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September 14, 2010

Mr. Scott Miller
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Region IV, Superfund North Florida Section
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Subject: Transmittal of the Report Entitled "*Upper Floridan Aquifer Well Installation: Investigation of the Northwestern Area of former Cabot Carbon/Koppers, Inc. Site, Gainesville, Florida*"

Dear Mr. Miller:

On behalf of Beazer East, Inc., attached is a copy of the report entitled "*Upper Floridan Aquifer Well Installation: Investigation of the Northwestern Area of former Cabot Carbon/Koppers, Inc. Site, Gainesville, Florida.*" Should you require additional information, please feel free to contact me at (303) 665-4390.

Sincerely,

James R. Erickson

James R. Erickson, P.G.
Principal Hydrogeologist

Enclosure

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UPPER FLORIDAN AQUIFER WELL INSTALLATION: INVESTIGATION OF NORTHWESTERN AREA OF FORMER CABOT CARBON/KOPPERS INC. SITE GAINESVILLE, FLORIDA

FINAL REPORT

Prepared For:

Beazer East, Inc.

Prepared by:

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September 14, 2010

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ACRONYMS

ASTM	American Society of Testing and Materials
Beazer	Beazer East, Inc.
bgs	Below Ground Surface
CGMSAP	Comprehensive Groundwater Monitoring Sampling Analysis Plan
cm/sec	centimeters per second
DNAPL	Dense Non-Aqueous Phase Liquid
EPA	Environmental Protection Agency
eV	Electron volt
GCTL	Groundwater Cleanup Target Level
gpm	Gallons per Minute
GRU	Gainesville Regional Utilities
HG	Hawthorn Group
HASP	Health and Safety Plan
ID	Inside Diameter
IDW	Investigational Derived Wastes
KI	Koppers Inc.
LTZ	Lower Transmissive Zone
MCL	Maximum Contaminant Level
msl	Mean Sea Level
NAPL	Non-Aqueous Phase Liquid
OD	Outer Diameter
PID	Photoionization Detector
POTW	Publicly Owned Treatment Works
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
SCM	Site Conceptual Model
SCU	Semi-confining unit
SJRWMD	St John's River Water Management District
Site	Koppers portion of the Cabot Carbon/Koppers Superfund Site
SOP	Standard Operating Procedure
SP	Spontaneous Potential
SVOCs	Semi-Volatile Organic Compounds
TD	Total Depth
UF	Upper Floridan
UTZ	Upper Transmissive Zone
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

This report documents the installation of five Upper Floridan (UF) Aquifer monitoring wells and one UF Aquifer groundwater extraction well at the former Koppers, Inc. portion (the Site) of the Cabot Carbon/Koppers Superfund Site in Gainesville, Florida (Figure 1-1). The approach to the well installation and testing is described in the GeoTrans November 4, 2009 workplan entitled: "*Upper Floridan Aquifer Well Installation Workplan: Investigation of Northwestern Area of Koppers Inc. Site, Gainesville, Florida"*. The workplan was approved by the U.S. Environmental Protection Agency (EPA) in an email response dated December 15, 2009. The five monitoring wells consist of three on-Site wells located in the northwestern area of the Site and two off-Site sentinel wells. The groundwater extraction well is located in the northwestern corner of the Site. The final well installation approach and testing were consistent with the approved workplan.

With the addition of the five new monitoring well, a total of 38 UF Aquifer monitoring wells are installed at or near the Site (Figure 1-2). Twenty-one of the 38 UF monitoring wells contain Westbay multiport sampling systems resulting in 83 discrete sampling zones in the 21 wells. The 38 wells and multiport sampling zones provide a comprehensive monitoring network for the UF Aquifer at Site.

1.1 OBJECTIVES AND APPROACH

Objectives

The on-Site monitoring well locations were selected to investigate the lateral and vertical extent of dissolved-phase impacts in this area of the Site. On-Site monitoring wells FW-27B and FW-30B help to define the downgradient lateral extent of the dissolved-phase plume originating from the FW-6 location (Figure 1-2). In addition, monitoring well FW-27B was installed approximately 50 feet into the semi-confining unit to investigate the vertical extent of dissolved-phase impacts downgradient of monitoring well FW-12B. Monitoring well FW-28B was installed along the northern Site property boundary to investigate the downgradient extent of impacts observed at monitoring well FW-22B. The off-Site sentinel wells (FW-29B and FW-29C) were located downgradient of on-Site impacts to provide additional sentinel monitoring locations.

Groundwater extraction well FW-31BE was installed to capture dissolved-phase impacts in the vicinity of monitoring well FW-22B prior to these impacts migrating off Site. Dissolved-phase impacts are primarily restricted to the upper 50 feet of the UF Aquifer in this area; however, the extraction well was screened over the upper 90 feet to help ensure compete capture of impacts in the Upper Transmissive Zone (UTZ).

Approach

During installation of the on-Site UF Aquifer monitoring wells, there was concern that the installation of these wells could potentially compromise the integrity of the Hawthorn Group (HG) middle and lower clay units, and thus provide a contaminant migration pathway. Because

of this concern, all on-Site monitoring wells were completed with telescoping isolation casings to minimize the potential introduction of Site constituents from overlying strata into the Lower Hawthorn deposits and the underlying UF Aquifer.

Each of the new on-Site UF Aquifer monitoring and extraction well designs consist of three telescoping casings (two isolation casings and one well casing) to minimize potential overlying impacts from the final UF Aquifer completion. The telescoping isolation casings (18-inch and 10-inch nominal diameter) were installed with a Barber-type rotary drill rig. The final well casings (4-inch nominal diameter) were installed using a rotasonic drill rig. The monitoring wells were completed as multiple-screened wells using alternating screen and blank casings. The extraction well was completed with a 90-foot long well screen that extended over the entire UTZ. The three on-Site monitoring wells were equipped with Westbay multiport sampling systems, similar to existing on-Site wells.

At the sentinel well locations there is no known source of groundwater impacts in the vicinity of these wells. As a precaution, a single isolation casing (9-inch nominal diameter) was completed into the HG lower clay unit to mitigate the potential for downward migration of non-Site related groundwater impacts into the UF Aquifer, if present at these well locations. The isolation casing and final well casings (4-inch nominal diameter) were installed using a rotasonic drill rig.

Each of the successive isolation casings was grouted in place prior to proceeding with the next casing installation. Although extensive precautions were taken to help ensure isolation of groundwater from the overlying deposits from the UF Aquifer, the potential for introducing migration pathways via the annular grout seal still exists. The technical challenge to the implementation of this program was to limit the possibility for the new wells from inadvertently providing vertical conduits for the downward migration of groundwater.

One of the lessons learned from previous UF Aquifer monitoring well installations is that even with extraordinary precautions to prevent “drag down” of constituents from overlying deposits, it is difficult to completely eliminate the potential for “drag down”. The HG and UTZ deposits are separated by approximately 30 feet of low-permeability clayey deposits, with approximately 90 feet of hydraulic-head difference across the clay deposit. Because of this, it is difficult to install a monitoring well without inadvertently introducing impacts (if present) from overlying deposits.

In addition to limiting the potential for introduction of Site constituents during the installation of the well, it is difficult to ensure long-term integrity of the annular grout seals. The approximately 120-foot hydraulic-head difference from the Surficial Aquifer to the UF Aquifer may induce flow along small pathways adjacent to a well casing. This flow would eventually result in transmission of detectable quantities of impacted groundwater (if present) over periods of months and years. Each section of core that was recovered was scanned for volatile organic vapors using a photo-ionization detector (PID) equipped with a 10.8 electron volt (eV) bulb. The PID measurements, geologic-core descriptions and well constructions are provided in Appendix A.

1.2 SITE LOCATION AND DESCRIPTION

The Site encompasses approximately 90 acres and is located within the Gainesville City limits in Alachua County, Florida (Figure 1-1). It was used as an active wood-treating facility for more than 90 years, but operations ceased in early 2010. The Site is located in an area of the city that is zoned industrial, with surrounding commercial and residential zoned properties. The adjacent property to the east of the Site is the former Cabot Carbon Superfund Site. This property was redeveloped for commercial use in the 1990s. The adjacent property to the north is the City of Gainesville vehicle/equipment maintenance facility. The properties to the west are private residences, and the properties to the south are a mixture of commercial and residential properties.

The Site is located on a gently sloping plain at an elevation of approximately 180 feet above mean sea level (msl). The ground surface immediately around the Site has low relief and slopes gently to the northeast. In general, the ground surface at the Site slopes gently to the north. From the southern property boundary to the northern property boundary (approximately 3,000 ft), the land-surface elevation decreases from approximately 190 feet to 170 feet above msl. A central drainage ditch bisects the Site and flows in a north to northeasterly direction.

1.3 REGIONAL HYDROGEOLOGY

The Site is located in the Northern Highlands of Alachua County, where the HG deposits confine the UF Aquifer. Three principal hydrostratigraphic units are present in this area: 1) Surficial Aquifer; 2) HG deposits; and 3) UF Aquifer.

Surficial Aquifer

The Surficial Aquifer consists of approximately 15- to 30-feet of Pliocene to Pleistocene marine-terrace deposits (Figure 1-3). These deposits are primarily comprised of unconsolidated, fine- to medium-grained sand, with thin layers of interbedded silt and clay deposits. The Surficial Aquifer groundwater flow is primarily controlled by land-surface topography and localized discharge points such as wetlands, creeks, and drainage ditches. The Surficial Aquifer is not a major source of potable groundwater.

Hawthorn Group Deposits

The HG deposits underlie the Surficial Aquifer and consist of a thick sequence of interbedded low- and moderate-permeability, unconsolidated sedimentary materials. These deposits are approximately 120 to 125 feet thick in the vicinity of the Site and separate the overlying Surficial Aquifer from the underlying UF Aquifer. The HG deposits consist of a complex sequence of interbedded clays, silts, sands and carbonates, with three predominantly clay deposits located at the top, middle, and bottom of this unit. Deposits separating the three major clay units are clayey sands, sands, silts, silty-sands, and isolated carbonate deposits. The HG deposits are not typically a source of potable groundwater for this area. Hydraulic heads in the HG deposits are primarily controlled by the three low-permeability clay units.

Upper Floridan Aquifer

The UF Aquifer underlies the HG deposits. The two primary formations that comprise the UF Aquifer are the Ocala Limestone and the Avon Park Formation (Figure 1-3). The UTZ is a secondary water-producing interval for the UF Aquifer and is located in the uppermost portion of the Ocala Limestone. The UTZ is highly variable and ranges locally from 50 to 100 feet in thickness. The LTZ is the major water-producing interval for the Murphree Wellfield in Alachua County. The LTZ is located at the contact of the Ocala Limestone and Avon Park Formation and is variable in thickness, ranging from 20 to 100 feet (GeoSys, Inc., 2000). Approximately 85 percent of the Murphree Wellfield production is obtained from the LTZ and 15 percent is obtained from the UTZ (GeoTrans, 2004). At the Site, the UTZ and LTZ are separated by a semi-confining unit (SCU). The SCU is approximately 100 feet of lower-permeability carbonate deposits. Historically, the regional groundwater flow direction in the UF Aquifer is to the west and northwest; however, groundwater withdrawals from the Murphree Wellfield have changed groundwater flow directions across a large area of the County. Because of Murphree Wellfield withdrawals, the UF Aquifer average groundwater flow direction at the Site is to the north and northeast. A more thorough discussion of the hydrogeologic site conceptual model (SCM) is provided in the report entitled: *Addendum 6: Groundwater Flow and Transport Model* (GeoTrans, 2004).

2.0 DRILLING AND MONITORING WELL CONSTRUCTION

Monitoring well installation was performed in accordance with the approved workplan (GeoTrans, 2009*)*. The five monitoring wells and one extraction were installed in the UF Aquifer using a combination of rotary and rotasonic drilling methods. Well construction began in January 2010 and was completed in May 2010. The monitoring well construction as-built logs are provided in Appendix A.

All monitoring wells installed under this program were 4-inch diameter multiple-screened wells. On-Site monitoring wells were installed with isolation casings set in the HG deposit middle clay unit (approximate depth of 65 feet bgs) and HG deposit lower clay unit (approximate depth of 110 feet bgs), and off-Site sentinel wells were installed with a single isolation casing set in the HG deposit lower clay unit. The extraction well (FW-31BE) is a 4-inch diameter well, with a continuous 90-foot long screen extending over the UTZ interval. Similar to the monitoring wells, isolation casings were set in the HG deposits middle and lower clay units for the extraction well.

2.1 MONITORING WELL LOCATIONS AND DEPTHS

The final UF Aquifer locations for monitoring wells (FW-27B, FW-28B and FW-30B), sentinel wells (FW-29B and FW-29C) and extraction well (FW-31BE) are shown on Figure 1-2. The target zone for completion of the UTZ monitoring and extraction wells were the upper 100 feet of the Ocala Limestone. The target zone for completion of the UTZ/SCU monitoring well was the upper 150 feet of the Ocala Limestone. The target zone for completion of the LTZ monitoring well was the lower 40 feet of the Ocala Limestone and upper 40 feet of the Avon Park Limestone.

2.2 DRILLING AND CORE COLLECTION APPROACH

The well designs for the on-Site monitoring and extraction wells consisted of three telescoping casings (two isolation casings and a well casing) to minimize potential for "drag down" of overlying impacts. The sentinel wells consist of two telescoping casings (one isolation casings and a well casing). Figures 2-1, 2-2, 2-3, 2-4, and 2-5 show the conceptual design for the monitoring wells, sentinel wells, and extraction well, respectively.

The well locations were cleared for utilities through the Sunshine One Call location service prior to the start of drilling. After utility locations had been marked and cleared, an air-knife (vacuum drill) was advanced to a depth of approximately 6 feet below ground surface (bgs) at each well location. The air-knife was used to confirm that no buried utilities and/or objects were present at the well locations.

A mini-sonic rig was utilized to obtain geologic core of the Surficial Aquifer and Upper Hawthorn at on-Site monitoring well locations (FW-27B, FW-28B, and FW-30B). The primary purpose of the core collection was to establish the HG deposit middle clay contact depth for the

installation of the upper isolation casing. The core was also used to identify lithologic contacts and DNAPL impacts, if present. The mini-sonic rig utilized a 4-inch diameter core barrel with a 6-inch override casing to advance the pilot borings. The soil core were described by the on-Site field hydrogeologist, photographed, and screened for volatile organic compounds (VOCs) using a photoionization detector (PID) equipped with a 10.6 eV bulb. The borings installed with the mini-sonic rig were backfilled with bentonite chips after core collection to minimize the potential for downward migration via the open borehole. Following the installation of the upper isolation casing at the on-Site monitoring well locations, geologic cores were collected with the full-size rotasonic rig from the base of the isolation casing to the HG lower clay unit to establish the lower isolation casing completion depths. Similar to the cores collected in the Upper Hawthorn, the Lower Hawthorn cores were logged and scanned for DNAPL impacts. Isolation casing completion depths for extraction well FW-31BE were based on geologic cores previously collected at adjacent monitoring well FW-22C.

2.2.1 BARBER RIG DRILLING

The Barber rig and associated casing and tools were decontaminated prior to drilling at each new well location. The Barber rig drilling procedure described below was utilized for the installation of the upper telescoping isolation casings for the on-Site monitoring and extraction wells.

Upper Hawthorn Isolation Casing

The Barber rig drilled a 22-inch borehole using a tri-cone rotary bit. Contemporaneous with drilling the borehole, a 22-inch outer diameter (OD) temporary black carbon steel casing, with a carbide button shoe welded to the bottom, was advanced to keep the borehole open. Water obtained from an on-Site potable water source was used to circulate cuttings from the boring. The drilling circulation water was discharged through a cyclone into a 25 cubic yard, watertight roll-off container.

The completion depth of the Upper Hawthorn isolation casing was established based on cores collected at the start of the program. The boring was advanced from ground surface to the target depth, penetrating approximately 3 feet into the HG middle clay. Stability of the borehole was maintained during drilling using the 22-inch temporary steel casing, which was beveled and triple-welded at each joint. This temporary casing also minimized the volume of circulation water lost to the formation.

Upon reaching the targeted depth of approximately 3 feet into the HG middle clay, a permanent 18-inch nominal OD black carbon steel isolation casing was placed inside of the 22-inch temporary casing. Centralizers were welded to the top and bottom of the 18-inch isolation casing to help ensure a complete and uniform cement grout seal and to minimize grout channeling. A bentonite plug was placed in the bottom of the 18-inch isolation casing to prevent cement grout from flowing in from the annulus, and the 18-inch isolation casing was tremie-grouted to ground surface with the simultaneous removal of the 22-inch temporary casing. The grout mixture consisted of 92 pounds of cement, 6 pounds of bentonite, and 6.5 gallons of water.

Approximately 5 feet of grout was maintained inside of the 22-inch temporary casing during its removal to ensure a complete and continuous grout seal.

Upon completion of the 18-inch casing installation, a protective steel plate was tack welded to the top of the casing to prevent debris from falling downhole prior to the start of drilling for the next telescoping isolation casing. The grout seal was allowed to cure for a minimum of 12 hours before additional work was performed in the well. The drill rig, drill pipe, and tools were decontaminated at the completion of the grouting process.

Lower Hawthorn Isolation Casing

The rotasonic rig was utilized to collect continuous core from the base of the 18-inch isolation casing to the HG deposit lower clay unit to establish completion depths for the second isolation casings. The Barber rig was used to advance the borehole from the base of the 18-inch isolation casing using a 16-inch diameter tri-cone rotary bit. Similar to the 22-inch borehole, a temporary 16-inch OD black carbon steel casing was advanced to keep the borehole open. Water was used to circulate cuttings from the boring using the same methods and equipment used to drill the 22-inch diameter borehole. The boring was advanced from the bottom of the 18-inch isolation casing to the target depth of approximately 4 feet into the HG lower clay.

Upon reaching the targeted depth, a permanent 10-inch nominal OD black carbon steel isolation casing was placed inside of the temporary 16-inch casing. Centralizers were welded to the top and bottom of the 10-inch isolation casing to help ensure a complete and uniform cement grout seal and to minimize grout channeling. A bentonite plug was placed in the bottom of the 10-inch isolation casing to prevent cement grout from flowing in from the annulus. The grout mixture and procedure for placing the grout was the same as for the 18-inch isolation casing.

2.2.2 ROTASONIC DRILLING

The rotasonic-drill rig was utilized at the on-Site monitoring and extraction well locations to complete drilling and sampling below the 10-inch isolation casing and for the installation of the 4-inch diameter well. The rotasonic rig was utilized at the off-Site sentinel well locations for all core collection and drilling activities.

The rotasonic drilling method is commonly used in Florida and employs the use of high-frequency, resonant energy to advance a core barrel and/or override casing into subsurface deposits. The resonant energy is transferred down the drill string to the bit face at various sonic frequencies, while simultaneously rotating the drill string. Samples are collected using an inner casing as the borehole is drilled and the outer (override) casing prevents borehole collapse.

For the on-Site monitoring and extraction wells, rotasonic drilling was initiated from the base of the 10-inch nominal casing in the HG lower clay (an average depth of 112 ft bgs) to the targeted borehole depth in each of the wells. Continuous core samples were collected using a 9-inch rotasonic override casing with a 7-inch rotasonic core barrel.

For the off-Site sentinel wells, rotasonic drilling was utilized from the base of the air-knife boring (approximately 6 feet bgs) to the targeted borehole depth for each of the wells. Continuous core samples were collected for the entire LTZ boring (FW-29C). A 10-inch diameter rotasonic override casing with an 8-inch rotasonic core barrel was used to advance the borings from ground surface to the target depth of approximately 3 feet into the HG lower clay. Upon reaching the target depth, the boreholes were enlarged with a 12.25-inch rotasonic override casing placed over the 10-inch override casing. The 10-inch override casing was removed and a permanent 8.25-inch OD black carbon steel isolation casing was placed inside of the 12.25-inch rotasonic override casing. The grout mixture and procedure for placing the grout was the same as for the on-Site wells. A 7-inch diameter override casing with a 6-inch diameter rotasonic core barrel was used to advance the borings from the base of the 8.25-inch isolation casing in the HG lower clay to the target depth of each boring.

All water used during drilling in the UF Aquifer and during well construction was tagged with a sodium bromide tracer solution. The tracer was added to the drilling makeup water reservoir at an approximate concentration of 120 mg/L.

Targeted borehole total depths in the four UTZ wells (FW-28B, FW-29B, FW-30B, FW-31BE) were 100 feet below the HG lower clay and Ocala Limestone contact. The targeted borehole depth of the UTZ/SCU well (FW-27B) was approximately 50 feet into the SCU. The targeted depth of the LTZ well (FW-29C) was 40 feet below the Ocala Limestone and Avon Park Formation contact.

When targeted depths had been reached in extraction well FW-31BE, the rotasonic override casing was withdrawn to the Ocala Limestone contact (approximately 140 feet) to run geophysical logs prior to well construction. Geophysical logs are discussed in Section 2.2.4.

2.2.3 GEOLOGIC CORE COLLECTION

A total of 1,294 feet of geologic core were collected during the drilling program. The continuous core samples were described by the on-Site field hydrogeologist, photographed, and screened for VOCs using a PID equipped with a 10.6 eV bulb. All rotasonic cores were disposed as investigative derived waste (IDW). Select rotasonic core samples were also described by Geohazards, Inc. of Gainesville, Florida, experts in the local stratigraphy. During the drilling operation, Geohazards personnel provided confirmation of key contact depths and stratigraphic markers. Geohazards report on the lithology of the cored sections of each of the boreholes is included in Appendix D. Monitoring well construction as-built drawings with geologic descriptions are provided in Appendix A; field core log forms are provided in Appendix B; and core photographs are provided in Appendix C. Summaries of the well as-built data are provided in Tables 2-1a, 2-1b, 2-1c and Figure 2-6.

2.2.4 GEOPHYSICAL LOGGING

Geophysical logs were run in extraction well FW-31BE from the Ocala Limestone contact (approximately 140 feet bgs) to the borehole total depth (approximately 242 feet). The geophysical logs consisted of: 1) Caliper; 2) Fluid conductivity; 3) Short- and long-normal

resistivity; 4) Natural gamma; and 5) Spontaneous potential. The geophysical logs are provided in Appendix E.

2.2.5 DRILLING FLUIDS

Barber rig and rotasonic drilling methods required the use of water for drilling and casing installation. A summary of fluid use during drilling and well construction in the UF Aquifer is provided in Table 2-2. As required by EPA (July 12, 2005), a bromide tracer was added to the drilling fluids during the drilling of the screen intervals. The bromide concentrations were monitored during well development as one of a number criteria for determining when well development was completed. Sodium bromide was added to the drilling water tank at an approximate concentration of 120 mg/L, based on experience gathered during the previous UF Aquifer well installation programs. Drilling fluid bromide concentrations and the daily field bromide concentrations during well development are provided in Table 2-3.

2.2.6 AQUIFER TESTING PROCEDURE

Aquifer testing was performed on extraction well FW-31BE to evaluate groundwater extraction rates required to capture and contain groundwater impacts in the northwestern area of the Site and to assess the hydrogeologic characteristics of the UTZ in the vicinity of the extraction well. The aquifer testing included a step-drawdown test during well development to identify an appropriate pumping rate for the 6-day constant-rate aquifer test.

For both the step-test and constant-rate test, continuous water-level measurements were collected with non-vented, data-logging pressure transducers in extraction well FW-31BE and nearby monitoring wells FW-2, FW-22B, FW-22C, FW-24B, FW-27B and FW-28B. Non-vented pressure transducers measure total pressure and need to be corrected for barometric pressure changes. A separate on-Site barometer was used to collect barometric pressure changes to adjust pressure transducer readings. In addition, monitoring well FW-11B was instrumented with a pressure transducer to monitor background water-level changes at the Site due to regional pumping at the Murphree Wellfield. The pumping test water-level data collected at FW-31BE and surrounding observation wells were corrected for the regional water-level changes observed at FW-11B over the duration of the aquifer test.

The data logger/pressure transducer software requires that fixed sample intervals be set for defined monitoring periods. In order to capture rapidly changing water levels during the early portions of the aquifer test, the pressure transducers were set to short sample intervals that were extended as the test progressed. For the first 10 minutes of the constant-rate test, the extraction well pressure transducer collected data at 0.5-second intervals and the observation well pressure transducers collect data at 1-second intervals. Following the first 10-minute interval, all of the transducers were set to collect data at 5-second intervals for 90 minutes, 10-second intervals for the next 90-minutes, 30-second intervals for next 90 minutes, and 5-minute intervals for the remainder of the 6-day aquifer test. For the recovery portion of the constant-rate test, the data collection intervals were reset to 1-second intervals for 10 minutes, 5-second intervals for 90 minutes, 10-second intervals for 90-minutes, 30-second intervals for 90 minutes, and 5-minute intervals for the remainder of the recovery.

The step-drawdown test was performed with a pump rated at 60 gpm, with water discharged to a 20,000 gallon frac tank via temporary discharge lines. The diameter of the pump including the wire guard was only slightly smaller than the diameter of the weld at the top of the stainless steel screen. Therefore, the bottom of the pump was placed immediately above the top of the screen during the step-drawdown test. The pump was approximately 5 feet long, and the transducer in FW-31BE was set approximately 6 inches above the top of the pump. As a result of pump placement and size, the transducer was located approximately 5 feet below the water surface. The step-drawdown test was conducted at pumping rates 10, 18, 30, 34, 48, and 54 gallons per minute (gpm). The individual steps were run until real-time field data indicated that water levels had stabilized. The durations of the six steps were 30, 25, 26, 25, 10, and 10 minutes, respectively. The water level in FW-31BE was drawn down below the level of transducer at pumping rates of 48 gpm and 54 gpm. After the pump was turned off, recovery data was collected with the pressure transducers. The total volume of water pumped during the step test was 4,209 gallons.

The constant-rate aquifer test was performed on extraction well FW-31BE in accordance with the April 28, 2010 workplan entitled: "*Upper Floridan Aquifer Extraction Well FW-31BE Performance Monitoring Workplan; Koppers Inc. Site, Gainesville, Florida*", which was approved by the EPA via an email on May 21, 2010. Background data was collected at 5 minute increments for approximately 2 weeks prior to initiating the constant-rate test. Following installation of the permanent submersible pump and associated piping to the on-Site water-treatment facility, the constant-rate test was initiated on June 8, 2010. Based on the data collected during the step test, a pumping rate of 30 gpm was targeted for the constant-rate test. The initial pumping rate was 30 gpm for approximately 2 minutes. As the piping to the on-Site water-treatment facility filled with water, the pumping rate tapered off over the next 3 minutes before settling at an average of 28.5 gpm for the remainder of the test. The pump was turned off on June 14, 2010, and recovery data in the extraction and observation wells were recorded with the pressure transducers. The total volume of water pumped during the constant-rate test was 253,955 gallons.

2.2.7 EQUIPMENT AND MATERIALS DECONTAMINATION PROCEDURES

Drilling equipment, tools, and associated materials used in well construction were decontaminated prior to first use on-Site, after the installation of each telescoping isolation casing, well installation, and prior to drilling at a new well location (i.e., before and after all operations). Decontamination was performed at the existing on-Site decontamination pad. Decontamination fluids were containerized for characterization, testing, and disposal. The following decontamination procedures were used:

1) The external and internal surfaces of equipment were washed with a high-pressure steam cleaner. If necessary, all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., was scrubbed with brushes for removal.
2) After cleaning, the equipment/material was rinsed with potable water.
3) All decontaminated drilling equipment, casings, and override casing were stored above ground on racks prior to being used in the drilling and well construction process.

2.2.8 INVESTIGATIVE DERIVED WASTE

All IDW originating from designated Superfund Sites must be treated as hazardous waste, unless laboratory analyses establish that it can be treated as nonhazardous waste. To make this determination, Beazer utilized the material handling and waste characterization process described below.

The material (drill cuttings, circulation fluids, etc.) generated from the Barber rig and rotasonic drilling activities during the installation of the monitoring wells described in this report were captured in 25 cubic yard watertight rolloff bins. Whenever possible, liquids were allowed to settle, and then were transported to the on-Site water-treatment facility. Solids were transferred into DOT- approved open-top drums. A total of 782 drums were generated during the monitoring well installation process. The drummed material was managed for off-Site transport and disposal.

2.3 WELL INSTALLATION AND COMPLETION

Each of the on-Site extraction and monitoring well designs incorporated multiple isolation casings to mitigate potential downward contaminant migration. The off-Site UTZ and LTZ sentinel well designs incorporated a single isolation casing. The annular space for the blank casing that separated the multiple well screens was isolated with a bentonite annular seal. The individual screened intervals for the on-Site monitoring wells were isolated with multiport Westbay systems.

2.3.1 WELL DESIGNS

UTZ Monitoring Well Designs

The on-Site UTZ monitoring well designs for FW-28B and FW-30B consisted of a 4-inch diameter, stainless steel well completion for the UF Aquifer with four 10-foot long, stainless steel screens, separated by 10-foot long blank stainless steel casing. A 15-foot long stainless steel sump was placed at the bottom of the well, and 40 feet of stainless steel casing extended from the top of the upper screen. Four-inch nominal black carbon steel casing extended from the top of the stainless steel casing to approximately 2.5 feet above ground surface. The conceptual design for the UTZ monitoring wells is shown in Figure 2-1.

UTZ/SCU Monitoring Well Design

The UTZ/SCU monitoring well design for FW-27B consisted of a 4-inch nominal, stainless steel well completion for the UF Aquifer with six 10-foot long, stainless steel screens, separated by 15-foot long blank stainless steel casing. A 15-foot long stainless steel sump was placed at the bottom of the well, and 40 feet of stainless steel casing extended from the top of the upper screen. Four-inch nominal black carbon steel casing extended from the top of the stainless steel casing to approximately 2.5 feet above ground surface. The conceptual design for the UTZ/SCU monitoring well is shown in Figure 2-2.

UTZ Sentinel Monitoring Well Design

The UTZ sentinel monitoring well design for FW-29B consisted of a 4-inch nominal, stainless steel well completion for the UF Aquifer with four 10-foot long, stainless steel screens, separated by 10-foot long blank stainless steel casing. A 15-foot long stainless steel sump was placed at the bottom of the well, and 40 feet of stainless steel casing extended from the top of the upper. Four-inch nominal black carbon steel casing extended from the top of the stainless steel casing to approximately 4 inches below ground surface (flush mount). The conceptual design for the UTZ sentinel monitoring well is shown in Figure 2-3.

LTZ Sentinel Monitoring Well Design

The LTZ sentinel monitoring well design for FW-29C consisted of a 4-inch nominal, stainless steel well completion for the UF Aquifer with three 10-foot long, stainless steel screens, separated by 20-foot long blank stainless steel casing. A 15-foot long stainless steel sump was placed at the bottom of the well, and 170 feet of stainless steel casing extended from the top of the upper screen. Four-inch nominal black carbon steel casing extended from the top of the stainless steel casing to approximately 4 inches below ground surface (flush mount). The conceptual design for the LTZ sentinel monitoring well is shown in Figure 2-4.

UTZ Extraction Well Design

The UTZ extraction well design for FW-31BE consisted of a 4-inch nominal, stainless steel well completion for the UF Aquifer with one 90-foot long, stainless steel screens. A 5-foot long stainless steel sump was placed at the bottom of the well, and 30 feet of stainless steel casing extended from the top of the upper screen. Four-inch nominal black carbon steel casing extended from the top of the stainless steel casing to approximately 2.5 feet above ground. The design for the UTZ extraction well is shown in Figure 2-5.

2.3.2 WELL INSTALLATION

UTZ Monitoring Wells

On-Site UTZ monitoring wells FW-28B and FW-30B required drilling an approximate 9-inch diameter borehole from the base of the 10-inch isolation casing set in the HG lower clay to the completion depth of the wells, 248.9 and 241.9 feet bgs, respectively.

The UTZ monitoring well completions consisted of four, 4-inch diameter by 10-foot long stainless steel, 0.010-inch slot, wire-wrapped well screens separated by 10-feet of blank stainless steel casing. The screen opening size was based on grain-size analyses previously performed on Ocala Formation cores collected at the Site. Based on the formation grain-size distribution, the well-screen manufacture recommended a maximum screen-slot size of 0.030-inch (30 slot screen) for a production well completed in this formation. A more conservative screen size of 0.010-inch was selected for monitoring well design to minimize the potential for fine-grained formation material entering the well.

The well casing above the uppermost screen interval consisted of both stainless steel and black-carbon steel. All well casing/screens that extend below the UF Aquifer potentiometric surface were stainless steel and all casing above the approximate potentiometric surface depth (i.e. standing water in the well) was black-carbon steel. Approximately 40 feet of stainless-steel casing was installed above the uppermost well screen, with black-carbon steel casing extending from the top of the stainless-steel casing to land surface.

The UTZ monitoring wells were constructed inside the 9-inch (on-Site wells) and 7-inch (off-Site well) rotasonic override casing to ensure borehole integrity during well construction. The 4-inch diameter well was constructed by assembling the flush-joint, threaded casing and screen together as it was lowered inside of the override casing. Each of the stainless steel sections were flush-joint threaded. The black-carbon steel was connected to the stainless steel using a threaded coupler that was welded to the bottom of a black-carbon steel casing. The 21-foot long black-carbon steel sections were welded together.

After the well screen and casing were installed inside of the override casing, annular backfill material was poured between the well casing and override casing. A tremie pipe was not used for the placement of the filter sand and bentonite seals because the override casing acted as an effective tremie pipe. The filter pack was sized to match the 10-slot screen opening and consisted of 10/20 silica sand. Alternating layers of filter pack material and bentonite chips were placed in the annular space opposite the well screens and blank casing, respectively.

Backfilling of the annular space in well FW-28B started with placement of filter sand opposite the 15-foot sump, to a point approximately 4 feet below the bottom of the lowest screen. A 2-foot layer of bentonite chips were then placed on top of the sand to isolate the sump annular material from the filter pack screen material above. Filter sand was then placed opposite the lowermost screen interval from approximately 2 feet below the screen to 2 feet above the top of the screen.

Backfilling of the annular space in well FW-30B started with placement of bentonite chips opposite the 15-foot sump to a point approximately 2 feet below the bottom of the lowest screen. Filter sand was then placed opposite the remainder of the 15-foot sump, and continued to approximately 2 feet above the top of the lowest screened interval. Placement of alternating layers of bentonite and filter pack material progressed upwards in the borehole until the upper screen filter pack was in place. Approximately 5 feet of bentonite chips were then placed above the uppermost filter pack to help minimize the potential for cement grout infiltration into the upper screened interval. During the placement of the backfill material, the override casing was systematically withdrawn. A minimum of 5 feet of backfill material was maintained inside of the override casing at all times during well construction. During placement of the backfill material the override casing was vibrated to pack the annular material and to minimize post-well construction settling.

The remainder of the borehole annulus from the top of the bentonite chips to ground surface was backfilled with cement-bentonite grout by injecting through a tremie pipe place immediately above the upper bentonite seal. Grouting was completed to ground surface by incrementally removing sections of the override casing as the grouting progressed to land

surface. After the grout returns were noted at the surface, the override casing was completely removed from the borehole.

Figure 2-6 and Tables 2-1a through 2-1c provides as-built specifications for screened intervals and backfill materials for the UTZ monitoring wells installed under this program.

UTZ/SCU Monitoring Well

The on-Site UTZ/SCU monitoring well FW-27B required drilling an approximate 9-inch diameter borehole from the base of the 10-inch isolation casing set in the HG lower clay to the total depth of the well (300 feet bgs). The monitoring well consisted of six, 4-inch diameter by 10-foot long stainless steel, 10-slot, wire-wrapped well screens separated by 15-feet of blank stainless steel casing.

A 15-foot long stainless steel sump was installed below the lowermost screen interval, and 30 feet of stainless steel casing was installed above the upper screen. The remaining well casing consists of black-carbon steel casing extending to land surface.

The UTZ/SCU monitoring well was constructed inside the 9-inch rotasonic override casing to ensure borehole integrity during well construction. The 4-inch diameter well was constructed similar to the UTZ monitoring well procedure discussed above. Tables 2-1a through 2-1c provides as-built specifications for screened intervals and backfill materials for the UTZ/SCU monitoring well installed under this program.

UTZ Sentinel Monitoring Well

Off-Site UTZ sentinel monitoring well FW-29B required drilling an approximate 7-inch diameter borehole from the base of the 8-inch isolation casing set in the HG lower clay to the total depth of the well (248.5 feet bgs).

The UTZ sentinel monitoring well completion consisted of four, 4-inch diameter by 10-foot long stainless steel, 10-slot, wire wrapped well screens separated by 10-feet of blank stainless steel casing.

A 15-foot long stainless steel sump was installed below the lowermost screen interval, and 40 feet of stainless steel casing was installed above the upper screen. The remaining well casing consists of black-carbon steel casing extending to land surface.

The UTZ sentinel monitoring well was constructed inside the 7-inch rotasonic override casing to ensure borehole integrity during well construction. The 4-inch diameter well was constructed similar to the on-Site monitoring wells, as described above. Tables 2-1a through 2-1c provides as-built specifications for screened intervals and backfill materials for the UTZ sentinel monitoring well.

LTZ Sentinel Monitoring Well

The off-Site LTZ sentinel monitoring well FW-29C required drilling an approximate 7-inch diameter borehole from the base of the 10-inch isolation casing set in the HG lower clay to the total depth of the well (377 feet bgs). The monitoring well consisted of three, 4-inch diameter by 10-foot long stainless steel, 10-slot, wire wrapped well screens separated by 20-feet of blank stainless-steel casing.

A 15-foot long stainless steel sump was installed below the lowermost screen interval, and 170 feet of stainless steel casing was installed above the upper screen. The remaining well casing consists of black-carbon steel casing extending to land surface. The 4-inch diameter well was constructed similar to the on-Site monitoring well discussed above. Tables 2-1a through 2-1c provides as-built specifications for screened intervals and backfill materials for the LTZ sentinel monitoring well.

UTZ Extraction Well

On-Site UTZ extraction well FW-31BE required drilling an approximate 9-inch diameter borehole from the base of the 10-inch isolation casing set in the HG lower clay to the total depth of the well. The UTZ extraction well completion consisted of one, 4-inch nominal diameter by 90-foot long stainless-steel, 20-slot, wire-wrapped well screen. To maximize groundwater production, at the same time minimizing the potential for fines entering the well during development and sampling, a screen-slot size of 0.020-inch was selected. The filter pack was sized to match the 20-slot screen opening and consisted of 12/20 silica sand.

A 5-foot long stainless-steel sump was installed below the lowermost screen interval, and 30 feet of stainless-steel casing was installed above the upper screen. The remaining well casing consists of black-carbon steel casing extending to land surface. Placement of the annular filter pack and seals was similar to the on-Site monitoring well discussed above. Tables 2-1a through 2-1c provides as-built specifications for screened intervals and backfill materials for the extraction well.

2.3.3 BOREHOLE AND CASING GROUTING

The cement grout mixture and preparation used in all components of the casing installation and well construction was in accordance with American Society of Testing and Materials (ASTM) 5092 and consisted of ASTM Type I/II Portland cement, powdered bentonite, and potable city water. The cement was mixed into a smooth slurry using 6.5 gallons of water, 6 pounds of bentonite, and 92 pounds of cement. Powdered bentonite was added to the cement grout mixture to minimize shrinkage during the curing process, as required by SJRWMD (Chapter 40C-3, F.A.C.). All grout used in casing installation and well construction was placed downhole using a tremie pipe. Grouting over each interval continued until grout returns were confirmed at ground surface. The grout was allowed to cure a minimum of 12 hours prior to additional work being performed inside of the casing.

Casing centralizers were used to help minimize grout channeling during the installations of the 18-inch, 10-inch, and 8-inch nominal isolation casings. Similarly, the 4-inch nominal well casings were set with a centralizer at the bottom of the well opposite the sump, a centralizer approximately 10 feet above the top of the upper screen, and centralizers spaced approximately 50 feet to ground surface. Monitoring wells FW-27B, FW-29B, FW-29C, and FW-30B were also set with additional centralizers located between screened intervals. The rotasonic override casing also helped to centralizer the well casing in the borehole during annular seal placement. With the combination of the external casing centralizers and the override casing, all well casings were effectively centered within the borehole.

2.3.4 WELL DEVELOPMENT

Well development is a standard practice performed at the completion of well construction to remove fine-grained formation materials opposite the screened interval and to improve hydraulic communication. In addition, well development is used to recover water that was lost to the formation during drilling and well-completion operations.

EPA (July 12, 2005) required that drilling fluids contain a tracer to quantify drilling fluids impacts on future groundwater samples collected from the well. A bromide tracer at an approximate concentration of 120 mg/L was added to drilling and well-completion water used to drill the screen intervals in the UF Aquifer.

Development Approach

Primary development was conducted using a 4-inch submersible pump capable of pumping approximately 20 gpm connected to 2-inch galvanized discharge pipe. K-packers were utilized during development to isolate individual screen intervals. A K-packer consists of 4-inch diameter flexible rubber seals on the outside of 2-inch diameter pipe. The rubber seals on the outside of the K-packer fit tightly inside of the 4-inch nominal well casings and effectively isolate the inside of the well casing above and below the screen interval being developed. The daily and total volume of development water removed from each well is provided in Table 2-3.

Primary well development for the monitoring wells was performed by targeting each of the individual 10-foot screened intervals. The intervals were isolated by positioning K-packers above and below each screen interval, then alternately surging and pumping from the individual screened interval. After each screen was developed, the pump was placed at the bottom of each well and the wells were pumped to remove any sediment that may have accumulated in the sump. When well development operations were temporarily halted (such as at the end of a 10-day shift), the individual screened intervals were isolated by K-packers to minimize inter-wellbore flow between screen intervals during extended non-work times.

Primary well development in the UTZ extraction well was performed by targeting overlapping 21-foot intervals within the 90-foot screen. The individual intervals were isolated by positioning K-packers above and below the pump, then alternately surging and pumping from the isolated interval. After the entire 90-foot screen interval was developed, the pump was placed at the bottom of the well to remove sediment that may have accumulated in the sump.

Development Criteria

Well development criteria were primarily based on the total volume of groundwater removed in relation to the volume of water injected into the UF Aquifer during rotasonic drilling at each of the wells. In addition, bromide concentrations were monitored during primary development from each of the screened intervals as a secondary indication of well development completion. Development continued until the bromide concentration in each well was below an approximate value of 30 mg/L or until a bromide concentration asymptote was reached. Immediately following the Westbay System installations, a second phase of development was performed by pumping from the Westbay pumping port with Waterra® inertial pumps. Development following the Westbay installations was primarily focused on removal of water and sediment resulting from the Westbay system installations. The lowering of the Westbay system into the well effectively surged the well resulting in groundwater mixing between zones and additional fine-grained material entering through the well screens. During this final development of the well, both bromide and turbidity concentrations were monitored to determine when to stop development.

Table 2-2 shows the volume of water injected during drilling versus the volume that was removed during drilling. Bromide concentrations during development were periodically measured using an Oakton Ion 5 – Acorn Series meter equipped with a bromide ion-specific probe (Table 2-3). Turbidity was measured using a LaMotte 2020e turbidity meter. Field measurements were recorded on field-data sheets (see Appendix F). An attempt was made to develop wells until the average bromide concentrations dropped below 30 mg/L, and turbidity readings dropped below 20 NTUs. At a few monitoring well locations, well development stopped before bromide concentrations and/or turbidity readings reached the target values. In these cases it was determined that the time projected to reach these levels was prohibitive with the limitations of the Westbay systems and low pumping rates of the Waterra® inertial pumps. In all but one well, the volume of water removed during well development was three to six times the volume of water lost to the formation during drilling (Table 2-2).

All development water was contained in portable poly storage tanks or a 20,000 gallon frac tank, until it was transported to the on-Site water-treatment facility. Figure 2-7 shows a timeline of well-development activities.

2.3.5 SURFACE COMPLETION AND SURVEY

The above-ground completions of the on-Site extraction and monitoring wells consisted of: 1) Cutting the 4-inch steel casing; 2) Installing a 6-inch protective aluminum casing with locking cover; 3) Constructing a 2-foot by 2-foot by 4-inch thick concrete apron around the well; and 4) Installing 4-inch diameter protective steel bollards filled with concrete. All isolation and well casings extending above ground surface were cut to their final height. The 18-inch and 10-inch nominal isolation casings were cut approximately flush with ground surface and the 4-inch well casing was cut to an approximate height of 30-inches above ground surface. The below-ground completions of the off-Site sentinel wells consisted of 1) Cutting the 4-inch steel casing approximately 4-inches bgs; 2) Installing a 6-inch traffic-rated flush mount well vault;

3) Installing a locked J-plug; and 4) Constructing a concrete apron around the well. The State Plane coordinates and casing elevations were surveyed on May 21, 2010 (Table 2-4).

2.3.6 WELL CONSTRUCTION AND AQUIFER TESTING TIMELINES

A timeline showing the schedule for individual monitoring wells is provided in Figure 2-7. The well drilling commenced on January 18, 2010 and was completed on May 1, 2010. Installation of the three Westbay Systems was completed on March 28, 2010, with final Westbay development completed on April 16, 2010. The constant-rate aquifer test was performed June 8-16, 2010.

3.0 WESTBAY SYSTEM

A Westbay System was installed in all of the on-Site UF Aquifer monitoring wells following completion of the initial well development. The Westbay System is a multi-level sampling system that allows groundwater samples to be collected from multiple discrete intervals within an individual well. The Schlumberger May 10, 2010 Completion Report for the Westbay system installation is provided in Appendix G.

3.1 WESTBAY SYSTEM INSTALLATION

The Westbay System consists of the following components: 1) Inflatable packers that isolate the well-screen intervals; 2) Purge ports to facilitate well development; and 3) Sampling/measurement ports for collecting groundwater samples and formation pressures.

The Westbay designs for the multiple-screened UTZ wells (FW-28B and FW-30B) are similar to designs used in the previous on-Site UTZ wells. Similarly, the Westbay design for the UTZ/SCU well (FW-27B) is similar to previous UTZ wells, with the exception that it contains six discrete sampling zones.

Westbay System Model 0238 packers were used to isolate individual sampling zones. These packers are effective in borehole diameters ranging from 3 to 5 inches. The basic design of the Westbay System is with a packer elements set above and below each of the screened intervals to isolate monitoring zones within the well. The packer placement, along with pumping port and measurement port depths are shown in Appendix G and Appendix A. The basic design of the Westbay System for the monitoring wells consists of the following:

1) Packer elements set above and below the screens to isolate each screened interval;
2) A 1.75-inch long screened port for purging individual monitoring zones;
3) A sample port for collecting water samples and formation pressure readings;
4) A 15-foot sump at the bottom of the system; and
5) Blank casing that extends to land surface.

In general, the sample and purge ports are separated by about 5 feet within the well screen interval. The purge ports for the Westbay System in wells FW-27B and FW-30B are located in the lower half of each sampling interval, and the sample port is located 5 feet above the purge port. The purge ports for the Westbay System in well FW-28B are located in the upper half of each sampling interval, and the sample port is located 5 feet below the purge port. The 15-foot sump at the base of the well is required to accommodate the sampling equipment during the collection of groundwater samples from the lower screen interval. A conceptual system design for each well was used by Westbay to develop the final design (see Appendix G).

Installation of the Westbay System was supervised by Westbay's technical representative with assistance from GeoTrans and the drilling contractor. Westbay System components were laid out sequentially on an above-ground support stand near the wellhead. Each section consisted of a 1.5-inch PVC section of casing and the appropriate coupling component.

Couplings were attached to the casing section using a nylon shear wire. The purge and measurement ports also act as couplings to connect sections of the Westbay System. Magnetic collars were placed between the purge port and measurement port to verify sample tool depths. Packer sections were pre-assembled and pre-tested by Westbay at their shop, and only required final assembly at the Site.

Each of the Westbay System components was manually assembled, starting with the bottom components. After securing each connection, the coupling was pressure tested before being lowered into the well to ensure that the various system components did not leak and that the coupling was properly sealed and mechanically competent. A hoist, attached to a drill rig or suitable overhead crane, was used to hold the system in place above the well while component testing was performed. A final hydraulic-integrity test was conducted after the assembled Westbay System was lowered into the well. The final integrity test included water-level measurements inside of the Westbay System to check for leaks and to verify that each sample/purge port was operating properly.

After performing the Westbay System integrity and quality assurance checks, the packer elements were inflated, beginning with the lowest packer element. Potable water was pumped into the packer element until the specified pressure was attained indicating proper inflation of the packer elements. The pressure inside of the packer was monitored to ensure that no leaks were present in the system and that the packer was properly set in the well casing (see Appendix G).

The final groundwater development of the Westbay System monitoring zones was conducted by GeoTrans personnel. Each of the monitoring zones were pumped to remove groundwater that may have been mixed vertically in the well and formation during the Westbay System installation. A minimum of three well volumes were removed from each 10-foot screened intervals during the final development of the well, with the exception of Zone 1 on FW-30B. The apparently low permeability of this zone resulted in decreasing flow rates as a function of time to where water could no longer be pumped. Well development for this well zone ceased after approximately 1.5 well volumes were removed. In addition to the groundwater purge volume measurements, field measurements of bromide and turbidity were collected to ensure stabilization of these parameters prior to completing the well purging (Table 2-5).

The approach to the final purge of the Westbay System monitoring zones consisted of opening the Westbay System purge port with a Westbay open/close tool. A Waterra® inertial pump was utilized to pump groundwater from each purge port zone. The pumping rates varied, but typical rates ranged between 1.0 and 1.5 gpm. Each purge port was sequentially closed prior to opening a different port in the Westbay System for development. The development process was repeated for each Westbay zone for all monitoring wells.

Field parameters were recorded during the final purge of the Westbay System by using an Oakton Ion 5 – Acorn Series meter equipped with a bromide ion-specific probe and a Lamotte 2020e turbidity meter. Development included: 1) Purging a minimum of three casing volumes from the screened interval; 2) Turbidity readings less than 20 NTUs; and 3) Field bromide concentrations less than 30 mg/L. Development continued beyond the three casing volumes if the field parameters did not reach their target levels, but ceased when bromide and turbidity

concentrations reached asymptotic levels. Purge/development water was contained in portable poly storage tanks and was transported to the on-Site water-treatment facility. Figure 2-7 shows a timeline of development activities for the wells.

3.2 WATER LEVEL MEASUREMENTS

Water-level measurements were collected from the new UF Aquifer monitoring and extraction wells installed under this program during development and aquifer testing. Measurements were collected manually with an electronic water-level meter. For monitoring wells equipped with Westbay Systems, the depth-to-water measurements were collected by opening the uppermost (Zone 1) purge port and performing a manual measurement inside of the Westbay casing. Water-level measurements obtained with the Westbay pressure transducer are not used to evaluate Site-wide potentiometric surface elevations due to limitations with the accuracy of the Westbay measurement. In particular, experience has shown that water-level measurements from the Westbay System are not accurate enough to use in potentiometric-surface contouring given the low hydraulic gradient in the UF Aquifer at the Site. The potentiometric elevations are discussed in Section 4.1.4.

3.3 WATER QUALITY SAMPLES

Baseline water quality samples were collected from the new wells, following standard operating procedures within the Comprehensive Groundwater Monitoring and Sample Analysis Plan (CGMSAP) (FTS and GeoTrans, 2010). The samples were submitted for analysis of VOCs and semi-volatile organic compounds (SVOCs). Sample results are discussed in Section 4.4.

Collection of groundwater samples from wells equipped with Westbay Systems is performed using the Westbay sampler probe equipped with a sample-bottle train. The limited volume of water collected in sample-bottle train requires four trips into the well per sampling zone to obtain the required volume of water for VOC and SVOC analyses. Field parameters are not measured during sampling for all monitoring wells with the Westbay System.

Water quality samples were collected from extraction well FW-31BE by running the permanent extraction pump and collecting the sample through a port in the extraction line.

4.0 HYDROGEOLOGIC DATA ANALYSIS

The data collected as part of this program support the hydrogeologic Site Conceptual Model (SCM) previously presented by GeoTrans (2004). As with the UTZ core samples collected during previous investigations (GeoTrans, 2006, 2007 and 2009), approximately 70 percent of the geologic core collected from the UF Aquifer as part of this drilling program was unconsolidated, with the remainder of the core being moderately consolidated. This finding includes the SCU and LTZ samples, which were similar to the UTZ in lithology, composition, and lithification. The geologic core supports the SCM of secondary dissolution features predominantly located in the upper 20 feet of the Ocala Limestone. Cores and drilling logs of the lower 40 feet of the LTZ also indicate the presence of solution cavities and/or fracture-related permeability. Additionally, visual inspection and PID measurements from approximately 690 feet of UF Aquifer core collected under this drilling program supports the conceptual model of no free-phase or residual DNAPL impacts to the UF Aquifer at the Site.

4.1 SITE HYDROGEOLOGY

4.1.1 GEOLOGIC CORE

The monitoring wells recently installed under the Floridan Aquifer Monitoring Program add to the comprehensive geologic core data at the Site. Data collected during this and previous drilling programs at the Site represent the majority of the geologic core data for the UF Aquifer in this part of Alachua County. Continuous cores were collected at the majority of the well locations from land surface to the base of the UTZ. In addition, continuous core was collected to the base of the LTZ at off-Site sentinel well FW-29C.

The geologic core from this program supports the SCM previously developed for the Site (GeoTrans, 2004). The thickness of the Surficial Aquifer deposits and depth to the top of the HG deposits are consistent with prior Site data. The thickness of the HG lower clay unit in the new UF wells ranged from about 27 to 37 feet. Previous investigations (GeoTrans, 2006, 2007, and 2008) report HG lower clay unit thicknesses ranging from about 25 to 40 feet. The depth to the top of the Ocala Limestone is also consistent with previous UF Aquifer wells installed at the Site.

The depth of the Ocala Limestone and Avon Park Formation contact at sentinel well FW-29C was 353.3 feet bgs (elevation -189 feet above msl). This contact elevation in the previously installed off-Site sentinel wells FW-25C and FW-26C was -196.6 and -191 feet above msl, respectively. The elevation of the geologic contact between the Ocala Limestone and the Avon Park Formation contact is approximately 36 feet lower in sentinel well FW-29C than it is in the northwest corner of the Site at monitoring well FW-22C (elevation -153 feet above msl). In addition, the Avon Park Formation contact at FW-29C is approximately 8 feet lower than the contact elevation at monitoring well FW-25C, which is located approximately 600 feet to the east of FW-29C. Hence, the Avon Park Formation contact appears to be dipping to the north-northwest in this area. Geologic Section A-A' is constructed through the new monitoring wells in the northwestern portion of the Site (Figure 4-2).

4.1.2 GEOPHYSICAL LOGS

A suite of geophysical logs were run in extraction well FW-31BE (see logs in Appendix E). The primary purpose of the geophysical logs was to evaluate borehole conditions prior to well construction. Geophysical logs run in extraction well FW-31BE include: 1) Caliper; 2) Natural Gamma; 2) Resistivity; and 3) Spontaneous Potential.

Caliper Log

A caliper log measures the borehole diameter as a function of depth. A caliper log is useful in identifying intervals in the borehole is enlarged indicating fracturing and/or solutions channels.

The caliper log was run in the open borehole from a depth of approximately 135 feet to the total depth. The caliper log does not show any major areas of the borehole that were enlarged. The borehole maintained a fairly constant diameter of about 9 to 10 inches over the entire UTZ, with only a few small zones where the borehole approached an 11 inch diameter.

Natural Gamma Log

The natural-gamma logs record gamma radiation resulting from the radioactive decay of naturally occurring minerals. Nearly all the radiation is the result of gamma rays produced by potassium-40 and the decay daughter products in uranium and thorium. Of these three possible sources, potassium-40 occurs in fine-grained materials, such as silts, clays and shales. Natural-gamma logs are often useful for evaluating the relative abundance of fine-grained materials in deposits. Deposits such as sand, limestone and dolomite contain little potassium, and hence have relatively low gamma signatures.

One of the advantages of the natural gamma log is that it can be run through casing and does not require an open borehole. Surficial and HG deposits have the highest gamma levels reflecting the higher percent of fine-grained clay deposits within these units. The higher gamma spikes at depths of approximately 22, 62 and 112 feet represents increasing clay content for the HG upper, middle and lower clay units, respectively. The gamma spike at an approximate depth of 84 to 88 feet is an indication of more fine-grained clay within this interval, although the core description indicates it is primarily silt. The significant gamma drop at a depth of approximately 144 feet bgs represents the bottom of the HG lower clay unit. The UF Aquifer has a relatively low gamma signature indicating that there are less fine-grained materials in this formation than the overlying Surficial Aquifer and HG deposits.

Resistivity Log

Resistivity is the measure of the ability of saturated geologic materials to oppose electrical flow. The use of long and short distances between electrodes provides measures of relatively shallow, near borehole resistance (short normal) or resistance deeper into the formation (long normal). Increased resistivity can be one indication of potentially higher permeability zones within a formation.

The short-normal resistivity spike at a depth of about 185 feet in FW-31BE correlates with a slight gamma reduction believed to be associated with fracturing, solution cavities, or other secondary permeability features. Drilling circulation was lost at this interval and no core was recovered indicating the presence of solution cavities at this depth.

Spontaneous-Potential Log

Spontaneous Potential (SP) measures naturally occurring electrical potentials within the well bore as a function of depth. The primarily use of SP is for geologic correlation and to differentiate between impermeable, electrically conductive beds, such as shales and clays, from permeable beds. The SP response in FW-31BE correlates to the short- and long-normal log responses discussed above.

4.1.3 EFFECTIVE POROSITY

The effective porosity of the UF Aquifer was qualitatively evaluated based on geologic cores collected as part of this and the previous (GeoTrans, 2005, 2006, 2007, and 2008) UF Aquifer Monitoring Programs. Visual inspection of core samples collected from the UTZ, SCU, and LTZ during these drilling programs indicate that approximately 70 percent of the UF Aquifer core collected at each of the monitoring well location is poorly indurated and either fragmented or completely unconsolidated. The remaining 30 percent of the cores were moderately indurated, with partial consolidation of the deposits. These moderately indurated layers tended to be thin (< 1 to 12 inches) limestone deposits.

A hypothesis considered for the significant amount of unconsolidated material encountered in these cores was that the sonic vibrations and down pressure from the rotasonic drilling were breaking the carbonate matrix cement that binds the individual grains together. However, large portions of the well-indurated dolomitized wackestone-mudstone that characterize the Ocala Limestone-Avon Park Formation contact were recovered largely intact. Less competent materials above and below the contact were relatively disaggregated, indicating that the rotasonic drilling is likely disaggregating some of the weakly cemented carbonate deposit layers.

Geologic core samples from the UTZ and LTZ demonstrate that the total porosity for this formation is high and approaching that of an unconsolidated alluvial silty-sand deposit. Given the high matrix porosity, in conjunction with the secondary dissolution features, it would be reasonable to assume that the average effective porosity for this formation is consistent with the GeoTrans fate and transport model analysis (GeoTrans 2004). The largely unconsolidated nature of the UTZ causes it to behave more like a porous media than a fractured media.

4.1.4 POTENTIOMETRIC SURFACE ELEVATIONS

Water-level measurements were obtained during well development and aquifer testing for each of the newly installed UF Aquifer monitoring wells. The water levels in all wells were measured directly with a conventional water-level probe. The results of the water-level measurements are presented in Table 4-1.

Static water-level measurements for monitoring well FW-30B and sentinel wells FW-29B and FW-29C were collected as part of the well-development activities in April and May 2010. The water-level measurements for extraction well FW-31BE and monitoring wells FW-27B and FW-28B were collected on a later date (June 8, 2010) prior to starting the constant-rate aquifer test.

Water-level data from the new wells are consistent with the potentiometric surface elevation in the northwestern area of the Site. In general, the hydraulic-head difference between wells is on the order of tenths of feet with a relatively flat gradient across the Site. The water-level measurements for monitoring wells FW-27B to FW-28B on June 8, 2010 showed a 0.19 foot decrease in pieziometric elevations from FW-27B to FW-28B (approximately 530 feet between these wells). This hydraulic-head difference corresponds to a hydraulic gradient of 3.6×10^{-4} ft/ft. Water-levels data for the northwest area of the Site demonstrate that groundwater flow in this region of the Site is to the north-northeast (Figure 4-6).

4.2 AQUIFER TEST ANALYSIS

A constant-rate pumping test was performed at extraction well FW-31BE to evaluate aquifer parameters and the potential capture area resulting from long-term pumping at this well. Temporal water-level data collected during the pumping and recovery phases of the constant-rate test at extraction well FW-31BE and surrounding monitoring wells (FW-2, FW-11B, FW-22B, FW-22C, FW-24B, FW-27B and FW-28B) were used in the analysis of aquifer test data to estimate hydrogeologic parameters for the UF Aquifer.

All wells monitored during the aquifer test were instrumented with pressure transducer data-logger systems, as described in Section 2.2.6. The data collected from the extraction and monitoring wells were adjusted for barometric pressure and regional water-level fluctuations over the duration of the test.

The target pumping rate for extraction well FW-31BE was 30 gpm; however, the actual pumping rate started at 30 gpm and declined to 28.5 gpm over the first 5 minutes of the test. This decline would be expected given the varying pressure conditions in the long discharge line to the treatment plant while it was filling. Rather than attempting to re-adjust the pumping rate, the constant-rate test was run at the 28.5 gpm rate for the remainder of the 6-day test.

The initial maximum drawdown in extraction well FW-31BE of 2.7 feet was reached within the first 20 seconds of pumping. The drawdown declined slightly to 2.5 feet and remained fairly constant at this level over the first 5 minutes of the test (Figure 4-3). The drawdown in FW-31BE slowly increased over the remainder of the 6-day test reaching a maximum drawdown of approximately 3.0 feet. The two monitoring wells with the greatest observed drawdown were FW-22B (0.20 feet) and FW-28B (0.14 feet) (Figure 4-4). Maximum drawdowns observed at the more distance monitoring wells (FW-2, FW-24B, and FW-27B) were small (0.05 feet). In addition, pumping at FW-31BE resulted in a small drawdown (0.03 feet) in LTZ monitoring well FW-22C, located about 11 feet from the extraction well. The limited drawdowns observed in the LTZ monitoring well and the more distance UTZ monitoring wells

did not allow for a separate analysis of data from these wells; however, the more significant drawdown observed in wells FW-22B, FW-28B and FW-31BE were appropriate for aquifer-test analysis.

Figure 4-4 shows that drawdown effects from pumping in FW-31BE were observed within 2 seconds of start of pumping in adjacent monitoring well FW-22B (13 feet from FW-31BE) and within 45 seconds at monitoring well FW-27B (342 feet upgradient of FW-31BE). Drawdown effects were also seen in monitoring wells FW-28B (200 feet downgradient of FW-31BE), FW-24B (328 feet upgradient of FW-31BE), FW-2 (306 feet upgradient of FW-31BE). Hence, drawdown effects were observed approximately 350 feet upgradient and 200 feet downgradient of FW-31BE. Given the magnitude of the response at downgradient monitoring wells FW-28B and upgradient well FW-27B during this test, it is reasonable to assume that drawdown effects extend approximately 100 feet off-site to the north and 300 feet off-Site to the west.

The Aqtesolv software package was used to analyze the data generated during the pumping and recovery portions of the constant-rate test. The Aqtesolv software is a compilation of a number of different analytical solutions that allows the user to readily compare and contrast various solutions for the aquifer-test data. The most common analytical solution for aquifer tests is the Theis solution for a homogeneous, isotropic porous media. In general, the majority of the other analytical solutions are various derivations of the Theis solution with different boundary condition assumptions, such as partial penetration of extraction wells, confined versus nonconfined, and overlying leaky aquifer conditions. A number of the analytical solutions are available for dual-porosity and single-fracture systems; however, these solutions tend to be difficult to uniquely match without detailed knowledge of the fracture sets. In general, these solutions do not work well in carbonate-aquifer systems with non-uniform solution cavities and channels.

Multiple analytical solutions were used to analyze the aquifer-test data including: Theis (1935) and Papadopulos-Cooper (1967) mathematical solutions for constant-rate pumping tests in confined aquifers, and the Hantush (1960) and Moench (1985) mathematical solutions for constant-rate pumping tests in leaky-confined aquifers. These analytical solutions assume that the aquifer is a homogeneous and isotropic porous media, groundwater flow to the pumping well is horizontal, the aquifer has a constant thickness, and is infinite in areal extent. In general, the assumptions used to derive the analytical solutions are not strictly valid for most aquifer systems; however, the analytical solutions can provide reasonable estimates of aquifer properties.

Extraction Well FW-31BE

The analysis of pumping-test data for the extraction well is typically not as good as the analysis of data from adjacent observation wells. Water-level data collected from the pumping well typically contain a fair amount of noise (water-level fluctuations) reflecting slight variations in pumping rates and wellbore storage. Observation well data are not significantly affected by slight variations in pumping rates and wellbore storage and therefore are better data for test analysis.

Analysis of drawdown data for pumping well FW-31BE requires an evaluation of wellbore-storage effects. Wellbore storage is a term used to define the volume of water that resides in the well casing. When a pump is first turned on, the early-time drawdown in the extraction well is primarily reflecting the removal of water that is stored inside of the well casing. Analytical equations used to analyze aquifer test data assume that groundwater is instantaneously removed from the aquifer and that no water is stored in the well casing. Therefore, early-time drawdown data that is dominated by wellbore storage effects are typically excluded in the aquifer-test analysis. Depending on the volume of water in a well the wellbore-storage effect can last from fractions of a second to 10s of seconds. The early-time data for when wellbore storage effects are dominant can be determined by constructing a log-log plot of drawdown versus time. Early-time drawdown data that are dominated by wellbore-storage effects have a characteristic slope of 1:1 and data that reflects aquifer properties has a slope of less than 1:1. A log-log plot of the FW-31BE data show that data prior to approximately 2 seconds after the start of the pump reflect wellbore storage and therefore data prior to this time were ignored for the aquifer-test analysis of FW-31BE data.

The UF Aquifer is best classified as a dual-porosity, non-homogeneous and anisotropic carbonate aquifer. The term dual-porosity aquifer means that that aquifer contains solution channels, fractures and/or cavities in addition to the primary porosity of the aquifer matrix. Therefore, when groundwater is extracted from the UF Aquifer it is derived from both solution channels/cavities and the primary matrix porosity.

The FW-31BE time versus drawdown data during the constant-rate aquifer test were best approximated by the Hantush (1960) and Moench (1985) leaky-confined aquifer solutions. The early-time drawdown is characteristic of a Theis solution; however, the later-time drawdown is significantly less than would be predicted by this solution. The relatively constant drawdown at late time is an indication that the aquifer material in the vicinity of the pumping well is receiving more recharge water than would be predicted for a porous media of uniform thickness. The recharge water could be originating from the overlying HG deposits, the underlying semi-confining unit and/or interconnected solution channels within the UTZ. The aquifer is behaving similar to leaky-confined aquifer where a continuous supply of groundwater is recharging the aquifer, thereby limiting the total drawdown. The leaky-confined aquifer analytical solutions are a fairly good match to the FW-31BE drawdown data (see Appendix H). Results of the curve-matching procedures for the Hantush and Moench analytical solutions indicate that the transmissivity of the UTZ ranged from approximately 1.2 square centimeters per second (cm^2/sec) to 3.4 cm^2/sec, respectively. Assuming the UTZ has a uniform thickness of 100 feet, the hydraulic conductivity of the UTZ near FW-31BE ranged from approximately 4.0×10^{-4} centimeters per second (cm/sec) to 1.1×10^{-3} cm/sec. The analytical type-curve matches to the data are presented in Appendix H.

In addition to analyzing the drawdown data during the pumping phase of the aquifer test, it is also possible to analyze the water-level recovery data for wells once the pumping ceases. The FW-31BE water-level recovery data were not well approximated by any of the analytical solutions. Therefore, no aquifer parameter values were estimated for the recovery phase of the test for this well.

Observation Well FW-22B

The time versus drawdown results indicate that the data collected at FW-22B during the pumping phase of constant-rate aquifer test are reasonably approximated by the Hantush (1960) and Moench (1985) leaky-confined analytical solutions. Results of the type-curve match for these two methods resulted in identical values of transmissivity (144.7 cm^2/sec) for both methods. Assuming a UTZ thickness of 100 feet (3,048 cm), the resulting hydraulic-conductivity value is 4.8×10^{-2} cm/sec. The storage-coefficient value resulting from these two methods were approximately similar values of 5.06×10^{-3} and 5.02×10^{-3}, respectively.

The data from the recovery phase of the constant-rate test were also reasonably approximated by the Hantush and Moench leaky-confined analytical solutions. The data analysis consists of plotting water-level recovery data versus Agarwal equivalent time. Agarwal equivalent time is defined as follows:

$$t_{equiv} = (t_p \times t') / (t_p + t') \qquad (1)$$

where:

t_p is total pumping time; and
t' is time since pumping stopped.

Results of the recovery analysis indicate that the transmissivity of the UTZ ranged from 15.28 to 16.54 cm^2/sec. Assuming a UTZ thickness of 100 feet (3,048 cm), the hydraulic-conductivity value resulting from the recovery data analysis ranged from 5.0×10^{-3} to 5.4×10^{-3} cm/sec (Table 4-3). The storage-coefficient value resulting from the recovery analysis ranged from 6.5×10^{-5} to 8.6×10^{-3}, approximately consistent with the drawdown analysis results.

Observation Well FW-28B

The time-drawdown results indicate that the data collected at observation well FW-28B during the pumping phase of constant-rate aquifer test are also reasonably approximated by the Hantush (1960) and Moench (1985) analytical solutions; however, the data-type curve match clearly demonstrates that boundary effects are present in the data. Results of the curve-matching procedures indicate that the transmissivity ranged from approximately 159.5 to 159.7 cm^2/sec. Assuming a UTZ thickness of 100 feet (3,048 cm), the resulting hydraulic-conductivity value is 5.2×10^{-2} cm/sec. The storage-coefficient value resulting from this analysis was 3.3×10^{-4}.

Data collected during the recovery phase of the constant-rate test were good matches to the Hantush and Moench leaky-confined analytical solutions. Results of the curve-matching indicate that the transmissivity ranged from 0.76 cm^2/sec to 6.46 cm^2/sec. Assuming a UTZ thickness of 100 feet (3,048 cm), the hydraulic-conductivity value resulting from the recovery data analysis ranged from 2.5×10^{-4} to 5.4×10^{-3} cm/sec (Table 4-3). The storage-coefficient values resulting from this analysis were 1.14×10^{-6} to 1.03×10^{-5}, respectively.

Summary of Aquifer Test Data

The analytical solutions used to evaluate the aquifer test data are based on a number of simplifying assumptions including the aquifer is an isotropic, homogeneous confined porous media. Under these ideal conditions, the analysis of the drawdown and recovery portions of the test should result in equivalent aquifer parameter values. In reality the assumptions are only approximated for the UF Aquifer and therefore, the aquifer parameter values resulting from the drawdown and recovery portions of the test differ by an approximate order of magnitude.

The drawdown data for FW-28B and FW-22B provide some insight into the UF Aquifer response to groundwater pumping. The time versus drawdown plot show multiple hydrologic boundary effects in the data during early and late time. These boundary effects result in a departure of the early and late-time data from the leaky-confined type-curve match. The early-time departure (first 10 seconds of test) is expected given the small water-level changes (thousands of feet) during this time period; however, the late-time departure (at approximately 19 hrs into test) shows the effects of the drawdown intercepting hydrologic boundaries, such as interconnected solution cavities/channels. The shape of the late-time drawdown data plot is similar to the shape of the plot at the beginning of the aquifer test. Although the data are being analyzed with a leaky-confined aquifer solution, the data are probably more indicative of solution cavities/channels having a similar effect to a leaky aquifer. Conceptually, what appears to be happening is that as the drawdown cone propagates out it is intercepting more higher permeability solution channels that are limiting the drawdown that would be projected under porous media conditions (i.e. similar to a leaky-confined aquifer response). Once the intercepted solution cavities/channels are effectively drained, the drawdown continues to propagate out similar to a porous media response until it intercepts additional solution channels. The net effect is a flattening of the drawdown slope similar to what is seen in a leaky-confined aquifer response.

A variation of the Theis analysis is the distance-drawdown method where drawdown data for multiple observation wells are plotted versus normalized time on one graph. The x-axis is a plot of time since start of the aquifer test normalized to the radial distance the observation well is from the pumping well. In an idealized porous media aquifer, the data from all the observation wells should fall along one continuous curve defined by the Theis solution. The farther the observation well is from the pumping well, the later in time the drawdown cone reaches the well. Hence, the normalized data for observation wells at greater distances falls along the Theis curve at earlier times, providing an enhanced definition of drawdown at earlier time.

Figure 4-5 is a plot of normalized time versus drawdown for the extraction well and all UTZ observation wells monitored during the aquifer test. Because the data exhibit characteristics similar to a leaky-confined aquifer, not all of the data would be expected to match a porous media type-curve solution. However, the plot does show the non-homogeneous and possibly anisotropic response of the UF Aquifer in this area of the Site. The data from the three observations wells (FW-24B, FW-2, and FW-27B) located to the south of FW-31BE fall along a similar trend. Similarly, the early-time data for the northern observation well FW-28B closely approximates the response in the southern observation wells, with the early-time data plotting on top of each other. It appears that the early-time response for all four observation wells

approximates a homogeneous porous media solution prior to the drawdown cone encountering secondary solution-cavity features.

In general, the recovery portion of an aquifer test is considered the more reliable data in that these data are not impacted by wellbore storage effects and varying pumping rates. It is the early-time data that primarily define the shape of the drawdown and recovery curves and most affect the final parameter values. The recovery portion of the aquifer test resulted in lower transmissivity and storage-coefficient values than were calculated from the drawdown data for these same wells (Table 4-3). The transmissivity and storage coefficient values were about one order-of-magnitude lower than the values resulting from the drawdown analyses. Interestingly, the parameter values resulting from the recovery analysis for the observation wells closely approximate the parameter values resulting from the drawdown analysis for FW-31BE. In addition, the hydraulic-conductivity and storage-coefficient values resulting from recovery portion of the aquifer test approximate the parameter values used in the GeoTrans (2004) calibrated numerical model (Table 4-3).

4.3 FW-31BE GROUNDWATER CAPTURE AREA

The maximum downgradient extent of groundwater capture for extraction well FW-31BE is the location where the drawdown due to pumping is equal to the change in hydraulic head due to the natural hydraulic gradient. For example, if the natural UF Aquifer hydraulic gradient is 0.1 feet of hydraulic-head change over 100-foot distance and the drawdown is equal to 0.1 feet at a distance of 100-foot, then the maximum downgradient extent of groundwater capture is 100 feet.

The non-pumping hydraulic-gradient between extraction well FW-31BE and monitoring well FW-28B is 0.14 feet over a 200-foot distance (Table 4-1). The maximum drawdown measured at the end of the 6-day aquifer test at FW-28B was 0.14 feet (FW-28B). Hence, the downgradient extent of groundwater capture at the end of the 6-day test is approximately 200 feet to the north of extraction well FW-31BE, coincident with the approximate location of FW-28B.

The lateral extent of groundwater capture can be approximated by the drawdown observed at upgradient wells FW-27B, FW-24B and FW-2. The maximum drawdown at the end of the 6-day test for these wells was 0.05 feet. These upgradient monitoring wells are located to the southeast, south and southwest at approximately the same radial distance (306 to 342 feet) from FW-31BE. If a drawdown of 0.05 feet is defined as the minimum drawdown that delineates groundwater capture in a direction perpendicular to groundwater flow, then the groundwater capture area during the aquifer test extended approximately 300 feet to the east and west of extraction well FW-31BE (Figure 4-6). The groundwater capture area upgradient of extraction well FW-31BE is projected to extend over approximately one-third of the Site and encompasses impacts observed at FW-27B, FW-12B, FW-6 and possibly FW-20B. The groundwater capture area also incorporates the former South Lagoon and former North Lagoon (Figure 4-6).

The 6-day aquifer test groundwater pumping rate was 28.5 gpm and the projected long-term groundwater extraction rate at FW-31BE is approximately 23 gpm. In general, less drawdown would be expected with lower pumping rates; however, water levels in the observation wells were continuing to trend downward at the completion of the aquifer test, such that the groundwater capture area was continuing to grow at a pumping rate of 28.5 gpm. Therefore, the estimate of a 300-foot radial capture area under projected long-term pumping rate of 23 gpm at FW-31BE is both conservative and reasonable.

4.5 UPPER FLORIDAN AQUIFER WATER QUALITY RESULTS

Extraction well FW-31BE was installed to capture groundwater impacts in the vicinity of monitoring well FW-22B. The dissolved-phase plume is hypothesized to be a relatively narrow plume originating from monitoring well FW-6 and migrating through the FW-20B and FW-12B monitoring well areas. Monitoring wells FW-27B, FW-28B and FW-30B were installed to better define the vertical and lateral extent of this plume. Sentinel wells FW-29B and FW-29C were installed downgradient of the Site to investigate if on-Site impacts are present off-Site to the north.

The initial groundwater sampling results confirm the conceptual model of a fairly narrow plume that extends from the FW-6 location to the FW-22B location. Only one of the five new monitoring well has dissolved-phase impacts, with the other four monitoring wells nondetect for all organic constituents. In addition, extraction well FW-31BE also contains groundwater impacts consistent with historical concentrations observed in adjacent monitoring well FW-22B. No groundwater impacts were detected along the northern property boundary or in the off-Site sentinel wells.

Water quality samples were collected from the new extraction well and monitoring wells in May and June 2010. The groundwater sampling for the new on-Site wells was based on the performance monitoring schedule for the startup of extraction well FW-31BE. Therefore, samples were collected on different dates for the six new wells. The new off-Site sentinel wells FW-29B and FW-29C were sampled on May 26, 2010 as part of the CGMSAP (FTS and GeoTrans, August 2010) monitoring. The performance monitoring schedule for FW-31BE startup required sample collection in extraction in FW-31BE and monitoring wells FW-27B and FW-28B prior to the start of pumping on July 5, 2010 and a sample from monitoring well FW-30B 2 weeks post-startup. Groundwater samples were collected in FW-31BE, FW-28B and FW-27B on June 22 through 29, 2010. Water quality samples were collected from monitoring well FW-30B on July 13, 2010. The results of the sample analyses are provided in Table 4-2. Laboratory analytical reports are provided in Appendix I.

Monitoring wells FW-28B and FW-30B, and sentinel wells FW-29B and FW-29C were all nondetect for VOCs and SVOCs. Monitoring well FW-30B is located to the north of FW-6 and to northeast of FW-12B. This well was installed to investigate groundwater quality in the north central portion of the Site. The absence of organic constituents in this well demonstrates that groundwater impacts from FW-6 do not extend into the north-central area of the Site. Monitoring well FW-28B was installed to the north and downgradient of FW-22B. The

nondetect concentrations for all organic constituents in this well demonstrates that groundwater impacts in the FW-22B area do not extend to the northern property boundary and are contained on-Site. Similarly, the nondetect concentrations for sentinel wells FW-29B and FW-29C further support the conclusion that on-Site impacts in the FW-22B area do not extend off-Site.

The only new monitoring well with constituent impacts is FW-27B. Monitoring well FW-27B was installed approximately 50 feet into the semi-confining unit underlying the UTZ. Monitoring zones 1 through 4 in FW-27B are completed in the UTZ and Zones 5 and 6 are completed in the semi-confining unit. Benzene, acenaphthene, and naphthalene were detected in all six zones of FW-27B above their respective GCTLs. Benzene was also detected above the Federal Maximum Contaminant Level (MCL) of 5 µg/L in the sample from Zone 3. Carbazole, dibenzofuran, and 2-methylnaphthalene were detected above their respective GCTLs in Zones 2 through 5. The presence of elevated organic constituents in this well is consistent with historical impacts observed in monitoring wells (FW-20B, FW-12B and FW-22B) completed in the footprint of the plume originating from monitoring well FW-6. The non-detect concentrations in other monitoring wells downgradient of the FW-6 area (FW-2, FW-11B, FW-13B, FW-24B, and FW-30B) indicate that the footprint of the dissolved-phase plume is relatively narrow and migrating to the northwest.

The dissolved-phase impacts observed at monitoring well FW-27B are higher than impacts currently present in FW-12B and FW-22B; however, the concentrations are equivalent to concentrations observed in FW-6 and FW-20B. Naphthalene concentrations in FW-27B Zones 2 through 5 ranged from 1,100 to 1,700 µg/L (Table 4-2). The 2009 naphthalene concentrations in monitoring well FW-6 were 2,600 µg/L in August 10, 2009. Similarly, the 2009 naphthalene concentrations in monitoring well FW-20B were 1,200 µg/L in November 17, 2009. The elevated concentrations of the remaining organic constituents in monitoring well FW-27B are consistent with historical concentrations in upgradient monitoring wells FW-6, FW-20B and FW-12B. Hence, the constituent concentrations observed in monitoring well FW-27B are consistent with a dissolved-phase plume originating from monitoring well FW-6. With the start of the IRM groundwater extraction in FW-6 on October 20, 2009, dissolved-phase impacts in the UF Aquifer are expected to decline. However, the dissolved-phase plume that is currently present in the UF Aquifer will continue to migrate towards the FW-22B area where it is captured by extraction well FW-31BE.

The dissolved-phase concentrations in extraction well FW-31BE were consistent with concentrations observed in adjacent monitoring well FW-22B. Acenaphthene and naphthalene were the only constituents detected in the sample collected from extraction well FW-31BE on June 29, 2010. Acenapthene was detected at a concentration of 23 µg/L and naphthalene was detected at a concentration of 50 µg/L (Table 4-2).

5.0 SUMMARY AND CONCLUSIONS

The new UTZ, UTZ/SCU, and LTZ monitoring wells were installed to investigate potential groundwater impacts in the northwestern area of the Site and to install an extraction well to capture impacts in this area. The new extraction well was installed in the vicinity of monitoring well FW-22B to capture groundwater impacts recently detected at this well. Each of the on-Site wells was designed to mitigate potential dragdown of Site constituents through the use of three telescoping isolation casings. The monitoring wells were completed as multiple-screened wells, with four to six monitoring zones for the UTZ/SCU wells and three monitoring zones in the LTZ well. The extraction well was completed with a single 90-foot long well screen that spans the thickness of the UTZ. The three on-Site monitoring wells constructed under this program were equipped with Westbay Systems with four to six depth-discreet zones for sampling.

The hydrogeologic characteristics of the HG deposits and UF Aquifer were defined by 1,294 feet of continuous geologic core collected at most wells and geophysical logs run in FW-31BE. The lithology, thickness and secondary dissolution features for the deposits were similar to previous wells installed at the Site. The geophysical logs of the UF Aquifer were similar to previous logs. The resistivity spike at a depth of about 185 feet correlates with a slight gamma reduction believed to be associated with fracturing, solution cavities, or other secondary permeability features. The hydrogeologic data and under this program support the SCM previously developed by GeoTrans (2004).

The UTZ potentiometric surface elevation indicate a predominantly northern groundwater flow direction in the northwest part of the Site, with a localized northwestern flow component. The horizontal hydraulic gradient in the northwest part of the Site is fairly low (3.6×10^{-4} ft/ft) and consistent with previous potentiometric surface maps for the Site. Given the low hydraulic gradient, it is difficult to readily discern the northwesterly flow direction from the FW-6 area; however, a northwesterly flow direction is clearly present based on water quality results.

Step-drawdown and constant-rate aquifer testing was performed in extraction well FW-31BE, in accordance with the workplan that was submitted to the EPA (GeoTrans, 2010). Leaky-confined aquifer, mathematical solutions were applied to the time-drawdown pumping and recovery data from extraction well FW-31BE and surrounding observation wells. The transmissivities, hydraulic-conductivity, and storage-coefficient values resulting from the analysis varied over one to two orders-of-magnitude. The aquifer tests provide an estimate of UF Aquifer parameter values; however, the assumptions inherent in the analytical solutions were only approximately met for the UF Aquifer system. Both the hydraulic-conductivity and storage coefficient values resulting from the test were consistent with values used in the calibration of the 2004 groundwater flow model developed for the Site.

Groundwater samples from the on-Site monitoring and extraction wells demonstrate that dissolved-phase Site constituents are not wide-spread. Organic constituents were not detected along the northern property boundary or in the off-Site sentinel wells. Well FW-27B was the only new monitoring well with dissolved-phase impacts; the four other new monitoring wells

were nondetect for all organic constituents. The dissolved-phase impacts observed in FW-27B are consistent with historical impacts observed in upgradient wells located within the plume footprint. The width of the plume is fairly small and well defined by existing monitoring wells; however, impacts were observed in the lowest monitoring zone in FW-27B completed approximately 50 feet into the semi-confining unit. No free-phase or residual DNAPL impacts were detected in continuous geologic core collected in the UF Aquifer at any of the new well locations.

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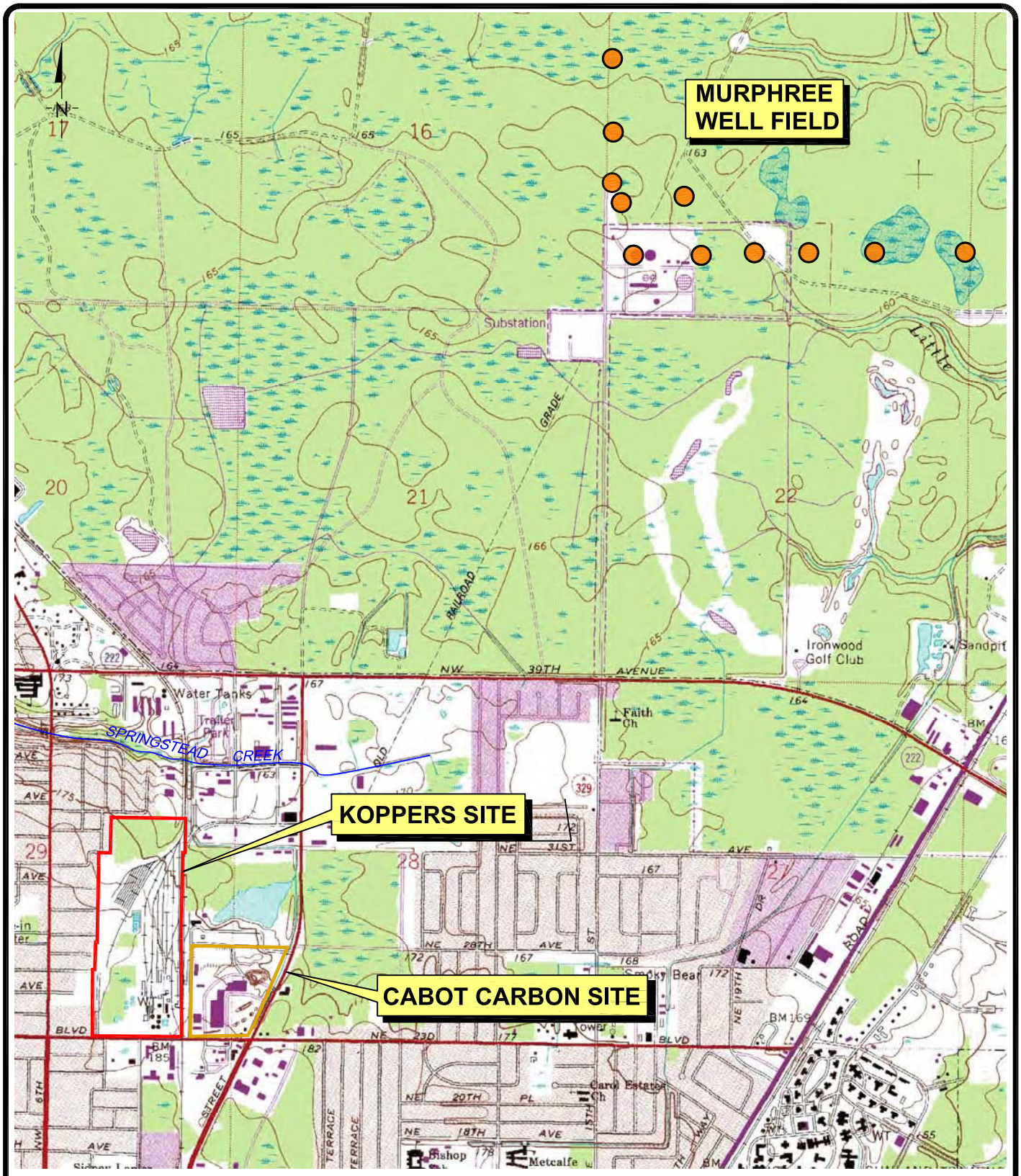
FIGURES



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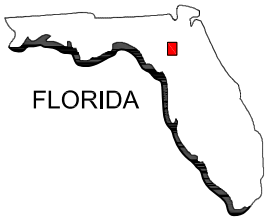

TITLE: **SITE LOCATION MAP**

LOCATION: **Cabot Carbon/Koppers Superfund Site, Gainesville, Florida**

GeoTrans, Inc. A TETRA TECH COMPANY

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DRAFTED	DJB
FILE	site location2
DATE	06/30/10

FIGURE: 1-1

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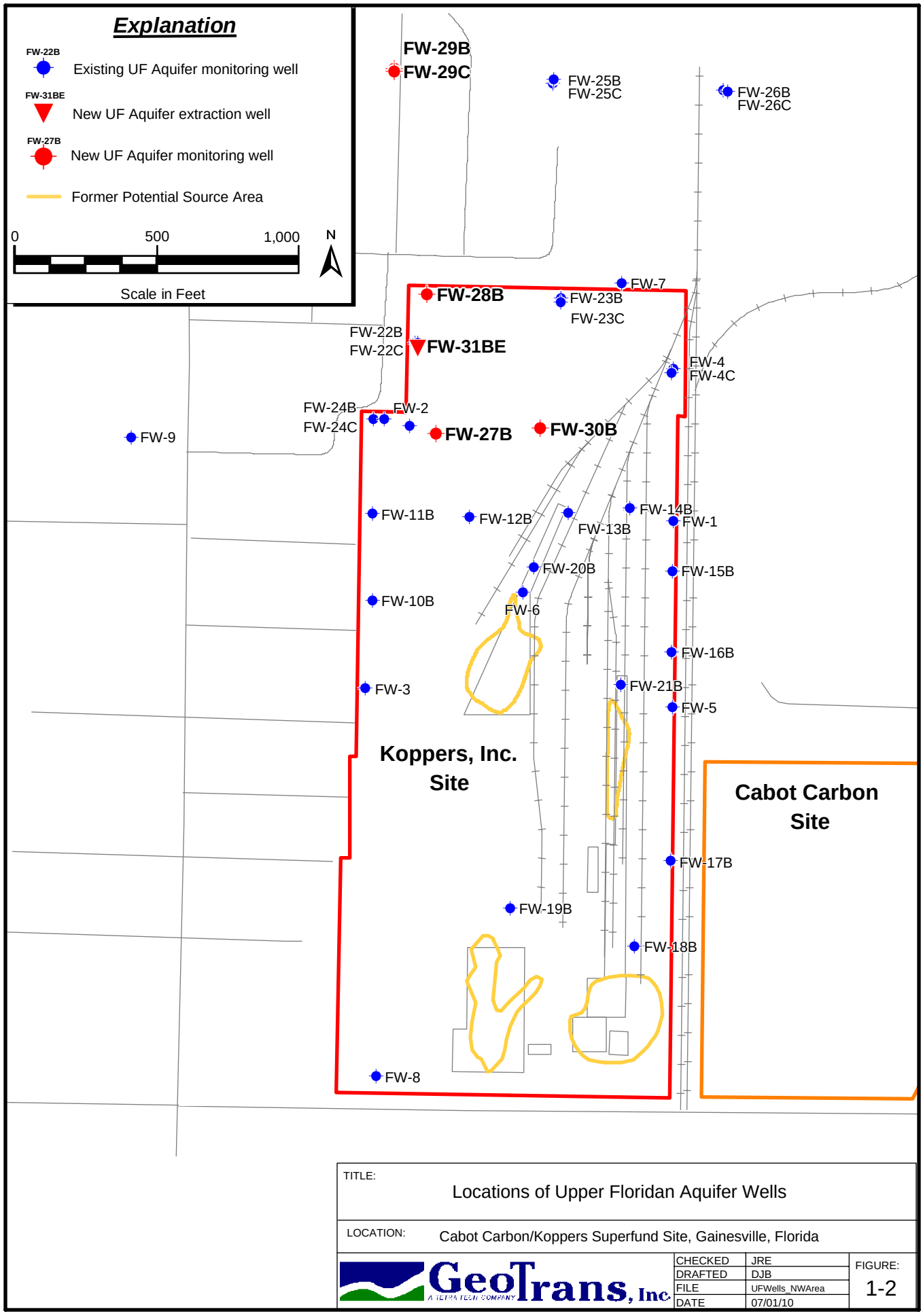

TITLE: Locations of Upper Floridan Aquifer Wells

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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FILE	UFWells_NWArea
DATE	07/01/10

FIGURE: 1-2

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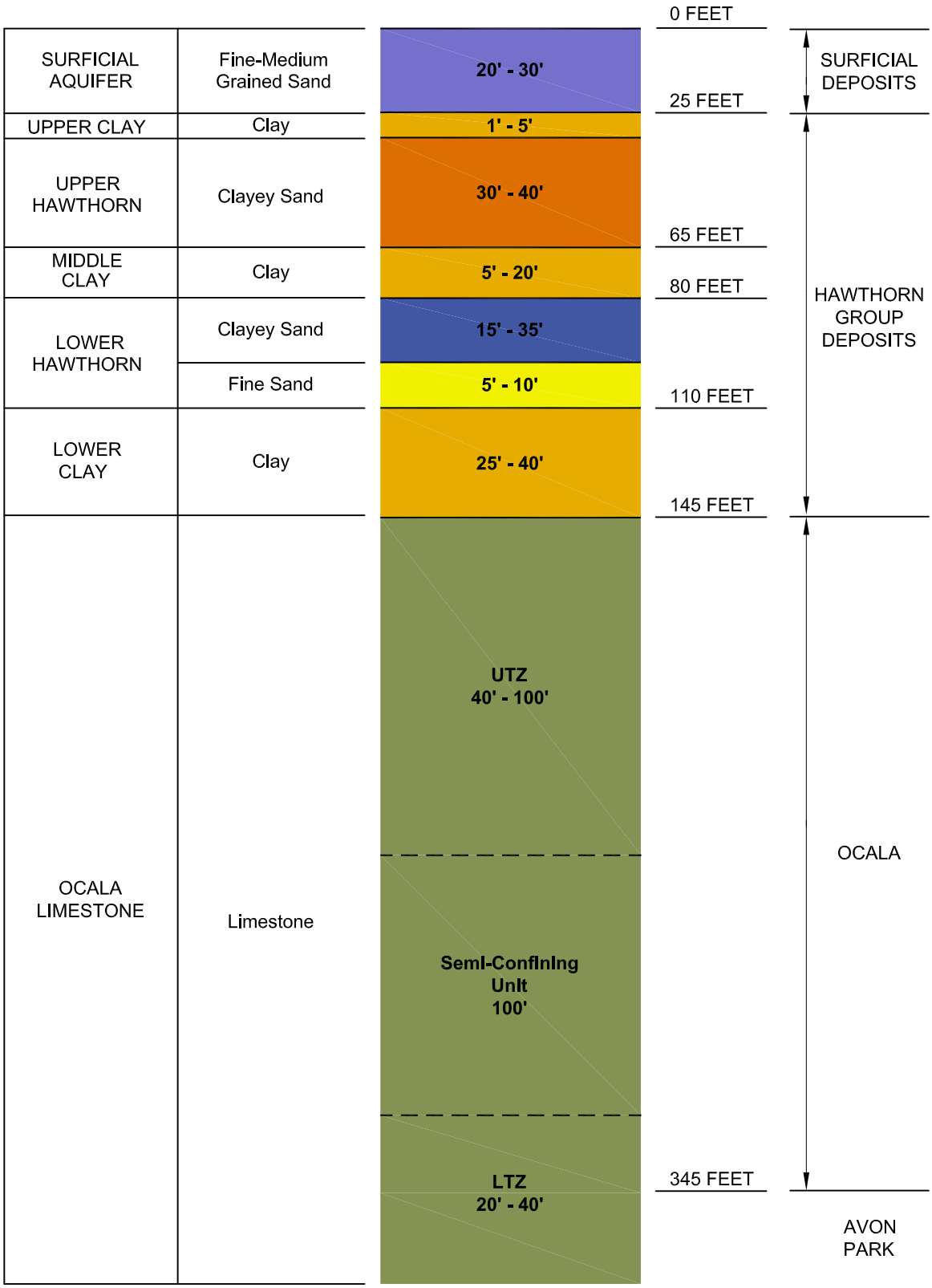

TITLE: HYDROSTRATIGRAPHY OF DEPOSITS BENEATH SITE

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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FILE	hydrostat column
DATE	06/30/10

FIGURE: 1-3

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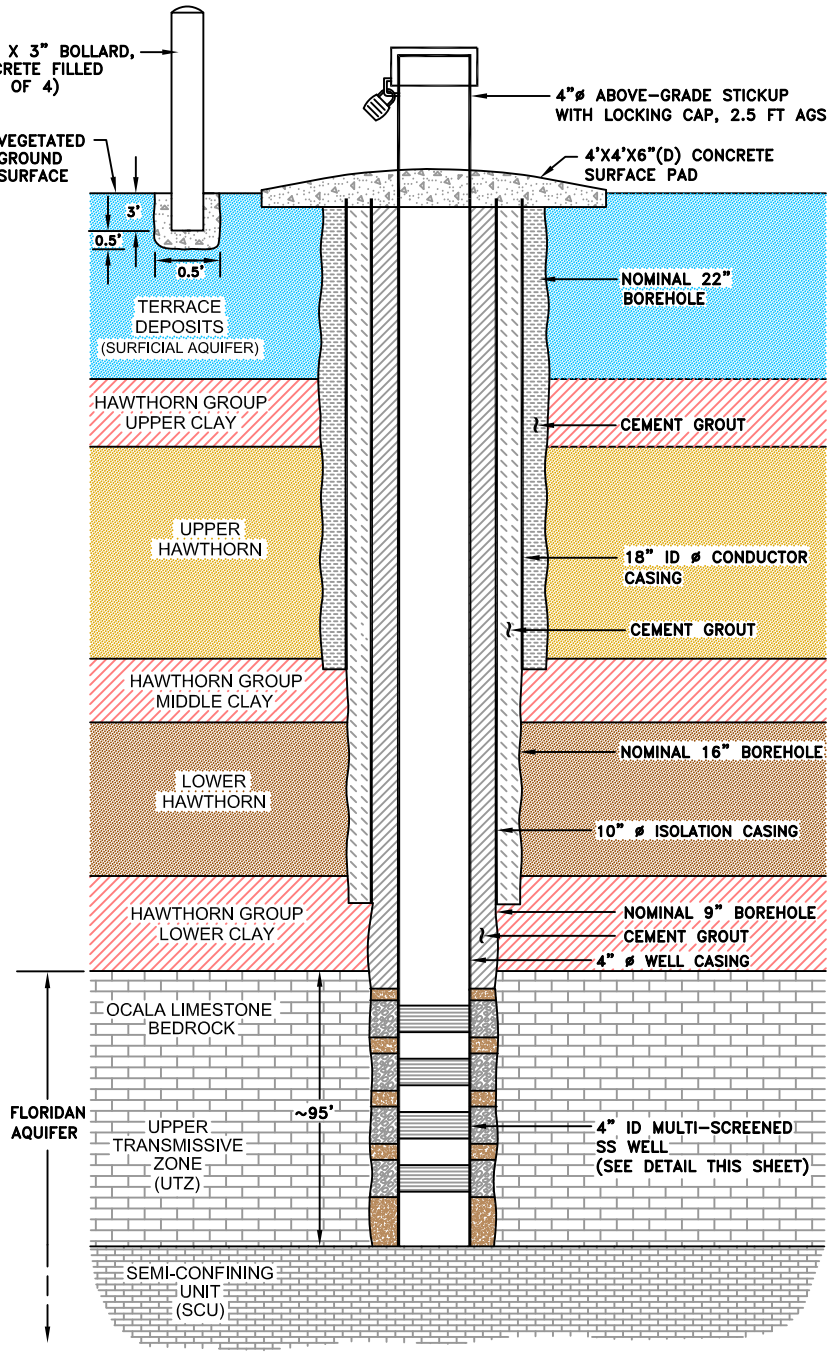

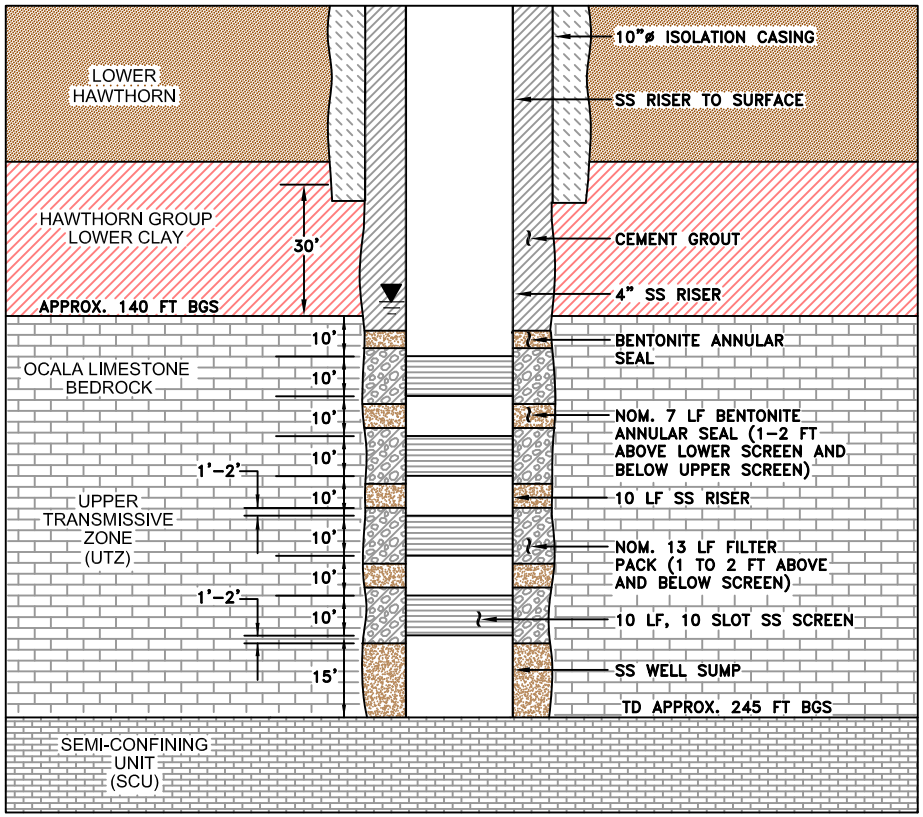

NOT TO SCALE

TITLE: CONCEPTUAL DESIGN FOR THE UPPER FLORIDAN AQUIFER UTZ MONITORING WELLS

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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DATE	06/30/10

FIGURE: 2-1

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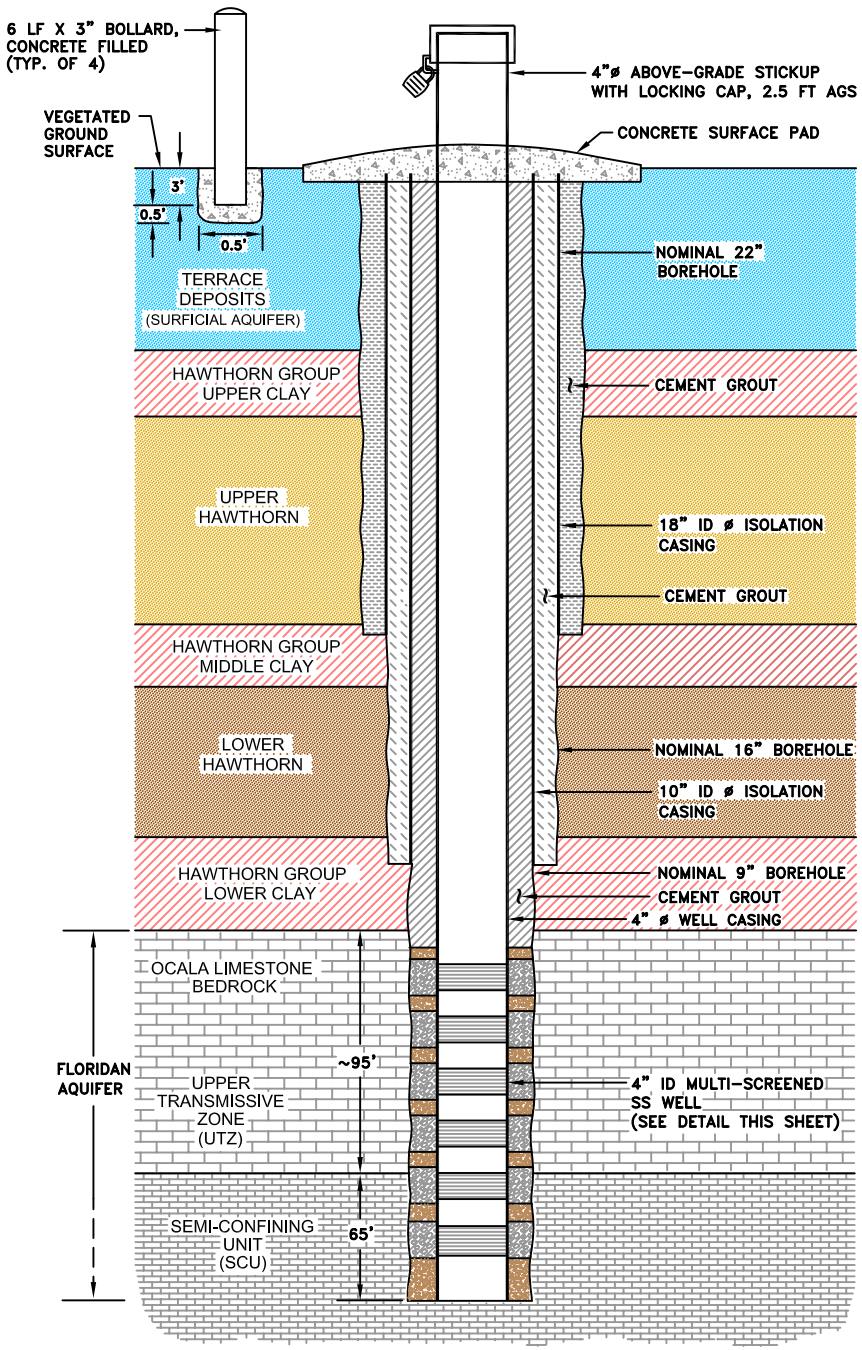

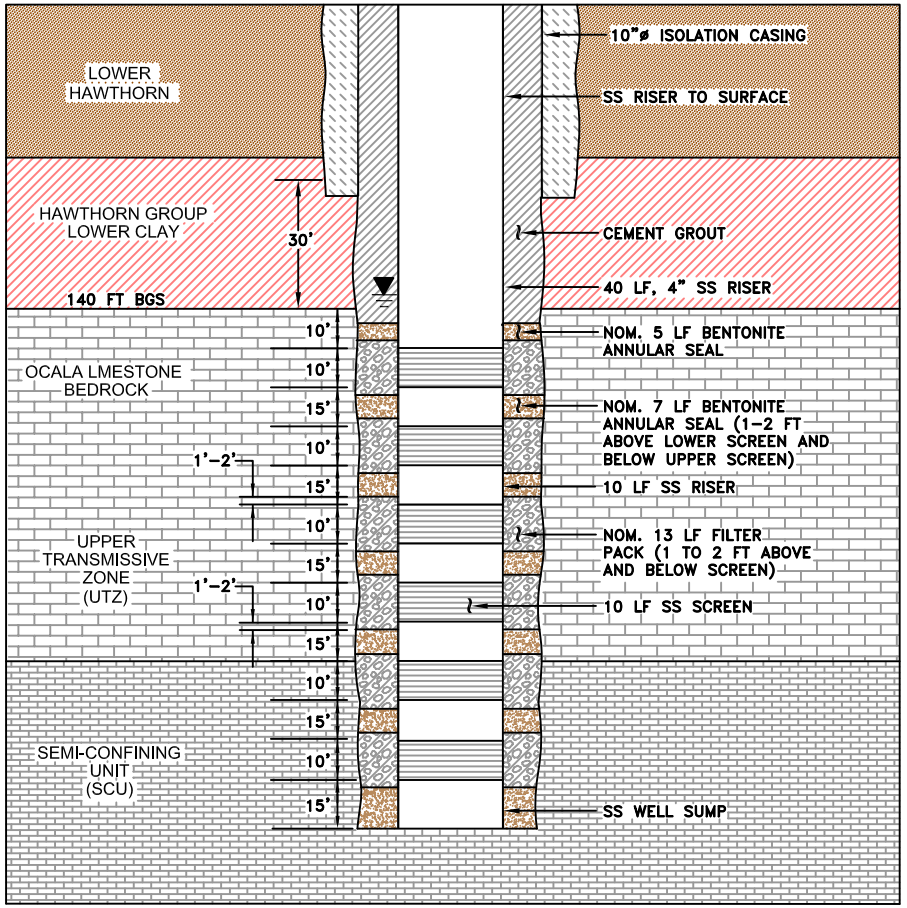

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TITLE:

CONCEPTUAL DESIGN FOR THE UPPER FLORIDAN AQUIFER UTZ/SCU MONITORING WELL

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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FILE	utz-scu design
DATE	06/30/10

FIGURE: 2-2

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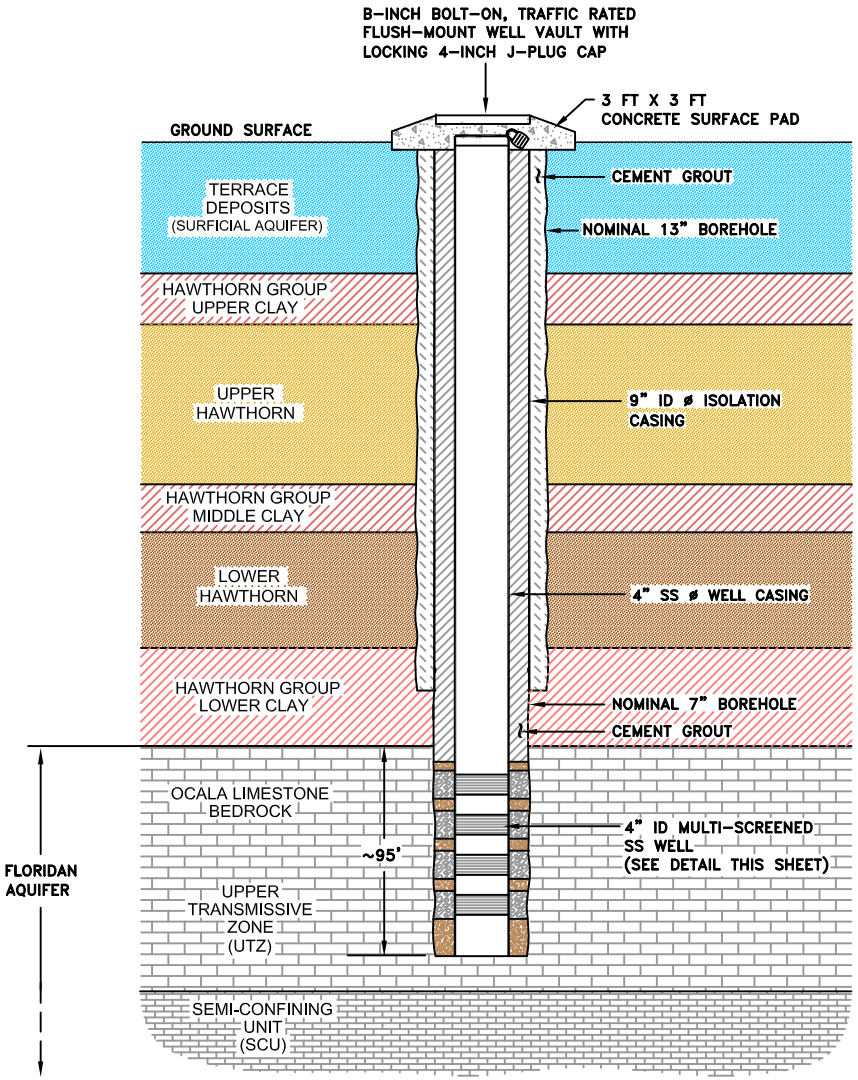

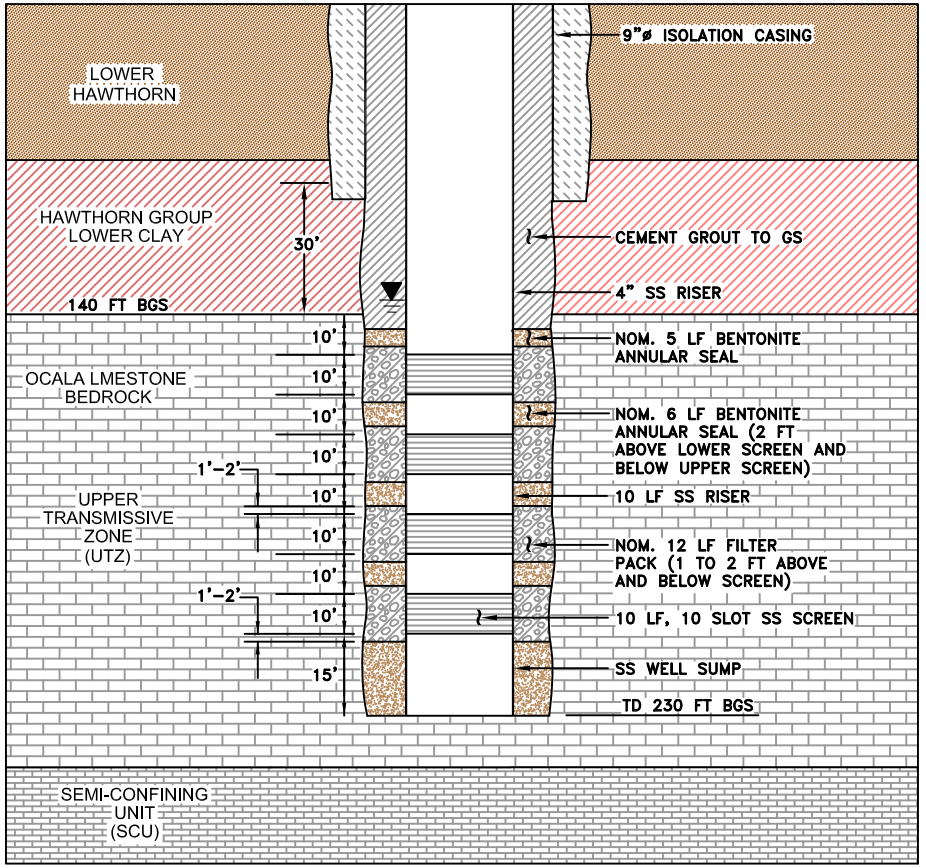

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TITLE: CONCEPTUAL DESIGN FOR THE UPPER FLORIDAN AQUIFER UTZ SENTINEL MONITORING WELL

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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DATE	06/30/10

FIGURE: 2-3

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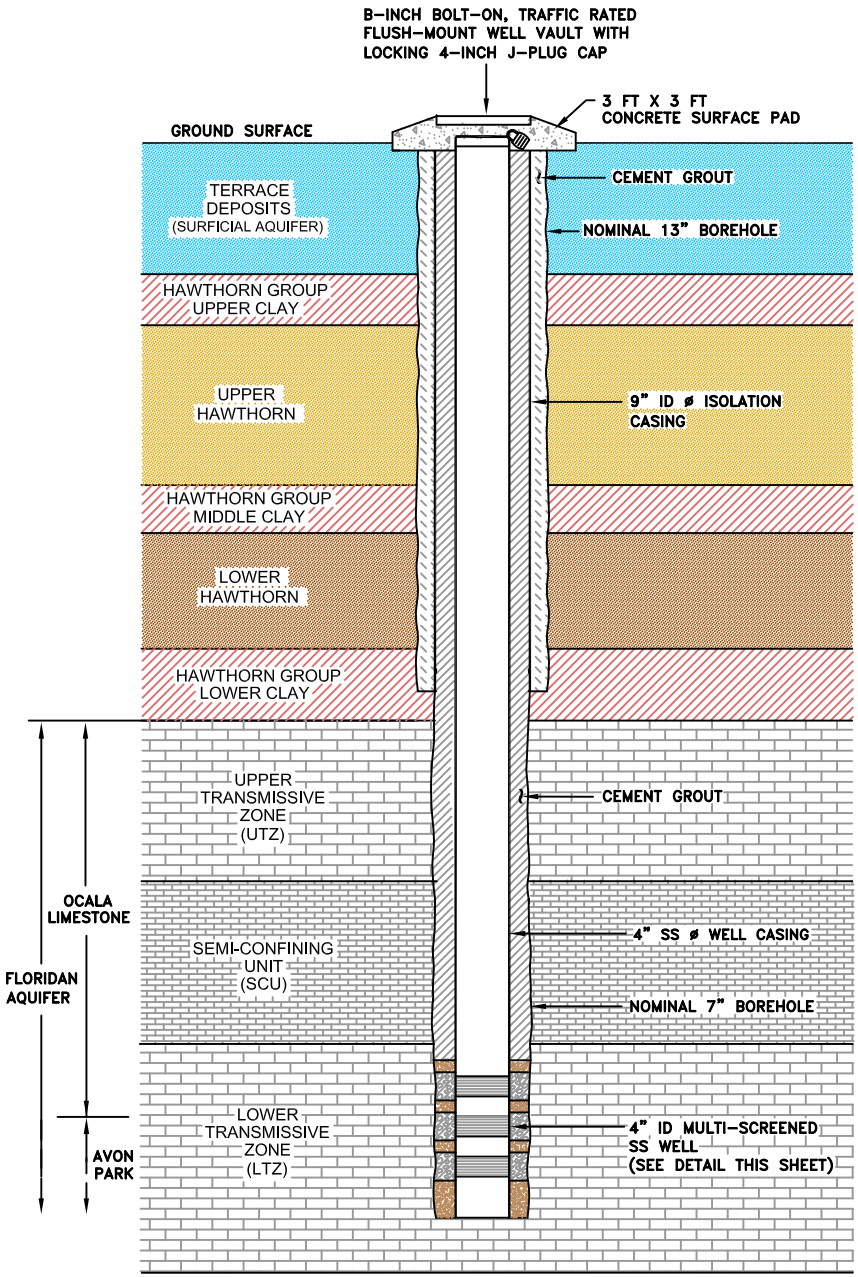

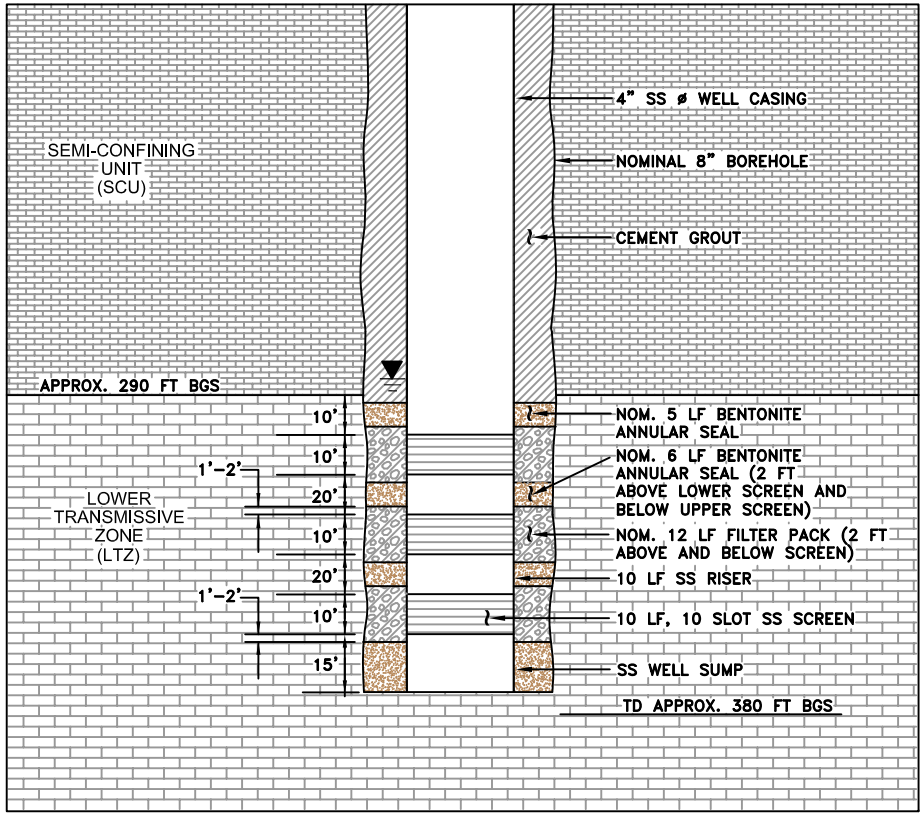

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CONCEPTUAL DESIGN FOR THE UPPER FLORIDAN AQUIFER LTZ SENTINEL MONITORING WELL

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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FILE	sentinel ltz design
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FIGURE: 2-4

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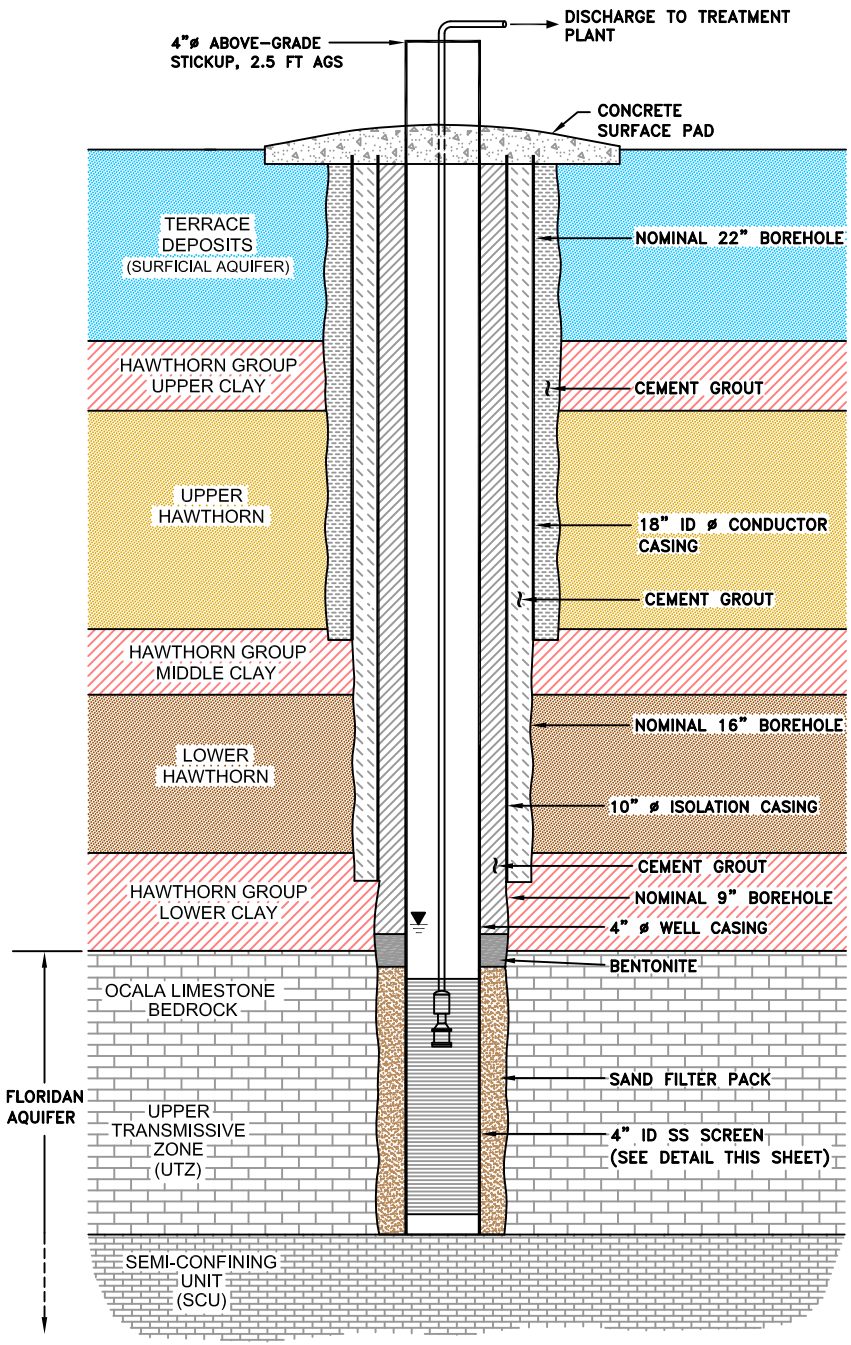

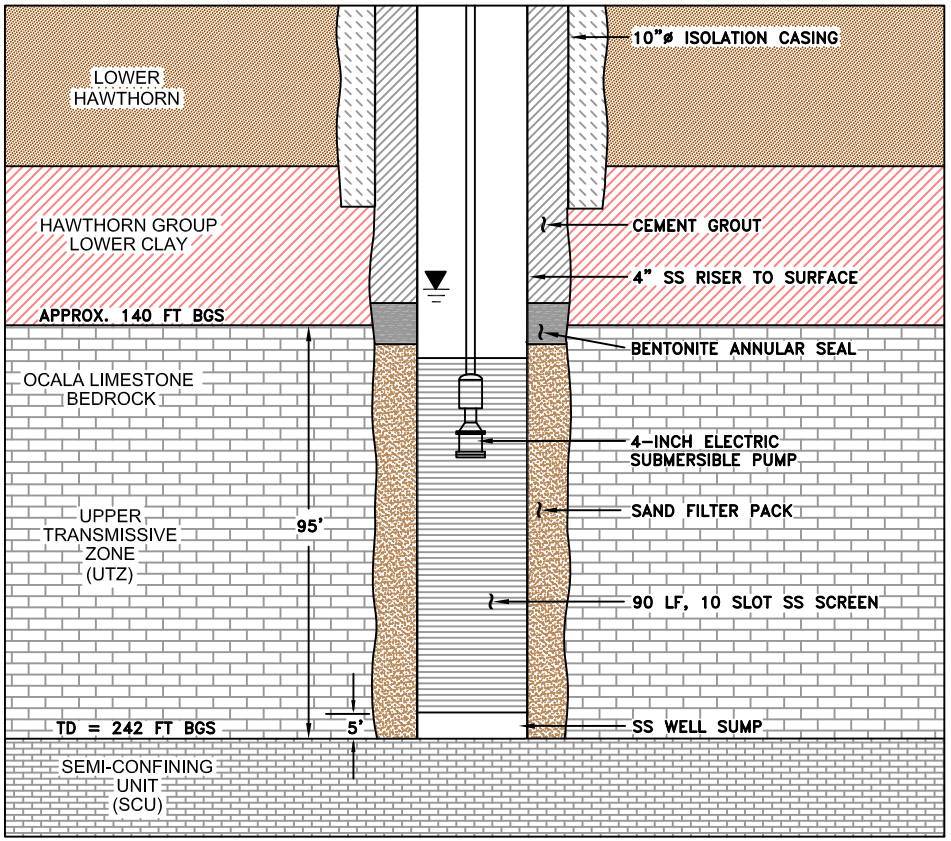

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TITLE: CONCEPTUAL DESIGN FOR THE UPPER FLORIDAN AQUIFER UTZ EXTRACTION WELL

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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FIGURE: 2-5

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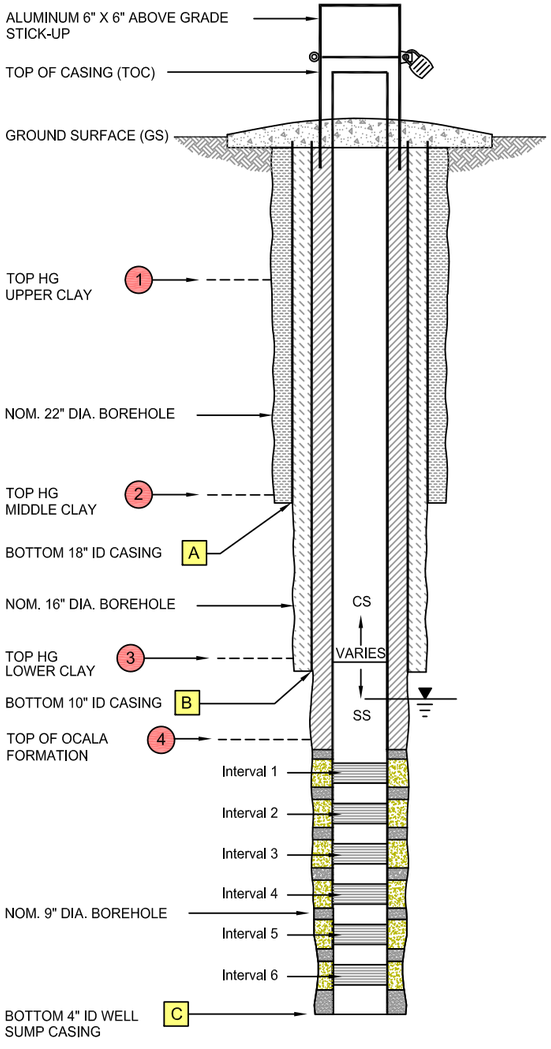
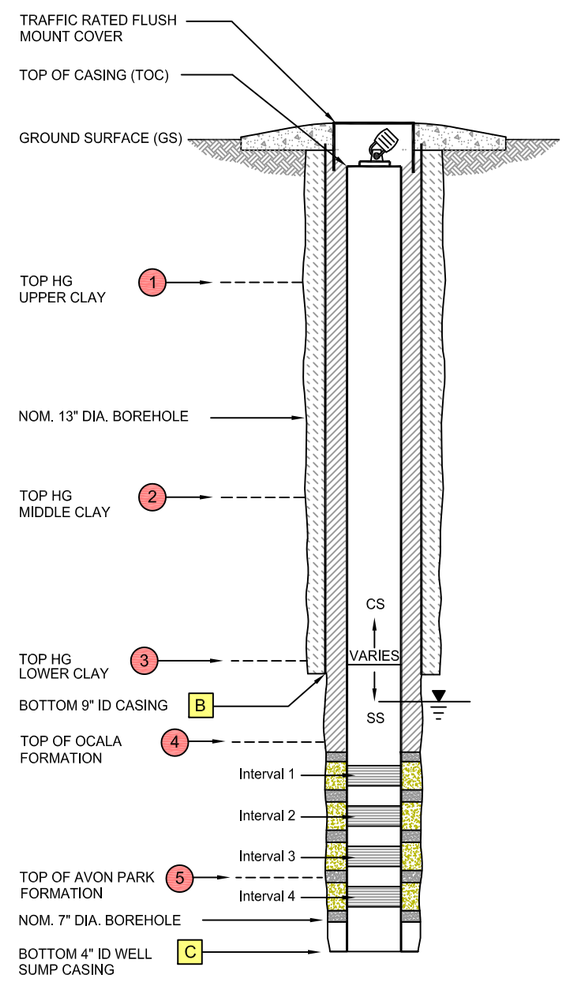


CONCEPTUAL ON-SITE UPPER FLORIDAN MULTI-SCREEN WELL SCHEMATIC



CONCEPTUAL OFF-SITE UPPER FLORIDAN MULTI-SCREEN WELL SCHEMATIC

NOTES:

BGS	BELOW GROUND SURFACE
AGS	ABOVE GROUND SURFACE
TOC	TOP OF 4" CASING (ABOVE GRADE)
INTERVAL	SCREEN INTERVAL (DEPTHS SHOWN ARE TO THE ACTUAL SCREEN SLOTS, NOT THE PIPE JOINTS)
CS	CARBON (BLACK) STEEL
SS	STAINLESS STEEL
HG UCL	HAWTHORN GROUP UPPER CLAY
HG MCL	HAWTHORN GROUP MIDDLE CLAY
HG LCL	HAWTHORN GROUP LOWER CLAY

FORMATION DEPTHS ARE SHOWN TO THE TOP OF TRANSITION SEQUENCE, IF ANY.

TOP OF 18", 10" , AND 9" CASINGS ARE AT GROUND SURFACE, WITHIN THE CONCRETE PAD.

TOP OF 4" CASING IS WITHIN THE ABOVE GRADE OR FLUSH MOUNT PROTECTION.

WELL ID	TOC (ft AGS)	Formation Depths (ft BGS)					Casing Depths (ft BGS)			Screen Interval Depths (ft BGS)											
										INTERVAL 1		INTERVAL 2		INTERVAL 3		INTERVAL 4		INTERVAL 5		INTERVAL 6	
		1 HG UCL	2 HG MCL	3 HG LCL	4 Ocala	5 Avon Park	A 18"	B 10"/9" *	C 4"	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
FW-27B	2.0	18.0	51.0	106.0	142.6	N/A	60.0	112.5	300.0	149.9	159.9	174.9	184.9	199.9	209.9	224.9	234.9	249.9	259.9	274.9	284.9
FW-28B	2.2	17.5	57.0	109.0	143.7	N/A	60.0	112.1	248.9	163.8	173.8	183.8	193.8	203.8	213.8	223.8	233.8	N/A	N/A	N/A	N/A
FW-29B	-0.3	15.6	57.5	118.8	146.5	N/A	N/A	123.7	248.5	163.4	173.4	183.4	193.4	203.4	213.4	223.4	233.4	N/A	N/A	N/A	N/A
FW-29C	-0.3	15.6	57.5	119.5	146.5	353.3	N/A	123.4	377.0	291.7	301.7	321.7	331.7	351.7	361.7	N/A	N/A	N/A	N/A	N/A	N/A
FW-30B	2.2	17.0	54.4	104.5	141.8	N/A	60.2	111.5	341.9	156.6	166.6	176.6	186.6	196.6	206.6	216.6	226.6	N/A	N/A	N/A	N/A
FW-31BE	2.1	23.0	60.0	108.6	142.2	N/A	62.4	112.5	242.0	146.7	236.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* - 10" casing for on-site wells, 9" casing for off-site Sentinel Wells

TITLE:

UPPER FLORIDAN WELL CONSTRUCTION SUMMARY

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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DATE	7/06/10

FIGURE: 2-6

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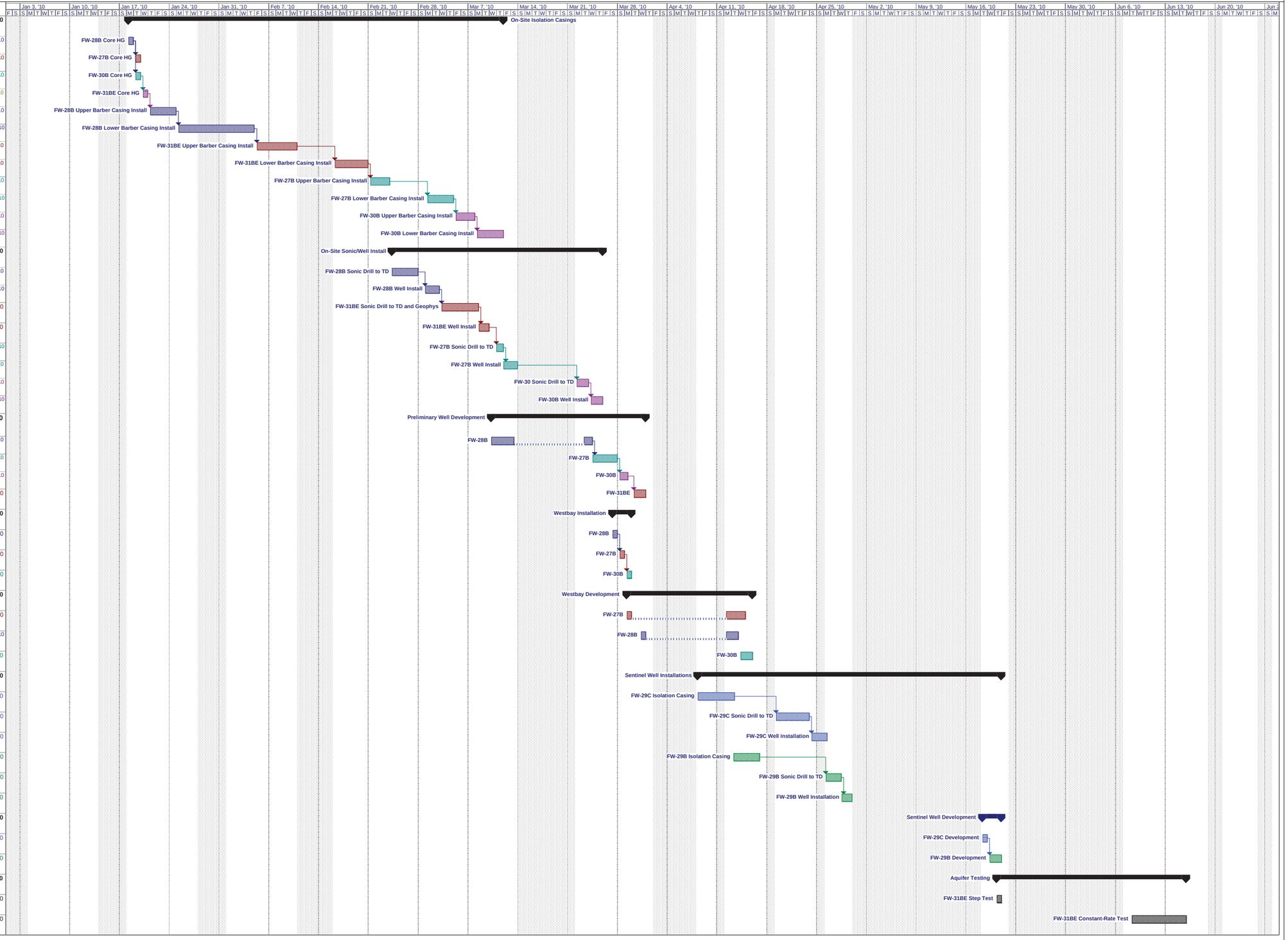
Figure 2-7. Well completion, development, Westbay installation, and aquifer testing timeline.

ID	Task Name	Duration	Start	Finish
1	**On-Site Isolation Casings**	**44 days**	**Mon 1/18/10**	**Thu 3/11/10**
2	FW-28B Core HG	1 day	Mon 1/18/10	Mon 1/18/10
3	FW-27B Core HG	1 day	Tue 1/19/10	Tue 1/19/10
4	FW-30B Core HG	1 day	Tue 1/19/10	Tue 1/19/10
5	FW-31BE Core HG	1 day	Wed 1/20/10	Wed 1/20/10
6	FW-28B Upper Barber Casing Install	4 days	Thu 1/21/10	Sun 1/24/10
7	FW-28B Lower Barber Casing Install	7 days	Mon 1/25/10	Thu 2/4/10
8	FW-31BE Upper Barber Casing Install	6 days	Fri 2/5/10	Wed 2/10/10
9	FW-31BE Lower Barber Casing Install	5 days	Tue 2/16/10	Sat 2/20/10
10	FW-27B Upper Barber Casing Install	3 days	Sun 2/21/10	Tue 2/23/10
11	FW-27B Lower Barber Casing Install	4 days	Mon 3/1/10	Thu 3/4/10
12	FW-30B Upper Barber Casing Install	3 days	Fri 3/5/10	Sun 3/7/10
13	FW-30B Lower Barber Casing Install	4 days	Mon 3/8/10	Thu 3/11/10
14	**On-Site Sonic/Well Install**	**22 days**	**Wed 2/24/10**	**Thu 3/25/10**
15	FW-28B Sonic Drill to TD	4 days	Wed 2/24/10	Sat 2/27/10
16	FW-28B Well Install	2 days	Sun 2/28/10	Tue 3/2/10
17	FW-31BE Sonic Drill to TD and Geophys	5.5 days	Wed 3/3/10	Mon 3/8/10
18	FW-31BE Well Install	1.5 days	Mon 3/8/10	Tue 3/9/10
19	FW-27B Sonic Drill to TD	1 day	Wed 3/10/10	Thu 3/11/10
20	FW-27B Well Install	2 days	Thu 3/11/10	Sat 3/13/10
21	FW-30 Sonic Drill to TD	2 days	Mon 3/22/10	Tue 3/23/10
22	FW-30B Well Install	2 days	Wed 3/24/10	Thu 3/25/10
23	**Preliminary Well Development**	**14 days**	**Wed 3/10/10**	**Wed 3/31/10**
24	FW-28B	5 days	Wed 3/10/10	Wed 3/24/10
25	FW-27B	3.5 days	Wed 3/24/10	Sat 3/27/10
26	FW-30B	1.5 days	Sun 3/28/10	Mon 3/29/10
27	FW-31BE	2 days	Tue 3/30/10	Wed 3/31/10
28	**Westbay Installation**	**3 days**	**Sat 3/27/10**	**Mon 3/29/10**
29	FW-28B	1 day	Sat 3/27/10	Sat 3/27/10
30	FW-27B	1 day	Sun 3/28/10	Sun 3/28/10
31	FW-30B	1 day	Mon 3/29/10	Mon 3/29/10
32	**Westbay Development**	**11 days**	**Mon 3/29/10**	**Thu 4/15/10**
33	FW-27B	3.75 days	Mon 3/29/10	Wed 4/14/10
34	FW-28B	2.75 days	Wed 3/31/10	Tue 4/13/10
35	FW-30B	2 days	Wed 4/14/10	Thu 4/15/10
36	**Sentinel Well Installations**	**22 days**	**Thu 4/8/10**	**Thu 5/20/10**
37	FW-29C Isolation Casing	4.5 days	Thu 4/8/10	Tue 4/13/10
38	FW-29C Sonic Drill to TD	5 days	Mon 4/19/10	Fri 4/23/10
39	FW-29C Well Installation	1.5 days	Sat 4/24/10	Mon 4/26/10
40	FW-29B Isolation Casing	4 days	Tue 4/13/10	Fri 4/16/10
41	FW-29B Sonic Drill to TD	2.5 days	Mon 4/26/10	Wed 4/28/10
42	FW-29B Well Installation	1.5 days	Wed 4/28/10	Thu 4/29/10
43	**Sentinel Well Development**	**3 days**	**Tue 5/18/10**	**Thu 5/20/10**
44	FW-29C Development	1 day	Tue 5/18/10	Tue 5/18/10
45	FW-29B Development	2 days	Wed 5/19/10	Thu 5/20/10
46	**Aquifer Testing**	**11 days**	**Thu 5/20/10**	**Tue 6/15/10**
47	FW-31BE Step Test	1 day	Thu 5/20/10	Thu 5/20/10
48	FW-31BE Constant-Rate Test	8 days	Tue 6/8/10	Tue 6/15/10



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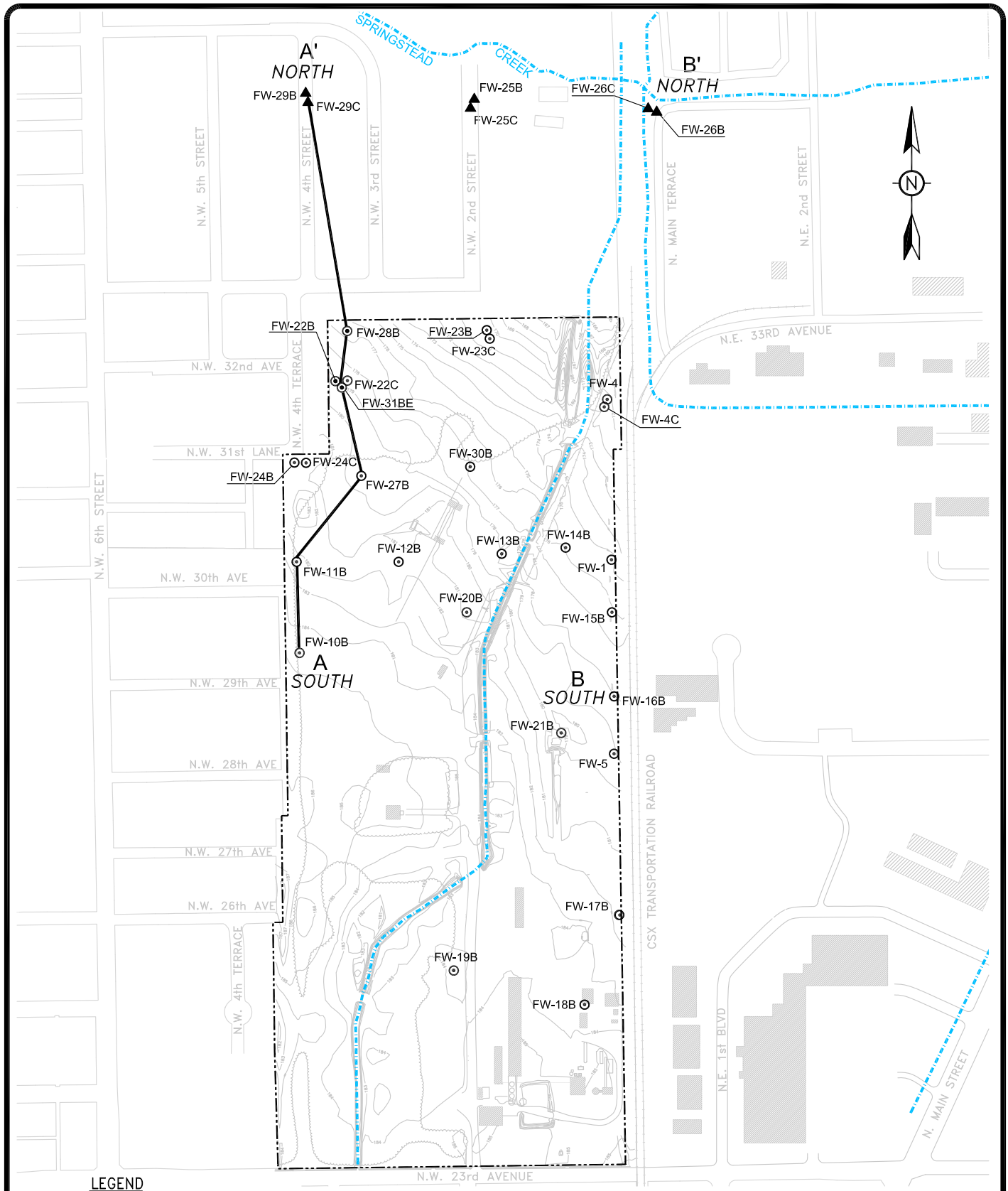

LEGEND

A—A' CROSS SECTION LOCATION

— - - - — SITE BOUNDARY

⊙ UPPER FLORIDAN MONITORING WELL

▲ UPPER FLORIDAN SENTINEL WELL

0 500 1000

SCALE IN FEET

TITLE: GEOLOGIC-SECTION LOCATION MAP

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

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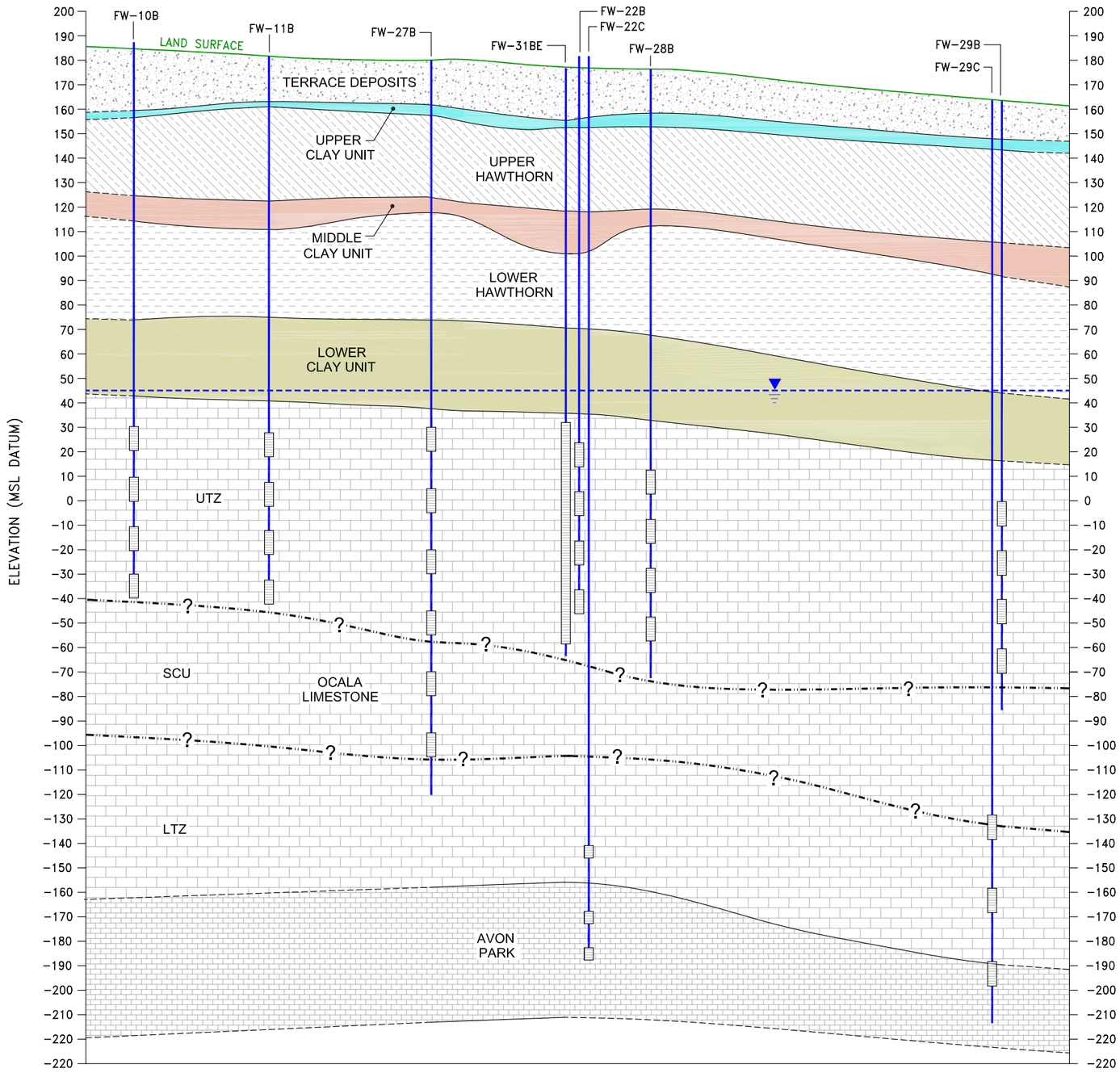
FILE	2201201005A.DWG
DATE	7-7-10

FIGURE: 4-1

A
SOUTH

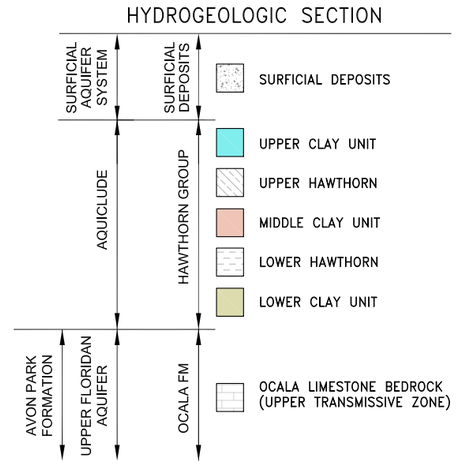
A'
NORTH

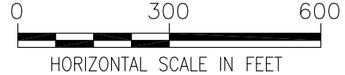


LEGEND

- POTENTIOMETRIC SURFACE IN SCREEN INTERVAL NO. 1
- BGS — BELOW GROUND SURFACE
- NGVD-29 — NATIONAL GEODETIC VERTICAL DATUM, 1929
- WELL SCREEN

HYDROGEOLOGIC SECTION





HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 6X

TITLE: GEOLOGIC-SECTION A–A'

LOCATION: Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

CHECKED	DB
DRAFTED	CP
FILE	2201201006A.DWG
DATE	7–7–10

FIGURE: 4-2

Figure 4-3. Temporal water-level fluctuations in FW-31BE during constant-rate test.

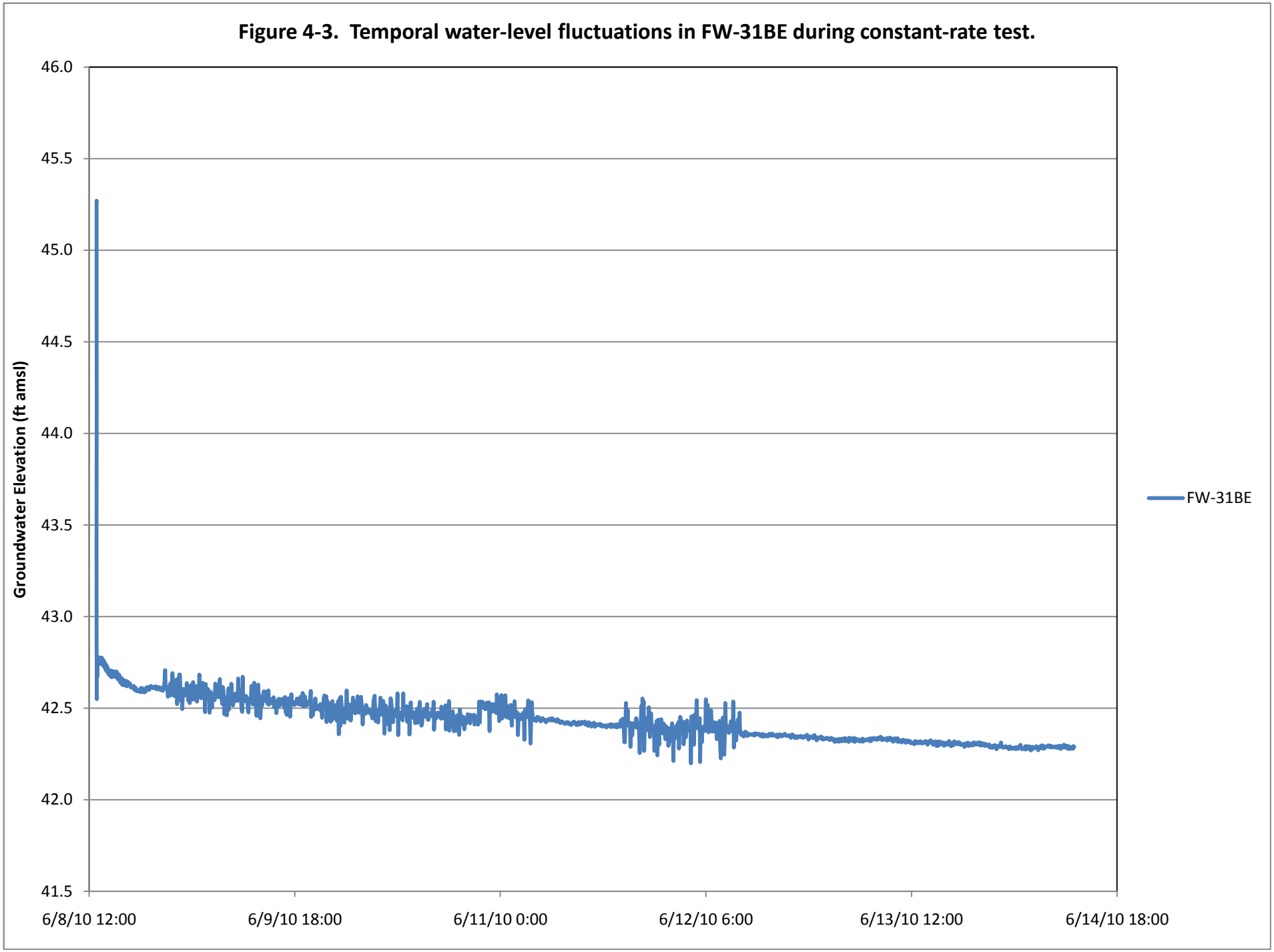


Figure 4-4. Early-time temporal water-level fluctuations in observation wells during constant-rate test.

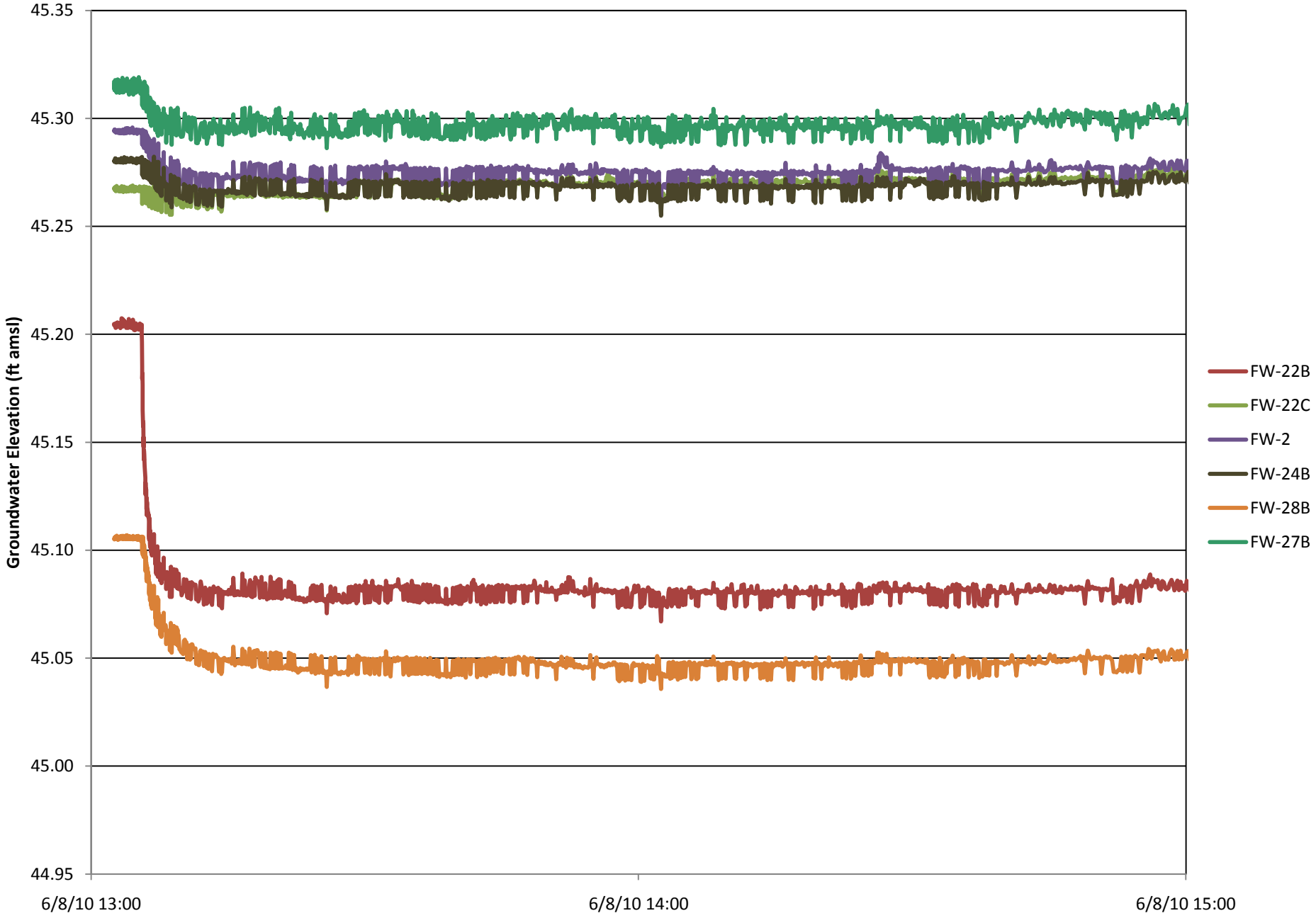
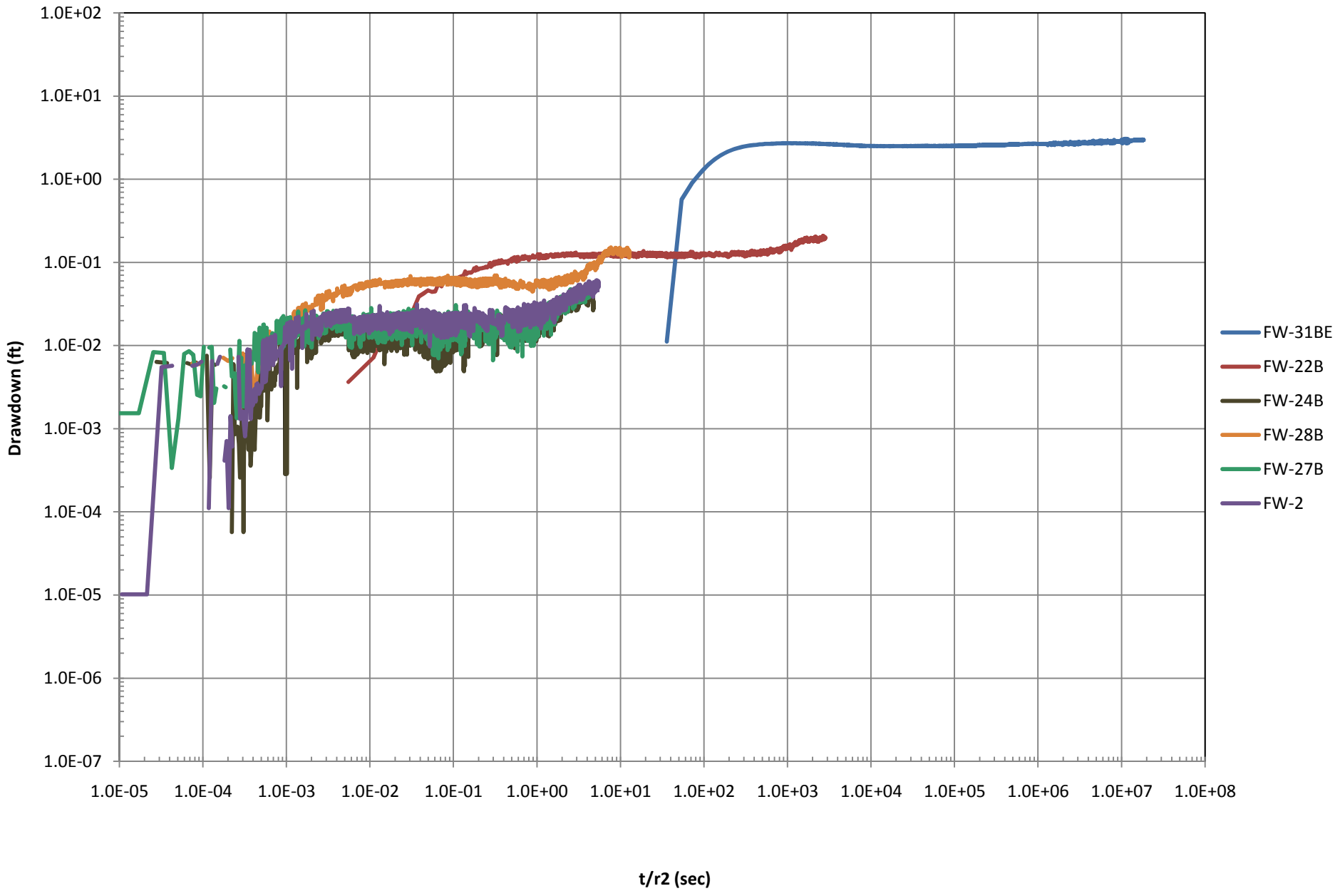
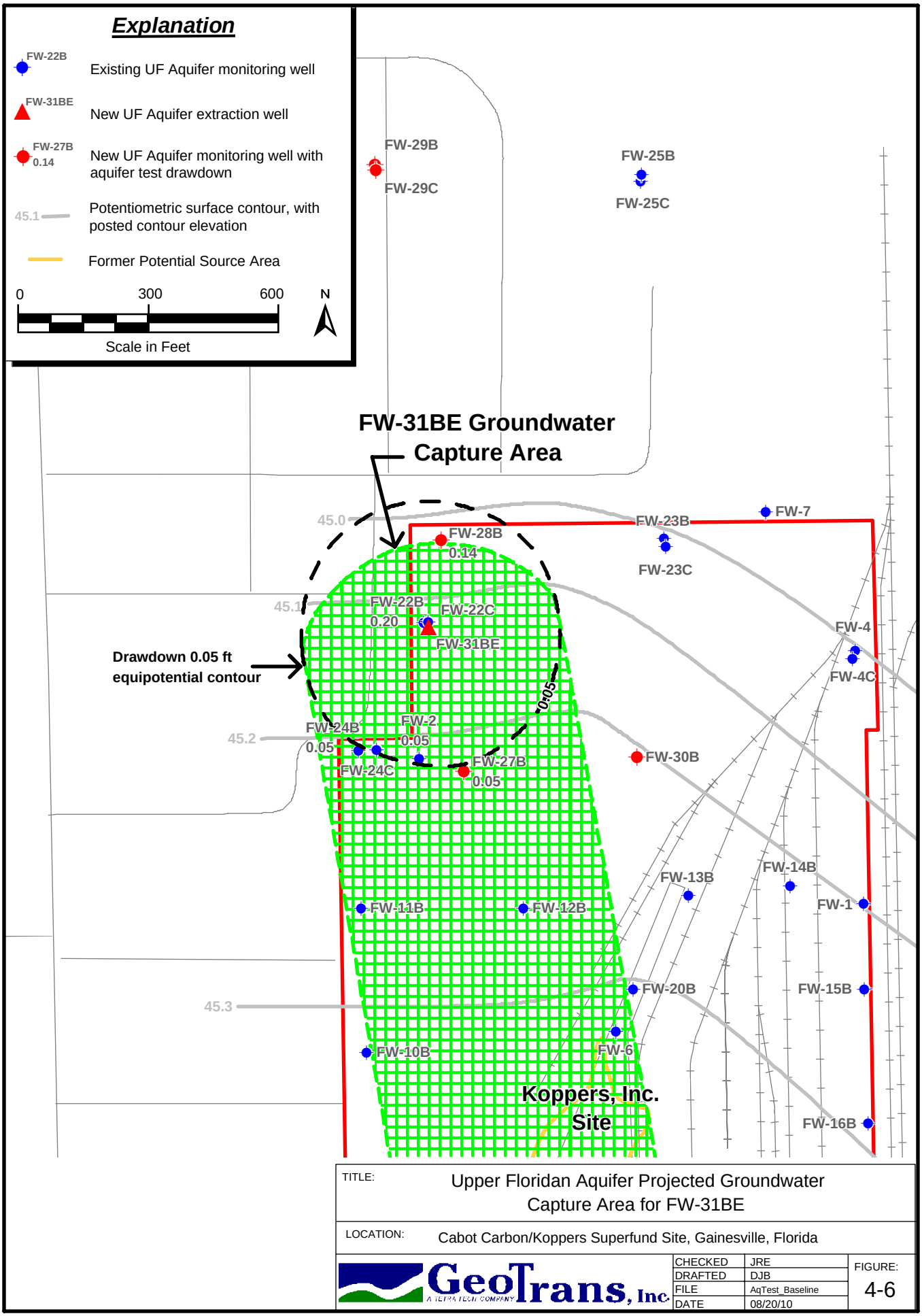


Figure 4-5. Normalized time versus drawdown in FW-31BE and observation wells during constant-rate test.





TITLE:	Upper Floridan Aquifer Projected Groundwater Capture Area for FW-31BE
LOCATION:	Cabot Carbon/Koppers Superfund Site, Gainesville, Florida

GeoTrans, Inc. A TETRA TECH COMPANY

CHECKED	JRE
DRAFTED	DJB
FILE	AqTest_Baseline
DATE	08/20/10

FIGURE: 4-6

t:\gainesville\mapinfo\watlev\2010\UFWells_AqTest_Baseline_082010.WOR

TABLES

Table 2-1a. Well casing elevations and completion depths.

Well ID	Well Type	Ground Surface Elevation (NGVD-29)	Surveyed Westbay TOC Elevation (NGVD-29)	Westbay Stickup Above Ground Surface (feet)	Total Depth Westbay (feet below TOC)	Total Depth Westbay (feet BGS)	Surveyed 4-in Well TOC Elevation (NGVD-29)	4-inch Well Stickup Above Ground Surface (feet)	Total Depth 4-in Well (feet below TOC)	Total Depth 4-in Well (feet BGS)	Total Depth Borehole (feet BGS)
FW-27B	Transect	179.9	182.08	2.18	299.5	297.0	181.93	2.03	302.0	300.0	300.4
FW-28B	Property Boundary	176.4	178.69	2.29	248.5	246.0	178.57	2.17	251.1	248.9	248.9
FW-29B	Sentinel	163.1	NA	NA	NA	NA	162.76	-0.34	248.3	248.6	248.6
FW-29C	Sentinel	163.4	NA	NA	NA	NA	163.08	-0.32	376.7	377.0	377.0
FW-30B	Transect	177.1	179.39	2.29	242.5	239.0	179.27	2.17	244.1	241.9	241.9
FW-31BE	Extraction	178.7	NA	NA	NA	NA	180.80	2.10	244.1	242.0	242.0

Notes: Survey conducted by DeGrove Surveyors on 05/21/2010.

Monitoring wells FW-27B, FW-28B, FW-29B, FW-29C, and FW-30B have a 15 LF 304 SS casing sump. Extraction well FW-31BE has a 5 LF SS casing sump.

Monitoring wells FW-27B, FW-28B, FW-29B, FW-29C, and FW-30B are constructed with 304 SS casing to 40 feet above the top screen, and are completed with black steel casing to grade or above grade. Extraction well FW-31BE is constructed with with 304 SS casing to 30 feet above the top of the screen, and is completed with black steel casing to above grade.

Monitoring wells FW-27B, FW-28B, and FW-30B and extraction well FW-31BE are completed within 18-in and 10-in telescoping isolation casings. Monitoring wells FW-29B and FW-29C are completed within 8-in telescoping isolation casings.

Filter pack media in screened completions is silica sand grade 10/20 or 12/20. Bentonite chips were placed between each of the screened interval filter packs.

Table 2-1b. Well screens, filter packs, and Westbay sampling port completion depths.

Well ID	Screen 1 / Zone 1					Screen 2 / Zone 2					Screen 3 / Zone 3				
	Top of Filter Pack	Top of Screen	Westbay Sampling Port	Bottom of Screen	Bottom of Filter Pack	Top of Filter Pack	Top of Screen	Westbay Sampling Port	Bottom of Screen	Bottom of Filter Pack	Top of Filter Pack	Top of Screen	Westbay Sampling Port	Bottom of Screen	Bottom of Filter Pack
FW-27B	145.6	149.9	152.0	159.9	160.9	170.8	174.9	177.0	184.9	186.7	196.0	199.9	202.0	209.9	212.2
FW-28B	160.7	163.8	171.0	173.8	175.6	181.8	183.8	191.0	193.8	195.8	201.9	203.8	211.0	213.8	215.4
FW-29B	159.5	163.4	NA	173.4	175.3	180.3	183.4	NA	193.4	194.6	199.9	203.4	NA	213.4	215.7
FW-29C	282.3	291.7	NA	301.7	301.7	316.9	321.7	NA	331.7	331.7	346.5	351.7	NA	361.7	377.0
FW-30B	153.0	156.6	159.0	166.6	168.5	173.4	176.6	179.0	186.6	188.3	193.4	196.6	199.0	206.6	207.5
FW-31BE	144.0	146.7	NA	236.7	242.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes: Survey conducted by DeGrove Surveyors on 05/21/2010.

Monitoring wells FW-27B, FW-28B, FW-29B, FW-29C, and FW-30B have a 15 LF 304 SS casing sump. Extraction well FW-31BE has a 5 LF SS casing sump.

Monitoring wells FW-27B, FW-28B, FW-29B, FW-29C, and FW-30B are constructed with 304 SS casing to 40 feet above the top screen, and are completed with black steel casing to grade or above grade. Extraction well FW-31BE is constructed with with 304 SS casing to 30 feet above the top of the screen, and is completed with black steel casing to above grade.

Monitoring wells FW-27B, FW-28B, and FW-30B and extraction well FW-31BE are completed within 18-in and 10-in telescoping isolation casings. Monitoring wells FW-29B and FW-29C are completed within 8-in telescoping isolation casings.

Filter pack media in screened completions is silica sand grade 10/20 or 12/20. Bentonite chips were placed between each of the screened interval filter packs.

All depths reference as feet Below Ground Surface (BGS), unless otherwise noted.

Table 2-1b (cont). Well screens, filter packs, and Westbay sampling port completion depths.

Well ID	Screen 4 / Zone 4					Screen 5 / Zone 5					Screen 6 / Zone 6				
	Top of Filter Pack	Top of Screen	Westbay Sampling Port	Bottom of Screen	Bottom of Filter Pack	Top of Filter Pack	Top of Screen	Westbay Sampling Port	Bottom of Screen	Bottom of Filter Pack	Top of Filter Pack	Top of Screen	Westbay Sampling Port	Bottom of Screen	Bottom of Filter Pack
FW-27B	221.0	224.9	227.0	234.9	238.5	246.0	249.9	252.0	259.9	261.7	270.8	274.9	277.0	284.9	288.9
FW-28B	221.5	223.8	231.0	233.8	235.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FW-29B	220.5	223.4	NA	233.4	236.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FW-29C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FW-30B	212.8	216.6	219.0	226.6	228.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
FW-31BE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes: Survey conducted by DeGrove Surveyors on 05/21/2010.

Monitoring wells FW-27B, FW-28B, FW-29B, FW-29C, and FW-30B have a 15 LF 304 SS casing sump. Extraction well FW-31BE has a 5 LF SS casing sump.

Monitoring wells FW-27B, FW-28B, FW-29B, FW-29C, and FW-30B are constructed with 304 SS casing to 40 feet above the top screen, and are completed with black steel casing to grade or above grade. Extraction well FW-31BE is constructed with with 304 SS casing to 30 feet above the top of the screen, and is completed with black steel casing to above grade.

Monitoring wells FW-27B, FW-28B, and FW-30B and extraction well FW-31BE are completed within 18-in and 10-in telescoping isolation casings. Monitoring wells FW-29B and FW-29C are completed within 8-in telescoping isolation casings.

Filter pack media in screened completions is silica sand grade 10/20 or 12/20. Bentonite chips were placed between each of the screened interval filter packs.

All depths reference as feet Below Ground Surface (BGS), unless otherwise noted.

Table 2-1c. Hydrostratigraphic contact depths and elvations at well locations.

Well ID	Formation Depths (ft BGS)							Formation Elevations (ft NGVD-29)						
	Top of HG Upper Clay	Bottom of HG Upper Clay	Top of HG Middle Clay	Bottom of HG Middle Clay	Top of HG Lower Clay	Top of Ocala Formation	Top of Avon Park	Top of HG Upper Clay	Bottom of HG Upper Clay	Top of HG Middle Clay	Bottom of HG Middle Clay	Top of HG Lower Clay	Top of Ocala Formation	Top of Avon Park
FW-27B	18.0	22.5	51.0	62.2	106.0	142.6	NA	161.9	157.4	128.9	117.7	73.9	37.3	NA
FW-28B	17.5	24.0	57.0	64.0	109.0	143.7	NA	158.9	152.4	119.4	112.4	67.4	32.7	NA
FW-29B	15.6	19.7	57.5	71.0	118.8	146.5	NA	147.5	143.4	105.6	92.1	44.3	16.6	NA
FW-29C	15.6	19.7	57.5	71.0	119.5	146.5	353.3	147.8	143.7	105.9	92.4	43.9	16.9	-189.9
FW-30B	17.0	24.5	54.4	64.0	104.5	141.8	NA	160.1	152.6	122.7	113.1	72.6	35.3	NA
FW-31BE	23.0	27.5	60.0	77.8	108.6	142.2	NA	155.7	151.2	118.7	100.9	70.1	36.5	NA

Table 2-2. Volume of drilling fluids lost to Upper Floridan Aquifer versus the volume of water removed during well development.

Well I.D.	Total Volume of Water Lost During Drilling[1] (gal)	Total Volume of Water Removed During Development[2] (gal)	Percent of Water Removed vs. Water Lost
FW-27B	5,300	36,152	682%
FW-28B	3,960	23,703	599%
FW-29B	3,005	11,300	376%
FW-29C	5,480	8,200	150%
FW-30B	4,385	13,701	312%
FW-31BE	4,420	13,971	316%
TOTALS	**26,550**	**107,027**	**AVG = 406%**

Notes:

1 - Total volume of water lost during drilling is the volume of water lost over the entire borehole installation.

2 - Total volume of water removed from FW-31BE includes pumping during the aquifer step-drawdown test.

Table 2-3. Drilling fluid bromide concentrations and daily field bromide concentrations during well development.

Purge Date	Interval	Daily Water Volume Removed (gal)	Field Bromide Concentration at Start of Day (mg/L)	Field Bromide Concentration at End of Day (mg/L)	Turbidity Measurement at End of Day (mg/L)	Total Water Volume Removed (gal)
FW-27B (Drilling fluid Br conc 120 mg/L)						
03/24/10	6	5,747	232	65.5		35,247
03/25/10	5	5,200	44.0	19.1		
03/25/10	4	4,300	13.3	68.6		
03/26/10	4	1,800	12.1	30.3		
03/25/10	3	500	10.2	25.6		
03/26/10	3	4,500	54.0	16.4		
03/26/10	2	5,100	8.2	34.9		
03/26/10	1	1,800	16.5	66.6		
03/27/10	1	3,900	8.2	17.6		
03/27/10	All	2,400	NM	NM		
03/29/10	6	150	NM	10.9	0	905
04/12/10	5	190	0.90	2.2	16	
04/13/10	4	150	0.75	1.7	3.4	
04/13/10	3	125	0.68	2.0	21	
04/14/10	2	130	23.0	64.4	5.2	
04/14/10	1	75	34.9	64.3	4.3	
04/15/10	1	85	54.2	55.0	2.1	
					Cumulative Total =	36,152

Purge Date	Interval	Daily Water Volume Removed (gal)	Field Bromide Concentration at Start of Day (mg/L)	Field Bromide Concentration at End of Day (mg/L)	Turbidity Measurement at End of Day (mg/L)	Total Water Volume Removed (gal)
FW-28B (Drilling fluid Br conc 120 mg/L)						
03/13/10	4	7,430	56.0	54.0	NM	22,804
03/13/10	3	3,470	54.0	34.0	NM	
03/13/10	2	4,000	50.0	7.0	NM	
03/13/10	1	3,240	13.0	12.0	NM	
03/23/10	4	2,189	50.6	59.7	NM	
03/23/10	3	1,350	9.6	44.3	NM	
03/26/10	All	1,125	NM	NM	NM	
03/31/10	4	211	0.49	0.67	0.4	899
04/12/10	3	396	11.2	15.9	3.9	
04/13/10	2	177	3.2	1.3	9.2	
04/13/10	1	115	0.65	2.1	18	
					Cumulative Total =	23,703

Purge Date	Interval	Daily Water Volume Removed (gal)	Field Bromide Concentration at Start of Day (mg/L)	Field Bromide Concentration at End of Day (mg/L)	Turbidity Measurement at End of Day (mg/L)	Total Water Volume Removed (gal)
FW-29B (Drilling fluid Br conc 120 mg/L)						
05/19/10	4	2,000	82.7	66.8	705	11,300
05/20/10	4	3,000	57.4	24.6	4.1	
05/20/10	3	2,100	10.0	15.2	17.6	
05/20/10	2	2,100	10.6	11.8	7.9	
05/20/10	1	2,100	12.1	16.2	6.2	
					Cumulative Total =	11,300

Notes:

NM = Not measured.

Unshaded cells indicate preliminary well development using a 3" submersible pump in a 4-inch screened well casing.

Shaded cells indicate Westbay well development using a Wattera pump.

Table 2-3 (cont). Drilling fluid bromide concentrations and daily field bromide concentrations during well development.

Purge Date	Interval	Daily Water Volume Removed (gal)	Field Bromide Concentration at Start of Day (mg/L)	Field Bromide Concentration at End of Day (mg/L)	Turbidity Measurement at End of Day (mg/L)	Total Water Volume Removed (gal)
FW-29C (Drilling fluid Br conc 120 mg/L)						
05/18/10	1	2,200	21.0	21.6	1.24	
05/18/10	2	2,400	24.3	27.7	11.3	8,200
05/18/10	3	3,600	89.7	40.2	17.3	
					Cumulative Total =	8,200

Purge Date	Interval	Daily Water Volume Removed (gal)	Field Bromide Concentration at Start of Day (mg/L)	Field Bromide Concentration at End of Day (mg/L)	Turbidity Measurement at End of Day (mg/L)	Total Water Volume Removed (gal)
FW-30B (Drilling fluid Br conc 120 mg/L)						
03/27/10	4	3,225	68.3	34.1	NM	
03/28/10	4	1,650	77.5	24.9	NM	
03/28/10	3	2,190	27.4	12.8	NM	12,936
03/28/10	2	2,175	13.4	6.5	NM	
03/28/10	1	1,875	15.7	17.7	NM	
03/29/10	All	1,821	NM	NM	NM	
04/14/10	4	175	13.0	13.5	5.2	
04/14/10	3	175	27.4	43.2	50	
04/15/10	3	45	55.3	50.0	230	765
04/15/10	2	200	52.2	20.5	22	
04/15/10	1	50	40.5	68.9	40	
04/16/10	3	120	35.7	69.7	40	
					Cumulative Total =	13,701

Purge Date	Interval (ft-ft)	Daily Water Volume Removed (gal)	Field Bromide Concentration at Start of Day (mg/L)	Field Bromide Concentration at End of Day (mg/L)	Turbidity Measurement at End of Day (mg/L)	Total Water Volume Removed (gal)
FW-31BE (Drilling fluid Br conc 120 mg/L)						
03/30/10	218-239	2,100	0	0.01	NM	
03/30/10	198-219	2,100	41.2	92.9	NM	
03/30/10	178-199	1,400	14.2	27.8	NM	
03/30/10	158-179	1,200	35.0	48.5	NM	13,971
03/31/10	138-159	1,200	0	0	NM	
03/31/10	146.7-236.7	1,800	NM	NM	NM	
05/20/10*	146.7-236.7	4,171	NM	NM	NM	
					Cumulative Total =	13,971

Notes:

NM = Not measured.

Unshaded cells indicate preliminary well development using a 3" submersible pump in a 4-inch screened well casing.

Shaded cells indicate Westbay well development using a Wattera pump.

* Development was conducted as part of aquifer step-drawdown test.

Table 2-4. Well survey coordinates and elevations.

Well ID	Northing (ft)	Easting (ft)	Elevation (ft)		
			Ground *	Top of Westbay**	4" Metal Casing***
FW-27B	254223	2658291	179.9	182.08	181.93
FW-28B	254754	2658239	176.4	178.69	178.57
FW-29B	255616	2658088	163.1	N/A	162.76
FW-29C	255604	2658090	163.4	N/A	163.08
FW-30B	254255	2658690	177.1	179.39	179.27
FW-31BE	254556	2658211	178.7	N/A	180.80

Notes:

Horizontal datum (northing/easting) is NAD 83 State Plane coordinate system zone Florida North stated in U.S.

Horizontal accuracy is ± 1m (3.28 ft).

Elevation datum is NGVD 1929 stated in U.S. survey feet.

*Ground elevation measured 2 ft north of well

**Elevation on top north rim of 1.5" Westbay PVC pipe

***Elevation on top north rim of 4" metal well casing

Survey performed by: De Grove Surveyors, Inc. of Gainesville, Florida on 05/21/2010

Table 2-5. Water quality field parameter measurement for wells at completion of well zone purging.

Well Designation	Zone	Date	Purge Volume (gal)	Bromide (mg/L)	Turbidity (NTU)
FW-27B	1	4/15/2010	160	55.0	2.1
	2	4/14/2010	130	64.4	5.2
	3	4/13/2010	125	2.0	21
	4	4/13/2010	150	1.7	3.4
	5	4/12/2010	190	2.2	16
	6	3/29/2010	150	10.9	0.0
FW-28B	1	4/13/2010	115	2.1	18
	2	4/13/2010	177	1.3	9.2
	3	4/12/2010	396	15.9	3.9
	4	3/31/2010	211	0.7	0.4
FW-29B	1	5/20/2010	2,100	16.2	6.2
	2	5/20/2010	2,100	11.8	7.9
	3	5/20/2010	2,100	15.2	17.6
	4	5/20/2010	5,000	24.6	4.1
FW-29C	1	5/18/2010	2,200	21.6	1.24
	2	5/18/2010	2,400	27.7	11.3
	3	5/18/2010	3,600	40.2	17.3
FW-30B	1	4/15/2010	50	68.9	40
	2	4/15/2010	200	20.5	22
	3	4/16/2010	340	69.7	40
	4	4/14/2010	175	13.5	5.2
FW-31BE	NA	3/31/2010	8,000	0.0	NM

Notes:

NA = not applicable

NM = not measured

Table 4-1. Hydraulic-head measurements for the Upper Floridan Aquifer wells

Well I.D.	Date	Measuring Point Elevation (ft msl)[1]	Depth to Water (ft)	Pieziometric Elevation (ft msl)
FW-27B	6/8/2010	182.08	136.84	45.24
FW-28B	6/8/2010	178.69	133.64	45.05
FW-29B	5/19/2010	162.76	117.53	45.23
FW-29C	5/18/2010	163.08	117.70	45.38
FW-30B	4/14/2010	179.39	133.14	46.25
FW-31BE	6/8/2010	180.80	135.61	45.19

Notes: 1. Depth to water in FW-27B, FW-28B, and FW-30B measured from the top of the Westbay system with the Zone 1 purge port open.

Table 4-2. Upper Floridan Aquifer northwest area wells water quality results.

Constituent	Federal MCL (µg/L)	Florida GCTL[1] (µg/L)	Well ID FW-27B Zone 1	Zone 2	Zone 3	Zone 4	Zone 5*	Zone 6
Sample Date			6/23/2010	6/23/2010	6/24/2010	6/24/2010	6/24/2010	6/24/2010
VOCs								
Benzene	5	1 (2)	2.1	4.1	5.7	3.0	4.7	3.8
Ethylbenzene	700	30 (3)	U	U	U	U	1.2	U
Toluene	1,000	40 (3)	U	U	U	U	U	U
Xylenes (total)	10,000	20 (3)	2.8	2.8	5.5	2.9	6.0	4.8
SVOCs								
2,4-Dimethylphenol	-	140	U	U	U	U	U	U
2-Methylnaphthalene	-	28	25	130	80	59	50	46
2-Methylphenol	-	35	U	U	U	U	U	U
3&4-Methylphenol	-	35/3.5 (5)	U	U	U	U	U	U
Acenaphthene	-	20	39	98	62	68	70	54
Acenaphthylene	-	210	U	U	U	U	U	U
Anthracene	-	2,100	U	6.0	U	U	U	U
Carbazole	-	1.8	1.6	24	11	10	15	10
Dibenzofuran	-	28	19	60	38	36	35	35
Fluoranthene	-	280	U	7.1	U	U	U	U
Fluorene	-	280	24	68	45	44	41	38
Naphthalene	-	14	560 J	1,700 J	1,100 J	1,100 J	1,300 J	850 J
Phenanthrene	-	210	14	48	36	28	25	20
Phenol	-	10	U	U	U	U	U	U
Pyrene	-	210	2.1	U	U	U	U	U

Notes

U - Indicates analyte was not detected above the method detection limit (MDL)

J - Indicates result is estimated

* - Indicates average of duplicate samples

Concentration exceeds Florida GCTL

Concentration exceeds Fedral MCL

(1) Florida Groundwater Cleanup Target Levels (GCTLs) are guidelines as set forth in 62-777 Florida Administrative Code (F.A.C.)

(2) Florida GCTL is the Primary Drinking Water Standard as set forth in 62-550 F.A.C.

(3) Florida GCTL is the Secondary Drinking Water Standard as set forth in 62-550 F.A.C.

(4) Federal MCL is the Secondary Drinking Water Standard

(5) 3-Methylphenol and 4-Methylphenol cannot be quantified separately using USEPA SW-846 Method 8270C.

Table 4-2 (cont.). Upper Floridan Aquifer northwest area wells water quality results.

Constituent	Federal MCL (µg/L)	Florida GCTL[1] (µg/L)	Well ID					
			FW-28B				FW-29B	FW-29C
			Zone 1	Zone 2	Zone 3	Zone 4		
Sample Date			6/22/2010	6/22/2010	6/22/2010	6/22/2010	5/26/2010	5/26/2010
VOCs								
Benzene	5	1 (2)	U	U	U	U	U	U
Ethylbenzene	700	30 (3)	U	U	U	U	U	U
Toluene	1000	40 (3)	U	U	U	U	U	U
Xylenes (total)	10000	20 (3)	U	U	U	U	U	U
SVOCs								
2,4-Dimethylphenol	-	140	U	U	U	U	U	U
2-Methylnaphthalene	-	28	U	U	U	U	U	U
2-Methylphenol	-	35	U	U	U	U	U	U
3&4-Methylphenol	-	35/3.5 (5)	U	U	U	U	U	U
Acenaphthene	-	20	U	U	U	U	U	U
Acenaphthylene	-	210	U	U	U	U	U	U
Anthracene	-	2,100	U	U	U	U	U	U
Carbazole	-	1.8	U	U	U	U	U	U
Dibenzofuran	-	28	U	U	U	U	U	U
Fluoranthene	-	280	U	U	U	U	U	U
Fluorene	-	280	U	U	U	U	U	U
Naphthalene	-	14	U J	U J	U J	U J	U	U
Phenanthrene	-	210	U	U	U	U	U	U
Phenol	-	10	U	U	U	U	U	U
Pyrene	-	210	U	U	U	U	U	U

Notes

U - Indicates analyte was not detected above the method detection limit (MDL)

J - Indicates result is estimated

* - Indicates average of duplicate samples

Concentration exceeds Florida GCTL

Concentration exceeds Fedral MCL

(1) Florida Groundwater Cleanup Target Levels (GCTLs) are guidelines as set forth in 62-777 Florida Administrative Code (F.A.C.)

(2) Florida GCTL is the Primary Drinking Water Standard as set forth in 62-550 F.A.C.

(3) Florida GCTL is the Secondary Drinking Water Standard as set forth in 62-550 F.A.C.

(4) Federal MCL is the Secondary Drinking Water Standard

(5) 3-Methylphenol and 4-Methylphenol cannot be quantified separately using USEPA SW-846 Method 8270C.

Table 4-2 (cont.). Upper Floridan Aquifer northwest area wells water quality results.

Constituent	Federal MCL (µg/L)	Florida GCTL[1] (µg/L)	Well ID				
			FW-30B				FW-31BE
			Zone 1	Zone 2	Zone 3	Zone 4	
Sample Date			7/13/2010	7/13/2010	7/13/2010	7/13/2010	6/29/2010
VOCs							
Benzene	5	1 (2)	U	U	U	U	U
Ethylbenzene	700	30 (3)	U	U	U	U	U
Toluene	1000	40 (3)	U	U	U	U	U
Xylenes (total)	10000	20 (3)	U	U	U	U	U
SVOCs							
2,4-Dimethylphenol	-	140	U	U	U	U	U
2-Methylnaphthalene	-	28	U	U	U	U	U
2-Methylphenol	-	35	U	U	U	U	U
3&4-Methylphenol	-	35/3.5 (5)	U	U	U	U	U
Acenaphthene	-	20	U	U	U	U	23
Acenaphthylene	-	210	U	U	U	U	U
Anthracene	-	2,100	U	U	U	U	U
Carbazole	-	1.8	U	U	U	U	U
Dibenzofuran	-	28	U	U	U	U	U
Fluoranthene	-	280	U	U	U	U	U
Fluorene	-	280	U	U	U	U	U
Naphthalene	-	14	U	U	U	U	50
Phenanthrene	-	210	U	U	U	U	U
Phenol	-	10	U	U	U	U	U
Pyrene	-	210	U	U	U	U	U

Notes

U - Indicates analyte was not detected above the method detection limit (MDL)

J - Indicates result is estimated

* - Indicates average of duplicate samples

Concentration exceeds Florida GCTL

Concentration exceeds Fedral MCL

(1) Florida Groundwater Cleanup Target Levels (GCTLs) are guidelines as set forth in 62-777 Florida Administrative Code (F.A.C.)

(2) Florida GCTL is the Primary Drinking Water Standard as set forth in 62-550 F.A.C.

(3) Florida GCTL is the Secondary Drinking Water Standard as set forth in 62-550 F.A.C.

(4) Federal MCL is the Secondary Drinking Water Standard

(5) 3-Methylphenol and 4-Methylphenol cannot be quantified separately using USEPA SW-846 Method 8270C.

Table 4-3. FW-31BE constant-rate test and recovery analysis summary.

		Transmissivity (T)		Hydraulic Conductivity (K)		Storage Coefficient
		cm^2/sec	ft^2/day	cm/sec	ft/day	dimensionless
Constant-Rate Test (Drawdown)						
FW-31BE	Hantush (1960)	1.22	113.0	3.99E-04	1.13	N/A
	Moench (1985)	3.41	316.6	1.12E-03	3.17	N/A
FW-22B	Hantush (1960)	144.7	13,452.2	4.75E-02	134.6	5.06E-03
	Moench (1985)	144.7	13,452.2	4.75E-02	134.6	5.02E-03
FW-28B	Hantush (1960)	159.5	14,828.1	5.23E-02	148.3	3.32E-04
	Moench (1985)	159.7	14,846.7	5.24E-02	148.5	3.32E-04
Constant-Rate Test (Recovery)						
FW-22B	Hantush (1960)	15.28	1,420.5	5.01E-03	14.2	3.28E-04
	Moench (1985)	16.54	1,537.7	5.43E-03	15.4	6.25E-05
FW-28B	Hantush (1960)	0.76	70.5	2.49E-04	0.7	1.14E-06
	Moench (1985)	6.46	600.1	2.12E-03	6.0	1.03E-05
*2004 Calibrated Groundwater Flow Model**						
Calibrated Model Parameters				8.10E-03	23.0	8.50E-04 to 1.05E-03

Notes:

UTZ aquifer thickness (b) = 100 feet

N/A = not applicable

* - GeoTrans, 2004