0.0024	0.0016	0.0010	0.0004	-0.0018	-0.0002
299-E17-22	6/30/2010 8:44	99.628	TOPP	0.007	121.860	121.864	0.0104	0.0120						
299-E17-23	6/30/2010 9:35	102.843	TOPP	0.005	121.857	121.856	0.0000	-0.0001	0.0013	0.0046	0.0044	0.0030	0.0025	
299-E17-25	6/30/2010 9:44	104.287	TOPP	0.006	121.873	121.867	0.0090	0.0086	0.0098					
299-E24-16	6/30/2010 8:35	98.188	TOPP	0.016	121.867	121.866	0.0150							
299-E24-18	6/30/2010 8:17	98.523	TOPP	0.005	121.852	121.845	-0.0102	-0.0078	-0.0066	-0.0062				
299-E24-21	6/30/2010 8:27	96.805	TOPP	0.004	121.862	121.857	0.0022	0.0054	0.0067	0.0060	0.0040	0.0034	0.0006	0.0005
299-E24-24	6/30/2010 7:57	99.436	TOPP	0.006	121.858	121.854	-0.0065	-0.0050	-0.0039	-0.0028	-0.0045	-0.0047		
299-E25-36	6/30/2010 9:25	94.899	TOPP	0.004	121.844	121.845	-0.0015	0.0026	0.0043	0.0030	0.0017	0.0000	-0.0005	-0.0006
699-37-47A	6/30/2010 9:04	97.659	TOPP	0.004	121.840	121.841	-0.0052	-0.0035	-0.0018	0.0000	0.0001	-0.0023	-0.0008	0.0003
				Range (m):	0.033	0.027								
				Gradient Magnitude (m/m):			1.15E-05	1.44E-05	1.48E-05	1.20E-05	1.25E-05	1.12E-05	1.40E-05	1.42E-05
				Direction (azimuth):			79	65	66	84	94	90	100	107
				R^2:			0.28	0.47	0.59	0.65	0.75	0.83	0.96	1.00
				p-Value:			0.2706	0.1107	0.0674	0.0724	0.0647	0.0725	0.0377	0.0546
				Statistically Significant?:			No	No	No	No	No	No	Yes	No

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	9/14/2010 8:43	98.967	TOPP	0.003	121.820	121.821	-0.0121	-0.0102						
299-E17-21	NM	NM	TOC	0.000	NM	NM								
299-E17-22	9/14/2010 10:16	99.656	TOPP	0.007	121.832	121.836	0.0009	0.0025	0.0011	-0.0002	0.0001			
299-E17-23	9/14/2010 9:05	102.865	TOPP	0.005	121.835	121.841	0.0025	0.0020	0.0005	0.0001	-0.0001			
299-E17-25	9/14/2010 9:12	104.319	TOPP	0.006	121.841	121.843	0.0029	0.0020	0.0009	0.0003	-0.0001			
299-E24-16	9/14/2010 10:09	98.210	TOPP	0.016	121.845	121.848	0.0160							
299-E24-18	9/14/2010 9:45	98.551	TOPP	0.005	121.824	121.824	-0.0112	-0.0088	-0.0095					
299-E24-21	9/14/2010 9:51	96.835	TOPP	0.004	121.832	121.833	-0.0010	0.0025	0.0021	-0.0009	-0.0002			
299-E24-24	9/14/2010 9:34	99.454	TOPP	0.006	121.840	121.841	0.0015	0.0028	0.0030	0.0003	0.0003			
299-E25-36	9/14/2010 8:56	94.916	TOPP	0.004	121.827	121.828	0.0001	0.0048	0.0027	0.0009				
699-37-47A	9/14/2010 10:25	97.673	TOPP	0.004	121.826	121.831	0.0005	0.0023	-0.0008	-0.0005	0.0001			
				Range (m):	0.025	0.027				0.015				
				Gradient Magnitude (m/m):			1.07E-05	1.56E-05	1.51E-05	**1.37E-05**	1.51E-05			
				Direction (azimuth):			57	47	38	**49**	48			
				R^2:			0.20	0.51	0.65	**0.99**	1.00			
				p-Value:			0.4497	0.1156	0.0723	**0.0001**	0.0000			
				Statistically Significant?:			No	No	No	**Yes**	Yes			

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	3/18/2011 8:47	98.975	TOPP	0.003	121.812	121.814	-0.0124	-0.0088						
299-E17-21	3/18/2011 8:06	103.575	TOC	0.000	121.852	121.848	0.0053	0.0045	0.0044					
299-E17-22	3/18/2011 8:36	99.656	TOPP	0.007	121.832	121.823	-0.0075	-0.0038	-0.0050					
299-E17-23	3/18/2011 8:24	102.861	TOPP	0.005	121.839	121.831	-0.0026	-0.0026	-0.0038					
299-E17-25	3/18/2011 8:11	104.319	TOPP	0.006	121.841	121.839	0.0026	0.0022	0.0013					
299-E24-16	3/18/2011 9:41	98.195	TOPP	0.016	121.860	121.858	0.0309							
299-E24-18	3/18/2011 9:52	98.555	TOPP	0.005	121.820	121.822	-0.0109	-0.0050	-0.0056					
299-E24-21	3/18/2011 10:13	96.839	TOPP	0.004	121.828	121.829	-0.0036	0.0045	0.0042					
299-E24-24	NM	NM	TOPP	0.006	NM	NM								
299-E25-36	3/18/2011 10:35	94.924	TOPP	0.004	121.819	121.816	-0.0049	0.0037	0.0018					
699-37-47A	3/18/2011 10:24	97.670	TOPP	0.004	121.829	121.823	0.0031	0.0054	0.0026					
				Range (m):	0.048	0.044		0.034						
				Gradient Magnitude (m/m):			1.58E-05	**2.15E-05**	2.05E-05					
				Direction (azimuth):			82	**57**	51					
				R^2:			0.24	**0.78**	0.84					
				p-Value:			0.3816	**0.0110**	0.0099					
				Statistically Significant?:			No	**Yes**	Yes					

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	6/20/2011 13:05	98.993	TOPP	0.003	121.794	121.790	-0.0111	-0.0092	-0.0098					
299-E17-21	6/20/2011 12:31	103.601	TOC	0.000	121.826	121.825	0.0027	0.0023	0.0006	0.0005				
299-E17-22	6/20/2011 13:41	99.673	TOPP	0.007	121.815	121.809	0.0021	0.0042	0.0026	0.0012				
299-E17-23	6/20/2011 12:42	102.888	TOPP	0.005	121.812	121.805	-0.0049	-0.0049	-0.0051	-0.0065				
299-E17-25	6/20/2011 12:37	104.336	TOPP	0.006	121.824	121.820	0.0063	0.0061	0.0055	0.0045				
299-E24-16	6/20/2011 13:11	98.231	TOPP	0.016	121.824	121.820	0.0168							
299-E24-18	6/20/2011 12:15	98.574	TOPP	0.005	121.801	121.798	-0.0129	-0.0097						
299-E24-21	6/20/2011 13:18	96.852	TOPP	0.004	121.815	121.811	-0.0002	0.0042	-0.0002	-0.0008				
299-E24-24	NM	NM	TOPP	0.006	NM	NM								
299-E25-36	6/20/2011 12:58	94.948	TOPP	0.004	121.795	121.795	0.0000	0.0046	0.0024	0.0002				
699-37-47A	6/20/2011 12:50	97.700	TOPP	0.004	121.799	121.793	0.0012	0.0025	0.0039	0.0008				
				Range (m):	0.032	0.035			0.035					
				Gradient Magnitude (m/m):			2.10E-05	2.28E-05	**2.43E-05**	2.23E-05				
				Direction (azimuth):			90	77	**89**	87				
				R^2:			0.53	0.74	**0.84**	0.92				
				p-Value:			0.0703	0.0171	**0.0102**	0.0060				
				Statistically Significant?:			No	Yes	**Yes**	Yes				

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	9/22/2011 7:43	99.004	TOPP	0.003	121.783	121.788	-0.0130	-0.0108						
299-E17-21	9/22/2011 7:11	103.606	TOC	0.000	121.821	121.822	0.0017	0.0011	0.0011	-0.0007	0.0000			
299-E17-22	9/22/2011 8:27	99.685	TOPP	0.007	121.803	121.808	0.0016	0.0038	0.0024	0.0006	0.0008			
299-E17-23	9/22/2011 7:25	102.895	TOPP	0.005	121.805	121.809	0.0002	0.0002	-0.0013	-0.0016	-0.0010			
299-E17-25	9/22/2011 7:19	104.348	TOPP	0.006	121.812	121.816	0.0037	0.0035	0.0024	0.0017				
299-E24-16	9/22/2011 7:50	98.237	TOPP	0.016	121.818	121.822	0.0186							
299-E24-18	9/22/2011 8:05	98.582	TOPP	0.005	121.793	121.797	-0.0137	-0.0101	-0.0107					
299-E24-21	9/22/2011 7:58	96.858	TOPP	0.004	121.809	121.812	0.0008	0.0056	0.0053	0.0004	0.0004			
299-E24-24	NM	NM	TOPP	0.006	NM	NM								
299-E25-36	9/22/2011 8:36	94.949	TOPP	0.004	121.794	121.795	-0.0010	0.0042	0.0019	-0.0007	-0.0009			
699-37-47A	9/22/2011 7:33	97.713	TOPP	0.004	121.786	121.793	0.0011	0.0025	-0.0010	0.0004	0.0006			
				Range (m):	0.038	0.034				0.029				
				Gradient Magnitude (m/m):			1.97E-05	2.14E-05	1.94E-05	**2.08E-05**	2.04E-05			
				Direction (azimuth):			95	78	74	**89**	92			
				R^2:			0.47	0.72	0.79	**0.99**	1.00			
				p-Value:			0.1112	0.0221	0.0200	**0.0001**	0.0003			
				Statistically Significant?:			No	Yes	Yes	**Yes**	Yes			

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	12/29/2011 8:20	98.986	TOPP	0.003	121.801	121.803	-0.0007	-0.0013	-0.0004					
299-E17-21	12/29/2011 9:02	103.613	TOC	0.000	121.814	121.827	0.0003	-0.0021	-0.0021					
299-E17-22	12/29/2011 8:14	99.691	TOPP	0.007	121.797	121.814	0.0040	0.0021	0.0032					
299-E17-23	12/29/2011 8:52	102.908	TOPP	0.005	121.792	121.815	0.0018	0.0016	0.0016					
299-E17-25	12/29/2011 8:46	104.347	TOPP	0.006	121.813	121.820	0.0027	0.0019	0.0019					
299-E24-16	12/29/2011 8:08	98.248	TOPP	0.016	121.807	121.816	0.0099	0.0070						
299-E24-18	12/29/2011 7:44	98.577	TOPP	0.005	121.798	121.800	-0.0146							
299-E24-21	12/29/2011 8:01	96.858	TOPP	0.004	121.809	121.815	0.0000	-0.0055	-0.0031					
299-E24-24	12/29/2011 8:36	98.490	TOPP	0.006	122.804	122.810	Outlier - Not Used							
299-E25-36	12/29/2011 9:10	94.951	TOPP	0.004	121.792	121.800	0.0028	0.0004	0.0027					
699-37-47A	12/29/2011 9:18	97.727	TOPP	0.004	121.772	121.787	-0.0064	-0.0041	-0.0038					
				Range (m):	1.032	1.023		0.040						
				Gradient Magnitude (m/m):			2.30E-05	**2.70E-05**	2.67E-05					
				Direction (azimuth):			91	**104**	98					
				R^2:			0.69	**0.90**	0.95					
				p-Value:			0.0157	**0.0009**	0.0004					
				Statistically Significant?:			Yes	**Yes**	Yes					

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	6/22/2012 9:48	99.037	TOPP	0.003	121.750	121.760	-0.0397	-0.0351	0.0134	0.0092	0.0097			
299-E17-21	6/22/2012 9:50	103.871	TOC	0.000	121.557	121.562	0.1478							
299-E17-22	6/22/2012 9:22	99.711	TOPP	0.007	121.777	121.780	-0.0444	-0.0238	-0.0018	-0.0048	-0.0037	-0.0011	0.0009	0.0010
299-E17-23	6/22/2012 9:35	102.927	TOPP	0.005	121.773	121.779	-0.0882	-0.0308	0.0021	0.0018	0.0020	0.0049		
299-E17-25	6/22/2012 9:40	104.377	TOPP	0.006	121.783	121.791	-0.0961	-0.0249	-0.0068	-0.0060	-0.0055	-0.0036	0.0002	-0.0005
299-E24-16	6/22/2012 9:11	98.262	TOPP	0.016	121.793	121.798	-0.0297	-0.0422	-0.0232					
299-E24-18	6/22/2012 8:51	98.617	TOPP	0.005	121.758	121.768	0.0086	0.0246	0.0134	0.0101				
299-E24-21	6/22/2012 8:48	96.899	TOPP	0.004	121.768	121.777	0.0307	0.0312	0.0044	-0.0001	0.0031	0.0029	0.0019	
299-E24-24	6/22/2012 8:39	99.509	TOPP	0.006	121.785	121.792	-0.0072	0.0459	-0.0023	-0.0029	0.0003	-0.0016	-0.0017	-0.0001
299-E25-36	6/22/2012 10:09	94.977	TOPP	0.004	121.766	121.767	0.0072	-0.0427	0.0009	-0.0074	-0.0059	-0.0016	-0.0012	-0.0004
699-37-47A	6/22/2012 10:13	97.936	TOPP	0.004	121.563	121.569	-0.1110	0.0976						
				Range (m):	0.236	0.236								
				Gradient Magnitude (m/m):			1.37E-04	1.17E-04	1.77E-05	2.44E-05	2.54E-05	2.08E-05	2.23E-05	2.17E-05
				Direction (azimuth):			171	123	87	75	84	73	58	67
				R^2:			0.25	0.51	0.25	0.66	0.77	0.88	0.98	1.00
				p-Value:			0.3104	0.0834	0.4177	0.0696	0.0518	0.0402	0.0194	0.0588
				Statistically Significant?:			No	No	No	No	No	Yes	Yes	No

Integrated Disposal Facility / PUREX Cribs

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)							
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration	6th Iteration	7th Iteration	8th Iteration
299-E17-18	9/12/2012 12:01	99.006	TOPP	0.003	121.781	121.770	0.0136	0.0116	0.0124					
299-E17-21	9/12/2012 11:42	103.620	TOC	0.000	121.807	121.804	0.0009	0.0019	0.0028	0.0030	0.0002	-0.0007		
299-E17-22	9/12/2012 12:12	99.692	TOPP	0.007	121.796	121.796	-0.0064	-0.0082	-0.0068	-0.0051	-0.0061			
299-E17-23	9/12/2012 11:55	102.905	TOPP	0.005	121.795	121.793	-0.0009	-0.0008	-0.0008	0.0010	-0.0014			
299-E17-25	9/12/2012 11:46	104.347	TOPP	0.006	121.813	121.805	-0.0090	-0.0086	-0.0084	-0.0071				
299-E24-16	9/12/2012 12:23	98.248	TOPP	0.016	121.807	121.803	-0.0167							
299-E24-18	9/12/2012 13:11	98.585	TOPP	0.005	121.790	121.780	0.0144	0.0117						
299-E24-21	9/12/2012 13:17	96.860	TOPP	0.004	121.807	121.798	-0.0029	-0.0066	-0.0030	-0.0022	-0.0017	-0.0026		
299-E24-24	9/12/2012 12:58	99.486	TOPP	0.006	121.808	121.800	0.0045	0.0028	0.0058	0.0057	0.0049	0.0041		
299-E25-36	9/12/2012 12:37	94.963	TOPP	0.004	121.780	121.779	-0.0009	-0.0054	-0.0031	-0.0003	0.0005	-0.0006		
699-37-47A	9/12/2012 12:45	97.724	TOPP	0.004	121.775	121.770	-0.0035	0.0016	0.0011	0.0049	0.0036	0.0023		
				Range (m):	0.038	0.035					0.034			
				Gradient Magnitude (m/m):			2.18E-05	2.38E-05	2.46E-05	2.21E-05	**2.15E-05**	2.18E-05		
				Direction (azimuth):			95	84	94	91	**101**	101		
				R^2:			0.54	0.70	0.79	0.86	**0.91**	0.96		
				p-Value:			0.0448	0.0154	0.0099	0.0070	**0.0076**	0.0082		
				Statistically Significant?:			Yes	Yes	Yes	Yes	**Yes**	Yes		

Water-Level Measurements and Trend-Surface Analysis Results for LLWMA-2

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	3/24/2009 10:34	72.577	TOPP	0.004	121.916	121.916	-0.0065				
299-E27-18	NM	NM	TOPP	0.005	NM	NM					
299-E27-8	3/24/2009 10:17	72.145	TOPP	0.012	123.378	123.380	Outlier - Not Used				
299-E27-9	3/24/2009 9:57	70.974	TOPP	0.012	121.919	121.924	0.0032	0.0001	-0.0002		
299-E33-14	3/24/2009 11:08	68.707	TOPP	0.005	121.920	121.922	-0.0008	-0.0005	-0.0006		
299-E33-37	3/24/2009 10:52	78.227	TOPP	0.004	121.927	121.927	0.0022	0.0005	-0.0001		
299-E34-10	3/24/2009 10:41	74.115	TOPP	0.004	121.923	121.924	0.0006	-0.0010			
299-E34-9	3/24/2009 11:03	70.756	TOPP	0.004	121.921	121.924	0.0014	0.0009	0.0008		
				Range (m):	1.462	1.464					
				Gradient Magnitude (m/m):			9.20E-06	1.32E-05	1.46E-05		
				Direction (azimuth):			41	23	24		
				R^2:			0.12	0.81	0.93		
				p-Value:			0.8189	0.1861	0.2711		
				Statistically Significant?:			No	No	No		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	4/30/2009 9:06	72.576	TOPP	0.004	121.917	121.920	-0.0101				
299-E27-18	NM	NM	TOPP	0.005	NM	NM					
299-E27-8	4/30/2009 8:54	73.598	TOPP	0.012	121.925	121.930	0.0001	-0.0027			
299-E27-9	4/30/2009 8:47	70.966	TOPP	0.012	121.927	121.934	0.0046	0.0019	-0.0001	0.0001	
299-E33-14	4/30/2009 9:36	68.704	TOPP	0.005	121.923	121.927	-0.0015	-0.0013	-0.0009	0.0001	
299-E33-37	4/30/2009 9:25	78.223	TOPP	0.004	121.931	121.934	0.0028	0.0006	0.0003	0.0002	
299-E34-10	4/30/2009 9:15	74.108	TOPP	0.004	121.930	121.932	0.0018	0.0000	-0.0007	-0.0004	
299-E34-9	4/30/2009 9:30	70.751	TOPP	0.004	121.926	121.931	0.0021	0.0015	0.0014		
				Range (m):	0.014	0.014					
				Gradient Magnitude (m/m):			8.89E-06	1.50E-05	1.62E-05	1.91E-05	
				Direction (azimuth):			24	16	8	9	
				R^2:			0.03	0.57	0.90	0.99	
				p-Value:			0.9331	0.2854	0.0973	0.0880	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	5/28/2009 10:59	72.553	TOPP	0.004	121.940	121.941	-0.0065				
299-E27-18	5/28/2009 11:23	77.308	TOPP	0.005	121.948	121.950	0.0014	0.0003	0.0003	0.0000	
299-E27-8	5/28/2009 10:47	73.577	TOPP	0.012	121.946	121.948	0.0004	-0.0012	-0.0011		
299-E27-9	5/28/2009 10:52	70.943	TOPP	0.012	121.950	121.949	0.0020	0.0003	0.0005	-0.0002	
299-E33-14	5/28/2009 11:29	68.685	TOPP	0.005	121.942	121.943	-0.0017	-0.0017	-0.0003	-0.0002	
299-E33-37	5/28/2009 11:18	78.206	TOPP	0.004	121.948	121.949	0.0003	-0.0005	-0.0005	-0.0005	
299-E34-10	5/28/2009 11:05	74.091	TOPP	0.004	121.947	121.949	0.0016	0.0007	0.0010	0.0008	
299-E34-9	5/28/2009 11:12	70.731	TOPP	0.004	121.946	121.948	0.0025	0.0021			
				Range (m):	0.010	0.009					
				Gradient Magnitude (m/m):			1.24E-05	1.38E-05	**1.80E-05**	1.78E-05	
				Direction (azimuth):			20	14	**14**	11	
				R^2:			0.19	0.70	**0.91**	0.97	
				p-Value:			0.5989	0.0906	**0.0272**	0.0325	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	6/29/2009 9:05	72.562	TOPP	0.004	121.931	121.932	-0.0391				
299-E27-18	6/29/2009 9:34	77.277	TOPP	0.005	121.979	121.980	0.0057	-0.0007	-0.0008	-0.0011	
299-E27-8	6/29/2009 8:47	73.548	TOPP	0.012	121.975	121.977	0.0078	-0.0019	-0.0017		
299-E27-9	6/29/2009 8:39	70.913	TOPP	0.012	121.980	121.979	0.0118	0.0012	0.0016	0.0004	
299-E33-14	6/29/2009 9:56	68.656	TOPP	0.005	121.971	121.971	-0.0023	-0.0024	-0.0002	0.0000	
299-E33-37	6/29/2009 9:47	78.172	TOPP	0.004	121.982	121.982	0.0057	0.0012	0.0012	0.0011	
299-E34-10	6/29/2009 9:23	74.061	TOPP	0.004	121.977	121.978	0.0047	-0.0005	0.0000	-0.0003	
299-E34-9	6/29/2009 10:02	70.700	TOPP	0.004	121.977	121.978	0.0057	0.0032			
				Range (m):	0.051	0.050					
				Gradient Magnitude (m/m):			1.72E-05	2.29E-05	**2.93E-05**	2.89E-05	
				Direction (azimuth):			49	19	**18**	15	
				R^2:			0.03	0.68	**0.89**	0.96	
				p-Value:			0.9249	0.1038	**0.0352**	0.0400	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	7/27/2009 8:27	72.526	TOPP	0.004	121.967	121.972	-0.0090				
299-E27-18	7/27/2009 8:03	77.274	TOPP	0.005	121.982	121.986	0.0029	0.0015	0.0009		
299-E27-8	7/27/2009 8:37	73.549	TOPP	0.012	121.974	121.980	-0.0009	-0.0031			
299-E27-9	7/27/2009 8:46	70.917	TOPP	0.012	121.976	121.984	0.0044	0.0019	-0.0003		
299-E33-14	7/27/2009 7:37	68.657	TOPP	0.005	121.970	121.975	-0.0009	-0.0009	-0.0005		
299-E33-37	7/27/2009 7:57	78.173	TOPP	0.004	121.981	121.984	0.0006	-0.0004	-0.0005		
299-E34-10	7/27/2009 8:09	74.059	TOPP	0.004	121.979	121.982	0.0011	-0.0001	-0.0006		
299-E34-9	7/27/2009 7:45	70.705	TOPP	0.004	121.972	121.979	0.0018	0.0012	0.0010		
				Range (m):	0.015	0.014					
				Gradient Magnitude (m/m):			2.34E-05	**2.52E-05**	2.51E-05		
				Direction (azimuth):			21	**16**	10		
				R^2:			0.29	**0.79**	0.97		
				p-Value:			0.4190	**0.0459**	0.0059		
				Statistically Significant?:			No	**Yes**	Yes		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	8/6/2009 11:09	72.509	TOPP	0.004	121.984	121.984	-0.0038				
299-E27-18	8/6/2009 12:12	77.265	TOPP	0.005	121.991	121.991	0.0015	0.0009	0.0005		
299-E27-8	8/6/2009 10:42	73.536	TOPP	0.012	121.987	121.987	-0.0008	-0.0018			
299-E27-9	8/6/2009 10:50	70.900	TOPP	0.012	121.993	121.989	0.0021	0.0011	-0.0002		
299-E33-14	8/6/2009 11:44	68.642	TOPP	0.005	121.985	121.983	-0.0007	-0.0007	-0.0005		
299-E33-37	8/6/2009 12:30	78.163	TOPP	0.004	121.991	121.990	0.0003	-0.0002	-0.0002		
299-E34-10	8/6/2009 11:21	74.050	TOPP	0.004	121.988	121.988	0.0002	-0.0003	-0.0006		
299-E34-9	8/6/2009 11:32	70.690	TOPP	0.004	121.987	121.986	0.0012	0.0010	0.0009		
				Range (m):	0.009	0.008					
				Gradient Magnitude (m/m):			1.88E-05	**1.96E-05**	1.94E-05		
				Direction (azimuth):			20	**18**	14		
				R^2:			0.56	**0.85**	0.96		
				p-Value:			0.1278	**0.0233**	0.0072		
				Statistically Significant?:			No	**Yes**	Yes		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	9/22/2009 9:24	72.553	TOPP	0.004	121.940	121.940	-0.0081				
299-E27-18	9/22/2009 9:39	77.305	TOPP	0.005	121.951	121.951	0.0020	0.0007	-0.0001	-0.0006	
299-E27-8	9/22/2009 9:20	73.576	TOPP	0.012	121.947	121.946	-0.0021	-0.0041			
299-E27-9	9/22/2009 9:15	70.943	TOPP	0.012	121.950	121.953	0.0054	0.0032	0.0003	0.0000	
299-E33-14	9/22/2009 9:47	68.682	TOPP	0.005	121.945	121.945	-0.0008	-0.0008	-0.0003	-0.0005	
299-E33-37	9/22/2009 9:34	78.203	TOPP	0.004	121.951	121.951	0.0020	0.0010	0.0010	0.0004	
299-E34-10	9/22/2009 9:29	74.089	TOPP	0.004	121.949	121.948	0.0000	-0.0011	-0.0018		
299-E34-9	9/22/2009 9:44	70.730	TOPP	0.004	121.947	121.948	0.0016	0.0011	0.0008	0.0006	
				Range (m):	0.011	0.013					
				Gradient Magnitude (m/m):			1.01E-05	1.19E-05	**1.23E-05**	1.32E-05	
				Direction (azimuth):			20	11	**355**	357	
				R^2:			0.08	0.38	**0.88**	0.97	
				p-Value:			0.8173	0.3889	**0.0412**	0.0277	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	10/29/2009 8:56	72.564	TOPP	0.004	121.929	121.926	-0.00328	-0.0016	-0.0013		
299-E27-18	10/29/2009 9:06	77.324	TOPP	0.005	121.932	121.930	0.0008	0.0006	0.0005	0.0003	0.0004
299-E27-8	10/29/2009 8:52	73.593	TOPP	0.012	121.930	121.927	-0.0026	0.0002	0.0005	-0.0003	-0.0001
299-E27-9	10/29/2009 8:39	70.955	TOPP	0.012	121.938	121.933	0.00329				
299-E33-14	10/29/2009 9:11	68.698	TOPP	0.005	121.929	121.926	-0.0014	-0.0017	0.0000	-0.0001	0.0000
299-E33-37	10/29/2009 9:03	78.222	TOPP	0.004	121.932	121.930	0.0011	-0.0003	-0.0005	-0.0004	-0.0003
299-E34-10	10/29/2009 8:59	74.108	TOPP	0.004	121.930	121.929	0.0002	0.0004	0.0008	0.0006	
299-E34-9	10/29/2009 9:15	70.744	TOPP	0.004	121.933	121.930	0.0020	0.0025			
				Range (m):	0.009	0.007					
				Gradient Magnitude (m/m):			3.77E-06	1.12E-05	1.66E-05	1.55E-05	1.54E-05
				Direction (azimuth):			355	39	32	30	30
				R^2:			0.11	0.42	0.83	0.95	0.98
				p-Value:			0.7526	0.3405	0.0681	0.0489	0.1430
				Statistically Significant?:			No	No	No	Yes	No

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	11/12/2009 10:07	72.584	TOPP	0.004	121.909	121.908	-0.0093				
299-E27-18	11/12/2009 9:50	77.335	TOPP	0.005	121.921	121.920	0.0014	-0.0002	0.0002	0.0002	0.0001
299-E27-8	11/12/2009 9:44	73.604	TOPP	0.012	121.919	121.918	0.0016	-0.0007	-0.0005	-0.0004	
299-E27-9	11/12/2009 9:39	70.975	TOPP	0.012	121.918	121.918	0.0024	-0.0001	0.0000	0.0003	0.0000
299-E33-14	11/12/2009 10:17	68.709	TOPP	0.005	121.918	121.917	-0.0014	-0.0014	-0.0012	0.0000	0.0000
299-E33-37	11/12/2009 9:56	78.233	TOPP	0.004	121.921	121.920	0.0005	-0.0006	-0.0002	-0.0001	-0.0001
299-E34-10	11/12/2009 10:01	74.115	TOPP	0.004	121.923	121.921	0.0027	0.00150			
299-E34-9	11/12/2009 10:12	70.756	TOPP	0.004	121.921	121.920	0.0021	0.00148	0.0017		
				Range (m):	0.014	0.013					
				Gradient Magnitude (m/m):			7.08E-06	8.05E-06	7.14E-06	1.03E-05	1.02E-05
				Direction (azimuth):			52	32	31	26	24
				R^2:			0.09	0.43	0.47	0.96	1.00
				p-Value:			0.7813	0.3293	0.3871	0.0419	0.0687
				Statistically Significant?:			No	No	No	Yes	No

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	1/4/2010 9:53	71.732	TOPP	0.004	122.761	122.755	Outlier - Not Used				
299-E27-18	1/4/2010 10:02	77.350	TOPP	0.005	121.906	121.903	0.0003	-0.0001	0.0003		
299-E27-8	1/4/2010 9:48	73.616	TOPP	0.012	121.907	121.900	-0.0021				
299-E27-9	1/4/2010 9:44	70.981	TOPP	0.012	121.912	121.903	0.0014	-0.0001	0.0001		
299-E33-14	1/4/2010 8:10	68.725	TOPP	0.005	121.902	121.898	0.0002	0.0005	0.0006		
299-E33-37	1/4/2010 9:58	78.249	TOPP	0.004	121.905	121.902	-0.0005	-0.0006	-0.0002		
299-E34-10	1/4/2010 10:09	74.132	TOPP	0.004	121.906	121.903	0.0017	0.0013			
299-E34-9	1/4/2010 10:13	70.774	TOPP	0.004	121.903	121.898	-0.0009	-0.0010	-0.0009		
				Range (m):	0.859	0.857					
				Gradient Magnitude (m/m):			1.38E-05	**1.38E-05**	1.30E-05		
				Direction (azimuth):			14	**7**	6		
				R^2:			0.67	**0.89**	0.95		
				p-Value:			0.1066	**0.0364**	0.0472		
				Statistically Significant?:			No	**Yes**	Yes		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	1/20/2010 12:32	72.602	TOPP	0.004	121.891	121.889	-0.0065				
299-E27-18	1/20/2010 12:47	77.359	TOPP	0.005	121.897	121.895	0.0009	-0.0001	-0.0008	-0.0004	
299-E27-8	1/20/2010 12:25	73.628	TOPP	0.012	121.895	121.894	-0.0021	-0.0037			
299-E27-9	1/20/2010 12:17	70.984	TOPP	0.012	121.909	121.901	0.0040	0.0023	-0.0003	0.0000	
299-E33-14	1/20/2010 13:12	68.727	TOPP	0.005	121.900	121.895	-0.0011	-0.0011	-0.0006	-0.0004	
299-E33-37	1/20/2010 12:53	78.257	TOPP	0.004	121.897	121.894	0.0006	-0.0002	-0.0002	0.0003	
299-E34-10	1/20/2010 12:40	74.140	TOPP	0.004	121.898	121.898	0.0031	0.0023	0.0017		
299-E34-9	1/20/2010 13:03	70.775	TOPP	0.004	121.902	121.897	0.0009	0.0005	0.0003	0.0005	
				Range (m):	0.018	0.012					
				Gradient Magnitude (m/m):			1.03E-05	9.58E-06	**1.15E-05**	1.24E-05	
				Direction (azimuth):			214	224	**237**	234	
				R^2:			0.11	0.36	**0.88**	0.98	
				p-Value:			0.7390	0.4133	**0.0424**	0.0217	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	2/18/2010 10:10	72.622	TOPP	0.004	121.871	121.872	-0.0061				
299-E27-18	2/18/2010 10:19	77.376	TOPP	0.005	121.880	121.881	0.0002	-0.0009	-0.0005	-0.0005	
299-E27-8	2/18/2010 9:56	73.645	TOPP	0.012	121.878	121.880	0.0029	-0.0005	-0.0002	0.0001	
299-E27-9	2/18/2010 9:29	70.013	TOPP	0.012	122.880	122.883	Outlier - Not Used				
299-E33-14	2/18/2010 10:28	68.753	TOPP	0.005	121.874	121.876	-0.0013	-0.0011	-0.0009	0.0000	
299-E33-37	2/18/2010 10:15	78.273	TOPP	0.004	121.881	121.882	0.0000	0.0000	0.0004	0.0003	
299-E34-10	2/18/2010 10:02	74.157	TOPP	0.004	121.881	121.882	0.0026	0.0016			
299-E34-9	2/18/2010 10:24	70.800	TOPP	0.004	121.877	121.879	0.0017	0.0010	0.0012		
				Range (m):	1.009	1.011					
				Gradient Magnitude (m/m):			1.88E-05	1.54E-05	1.47E-05	1.76E-05	
				Direction (azimuth):			35	20	20	21	
				R^2:			0.28	0.78	0.87	0.98	
				p-Value:			0.5124	0.1012	0.1279	0.1299	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	3/10/2010 10:37	72.639	TOPP	0.004	121.854	121.859	-0.1210	-0.0114			
299-E27-18	3/10/2010 10:49	77.382	TOPP	0.005	121.874	121.877	0.0149	0.0020	0.0001	0.0008	
299-E27-8	3/10/2010 10:57	73.656	TOPP	0.012	121.867	121.873	-0.1832	0.0049	-0.0015	-0.0009	
299-E27-9	3/10/2010 11:02	70.553	TOPP	0.012	122.340	122.349	0.2189				
299-E33-14	3/10/2010 10:14	68.762	TOPP	0.005	121.865	121.869	0.0176	-0.0024	-0.0021	-0.0017	
299-E33-37	3/10/2010 10:44	78.281	TOPP	0.004	121.873	121.876	0.0919	-0.0014	-0.0014	-0.0006	
299-E34-10	3/10/2010 10:30	74.162	TOPP	0.004	121.876	121.878	-0.0093	0.0049	0.0029		
299-E34-9	3/10/2010 10:21	70.808	TOPP	0.004	121.869	121.874	-0.0299	0.0034	0.0020	0.0024	
				Range (m):	0.486	0.490					
				Gradient Magnitude (m/m):			5.64E-04	2.76E-05	2.06E-05	1.94E-05	
				Direction (azimuth):			237	41	24	24	
				R^2:			0.47	0.22	0.60	0.72	
				p-Value:			0.2071	0.6014	0.2498	0.2764	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	5/23/2010 7:54	74.644	TOPP	0.004	119.849	119.856	Outlier - Not Used				
299-E27-18	5/23/2010 7:38	77.387	TOPP	0.005	121.869	121.874	0.0098	0.0337			
299-E27-8	5/23/2010 8:10	73.656	TOPP	0.012	121.867	121.875	0.1258				
299-E27-9	5/23/2010 8:19	71.300	TOPP	0.012	121.593	121.603	-0.1051	-0.0160	-0.0109		
299-E33-14	5/23/2010 7:00	68.707	TOPP	0.005	121.920	121.926	0.0076	-0.0033	-0.0085		
299-E33-37	5/23/2010 7:29	78.290	TOPP	0.004	121.864	121.868	-0.0464	-0.0446	-0.0228		
299-E34-10	5/23/2010 7:21	74.172	TOPP	0.004	121.866	121.870	0.0083	0.0302	0.0422		
299-E34-9	5/23/2010 7:10	71.805	TOPP	0.004	120.873	120.882	Outlier - Not Used				
				Range (m):	2.071	2.070					
				Gradient Magnitude (m/m):			2.68E-04	3.70E-04	3.32E-04		
				Direction (azimuth):			77	81	94		
				R^2:			0.57	0.93	0.96		
				p-Value:			0.2850	0.0654	0.1988		
				Statistically Significant?:			No	No	No		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	6/30/2010 10:05	72.645	TOPP	0.004	121.848	121.857	-0.0108				
299-E27-18	6/30/2010 10:36	77.391	TOPP	0.005	121.865	121.871	0.0017	0.0000	-0.0002		
299-E27-8	6/30/2010 9:57	73.665	TOPP	0.012	121.858	121.870	0.0013	-0.0013	-0.0011		
299-E27-9	6/30/2010 9:52	71.033	TOPP	0.012	121.860	121.871	0.0032	0.0003	0.0007		
299-E33-14	6/30/2010 10:50	68.778	TOPP	0.005	121.849	121.856	-0.0029	-0.0029	-0.0002		
299-E33-37	6/30/2010 10:30	78.289	TOPP	0.004	121.865	121.870	0.0013	0.0001	0.0000		
299-E34-10	6/30/2010 10:20	74.177	TOPP	0.004	121.861	121.868	0.0015	0.0001	0.0007		
299-E34-9	6/30/2010 10:59	70.821	TOPP	0.004	121.856	121.866	0.0046	0.0038			
				Range (m):	0.017	0.015					
				Gradient Magnitude (m/m):			2.80E-05	**3.05E-05**	3.82E-05		
				Direction (azimuth):			12	**8**	9		
				R^2:			0.39	**0.86**	0.99		
				p-Value:			0.2942	**0.0210**	0.0017		
				Statistically Significant?:			No	**Yes**	Yes		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	7/13/2010 11:06	72.645	TOPP	0.004	121.848	121.857	-0.0107				
299-E27-18	7/13/2010 10:39	77.392	TOPP	0.005	121.864	121.871	0.0013	-0.0004	-0.0005	0.0000	
299-E27-8	7/13/2010 10:51	73.666	TOPP	0.012	121.857	121.869	0.0016	-0.0010	-0.0009	-0.0006	
299-E27-9	7/13/2010 10:58	71.039	TOPP	0.012	121.854	121.869	0.0028	-0.0001	0.0003	0.0005	
299-E33-14	7/13/2010 10:16	68.774	TOPP	0.005	121.853	121.862	-0.0025	-0.0026	-0.0005	0.0000	
299-E33-37	7/13/2010 10:32	78.289	TOPP	0.004	121.865	121.871	0.0008	-0.0004	-0.0004	0.0002	
299-E34-10	7/13/2010 11:11	74.173	TOPP	0.004	121.865	121.871	0.0030	0.0016	0.0021		
299-E34-9	7/13/2010 10:25	70.820	TOPP	0.004	121.857	121.869	0.0037	0.0030			
				Range (m):	0.017	0.014					
				Gradient Magnitude (m/m):			1.86E-05	2.07E-05	**2.67E-05**	2.60E-05	
				Direction (azimuth):			25	18	**17**	16	
				R^2:			0.15	0.68	**0.91**	0.99	
				p-Value:			0.6686	0.1008	**0.0293**	0.0107	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	8/23/2010 10:20	72.679	TOPP	0.004	121.814	121.830	-0.0146				
299-E27-18	8/23/2010 10:38	77.419	TOPP	0.005	121.837	121.848	0.0022	-0.0002	-0.0006		
299-E27-8	8/23/2010 10:15	73.697	TOPP	0.012	121.826	121.846	0.0015	-0.0021			
299-E27-9	8/23/2010 10:11	71.071	TOPP	0.012	121.822	121.849	0.0052	0.0013	-0.0002		
299-E33-14	8/23/2010 10:50	68.802	TOPP	0.005	121.825	121.840	-0.0015	-0.0015	-0.0012		
299-E33-37	8/23/2010 10:33	78.316	TOPP	0.004	121.838	121.848	0.0020	0.0003	0.0003		
299-E34-10	8/23/2010 10:27	74.201	TOPP	0.004	121.837	121.847	0.0025	0.0005	0.0002		
299-E34-9	8/23/2010 10:44	70.851	TOPP	0.004	121.826	121.845	0.0027	0.0017	0.0016		
				Range (m):	0.024	0.019					
				Gradient Magnitude (m/m):			1.40E-05	**1.72E-05**	1.73E-05		
				Direction (azimuth):			21	**10**	4		
				R^2:			0.06	**0.78**	0.91		
				p-Value:			0.8554	**0.0472**	0.0252		
				Statistically Significant?:			No	**Yes**	Yes		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	9/17/2010 7:46	72.642	TOPP	0.004	121.851	121.852	-0.0110				
299-E27-18	9/17/2010 8:00	77.391	TOPP	0.005	121.865	121.865	0.0017	-0.0001	-0.0007	-0.0005	
299-E27-8	9/17/2010 7:38	73.661	TOPP	0.012	121.862	121.863	-0.0008	-0.0035			
299-E27-9	9/17/2010 7:33	71.026	TOPP	0.012	121.867	121.869	0.0053	0.0023	-0.0002	0.0000	
299-E33-14	9/17/2010 8:09	68.770	TOPP	0.005	121.857	121.857	-0.0011	-0.0011	-0.0006	-0.0005	
299-E33-37	9/17/2010 7:56	78.290	TOPP	0.004	121.864	121.864	0.0014	0.0001	0.0001	0.0003	
299-E34-10	9/17/2010 7:51	74.173	TOPP	0.004	121.865	121.865	0.0030	0.0015	0.0010		
299-E34-9	9/17/2010 8:05	70.817	TOPP	0.004	121.860	121.861	0.0014	0.0007	0.0005	0.0007	
				Range (m):	0.016	0.017					
				Gradient Magnitude (m/m):			1.22E-05	1.51E-05	**1.60E-05**	1.55E-05	
				Direction (azimuth):			4	357	**347**	346	
				R^2:			0.15	0.74	**0.97**	0.99	
				p-Value:			0.6564	0.0678	**0.0041**	0.0125	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	1/4/2011 11:31	72.629	TOPP	0.004	121.864	121.862	-0.0014	-0.0007			
299-E27-18	1/4/2011 11:47	77.389	TOPP	0.005	121.867	121.866	0.0011	0.0014			
299-E27-8	1/4/2011 11:19	73.656	TOPP	0.012	121.867	121.866	0.0023				
299-E27-9	1/4/2011 11:01	71.029	TOPP	0.012	121.864	121.861	-0.0018	-0.0005			
299-E33-14	1/4/2011 12:04	68.768	TOPP	0.005	121.859	121.857	-0.0005	-0.0008			
299-E33-37	1/4/2011 11:56	78.290	TOPP	0.004	121.864	121.863	-0.0017	-0.0018			
299-E34-10	1/4/2011 11:39	74.174	TOPP	0.004	121.864	121.864	0.0012	0.0015			
299-E34-9	1/4/2011 12:13	70.816	TOPP	0.004	121.861	121.860	0.0008	0.0009			
				Range (m):	0.008	0.009					
				Gradient Magnitude (m/m):			**2.13E-05**	2.17E-05			
				Direction (azimuth):			**16**	20			
				R^2:			**0.74**	0.81			
				p-Value:			**0.0348**	0.0351			
				Statistically Significant?:			**Yes**	Yes			

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	2/11/2011 9:28	72.649	TOPP	0.004	121.844	121.840	-0.0134	-0.0030	-0.0022		
299-E27-18	2/11/2011 9:04	77.403	TOPP	0.005	121.853	121.850	0.0027	0.0015	0.0012	0.0009	
299-E27-8	2/11/2011 9:36	73.677	TOPP	0.012	121.846	121.841	-0.0174	0.0004	0.0011	-0.0001	
299-E27-9	2/11/2011 10:00	71.004	TOPP	0.012	121.889	121.883	0.0207				
299-E33-14	2/11/2011 8:47	68.784	TOPP	0.005	121.843	121.839	-0.0018	-0.0037	0.0003	0.0001	
299-E33-37	2/11/2011 8:36	78.301	TOPP	0.004	121.853	121.851	0.0087	-0.0002	-0.0005	-0.0005	
299-E34-10	2/11/2011 9:23	74.191	TOPP	0.004	121.847	121.845	-0.0022	-0.0008	0.0001	-0.0003	
299-E34-9	2/11/2011 8:56	70.825	TOPP	0.004	121.852	121.848	0.0026	0.0058			
				Range (m):	0.046	0.044					
				Gradient Magnitude (m/m):			2.48E-05	3.57E-05	**4.83E-05**	4.63E-05	
				Direction (azimuth):			263	38	**33**	31	
				R^2:			0.29	0.59	**0.94**	0.99	
				p-Value:			0.4249	0.1643	**0.0145**	0.0099	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	3/21/2011 9:07	72.667	TOPP	0.004	121.826	121.824	-0.0059				
299-E27-18	3/21/2011 9:15	77.419	TOPP	0.005	121.837	121.834	0.0016	0.0006	0.0001	0.0007	
299-E27-8	3/21/2011 9:02	73.692	TOPP	0.012	121.831	121.828	-0.0010	-0.0024			
299-E27-9	3/21/2011 8:53	71.057	TOPP	0.012	121.836	121.830	0.0026	0.0010	-0.0007	-0.0004	
299-E33-14	3/21/2011 9:27	68.795	TOPP	0.005	121.832	121.827	-0.0013	-0.0014	-0.0010	-0.0008	
299-E33-37	3/21/2011 9:19	78.318	TOPP	0.004	121.836	121.833	-0.0005	-0.0012	-0.0012	-0.0006	
299-E34-10	3/21/2011 9:11	74.201	TOPP	0.004	121.837	121.834	0.0031	0.0023	0.0019		
299-E34-9	3/21/2011 9:23	70.842	TOPP	0.004	121.835	121.830	0.0015	0.0011	0.0009	0.0012	
				Range (m):	0.011	0.010					
				Gradient Magnitude (m/m):			1.92E-05	2.02E-05	1.97E-05	1.85E-05	
				Direction (azimuth):			32	28	22	22	
				R^2:			0.35	0.65	0.80	0.90	
				p-Value:			0.3398	0.1222	0.0867	0.1022	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	4/25/2011 11:15	72.660	TOPP	0.004	121.833	121.824	-0.0003	-0.0001			
299-E27-18	4/25/2011 11:28	77.422	TOPP	0.005	121.834	121.827	0.0001	0.0004			
299-E27-8	4/25/2011 11:10	73.688	TOPP	0.012	121.835	121.823	-0.0010	-0.0009			
299-E27-9	4/25/2011 11:02	71.051	TOPP	0.012	121.842	121.823	0.0006	0.0006			
299-E33-14	4/25/2011 12:03	68.800	TOPP	0.005	121.827	121.819	-0.0003	0.0000			
299-E33-37	4/25/2011 11:23	78.320	TOPP	0.004	121.834	121.827	-0.0005	-0.0001			
299-E34-10	4/25/2011 11:19	74.207	TOPP	0.004	121.831	121.826	0.0015				
299-E34-9	NM	NM	TOPP	0.004	NM	NM					
				Range (m):	0.015	0.008					
				Gradient Magnitude (m/m):			**2.63E-05**	2.58E-05			
				Direction (azimuth):			**23**	22			
				R^2:			**0.92**	0.97			
				p-Value:			**0.0063**	0.0050			
				Statistically Significant?:			**Yes**	Yes			

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	5/25/2011 10:36	72.665	TOPP	0.004	121.828	121.821	0.0006	-0.0002	-0.0001		
299-E27-18	5/25/2011 10:58	77.429	TOPP	0.005	121.827	121.822	0.0002	-0.0001	-0.0001		
299-E27-8	5/25/2011 10:29	73.697	TOPP	0.012	121.826	121.818	-0.0024				
299-E27-9	5/25/2011 10:18	71.060	TOPP	0.012	121.833	121.821	0.0014	0.0001	0.0001		
299-E33-14	5/25/2011 11:09	68.802	TOPP	0.005	121.825	121.817	-0.0002	0.0000	0.0001		
299-E33-37	5/25/2011 10:52	78.326	TOPP	0.004	121.828	121.822	0.0000	0.0000	0.0001		
299-E34-10	5/25/2011 10:46	74.213	TOPP	0.004	121.825	121.821	0.0006	0.0003			
299-E34-9	5/25/2011 11:04	70.851	TOPP	0.004	121.826	121.818	-0.0001	-0.0002	-0.0001		
				Range (m):	0.008	0.005					
				Gradient Magnitude (m/m):			1.51E-05	**1.47E-05**	1.45E-05		
				Direction (azimuth):			21	**15**	15		
				R^2:			0.70	**0.99**	1.00		
				p-Value:			0.0503	**0.0001**	0.0001		
				Statistically Significant?:			No	**Yes**	Yes		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	6/20/2011 10:31	72.684	TOPP	0.004	121.809	121.813	0.0203				
299-E27-18	6/20/2011 10:51	77.437	TOPP	0.005	121.819	121.822	0.0047	0.0082	-0.0029	-0.0037	
299-E27-8	6/20/2011 10:25	73.771	TOPP	0.012	121.752	121.757	-0.0192	-0.0079	-0.0029	-0.0009	
299-E27-9	NM	NM	TOPP	0.012	NM	NM					
299-E33-14	6/20/2011 9:11	68.815	TOPP	0.005	121.812	121.816	-0.0069	-0.0075	-0.0076	-0.0016	
299-E33-37	6/20/2011 10:47	78.333	TOPP	0.004	121.821	121.823	-0.0111	-0.0111			
299-E34-10	6/20/2011 10:37	74.221	TOPP	0.004	121.817	121.820	0.0072	0.0107	0.0048	0.0062	
299-E34-9	6/20/2011 10:40	70.865	TOPP	0.004	121.812	121.816	0.0051	0.0076	0.0087		
				Range (m):	0.069	0.066					
				Gradient Magnitude (m/m):			1.14E-04	1.31E-04	1.98E-04	2.18E-04	
				Direction (azimuth):			60	63	54	51	
				R^2:			0.68	0.85	0.94	0.98	
				p-Value:			0.1014	0.0558	0.0567	0.1370	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	7/14/2011 9:58	72.689	TOPP	0.004	121.804	121.806	-0.0063				
299-E27-18	7/14/2011 10:20	77.443	TOPP	0.005	121.813	121.815	0.0005	-0.0005	-0.0006	-0.0004	
299-E27-8	7/14/2011 9:52	73.713	TOPP	0.012	121.810	121.813	0.0011	-0.0004	-0.0003	-0.0001	
299-E27-9	7/14/2011 9:41	71.082	TOPP	0.012	121.811	121.812	0.0014	-0.0003	0.0001	0.0002	
299-E33-14	7/14/2011 11:15	68.821	TOPP	0.005	121.806	121.807	-0.0026	-0.0026	-0.0002	0.0000	
299-E33-37	7/14/2011 10:15	78.339	TOPP	0.004	121.815	121.816	0.0009	0.0001	0.0001	0.0004	
299-E34-10	7/14/2011 10:04	74.226	TOPP	0.004	121.812	121.814	0.0012	0.0003	0.0009		
299-E34-9	7/14/2011 10:09	70.865	TOPP	0.004	121.812	121.814	0.0038	0.0034			
				Range (m):	0.011	0.010					
				Gradient Magnitude (m/m):			1.89E-05	2.01E-05	**2.68E-05**	2.66E-05	
				Direction (azimuth):			27	22	**20**	20	
				R^2:			0.29	0.64	**0.97**	0.99	
				p-Value:			0.4189	0.1306	**0.0043**	0.0074	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	8/15/2011 9:40	72.695	TOPP	0.004	121.798	121.804	-0.0154				
299-E27-18	8/15/2011 10:06	77.436	TOPP	0.005	121.820	121.824	0.0029	0.0004	-0.0003	-0.0003	
299-E27-8	8/15/2011 9:33	73.712	TOPP	0.012	121.811	121.819	0.0005	-0.0033			
299-E27-9	8/15/2011 9:26	71.081	TOPP	0.012	121.812	121.823	0.0056	0.0014	-0.0008	-0.0005	
299-E33-14	8/15/2011 10:29	68.814	TOPP	0.005	121.813	121.818	-0.0022	-0.0023	-0.0019	-0.0005	
299-E33-37	8/15/2011 10:00	78.335	TOPP	0.004	121.819	121.823	0.0009	-0.0009	-0.0010	-0.0010	
299-E34-10	8/15/2011 9:45	74.217	TOPP	0.004	121.821	121.825	0.0045	0.0024	0.0019	0.0023	
299-E34-9	8/15/2011 10:21	70.861	TOPP	0.004	121.816	121.823	0.0032	0.0022	0.0020		
				Range (m):	0.023	0.021					
				Gradient Magnitude (m/m):			9.72E-06	1.19E-05	1.15E-05	1.56E-05	
				Direction (azimuth):			45	24	11	12	
				R^2:			0.05	0.28	0.56	0.77	
				p-Value:			0.8856	0.5255	0.2877	0.2258	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	9/26/2011 9:11	72.684	TOPP	0.004	121.809	121.818	-0.0095				
299-E27-18	9/26/2011 9:31	77.430	TOPP	0.005	121.826	121.832	0.0028	0.0013	0.0009		
299-E27-8	9/26/2011 8:56	73.707	TOPP	0.012	121.816	121.827	0.0007	-0.0017			
299-E27-9	9/26/2011 9:02	71.077	TOPP	0.012	121.816	121.829	0.0037	0.0011	-0.0001	0.0000	0.0000
299-E33-14	9/26/2011 9:41	68.804	TOPP	0.005	121.823	121.830	-0.0001	-0.0001	0.0001	0.0000	-0.0001
299-E33-37	9/26/2011 9:35	78.327	TOPP	0.004	121.827	121.831	0.0006	-0.0005	-0.0005	0.0001	0.0000
299-E34-10	9/26/2011 9:17	74.214	TOPP	0.004	121.824	121.830	0.0010	-0.0003	-0.0006	-0.0002	
299-E34-9	9/26/2011 9:25	70.857	TOPP	0.004	121.820	121.830	0.0009	0.0002	0.0001	0.0001	0.0001
				Range (m):	0.018	0.014					
				Gradient Magnitude (m/m):			6.99E-06	7.20E-06	6.47E-06	4.15E-06	4.45E-06
				Direction (azimuth):			69	46	36	43	42
				R^2:			0.16	0.59	0.72	0.96	0.99
				p-Value:			0.6376	0.1703	0.1492	0.0387	0.0742
				Statistically Significant?:			No	No	No	Yes	No

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	11/30/2011 10:17	72.689	TOPP	0.004	121.804	121.813	-0.0191				
299-E27-18	11/30/2011 10:30	77.423	TOPP	0.005	121.833	121.839	0.0041	0.0010	0.0009		
299-E27-8	11/30/2011 10:12	73.700	TOPP	0.012	121.823	121.834	0.0038	-0.0009	-0.0008		
299-E27-9	11/30/2011 9:01	71.077	TOPP	0.012	121.816	121.834	0.0056	0.0005	0.0006		
299-E33-14	11/30/2011 10:41	68.801	TOPP	0.005	121.826	121.835	-0.0008	-0.0008	0.0002		
299-E33-37	11/30/2011 10:26	78.321	TOPP	0.004	121.833	121.839	0.0021	-0.0001	-0.0001		
299-E34-10	11/30/2011 10:22	74.204	TOPP	0.004	121.834	121.836	0.0015	-0.0010	-0.0008		
299-E34-9	11/30/2011 10:36	70.851	TOPP	0.004	121.826	121.837	0.0027	0.0014			
				Range (m):	0.030	0.026					
				Gradient Magnitude (m/m):			1.29E-05	**1.41E-05**	1.68E-05		
				Direction (azimuth):			62	**38**	34		
				R^2:			0.12	**0.80**	0.91		
				p-Value:			0.7283	**0.0414**	0.0290		
				Statistically Significant?:			No	**Yes**	Yes		

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	12/29/2011 10:46	72.687	TOPP	0.004	121.806	121.816	-0.0149				
299-E27-18	12/29/2011 11:18	77.425	TOPP	0.005	121.831	121.837	0.0036	0.0011	0.0012	0.0003	
299-E27-8	12/29/2011 10:36	73.704	TOPP	0.012	121.819	121.832	0.0029	-0.0008	-0.0009	-0.0009	
299-E27-9	12/29/2011 10:30	71.076	TOPP	0.012	121.817	121.832	0.0045	0.0005	0.0003	0.0006	
299-E33-14	12/29/2011 13:33	68.795	TOPP	0.005	121.832	121.836	0.0010	0.0009	-0.0001	0.0000	
299-E33-37	12/29/2011 11:05	78.323	TOPP	0.004	121.831	121.836	0.0007	-0.0010	-0.0010		
299-E34-10	12/29/2011 10:52	74.207	TOPP	0.004	121.831	121.836	0.0028	0.0008	0.0005	0.0000	
299-E34-9	12/29/2011 10:57	70.853	TOPP	0.004	121.824	121.833	-0.0005	-0.0015			
				Range (m):	0.026	0.021					
				Gradient Magnitude (m/m):			1.07E-05	1.09E-05	8.52E-06	1.28E-05	
				Direction (azimuth):			71	47	58	49	
				R^2:			0.17	0.75	0.86	0.95	
				p-Value:			0.6306	0.0612	0.0537	0.0542	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	1/25/2012 10:36	72.700	TOPP	0.004	121.793	121.806	-0.0446				
299-E27-18	1/25/2012 10:56	77.431	TOPP	0.005	121.825	121.834	0.0079	0.0006	-0.0058	-0.0063	0.0008
299-E27-8	1/25/2012 10:29	73.702	TOPP	0.012	121.821	121.838	-0.0224	-0.0335			
299-E27-9	1/25/2012 9:01	71.009	TOPP	0.012	121.884	121.910	0.0346	0.0225	-0.0009	0.0029	0.0001
299-E33-14	1/25/2012 11:09	68.801	TOPP	0.005	121.826	121.838	-0.0194	-0.0194	-0.0153	0.0006	0.0003
299-E33-37	1/25/2012 10:50	78.333	TOPP	0.004	121.821	121.829	0.0140	0.0088	0.0083	0.0082	
299-E34-10	1/25/2012 10:42	74.204	TOPP	0.004	121.834	121.841	0.0018	-0.0041	-0.0096	-0.0055	-0.0013
299-E34-9	1/25/2012 11:04	70.806	TOPP	0.004	121.871	121.886	0.0281	0.0252	0.0233		
				Range (m):	0.091	0.104					
				Gradient Magnitude (m/m):			1.69E-04	1.63E-04	1.78E-04	**1.40E-04**	1.74E-04
				Direction (azimuth):			215	219	227	**237**	232
				R^2:			0.35	0.53	0.83	**0.97**	1.00
				p-Value:			0.3417	0.2172	0.0727	**0.0322**	0.0251
				Statistically Significant?:			No	No	No	**Yes**	Yes

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	2/28/2012 11:12	72.670	TOPP	0.004	121.823	121.817	-0.0030	-0.0027	-0.0008		
299-E27-18	2/28/2012 11:30	77.431	TOPP	0.005	121.825	121.822	0.0010	0.0008	0.0006	0.0004	
299-E27-8	2/28/2012 11:05	73.699	TOPP	0.012	121.824	121.817	-0.0026	-0.0025	0.0006	0.0001	
299-E27-9	2/28/2012 8:33	71.063	TOPP	0.012	121.830	121.822	0.0031	0.0035			
299-E33-14	2/28/2012 11:44	68.803	TOPP	0.005	121.824	121.817	-0.0023	0.0002	0.0002	0.0002	
299-E33-37	2/28/2012 11:24	78.329	TOPP	0.004	121.825	121.823	0.0015	0.0015	0.0000	0.0000	
299-E34-10	2/28/2012 11:18	74.216	TOPP	0.004	121.822	121.819	-0.0014	-0.0008	-0.0005	-0.0007	
299-E34-9	2/28/2012 11:37	70.848	TOPP	0.004	121.829	121.823	0.0036				
				Range (m):	0.008	0.006					
				Gradient Magnitude (m/m):			8.15E-06	1.53E-05	**2.48E-05**	2.40E-05	
				Direction (azimuth):			32	23	**35**	34	
				R^2:			0.10	0.35	**0.95**	0.98	
				p-Value:			0.7591	0.4262	**0.0098**	0.0216	
				Statistically Significant?:			No	No	**Yes**	Yes	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	4/18/2012 9:00	72.701	TOPP	0.004	121.792	121.790	-0.0288	-0.0092			
299-E27-18	4/18/2012 9:11	77.450	TOPP	0.005	121.806	121.805	0.0050	0.0027	0.0011	0.0016	
299-E27-8	4/18/2012 8:53	73.720	TOPP	0.012	121.803	121.801	-0.0293	0.0042	-0.0009	-0.0005	
299-E27-9	4/18/2012 9:35	71.008	TOPP	0.012	121.885	121.881	0.0390				
299-E33-14	4/18/2012 9:22	68.820	TOPP	0.005	121.807	121.805	0.0032	-0.0004	-0.0002	0.0001	
299-E33-37	4/18/2012 9:08	78.350	TOPP	0.004	121.804	121.803	0.0149	-0.0018	-0.0018	-0.0012	
299-E34-10	4/18/2012 9:04	74.230	TOPP	0.004	121.808	121.806	0.0012	0.0037	0.0021		
299-E34-9	4/18/2012 9:17	70.871	TOPP	0.004	121.806	121.804	-0.0051	0.0008	-0.0003	0.0000	
				Range (m):	0.093	0.091					
				Gradient Magnitude (m/m):			9.41E-05	1.25E-05	4.32E-06	4.03E-06	
				Direction (azimuth):			233	82	87	99	
				R^2:			0.38	0.30	0.40	0.60	
				p-Value:			0.3004	0.4855	0.4665	0.3972	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	5/15/2012 11:15	72.687	TOPP	0.004	121.806	121.805	-0.0018	-0.0014	-0.0012		
299-E27-18	5/15/2012 10:42	77.446	TOPP	0.005	121.810	121.809	0.0004	0.0003	0.0006	0.0004	
299-E27-8	5/15/2012 11:20	73.715	TOPP	0.012	121.808	121.806	0.0001	0.0004	0.0006	-0.0001	
299-E27-9	NM	NM	TOPP	0.012	NM	NM					
299-E33-14	5/15/2012 11:06	68.818	TOPP	0.005	121.809	121.805	-0.0018	-0.0002	0.0001	0.0000	
299-E33-37	5/15/2012 10:32	78.343	TOPP	0.004	121.811	121.809	-0.0005	-0.0007	-0.0002	-0.0003	
299-E34-10	5/15/2012 10:54	74.228	TOPP	0.004	121.810	121.809	0.0012	0.0016			
299-E34-9	5/15/2012 10:59	70.865	TOPP	0.004	121.812	121.809	0.0024				
				Range (m):	0.006	0.004					
				Gradient Magnitude (m/m):			1.16E-05	1.68E-05	1.64E-05	1.54E-05	
				Direction (azimuth):			39	33	32	30	
				R^2:			0.40	0.74	0.87	0.98	
				p-Value:			0.3561	0.1339	0.1312	0.1430	
				Statistically Significant?:			No	No	No	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	6/14/2012 13:03	72.701	TOPP	0.004	121.792	121.791	-0.0044	-0.0118	-0.0168		
299-E27-18	6/14/2012 12:56	77.462	TOPP	0.005	121.794	121.794	0.0109	0.0147	0.0070	0.0037	0.0056
299-E27-8	6/14/2012 11:59	73.726	TOPP	0.012	121.797	121.797	0.0188	0.0158	0.0125	0.0079	
299-E27-9	6/14/2012 11:54	71.095	TOPP	0.012	121.798	121.793	0.0086	-0.0006	-0.0023	-0.0072	-0.0013
299-E33-14	6/14/2012 13:09	68.631	TOPP	0.005	121.996	121.994	0.0706	0.0098	0.0022	0.0008	0.0005
299-E33-37	6/14/2012 12:51	78.350	TOPP	0.004	121.804	121.802	0.0055	0.0068	-0.0025	-0.0052	-0.0047
299-E34-10	6/14/2012 12:44	74.241	TOPP	0.004	121.797	121.798	-0.0208	-0.0347			
299-E34-9	6/14/2012 13:14	70.880	TOPP	0.004	121.797	121.796	-0.0892				
				Range (m):	0.204	0.203					
				Gradient Magnitude (m/m):			3.48E-04	5.28E-04	5.18E-04	**5.16E-04**	5.15E-04
				Direction (azimuth):			188	190	189	**189**	188
				R^2:			0.59	0.94	0.98	**1.00**	1.00
				p-Value:			0.1046	0.0033	0.0019	**0.0050**	0.0433
				Statistically Significant?:			No	Yes	Yes	**Yes**	Yes

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	7/30/2012 8:58	72.705	TOPP	0.004	121.788	121.790	-0.0091				
299-E27-18	7/30/2012 8:47	77.453	TOPP	0.005	121.803	121.804	0.0026	0.0011	0.0011		
299-E27-8	7/30/2012 9:04	73.727	TOPP	0.012	121.796	121.799	0.0013	-0.0010	-0.0009	-0.0007	
299-E27-9	7/30/2012 9:20	71.098	TOPP	0.012	121.795	121.799	0.0027	0.0002	0.0004	0.0004	
299-E33-14	7/30/2012 8:13	68.829	TOPP	0.005	121.798	121.800	-0.0009	-0.0009	0.0000	-0.0002	
299-E33-37	7/30/2012 8:23	78.353	TOPP	0.004	121.801	121.803	0.0002	-0.0008	-0.0008	-0.0001	
299-E34-10	7/30/2012 8:39	74.236	TOPP	0.004	121.802	121.802	0.0013	0.0001	0.0003	0.0006	
299-E34-9	7/30/2012 8:30	70.878	TOPP	0.004	121.799	121.802	0.0019	0.0013			
				Range (m):	0.015	0.014					
				Gradient Magnitude (m/m):			1.18E-05	1.26E-05	1.50E-05	1.22E-05	
				Direction (azimuth):			51	39	35	36	
				R^2:			0.23	0.76	0.87	0.92	
				p-Value:			0.5279	0.0569	0.0479	0.0844	
				Statistically Significant?:			No	No	Yes	No	

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	NM	NM	TOPP	0.004	NM	NM					
299-E27-18	8/20/2012 8:23	77.453	TOPP	0.005	121.803	121.806	0.0005	0.0004			
299-E27-8	8/20/2012 8:57	73.728	TOPP	0.012	121.795	121.802	0.0006	0.0007			
299-E27-9	8/20/2012 9:12	71.102	TOPP	0.012	121.791	121.799	-0.0006	-0.0004			
299-E33-14	8/20/2012 8:01	68.829	TOPP	0.005	121.798	121.802	-0.0008	0.0003			
299-E33-37	NM	NM	TOPP	0.004	NM	NM					
299-E34-10	8/20/2012 8:40	74.237	TOPP	0.004	121.801	121.803	-0.0012	-0.0010			
299-E34-9	8/20/2012 8:31	70.878	TOPP	0.004	121.799	121.804	0.0016				
				Range (m):	0.012	0.007					
				Gradient Magnitude (m/m):			1.82E-05	2.11E-05			
				Direction (azimuth):			39	35			
				R^2:			0.80	0.93			
				p-Value:			0.0907	0.0738			
				Statistically Significant?:			No	No			

Low-Level Waste Management Area 2

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP Desc.	MP-RP	Hydraulic Head (m NAVD88)		Trend-Surface Analyses Residuals (m)				
					New RP & Gyro Correction	New RP, Gyro Correction & BP	1st Iteration	2nd Iteration	3rd Iteration	4th Iteration	5th Iteration
299-E27-17	9/11/2012 8:08	72.718	TOPP	0.004	121.775	121.787	-0.0160				
299-E27-18	9/11/2012 7:56	77.455	TOPP	0.005	121.801	121.809	0.0026	0.0000	0.0003		
299-E27-8	9/11/2012 8:16	73.734	TOPP	0.012	121.789	121.804	0.0033	-0.0007	-0.0005		
299-E27-9	9/11/2012 8:28	71.113	TOPP	0.012	121.780	121.803	0.0044	0.0001	0.0002		
299-E33-14	9/11/2012 7:20	68.833	TOPP	0.005	121.794	121.806	-0.0008	-0.0008	-0.0006		
299-E33-37	9/11/2012 7:47	78.352	TOPP	0.004	121.802	121.810	0.0013	-0.0005	-0.0002		
299-E34-10	9/11/2012 7:36	74.236	TOPP	0.004	121.802	121.809	0.0033	0.0012			
299-E34-9	9/11/2012 7:28	70.883	TOPP	0.004	121.794	121.807	0.0018	0.0007	0.0009		
				Range (m):	0.027	0.023					
				Gradient Magnitude (m/m):			1.63E-05	**1.73E-05**	1.66E-05		
				Direction (azimuth):			58	**42**	42		
				R^2:			0.21	**0.92**	0.96		
				p-Value:			0.5634	**0.0061**	0.0091		
				Statistically Significant?:			No	**Yes**	Yes		

Water-Level Measurements and Trend-Surface Analysis Results for LERF

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	11/26/2008 8:52	62.643	TOPP	0.006	121.793	121.797
299-E26-77	11/26/2008 8:41	63.054	TOPP	0.010	121.988	121.990
299-E26-79	11/26/2008 8:45	61.618	TOPP	0.010	121.976	121.978
				Range (m):	0.195	0.193
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	2/23/2009 9:55	62.477	TOPP	0.006	121.959	121.952
299-E26-77	2/23/2009 9:31	63.082	TOPP	0.010	121.961	121.960
299-E26-79	2/23/2009 9:40	61.612	TOPP	0.010	121.982	121.978
				Range (m):	0.023	0.026
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	3/24/2009 9:13	62.502	TOPP	0.006	121.934	121.945
299-E26-77	3/24/2009 9:31	63.087	TOPP	0.010	121.956	121.961
299-E26-79	3/24/2009 9:34	61.647	TOC	0.000	121.937	121.946
				Range (m):	0.022	0.016
				Gradient Magnitude (m/m):	2.06E-04	1.50E-04
				Direction (azimuth):	177	175
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	4/30/2009 8:28	62.495	TOPP	0.006	121.941	121.948
299-E26-77	4/30/2009 8:13	63.095	TOPP	0.010	121.948	121.951
299-E26-79	4/30/2009 8:21	61.655	TOPP	0.010	121.939	121.944
				Range (m):	0.009	0.007
				Gradient Magnitude (m/m):	6.62E-05	3.30E-05
				Direction (azimuth):	166	143
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	5/28/2009 9:46	62.469	TOPP	0.006	121.967	121.968
299-E26-77	5/28/2009 9:32	63.077	TOPP	0.010	121.965	121.966
299-E26-79	5/28/2009 9:38	61.623	TOPP	0.010	121.971	121.972
				Range (m):	0.006	0.006
				Gradient Magnitude (m/m):	2.53E-05	2.53E-05
				Direction (azimuth):	312	312
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	6/29/2009 8:23	62.440	TOPP	0.006	121.996	121.996
299-E26-77	6/29/2009 7:33	63.049	TOPP	0.010	121.993	121.995
299-E26-79	6/29/2009 7:42	61.602	TOC	0.000	121.981	121.983
				Range (m):	0.015	0.013
				Gradient Magnitude (m/m):	6.78E-05	5.47E-05
				Direction (azimuth):	60	75
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	7/13/2009 8:53	62.416	TOC	0.000	122.014	122.016
299-E26-77	7/13/2009 10:00	63.015	TOC	0.000	122.017	122.018
299-E26-79	7/13/2009 11:20	61.564	TOC	0.000	122.018	122.018
				Range (m):	0.004	0.002
				Gradient Magnitude (m/m):	3.23E-05	2.03E-05
				Direction (azimuth):	204	198
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	7/27/2009 8:58	62.438	TOPP	0.006	121.998	122.003
299-E26-77	7/27/2009 9:14	63.039	TOPP	0.010	122.003	122.005
299-E26-79	7/27/2009 9:20	61.328	TOPP	0.010	122.259	122.261
				Range (m):	0.261	0.258
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	8/6/2009 9:15	62.429	TOPP	0.006	122.007	122.004
299-E26-77	8/6/2009 9:34	63.029	TOPP	0.010	122.013	122.010
299-E26-79	8/6/2009 9:46	61.581	TOPP	0.010	122.012	122.007
				Range (m):	0.006	0.006
				Gradient Magnitude (m/m):	5.94E-05	5.72E-05
				Direction (azimuth):	194	186
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	9/22/2009 8:50	62.476	TOPP	0.006	121.960	121.967
299-E26-77	9/22/2009 9:00	63.071	TOPP	0.010	121.971	121.977
299-E26-79	9/22/2009 9:06	61.633	TOPP	0.010	121.961	121.970
				Range (m):	0.011	0.010
				Gradient Magnitude (m/m):	1.03E-04	9.41E-05
				Direction (azimuth):	176	181
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	10/29/2009 7:40	69.423	TOPP	0.006	115.041	115.044
299-E26-77	10/29/2009 7:52	63.085	TOPP	0.010	121.958	121.961
299-E26-79	10/29/2009 7:56	61.654	TOPP	0.010	121.940	121.944
				Range (m):	6.917	6.917
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	11/12/2009 9:01	62.494	TOPP	0.006	121.942	121.938
299-E26-77	11/12/2009 9:20	63.095	TOPP	0.010	121.948	121.946
299-E26-79	11/12/2009 10:50	61.665	TOPP	0.010	121.930	121.926
				Range (m):	0.018	0.020
				Gradient Magnitude (m/m):	7.60E-05	9.09E-05
				Direction (azimuth):	132	140
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	1/4/2010 9:12	62.519	TOPP	0.006	121.917	121.918
299-E26-77	1/4/2010 9:30	63.117	TOPP	0.010	121.926	121.925
299-E26-79	NM	NM	TOPP	0.010	NM	NM
				Range (m):	0.009	0.007
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	2/18/2010 9:10	62.540	TOPP	0.006	121.896	121.898
299-E26-77	2/18/2010 9:22	63.138	TOPP	0.010	121.905	121.907
299-E26-79	NM	NM	TOPP	0.010	NM	NM
				Range (m):	0.009	0.009
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	3/10/2010 11:46	62.546	TOPP	0.006	121.890	121.892
299-E26-77	3/10/2010 12:07	63.140	TOPP	0.010	121.903	121.904
299-E26-79	NM	NM	TOPP	0.010	NM	NM
				Range (m):	0.013	0.012
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	4/28/2010 7:50	62.546	TOPP	0.006	121.890	121.879
299-E26-77	4/28/2010 7:36	63.149	TOPP	0.010	121.894	121.888
299-E26-79	NM	NM	TOPP	0.010	NM	NM
				Range (m):	0.004	0.009
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	5/23/2010 8:34	62.555	TOPP	0.006	121.881	121.881
299-E26-77	5/23/2010 9:00	63.155	TOPP	0.010	121.888	121.887
299-E26-79	NM	NM	TOPP	0.010	NM	NM
				Range (m):	0.007	0.006
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	6/30/2010 9:15	62.599	TOPP	0.006	121.837	121.841
299-E26-77	6/30/2010 8:40	63.146	TOPP	0.010	121.897	121.897
299-E26-79	6/30/2010 8:50	61.607	TOPP	0.010	121.986	121.986
				Range (m):	0.149	0.145
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	7/13/2010 11:24	62.553	TOPP	0.006	121.883	121.889
299-E26-77	7/13/2010 10:20	63.149	TOPP	0.010	121.894	121.894
299-E26-79	7/13/2010 10:34	61.704	TOPP	0.010	121.892	121.893
				Range (m):	0.011	0.005
				Gradient Magnitude (m/m):	1.09E-04	4.93E-05
				Direction (azimuth):	193	193
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	8/23/2010 9:10	62.589	TOPP	0.006	121.847	121.865
299-E26-77	8/23/2010 9:26	63.174	TOPP	0.010	121.870	121.876
299-E26-79	8/23/2010 9:31	61.731	TOPP	0.010	121.865	121.875
				Range (m):	0.023	0.011
				Gradient Magnitude (m/m):	2.26E-04	1.10E-04
				Direction (azimuth):	193	196
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	9/17/2010 6:28	62.560	TOPP	0.006	121.876	121.877
299-E26-77	9/17/2010 6:54	63.157	TOPP	0.010	121.886	121.886
299-E26-79	9/17/2010 7:02	61.715	TOPP	0.010	121.881	121.881
				Range (m):	0.010	0.009
				Gradient Magnitude (m/m):	9.53E-05	8.54E-05
				Direction (azimuth):	186	185
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	1/4/2011 10:01	62.559	TOPP	0.006	121.877	121.883
299-E26-77	1/4/2011 10:30	63.159	TOPP	0.010	121.885	121.891
299-E26-79	1/4/2011 10:21	61.715	TOPP	0.010	121.881	121.891
				Range (m):	0.008	0.008
				Gradient Magnitude (m/m):	7.63E-05	8.12E-05
				Direction (azimuth):	186	198
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	2/11/2011 11:10	62.563	TOPP	0.006	121.873	121.864
299-E26-77	2/11/2011 11:46	63.155	TOPP	0.010	121.888	121.881
299-E26-79	2/11/2011 11:57	61.715	TOPP	0.010	121.881	121.870
				Range (m):	0.015	0.017
				Gradient Magnitude (m/m):	1.43E-04	1.60E-04
				Direction (azimuth):	187	182
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	3/21/2011 7:53	62.577	TOPP	0.006	121.859	121.850
299-E26-77	3/21/2011 8:06	63.162	TOC	0.000	121.872	121.867
299-E26-79	3/21/2011 8:11	61.721	TOPP	0.010	121.875	121.866
				Range (m):	0.016	0.017
				Gradient Magnitude (m/m):	1.37E-04	1.71E-04
				Direction (azimuth):	202	196
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	4/25/2011 10:20	62.596	TOPP	0.006	121.840	121.827
299-E26-77	4/25/2011 10:05	63.187	TOC	0.000	121.847	121.841
299-E26-79	4/25/2011 10:10	61.739	TOPP	0.010	121.857	121.846
				Range (m):	0.017	0.019
				Gradient Magnitude (m/m):	9.52E-05	1.51E-04
				Direction (azimuth):	221	205
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	5/25/2011 9:54	62.601	TOPP	0.006	121.835	121.832
299-E26-77	5/25/2011 9:33	63.198	TOC	0.000	121.836	121.837
299-E26-79	5/25/2011 9:41	61.755	TOPP	0.010	121.842	121.844
				Range (m):	0.007	0.012
				Gradient Magnitude (m/m):	3.04E-05	6.76E-05
				Direction (azimuth):	247	221
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	6/20/2011 9:38	61.608	TOPP	0.006	122.826	122.827
299-E26-77	6/20/2011 9:24	63.188	TOC	0.000	121.846	121.846
299-E26-79	6/20/2011 9:26	61.752	TOPP	0.010	121.845	121.845
				Range (m):	0.981	0.982
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	7/14/2011 8:54	62.599	TOPP	0.006	121.837	121.836
299-E26-77	7/14/2011 8:29	63.211	TOPP	0.010	121.833	121.831
299-E26-79	7/14/2011 8:39	61.756	TOPP	0.010	121.841	121.838
				Range (m):	0.008	0.007
				Gradient Magnitude (m/m):	4.13E-05	4.77E-05
				Direction (azimuth):	330	343
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	8/15/2011 8:47	62.611	TOPP	0.006	121.825	121.828
299-E26-77	NM	NM	TOPP	0.010	NM	NM
299-E26-79	8/15/2011 8:29	61.763	TOPP	0.010	121.834	121.835
				Range (m):	0.009	0.007
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	9/26/2011 10:10	62.602	TOPP	0.006	121.834	121.837
299-E26-77	9/26/2011 9:53	63.198	TOPP	0.010	121.846	121.845
299-E26-79	9/26/2011 9:58	61.751	TOPP	0.010	121.846	121.845
				Range (m):	0.012	0.008
				Gradient Magnitude (m/m):	1.22E-04	8.12E-05
				Direction (azimuth):	198	198
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	11/30/2011 9:30	62.603	TOPP	0.006	121.833	121.841
299-E26-77	11/30/2011 9:51	63.201	TOPP	0.010	121.843	121.850
299-E26-79	11/30/2011 9:56	61.758	TOPP	0.010	121.839	121.849
				Range (m):	0.010	0.009
				Gradient Magnitude (m/m):	9.62E-05	8.98E-05
				Direction (azimuth):	188	195
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	12/29/2011 9:32	62.593	TOPP	0.006	121.843	121.838
299-E26-14	12/29/2011 9:10	61.315	TOPP	0.007	121.922	121.911
299-E26-77	12/29/2011 8:46	63.194	TOPP	0.010	121.850	121.844
299-E26-79	12/29/2011 8:55	61.739	TOPP	0.010	121.857	121.847
				Range (m):	0.079	0.073
				Gradient Magnitude (m/m):	2.89E-04	2.75E-04
				Direction (azimuth):	198	195
				R^2:	0.93	0.92
				p-Value:	0.2653	0.2858
				Statistically Significant?:	No	No

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	1/25/2012 9:37	61.612	TOPP	0.006	122.822	122.831
299-E26-14	1/25/2012 10:00	61.372	TOPP	0.007	121.865	121.867
299-E26-77	1/25/2012 10:07	63.201	TOPP	0.010	121.843	121.846
299-E26-79	1/25/2012 10:13	61.775	TOPP	0.010	121.822	121.828
				Range (m):	1.000	1.003
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	2/28/2012 9:14	62.600	TOPP	0.006	121.836	121.834
299-E26-14	2/28/2012 9:36	61.341	TOPP	0.007	121.896	121.895
299-E26-77	2/28/2012 9:42	63.201	TOPP	0.010	121.843	121.843
299-E26-79	2/28/2012 9:48	61.762	TOPP	0.010	121.835	121.835
				Range (m):	0.061	0.061
				Gradient Magnitude (m/m):	2.49E-04	2.49E-04
				Direction (azimuth):	186	186
				R^2:	0.91	0.93
				p-Value:	0.2970	0.2670
				Statistically Significant?:	No	No

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88) New RP & Gyro Correction	Hydraulic Head (m NAVD88) New RP, Gyro Correction & BP Adjustment
299-E26-10	4/18/2012 8:13	62.62	TOPP	0.006	121.816	121.816
299-E26-14	4/18/2012 8:28	61.35	TOPP	0.007	121.887	121.890
299-E26-77	4/18/2012 8:33	63.22	TOPP	0.010	121.824	121.824
299-E26-79	4/18/2012 8:38	61.78	TOPP	0.010	121.817	121.818
				Range (m):	0.071	0.074
				Gradient Magnitude (m/m):	2.88E-04	2.98E-04
				Direction (azimuth):	187	188
				R^2:	0.91	0.91
				p-Value:	0.2927	0.2928
				Statistically Significant?:	No	No

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	5/15/2012 13:04	62.608	TOPP	0.006	121.828	121.818
299-E26-14	5/15/2012 13:30	61.337	TOPP	0.007	121.900	121.894
299-E26-77	NM	NM	TOPP	0.010	NM	NM
299-E26-79	5/15/2012 12:53	61.759	TOPP	0.010	121.838	121.828
				Range (m):	0.072	0.076
				Gradient Magnitude (m/m):	2.93E-04	3.11E-04
				Direction (azimuth):	181	181
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	6/14/2012 12:17	62.630	TOPP	0.006	121.806	121.805
299-E26-14	NM	NM	TOPP	0.007	NM	NM
299-E26-77	NM	NM	TOPP	0.010	NM	NM
299-E26-79	NM	NM	TOPP	0.010	NM	NM
				Range (m):	0.000	0.000
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	NM	NM	TOPP	0.006	NM	NM
299-E26-14	7/26/2012 13:15	61.355	TOPP	0.007	121.882	121.882
299-E26-77	7/26/2012 13:20	63.168	TOPP	0.010	121.876	121.875
299-E26-79	7/26/2012 13:29	61.771	TOPP	0.010	121.826	121.823
				Range (m):	0.056	0.059
				Gradient Magnitude (m/m):		
				Direction (azimuth):		
				R^2:		
				p-Value:		
				Statistically Significant?:		

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	8/20/2012 9:42	62.628	TOPP	0.006	121.808	121.808
299-E26-14	8/20/2012 10:28	61.358	TOPP	0.007	121.879	121.878
299-E26-77	8/20/2012 10:35	63.223	TOPP	0.010	121.821	121.820
299-E26-79	8/20/2012 10:50	61.781	TOPP	0.010	121.816	121.813
				Range (m):	0.071	0.070
				Gradient Magnitude (m/m):	2.75E-04	2.77E-04
				Direction (azimuth):	190	188
				R^2:	0.95	0.94
				p-Value:	0.2140	0.2348
				Statistically Significant?:	No	No

Liquid Effluent Retention Facility

Well Name	Measurement Date & Time (PST)	Measured Depth to Water (m)	MP	MP-RP	Hydraulic Head (m NAVD88)	
					New RP & Gyro Correction	New RP, Gyro Correction & BP Adjustment
299-E26-10	9/11/2012 8:42	62.638	TOPP	0.006	121.798	121.809
299-E26-14	9/11/2012 9:16	61.363	TOPP	0.007	121.874	121.878
299-E26-77	9/11/2012 9:24	63.226	TOPP	0.010	121.818	121.822
299-E26-79	9/11/2012 9:34	61.785	TOPP	0.010	121.812	121.816
				Range (m):	0.076	0.069
				Gradient Magnitude (m/m):	2.86E-04	2.69E-04
				Direction (azimuth):	191	189
				R^2:	0.98	0.95
				p-Value:	0.1266	0.2132
				Statistically Significant?:	No	No

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Appendix D

200 East Area Water Table Fluctuation Study

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Appendix D

200 East Area Water Table Fluctuation Study

During 2002 and 2003, the water table elevation beneath the 200 East Area fluctuated (i.e., the normal rate of decline slowed and the water table elevation actually increased in some areas). A study was conducted to determine the cause of the fluctuation. Several potential stressors to the unconfined aquifer were evaluated, including discharges to the Treated Effluent Disposal Facility (TEDF) and large seasonal changes in Columbia River stage. The results were described in a previously unpublished letter report, which is presented in this appendix. The overall conclusion was that discharges to the TEDF were one cause of the water table fluctuation, but higher-than-normal stage in the Columbia River may also have been a factor. This report first described the hypothesis that Columbia River stage may be affecting the water table beneath the 200 East Area.

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The 2002-2003 Fluctuation of the Water-Table Elevation in the 200 East Area and Vicinity: Evaluation of Potential Causes

John P. McDonald
April 2006

1.0 Introduction

After decades of water-table elevation increases caused by effluent discharges to the soil column at the Hanford Site (Zimmerman et al. 1986), the water-table elevation has been declining over much of the site since the mid-1980s in response to curtailment of waste water discharges (Hartman et al. 2003). In the central part of the site (200 East Area and vicinity), this general declining trend has been interrupted occasionally. Of particular note are two time periods, 1994-1997 and 2002-2003, where the rate of decline was greatly reduced, and the water-table elevation actually increased at some wells for a short time period (Figure 1). These fluctuations (i.e., deviations from the long-term rate of decline) in the water-table elevation were not limited to the 200 East Area, but were widespread and occurred as far away as 5 kilometers southeast at the Central Landfill (Figure 2), and north of Gable Butte and Gable Mountain (Figure 3).

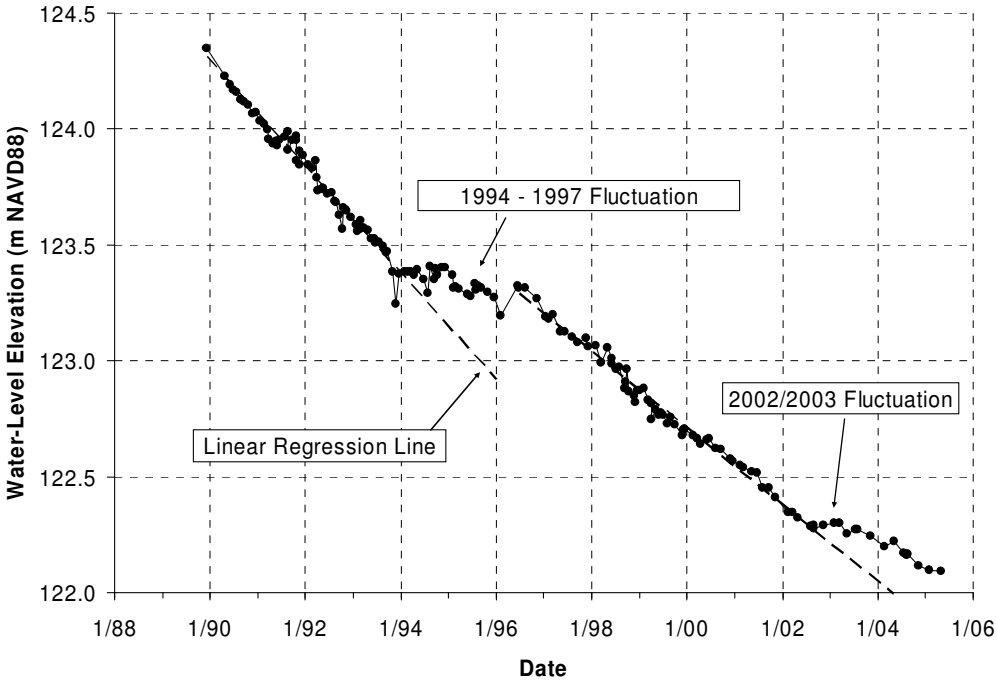

Figure 1. Water-level elevation in well 299-E33-32 located in the northwestern part of the 200 East Area[1].

[1] Linear regression lines are used in many figures throughout this report to emphasize departures from normal trends.

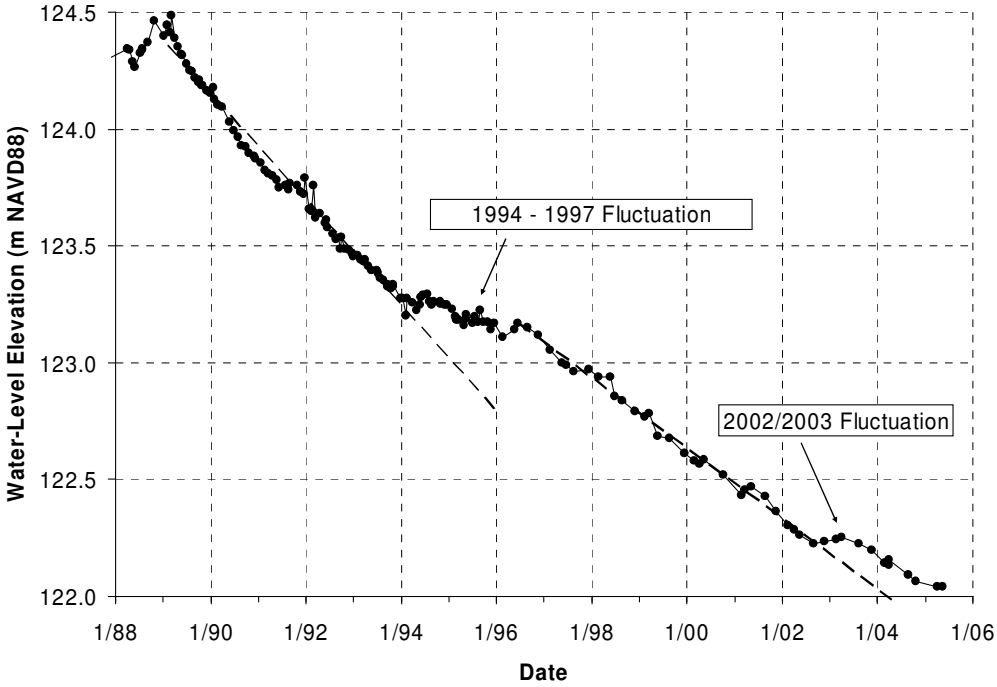

Figure 2. Water-level elevation in well 699-24-35 located at the Central Landfill, 5 kilometers southeast of the 200 East Area.

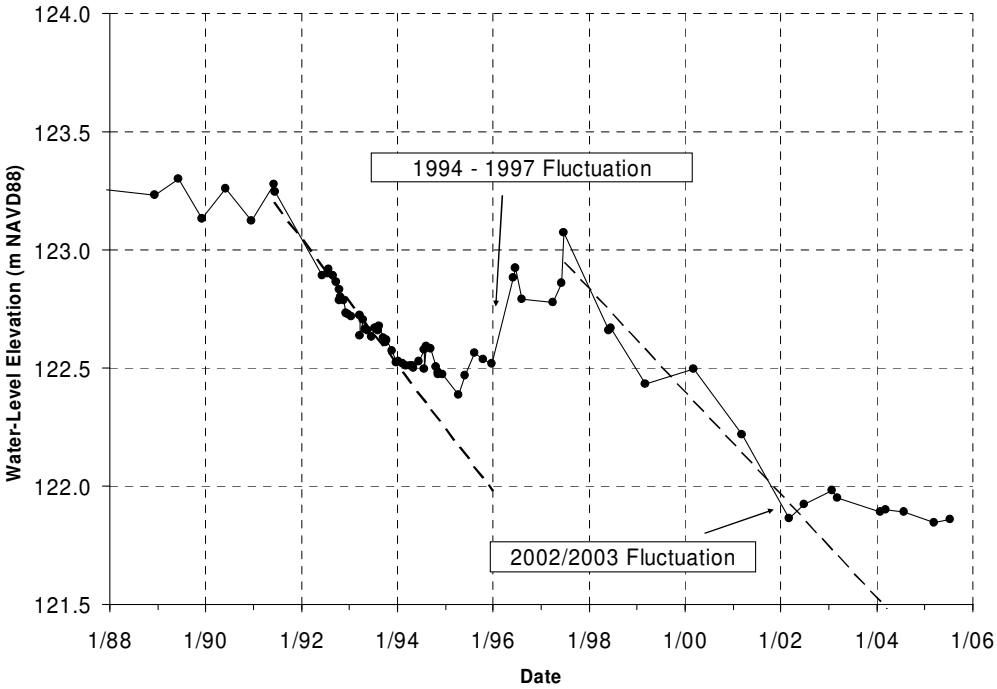

Figure 3. Water-level elevation for well 699-66-64 located north of Gable Butte and Gable Mountain.

The area affected by these fluctuations correlates with a highly permeable paleochannel trending northwest to southeast from north of Gable Gap (i.e., the water gap between Gable Butte and Gable Mountain) through the 200 East Area to the Central Landfill (Figure 4). The channel was formed by fluvial incision of the ancestral Columbia River and Pleistocene cataclysmic flooding (Williams et al. 2000), and is filled with very highly conductive sediments causing a relatively flat water-table (i.e., a very low hydraulic gradient) (Hartman et al. 2005). Stressors that have an effect on the water-table elevation also have the potential to affect groundwater flow. In areas of very low hydraulic gradients, it is surmised that the groundwater flow rate and direction can be easily altered by external stresses (e.g., Russell et al. 1987, Spane 2002). Therefore, it is important to determine the cause of observed water-table fluctuations in the 200 East Area and vicinity, because they may indicate a change in groundwater flow.

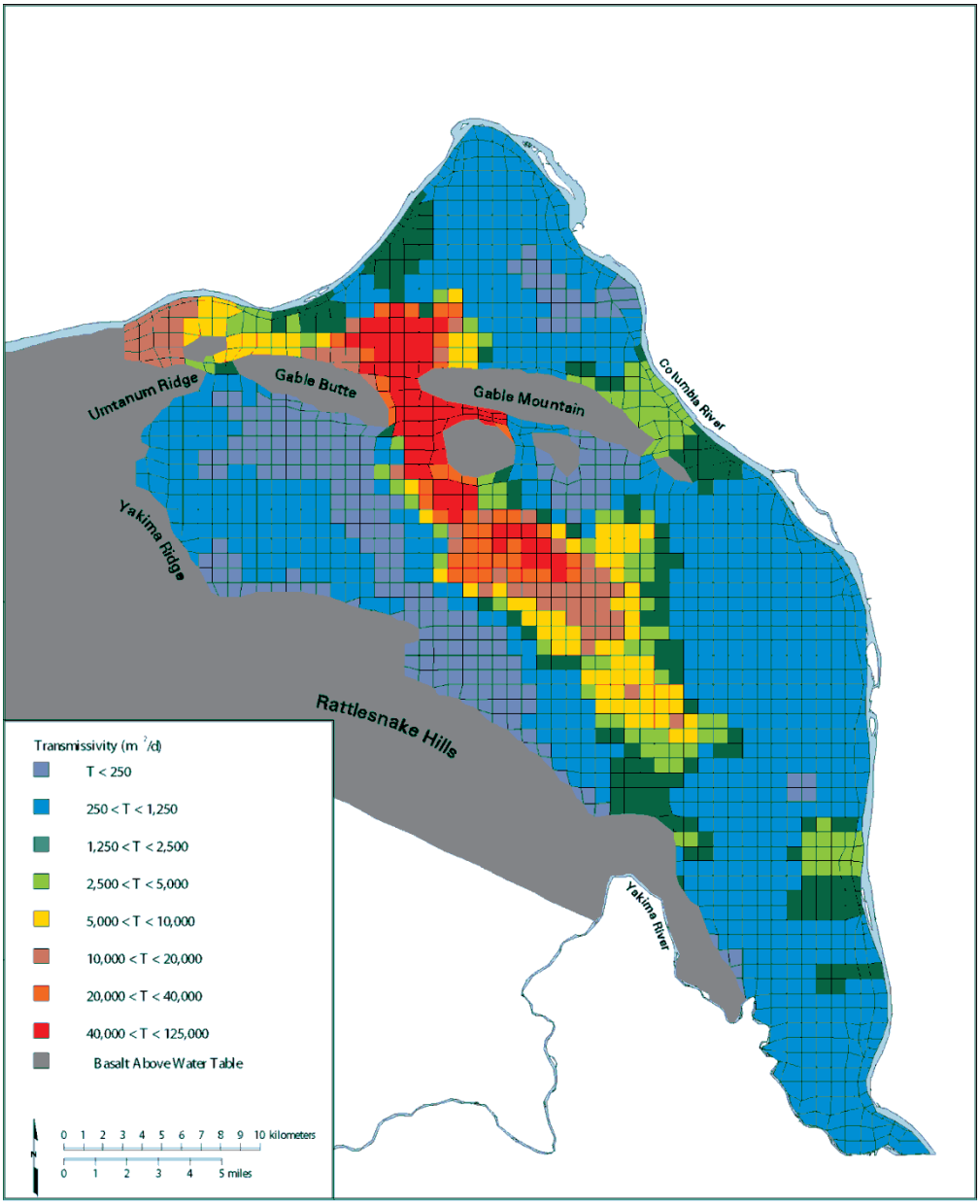

Figure 4. Transmissivity distribution for the Hanford Site unconfined aquifer resulting from an inverse calibration of a two-dimensional groundwater model (Cole et al. 1997). Red through yellow colors denote the high transmissivity region corresponding to the paleochannel.

It has long been recognized that the water-table elevation beneath Hanford responds to liquid effluent discharges to the soil column (Bierschenk 1957, Bierschenk and McConiga 1957, Newcomb et al. 1972, Newcomer 1990, and Zimmerman et al. 1986). Therefore, fluctuations of the water-table elevation, beyond the region of obvious groundwater/surface water interaction adjacent to the Columbia River, were historically attributed to changes in liquid effluent discharges. However, effluent disposal was greatly reduced in the 1990s due to a change in Hanford's mission from plutonium production to environmental cleanup. Because the 216-B-3 Pond (located just east of the 200 East Area) was in operation until 1997, the cause of the 1994-1997 fluctuation was thought to be known – the water-table elevation was still responding to effluent disposal practices. Since 1997 however, the effluent volume released to ground in the 200 East Area and vicinity is only a small fraction of historical volumes[2]. Therefore, the 2002-2003 fluctuation in the 200 East Area was unexpected, because it was not readily apparent that this fluctuation was caused by effluent discharges.

In this paper, potential causes of the most recent (2002-2003) water-table fluctuation in the 200 East Area and vicinity are examined. Characterization of groundwater flow within this area is needed to support ongoing Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and Atomic Energy Act (AEA) groundwater monitoring, and to support the 200-BP-5 and 200-PO-1 operable unit remedial investigation/feasibility studies. The 2002-2003 fluctuation is being studied because it occurred when effluent discharges to the soil column were small compared to historical discharges, and therefore other stresses to the water-table elevation may be more discernable. Therefore, the emphasis of this paper is on this most recent fluctuation, although the 1994-1997 fluctuation will also be considered.

2.0 Study Area Boundary

A map of the change in water-level elevations from March 2002 to March 2003 for wells monitoring the upper part of the unconfined aquifer shows the region affected by the smaller than normal decline during this time (Figure 5). Well water-level elevations north of Gable Butte and the western most end of Gable Mountain increased from March 2002 to March 2003. This region is known to be affected by changes in Columbia River stage (Newcomb et al. 1972), and discharge in the river was higher than normal during the spring of 2002. In the 200 East Area, the annual decline in well water-level elevations is normally between 10 and 20 centimeters (e.g., see Hartman et al. 2003). However, during March 2002 to March 2003, the average decline was only 4 centimeters (Hartman et al. 2004), and in the southern part of the 200 East Area extending south and east into the surrounding 600 Area, water-level elevations actually increased. Figure 5 shows that this smaller than normal decline extends from Gable Gap south and southeast through the 200 East Area to beyond the Central Landfill (i.e., the region bounded by the -0.05 meter contour). To the south, along the Rattlesnake Hills, water-level elevations increased. Water-level elevation changes near the Rattlesnake Hills may be related to runoff from the hills.

[2] The annual average release for 1997 to 2003 was ~9% of the annual average release for 1988 to 1996.

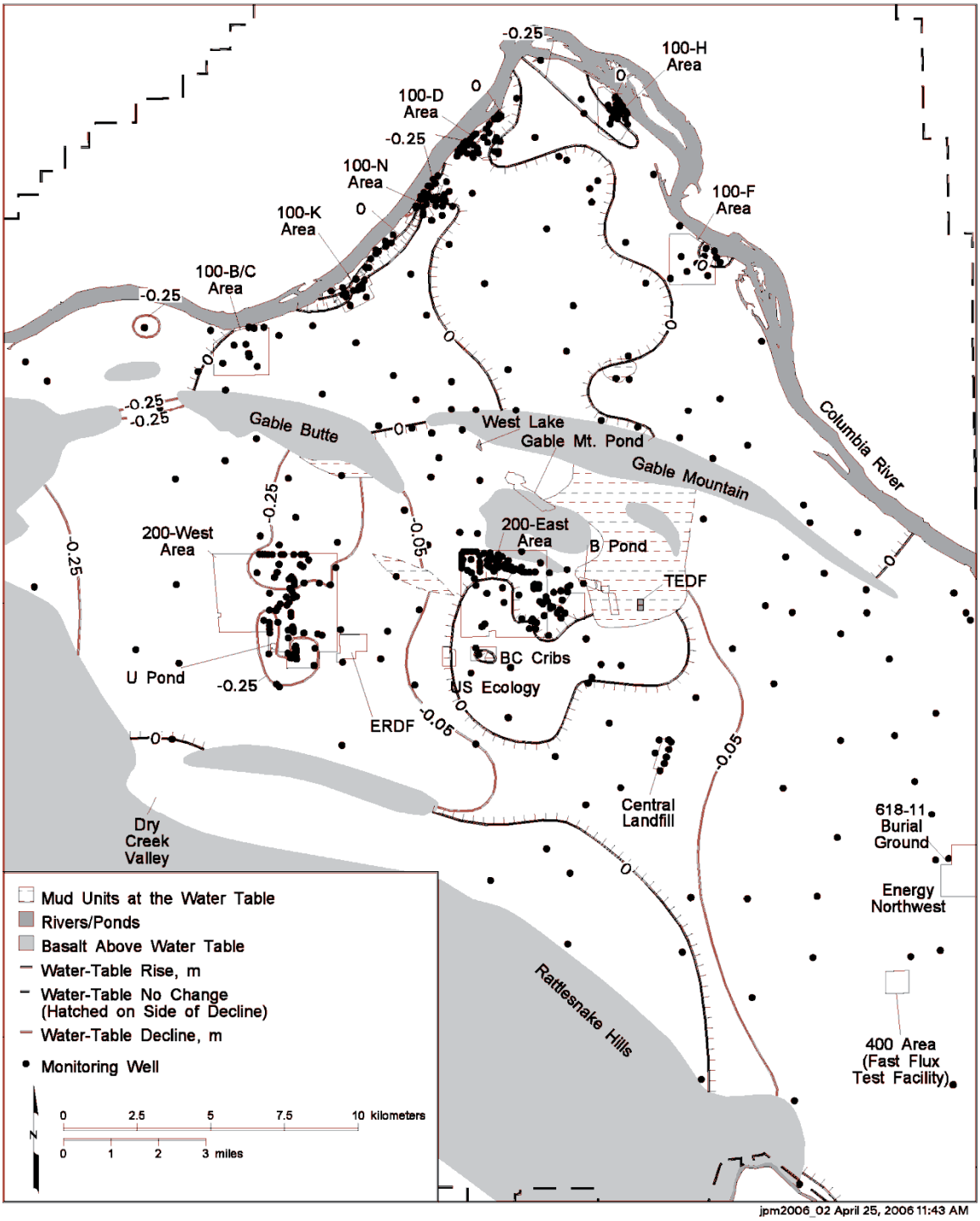

Figure 5. March 2002 to March 2003 water-level elevation change map for wells monitoring the upper part of the Hanford Site unconfined aquifer.

The study area (Figure 6) consists of the paleochannel south of Gable Gap, bounded by basalt and mud units above the water table and by the -0.05 meter contour lines in Figure 5. This region was chosen because the cause of the fluctuation in this area is not readily apparent. The approximate edge of the paleochannel itself forms the southwestern and southern boundary of the study area. The -0.05 meter contour in Figure 5 extends out of the paleochannel southwest of the 200 East Area, but this region was excluded from this study because wells within this area did not exhibit the obvious water-level fluctuation seen within the channel (Figure 7). The area north of Gable Butte and Gable Mt. experienced a water-table elevation increase from March 2002 to March 2003 (from 4 to 10 centimeters). This region was excluded from consideration, because the water-table north of Gable Butte and Gable Mt. is more obviously affected by changes in Columbia River stage. The area along the Rattlesnake Hills was excluded because this region may be affected by runoff – it is treated as a potential source of water causing the observed fluctuation in the paleochannel.

3.0 Potential Causes of the 2002-2003 Fluctuation

The water-table elevation within an unconfined aquifer is a result of the amount of water stored within the aquifer. Thus, the water-table elevation changes in response to changes in the amount of water in storage. This follows directly from the law of mass conservation as expressed in the well-known hydrologic equation (Fetter 1988):

$$Inflow = Outflow \pm \Delta Storage \qquad (1)$$

For an unconfined aquifer (or that portion of an unconfined aquifer under consideration), if the total recharge (inflow) equals the total discharge (outflow) over a particular time period, there will be no net change in the amount of water in storage and no net change in the water-table elevation. The long-term declining water-level elevation trend exhibited by many unconfined aquifer wells at Hanford signifies that the amount of water in storage is declining, which can only occur if the discharge of water is larger than the recharge. Recharge to the unconfined aquifer has been greatly reduced over the last 15 years due to the curtailment of liquid effluent releases to ground, causing the current imbalance between recharge and discharge. The amount of water stored in the unconfined aquifer will continue to decrease (i.e., the water-table elevation will continue to decline) until an equilibrium is achieved between recharge and discharge to the unconfined aquifer system. If the recharge and discharge rates are constant, but not equal, then the rate of decline in groundwater storage (i.e., the rate of water-table elevation decline) will be constant. The fluctuations (or changes) in the rate of water-table elevation decline observed in 1994-1997 and 2002-2003 indicates that the rate of decline is not always constant. These departures from the overall water-table decline trend can only occur if there has been a change in the rate of recharge and/or discharge.

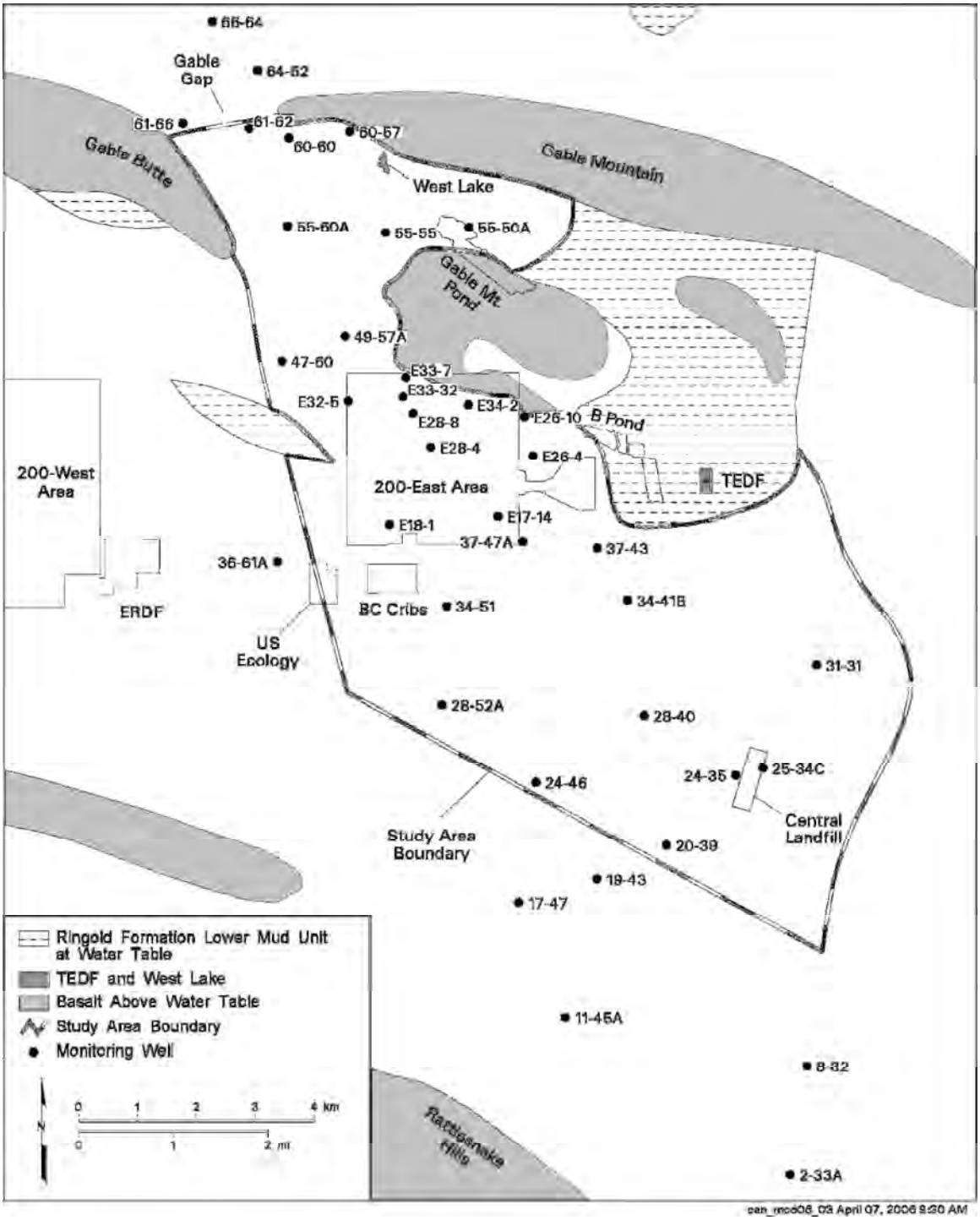

Figure 6. Map of the study area showing the groundwater monitoring wells used in this study.

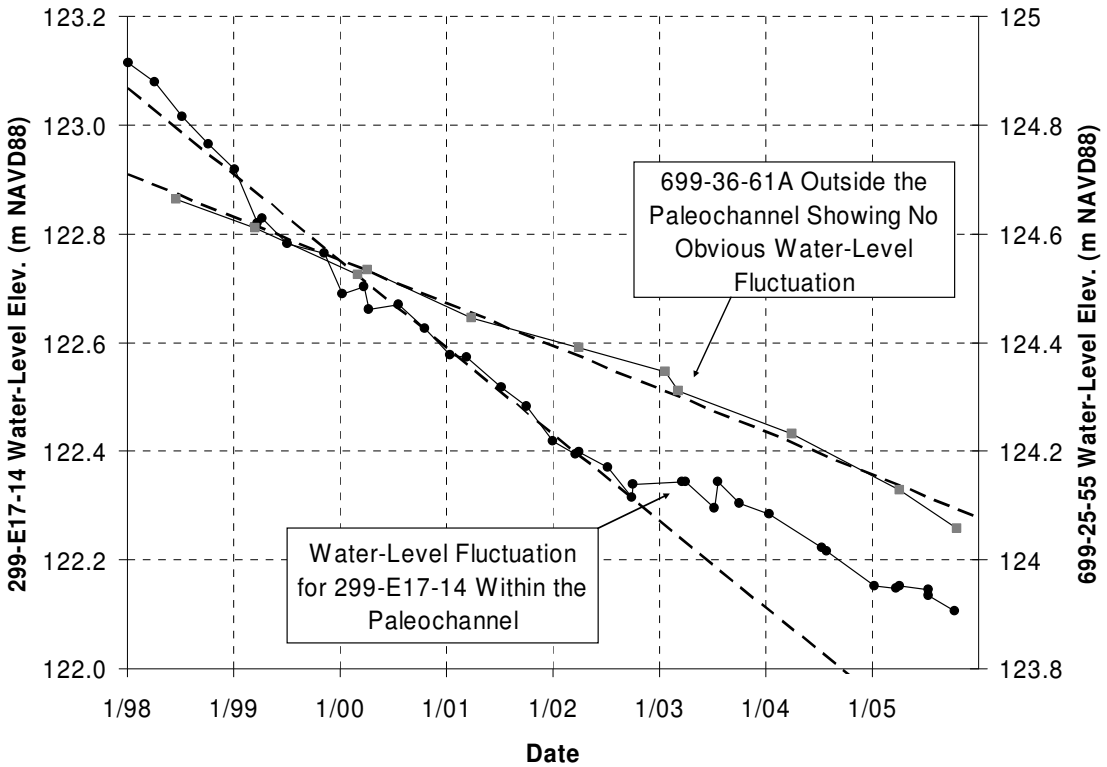

Figure 7. Well water-level elevations for 699-36-61A located about 0.5 to 1 kilometer southwest of the paleochannel and 299-E17-14 located within the paleochannel. Wells outside the paleochannel to the southwest do not exhibit the water-level fluctuation seen within the channel.

The method of multiple working hypotheses was employed to investigate the change in the recharge and/or discharge rates that have caused the 2002-2003 fluctuation. With this technique, possible explanations for a change in groundwater storage are identified, and then each hypothesis is evaluated to determine its feasibility to explain the observed water-table fluctuation. The hypotheses evaluated are:

- An increase in natural recharge directly from the overlying vadose zone due to higher than normal precipitation during the winter of 2002-2003 or some earlier period.
- An increase in groundwater recharge into the study area from a region of water-table elevation increase along the Rattlesnake Hills.
- An increase in artificial recharge due to a water line leak in the 200 East Area on 11/30/2002.
- An increase in artificial recharge due to effluent disposal at the Treated Effluent Disposal Facility (TEDF).
- An increase in artificial recharge due to waste water discharges to ground at the Waste Treatment Plant (i.e., the vit plant) construction site.
- Decreased discharge from the 200 East Area vicinity caused by a gradient effect associated with changes in Columbia River stage (i.e., bank storage effects).

It is possible that several causative conditions may have contributed to the observed fluctuation. It is also possible that none of the hypotheses examined will be satisfactory and additional alternative explanations are needed. These factors must always be considered when employing this type of investigative method.

4.0 Groundwater Storage Change Estimate

To evaluate the hypotheses above, it is necessary to quantify the change in groundwater storage within the study area that produced the 2002-2003 fluctuation, as it relates to the amount that would have been in storage had the historical rate of water-table elevation decline continued unchanged (i.e., the volume of "extra" water in the aquifer). The change in the amount of water in storage is given by:

$$\Delta V = S \cdot A \cdot \Delta h \cdot 1000 \qquad (2)$$

where ΔV is the change in groundwater storage (liters), S is the storativity (unitless), A is the area of the aquifer affected (square meters), Δh is the difference between the measured water-table elevation for March 2003 and the water-table elevation that would have occurred in March 2003 if the historical rate of water-table elevation decline was unchanged (meters), and the scalar (1000) converts from cubic meters to liters. This equation follows directly from the definition of storativity: the volume of water an aquifer will take in or release from storage per unit surface area per unit change in head (Fetter 1988).

The Thiessen polygon method was used to estimate the change in groundwater storage (Davis 2002, Fetter 1988). Twenty-two wells across the study area were chosen, and Thiessen polygons were constructed around each well using a geographic information system (GIS)[3] (Figure 8). This method assigns a spatial region of the aquifer to each well such that all points within a polygon are closer to the central well than any other well. The polygons were truncated at the study area boundary. Equation 2 was applied to each polygon separately, and the results summed to estimate the groundwater storage change. The area of each polygon was calculated by the GIS (Table 1).

For each of the 22 wells, linear regression was used to extrapolate the historical rate of water-level elevation decline to March 2003. Least squares linear regression was performed on the water-level elevation measurements for each well starting from the first available measurement no earlier than January 1998 and extending to March 2002. By using this time period, effects of the 1994-1997 and 2002-2003 fluctuations are avoided in the regression. Measurements that were obviously off trend were not used in the analysis. The regression equation determined for each well was then used to predict the water-level elevation for March 2003, and the difference between the measured and predicted elevations was used in Equation 2 (example in Figure 9). The difference between the extrapolated and measured water-level elevations for each well are shown in Table 1.

To estimate the change in groundwater storage, a storativity value is required. For confined aquifers, water is stored or released entirely from elastic storage (i.e., compressibility of the pore water and the aquifer matrix). For an unconfined aquifer, groundwater is stored due to filling of the pore space in addition to elastic storage. Filling of the pore space is quantified by specific yield, which is the amount of water yielded by gravity drainage from a fully saturated rock or soil sample divided by the total volume of the sample (Fetter 1988). For unconfined aquifers, the elastic storage component is very small in comparison to specific yield, so specific yield is commonly used as the storativity for unconfined aquifers (Fetter 1988).

[3] ARC/INFO Version 9.0 developed by Environmental Systems Research Institute, Inc. (ESRI)

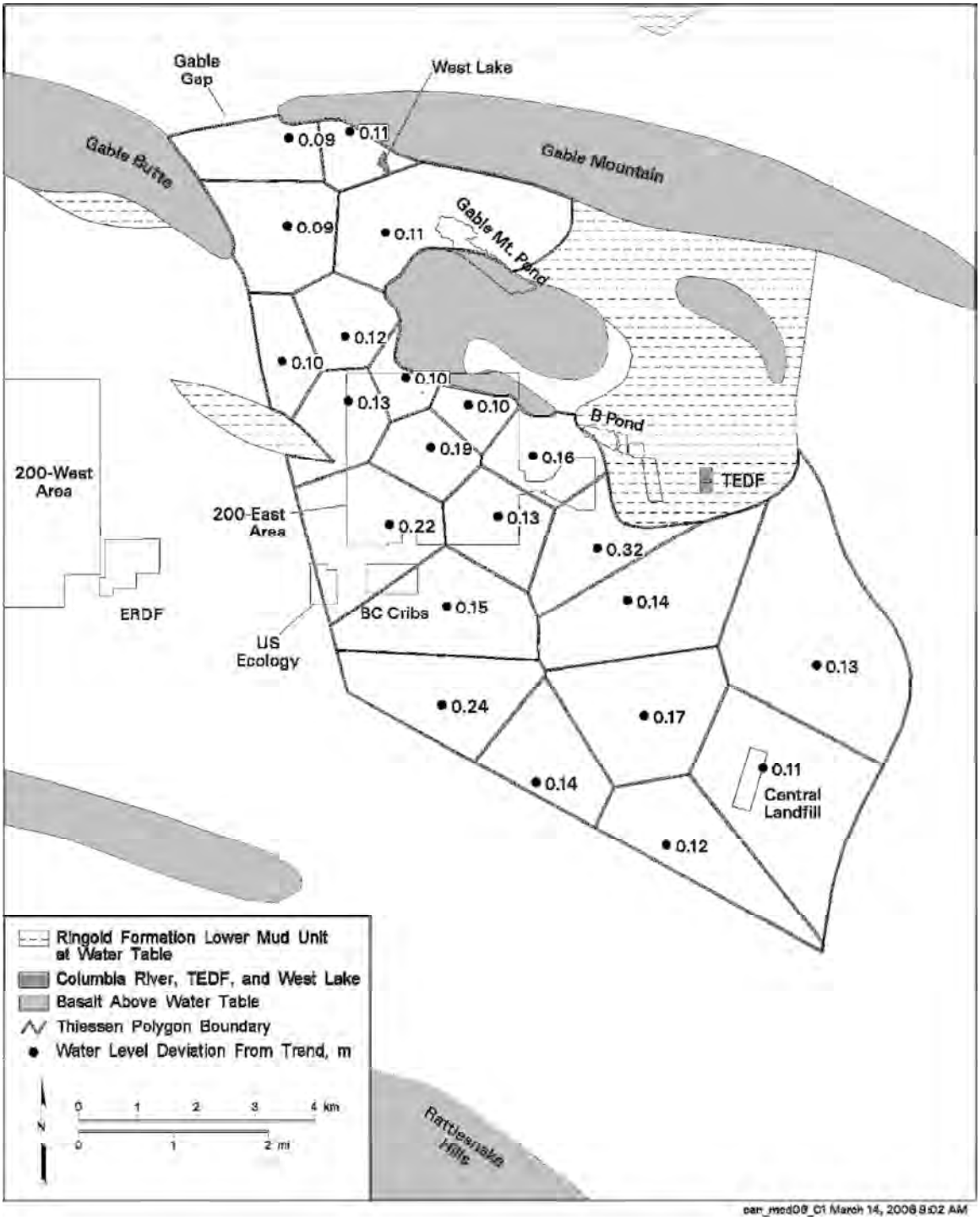

Figure 8 Map of the study area showing the Thiessen polygons used for the groundwater storage change estimate. Also shown are the wells used in the storage change estimate along with the difference (in meters) between the observed March 2003 water-level elevation and the projected elevation assuming the historical rate of decline was unchanged (see Figure 9). See Table 1 and Figure 6 for well names.

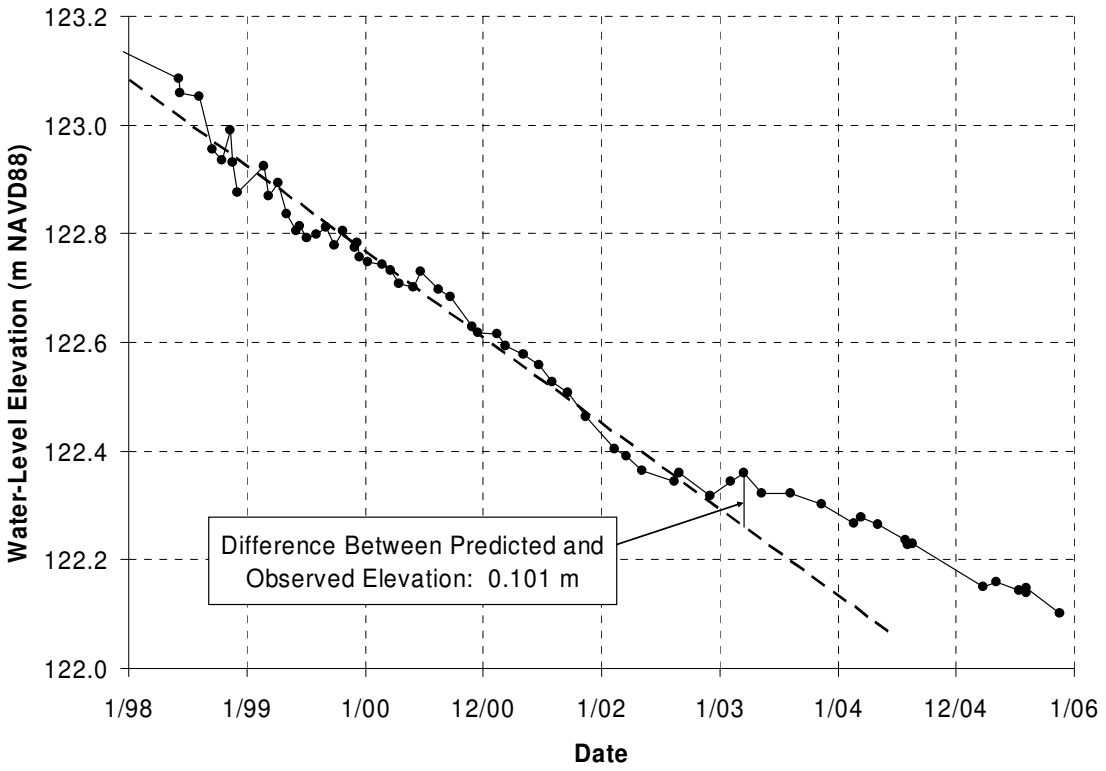

Figure 9. Hydrograph for well 299-E33-7 showing the extrapolated water-table elevation for March 2003 based on historical declines and the measured water-table elevation for March 2003.

Values of total porosity and effective porosity can be used to estimate specific yield. Total porosity is the fraction of a rock or soil sample that consists of pore space, and is an upper bound to specific yield. Effective porosity is defined as that portion of the total pore space available for fluid flow (Fetter 1988). It excludes non-interconnected pores, dead end pores, and the pore space holding water by capillary forces. The specific yield is also that portion of the total porosity that excludes non-interconnected pores, dead-end pores, and the pore space holding water by capillary forces, because water in this pore space will not be yielded under gravity drainage. Therefore, effective porosity is a good approximation of specific yield, and either can be used as the storativity term in Equation 2.

Representative specific yield or effective porosity estimates for the unconfined aquifer in the study area are limited. Only a few measurements are available for the entire Hanford Site, and many of the measurements may have large uncertainties for the area investigated. The water table in the paleochannel occurs within the Hanford formation. Wurstner et al. (1995) estimated that specific yield for the Hanford formation sediments ranges from 0.1 to 0.3. Newcomb et al. (1972) calculated an effective porosity of 0.11 for both the B Pond groundwater mound and the 200 West Area mound using effluent discharge data along with the growth of the mounds from 1948 to 1953.

However, the B Pond facility is to the north of the paleochannel, and it is known that there are mud units present at B Pond that are not at the water table in the paleochannel. In addition, many of the wells surrounding B Pond were completed in a semi-confined unit and the water-level data from these wells was historically analyzed as if the wells were in an unconfined unit (Williams et al. 2000). Therefore, an effective porosity of 0.11 may not be representative of the paleochannel. Wurstner et al. (1995) calculated a specific yield of 0.17 for the unconfined aquifer beneath the 200 West Area based on the dissipation of the groundwater mound from 1985 to 1995. However, this area is to the west of the

paleochannel where the water table occurs in the Ringold formation. Wurstner et al. (1995) also summarized historical specific yield data determined from multiple well aquifer tests across the entire Hanford Site, and provided a range of 0.01 to 0.37 with an average of 0.15. Only one of these wells was within the paleochannel (699-55-50A), which yielded a value of 0.2. A specific yield estimate of 0.13 was reported by Spane and Newcomer (2004) from a single-well, constant rate pumping test conducted at well 299-E26-10, which is located within the paleochannel region. Holdren et al. (1995) provided model input parameters for various environmental settings on the Hanford Site. For the 200-East environmental setting, which encompasses the paleochannel south of Gable Gap to the central part of the site, they provide values of 0.18 for total porosity and 0.10 for effective porosity. However, the boundaries of the 200-East setting encompass more than just the paleochannel, so these values may not be representative of the channel itself. Based on this information, storativity within the study area was assumed to range from 0.10 to 0.20.

The results of applying Equation 2 to estimate the groundwater storage change are shown in Table 1. The volume of additional water in storage above what would have been in storage had the historical rate of water-level elevation decline continued unchanged, was estimated to range from 1.1×10^9 to 2.3×10^9 liters.

Table 1. Results of calculating the groundwater storage change estimate within the study area using the Thiessen polygon method.

Polygon (Well)	Area (m^2)	Water-Level Difference (m)	Storage Chg. (L) (S = 0.1)	Storage Chg. (L) (S = 0.2)
299-E17-14	2.52×10^6	0.125	3.15×10^7	6.30×10^7
299-E18-1	4.33×10^6	0.223	9.66×10^7	1.93×10^8
299-E26-4	2.30×10^6	0.156	3.58×10^7	7.16×10^7
299-E28-4	1.81×10^6	0.194	3.51×10^7	7.02×10^7
299-E32-5	2.22×10^6	0.135	2.99×10^7	5.99×10^7
299-E33-7	8.92×10^5	0.101	8.98×10^6	1.80×10^7
299-E34-2	9.82×10^5	0.102	1.00×10^7	2.00×10^7
699-20-39	4.02×10^6	0.123	4.94×10^7	9.88×10^7
699-24-46	2.87×10^6	0.144	4.12×10^7	8.24×10^7
699-25-34C	6.98×10^6	0.112	7.79×10^7	1.56×10^8
699-28-40	4.93×10^6	0.166	8.17×10^7	1.63×10^8
699-28-52A	3.99×10^6	0.245	9.76×10^7	1.95×10^8
699-31-31	9.57×10^6	0.132	1.27×10^8	2.53×10^8
699-34-41B	5.77×10^6	0.140	8.05×10^7	1.61×10^8
699-34-51	4.48×10^6	0.149	6.70×10^7	1.34×10^8
699-37-43	2.73×10^6	0.324	8.85×10^7	1.77×10^8
699-47-60	1.68×10^6	0.100	1.68×10^7	3.37×10^7
699-49-57A	2.04×10^6	0.120	2.45×10^7	4.91×10^7
699-55-55	5.77×10^6	0.114	6.57×10^7	1.31×10^8
699-55-60A	3.32×10^6	0.089	2.97×10^7	5.93×10^7
699-60-57	1.18×10^6	0.110	1.29×10^7	2.59×10^7
699-60-60	2.29×10^6	0.095	2.17×10^7	4.34×10^7
Totals	7.7×10^7		1.1×10^9	2.3×10^9

5.0 Hypothesis Evaluations

In this section, each hypothesis identified in Section 3.0 is evaluated. Many of the evaluations rely on simple visual comparisons between graphs of the hypothesized stressor and the observed water-level elevation response, and are therefore somewhat subjective. Employing various statistical methods (e.g., statistical correlation, multivariate analysis, or convolution/deconvolution techniques) would be a more rigorous method of evaluating these hypotheses, but the level of effort required to implement these techniques is beyond the scope of this work. In addition, many of these techniques require frequent water-level elevation data collected at regular intervals. Such a data set is currently not available for the study area, because only a few measurements are collected per year in the wells. Using the available data set would necessitate interpolation between measurements, which may result in artificial or unrealistic trends in the data, and increased uncertainty in the results. A network of automated water-level recording equipment was recently installed in the northwest corner of the 200 East Area (at Low-Level Waste Management Area 1), with data collection beginning on September 1, 2005. After measurements are collected for a sufficient time period, this dataset will be available to further evaluate some of these hypotheses.

An increase in natural recharge directly from the overlying vadose zone due to higher than normal precipitation during the winter of 2002/2003 or some earlier period.

To assess the feasibility that infiltration of precipitation through the vadose zone overlying the study area could have caused the observed 2002-2003 water-table fluctuation, the time required for precipitation to migrate from land surface to the water table was estimated. The average linear velocity of a fluid migrating through a porous medium is given by (Fetter 1988):

$$v = \frac{Q}{n_e \cdot A} \tag{3}$$

where v is the average linear velocity (meters/year), Q is the volumetric water discharge (cubic meters/year), A is the cross-sectional area of flow (square meters), and n_e is the effective porosity (fraction). The quantity Q/A is the specific discharge (meters/year), which for the vadose zone, is the amount of deep-drainage percolation (i.e., amount of precipitation less water lost from the surface soil by evapotranspiration). For unsaturated flow in the vadose zone, the equivalent parameter for effective porosity is the volumetric water content, which is the volume of water present in a soil sample divided by the bulk volume of the sample (Fetter 1988). An expression for travel time was developed by using i to represent deep-drainage percolation and θ to represent the volumetric water content, expressing velocity as distance (x, meters) divided by time (t, years), and substituting these parameters into Equation 3 and solving for time:

$$t = \frac{x \cdot \theta}{i} \tag{4}$$

This equation is only applicable under a unit hydraulic gradient, which is generally considered to be a valid simplifying assumption for screening-level analyses (e.g., see Whelan et al. 1996).

Conservative values that minimize the travel time were used in Equation 4. Within the study area, the highest deep-drainage percolation occurs at the 200 East Area. The minimum vadose zone thickness in the 200 East Area is about 75 meters. The volumetric water content was assumed to be equal to field capacity, the minimum moisture content at which gravity drainage ceases (Fetter 1988). Holdren et al. (1995) provides field capacity values of 0.19 and 0.085 for different vadose zone layers in the

200 East environmental setting. A value of 0.085 was used in Equation 4. Deep-drainage percolation for the 200 East Area has been estimated to range from 5 to 10 centimeters/year (Fayer and Walters 1995) – 10 centimeters/year (0.10 meters/year) was used in Equation 4. The result is a travel time of 64 years for precipitation to migrate from land surface to the water table. In the northern part of the study area at Gable Gap, the vadose zone is only about 35 meters thick. However, the deep-drainage percolation in this area is lower, and is estimated to be 0.5 to 1 centimeter/year (Fayer and Walters 1995). Using 1 centimeter/year (0.01 meters/year) with a travel distance of 35 meters and the same field capacity of 0.085, the travel time is approximately 300 years. Because conservative values were used in Equation 4, actual travel times are expected to be longer. Therefore, it is not possible for precipitation occurring in recent times to migrate through the vadose zone and affect the water table within the study area. In addition, higher than normal precipitation in earlier times should also have no obvious effect on the water table. The migration of precipitation through the vadose zone occurs over much longer time intervals than periods of variation in natural precipitation (i.e., temporally far-field conditions). Longitudinal dispersion in the vadose zone would, therefore, smooth out variations in precipitation resulting in a uniform rate of recharge reaching the water table.

An increase in groundwater recharge into the study area from a region of water-table elevation increase along the Rattlesnake Hills.

Between March 2002 and March 2003, the water-table elevation increased along the Rattlesnake Hills (Figure 5). The groundwater flow direction in this area is northeast toward the paleochannel. Increasing water-level elevations along the Rattlesnake Hills combined with decreasing water levels in the paleochannel cause an increase in the magnitude of the hydraulic gradient and an increase in groundwater recharge to the paleochannel.

Recharge can be estimated using Darcy's Law (Fetter 1988):

$$Q = K \cdot A \cdot \frac{dh}{dl} \cdot 365{,}250 \qquad (5)$$

where Q is the recharge (liters/year), K is the hydraulic conductivity (meters/day), A is the cross-sectional area of flow (square meters), dh/dl is the hydraulic gradient (meter/meter), and the scalar (365,250) converts from cubic-meters/day to liters/year. Hydrologic testing has been performed at two wells in this area: 699-17-47 and 699-8-32 (Thorne and Newcomer 1992). The hydraulic conductivity was reported as 18 feet/day (5.5 meters/day) at 699-17-47, and 20 feet/day (6.1 meters/day) at 699-8-32. Based on these test results, a value of 6 meters/day was used in Equation 5. The width of the region of water-level elevation increase was estimated at 6,000 meters. The aquifer thickness was estimated as the distance from the water table to the uppermost mud unit. A value of 20 meters was chosen based on inspection of well logs for 699-8-32 (>14 meters aquifer thickness), 699-2-33A (18 meters), and 699-17-47 (15 meters). This gives a cross-sectional area of 120,000 square meters. Hydraulic gradients were computed using a least squares fit of a plane to the water-level elevation data for wells 699-11-45A, 699-19-43, 699-2-33A, and 699-8-32, using the spreadsheet developed by Devlin (2003). From 2000 to 2005, the hydraulic gradient gradually increased, with no appreciable change in the rate of increase from 2002 to 2003. The hydraulic gradient was 1.78×10^{-3} during early April 2002, and 1.82×10^{-3} during early April 2003.

Using these values in Equation 5 provides a discharge of 4.7×10^{8} liters during April 2002 and 4.8×10^{8} liters during April 2003, for a difference of 1.0×10^{7} liters. This is approximately 2 orders of magnitude below the groundwater storage change estimate of 1.1×10^{9} to 2.3×10^{9} liters. Therefore, it

does not seem feasible that increased recharge emanating from the Rattlesnake Hills area can account for the observed water-table fluctuation.

An increase in artificial recharge due to a water line leak in the 200 East Area on 11/30/2002.

On November 30th, 2002, a leak occurred in an 8-inch potable water line at the intersection of 4th and Baltimore in the southwestern part of the 200 East Area. Fluor Hanford Utilities estimated the volume leaked at 1.3×10^5 liters over a period of 78 minutes (1700 liters/minute). This is four orders of magnitude below the estimated amount of additional water in storage in the aquifer of 1.1×10^9 to 2.3×10^9 liters. At 1700 liters/minute, 450 to 940 days would have to elapse to produce the volume of water required. If only a small area of the aquifer is considered, say 200 meters by 200 meters, the volume reported to have leaked would have raised the water-table elevation by only 1.6 cm to 3.3 cm (assuming storativity values of 0.10 and 0.20 and that all the water leaked reached the water table quickly). Therefore, while it may be possible that this leak temporarily raised the water-table elevation by a small amount in a limited area surrounding the leak, it is not feasible that this leak produced or contributed to the 2002-2003 water-table fluctuation observed throughout the paleochannel.

An increase in artificial recharge due to effluent disposal at the Treated Effluent Disposal Facility (TEDF).

Effluent release volumes to the TEDF for one-year periods beginning in April 1995 (when discharges to the TEDF began) are shown in Figure 10 (note: data from discharge monitoring reports in the Administrative Record and Public Information Repository, available online at http://www2.hanford.gov/arpir/). The discharge volumes for April 2002 to March 2003 and for April 2003 to March 2004 were higher than the average annual release volume of 7.4×10^8 liters. One method of evaluating the effect of these discharges is to compare the discharge volume with observed water-level elevation trends. Such a comparison is valid because the travel time for effluent to reach the aquifer is short due to the large volumes disposed of to the TEDF. Figure 11 shows monthly discharge volumes at the TEDF along with the water-level elevation trend for well 299-E33-32 located at Waste Management Area B-BX-BY (5.5 kilometers from TEDF - chosen because water-level measurements are collected frequently in this well making a large dataset available for comparison). Because the TEDF came online in April 1995, discharges to this facility were not the only cause of the 1994 to 1997 fluctuation (which began over a year earlier). However, visual inspection shows that there appears to be an association between periods of higher than normal release volumes to the TEDF and fluctuations in the water table elevation. Periods of higher than normal discharge volumes occurred in late 1997 through early 1998, and again in late 2002 to mid-2004. The increased volume of discharge in 1997/1998 probably had little effect on the water table, because the total volume of effluent released to ground in the 200 East Area during 1997 (1.4×10^9 liters) was significantly less than the amount released during 1996 (5.6×10^9 liters) and in the preceding years. This factor probably was a much more dominant effect on the water-table elevation than increased discharge to TEDF.

Figure 12 shows the TEDF effluent discharges and well water-level elevations for 299-E33-32 in more detail for the 2002-2003 fluctuation. From the latter half of 2002 through early 2004, whenever a large volume of effluent was released to the TEDF, the water-table elevation trended upward shortly thereafter. Between periods of large effluent releases, the water-table elevation trended downward. The large release in March 2005 did not result in an increase in the water-table elevation at 299-E33-32, but the trend showed a smaller decrease. This same apparent association of the water table elevation to large releases of effluent at the TEDF can also be seen in other 200 East Area wells closer to the TEDF site, e.g., 699-37-47A (3.2 kilometers from TEDF), in which the water-table elevation did increase following the March 2005 release (Figure 13). This data suggests that effluent releases to the TEDF do have an impact on the water table elevation in the study area.

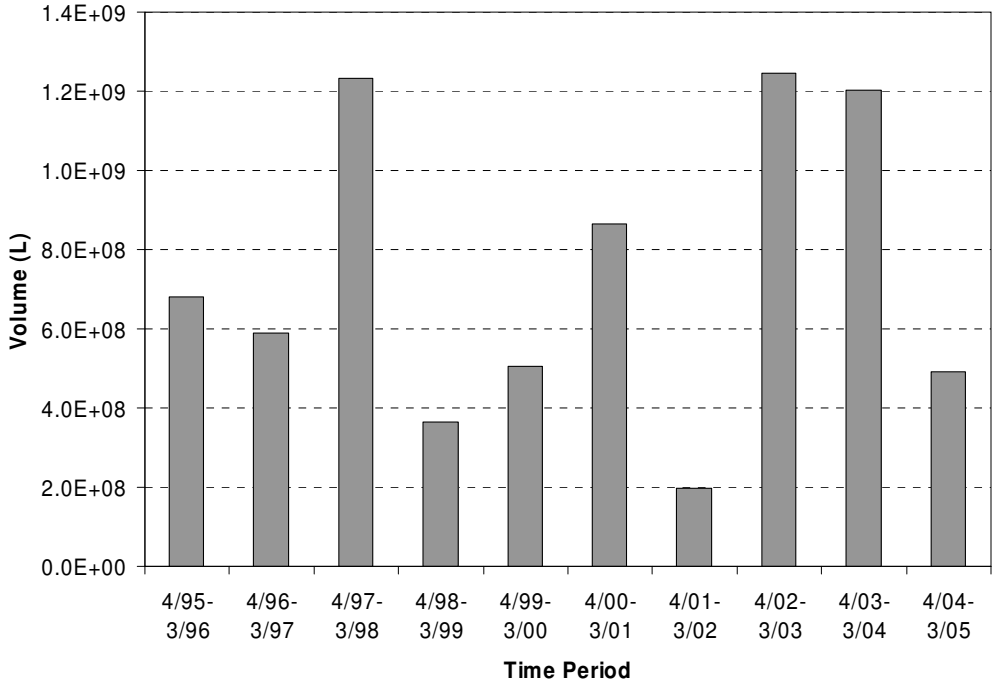

Figure 10. One-year effluent release volumes disposed of at the 200 Areas Treated Effluent Disposal Facility (TEDF) since releases began in April 1995.

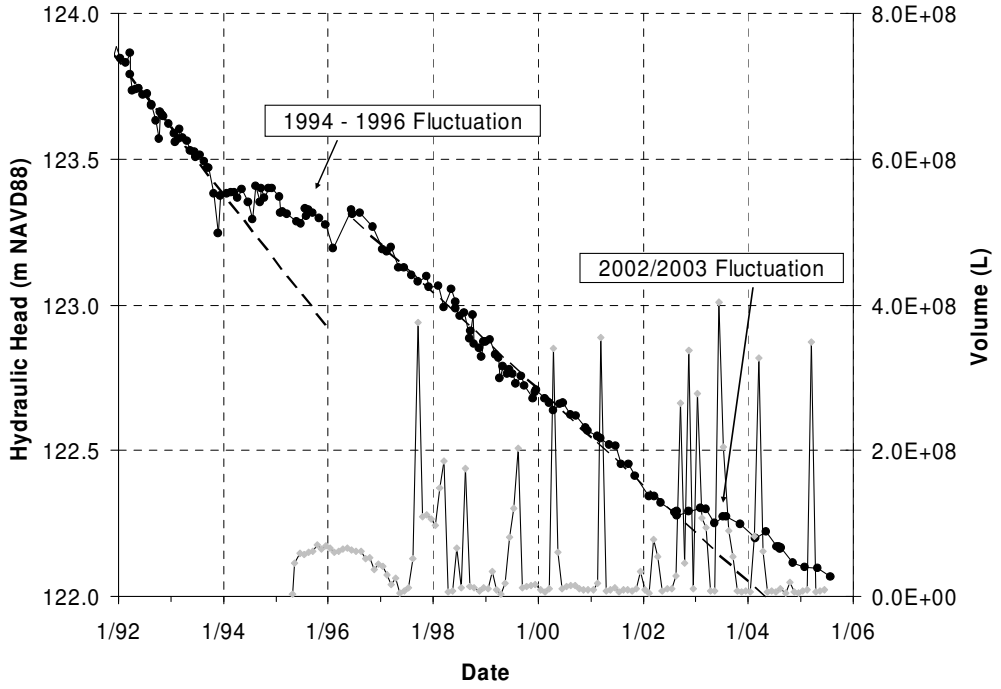

Figure 11. Comparison of hydraulic head in well 299-E33-32 (black circles) in the northwest part of the 200 East Area with monthly effluent discharge volumes at the 200 Areas Treated Effluent Disposal Facility (TEDF) (gray diamonds).

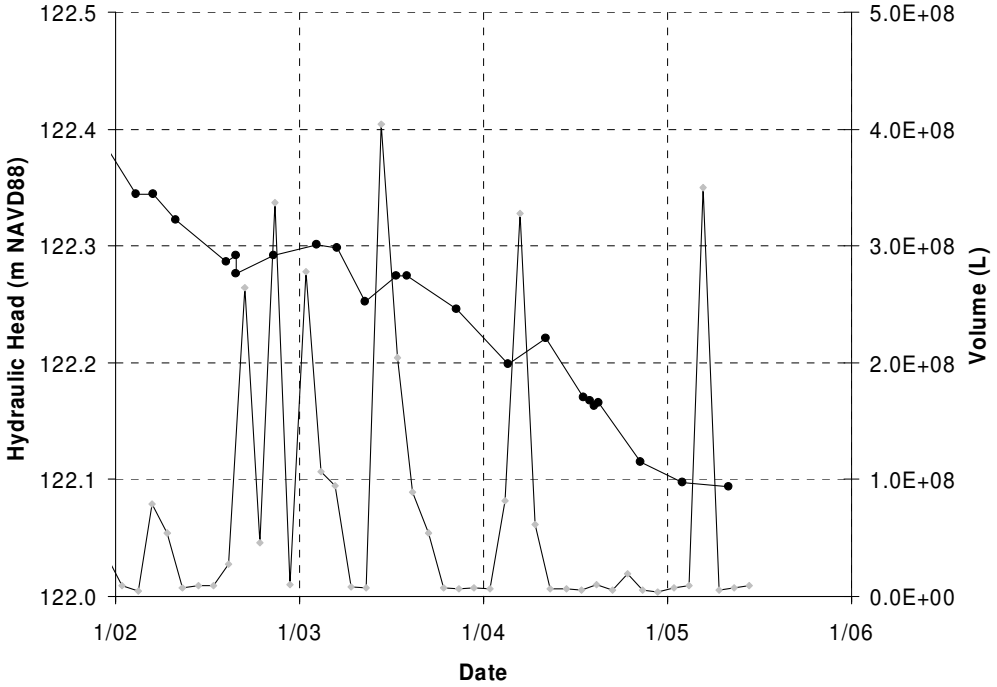

Figure 12. Well water-level elevation in 299-E33-32 (black circles) and monthly effluent discharge volumes at the 200 Areas Treated Effluent Disposal Facility (TEDF) (gray diamonds) for the 2002-2003 water-table fluctuation.

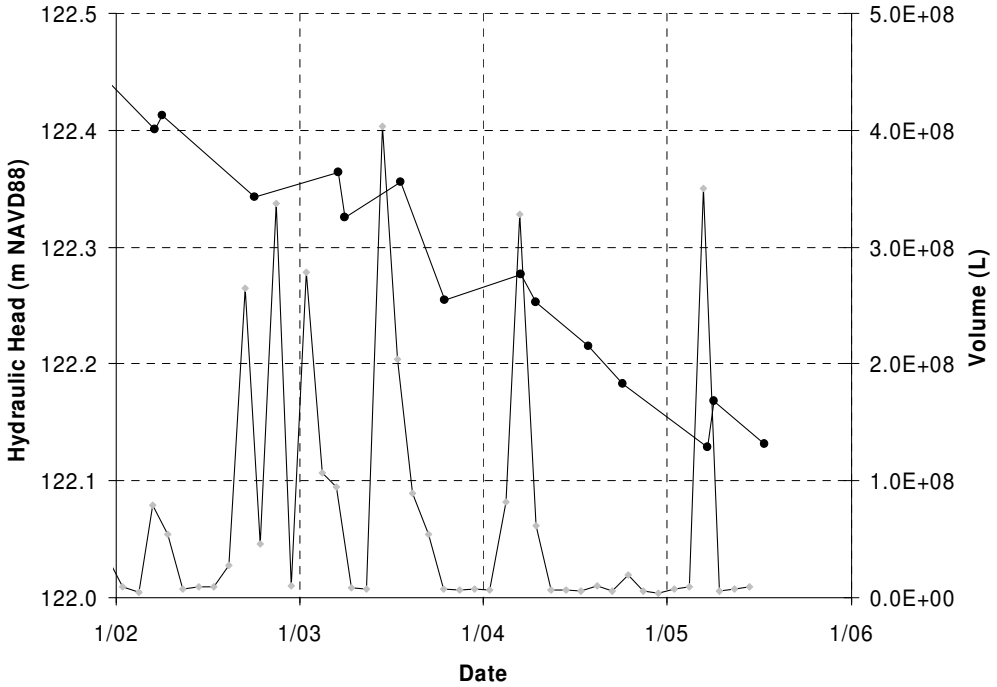

Figure 13. Well water-level elevation in 699-37-47A (black circles) and monthly effluent discharge volumes at the 200 Areas Treated Effluent Disposal Facility (TEDF) (gray diamonds) for the 2002-2003 water-table fluctuation.

To assess whether the higher than normal release volumes to TEDF account for the groundwater storage change, a volumetric comparison was made The storage change estimate of 1.1×10^9 to 2.3×10^9 liters is for the period of March 2002 to March 2003. Considering the four one-year periods beginning in April 1998 through March 2002, the average effluent volume per year disposed of to the TEDF was 5.0×10^8 liters. From March 2002 to March 2003, 1.2×10^9 liters of effluent were disposed of, which is an increase of 7.0×10^8 liters above average. This is 4.0×10^8 to 1.6×10^9 liters below the storage change estimate. The groundwater storage change estimate does have some error associated with it however, mostly because the storativity is not known – a range of 0.1 to 0.2 was assumed. However, for the higher than normal TEDF release volumes to account for all of the groundwater storage change, the storativity for the aquifer would have to be 0.06, which appears to be unrealistically low (see the discussion of storativity in Section 4.0). Therefore, it is reasonable to conclude that higher than normal effluent releases to the TEDF were a significant contributor to the 2002-2003 water-table fluctuation, but these releases do not fully account for the groundwater storage change within the aquifer.

An increase in artificial recharge due to waste water discharges to ground at the Waste Treatment Plant construction site.

Construction of the Waste Treatment Plant (WTP) began with site clearing excavations during October 2001. The site is located just east of the 200 East Area boundary. Fluor Hanford (2003) lists four ponds associated with the WTP site: Process Pond #1, Process Pond #2, Area #1 Stockpile Pond, and Area #2 Crusher Pond. However, it is unclear how much these ponds were used during the year, if at all. Hydrotest, maintenance, and construction water was discharged to ground, and presumably this includes dust control water. Water use at the site is not metered, so the amount of water discharged to ground is unknown, which makes it difficult to assess the impact of these discharges on the water table.

From examining an April 2002 aerial photograph of the WTP site, water was clearly being used for dust control on the roads, but there is no other evidence of obvious large-scale water use. The concrete mixing and gravel plants were yet to be established, and no ponds were evident. In a December 2003 aerial photograph, only a single dry pond was identified (estimated to be about 5 meters in diameter), although the northwest and southeast corners of the site were cropped off the photograph. Based on these observations, it seems unlikely that effluent was discharged to ground in sufficient quantities to impact the water table. However, the hypothesis that effluent discharges from WTP construction influenced the 2002-2003 water-table fluctuation cannot be definitively ruled out, because the actual volume of the discharges is unknown.

Decreased discharge from the 200 East Area vicinity caused by a gradient effect associated with changes in Columbia River stage (i.e., bank storage effects).

Figure 14 shows the water-level elevation trends at wells 699-60-60 in Gable Gap and 299-E33-32 in the northwest portion of the 200 East Area, along with monthly average discharge in the Columbia River. For the higher monthly discharges occurring in 1996, 1997 and 2002, there appears to be an association between increased river discharge and the water-table elevation at Gable Gap and in the 200 East Area. This observation suggests that long-term changes in average Columbia River stage may be affecting the water-table elevation in the 200 East Area, and at locations even more distant from the river.. The hypothesis is that during years of higher than normal flow in the Columbia River (and thus, higher than normal stage), the hydraulic gradient through Gable Gap decreases (because the water-table elevation north of the gap rises) which reduces the amount of groundwater discharging to the north through the gap. This would lead to a relative change in the amount of water in storage along the paleochannel south of Gable Gap causing a fluctuation in the water-table elevation.

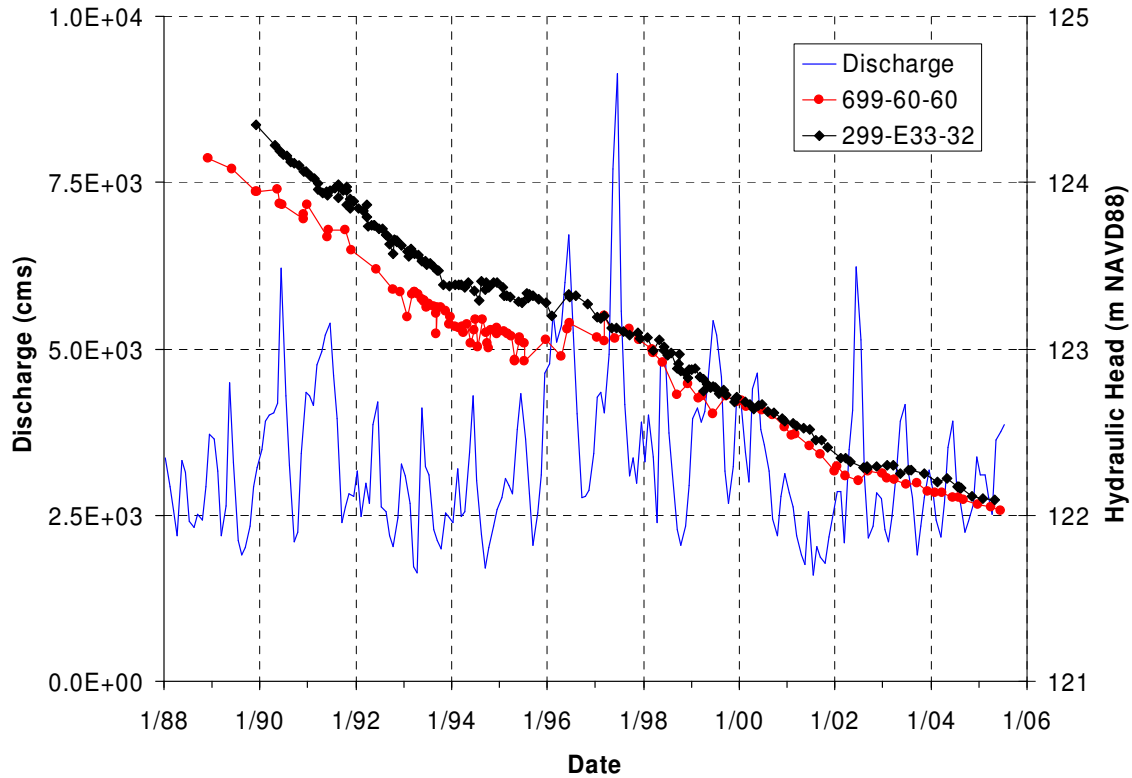

Figure 14. Monthly average discharge in the Columbia River (from USGS station 12472800 south of Priest Rapids Dam) compared to the water-level elevation at Gable Gap (well 699-60-60) and the 200 East Area (well 299-E33-32).

Ferris (1952) mathematically related changes in river stage to corresponding water-table changes in the adjacent aquifer, assuming that the river stage fluctuates in a sinusoidal manner. The following equation provides the range of water-table fluctuation at an observation well at some distance from a river boundary (Ferris 1952):

$$S_r = 2 \cdot s_o \cdot e^{-x \cdot \left(\frac{\pi \cdot S}{t_o \cdot T} \right)^{\frac{1}{2}}} \tag{6}$$

where S_r is the range of water-table fluctuation at the observation well (meters), s_o is the amplitude (or half-range) of the river stage fluctuation (meters), x is the distance from the river boundary to the observation well (meters), S is the storativity (unitless), t_o is the period of the stage fluctuation (years), and T is the transmissivity of the aquifer (square-meters/year). The time lag of a given maximum or minimum, t_l (years), is given by (Ferris 1952):

$$t_l = x \cdot \left(\frac{t_o \cdot S}{4 \cdot \pi \cdot T} \right)^{\frac{1}{2}} \tag{7}$$

Inspection of Equation 6 will reveal that lower frequency fluctuations (i.e., longer stage-fluctuation periods, t_o) will result in larger water-table fluctuations at an observation well (S_r). Therefore, lower frequency fluctuations will penetrate to greater distances from the river boundary. This is consistent with the hypothesis that long-term changes in river stage (i.e., high-water years) may be affecting the water-table within the paleochannel south of the Gable Gap region, whereas short-term fluctuations (i.e., monthly) would not.

Equations 6 and 7 were employed to assess the feasibility that long-term changes in Columbia River stage could affect the water-table in the 200 East Area (10 kilometers from the river). The storativity is assumed to range from 0.1 to 0.2, and the distance from the river boundary to the 200 East Area is about 10,000 meters. The amplitude of the stage fluctuation is roughly estimated to be about 0.5 meters for 2002, and the period is assumed to be 1 year (based on river stage measurements collected at the 100-B,C Area). Transmissivity estimates for the paleochannel are taken from a steady-state, two-dimensional groundwater flow model calibration (Vermeul et al., 2001), and range from 40,000 to 125,000 square-meters/day (1.5×10^7 to 4.6×10^7 square-meters/year). However, transmissivity along the river near the 100-B,C Area is less, and ranges from 1,250 to 10,000 square-meters/day (4.6×10^5 to 3.6×10^6 square-meters/year). Table 2 gives the results of applying Equations 6 and 7 to all four of these transmissivity estimates, and Figure 15 shows the results of Equation 6 for a range of transmissivity values up to 150,000 square meters/day (5.5×10^7 square meters/year).

Table 2. Estimated range of the water-table fluctuation in the 200 East Area due to long-term changes in Columbia River stage, using the method of Ferris (1952).

Transmissivity (m^2/day)	Range of Water-Table Fluctuation (cm)	Time Lag of Water-Table Fluctuation (months)
	Storativity = 0.1	
1,250	0.025	16
10,000	5.3	5.6
40,000	23	2.8
125,000	44	1.6
	Storativity = 0.2	
1,250	.00080	22
10,000	1.6	7.9
40,000	13	4.0
125,000	31	2.2

There are some limitations in applying the Ferris method. Long-term changes in river stage are not necessarily sinusoidal. However, according to Ferris (1952), it has been shown that "these methods can also be applied with fair results to variations that resemble periodic motion but are limited in duration to a single maximum or minimum." In addition, the Ferris equations assume the aquifer is bounded at the river and is of infinite lateral extent elsewhere. This is not the case for the 200 East Area because Gable Butte and Gable Mt. serve as no flow boundaries between the 200 East Area and the river. It can be reasoned that the effect of Gable Butte and Gable Mt. would be to attenuate the river stage pulse, so that the actual effect on the aquifer would be less than shown in Figure 15 and Table 2. However, the degree of this attenuation is not known. Limitations notwithstanding, the results in Figure 15 and Table 2 demonstrate that it is within the realm of possibility that the water table elevation beneath the 200 East Area may fluctuate in response to river stage changes, as long as the representative transmissivity between the 200 East Area and the river is about 10,000 square meters/day or greater. It should be noted that as the water-table elevation continues to decline in the paleochannel, the transmissivity of the aquifer will decline (since transmissivity is dependent on aquifer thickness). Any effect that river stage has on

the water-table elevation in the paleochannel depends on the transmissivity of the aquifer. Thus, if river stage effects are occurring in the paleochannel south of Gable Gap, that effect may diminish over time due to the declining water-table elevation.

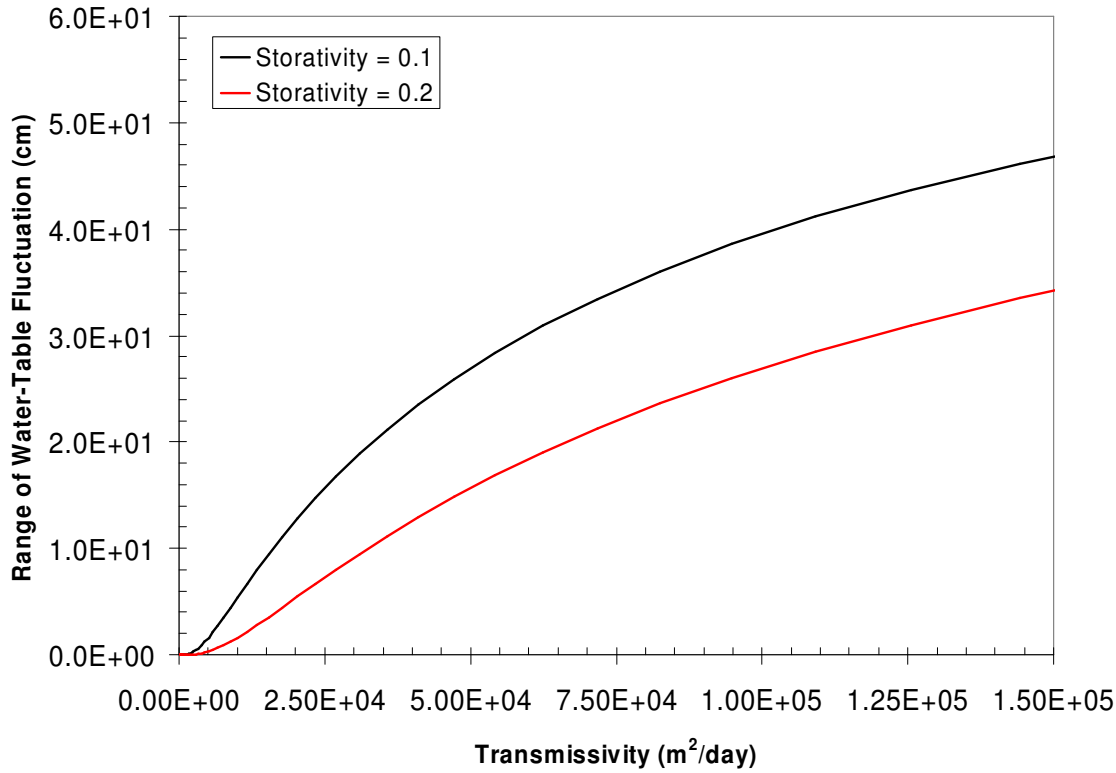

Figure 15. Theoretical range of water-table fluctuation for the 200 East Area (10 kilometers from the Columbia River) due to long-term changes in river stage as a function of transmissivity based on the method of Ferris (1952). The amplitude of the river stage fluctuation is assumed to be 0.5 meters over a period of one year.

Another method of assessing the feasibility of this hypothesis is to estimate the discharge of groundwater through Gable Gap, and compare this to the groundwater storage change estimate. If the annual discharge through the gap is small, then reducing this discharge would not have an appreciable effect on the water table south of the gap. However, if the discharge is large, then only a small change in that discharge may produce a water table fluctuation.

To estimate the discharge through Gable Gap, Darcy's Law was again used (Fetter 1988):

$$Q = K \cdot A \cdot \frac{dh}{dl} \cdot 365{,}250 \qquad (8)$$

where Q is the discharge (liters/year), K is the hydraulic conductivity (meters/day), A is the cross-sectional area of flow (square meters), dh/dl is the hydraulic gradient (meter/meter), and the scalar (365,250) converts from cubic-meters/day to liters/year. The width of the aquifer through the gap is the distance between the basalt subcrops above the water table, which is about 1800 meters. However, the aquifer becomes thinner near the basalt outcrops, so a more representative value of 1400 meters was used in Equation 8. The aquifer thickness was estimated at 20 meters based on basalt elevations determined

from wells 699-61-62 and 699-61-66 and a water-table elevation of 122 meters (NAVD88). Using these values, the cross-sectional area of flow is estimated to be 28,000 square meters. As mentioned above, transmissivity values through the gap are between 40,000 and 125,000 square-meters/day. Dividing by an aquifer thickness of 20 meters gives a hydraulic conductivity range of 2,000 meters/day to 6,250 meters/day. The hydraulic gradient was determined using water-level measurements from wells 699-60-60, 699-61-62, 699-61-66, and 699-64-62 using the spreadsheet developed by Devlin (2003). The gradient has been fairly stable since the year 2000 at an average of 1.5×10^{-4} (with an average direction of 354 degrees).

The estimated annual discharge through Gable Gap as a function of hydraulic conductivity is shown in Figure 16. Over the hydraulic conductivity range of 2,000 to 6,250 meters/day, the estimated annual discharge is 3.1×10^9 to 9.6×10^9 liters. These values are larger than the storage change estimate for the paleochannel south of the gap, less the additional water added by the TEDF (4.0×10^8 to 1.6×10^9 liters). Therefore, it appears physically possible that a reduction of flow through Gable Gap could have caused the 2002-2003 water-table fluctuation within the paleochannel.

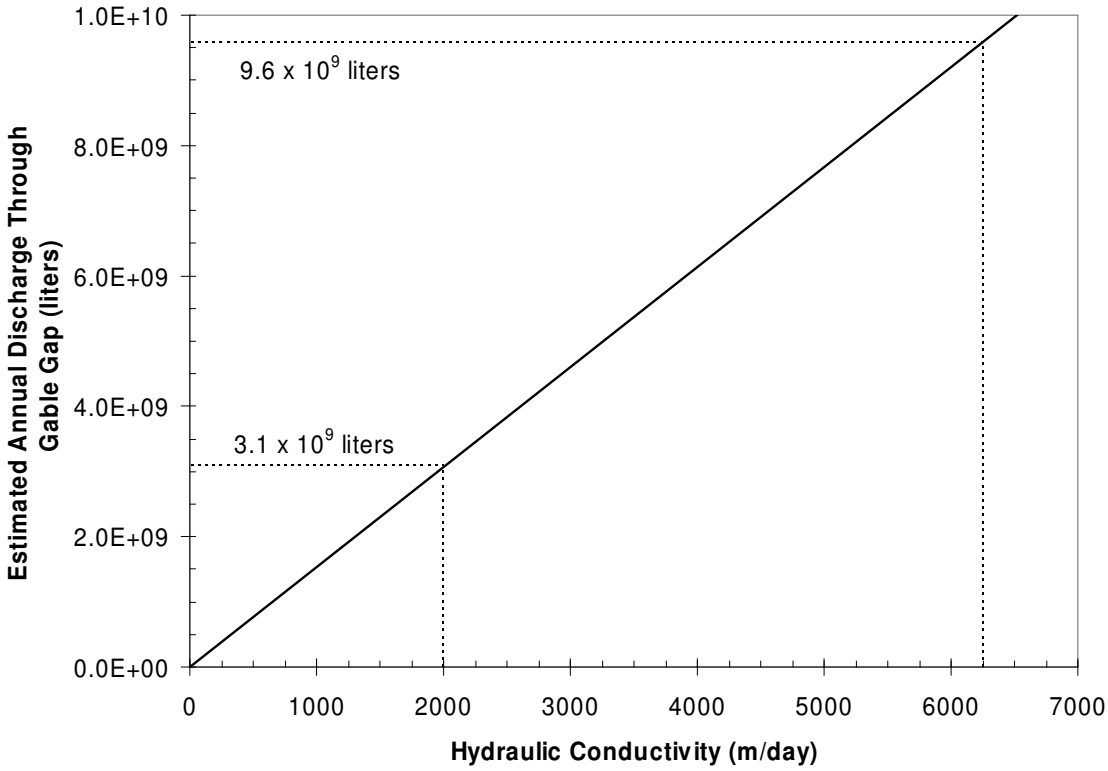

Figure 16. Estimated groundwater discharge north through Gable Gap as a function of hydraulic conductivity.

While it appears feasible that changes in river stage can affect the water-table elevation in the paleochannel, for this effect to occur, the hydraulic gradient in Gable Gap must be reduced during the period in which a water-table fluctuation occurs. Previous researchers have concluded that changes in Columbia River stage have affected the water table within the Gable Gap area. Olaf P. Jenkins conducted the first detailed hydrogeologic investigation within what would become the Hanford Site. He states on page 13 of his report (Jenkins 1922):

> *Another old conspicuous channel occurs on the south and east side of Gable Mountain. In its lowest point there is a spring* [West Lake] *which is said to flow during the time of the year when the river is higher than it was when this investigation was made* [October 19th to 26th, 1921]. *The elevation of the position of this spring is 400 feet, which is a little higher than the water table was found to be at that time, and that fact probably accounts for the spring not issuing when the river is low.*

The spring referred to, West Lake, is about 1 kilometer to the east of Gable Gap along the south side of Gable Mt. (see Figure 6). In referring to bank storage effects from the Columbia River at Hanford, Newcomb et al. (1972) state on page 31:

> *In most years the levels of the bank-stored ground water south of Coyote Rapids* [100-K Area] *become sufficiently high to cause a natural ground-water gradient through the gravel-filled gap between Gable Mountain and Gable Butte and to increase the gradient southeastward in the glaciofluviatile and fluviatile deposits south of Gable Mountain. Prior to the time when artificial recharge greatly altered the levels of the ground water in places near Gable Mountain, the southeastward gradient from the bank storage farther north caused the ground water to rise above the 396-foot altitude of the land surface at the spring in the stream-channel scar in the SE 1/4 NW 1/4 sec. 22, T. 13 N., R. 26 E* [West Lake]. *Though records of its level were not maintained, the high level of the spring pond was observed each summer by the authors, 1 or 2 months after the annual flood rise of the Columbia River.*

The authors apparently confirmed the statement in Jenkins (1922) that West Lake responds to seasonal bank storage effects prior to the increase in the water-table elevation by artificial recharge. In Plate 1 of Newcomb et al. (1972), the authors approximate the region of the unconfined aquifer affected by bank storage effects. It includes the area south of Gable Gap to just north of the 200 East Area, although no justification is provided in the text for extending this region to near the 200 East Area.

To assess whether river-stage effects have caused changes in hydraulic gradient conditions at Gable Gap in more recent times, well water levels were analyzed. Figure 17 shows a trend plot of the hydraulic gradient in the gap based on water-level measurements at wells 699-60-60, 699-61-62, 699-61-66, and 699-64-62 (calculated using the spreadsheet of Devlin [2003]), along with measured water-level elevations at well 699-60-60. Seasonal bank storage effects are not evident in this data, but the gradient may be responding to years in which the river flow is greater than normal. The data are inconclusive with regard to the 2002-2003 fluctuation, because at the time the hydraulic head increased in well 699-60-60, there were no additional water-level measurements collected in the gap area to allow for a hydraulic gradient determination.

There is, however, a sharp drop in the hydraulic gradient between the end of 1995 and early 1996, and the hydraulic head in 699-60-60 increased during this time. Subtle fluctuations in the hydrograph for 299-E33-32 also occur during 1996 and again in 1997-1998 (Figure 14). During 1996 and 1997, flow in the Columbia River was much higher than in previous and subsequent years (Figure 14). The drop in the hydraulic gradient at about this time suggests that river stage may have affected the water-table elevation in the paleochannel, at least during 1996. However, the hydraulic gradient remained at this lower value during the following years when Columbia River flows returned to normal. Figure 18 shows the volume of effluent discharged to ground in the 200 East Area by calendar year since 1988. Effluent discharges during 1996 were similar to the previous four years, so it would seem that an increase in river stage is the only plausible mechanism to explain the hydraulic gradient decline in the gap at this time along with the increased water level at 699-60-60. Effluent discharges to ground were significantly reduced in 1997, perhaps explaining why the hydraulic gradient has never returned to its pre-1996 value.

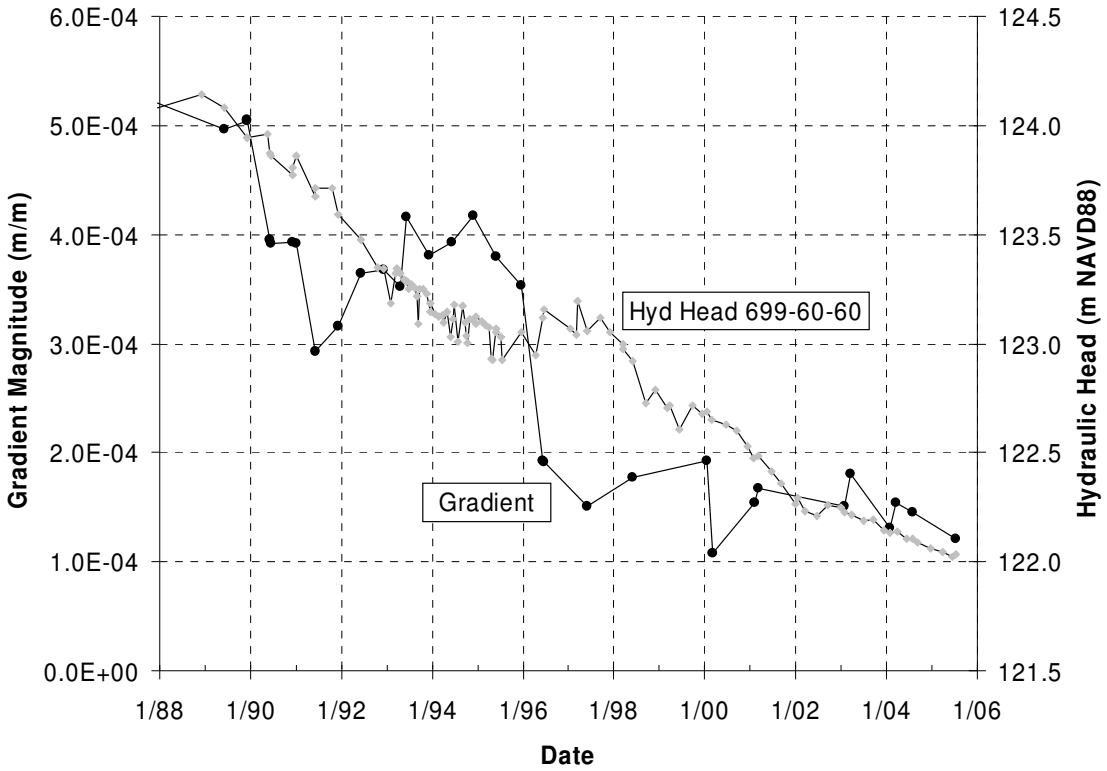

Figure 17. Trend plot of the magnitude of the hydraulic gradient within Gable Gap (black circles) along with the hydraulic head at well 699-60-60 within the gap (gray diamonds).

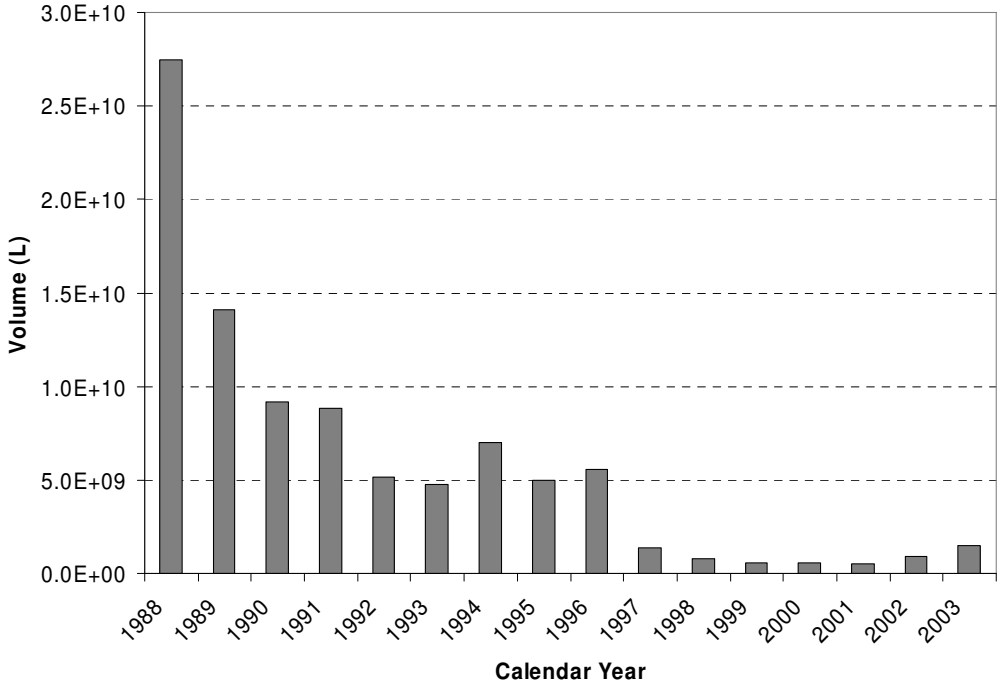

Figure 18. Total volume of effluent discharged to ground in the 200 East Area from calendar year 1988 to 2003 (Waste Treatment Plant construction site discharges not included).

Within Gable Gap, the hydraulic gradient also declined during 1990 and 1991 when discharge in the river was high. However, a corresponding fluctuation in the water-table hydrographs for wells in Gable Gap and the 200 East Area is not evident during 1990 and 1991 (Figure 14). Perhaps effluent discharges were large enough to dominate over river stage effects at that time. Effluent discharges were significantly reduced during 1997, so river stage effects may be more apparent now.

In summary, it appears physically plausible that significant changes in Columbia River stage may result in water-table fluctuations in the paleochannel region south of Gable Gap. However, there are no available data to confirm that this occurred for the 2002-2003 fluctuation. The hydraulic gradient in Gable Gap did respond to seasonal bank storage effects prior to the time when artificial recharge from Hanford operations resulted in a high water-table elevation. Recent data indicates that the hydraulic gradient no longer responds to normal seasonal discharge variations, but it apparently did respond to the higher than normal river stage in 1990-1991 and 1996-1997. A water-table fluctuation in the paleochannel is not evident during 1990-1991, perhaps due to effluent discharges to ground dominating over bank storage effects. Available data suggests that high river stage during 1996 and 1997 may have resulted in a water-table fluctuation in the paleochannel, but the data are not compelling enough to confirm this. Therefore, the validity of this hypothesis and any effect it may have had on the 2002-2003 fluctuation is yet to be determined.

6.0 Conclusion

Of the hypotheses considered, only effluent discharges to the TEDF were conclusively found to have been a factor in the 2002-2003 water table fluctuation. Effluent discharges at the TEDF from April 2002 to March 2003 were 7.0×10^8 L above average, which accounts for about 30 to 65 percent of the groundwater storage change within the aquifer (1.1×10^9 to 2.3×10^9 liters). Assuming the storage change estimate is accurate, the remainder of the water may have been supplied by effluent discharges at the WTP construction site or by bank storage effects associated with higher than normal flow in the Columbia River during 2002, or both. However, neither of these hypotheses could be confirmed or refuted. Long-term changes in Columbia River stage apparently do affect the hydraulic gradient in the Gable Gap region, but it could not be established that this would result in a significant fluctuation to the water-table elevation south of the gap. It is possible that increased effluent discharge to the TEDF was the sole cause of the water-table fluctuation, and that the discrepancy between the TEDF release volume and the storage change estimate is due to inaccuracies in the storage change estimate. Three other hypotheses, namely higher than normal precipitation during the winter of 2002-2003, increased recharge from the Rattlesnake Hills area, and a water line leak in the 200 East Area, were shown to not be causes of the observed water-table fluctuation.

7.0 Recommendations

The following courses of action are recommended to continue the development of a conceptual model for groundwater flow within the 200 East Area and vicinity. Such a model is needed to support ongoing RCRA/CERCLA groundwater monitoring, and to provide needed information to the 200-BP-5 and 200-PO-1 operable unit Remedial Investigation/Feasibility Studies:

1) Investigate the effect that effluent releases to the TEDF have on groundwater flow directions within the 200 East Area and vicinity. The episodic nature of the TEDF releases may produce a dynamic system of changing groundwater flow directions in the area. A network of automated water-level monitoring equipment was installed in 10 wells at Low-Level Waste Management Area 1 (LLWMA-1), and data collection began during September 2005. The goals of the study

are to reduce the error in water-level measurements as much as is practicable and to use the resulting data to determine the hydraulic gradient and evaluate the variability of that gradient over time. If successful, this study should be expanded to other parts of the 200 East Area allowing the full effect of the TEDF releases to be investigated. Prior to this, however, automated water-level measurements should be collected from a well within the paleochannel near the TEDF (e.g., 699-37-47A) to further establish and quantify the relationship between TEDF effluent releases and the water-table elevation response.

2) To evaluate the effect that WTP construction site activities may be having on the water-table elevation, it is necessary to quantify the amount of water being discharged to ground. This is probably impractical to measure due to all the varied water uses at the site. However, if the amount of water being supplied to the construction site were known, it would serve as a bounding value on the discharges, and also allow for the actual discharge volume to be estimated. Therefore, it is recommended that the water supply lines to the WTP construction site be metered and the water use recorded on at least a monthly basis.

3) The hypothesis that long-term changes in Columbia River stage may be affecting the water table in the paleochannel should be further evaluated. The water-level study at LLWMA-1 will provide useful information to evaluate this hypothesis, but detailed information on the hydraulic gradient in Gable Gap is also needed for comparison with river stage changes. Therefore, it is recommended that monthly water-level measurements be collected from a small network of wells in Gable Gap.

4) The cause of the 1994–1997 water-table fluctuation should be fully evaluated. During this time, monthly average discharge in the Columbia River reached levels higher than at any time since 1981. Examining this fluctuation may provide further insight into any relationship that may exist between long-term stage changes in the Columbia River and the water-table elevation in the paleochannel south of Gable Gap.

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