FINAL
SWMU-B3 FLOOD TEST ASSESSMENT REPORT

Prepared for:

Camp Stanley Storage Activity
Boerne, Texas

February 2010

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Contract Number: W9126G-07-D-0028
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Executive Summary

To further understanding of migration pathways beneath the bioreactor and to better target remediation efforts, a tracer flood study will be implemented at the site in September/October 2009. The study injected approximately 100,000 gallons of water per day into the most upgradient trench of the bioreactor for a period of one month. During the flood, water pressures/levels were continually monitored in four discrete interval monitoring wells (Westbay wells) located around the Bioreactor. The monitoring wells were designed with sampling ports in several vadose and saturated zones. Periodic ground water samples will be collected to track the water flush, contaminant absorption and migration.

Results of the testing indicated flooding of Trench 6 increased the VOC mass transfer from the VOC source area(s) to the underlying Upper Glen Rose (UGR) member of the aquifer and that the bulk of the UGR VOC mass migrated southward toward the area around WB06. Also, flooding into Trench 6 impacted several Lower Glen Rose (LGR) zones with the most prominent impact being seen at WB06. However, heavy rainfall half way through the test period overshadowed the flood impacts and resulted in regional "bottom fill" recharge.

Pumping from the LGR bioreactor extraction wells (MW-16LGR and EXW-01) during the test confirmed these wells influence in the LGR04 zone in all of the Westbay wells. In addition, the extraction wells were shown to influence LGR03B zone in WB08. During the test, over 17.5 million gallons of water was added to Trench 6 (September 14, 2009 to February 11, 2010). Rainfall over that pumping period totaled almost 21 inches. The data suggested the bioreactor discharges between 2,000 and 3,000 gallons of water per hour to the underlying UGR.

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SECTION 1
INTRODUCTION

This report summarizes operations and results from a flood test conducted at Solid Waste Management Unit (SWMU) B-3 at Camp Stanley Storage Activity (CSSA). The flood test described in this document was conducted from September 14, 2009 to October 14, 2009. Flood test activities performed were intended to identify flow paths (both vertical and horizontal) from the surface in and around the bioreactor located at B3. A secondary objective of the test was to evaluate contaminant diffusion resulting from the flood. Both these tasks were accomplished by monitoring Westbay and other selected wells surrounding the bioreactor and monitoring of sumps within the bioreactor trenches before, during and after addition of "flood" water to the bioreactor.

Chapter 2 provides a description of the flood test objectives. Chapter 3 includes the results of the flood test and describes the conclusions derived from data collected during and after the flood test was completed. Chapter 4 includes recommendations for future management of the bioreactor at B-3 based on the results and conclusions from the flood test.

1.1 PURPOSE

This document was prepared as an assessment report of the flood test conducted at the bioreactor at SWMU B-3. The purpose of this assessment is to evaluate and assess the results following the conclusion of the 30-day flood test and associated activities.

Activities performed during the flood test include:

- Installation of four Westbay transducer probe strings into Westbay wells surrounding the bioreactor at B-3.
    - 8 probes installed in CS-WB05 in zones LGR-01, LGR-02, LGR-03B, LGR-04A, LGR-04B, BS-01, CC-01, and CC-02.
    - 5 probes installed in CS-WB06, CS-WB07, and CS-WB08 in zones UGR-01, LGR-01, LGR-02, LGR-03B, and LGR-04.
- Injection of uncontaminated groundwater pumped from CS-12 to trench 6.
- Daily collection of water levels in trench sumps.
    - Trench Sumps 1-1, 1-2, 1-3, 2-1, 2-2, 3-1, 3-2, 4-1, 5-1, 5-2, 6-1, and 6-2.
- Weekly collection of water levels in monitoring wells.
    - Monitoring wells MW1-LGR, MW16-LGR, B3-MW01, and MW2-LGR.
    - MW24-LGR monitored remotely via SCADA.
- Groundwater sampling including:
    - Weekly collection of groundwater samples from trench sumps
    - Collection of groundwater samples from all saturated zones in all of the Westbay wells before, during, and or after the test.

- Requires the removal of Westbay probe strings prior to sampling and the reinstallation of probe strings following sampling.

1.2 SITE DESCRIPTION

CSSA is located in northwestern Bexar County about 19 miles northwest of San Antonio, Texas. The installation consists of 4,004 acres immediately east of State Highway 3351 and approximately one-half mile from Interstate Highway 10. Additional background information regarding CSSA is located in CSSA's Environmental Encyclopedia (**Volume 1-1, Background Information Report**).

SWMU B-3 was a landfill area thought to have been used primarily for garbage disposal and trash burning from the 1950's through the 1980's. Reportedly, the trench areas were capped and brought to grade in 1990-1991. In 1991, chlorinated hydrocarbons were detected in groundwater from Well CS-16, approximately 500 feet north-northwest of SWMU B-3. The VOC concentrations, which were above drinking water standards, prompted several investigations aimed at identifying possible source areas that could be contributing to the contamination. SWMU B-3, along with nearby SWMU O-1 (oxidation pond), were identified as potential sources of groundwater contamination found at CS-16.

As part of the Resource Conservation and Recovery Act (RCRA) Administrative Consent Order, a pilot study using a bioreactor was conceptualized, designed, and constructed at SWMU B-3. The bioreactor is designed to remediate the affected groundwater and unsaturated zone underlying SWMU B-3. The design included excavation, removal, and offsite disposal of affected soil, debris, and waste contained within six trenches. The waste is believed to be a likely source of contaminants impacting the underlying fractured limestone (bedrock) and groundwater.

The current remediation method employed at SWMU B-3 is enhanced anaerobic remediation via a bioreactor. The bioreactor consists of six trenches backfilled with a combination of native deciduous tree mulch and pea-gravel. Since April 2007, groundwater extracted from near by wells CS-16LGR, CS-16CC, and more recently B3EXW01 has been injected into the trenches, where microbial activity promotes the dechlorination of contaminants in groundwater. In addition, in August 2005, injection well MW-01 was installed in the LGR03 zone and used to place substrate into the aquifer to see if biodegradation could be stimulated at depth. Monitoring the bioreactor is accomplished from four multi-port monitoring wells (Westbay wells) around the bioreactor and twelve sumps located within the bioreactor trenches, Figure 1.1. The bioreactor has been in operation at SWMU B-3 since April 2007.

1.3 SITE GEOLOGY

The primary groundwater source at CSSA is the Middle Trinity aquifer, which consists of the Cow Creek Limestone, Bexar Shale (Hensell Sand), and the Lower Glen Rose Limestone. Overlaying the Lower Glen Rose, the Upper Glen Rose is the upper most lithologic unit encountered at the site. Limestones and shales in this region are fractured and faulted due to their proximity to the Balcones Fault Zone to the south of the site. The fractures may become solutionally enlarged as rainwater dissolves carbon dioxide in the air and soil zone forming a weak carbonic acid which infiltrates on and through the bedrock along joints and fractures and dissolves the calcite at the water-rock interface enlarging fractures and creating voids (conduits). The enlargement of fractures creates triple porosity or triple permeability conditions in the subsurface where matrix, fracture, and conduit porosity and permeability co-exist. Though three types of porosity make up the aquifer, groundwater flow through the regional system is dominated by conduits, if present, and by fractures in the local system. The resulting drainage and circulation system allows for rapid and direct recharge through features that connect the surface to the aquifer. Though the connecting features may not be present in the immediate area, the open communication they provide has a dramatic impact on the local disposition of the aquifer.

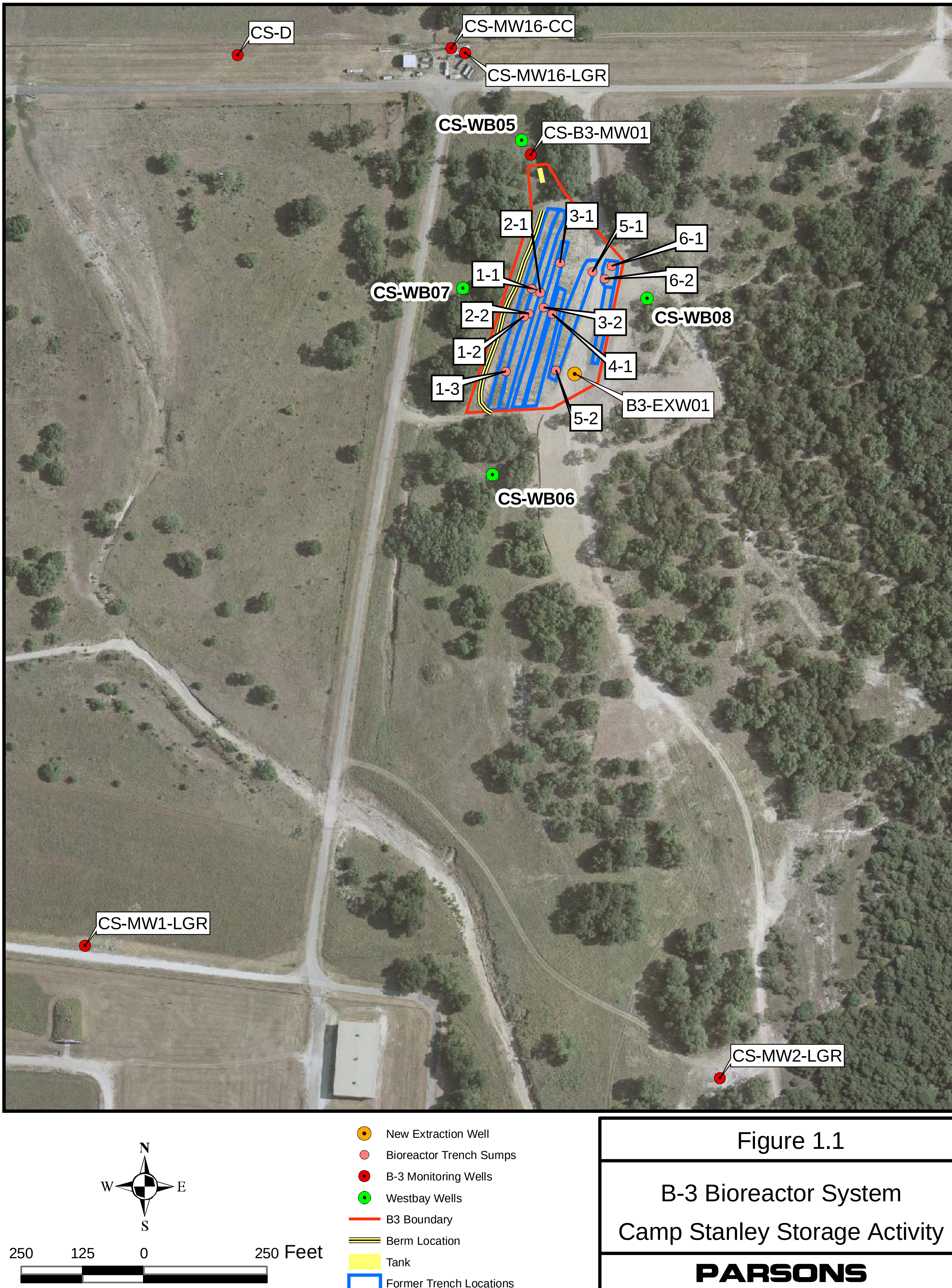

Figure 1.1

B-3 Bioreactor System

Camp Stanley Storage Activity

PARSONS

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SECTION 2
OBJECTIVES

The overall objective of the flood test is to use groundwater from CS-12 as a tracer to determine flow paths and/or flow direction and travel times from the bioreactor at trench 6 to the other bioreactor trenches, monitoring wells, specific zones in Westbay wells, and extraction wells in the vicinity. Ideal conditions for a water tracer test require an overall depletion in local water levels (drought conditions) with little external influence (little rain). This allows any water level changes to be directly attributable to the flood and not the result of any other factors.

Flowpaths and overall flow direction is determined from flood test data by evaluating the change in water levels in the various hydrogeologic units at B3. The change in water level is measured as the change in pressure at the sample ports in each of the zones in the Westbay wells and water levels in the trench sumps and surrounding monitoring and extraction wells. Knowledge of the flow paths and travel times allows a better understanding of the hydrogeology of the unsaturated near surface (vadose zone), and the semi-saturated hydrologic zones of the Middle Trinity aquifer at CSSA.

A secondary objective of the test was to collect ground water samples from selected intervals before, during and after the flooding to see if VOC concentrations would be impacted.

2.1 PRE-TEST

A large volume of water is required to conduct the flood test; moreover, a constant water application rate is required. Together, the bioreactor extraction wells CS-16CC, CS-16LGR, and B3-EXMW01 provide approximately 25 gpm and are located such that their radius of influence would affect the test. In addition, under drought conditions, these wells frequently draw down the water table and trigger the low water pump cut off. Consequently, these wells were not suited to be the primary source of water for the test. A suitable source of water was identified in the recently drilled drinking water well, CS-12. This well is located approximately one mile northwest of B3 and produces water from both the Lower Glen Rose and Cow Creek members of the Middle trinity Aquifer. Because of it's distance from the bioreactor, drawdown from this well would not impact water levels in the test area and the well was capable of supplying a reliable 50 to 60 gpm. Flexible HDPE 2" piping was installed from CS-12 directly to trench 6, near sump 6-1, in the bioreactor. A flowmeter was installed at the outfall so the flowrate and injection volume could be ascertained. Extraction of water at CS-12 began on September 14, 2009.

Westbay probe strings consist of either five or eight probes and pre-cut cables measured to fit the distance between monitored ports in each Westbay well. The port spacing for a particular zone in each Westbay well is unique, thus the pre-measured, pre-cut cables will only fit the port spacing for a specific well. The Westbay probe strings were installed in bioreactor Westbay wells CS-WB05, -WB06, -WB07, and -WB08. Eight zones in WB05 were monitored during the flood test including: LGR-01, LGR-02,

LGR-03B, LGR-04A, LGR-04B, BS-01, CC-01, and CC-02. Five zones in Westbay wells WB06, WB07, and WB08 were monitored including: UGR-01, LGR-01, LGR-02, LGR-03B, and LGR-04. At the surface, a final probe collects the atmospheric pressure for each of the Westbay strings, so the pressure data can be normalized. The Westbay strings are connected to a data logger that records the zone pressures and atmospheric pressure at the surface. Data points are collected every ten minutes, or if a threshold pressure change is detected (threshold pressure set at 1.0 psi). All the data loggers were connected to the same laptop PC to ensure that the data logger clocks were set to precisely the same time, thus, all measurements from all 27 probes would be collected at the same time.

2.2 BASELINE

Prior to the initiation of the flood test the current conditions in each of the zones in the Westbay wells, sump water levels, and monitoring well water levels were determined. The extraction wells CS-MW16-LGR, CS-MW16-CC, and B3EXW01 were turned off on September 11, 2009 at 7:00 a.m. and allowed to recover. This was to ensure that observed fluctuations in the zone water levels could be attributed to the application of water in trench 6 rather than the effects of the aquifer recovering from previous usage. Data loggers at the Westbay wells began collecting data on September 9, 2009 so that any trends in the water levels before the flood test would be identified, thus not attributed to the application of water in trench 6. After the data loggers collected five days of baseline water level data, the baseline event was concluded and data downloaded. Daily water levels were collected from the trench sumps by hand. Extraction wells and monitoring wells were monitored with pressure transducers.

2.3 FLOOD TEST

The flood test began at 12:00 a.m. on September 14, 2009, when the data loggers were programmed to collect the first data points. CS-12 water was initially applied to trench 6 at a rate of ~75 gpm, but was reduced to ~55 gpm on September 16 to ensure the water level at CS-12 remained above the pump. The test was concluded on the morning of October 14, 2009 when the transducers were removed. However, flooding of water into Trench T6 continued until February 2010.

2.3.1 Water Levels

The majority of the data collected came from the Westbay probe strings. Zone pressure and atmospheric pressure data was collected every ten minutes from each of the probes on the Westbay strings through the duration of the test. These data were stored in data loggers attached to the probe strings, which was downloaded on a weekly basis. Daily water levels were collected by hand from trench sumps and weekly water level data was collected from nearby monitoring wells. Water levels in monitoring wells outside the subject area were monitored via SCADA to compare regional water level trends.

2.3.2 Sampling

The timing of the flood test coincides with normal groundwater monitoring operations at the bioreactor. The August monthly groundwater sampling event was completed on August 20, 2009, and the quarterly groundwater sampling began following the completion of the flood test and was completed on October 30, 2009. Groundwater samples were collected from the trench sumps weekly during the flood test using a peristaltic pump. Groundwater samples were collected from saturated zones in two of the Westbay wells surrounding the bioreactor during the test (WB08 and WB06). Water samples were collected from all saturated zones in WB08 on September 24, and WB06 on October 5. Water samples were analyzed for volatile chlorinated compounds (VOCs) and various field parameters. Two samples were collected from each of the extraction wells (CS-MW16-LGR, CS-MW16-CC, and B3-EXW01) during the test. The first was collected mid-way through the test and the second at the conclusion of the test.

2.3.3 Extraction Wells

Near the conclusion of the flood test the extraction wells were returned to normal bioreactor operation mode. Each extraction well (CS-MW16-LGR, CS-MW16-CC, and B3-EXW01) was turned on independently in order to determine the affect pumping has on specific zones in each Westbay well. Each extraction well was turned on independently a few days after one another, thus the effects of each being turned on are temporally separated. Once a well was turned on, it was left to run in normal bioreactor operational mode for the remainder of the flood test.

SECTION 3
RESULTS

This section presents data obtained from the Westbay strings, daily water levels, flow rates and volumes from well CS-12, and analytical data from water samples collected in association with the flood test at the SWMU B-3 bioreactor.

3.1 BASELINE

Collecting baseline data helps determine water level trends prior to the initiation of the flood test. Results of the Westbay string baseline testing are presented in figures 3.1, 3.2, 3.3, and 3.4. Baseline sump water levels are presented in figures 3.5 and 3.6. Regional baseline water levels are presented in figure 3.7.

3.2 SUMP WATER LEVELS

Daily water level data collected from trench sumps during the flood test are presented in Table 3.1 through 3.4. Depth to water from the top of sump casing is presented in Table 3.1. Sump water elevation is presented in Table 3.2 and in Figure 3.5. Sump water thickness (from the base of the sump to the current water level) is shown in Table 3.3. Overall changes in sump water thickness throughout the flood test are presented in Table 3.4 as well as Figure 3.6. The baseline sump water level used to determine the overall changes in sump water level were collected on August 27, 2009, prior to any water injected into trench 6 and before the normal bioreactor operations were interrupted (extraction wells CS-16LGR, CS-16CC, and B3EXW01 in normal operation).

Based on this water level data, the bioreactor trenches held approximately 16,000 gallons of water at the start of the flood. All of this water was located in trenches T1 and T2. By October 2, 2009, the bioreactor held approximately 53,500 gallons of water and water was located in all six trenches. This represents a net gain of approximately 37,422 gallons. Over that period, CS-12 contributed almost 1,420,314 gallons to trench T6 and rainfall was minimal. Based on these totals, the bioreactor discharged approximately 3,164 gallons/hour to the vadose during this initial 18 days of the test.

Pumping from CS-12 and activation of the other three extraction wells continued to supply water to the bioreactor during the remainder of the test period. In all, these wells contributed approximately 1,437,618 gallons of water to the bioreactor from October 2 through October 14. In addition, nearly six inches of rainfall fell on the bioreactor between October 3 and October 15. This pumping and rainfall caused considerable increases in bioreactor water levels. On October 15, the bioreactor contained approximately 232,291 gallons of water, a net gain of 178,845 gallons of water.

Pumping from CS-12 and the other bioreactor extraction wells to trench 6 was terminated on February 11, 2010. At that point, the bioreactor trenches contained approximately 486,000 gallons of water. By February 17 the bioreactor had been drained down to an estimated volume of 226,000 gallons of water. This data indicates the bioreactor contributed approximately 2,000 gallons/hour to the UGR, over that 6 day period.

3.3 MONITORING WELL WATER LEVELS

Monitoring well water levels were collected weekly using hand measurements. The monitoring well water level data are presented in Table 3.5. Regional groundwater fluctuations are presented in figure 3.7, which show changes in the Lower Glen Rose from MW24-LGR, a monitoring well with a transducer installed and continuously monitored by SCADA. MW24-LGR is located outside the bioreactor area of influence (by neither pumping nor injections).

3.4 WESTBAY WELL WATER LEVELS

Data collected from the Westbay wells are measured in pressure (psi). This pressure is normalized for atmospheric pressure, which then can viewed in terms of the relative change since the flood test began (Table 3.1 and Table 3.2) or be used to calculate the piezometric water level using:

$$P_{wl} = ((p_z - p_a) \times 2.308) + E_{pd}$$

Where P_{wl} is the piezometric water level, p_z is the zone pressure, p_a is the atmospheric pressure, and E_{pd} is the elevation of the sample port.

Although data is collected every ten minutes at each of the probes, an abbreviated data set showing the daily noon value is presented.

Figure 3.1 WB05 Baseline Data

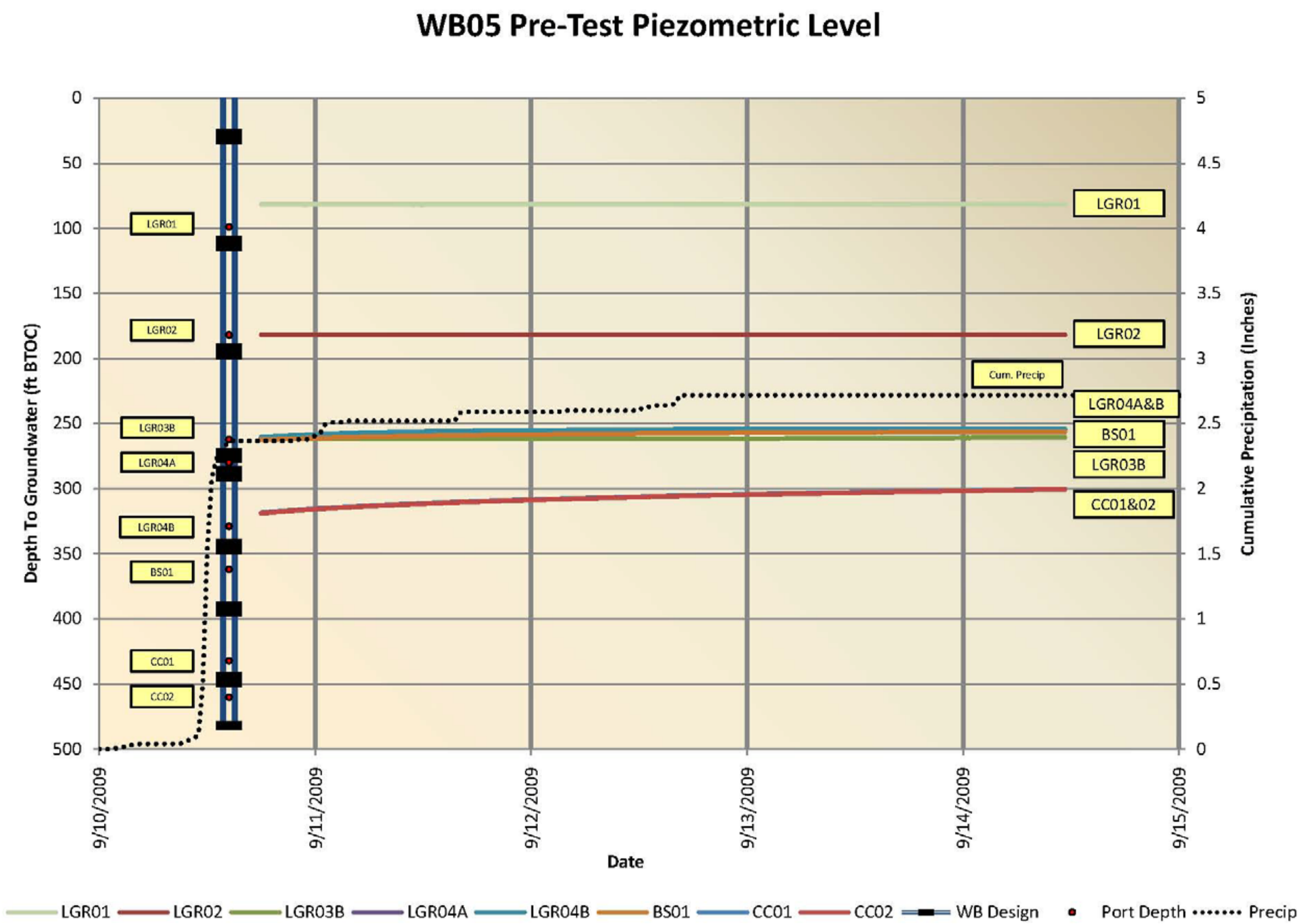


Figure 3.2 WB06 Baseline Data

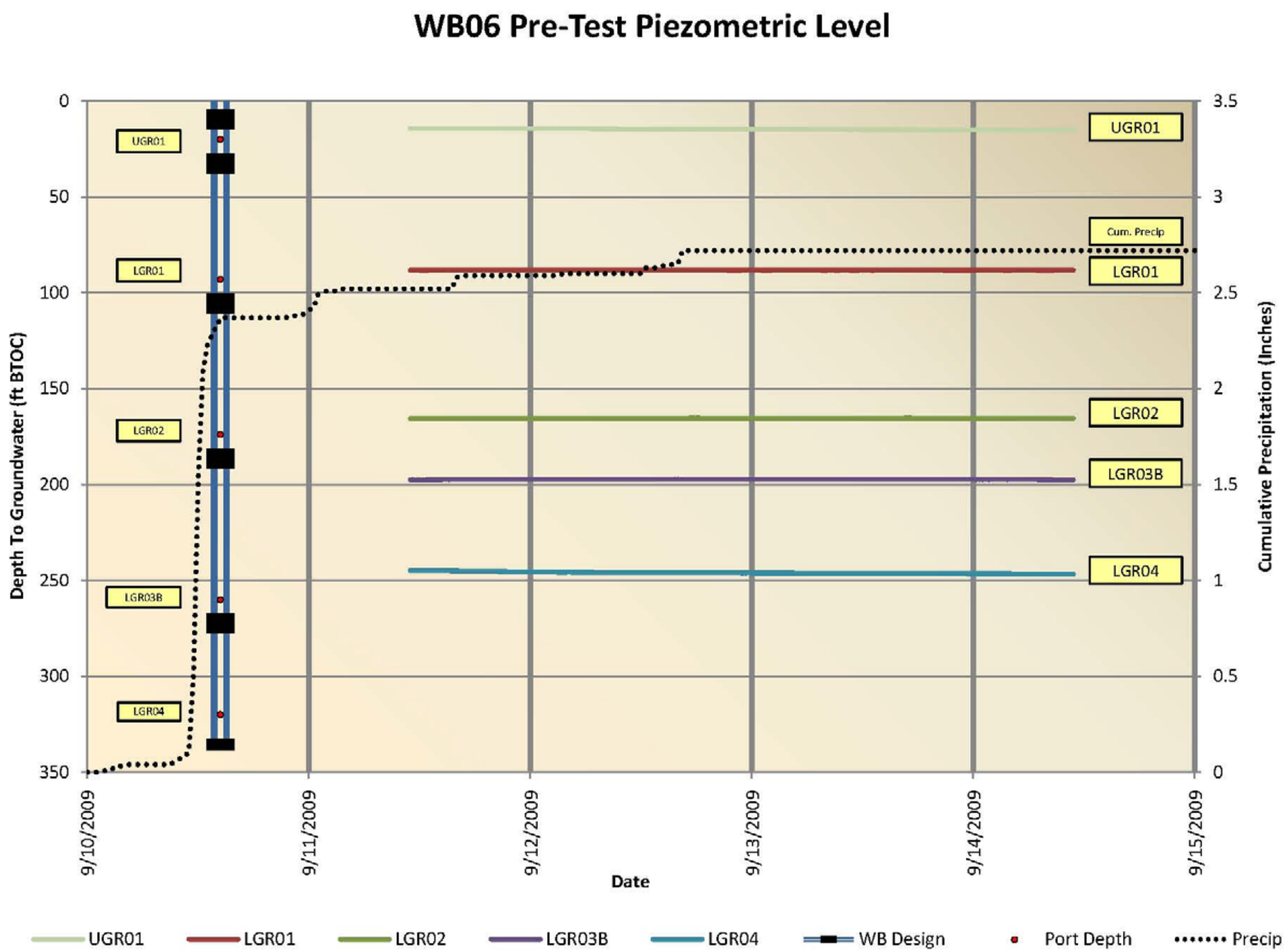


Figure 3.3 WB07 Baseline Data

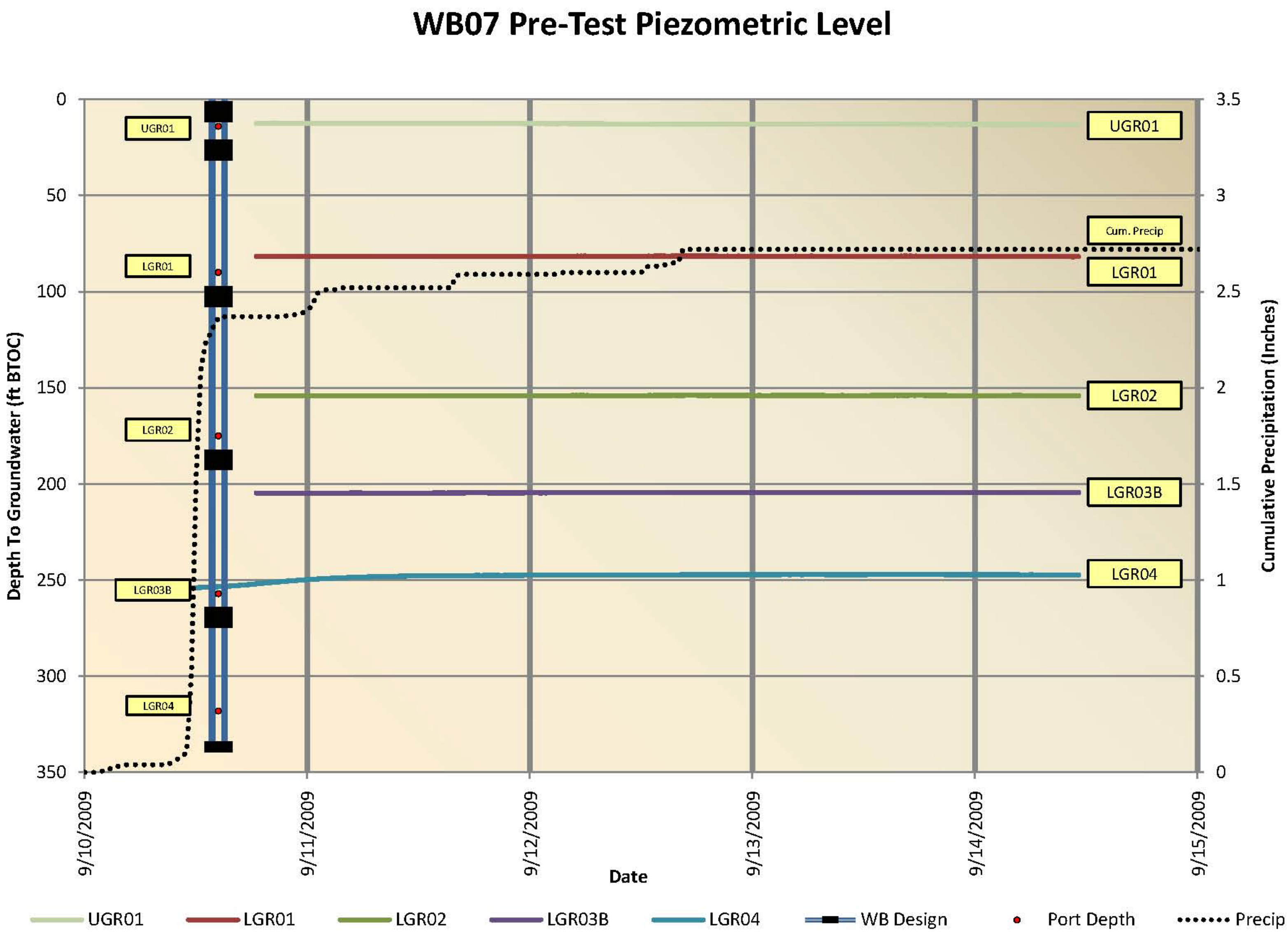


Figure 3.4 WB08 Baseline Data

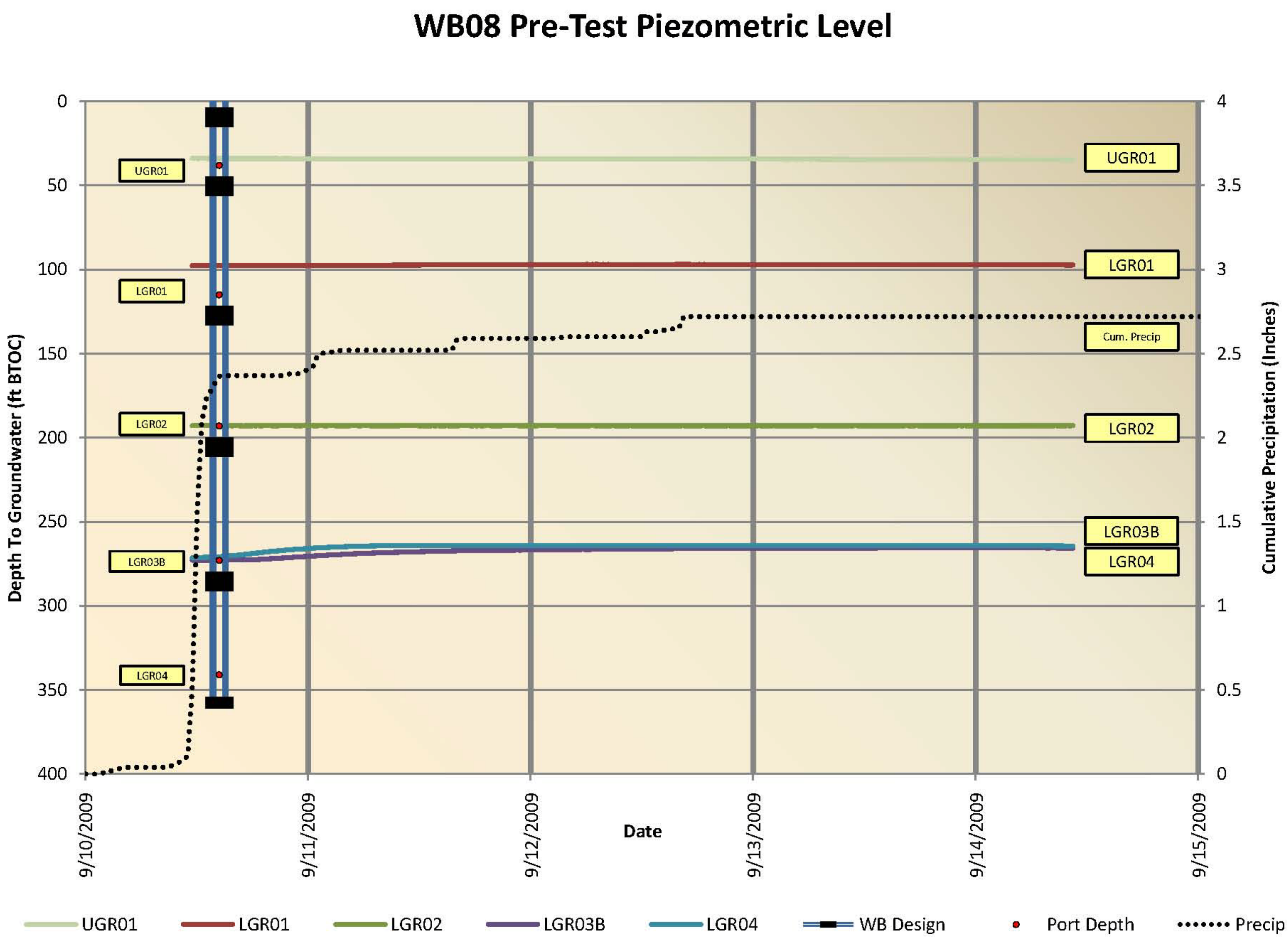


Table 3.1 Sump Depth to Water

			Sump Depth to Water from TOC (ft)																											
Sump depth (ft BTOC)	TOC elev (ft.)	Trench - Sump	8/27/2009	9/4/2009	9/14/2009	9/15/2009	9/16/2009	9/17/2009	9/18/2009	9/21/2009	9/22/2009	9/23/2009	9/24/2009	9/25/2009	9/28/2009	9/29/2009	9/30/2009	10/1/2009	10/2/2009	10/5/2009	10/6/2009	10/7/2009	10/8/2009	10/9/2009	10/12/2009	10/13/2009	10/14/2009	10/15/2009	10/16/2009	10/19/2009
12.9	1235.91	T1-1	9.23	9.26	11.67	11.11	10.51	10.24	10.02	9.65	9.61	9.53	9.53	9.48	9.52	9.49	9.46	9.43	9.43	7.08	7.57	7.15	6.62	6.20	5.52	4.92	4.21	4.58	4.47	5.32
12.4	1235.63	T1-2	8.88	8.90	11.29	10.90	10.30	10.02	9.79	9.41	9.37	9.30	9.28	9.24	9.26	9.25	9.23	9.20	9.18	6.78	7.26	6.87	6.36	5.94	5.26	4.70	4.51	4.37	4.23	4.91
12.85	1235.14	T1-3	8.56	8.60	11.02	10.92	10.25	9.92	9.69	9.35	9.32	9.27	9.25	9.21	9.25	9.24	9.21	9.18	9.18	6.44	6.95	6.63	6.23	5.47	5.03	4.61	4.27	4.03	3.88	4.52
9.67	1237.23	T2-1	8.57	8.7	9.23	9.06	8.93	8.91	8.92	8.9	8.9	8.97	8.97	8.96	9.03	9.04	8.96	8.93	8.94	8.44	8.67	8.52	8.07	7.64	6.96	6.36	6.16	6.02	5.9	6.76
10.01	1237.52	T2-2	8.58	8.65	9.30	9.41	9.31	9.20	9.10	8.92	8.93	8.97	8.97	8.96	9.03	9.04	9.03	9.03	9.03	8.42	8.54	8.40	8.15	7.85	7.19	6.68	6.46	6.31	6.19	6.85
9.96	1240.15	T3-1	9.09	9.07	9.05	9.09	8.82	8.68	8.55	8.36	8.36	8.37	8.42	8.46	8.59	8.62	8.64	8.66	8.68	7.50	7.77	7.94	7.99	6.95	7.49	7.61	7.57	7.53	7.53	7.69
7.4	1240.11	T3-2	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.03	7.07	7.32	7.40	7.40	7.40	7.40	7.40	7.40	7.40	7.40
6.32	1239.78	T4-1	6.32	6.32	6.22	6.24	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	6.32	5.93	6.12	6.19	6.22	5.72	6.05	6.01	5.95	5.91	5.94	6.12
9.33	1243.55	T5-1	9.23	9.24	9.22	8.01	7.98	7.97	8.02	8.11	8.15	8.06	8.32	8.15	8.26	8.21	8.24	8.18	8.22	7.79	7.93	7.78	7.71	7.36	7.34	7.30	7.21	7.15	7.18	7.43
7.98	1239.49	T5-2	7.93	7.81	7.56	7.78	7.79	7.79	7.79	7.80	7.81	7.81	7.81	7.81	7.81	7.81	7.86	7.81	7.87	5.80	6.68	7.38	7.72	5.37	7.26	7.51	7.68	7.58	7.69	7.80
11.45	1245.08	T6-1	11.15	11.12	11.11	6.62	7.00	7.03	7.12	7.29	7.34	7.40	6.36	7.28	7.36	7.32	7.31	7.31	7.31	7.17	7.16	6.93	6.91	6.71	6.59	6.62	6.57	6.56	6.57	6.78
12.34	1244.82	T6-2	12.05	12	11.98	6.39	6.79	6.82	6.92	7.1	7.14	7.2	7.19	7.02	7.25	7.21	7.2	7.19	7.22	7.05	7.06	6.83	6.8	6.6	6.48	6.49	6.44	6.41	6.44	6.67

Table 3.2 Sump Water Elevation

	Sump Water Elevation (ft)																											
Trench - Sump	8/27/2009	9/4/2009	9/14/2009	9/15/2009	9/16/2009	9/17/2009	9/18/2009	9/21/2009	9/22/2009	9/23/2009	9/24/2009	9/25/2009	9/28/2009	9/29/2009	9/30/2009	10/1/2009	10/2/2009	10/5/2009	10/6/2009	10/7/2009	10/8/2009	10/9/2009	10/12/2009	10/13/2009	10/14/2009	10/15/2009	10/16/2009	10/19/2009
T1-1	1226.68	1226.65	1224.24	1224.80	1225.40	1225.67	1225.89	1226.26	1226.30	1226.38	1226.38	1226.43	1226.39	1226.42	1226.45	1226.48	1226.48	1228.83	1228.34	1228.76	1229.29	1229.71	1230.39	1230.99	1231.70	1231.33	1231.44	1230.59
T1-2	1226.75	1226.73	1224.34	1224.73	1225.33	1225.61	1225.84	1226.22	1226.26	1226.33	1226.35	1226.39	1226.37	1226.38	1226.40	1226.43	1226.45	1228.85	1228.37	1228.76	1229.27	1229.69	1230.37	1230.93	1231.12	1231.26	1231.40	1230.72
T1-3	1226.58	1226.54	1224.12	1224.22	1224.89	1225.22	1225.45	1225.79	1225.82	1225.87	1225.89	1225.93	1225.89	1225.90	1225.93	1225.96	1225.96	1228.70	1228.19	1228.51	1228.91	1229.67	1230.11	1230.53	1230.87	1231.11	1231.26	1230.62
T2-1	1228.66	1228.53	1228.00	1228.17	1228.30	1228.32	1228.31	1228.33	1228.33	1228.26	1228.26	1228.27	1228.20	1228.19	1228.27	1228.30	1228.29	1228.79	1228.56	1228.71	1229.16	1229.59	1230.27	1230.87	1231.07	1231.21	1231.33	1230.47
T2-2	1228.94	1228.87	1228.22	1228.11	1228.21	1228.32	1228.42	1228.60	1228.59	1228.55	1228.55	1228.56	1228.49	1228.48	1228.49	1228.49	1228.49	1229.10	1228.98	1229.12	1229.37	1229.67	1230.33	1230.84	1231.06	1231.21	1231.33	1230.67
T3-1	1231.06	1231.08	1231.10	1231.06	1231.33	1231.47	1231.60	1231.79	1231.79	1231.78	1231.73	1231.69	1231.56	1231.53	1231.51	1231.49	1231.47	1232.65	1232.38	1232.21	1232.16	1233.20	1232.66	1232.54	1232.58	1232.62	1232.62	1232.46
T3-2	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1233.08	1233.04	1232.79	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71	1232.71
T4-1	1233.46	1233.46	1233.56	1233.54	1233.46	1233.46	1233.46	1233.46	1233.46	1233.46	1233.46	1233.46	1233.46	1233.46	1233.46	1233.46	1233.46	1233.85	1233.66	1233.59	1233.56	1234.06	1233.73	1233.77	1233.83	1233.87	1233.84	1233.66
T5-1	1234.32	1234.31	1234.33	1235.54	1235.57	1235.58	1235.53	1235.44	1235.40	1235.49	1235.23	1235.40	1235.29	1235.34	1235.31	1235.37	1235.33	1235.76	1235.62	1235.77	1235.84	1236.19	1236.21	1236.25	1236.34	1236.40	1236.37	1236.12
T5-2	1231.56	1231.68	1231.93	1231.71	1231.70	1231.70	1231.70	1231.69	1231.68	1231.68	1231.68	1231.68	1231.68	1231.68	1231.63	1231.68	1231.62	1233.69	1232.81	1232.11	1231.77	1234.12	1232.23	1231.98	1231.81	1231.91	1231.80	1231.69
T6-1	1233.93	1233.96	1233.97	1238.46	1238.08	1238.05	1237.96	1237.79	1237.74	1237.68	1238.72	1237.80	1237.72	1237.76	1237.77	1237.77	1237.77	1237.91	1237.92	1238.15	1238.17	1238.37	1238.49	1238.46	1238.51	1238.52	1238.51	1238.30
T6-2	1232.77	1232.82	1232.84	1238.43	1238.03	1238.00	1237.90	1237.72	1237.68	1237.62	1237.63	1237.80	1237.57	1237.61	1237.62	1237.63	1237.60	1237.77	1237.76	1237.99	1238.02	1238.22	1238.34	1238.33	1238.38	1238.41	1238.38	1238.15

Table 3.3 Sump Water Thickness

	Sump Water Thickness (ft)																											
Trench - Sump	8/27/2009	9/4/2009	9/14/2009	9/15/2009	9/16/2009	9/17/2009	9/18/2009	9/21/2009	9/22/2009	9/23/2009	9/24/2009	9/25/2009	9/28/2009	9/29/2009	9/30/2009	10/1/2009	10/2/2009	10/5/2009	10/6/2009	10/7/2009	10/8/2009	10/9/2009	10/12/2009	10/13/2009	10/14/2009	10/15/2009	10/16/2009	10/19/2009
T1-1	3.67	3.64	1.23	1.79	2.39	2.66	2.88	3.25	3.29	3.37	3.37	3.42	3.38	3.41	3.44	3.47	3.47	5.82	5.33	5.75	6.28	6.7	7.38	7.98	8.69	8.32	8.43	7.58
T1-2	3.52	3.50	1.11	1.50	2.10	2.38	2.61	2.99	3.03	3.10	3.12	3.16	3.14	3.15	3.17	3.20	3.22	5.62	5.14	5.53	6.04	6.46	7.14	7.70	7.89	8.03	8.17	7.49
T1-3	4.29	4.25	1.83	1.93	2.60	2.93	3.16	3.50	3.53	3.58	3.60	3.64	3.60	3.61	3.64	3.67	3.67	6.41	5.90	6.22	6.62	7.38	7.82	8.24	8.58	8.82	8.97	8.33
T2-1	1.10	0.97	0.44	0.61	0.74	0.76	0.75	0.77	0.77	0.70	0.70	0.71	0.64	0.63	0.71	0.74	0.73	1.23	1.00	1.15	1.60	2.03	2.71	3.31	3.51	3.65	3.77	2.91
T2-2	1.43	1.36	0.71	0.60	0.70	0.81	0.91	1.09	1.08	1.04	1.04	1.05	0.98	0.97	0.98	0.98	0.98	1.59	1.47	1.61	1.86	2.16	2.82	3.33	3.55	3.70	3.82	3.16
T3-1	0.87	0.89	0.91	0.87	1.14	1.28	1.41	1.60	1.60	1.59	1.54	1.50	1.37	1.34	1.32	1.30	1.28	2.46	2.19	2.02	1.97	3.01	2.47	2.35	2.39	2.43	2.43	2.27
T3-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.33	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T4-1	0.00	0.00	0.10	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.20	0.13	0.10	0.60	0.27	0.31	0.37	0.41	0.38	0.20
T5-1	0.10	0.09	0.11	1.32	1.35	1.36	1.31	1.22	1.18	1.27	1.01	1.18	1.07	1.12	1.09	1.15	1.11	1.54	1.40	1.55	1.62	1.97	1.99	2.03	2.12	2.18	2.15	1.90
T5-2	0.05	0.17	0.42	0.20	0.19	0.19	0.19	0.18	0.17	0.17	0.17	0.17	0.17	0.17	0.12	0.17	0.11	2.18	1.30	0.60	0.26	2.61	0.72	0.47	0.30	0.40	0.29	0.18
T6-1	0.30	0.33	0.34	4.83	4.45	4.42	4.33	4.16	4.11	4.05	5.09	4.17	4.09	4.13	4.14	4.14	4.14	4.28	4.29	4.52	4.54	4.74	4.86	4.83	4.88	4.89	4.88	4.67
T6-2	0.29	0.34	0.36	5.95	5.55	5.52	5.42	5.24	5.20	5.14	5.15	5.32	5.09	5.13	5.14	5.15	5.12	5.29	5.28	5.51	5.54	5.74	5.86	5.85	5.90	5.93	5.90	5.67

Table 3.4 Change in Sump Water Thickness

	Change in Sump Water Thickness from 8/27/09																											
Trench - Sump	8/27/2009	9/4/2009	9/14/2009	9/15/2009	9/16/2009	9/17/2009	9/18/2009	9/21/2009	9/22/2009	9/23/2009	9/24/2009	9/25/2009	9/28/2009	9/29/2009	9/30/2009	10/1/2009	10/2/2009	10/5/2009	10/6/2009	10/7/2009	10/8/2009	10/9/2009	10/12/2009	10/13/2009	10/14/2009	10/15/2009	10/16/2009	10/19/2009
T1-1	0.00	-0.03	-2.44	-1.88	-1.28	-1.01	-0.79	-0.42	-0.38	-0.30	-0.30	-0.25	-0.29	-0.26	-0.23	-0.20	-0.20	2.15	1.66	2.08	2.61	3.03	3.71	4.31	5.02	4.65	4.76	3.91
T1-2	0.00	-0.02	-2.41	-2.02	-1.42	-1.14	-0.91	-0.53	-0.49	-0.42	-0.40	-0.36	-0.38	-0.37	-0.35	-0.32	-0.30	2.10	1.62	2.01	2.52	2.94	3.62	4.18	4.37	4.51	4.65	3.97
T1-3	0.00	-0.04	-2.46	-2.36	-1.69	-1.36	-1.13	-0.79	-0.76	-0.71	-0.69	-0.65	-0.69	-0.68	-0.65	-0.62	-0.62	2.12	1.61	1.93	2.33	3.09	3.53	3.95	4.29	4.53	4.68	4.04
T2-1	0.00	-0.13	-0.66	-0.49	-0.36	-0.34	-0.35	-0.33	-0.33	-0.40	-0.40	-0.39	-0.46	-0.47	-0.39	-0.36	-0.37	0.13	-0.10	0.05	0.50	0.93	1.61	2.21	2.41	2.55	2.67	1.81
T2-2	0.00	-0.07	-0.72	-0.83	-0.73	-0.62	-0.52	-0.34	-0.35	-0.39	-0.39	-0.38	-0.45	-0.46	-0.45	-0.45	-0.45	0.16	0.04	0.18	0.43	0.73	1.39	1.90	2.12	2.27	2.39	1.73
T3-1	0.00	0.02	0.04	0.00	0.27	0.41	0.54	0.73	0.73	0.72	0.67	0.63	0.50	0.47	0.45	0.43	0.41	1.59	1.32	1.15	1.10	2.14	1.60	1.48	1.52	1.56	1.56	1.40
T3-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.33	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T4-1	0.00	0.00	0.10	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.20	0.13	0.10	0.60	0.27	0.31	0.37	0.41	0.38	0.20
T5-1	0.00	-0.01	0.01	1.22	1.25	1.26	1.21	1.12	1.08	1.17	0.91	1.08	0.97	1.02	0.99	1.05	1.01	1.44	1.30	1.45	1.52	1.87	1.89	1.93	2.02	2.08	2.05	1.80
T5-2	0.00	0.12	0.37	0.15	0.14	0.14	0.14	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.07	0.12	0.06	2.13	1.25	0.55	0.21	2.56	0.67	0.42	0.25	0.35	0.24	0.13
T6-1	0.00	0.03	0.04	4.53	4.15	4.12	4.03	3.86	3.81	3.75	4.79	3.87	3.79	3.83	3.84	3.84	3.84	3.98	3.99	4.22	4.24	4.44	4.56	4.53	4.58	4.59	4.58	4.37
T6-2	0.00	0.05	0.07	5.66	5.26	5.23	5.13	4.95	4.91	4.85	4.86	5.03	4.80	4.84	4.85	4.86	4.83	5.00	4.99	5.22	5.25	5.45	5.57	5.56	5.61	5.64	5.61	5.38

Figure 3.5 Sump Water Elevation

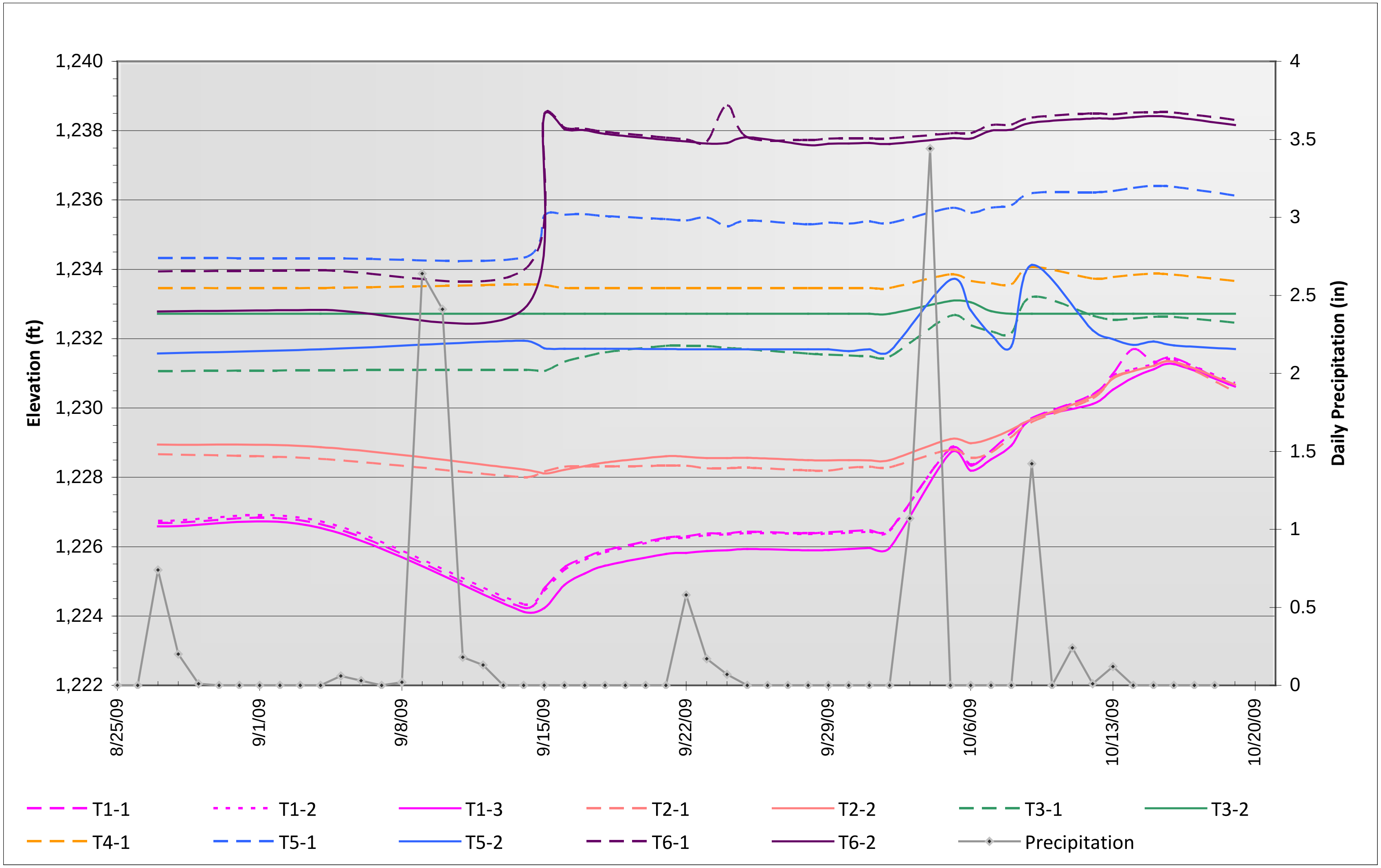


Figure 3.6 Change in Sump Water Thickness

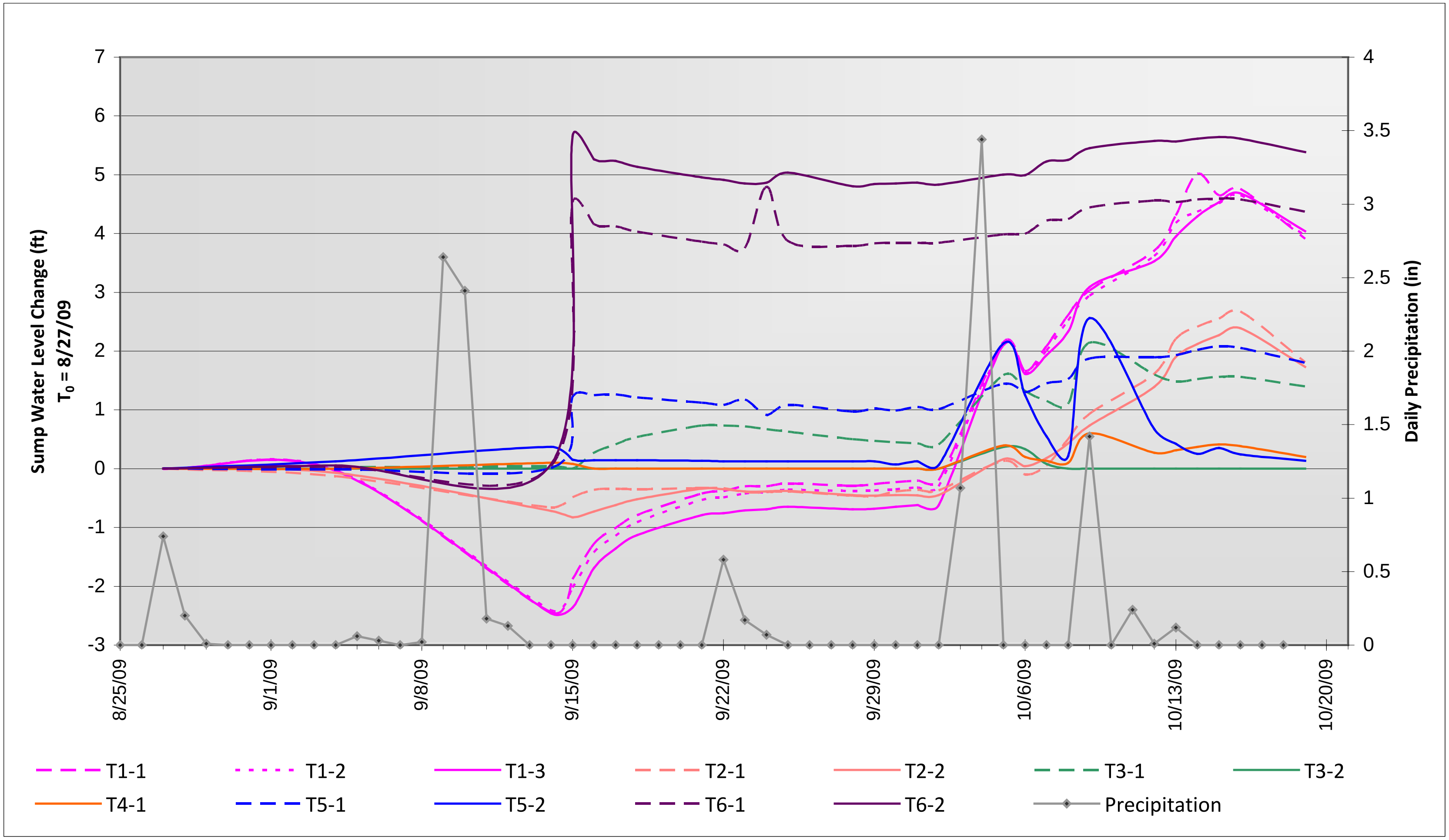
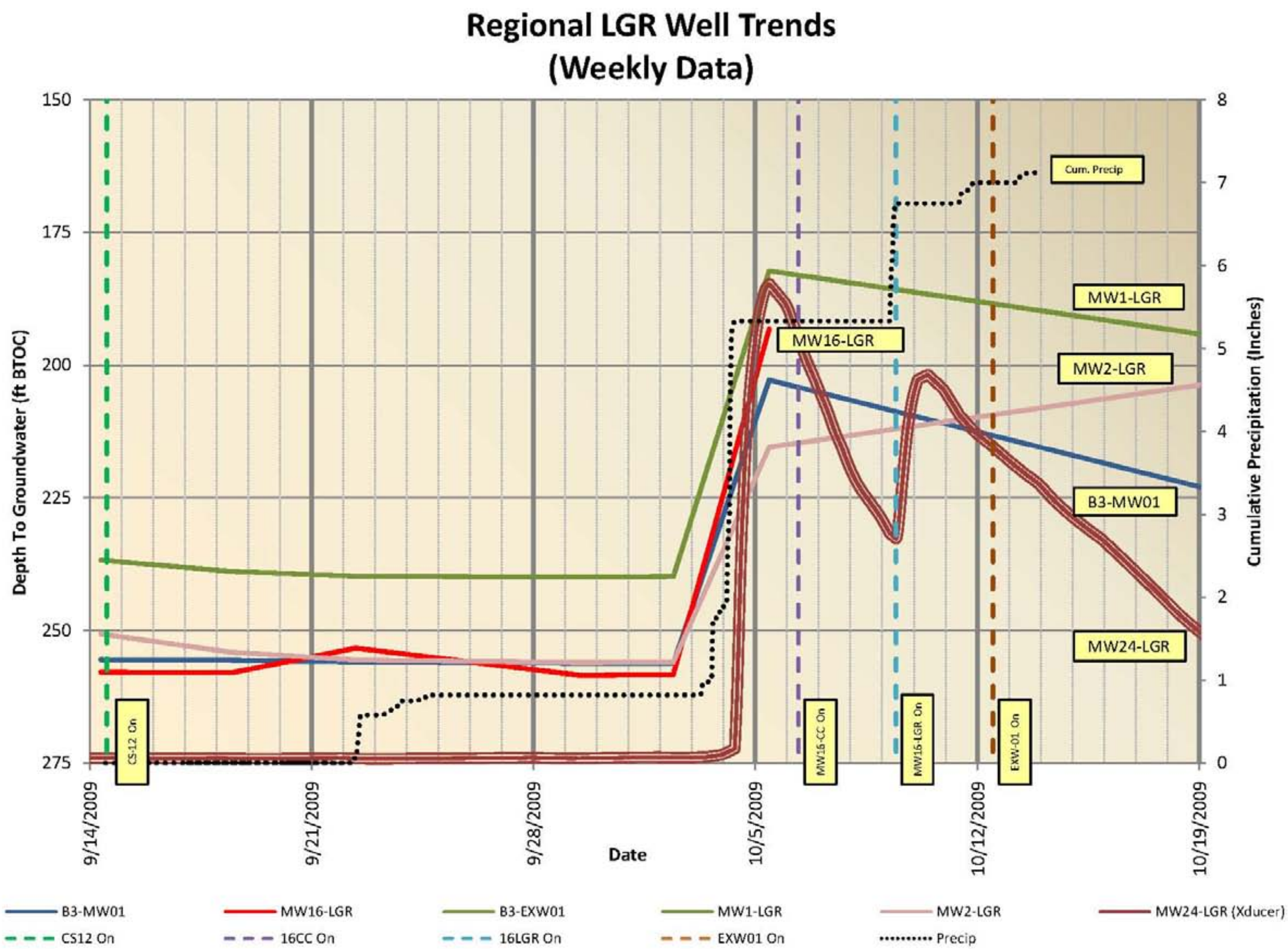


Figure 3.7 Regional Water Levels



3.5 METEOROLOGICAL DATA

The flood test is a water flux observation test. Water is injected in a specific area, and the changes associated with this additional water are recorded. Any external sources of water may confound the results, such that, flow paths from the site of injected water may not be observed, or misinterpreted due to the external source. The weather is a factor in the overall success of the flood test. The test was scheduled at a time when regional water levels were down due to extended drought conditions and during a normally drier part of the year.

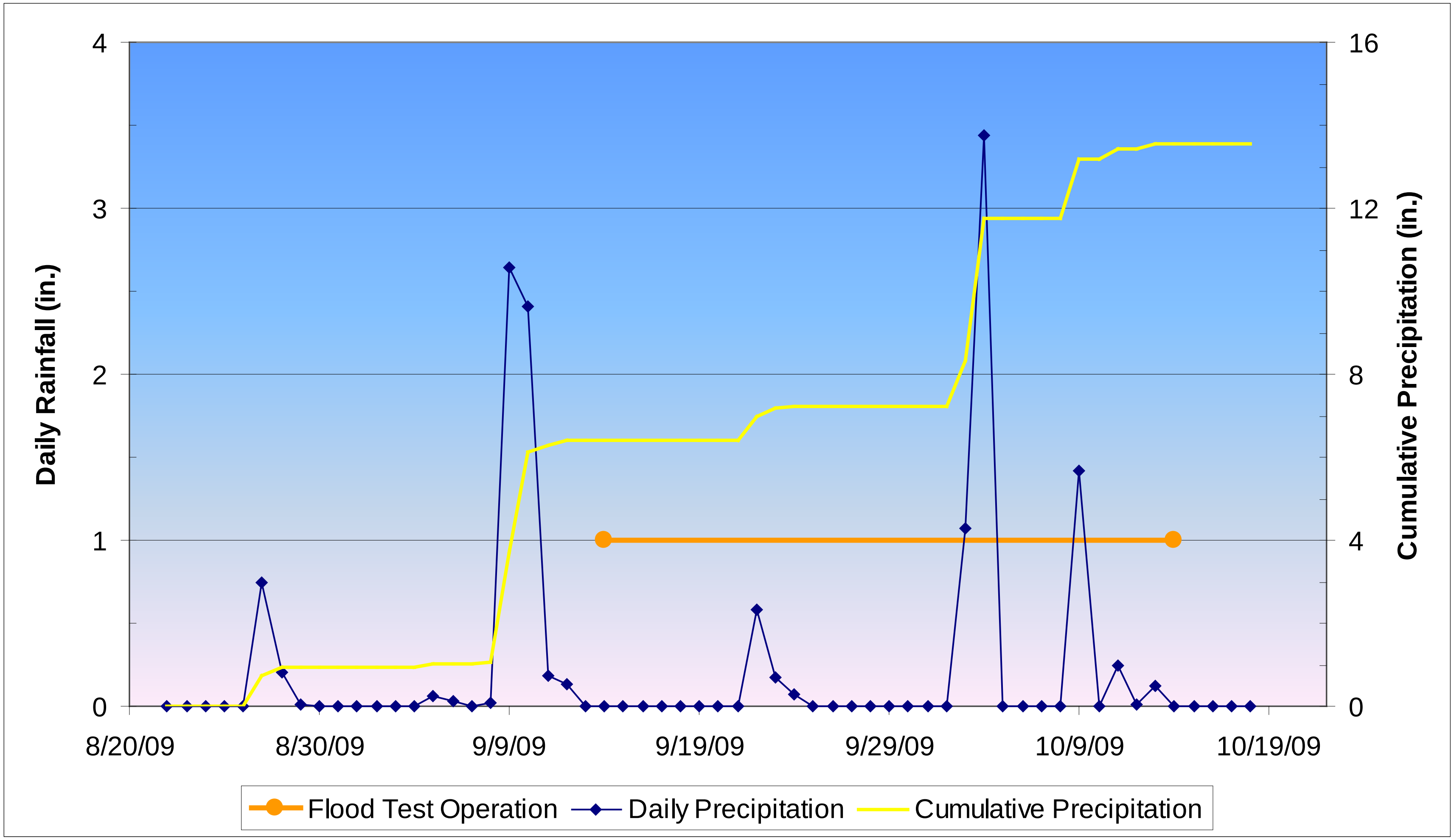
Although the flood test was scheduled during a time of year with a low probability of rain, precipitation data was collected from an on site weather station to account for any rain during the test that could affect zone pressures, sump water levels, and monitoring well water levels. Data collected from the weather station located at CSSA is presented in Figure 3.8.

As indicated in figure 3.8, much more rain fell than was anticipated. Two weeks prior to the initiation of the flood test 1.04 inches of rain fell, which likely would not have had a significant impact on the results of the test. Between September 9th and September 12th, 2 to 5 days prior to the initiation of the flood test, 5.38 inches of rain fell at the bioreactor. This significant rain event likely affected the baseline water level data, and potentially saturated parts of the UGR zone that had been previously unsaturated, so that pressure changes caused by flood test operations would not be as observable in that zone. During the flood test 7.12 inches of precipitation fell which, combined with the rain from just prior to the flood test, was responsible for recharging the aquifer locally and regionally to pre-drought levels. The amount of water applied during the flood test is an insignificant amount compared to that provided by precipitation during the test. However, between September 12th and October 2nd, only 0.82 inches of rain fell. During that time, some results can be attributed to the flood test operations.

3.6 ANALYTICAL DATA

All saturated Westbay zones were sampled during July 2009 as part of the regular bioreactor monitoring program. Selected saturated zones in WB05 were sampled on October 15 and 26 and November 2, in WB06 on October 5 and 16, and November 16, in WB07 on October 14 and 27 and November 16, and in WB08 on September 24, October 14, and November 16. Analytical results from sampling events before, during, and after the flood test may be found in the *CSSA B-3 Bioreactor Operations Performance Status Report*(s) for quarters 10, 11, and 12.

Figure 3.8 Precipitation Data



SECTION 4
OBSERVATIONS

Though the weather did not cooperate during the 30-day flood test, several observations regarding the response of various hydrostratigraphic zones to the flooding of the bioreactor trench 6 can.

4.1 NEAR SURFACE

4.1.1 Trench Sumps

The sump water level response to the interruption of normal bioreactor operations is shown in figures 3.1 (water level elevations) and 3.2 (sump water thickness change). Groundwater from the CS-MW16-CC and –LGR, and B3-EXW01 has been injected into trenches 1 and 2 during normal bioreactor operations. During the baseline monitoring, extraction of groundwater and subsequent injection of groundwater into the trenches ceased. During this time the sump water thicknesses in both the trench 1 and trench 2 sumps declined. Trench 1 water thickness declined approximately 2.5 feet from the time the injection system was shut down to the initiation of the flood test, and trench 2 water thicknesses declined approximately 0.6 feet during that time.

Twenty-four hours after the flood test began; significant changes in trench sump water thicknesses are observable. It is no surprise that the largest change in sump water thickness occurred in trench 6 sumps because that was the trench where CS-12 water was applied. Sumps T1-1, T1-2, T2-1, and T5-1 also show significant water thickness increases over the initial 24-hour period indicating a direct connection to trench 6. Sumps T1-3, T2-2, and T3-1 indicate less direct connections to trench 6 as changes in water levels in these sumps begin to occur 48 hours after water is applied to trench 6. Sumps T3-2, T4-1, and T5-2 appear to have no connection to trench 6 as the changes in water thickness at these sumps is attributable to rain events occurring mid-way through the flood test.

The influence of rain on sump water levels is clearly seen in figures 3.5 and 3.6 during the latter half of the test. Water levels in trench 1 sumps increase sharply after significant rain events (October 3), and once the water level in trench 1 reaches approximately 1,228.5 feet, water from trench 1 spills into trench 2 and the two fill at the same pace. Sumps T3-1, T4-1, and T5-2 appear to respond quickly to rain events as well, however, they also appear to drain as rapidly. Sumps T5-1, T6-1, and T6-2 seem less influenced by rain, though a noticeable, sustained increase in water levels is observed following the October 3, rain event.

The bioreactor sumps were sampled before, during and after the flood test. Laboratory analyses of the sump water samples indicated an initial decrease in the VOC molar concentrations in Trench 1. This decrease was most pronounced in the northern part of the trench. After significant rain in early October, VOC levels in the middle and southern portions of Trench 1 rebounded suggesting that the extra surge of water caused by the heavy rains migrated through impacted source area(s).

4.1.2 Westbay UGR-01 Zones

Changes in water levels in the UGR-01 zone were observed in WB06, WB07, and WB08 through the course of the flood test. These changes can be attributed to the application of water in trench 6 as well as from precipitation. Figure 4.1 shows the change in pressure recorded by the Westbay probes in the UGR-01 zone. WB07 appears to be least affected by the application of water in trench 6, though an increase in pressure is observed 48 hours after the flood test began. WB06 indicated an increase in pressure 18 hours after the flood test began. WB08 indicated a significant increase in pressure; however, due to the improper seating of the UGR-01 probe in WB08, the timing of the pressure increase may only be interpreted from data collected at WB06 and WB07. The initial pressure at WB08-UGR-01 matched the previously recorded pressure from the weekly profiling event, which indicated that WB08-UGR-01 was dry. It is suspected that during or shortly after installation, the seal on the probe that abuts the sample port lost contact, resulting in a leak from the UGR-01 zone into the well casing. The resulting data indicated the pressure began declining shortly after the test began and continued to decline until the probe string was removed on September 24 for sampling. Further investigation indicated that the pressure decrease was in fact due to a leaky seal, when, during the re-installation of the probe strings in WB08, an increase in water level inside the well casing was noticed. It is likely that the response in WB08-UGR-01 occurred sooner than at WB06 or WB07 due to the proximity of WB08 to trench 6.

Rainfall responses in the UGR-01 zone are seen as an almost immediate increase in pressure or an increase in pressure over a few hours. This is not unexpected, as the UGR crops out at the surface and many of the rain events are significant.

Laboratory analyses of the UGR water from WB-06 showed a strong increase in VOCs over the test period. Concentrations in WB06 UGR-01 went from below MCL for PCE and TCE to levels ranging from 190 to 63 ppb, while DCE increased from 14 to 220 ppb. Samples from WB08 UGR-01 showed elevated levels of VOCs ranging from 22 to 25 ppb for TCE and PCE and up to 320 ppb for DCE. Attempts to sample the UGR in WB07 failed on October 14 and 27, 2009 due to lack of water.

4.2 UNSATURATED ZONES

4.2.1 LGR-01 Zone

Response to flood test operations in the LGR-01 hydrostratigraphic zone were minimal at all Westbay wells, figure 4.2. WB08-LGR-01 indicated the greatest amount of pressure change among the LGR-01 zones, yet the increase in pressure observed at this well was less than 1.0 psia through the course of the test. It is likely that the increase in pressure at WB08-LGR-01 is due to the proximity of WB08 and the injection point in trench 6. In WB06 and WB07 the LGR-01 zone indicated less than 0.15 psia change. The pressure at WB05-LGR-01 remained stable during the first half of the test and fell during the second half of the test, suggesting no influence from injection.

Laboratory analyses of LGR-01 water from WB05 and WB07 found below MCL levels of VOCs. LGR-01 in WB06 was above MCLs, generally ranging between 30 and

40 ppb. LGR-01 in WB08 had generally low levels of PCE and TCE (ranging between 0 and 8.7 ppb), and slightly higher levels of DCE (ranging from 16-18 ppb.

4.2.2 LGR-02 Zone

Responses to flood test injection in the LGR-02 hydrostratigraphic zone were mixed as shown in figure 4.3. Negligible pressure change was observed in WB05 which indicates there was little influence from the injections or rain; the zone at this location was dry and remained dry throughout the test period despite injections or precipitation; or the probe was incorrectly installed (similar to the WB08-UGR-01 probe) and, because WB05 zones were not sampled until after the test, was never re-installed. Data from WB08 shows a steady increase in pressure over the testing period, however, the initial breakthrough was not collected because the probe was incorrectly set in the sample port. The LGR-02 zone at WB06 and WB07 indicate a response from the flooding at trench 6 as well as a response to precipitation recharge. No significant pressure changes were recorded by the probes in WB06 or WB07 until 9/30/09 for WB06 and 10/1/09 for WB07, two weeks after the test began. On 9/22/09 0.58 inches of precipitation fell, yet there was no change in pressure for eight days. From 10/3/09 through 10/4/09, 4.5 inches of rain fell at the bioreactor, and an increase in pressure was observed within approximately 10 hours at WB06 and 21 hours at WB07. Similarly, on 10/9/09 1.42 inches of rain fell on the bioreactor and a response in pressure was observed in WB06 within 9 hours and 22 hours at WB07.

The LGR-02 zone in WB05 remained dry throughout the test was not able to be sampled. No major VOC fluctuations were seen in LGR-02 WB06 and WB08. Water from LGR-02 in WB06 found VOC concentrations of 5 to 16 ppb for PCE and TCE and 21 to 49 ppb for DCE. Water from LGR-02 in WB08 was below MCL for PCE and TCE and ranged from 25 to 33 ppb for DCE. LGR-02 in WB07 was consistently below the MCL for all VOC constituents.

Figure 4.1 UGR01 Flood Test Data

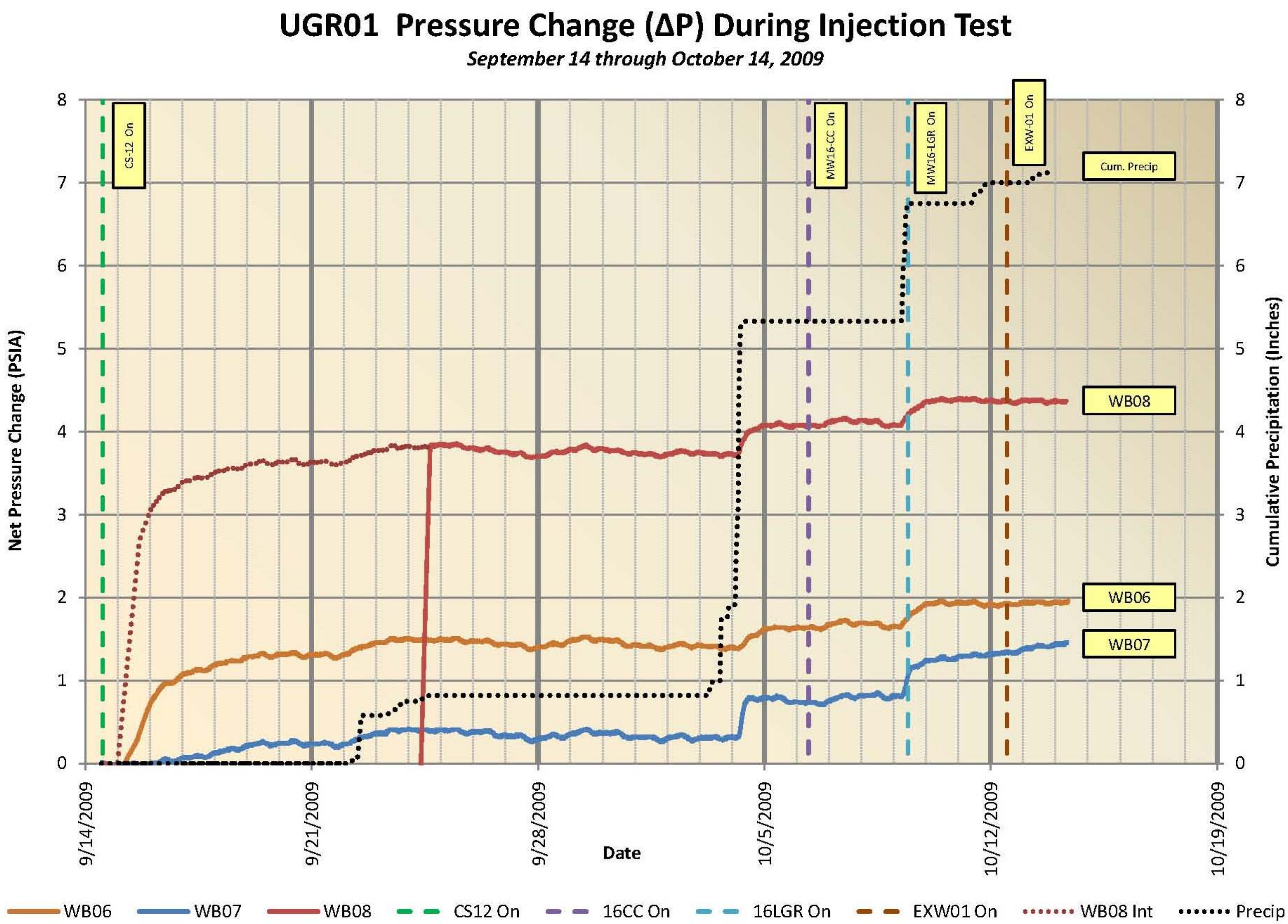


Figure 4.2 LGR01 Flood Test Data

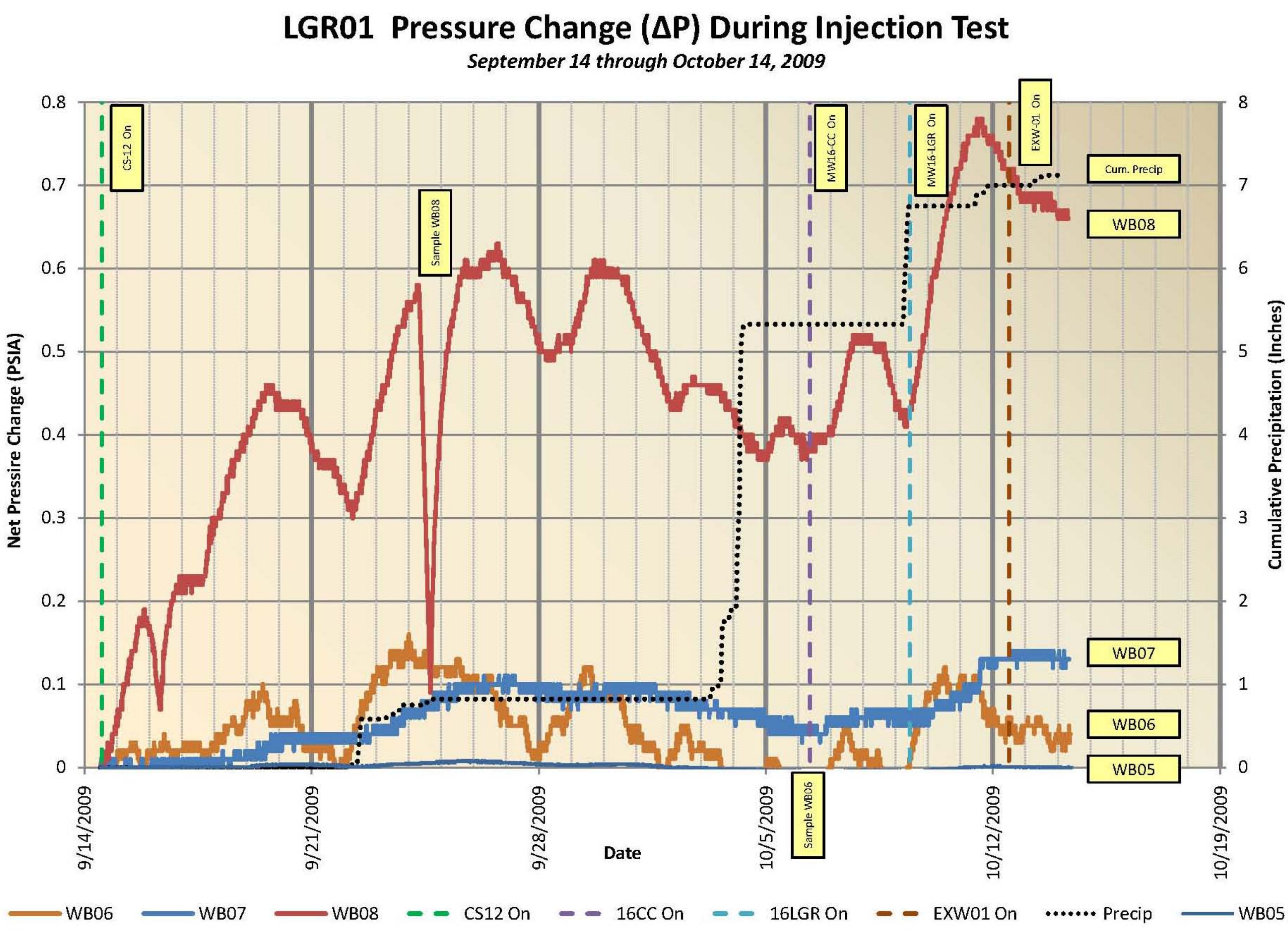
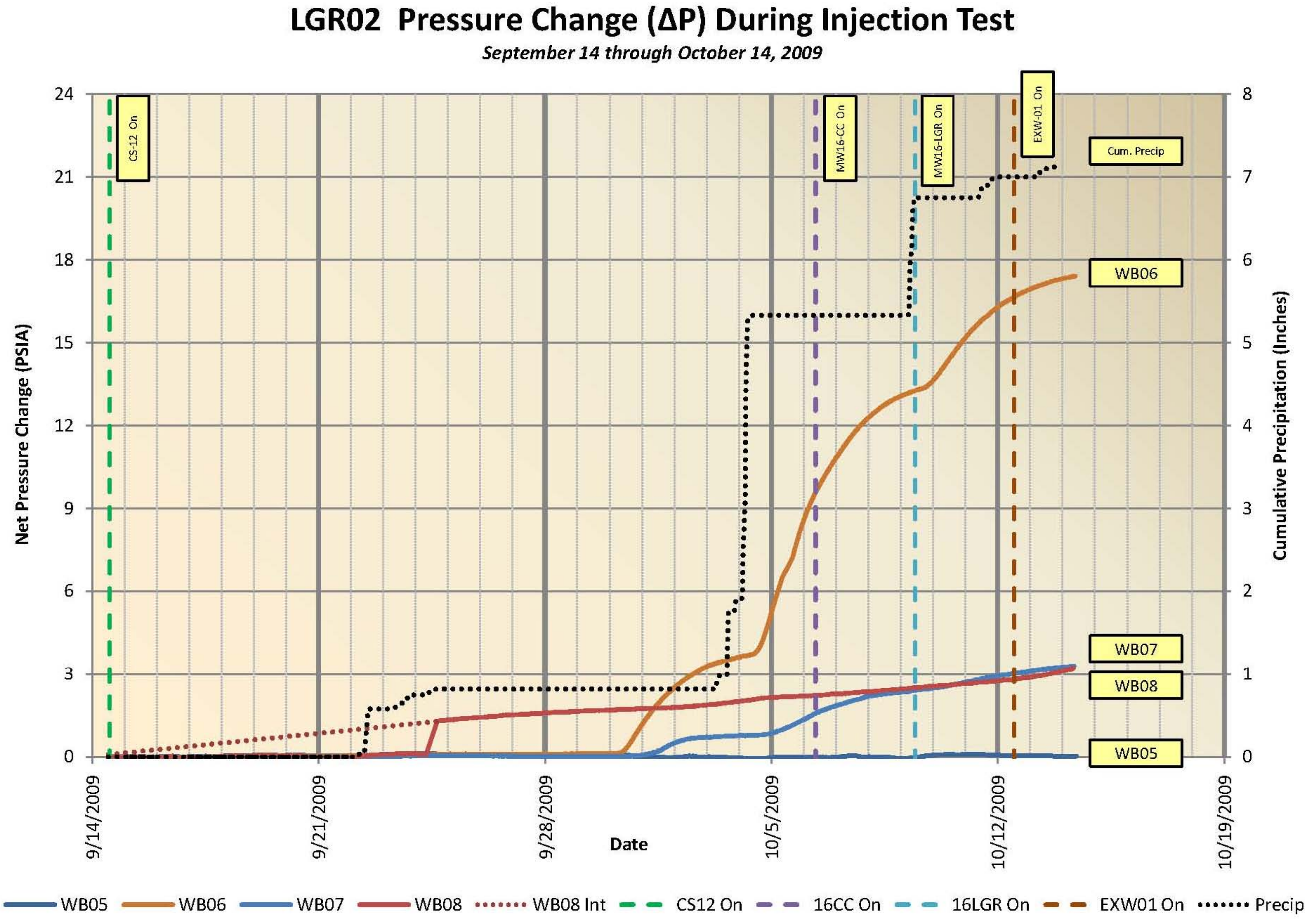


Figure 4.3 LGR02 Flood Test Data



4.3 SATURATED ZONES

4.3.1 LGR-03B Zone

Response to flooding and precipitation as well as pumping is visible in figure 4.4. Prior to the start of the flood test the extraction wells used for bioreactor operations were turned off. The recovery of the CS-16LGR well can be seen in the WB05-LGR-03B data. WB05 is closest of the Westbay wells to the CS-16LGR well. As soon as the data collection begins, there is an increase in pressure in the WB05-LGR-03B zone, which continues for 19 days until stabilizing. Subsequent responses in the LGR-03B zone at WB05 are due to precipitation. Responses to precipitation are evident at WB08The effects of pumping are visible in data from the LGR-03B probe at WB08 when the B3-EXW01 well is turned on and left to cycle, the pressure begins to fall.

The effects of trench 6 water injection are clearly seen in the LGR-03B zone data for WB06 and, though subtle, are also seen in WB07 data. The curve created from the LGR-03B data for WB06 is similar to the LGR-02 curve. Though the overall net pressure increase is less, the responses are similar. The timing of the responses due to flooding and precipitation in WB06-LGR03B occurs three hours sooner than the responses seen in LGR-02. Likewise in WB07, the rainfall responses for the LGR-03B zone occur 3 hours before the responses in the LGR-02 zone, but the flooding response occurs 26 hours *after* the response in the LGR-02 zone.

The responses observed in LGR-03B zone at WB08 appear consistent with the responses observed in the LGR04 (04A and 04B) zone(s) at WB05, WB06, WB07, and WB08 indicating a direct connection between LGR03B and LGR04 at this location.

On October 9, extraction well MW-16 LGR was turned on. This resulted in a pressure drop (and water level decrease) in the LGR03B zone of WB-08. None of the other WB wells showed reaction to this well being turned on. This suggests WB08 LGR03B is hydraulically connected to the MW-16LGR extraction zone. On October 12, LGR extraction well EXW-01 was turned on. Again, WB08 LGR03B showed strong reaction (water level drop) to pumping from this well while WB05 LGR03B showed a slight reaction. This data suggests WB08 LGR03B has a strong hydraulic connection to the EXW-01 extraction well and WB05 LGR03B has a faint connection.

Laboratory analyses of water from the LGR-03B zone in WB05 found PCE and TCE levels consistent with pre-flood data. PCE and TCE levels ranged from less than MCL up to 26 ppb. DCE levels in this well are considerably higher and ranged from 100 to 120 ppb. Analyses of water samples from LGR-03B in WB06 found relatively high VOC levels, ranging from 180 to 260 ppb, with DCE having the highest concentration. These levels were consistent with pre-test concentrations. A similar situation was found at WB-07 LGR-03B. Consistent with pre-test data, analyses found PCE and TCE concentrations less than the MCL, and DCE at 27 ppb. VOC levels in WB08 LGR-03B showed considerable variation through the flood test period. PCE, TCE, and DCE showed consistent increases between September 24 and October 14, 2009. PCE increased from 73 to 180 ppb, TCE from 57 to 210 ppb, and DCE from 49 to 200 ppb.

4.3.2 LGR-04 Zone

Responses observed in the LGR04 zone at the Westbay wells surrounding the bioreactor do not appear to indicate any influence from the flooding at trench 6. The pressure fluctuations recorded by the probes in this zone are due to regional recharge from precipitation and pumping the B3-EXW01 well. Figure 4.5 depicts the change in pressure observed in the LGR04 zone at WB06, WB07, and WB06, and the LGR04A and LGR04B zones in WB05. Response to the intense rain event that began on 10/4/09 at 2:30 a.m. was observed approximately six hours later in the LGR04 zone. As much as a 28 psi increase in pressure was observed in the WB07-LGR04 probe before cresting at 1:20 a.m. on 10/6/09, which is approximately a 65-foot rise in water level in 47 hours. The timing of the cresting is significant in that the cresting occurs prior to turning on the MW16-CC well (8:45 a.m. on 10/6/09).

On October 9, extraction MW-16 LGR was turned on. Decreases in pressures/water levels were noted in the LGR04 zone of all four WB wells. The greatest impact was noted in WB07. On October 12, LGR extraction well EXW-01 was turned on. Again, the LGR04 zone in all four WB wells showed impact. The strongest response was seen in WB06, WB07 and WB08. This suggests a strong hydraulic connection between MW-16LGR and EXW-01 to the LGR04 zone in all of the WB wells.

Consistent with pre-flood data, laboratory analyses of water from the LGR-04 zone in WB05 found very high VOC levels. PCE and TCE levels ranged from 64 to 240 ppb, with DCE levels considerably higher, ranging up to 860 ppb, the highest levels seen around the bioreactor. Analyses of water samples from LGR-04 in WB06 and WB07 also found consistently high levels of VOCs, but at concentrations lower than WB05 LGR-04. PCE and TCE ranged from 160 to 220 ppb, while DCE ranged from 260 to 460 ppb. VOC levels in WB08 LGR-04 showed considerable variation over the test period. In general, VOC levels decreased between September 24 and October 14, 2009. PCE dropped from 80 to 25 ppb, TCE dropped from 39 to 16 ppb, while DCE decreased from 140 to 57 ppb.

4.3.3 BS and CC Zones

Only one Westbay well (WB05) has sample ports set in the BS (Bexar Shale) and CC (Cow Creek A and Cow Creek B) zones. Data collected from both of the CC zones and the BS zone indicate a response from pumping, while the effects of precipitation are indicated in the data from the BS zone in figure 4.6. No response from the flood test injections were observed in either the BS or CC zones.

Extraction well MW-16 CC was turned on October 6. Strong decreases in pressures/water levels were seen in WB05 CC-01 and CC-02. None of the LGR zones in any of the WB wells showed reaction to the MW-16CC pumping. This suggests a strong hydraulic connection between MW-16CC and WB05 CC-01 and CC-02 and that the Bexar Shale is an effective aquitard separating the CC from the LGR.

VOC levels in WB05 BS, CC-01 and CC-02 remained consistent with pre-flood concentrations. The samples were less than MCL for PCE, while TCE and DCE ranged from 3.9 up to 92 ppb. The highest concentrations were noted in CC-02.

Figure 4.4 LGR03B Flood Test Data

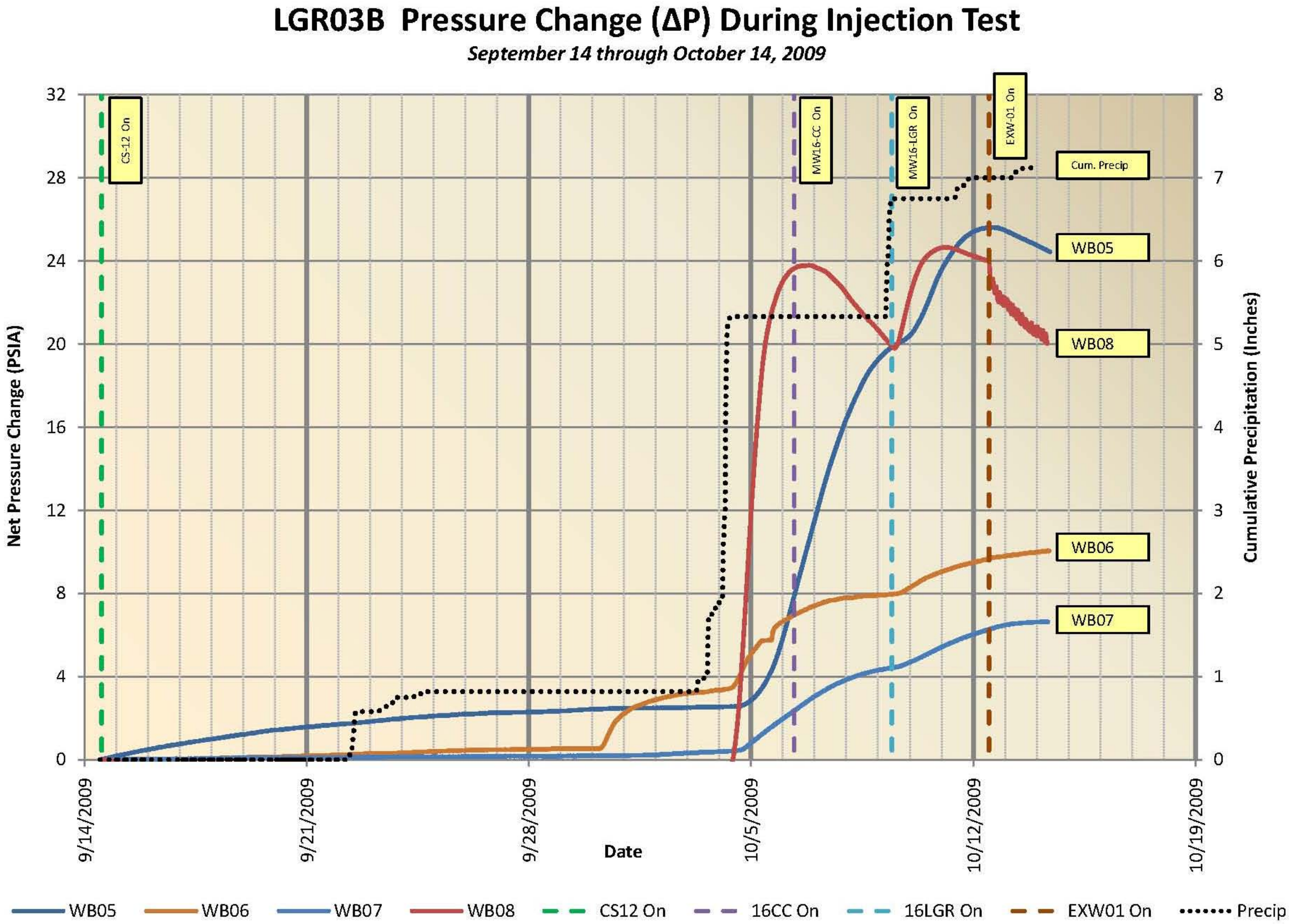


Figure 4.5 LGR04 Flood Test Data

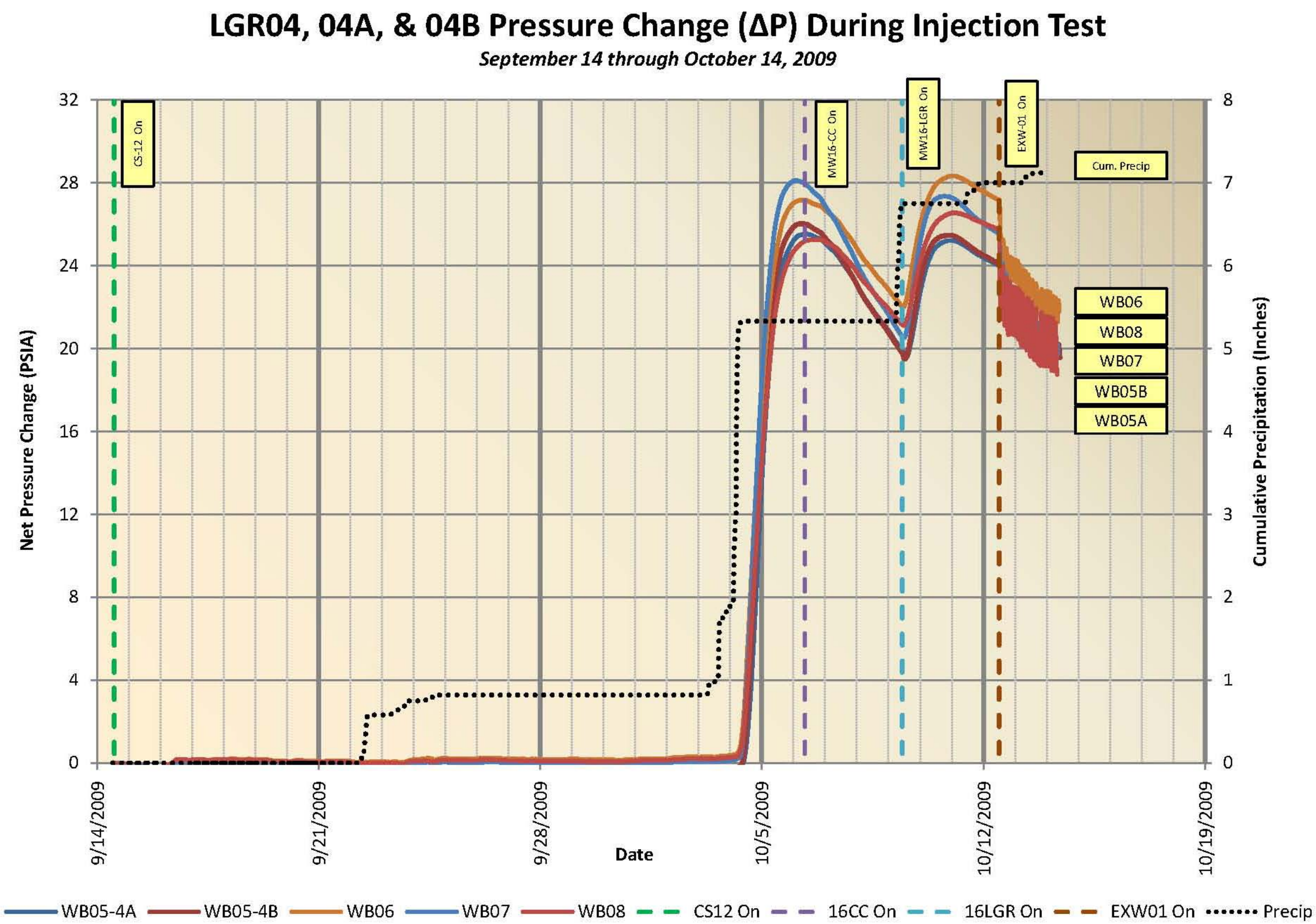
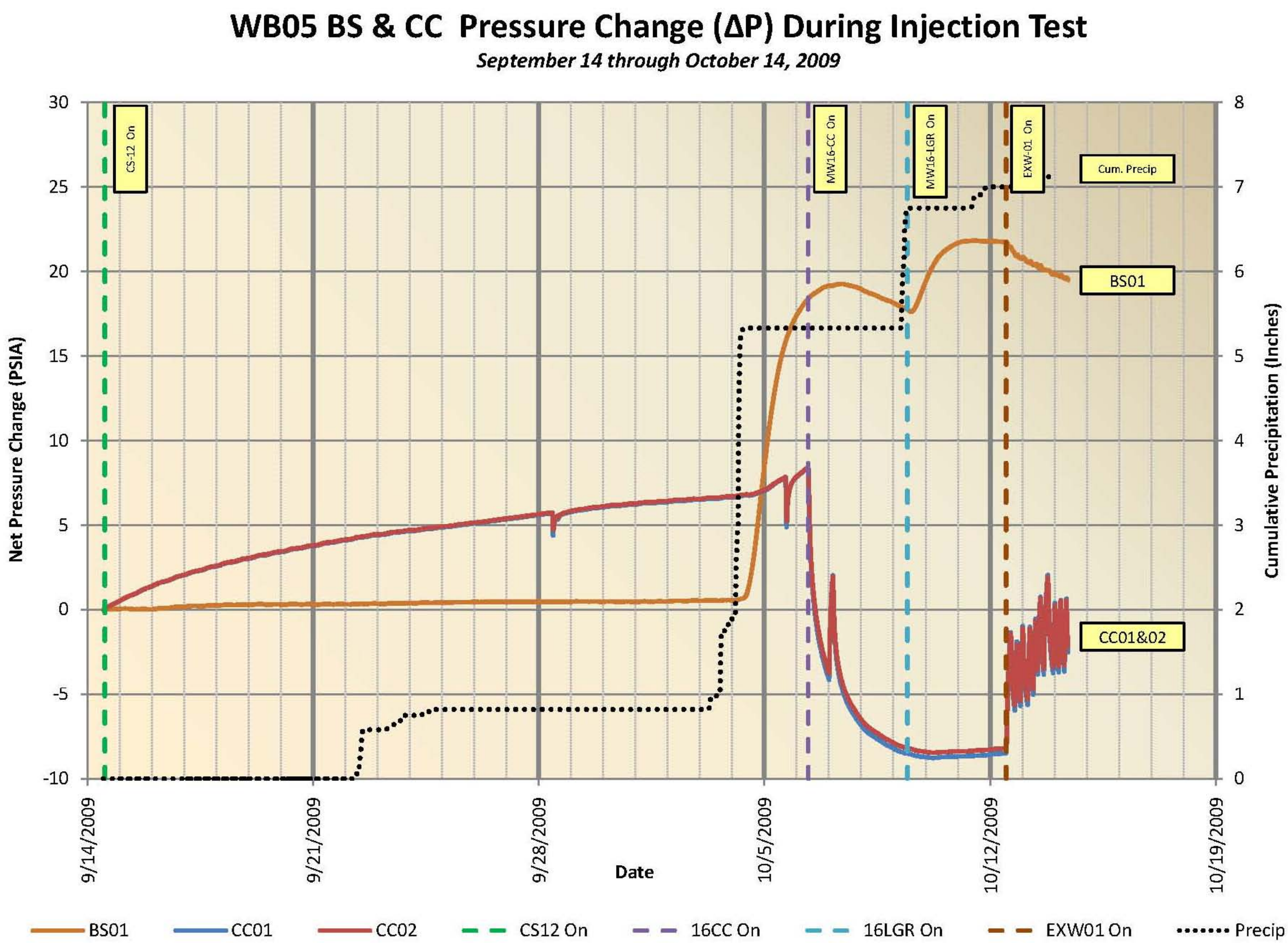


Figure 4.6 BS and CC Flood Test Data



SECTION 5
CONCLUSIONS

The goal of the flood test was to use injected water as a tracer and determine preferential pathways, trench connectivity, groundwater flow direction, contaminant transport characteristics and travel times from the bioreactor at trench 6 to the other trenches that make up the bioreactor, specific hydrostratigraphic zones in Westbay wells that surround the bioreactor, and monitoring and extraction wells surrounding SWMU B3 at CSSA. Though conditions were favorable at the beginning of the test, several significant rainfall events interfered with observed responses and masked the influence caused by the flooding of trench 6.

1. WB08 shows the greatest responses to the flooding of trench 6 (pressure increases in the hydrostratigraphic zones) due to its proximity to the bioreactor and trench 6.
2. Flow in the UGR01 and unsaturated LGR01, and LGR02 tends to go south and southwest as observed in the flooding responses in these zones at WB06 and lesser responses in these zones at WB07, which corresponds to the regional groundwater flow direction.
3. Trench 6 is connected to trench 1 and 2 and the northern portion of trenches 5 most directly, this was determined by the amount and timing of the water thickness increases in sumps T1-1, T1-2, T2-1, and T5-1. Trench 6 is less directly connected to trench 3 and the southern portions of trenches 1 and 2, and appears to have little connection to trench 4, and the southern portions of trenches 3 and 5.
4. A connection exists between trench 6 and CS-MW01 and from CS-MW01 to CS-MW16-LGR. Analytical data collected from CS-MW01 indicated a significant shift in *cis*-DCE from the previous years possibly due to flushing of contaminants from underneath trench 6. Though this *cis*-DCE front is not as apparent in WB05-LGR04B, a slight increase in *cis*-DCE is noted in the sample collected at the conclusion of the flood test. Though no significant increases in *cis*-DCE are observed in CS-MW16LGR, the appearance of water collected before the pump was restarted at the conclusion of the test looked and smelled similar to that of CS-MW01 water (gray, cloudy, with an odor of decaying biological material). Prior to the flood test the water collected from CS-MW16-LGR was clear and had no odor.
5. Regional recharge provided the greatest response to saturated and unsaturated zones as evidenced by the rapid and high magnitude response in the lower, saturated portions of the aquifer.
6. VOC levels in the vicinity of WB06 UGR were greatly impacted by flooding at Trench 6 and later by the heavy rainfall. Levels of PCE, TCE and DCE increased substantially during the test period, suggesting that as water in the UGR migrated away from Trench 6 and toward WB06, it picks up significant VOCs.
7. Fluctuations of VOC levels in WB08 LGR03B and LGR04 suggest this area is very sensitive to recharge. Flooding with clean water from CS-12 initially caused VOC levels in LGR03 to increase, while levels in LGR04 decreased. However,

after additional significant rainfall/recharge occurred, VOC levels in both these zones decreased suggesting possible dilution of the contaminants by the shear volume of water recharge.

8. Water levels and VOC data strongly indicate that the lower Glen Rose in the WB06 area is vertically connected. Vertical transport in the WB05 and WB08 areas is varied and less well defined. Vertical transport around WB07 is limited.
9. Increasing recharge by adding water to Trench 6 increased mass transfer around the Bioreactor. Additional moderate rainfall was shown to further increase mass transfer, while extreme recharge from prolonged, heavy rains decreased mass concentrations through dilution.
10. Moderate, sustained rainfall creates a regional recharge phenomenon expressed as "bottom filling". This type of recharge is clearly seen in the bottom units of the Lower Glen Rose. The UGR zone appears to be impacted by surface recharge only.
11. Flooding water into Trench 6 mimics old landfill operations where materials were drenched with solvent, burned and then extinguished using a nearby hydrant.
12. The bioreactor can maintain reducing conditions even when it is flooded with fresh water from an uncontaminated source or from rainfall.
13. The LGR04 zone is laterally well connected and contains the highest VOC concentrations in the bioreactor area.
14. The radius of influence of the LGR extraction wells (MW-16 LGR and EXW-01) extends to the LGR zone of all four WB wells. The LGR03B zone in WB08 is also influenced by the LGR extraction wells. This suggests a connection between LGR03B and LGR-04 zones in WB08.