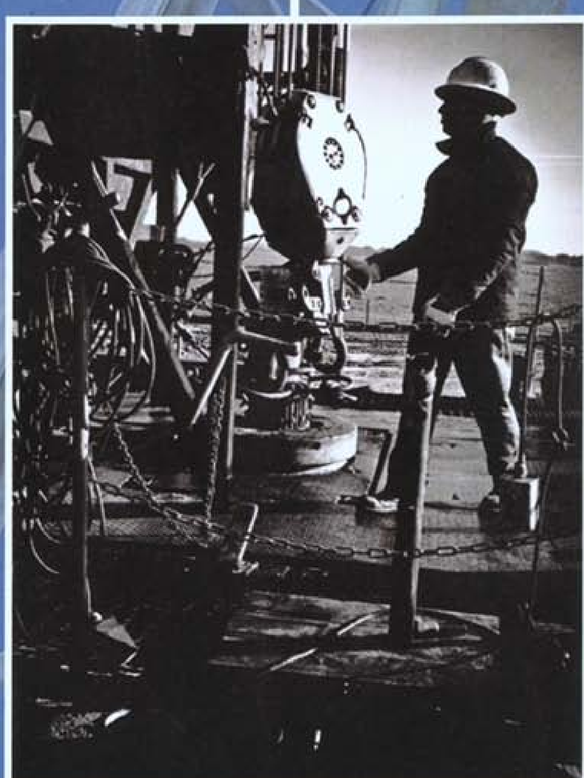
Toho Water Authority

TOHOPEKALIGA WATER AUTHORITY CHAPMAN SITE EXPLORATORY TEST WELLS WELL CONSTRUCTION AND TESTING SUMMARY REPORT

March 2011

Volume 1



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TOHOPEKALIGA WATER AUTHORITY
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

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ACRONYMS AND ABBREVIATIONS

APPZ	Avon Park Permeable Zone
AWS	Alternative Water Supply
BLS	below land surface
Bronson (Site)	Test Location No. 1 or “Cypress Lake”
BZ	Boulder Zone within Lower Floridan Aquifer
CFCA	Central Florida Coordination Area
Chapman (Site)	Test Location No. 2 or “Double C Bar Ranch”
CRDT	constant rate discharge test
CY	cubic yards
ºC	temperature in degrees Celsius
ºF	temperature in degrees Fahrenheit
DZMW-A1	Dual-Zone Monitor Well (TZMW-A1 during construction)
EDS	Environmental Drilling Services, Inc.
FAC	Florida Administrative Code
FAS	Floridan Aquifer System
FDD	Florida Design Drilling Corporation, Inc.
FDEP	Florida Department of Environmental Protection
FGS	Florida Geological Survey
ft/day	feet per day (a unit of hydraulic conductivity)
ft/day/ft	feet per day per foot (a unit of leakance)
ft^2/day	feet squared per day (unit of transmissivity)
GEC	Geotechnical and Environmental Consultants, Inc.
gpm	gallons per minute
ICU	Intermediate Confining Unit
LC1	Lower Confining Unit – upper zone
LF1	Lower Floridan Aquifer – upper flow zone
LF2	Lower Floridan Aquifer – lower flow zone
LFA	Lower Floridan Aquifer
LFAS	Lower Floridan Aquifer System
LFMW-A2 / LFMW-A3	Lower Floridan Aquifer Monitor Well

ACRONYMS AND ABBREVIATIONS (Continued)

MC1	Middle Semi-Confining Unit – upper zone
MC2	Middle Semi-Confining Unit – lower zone
MCL	maximum contaminant level
mg/L	milligrams per liter
mV	millivolts potential
ND	nominal diameter
ppm	parts per million (mass or volume, as stated)
SAS	Surficial Aquifer System
SDT	step drawdown test
SFWMD	South Florida Water Management District
SJRMWD	St. Johns River Water Management District
SMW-A1 / SMW-A2 / SMW-A3	Surficial Aquifer Monitor Well
STOPR	St. Cloud, Tohopekaliga, Orange County, Polk County, and Reedy Creek Utilities
SWFWMD	Southwest Florida Water Management District
t/r^2	quotient of time divided by the square of radial distance
TDS	total dissolved solids
Toho	Tohopekaliga Water Authority
TPW-A1	Lower Floridan Aquifer Test/Production Well
TZMW-A1	Tri-Zone Monitor Well
UFA	Upper Floridan Aquifer
UFAS	Upper Floridan Aquifer System
UFMW-A1	Upper Floridan Aquifer Monitor Well
USGS	United States Geological Survey
VFD	variable-frequency drive
WWS	Wells and Water Systems, Inc.

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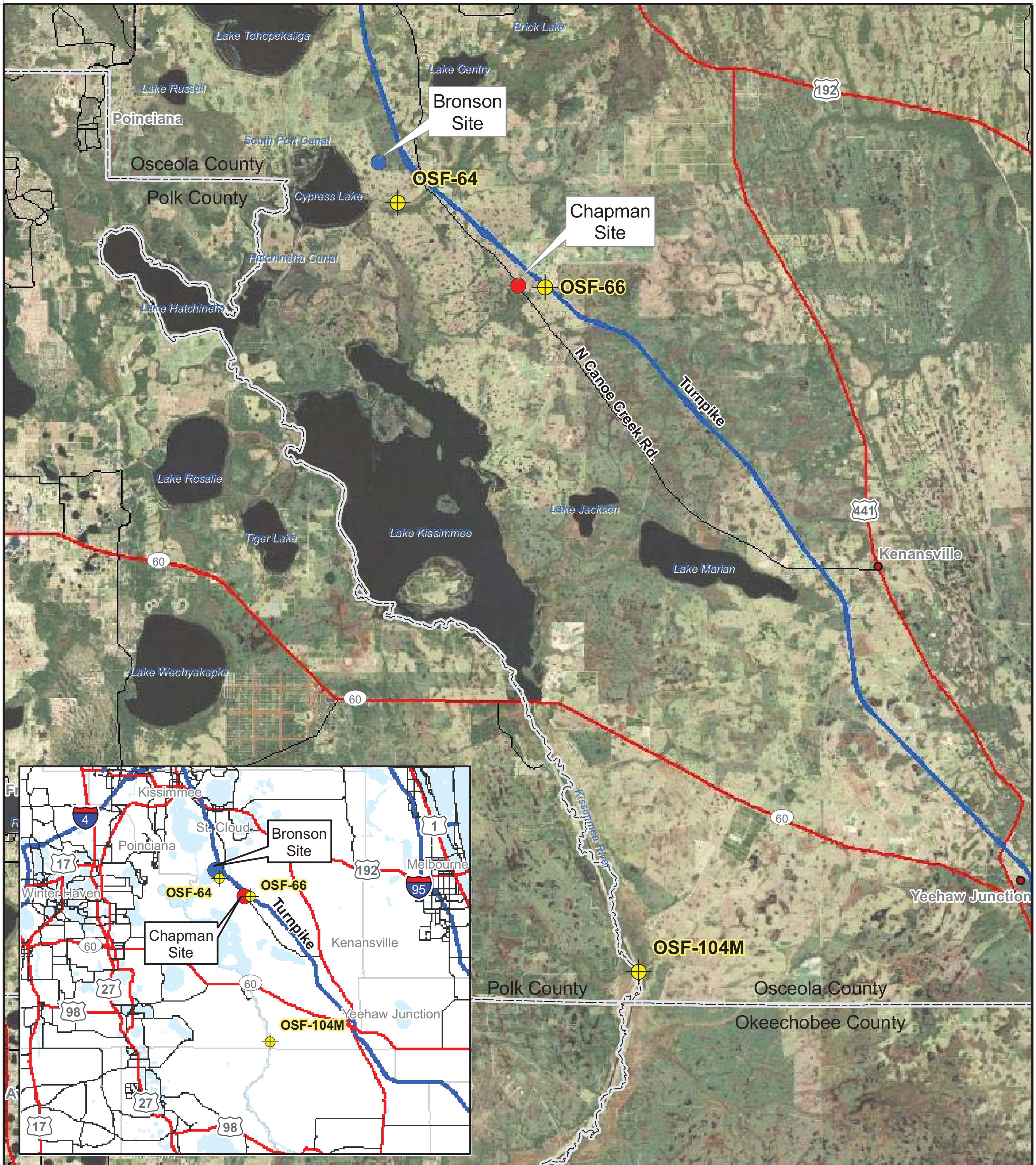
EXECUTIVE SUMMARY

Use of groundwater in Osceola County is regulated in the South Florida Water Management District (SFWMD) by Ch. 40E-2 and in the St. Johns River Water Management District (SJRWMD) by Ch. 40C-2. Due to concerns over availability of groundwater from the Upper Floridan aquifer, SFWMD, SJRWMD, and Southwest Florida Water Management District (SWFWMD) developed an action plan and the interim permitting rules for the Central Florida Coordination Area (CFCA). Within the CFCA, interim rules of the SFWMD require that all demands in excess of the 2013 demand shall be met using supplemental water supplies, or, as identified in the 2006 Action Plan, alternative water supplies (AWS). Consequently, public water supply utilities in central Florida must investigate lower quality sources, or sources not previously considered suitable for public water supply. To assure a reliable supply, to meet future demand, and to minimize potential impacts of groundwater pumpage by redistributing pumpage to less sensitive locations within their water service area, the Tohopekaliga Water Authority (Toho) is investigating the feasibility of constructing an AWS wellfield – the Cypress Lake Wellfield Testing Program.

In 2006, Toho authorized Tetra Tech to investigate aquifer hydraulic properties and groundwater quality in a portion of central Osceola County. The first test was located east of Cypress Lake near Canoe Creek Road (Bronson site). Testing at the Bronson site determined that water quality and aquifer hydraulic properties in potential producing zones of the Lower Floridan aquifer (LFA) were adequate for development of a water supply wellfield. Testing at the Bronson site also produced data sufficient for local refinement and confirmation of calibration of a regional groundwater flow model for design and permitting of an AWS wellfield.

In early 2009, Toho submitted to the SFMWD an application for a WUP based on the positive results of the testing program at the Bronson site. The SFWMD postponed further review of the application pending the results of scheduled testing at a second site located near the southern end of the proposed wellfield as illustrated in **Figure ES-1**. Additional testing was required to confirm water quality in the LFA, to confirm the depth to the LFA, and to determine the values of hydraulic properties of the LFA and other hydrogeologic units that could influence computation of drawdown impacts. In 2009, Toho, and retroactively their regional utility partners in the STOPR group, authorized an investigation of the physical and geochemical properties at the southern end of the proposed wellfield.



LEGEND

- Chapman Site
- Bronson Site
- Regional Observation Well

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TETRA TECH

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Miles

CHAPMAN AND BRONSON SITES LOCATION MAP
TOHOPEKALIGA WATER AUTHORITY
CHAPMAN SITE EXPLORATORY TEST WELLS
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ES - 1

The second test site, the Chapman site, is located east of Canoe Creek Road approximately seven miles southeast of the Bronson site, as illustrated in **Figure ES-2**. Although the testing at Bronson provided valuable data, changes, some of which were suggested by SFWMD scientists, were made to collect additional data from selected intervals, and to minimize the possibility of interference from other intervals during testing. Differences between the testing program at the Bronson site and the Chapman site include:

- Greater separation between the LFA test/production well and the LFA observation wells to allow testing of a greater volume of the aquifer and to make the observed aquifer responses more suitable for model calibration;

- Monitoring of additional aquifer intervals to observe the magnitude of drawdown in the Upper Floridan aquifer (UFA) and in the underlying Avon Park permeable zone (APPZ) in response to pumping from the LFA;

- Testing of an additional aquifer, the APPZ, to estimate the transmissivity of the APPZ;

- More frequent collection of water level data during drilling of the test production well to assist in identification of the contact between the lower zone of the middle confining unit (MC2) and the LFA ;

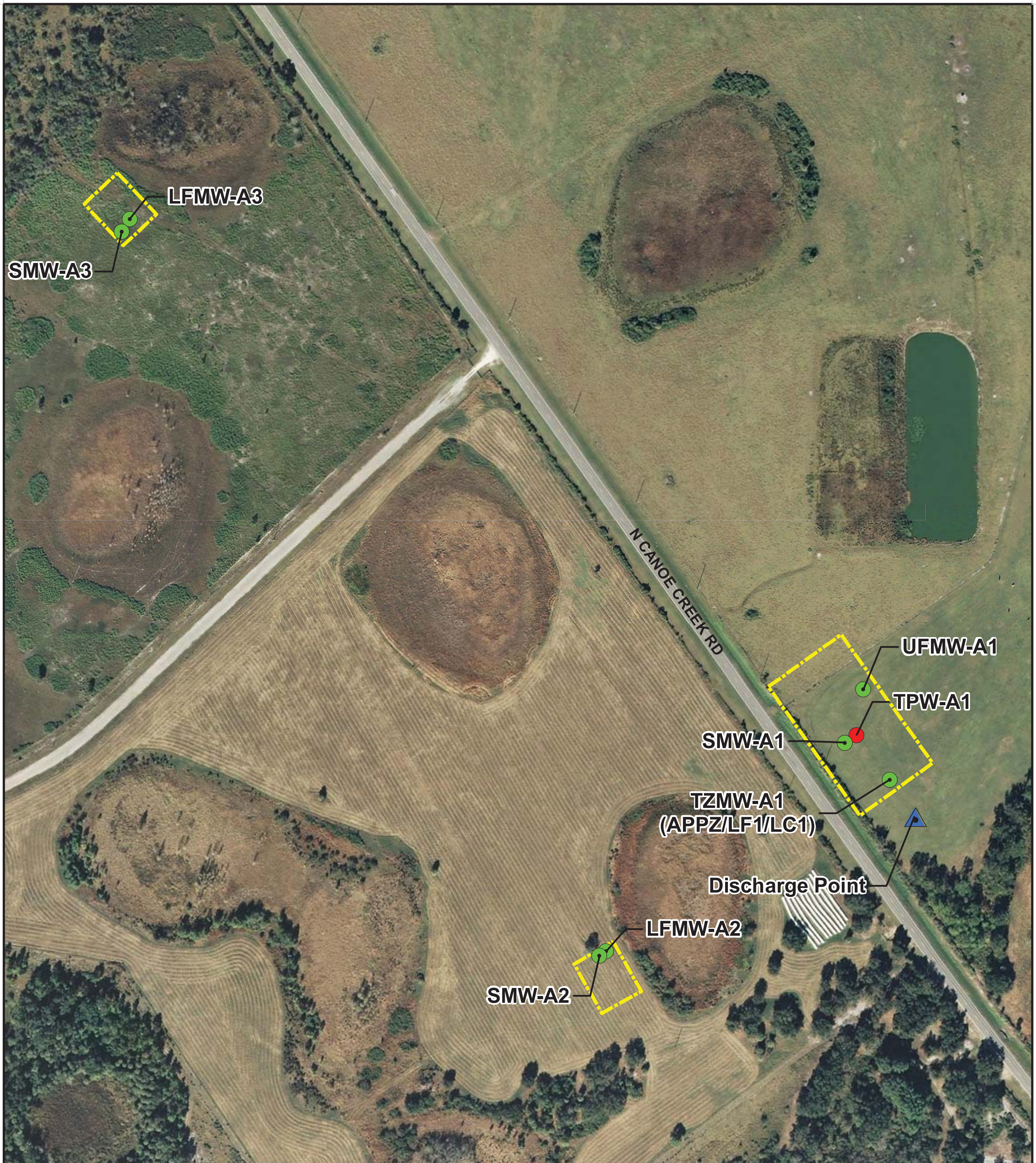
- Isolation of highly productive intervals of the UFA and the APPZ to assist in collection of representative water quality samples during drilling in the LFA;

- Use of single element packer tests to minimize the influence on the tested interval of water from elsewhere in the borehole.

Overall, the testing program at Chapman comprised:

- Construction and logging of an UFA observation well;

- Construction and logging of an LFA exploratory test/production well;



Source: Oscoela County 2008 Aerial Imagery

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LEGEND

- Test Production Well
- Monitor Well
- Discharge Point
- Site Boundary

TETRA TECH

0 N 300
Feet

CHAPMAN SITE WELL LOCATION MAP
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- Construction and logging of an LFA tri-zone observation well (originally designed as a dual-zone monitor well) completed in the Avon Park permeable zone (APPZ), the LFA production zone (LF1), and in the underlying lower confining unit (LC1);

- Sampling for field and laboratory analysis of groundwater during drilling;

- Sampling and analysis of groundwater from selected intervals during packer tests;

- Construction and logging of two additional LFA production zone observation wells;

- Execution and analysis of constant rate discharge tests (CRDT) in the UFA (including the APPZ) and in the LFA;

- Construction of three surficial aquifer monitor wells;

- Sampling for field and laboratory analysis of groundwater during the LFA CRDT;

- Analysis of aquifer testing data to determine aquifer hydraulic properties.

The well drilling sequence and aquifer testing was conducted in three phases to allow targeted determination of important aquifer hydraulic properties of the UFA, the overlying intermediate confining unit (ICU), the underlying APPZ, the middle semi-confining unit or (MC1), the LFA, and the lower confining unit (LC1). Each aquifer testing phase followed completion of the test production well to the expected base of significant aquifer units. The first phase ended with a 24-hour CRDT in the UFA; the second phase ended with a 24-hour CRDT in the UFA and APPZ; and the third phase ended with the 14-day CRDT in the LFA.

Well construction and aquifer testing at the Chapman site provided hydrogeologic data that was previously unavailable for this portion of Osceola County. Hydrogeologic data obtained from well construction and aquifer testing of the wells at the Chapman site includes the following:

- The top of the Floridan aquifer system (FAS) is at a depth of 310 feet below land surface (BLS) at the Chapman Site.

- The mean (or average) transmissivity value for the UFA (not including the APPZ) using only onsite wells TPW-A1 and UFMW-A1 is approximately 9,100 ft2/day, the mean storativity value is approximately 8.7 x 10-5 (commonly shown as dimensionless) and the mean combined leakance value of the overlying and underlying confining units is approximately 8.7 x 10-5 ft/day/ft. The mean transmissivity value for the UFA calculated using the onsite wells and OSF-66, is approximately 19,000 ft2/day, the mean storativity value is approximately 0.00012 and the mean leakance value is approximately 0.00020 ft/day/ft.

- The MC1 occurs from 440 to 697 feet BLS.

- The APPZ occurs from 697 to 1,190 feet BLS.

- The mean transmissivity value for the UFAS (including the APPZ) calculated using only drawdown data at well TPW-A1 is approximately 150,000 ft2/day. Storativity and leakance values could not be calculated from this test since no observation wells monitored the same interval as the pumping well.

- The MC2 occurs from 1,190 to 1,305 feet BLS.

- Aquifer performance testing, lithologic logs, geophysical logs, and borehole video logs indicate that the Upper Floridan aquifer system (UFA and APPZ), has good production capacity with a correspondingly high value of transmissivity. Specific capacity values from the UFMW-A1 SDT (UFA) range from 13 to 16 gpm/ft at pumping rates between 209 and 412 gpm and with measured drawdown between 13.01 to 32.33 feet. Specific capacity from CRDT No. 1 (UFA and APPZ) was 25 gpm/ft at a pumping rate of 1,350 gpm and with measured drawdown of 53 feet.

- The top of the Lower Floridan aquifer (LFA), as indicated by lithologic and geophysical logs occurs at a depth of 1,305 feet BLS, and units of the lower Floridan aquifer extended to the deepest penetration of the pilot hole boring at a depth of 2,362 feet BLS (with open intervals of the boulder zone present from 1,965 to 2,235feet BLS).

- Aquifer performance testing, lithologic logs, geophysical logs, and borehole video logs indicate that the production zone (LF1) of the LFA at the Chapman Site (1,305 to 1,610 feet BLS) has very good production capacity with a correspondingly high value of transmissivity.

- Testing of well TPW-A1 while open in Lower Floridan aquifer (LF1) indicates a specific capacity value of 62 gpm/ft at a pumping rate of 2,179 gpm with measured drawdown of 35 feet.

- At a discharge of 2,179 gpm from the LFA test/production well (TPW-1A), equilibrium drawdown in the observation well at a distance of 124 feet is approximately 8.2 feet; at a distance of 732 feet is approximately 5.0 feet; and at 1,982 feet is approximately 3.1 feet. Extrapolating drawdown over the extent of the proposed Cypress Lake wellfield, the maximum interference at any well will be approximately nine feet.

- The mean (or average) LF1 transmissivity is approximately 37,000 ft2/day, the mean storativity is 9.0 x 10-5, and the mean leakance of the overlying and underlying semi confining units is 0.0004 ft/day/ft.

- Drawdown was not detected in the LC1 during the 14-day CRDT at the tri-zone monitor well (TZMW-A1) at a distance of 124 feet.

- Drawdown in the UFA at well UFMW-A1 and in the UFA observation interval of well TPW-A1 was not detected during the 14-day constant rate discharge test.

- The APPZ zone of tri-zone monitoring well TZMW-A1 recorded an immediate response to pumping, which reached equilibrium after approximately 2½ days of pumping. The equilibrium drawdown was 0.1 feet.

- Based upon the results of the Upper and Lower Floridan aquifer testing and water quality analyses, a long-term production rate of 3.125 million gallons per day per production well is feasible at the Chapman site. Water quality results indicate additional treatment is required to improve water quality to primary and secondary drinking water standards.

- Based upon the results of the Upper and Lower Floridan aquifer testing and water quality analyses, a long-term production rate of 3 million gallons per day per production well is feasible at the Chapman site. Water quality results indicate additional treatment is required to improve water quality to primary and secondary drinking water standards.

- Groundwater collection and laboratory analysis at the Chapman site produced the following results:

Hydrogeologic Unit	Well ID	Chloride (mg/L)	TDS (mg/L)	Iron (mg/L)
Upper Floridan	UFMW-A1	15	160	0.27
APPZ	*TPW-A1	46	360	0.26
LF1	TPW-A1	470	1,100	0.039

*Results from Packer Test #1 at TPW-A1

From these results, the following can be asserted:

- The absence of drawdown in LC1 and the rapid response to pumping in APPZ indicates that APPZ is the source bed for leakage into LF1 during pumping.

- The absence of drawdown response in LC1 indicates there is little potential for upconing of saline water into the production zone.

- Absence of drawdown response after 14 days in wells at the Bronson site indicates discharge of water from the production zone during pumping reaches equilibrium with a local source of leakage.

- The testing results at the Chapman site near the southern end of the proposed Cypress Lake wellfield differ from the Lower Floridan aquifer results at the Bronson site near the northern end with respect to water quality identified during well construction, packer testing, and during aquifer testing. Water quality results identified higher chloride, sulfate, specific conductance, and TDS at the Chapman site that subsequently will require additional treatment to meet public supply standards.

It is feasible for the proposed Cypress Lake wellfield to sustain a long-term discharge of 3 million gallons per day per production well, therefore, evaluation of treatment options is recommended.

The results of this exploratory and testing program will be incorporated as aquifer parameters and calibration targets into the Cypress Lake MODFLOW model constructed in support of the Cypress Lake AWS Wellfield WUP application. Changes to the Cypress Lake MODFLOW model, and the results of modeling of wellfield impacts using the revised model, are addressed in a separate modeling report.

SECTION 1
INTRODUCTION

1.1 General

As a requirement for obtaining a WUP, the SFWMD is requiring that all demands in excess of the 2013 demand shall be met with alternative water supplies in the future, as required by the CFCA interim rules. Consequently, public water supply utilities in central Florida must investigate lower quality sources, or sources not previously considered suitable for public water supply. To assure a reliable supply, to meet future demand, and to minimize potential impacts of groundwater pumpage by redistributing pumpage to less sensitive areas of their water service areas, Toho has undertaken such an investigation with the Cypress Lake Program Exploratory Wellfield.

In 2007, Toho authorized Tetra Tech to investigate aquifer hydraulic properties and groundwater quality in a portion of central Osceola County. The first test was located east of Cypress Lake near Canoe Creek Road (Bronson site). Testing at the Bronson site determined that water quality and aquifer hydraulic parameters in potential producing zones in the lower Floridan aquifer (LFA) were adequate for development of a water supply wellfield. Testing at the Bronson site also produced data sufficient for local refinement and confirmation of calibration of a regional groundwater flow model that was used to design an alternative water supply (AWS) wellfield.

In early 2009, Toho submitted to the SFWMD an application for a WUP based on the positive results of the testing program at the Bronson site. The District withheld approval of the application pending the results of testing at a second site located near the southern end of the proposed wellfield. Additional testing was required to confirm water quality in the LFA, to confirm the depth to the LFA, and to determine the values of hydraulic properties of the LFA and other hydrogeologic units that could influence computation of drawdown impacts. In 2009, Toho, and retroactively their partners in the STOPR group of utilities, authorized an investigation of the physical and geochemical properties at the southern end of the proposed wellfield.

The second test site, the Chapman site, is located east of Canoe Creek Road approximately seven miles southeast of the Bronson as shown on **Figure 1-1**.

Although the testing at Bronson provided valuable data, several changes, some of which were suggested by District scientists, were made to collect additional data from selected intervals, and to minimize the possibility of interference from other intervals. Recommended changes to the aquifer testing project at the Chapman site include:

- Greater separation between the LFA test production well and the LFA observation wells to allow testing of a greater volume of the aquifer and to make the observed aquifer responses more suitable for model calibration;

- Monitoring of additional aquifer intervals to observe the magnitude of drawdown in the Upper Floridan aquifer (UFA) and in the underlying Avon Park permeable zone (APPZ) in response to pumping from the LFA;

- Testing of an additional aquifer, the APPZ, to estimate the transmissivity of the APPZ;

- More frequent collection of water level data during drilling of the test production well to assist in identification of the contact between the upper zone of the middle confining Unit (MC1);

- Isolation of highly productive intervals of the UFA and the APPZ during drilling in the LFA to assist in collection of representative water quality samples in the LFA;

- Use of single element packer tests to minimize the influence on the tested interval of water from elsewhere in the borehole.

Acceptable water quality, and the presence of at least two productive aquifers (UFA and APPZ) and at least three confining beds between the production zone and the surficial aquifer, suggest that the LF1 aquifer is likely to be suitable for development of an AWS wellfield. The results of this exploratory and testing program will be incorporated as aquifer parameters and calibration targets into the Cypress Lake MODFLOW model constructed in support of the Cypress Lake AWS Wellfield WUP application. Changes to the Cypress Lake MODFLOW model, and the results of modeling of wellfield impacts using the revised model, are addressed in a separate report.

1.2 Background

The SFWMD, St. Johns River Water Management District (SJRWMD), and Southwest Florida Water Management District (SWFWMD) concluded that sustainable quantities of fresh groundwater in central Florida may be insufficient to meet all future public water supply demands, and that there was an immediate need to develop alternative water supply projects within this area. The CFCA includes Osceola, Polk, Orange, and Seminole counties, as well as south Lake County. Portions of the CFCA fall within the SFWMD, SJRWMD, and SWFWMD, and the Districts developed an Action Plan to investigate the availability of water resources within the CFCA. The Districts also adopted interim rules to address permitting actions in one district that could affect water resources and water users throughout the area. The interim rules limit future fresh groundwater withdrawals to no more than that needed to meet 2013 demands. Additional supply beyond 2013 must be developed from alternative water supply (AWS) projects. The interim rules will sunset on December 31, 2012.

The CFCA rules and Toho's current WUP prompted Toho to seek implementation of AWS projects to identify additional water resources to meet demands beyond 2013. Since the Toho service area falls within the CFCA and the UFA is classified as a source of limited availability, the SFWMD will permit future projects using groundwater from the UFA for a duration of five years or less. The permit duration for projects that seek withdrawal from an aquifer that is not a source of limited availability can be as long as 20 years. With the goal to identify alternative sources, Toho specified that the aquifer testing project should determine water quality and aquifer hydraulic parameters in potential producing zones in the LFA. A second goal was to produce data sufficient for local refinement or confirmation of calibration of a regional groundwater flow model that will be used to design and permit an AWS wellfield. Therefore, Toho chose to seek an AWS project with withdrawals from the LFA to provide supplemental supply beyond 2013, to obtain a 20-year permit for the water use, and to comply with conditions of their current WUP.

Testing at the Bronson site determined that water quality and aquifer hydraulic parameters in potential producing zones in the LFA were adequate for development of a water supply wellfield. Testing at the Bronson site also produced data sufficient for local refinement and confirmation of calibration of a regional groundwater flow model that was used to design an AWS wellfield.

Several uncertainties remain following completion of testing and analyses at the Bronson site. Water quality was better than expected and head differential between units of the UFA and LFA was less than expected. SFWMD scientists attributed these discrepancies to the sequence of construction and testing, and to the production interval of the test and observation wells. Well construction was completed into a productive portion of the aquifer that was believed to be fully within the LFA. Geophysical and video logs as well as lithologic data from the proposed production zone interval at the Bronson site were also reviewed by SFWMD scientists, who initially agreed with Tetra Tech's assessment of the UFA/LFA boundary, and the proposed depth of the casing and open borehole production zone. After review of the well construction and testing report from the Bronson site, the District believes that the Bronson production interval, from 1,020 to 1,500 feet BLS, is open to an unnamed permeable interval in the lower part of the UFA (a part of MC2), as well as to the upper part of the LFA. Toho also recognized a second group of uncertainties – the extent of freshwater in the LFA and the water quality elsewhere in the proposed Cypress Lake wellfield. Additional testing was needed to resolve questions about water quality changes with depth. Therefore, testing at the Chapman site was developed to address these issues.

1.3 Project Scope

Testing at the Chapman site will produce site-specific data from the southern end of the proposed Cypress Lake wellfield. These data include the hydraulic properties (transmissivity, storativity, and leakance) of the UFAS and LFAS that are needed to confirm the values used in the Cypress Lake MODFLOW model, and water quality measurements to determine the level of treatment needed to meet public supply standards.

Calibration of the regional model to aquifer performance tests requires reliable data; therefore, CRDTs were designed to record drawdown response at as many locations as practical. We observed drawdown at four locations in LF1, three locations in the UFA, and at one location each in the APPZ and LC1 during the LF1 CRDT. To predict better the range of likely regional impacts, the observation wells are not collinear, nor are they so distant that we could not accurately measure drawdown. Distances to those stations ranged from zero feet (at TPW-A1) to 1,981 feet at the most distant LF1 observation well (LFMW-A3), and 5,317 feet to the most distant UFA observation well (OSF-66).

Model calibration also requires data to constrain the values of aquifer properties that affect vertical movement of groundwater. Because head responses in regional models are sensitive to leakance, observation wells were included to monitor drawdown in the hydrogeologic units that overlie and underlie the pumped aquifer. The testing program collected data to estimate the hydraulic properties of the UFAS and LFA during three separate CRDTs, three step-drawdown tests, and six packer tests. The two UFAS tests produced properties for the UFA and the APPZ including a total leakance into the UFA (the sum of ICU and MC1 leakance). Undisturbed sediment (Shelby tube) samples were collected from the intermediate confining unit (ICU) for vertical permeability testing. The LF1 CRDT produced data that will be used to calculate hydraulic properties for the UFA, the upper zone of the middle semi-confining unit (MC1), the APPZ, the lower zone of the middle semi-confining unit (MC2), the upper flow zone of the LFA (LF1), and the upper zone of the lower confining unit (LC1). Packer testing provided data on the hydrologic response to pumping in MC2, LF1, LC1, and the BZ. The testing program was conducted in phases that coincided with drilling progress to allow concurrent measurement of water quality and hydraulic properties of the hydrogeologic units present at the site.

Tetra Tech designed and executed the aquifer testing program. Overall, the testing program consisted of:

- Construction and logging of an UFA observation well;
- Construction and logging of an LFA exploratory test/production well (TPW-A1) with annular observation of the UFA during the LF1 CRDT;
- Construction and logging of a LFA tri-zone monitor well (originally designed as a dual-zone monitor well) completed in the Avon Park permeable zone (APPZ), in the LFA production zone (LF1), and in the underlying confining unit (LC1);
- Construction and logging of two additional LF1 production zone observation wells;
- Sampling and analysis of groundwater during drilling;
- Single element packer tests of six depth intervals during drilling
- Sampling and analysis of groundwater from each interval during interval packer testing;

- Execution and analysis of constant rate discharge tests (CRDT) in the UFA, in the UFAS (combined UFA, MC1, and APPZ), and in the LFA (LF1);

- Construction of three surficial aquifer monitor wells.

1.4 Project Location

The Chapman Site is located in central Osceola County, approximately 3 miles north of the intersection of North Canoe Creek Road (CR 523) and Joe Overstreet Road, as shown on **Figure 1-1.** The Chapman Site is located in Section 22, Township 28 South, Range 31 East, on property owned by the Double C Bar Ranch Corporation. Toho has obtained an easement for the well site and wellhead protection radius from the property owner. The Lower Floridan exploratory test/production well site consists of a 1.15 acre fenced area on the east side of CR 523 with two small parcels on the southwest side of CR 523 with observation monitor wells constructed into the LFA.

1.5 Regional Hydrogeologic Framework

In this report, and during this project, we employ commonly used terminology for the aquifers and confining beds of the Floridan aquifer system (FAS) and overlying units. Descriptions in the literature are varied, and to some extent, are colloquial. Descriptions of these units and their component geologic formations as we used them in this report are summarized below. This report uses the hydrogeologic nomenclature of the SFWMD for clarity of comparison to other test sites and to District modeling efforts. **Figure 1-2** provides a summary of the hydrogeologic units, associated geologic units, short lithologic description, and associated marker units of subsurface geology in central and southern Florida, as described by Reese and Richardson (2008).

The surficial aquifer system (SAS) comprises reworked and primarily siliciclastic marine sediments. Groundwater from the SAS is not generally used for large irrigation or public supply uses, but it is a source for small irrigation systems and domestic self-supply wells. The ICU comprises, primarily, upper Miocene to Pliocene Series clay-rich sediments with most of the ICU confining beds being of the Miocene Series. Some intervals within SAS or ICU may be locally used for domestic self-supply and irrigation.

In contrast, the UFAS is a very important source of water for irrigation, public supply (Toho, the City of St. Cloud, and several nearby sod farms, for example), commercial/industrial supply, and domestic self-supply. The UFAS comprises the permeable and highly productive portions of the Ocala Limestone (Late Eocene Series) and Avon Park Formation (Middle Eocene Series). Matrix permeability within portions of the UFA is high, and secondary porosity features such as cavities and conduits in the Ocala Limestone and fractures and conduits in the Avon Park Formation increase overall permeability. Local experience indicates that the APPZ near the Chapman site is highly productive, and several irrigation wells in the area produce from that zone. Reese and Richardson speculate on the depth to the LFA and included units, but as discussed above, no wells penetrate to the LFA near the Chapman site, that could be used, prior to this exploratory program, to confirm that speculation

1.6 Acknowledgements

Tetra Tech and the Tohopekaliga Water Authority would like to acknowledge the funding assistance of the SFWMD and the cooperation of the Chapman Family who allowed access to the Double C Bar Ranch for drilling and aquifer testing.

SECTION 2
PHYSICAL INVESTIGATION

2.1 Introduction

Aquifer performance testing is a directed activity designed to collect information for a specific purpose. The term is used inclusively; aquifer performance testing includes all field activities that produce data about the aquifer. It comprises drilling, collecting lithologic and groundwater samples, performing geophysical and borehole video logging, as well as step-drawdown testing, packer testing, and constant rate discharge testing. The first three record physical or chemical properties of the aquifer matrix and groundwater, whereas the latter three are pumping tests that primarily record aquifer responses to known stresses. Florida Design and Drilling (FDD) was the prime contractor for drilling and testing at the Chapman site. Water level observations in several wells occurred throughout the project: FDD recorded water level in the well at the start of each shift during drilling of the test/production well (TPW-A1). This section describes the physical portion of the investigation.

The previous APT investigated conditions near the northern end of the proposed Cypress Lake wellfield at the Bronson site. Aquifer performance testing at the Chapman site produced site-specific data from the southern end. These data include the hydraulic properties (transmissivity, storativity, and leakance) of the UFAS and LFAS that are needed to confirm the values used in the Cypress Lake MODFLOW model, submitted with the WUP application and laboratory water quality data to determine the level of treatment needed to meet public supply standards.

Calibration of the regional model to aquifer performance tests requires reliable data; therefore, we designed the CRDT to record drawdown response at as many locations as is practical. We recorded drawdown at four locations in LF1, three locations in the UFA, and at one location each in the APPZ and LC1 during the LF1 CRDT. To predict better the range of likely regional impacts, the observation wells are not collinear, nor are they so distant that we could not accurately measure drawdown. Distances to those stations ranged from zero feet (at TPW-A1) to 1,981 feet at the most distant LFA (LF1) observation well (LFMW-A3), and 5,317 feet to the most distant UFA observation well (OSF-66).

Model calibration also requires data to constrain the values of aquifer properties that affect vertical movement of groundwater. Because regional model results are sensitive to leakance values, we included observation wells to monitor drawdown in the hydrogeologic units that overlie and underlie the pumped aquifer. The testing program collected data to estimate the hydraulic properties of the UFAS and LFA during three separate CRDTs, three step-drawdown tests, and six packer tests. The two UFAS tests produced properties for the UFA and the APPZ including a total leakance into the UFA (the sum of ICU and MC1 leakance). FDD collected undisturbed sediment samples from the intermediate confining unit (ICU) for vertical permeability testing. The LFA production zone (LF1) CRDT produced data that was used to calculate hydraulic properties for the UFA, the upper zone of the middle semi-confining unit (MC1), the APPZ, the lower zone of the middle semi-confining unit (MC2), the upper flow zone of the LFA (LF1), and the upper zone of the lower confining unit (LC1). Packer testing provided data on the water quality and on the hydrologic response to pumping in MC2, LF1, LC1, and the BZ. The testing program was conducted in phases that coincided with drilling progress to allow concurrent measurement of water quality and aquifer hydraulic properties of the hydrogeologic units present at the site.

By phase, aquifer testing at the Chapman site consisted of: 1) SAS/ICU/UFA drilling and testing; 2) UFA/MC1/APPZ drilling and testing; 3) MC2/LF1/LC1/BZ drilling and testing; and 4) LF1 constant rate discharge testing. The first phase included drilling and testing of the Upper Floridan aquifer monitor well (UFMW-A1), the surficial aquifer monitor well (SMW-A1), and the upper 600 feet of Lower Floridan aquifer test/production well (TPW-A1), running geophysical and borehole video logs of well UFMW-A1, and completing a 24-hour CRDT of the UFA. The second phase included drilling well TPW-A1 to a depth of 1,200 feet BLS, running geophysical and borehole video logs of well TPW-A1, opening the borehole on well TPW-A1 to 24-inch nominal diameter (ND) and 1,015 feet BLS, and completing a 24-hour CRDT of the lower portion of the UFA, all of the MC1, and much of the APPZ. The third phase included advancing a 12-inch diameter pilot borehole in well TPW-A1 to a total depth of 2,362 feet BLS, and conducting six packer tests in various aquifers and confining units from the APPZ to the total depth of the well. The fourth and final phase of the project included installing the final casing at well TPW-A1 to a total depth of 1,350 feet BLS, opening the borehole to 15-inch ND and 1,560 feet BLS, drilling and testing of the tri-zone monitor well (TZMW-A1), drilling and testing two LFA monitor wells (LFMW-A2 and LFMW-A3), drilling two additional surficial aquifer monitor wells (SMW-A2 and SMW-A3), and completing a 14-day CRDT of the production zone (LF1) of the LFA.

2.2 Well Construction

FDD initiated construction at the Chapman site on July 20, 2009 with site stabilization, earthwork and fence installation and concluded on October 5, 2010 with the final survey of the new culvert at the site entrance. SFWMD and Osceola County well construction permits obtained by drilling contractors are in **Appendix A**. Well completion reports are in **Appendix B**, and the final project survey drawings are in **Appendix C**. **Table 2-1** summarizes dimensions and construction details of the eight observation and testing wells installed at Chapman. The mill certificates for all line-item casings are in **Appendix D** for UFMW-A1, TPW-A1, TZMW-A1, LFMW-A2 and LFMW-A3.

2.2.1 Upper Floridan Monitor Well (UFMW-A1)

Wells and Water Systems, Inc. (WWS) a subcontractor to FDD drilled well UFMW-A1 and installed surface casing for all of the FAS wells. WWS drilled well UFMW-A1 first to provide a water source for construction of the remaining onsite wells, and to provide an observation well in the UFA. Construction of well UFMW-A1 was initiated on July 28, 2009 with the installation of an 18-inch steel pit casing to a depth of 55 feet BLS. WWS installed the 6-inch steel final well casing to a depth of 315 feet BLS and grouted the casing in place on August 6, 2009. **Tables 2-2** and **2-3** summarize casing and grout quantities for this well. Drilling of the 6-inch open borehole was completed using the reverse air method to a total well depth of 600 feet BLS on August 13, 2009. WWS collected drill-stem water quality samples for field and laboratory analysis at intervals of 30 feet from approximately 340 to 600 feet BLS.

Development of the well was conducted using a 4-inch submersible pump and the “pump and surge” method. FDD completed well development after four hours of pumping at an approximate pump rate of 400 gallons per minute (gpm), when turbidity reached 0.67 NTUs and the sand content was at 0.0 parts per million (ppm). The step drawdown test (SDT) was conducted at pump rates of 208, 283, 354 and 412 gpm each for approximately one hour at each pump rate. Shortly before the conclusion of the SDT, Tetra Tech well-site geologists collected groundwater samples for laboratory analysis of primary and secondary drinking water standard parameters per (Ch. 62-550 FAC) and for additional parameters.

MV Geophysical Survey, Inc. (MV Geophysical) of Fort Myers, Florida conducted a partial run of geophysical logs (caliper, natural gamma, fluid conductivity and temperature logs) on

September 15, 2009. Logging was interrupted by a fragment of solidified cement grout "rock" that was dislodged during logging activities. The remaining geophysical and video logs (spontaneous potential, dual induction, static and dynamic flow, and borehole compensated sonic with variable density log) were completed on September 24, 2009

2.2.2 Lower Floridan Test/Production Well (TPW-A1)

WWS initiated construction at TPW-A1 on July 23, 2009, by installing and grouting a 42-inch steel pit casing to a depth of 55 feet BLS. FDD resumed construction activities at the well by advancing the borehole to a depth of 315 feet BLS, and installing and grouting the 30-inch diameter surface casing. Well casing and grout quantity summaries for this well are provided in **Table 2-4** and **Table 2-5**. FDD switched to the reverse air method and drilled a 10-inch nominal diameter (ND) pilot borehole from approximately 330 to 600 feet BLS.

FDD opened the pilot borehole to 12-inch ND and advanced the 12-inch ND pilot borehole from 600 to 1,200 feet BLS. Tetra Tech well-site geologists collected drill-stem groundwater samples at intervals of 30 feet from approximately 630 to 1,190 feet BLS, completed field water quality analyses, and submitted the samples for laboratory analysis of inorganic parameters. MV Geophysical conducted geophysical and video logging of the 12-inch pilot borehole from land surface to 1,200 feet BLS. FDD opened the borehole using a 29-inch diameter drill bit to 1,200 feet BLS and installed a 10-inch diameter submersible pump in the borehole to run the second 24-hour CRDT. At the time of the second CRDT, the 24-inch ND borehole was open from 315 feet to 1,015 feet BLS. MV Geophysical conducted geophysical (caliper only) logging of the 29-inch reamed borehole from 315 to 1,015 feet BLS, prior to installation of the 24-inch diameter intermediate casing.

FDD completed installation and grouting of the 24-inch steel intermediate casing to a depth of 1,012 feet BLS on November 5, 2009. The annulus of the intermediate casing was grouted to a depth of 405 feet BLS, which left the annulus open to the UFA (for monitoring) between 405 and 315 feet BLS. The 12-inch pilot borehole was advanced from 1,200 to 2,155 feet BLS, and on December 30, 2009, FDD switched to a 9 5/8-inch drill bit to complete the pilot borehole to a depth of 2,362 feet BLS. Tetra Tech well-site geologists collected drill stem groundwater samples at intervals of 30 feet from approximately 1,230 to 2,360 feet BLS, completed field analysis of selected inorganic analytes, and submitted the samples for laboratory analysis of inorganic parameters. On January 12, 2010, MV Geophysical completed geophysical and video logs of the pilot borehole from 1,012 to 2,362 feet BLS.

Six single element packer tests were conducted during drilling from 1,138 to 2,362 feet BLS in the 10-inch pilot borehole to provide water quality and specific capacity values from isolated intervals within the APPZ, MC2, LF1, LC1, and BZ. Based on drill stem groundwater results, geophysical and video logging, and lithologic sampling, Tetra Tech determined the interval between 1,305 and 1,610 feet BLS comprises the production zone (LF1) of the LFA.

The test/production well was completed by using tremie pipe to back-plug the well with cement grout from 2,362 to 2,207 feet BLS, then reaming the 10-inch ND borehole with a 15-inch ND drill bit to 1,612 feet BLS, reaming the pilot borehole using a nominal 23-inch drill bit from 1,015 to 1,350 feet BLS, and back-plugging of the well with cement grout from 2,107 to 1,636 feet BLS. FDD completed construction of the well with the installation and grouting of 17.4-inch SDR 17 Certa-Lok PVC final casing to a depth of 1,350 feet BLS using two cement baskets set approximately 2 feet and 5 feet above the bottom of the casing. The open borehole was back-plugged on March 8^{th} and 9, 2010 to a final well depth of 1,557 feet BLS using limestone gravel and neat cement grout to reduce the impact of low quality groundwater in the open borehole below 1,560 feet BLS. **Figure 2-1** illustrates the dimensions and construction details of well TPW-A1 at each phase of testing.

Development of the well was conducted with a 10-inch submersible pump using the pump and surge method. FDD completed the well development after approximately eleven hours at a pump rate of approximately 3,000 gpm, with turbidity at 0.93 NTU, and the sand content at 0.0 ppm. The SDT was conducted at pump rates of 500, 2,105, 2,570 and 3,085 gpm for approximately one hour during each pump rate. Tetra Tech geologists collected groundwater samples for laboratory analysis of primary and secondary drinking water standard parameters per Ch. 62-550 F.A.C. and for additional parameters at the conclusion of the SDT. MV Geophysical Surveys, Inc. (MV Geophysical) conducted the final geophysical and video logging run on March 5, 2010 at the test/production well from 1,350 to 1,557 feet BLS.

After construction of the LFA monitor wells were completed, FDD installed a 10-inch submersible pump to run the third CRDT in the production zone (LF1) of the LFA. The 14-day CRDT was initiated on July 22, 2010, at an approximate pump rate of 2,100 gpm and completed on August 5, 2010. FDD completed grouting of the 24-inch intermediate casing on August 27, 2010 and August 30, 2010 using neat cement grout. The casing and grout summaries for this well are provided in **Table 2-4** and **Table 2-5**. The chronological sequence of well construction is provided in **Figure 2-1**.

2.2.3 Surficial Monitor Well (SMW-A1)

Surficial aquifer system (SAS) monitor wells were constructed at the Chapman site to document water table conditions before, during and after the CRDTs. Environmental Drilling Services (EDS) performed a standard penetration test (SPT) boring at the SMW-A1 location in accordance with the methodology outlined in ASTM D-1586. The SPT was conducted to collect soil and shallow unconsolidated sediment samples, and a static water table level prior to installation of the surficial monitor well. The SPT boring was continuously advanced from 0 to 12 feet BLS and was run at 5-foot intervals from 13 to 80 feet BLS. Geotechnical and Environmental Consultants (GEC) collected two Shelby tube samples at depths of 37 to 39 feet BLS and 75 to 77 feet BLS.

EDS installed surficial monitor well 1 (SMW-A1) using a 4-inch (inside) diameter hollow stem auger to a depth of 20 feet BLS. The well consists of a 2-inch diameter 0.5-foot long Schedule 40 PVC well point connected to 2-inch diameter 10-foot long 0.01-inch slotted Schedule 40 PVC screen, and 12.75-feet of 2-inch diameter Schedule 40 threaded flush-joint PVC casing. The screen was set between 20 and 10 feet BLS and the casing was set from 10 feet BLS to approximately 2.75 feet above land surface. The annular space was backfilled with a 20/30 silica filter pack approximately 1 foot above the top of the screen, 2 feet of 30/65 fine sand pack was placed above filter pack, and grouted to surface with a neat cement grout. SMW-A1 was finished with a 2’x2’x0.50’ concrete pad and 4-inch x 4-inch aluminum aboveground protector with locking cover.

2.2.4 Tri-Zone Monitor Well (TZMW-A1)

Tetra Tech designed this well as a dual-zone monitor well (DZMW-A1), however, during construction and testing at the Chapman site, it became apparent that the APPZ was highly permeable, and should be monitored during LF1 testing. The dual-zone monitor well design was modified by installing a steel 2-inch diameter monitoring tube in the annulus of the final casing. WWS initiated construction of TZMW-A1 on August 18, 2009, by installing and grouting the 30-inch diameter steel pit casing to a depth of 55 feet BLS. WWS later installed and grouted the

20-inch diameter steel surface casing to a depth of 300 feet BLS. The casing and grout summaries for this well are provided in **Table 2-6** and **Table 2-7**.

FDD resumed construction of the well with reaming of the borehole using a 19-inch ND chandelier drill bit to depth of 798 feet BLS using the reverse air method. Reaming of the borehole to a depth of 1,350 feet BLS resumed using a 15-inch ND diameter drill bit, and was completed with a 8-inch ND borehole to a total well depth of 1,930 feet BLS. MV Geophysical conducted geophysical logging (caliper, natural gamma, spontaneous potential, dual induction, temperature (static), and fluid conductivity (static)) of the borehole on May 6, 2010, prior to installation of the 8-inch steel casing.

The 8-inch steel intermediate casing was installed and grouted in place to a depth of 1,350 feet BLS, using Halliburton cement baskets. FDD placed limestone gravel into the annular space (to open the cement basket), and a combination of neat cement grout, and up to 6% bentonite grout. FDD installed 820 feet of 2-inch steel casing, with 20 feet of slotted screen (total depth 840 feet BLS) into the annular space between the 8-inch intermediate casing and the 20-inch surface casing, to monitor the APPZ. The annular space containing the APPZ monitoring zone tube was filled with limestone gravel from 958 to 781 feet BLS, and a fine sand seal from 781 to 784 feet BLS, and grouted to surface with up to 6% bentonite grout.

MV Geophysical conducted geophysical (flow (static and dynamic), borehole compensated sonic with variable density log) and video logging of the borehole on May 26, 2010, prior to installation of the final 3.5-inch casing.

The 3.5-inch steel final casing was installed to a depth of 1,880 feet BLS using two Halliburton cement baskets set approximately 2 feet and 5 feet from the bottom of the casing. FDD grouted the final casing in place using up to 6% bentonite grout to a depth of 1,560 feet BLS, creating the lower monitoring zone (LC1) from 1,930 to 1,880 feet BLS, and the middle monitoring zone (LF1) from 1,560 to 1,350 feet BLS. The casing and grout summaries for this well are provided in **Table 2-6** and **Table 2-7**. On July 14, 2010 FDD installed a 6-inch submersible pump and developed the middle monitoring zone in preparation for the third CRDT in the LF1 on July 22, 2010.

Development of the middle monitoring zone was conducted with a 6-inch submersible pump using the pump and surge method. FDD completed well development after 4.5 hours of pumping at an approximate pump rate of 470 gpm, with turbidity below 1.0 NTU, and sand content below 1.0 ppm.

Tetra Tech geologists collected groundwater samples for primary and secondary drinking water standard parameters per 62-550 F.A.C. and for additional parameters on July 15, 2010 after development of the lower monitoring zone was completed using the pump and surge method.

2.2.5 Lower Floridan Monitor Well 2 (LFMW-A2)

This well was constructed to provide an observation well in the production zone (LF1) during the CRDTs. WWS initiated construction of this well on September 10, 2009 with the installation and grouting of a 30-inch steel pit casing to a depth of 55 feet BLS. WWS later installed and grouted the 20-inch steel surface casing to a depth of 290 feet BLS. The casing and grout summaries for this well are provided in **Table 2-8** and **Table 2-9**.

FDD resumed construction of the well with reaming of the borehole using a nominal 15-inch drill bit to depth of 1,353 feet BLS, and an 8-inch ND drill bit to a depth of 1,560 feet BLS using the reverse air method. All Webbs Enterprises, Inc. (All Webbs) conducted geophysical (caliper only) logging of the 15-inch reamed borehole from 290 to 1,353 feet BLS, prior to installation of 8-inch final casing. The 8-inch steel final casing was installed to a depth of 1,350 feet BLS. FDD completed the grouting of the final casing using neat cement grout, limestone gravel (to fill voids), and up to 6% bentonite grout. The casing and grout summaries for this well are provided in **Table 2-8** and **Table 2-9**.

Development of the well was conducted with a 5-inch submersible pump using the pump and surge method. FDD completed well development after five hours of pumping at an approximate pump rate of 435 gpm, with 0.85 NTU, and sand content of 0.0 ppm. The SDT was conducted at pump rates of 268, 313, 373 and 423 gpm for approximately one hour during each pump rate. Tetra Tech geologists collected groundwater samples for laboratory analysis of primary and secondary drinking water standard parameters per Ch. 62-550 F.A.C. and for additional parameters at the conclusion of the SDT. MV Geophysical conducted geophysical and video logging on April 21, 2010.

2.2.6 Surficial Monitor Well 2 (SMW-A2)

SAS monitor wells were constructed at the Chapman site to document water table conditions before, during and after the CRDTs. EDS performed an SPT boring at the SMW-A2 location in general accordance with the methodology outlined in ASTM D-1586. The SPT was conducted to determine soil profile and static water table level prior to installation of the surficial monitor well. The SPT boring was continuously advanced from 0-12 feet BLS and was run at 5-foot intervals from 13 to 80 feet BLS. GEC collected three Shelby tube samples during the SPT boring from depths of 46.5 to 48.5 feet BLS, from 66.5 to 68.5 feet BLS, and from 76.5 to 78.5 feet BLS. Collection of the Shelby tube sample from 76.5 to 78.5 feet BLS produced no recovery.

EDS installed surficial monitor well 2 (SMW-A2) using a 4-inch (inside) diameter hollow stem auger to a depth of 20 feet BLS. Well construction consisted of a 2-inch diameter 0.5-foot long Schedule 40 PVC well point connected to 2-inch diameter 10-foot long 0.01-inch slotted Schedule 40 PVC screen, and a 2-inch diameter 10-foot long Schedule 40 threaded flush-joint solid PVC riser. The slotted screen was set from 20 to 10 feet BLS and the solid riser was set from 10 feet BLS to approximately 2.75 feet above land surface. The annular space was backfilled with a 20/30 silica filter pack approximately 1 foot above the top of the screen, 2 feet of 30/65 fine sand pack was placed above the filter pack, and grouted to surface with neat cement grout. SMW-A2 was finished with a 2’x2’x0.50’ concrete pad and 4-inch x 4-inch aluminum aboveground protector with locking cover.

2.2.7 Lower Floridan Monitor Well 3 (LFMW-A3)

This well was constructed to provide an observation well in the production zone (LF1) during the CRDTs. WWS initiated construction of this well on September 28, 2009 with the installation and grouting of a 30-inch steel pit casing to a depth of 55 feet BLS. WWS later installed and grouted the 20-inch steel surface casing to a depth of 285 feet BLS. The casing and grout summaries for this well are provided in **Table 2-10** and **Table 2-11**.

FDD resumed construction of the well with reaming of the borehole using a 15-inch drill bit to a depth of 1,340 feet BLS, and a 10-inch ND drill bit to a depth of 1,560 feet BLS using the reverse air method. MV Geophysical conducted geophysical logging (caliper, natural gamma, spontaneous potential, dual induction, temperature (static), and fluid conductivity (static)) of the borehole on June 23, 2010, from 290 to 1,560 feet BLS, prior to installation of 8-inch final casing. The 8-inch steel final casing was installed to a depth of 1,350 feet BLS. FDD completed the grouting of the final casing using neat cement grout, limestone gravel (to fill voids), and up to 6% bentonite grout. The casing and grout summaries for this well are provided in **Table 2-10** and **Table 2-11**.

Development of the well was conducted with a 5-inch submersible pump using the pump and surge method. FDD completed well development after six hours of pumping at an approximate pump rate of 450 gpm, with 0.55 NTU, and sand content of 0.1 ppm. The SDT was conducted at pump rates of 298, 347, 405 and 440 gpm for approximately one hour during each pump rate. Tetra Tech geologists collected groundwater samples for primary and secondary drinking water standard parameters per Ch. 62-550 F.A.C. and for additional parameters at the conclusion of the SDT. MV Geophysical conducted geophysical (flow (static and dynamic), borehole compensated sonic with variable density log) and video logging of the borehole on April 21, 2010.

The casing mill certificates for all non-pit casings are provided in **Appendix D** for UFMW-A1, TPW-A1, TZMW-A1, LFMW-A2 and LFMW-A3.

2.2.8 Surficial Monitor Well 3 (SMW-A3)

SAS monitor wells were constructed at the Chapman site to document water table conditions before, during and after the CRDTs. EDS performed an SPT boring at the SMW-A3 location in general accordance with the methodology outlined in ASTM D-1586. The SPT was conducted to determine soil profile and static water table level prior to installation of the surficial monitor well. The SPT boring was continuously advanced from 0-12 feet BLS and was run at 5-foot intervals from 13 to 80 feet BLS. GEC collected three Shelby tube samples during the SPT boring from depths of 37 to 39 feet BLS, from 72 to 74 feet BLS and from 77.5 to 79.5 feet BLS. Collection of the Shelby tube sample from 72 to 74 feet BLS produced no recovery.

EDS installed surficial monitor well 3 (SMW-A3) using a 4-inch (inside) diameter hollow stem auger to a depth of 20 feet BLS. Well construction consisted of a 2-inch diameter 0.5-foot long Schedule 40 PVC well point connected to 2-inch diameter 10-foot long 0.01-inch slotted Schedule 40 PVC screen, and a 2-inch diameter 10-foot long Schedule 40 threaded flush-joint solid PVC riser. The slotted screen was set from 20 to 10 feet BLS and the solid riser was set from 10 feet BLS to approximately 2.95 feet above land surface. The annular space was backfilled with a 20/30 silica filter pack approximately 1 foot above the top of the screen, 2 feet of 30/65 fine sand pack was placed above the filter pack, and grouted to surface with neat cement grout. SMW-A3 was finished with a 2'x2'x0.50' concrete pad and 4-inch x 4-inch aluminum aboveground protector with locking cover.

2.3 Hydrogeologic Testing

2.3.1 Lithologic Sampling

The well drilling contractor, FDD, collected lithologic samples from each well during construction using a sampling interval of 5 feet in the siliciclastic sediments and 10 feet in the carbonate rocks of the Floridan aquifer. Lithologic samples collected from each well were examined and described onsite by Tetra Tech geologists to create a field boring log (lithologic log) for each well. Lithologic logs for UFMW-A1, TPW-A1, SMW-A1, TZMW-A1, LFMW-A2, SMW-A2, LFMW-A3 and SMW-A3 are provided in **Appendix E**.

Based on the analysis of lithologic samples, the geology at UFMW-A1 and TPW-A1 is as follows: Undifferentiated surficial sediments consisting of fine grain quartz sand from land surface to a depth of 35 feet BLS. Undifferentiated clay, consisting of sandy to silty clay, with coarse shell fragments, was identified from 30 to 95 feet BLS. The Hawthorn Group occurs from 95 to 360 feet BLS, and is characterized by the occurrence of phosphatic sands. The Peace River Formation of the Upper Miocene Hawthorn Group (Scott, 1988) consisting of interbedded quartz sands (phosphatic), sandy to silty clay, clayey sand, and carbonates occurs from 95 to 190 feet BLS; and the undifferentiated Arcadia Formation of the Hawthorn Group (Scott, 1988) consisting of interbedded granular and fine grain limestone and dolostone containing varying amounts of quartz sand, clay and phosphate grains, occurs from 190 to 360 feet BLS. The carbonate units of the Upper Eocene Ocala Limestone, consisting of interbedded granular and fine grain limestones, occur from 360 to 400 feet BLS. Abundant benthic foraminifera, particularly the diagnostic index fossil *Lepidocyclina ocalina* and *Nummulites sp*, characterize the limestone of the Ocala Limestone (Ward and others, 2003). The Middle Eocene Avon Park Formation, consisting of interbedded granular and fine grain limestones, dolomitic limestone and crystalline dolomite (dolostone), occurs from 410 to 1,860 feet BLS. Abundant benthic foraminifera also characterize limestones of the Avon Park Fm, particulary *Dictyoconus* sp. (Duncan and others, 1994a), which identify the upper boundary of the Avon Park Formation. The top of the Lower Eocene Oldsmar Formation, consisting of alternating beds of porous limestone, dolomitic limestone, and crystalline dolomite, is marked by the "glauconite marker horizon" (Reese and Richardson, 2008), and occurs in the drill cuttings from 1,860 to 2,362 feet BLS.

The following hydrostratigraphic units were identified: SAS from land surface to 130 feet BLS; ICU from 130 to 310 feet BLS; UFA from 310 to 440 feet BLS; MC1 from 440 to 697 feet BLS; APPZ from 697 to 1,190 feet BLS; MC2 from 1,190 to 1,305 feet BLS; LF1 from 1,305 to 1,610 feet BLS, LC1 from 1,610 to 1,965 feet BLS, and the BZ from 1,965 to 2,235 feet BLS. The bottom 27 feet of the borehole appears to be within a confining bed that may be within the BZ. **Figure 2-2** shows the construction details of each well (TPW-A1, UFMW-A1, TZMW-A1, LFMW-A2 and LFMW-A3) and the corresponding hydrostratigraphic units they intercept.

2.3.1.1 Constant Head Permeability Analysis

Undisturbed (Shelby tube) soil samples were collected from the SPT pilot borehole borings at each of the surficial aquifer monitor well locations (SMW-A1, SMW-A2, and SMW-A3) to determine the permeability (or confinement) of clay lithology within the surficial aquifer system. These data could be used to estimate leakance values between the SAS and the ICU. A total of six Shelby tube samples were collected for submittal to a certified geotechnical testing laboratory for constant-head permeability analysis. Sampled intervals are:

- SPT 1 (SMW-A1)
    - 37 to 39 feet BLS
    - 77 to 79 feet BLS
- SPT 2 (SMW-A2)
    - 46.5 to 28.5 feet BLS
    - 66.5 to 68.5 feet BLS
- SPT-3 (SMW-A3)
    - 37 to 39 feet BLS
    - 77.5 to 79.5 feet BLS

Results from the constant-head permeability analyses conducted from samples collected are summarized on **Table 2-12**. Universal Engineering Sciences, Inc. (Universal) described green to gray clayey sand to silty clayey sands with permeabilities of 2.4×10^{-2} to 1.9×10^{-4} ft/day.

Copies of the laboratory analytical reports for the constant head permeability results are included in **Appendix F.1**.

2.3.2 Daily Water Level Measurements

FDD crew and Tetra Tech geologists collected daily water level readings at the beginning of the work day during reverse-air drilling of the pilot borehole at UFMW-A1 and TPW-A1. FDD began reverse-air drilling on August 25, 2009 at a depth of 330 feet BLS and completed the pilot borehole at TPW-A1 on January 15, 2010 at a depth 2,362 feet BLS. Water levels were collected during pilot-borehole drilling to determine if a change in head existed at the transition from the Upper Floridan aquifer system (UFAS) into the Lower Floridan aquifer system (LFAS). **Figure 2-3** illustrates borehole head changes with time and depth. The top graph (borehole head vs. time) plots the daily measured borehole water elevations (ft NGVD) for the first measurement of equilibrium water level following penetration to each depth. The first occurrence measurements for this analysis were used because the borehole may have had the same total depth under different periods of exposure to the aquifer (borehole may have been at one depth for many days), or may have had different lengths of casing or open borehole. The field water level data collected at the start of each day during drilling was compared to the head elevation of SFWMD offsite regional observation well OSF-66, and to TPW-A1 measured borehole water levels that have been normalized to the change in OSF-66 head over the illustrated interval. The bottom graph (borehole head vs. depth) illustrates the field borehole water levels with depth as well as TPW-A1 head normalized to the OSF-66 data. The purpose of the normalized data is to remove the regional trend so that changes in head are only affected by the transition from the UFAS into the LFAS. The transition from the UFAS to the LFAS is apparent as the break from more-or-less constant normalized elevation above 1,300 feet BLS to a zone of increasing normalized head deeper than 1,300 feet BLS. The change in head is consistent with other indicators found at the TPW-A1 and indicates that the contact between the UFAS and the LFAS is approximately at a depth of 1,305 – 1,340 feet BLS. A table of the measured and normalized borehole water levels at TPW-A1 and OSF-66 is provided in **Appendix G**.

2.3.3 Water Quality Sampling

Groundwater samples were collected at intervals of 30-feet during reverse-air drilling of the pilot boreholes at UFMW-A1 and TPW-A1, from depths of 340 to 2,360 feet BLS. Tetra Tech geologists analyzed drill-stem groundwater samples in the field for the following parameters:

specific conductance	temperature	pH
turbidity	ORP	chloride
hardness	iron	alkalinity
manganese	hydrogen sulfide	

In addition, Tetra Tech geologists collected drill stem groundwater samples for submittal to Test America Laboratories, Inc. for laboratory analysis of inorganic parameters. Drill stem groundwater samples were analyzed for the following parameters:

specific conductance	temperature	pH
turbidity	ORP	chloride
hardness	iron	Bicarbonate alkalinity
manganese	hydrogen sulfide	total dissolved solids
sulfate	sodium	potassium
calcium	magnesium	fluoride
hydrogen sulfide	barium	arsenic

2.3.3.1 UFMW-A1 and TPW-A1 Drill Stem Water Quality

At well UFMW-A1, WWS drilled the $5^{5}/_{8}$ -inch pilot borehole from 315 to 600 feet BLS between August 11, 2009 and August 13, 2009. The pilot borehole at well TPW-A1 was drilled from 600 to 2,362 feet BLS between September 8, 2009 to January 15, 2010. Groundwater samples were collected and analyzed as described above, and used in conjunction with the geophysical and lithologic logs to determine intervals for packer testing at TPW-A1.

Water quality at UFMW-A1 was stable during pilot borehole drilling from 340 to 600 feet BLS. Significant water quality changes were identified at three different depths during the pilot borehole drilling at TPW-A1. The analytes that showed spikes in water quality with depth were conductivity, TDS, chloride and sulfate, as illustrated in **Figure 2-4**. Between 1,290 and 1,380 feet BLS, conductivity increased from 640 to 1,200 µmhos/cm, TDS increased from390 to 490 mg/L, chloride increased from 79 to 220 mg/L and sulfate increase from 110 to 120 mg/L. Between 1,950 and 1,980 feet BLS, conductivity increased from3,300 to 14,000 µmhos/cm, TDS increased from 1,600 to 6,500 mg/L, chloride increased from 870 to 3,700 mg/L and sulfate increased from 170 to 650 mg/L. Between 2,110 to 2,170 feet BLS, conductivity increased from

21,000 to 43,000 µmhos/cm, TDS increased from 10,000 to 23,000 mg/L, chloride increased from 5,700 to 16,000 mg/L and sulfate increased from 990 to 2,300 mg/L. During the pilot borehole drilling the conductivity ranged from 240 to 50,000 µmhos/cm, TDS ranged from 140 to 30,000 mg/L, chloride ranged from 13 to 20,000 mg/L, and sulfate ranged from 3.6 to 2,700 mg/L. **Table 2-13** provides the field drill stem water quality results from the TPW-A1. **Table 2-14** and **Table 2-15** provide the laboratory drill stem water quality results from the UFMW-A1 and TPW-A1. **Figure 2-4** shows a graph of the drill stem water quality for the analytes discussed above at UFMW-A1 and TPW-A1 from 340 to 2,360 feet BLS. The laboratory analytical reports for the drill stem water quality results are provided in **Appendix F.2**.

2.3.3.2 Primary and Secondary Water Quality

Groundwater samples were collected from UFMW-A1, TPW-A1, TZMW-A1, LFMW-A2, and LFMW-A3 after well development and submitted to Test America Laboratories, Inc. for laboratory analysis of primary and secondary drinking water standards per Ch. 62-550 F.A.C., and for additional parameters.

Laboratory results from UFMW-A1 (UFA) identified an exceedance of the maximum contaminant level (MCL) only for odor per Ch. 62-550 F.A.C. Laboratory results from TPW-A1, LFMW-A2, and LFMW-A3 (LF1) identified exceedances of the MCL for sodium, chloride, and TDS. Laboratory results from TZMW-A1, (LC1) identified exceedances of the MCL for sodium, bromate, chlorite, chloride, copper, iron, sulfate, color, TDS, and radium-226. **Tables 2-16** through **Table 2-20** provide the laboratory primary and secondary drinking water standards results for the wells listed above. The laboratory analytical reports for the primary and secondary drinking water standards results are provided in **Appendix F.3**.

2.3.3.3 Generic Discharge Permit Water Quality

After switching from the mud rotary to the reverse-air drilling method in the UFA, groundwater samples were collected to comply with the requirements of the General Permit for Discharge of Produced Ground Water from any Non-Contaminated Site Activity, and submitted for the various parameters listed in Table 1 of the permit. The initial Generic Discharge Permit groundwater samples were collected on August 11, 2009 from UFMW-A1. Additional samples were collected on September 16, 2009 (approximately 30 days) and October 30, 2009 for the same parameters from TPW-A1. The final Generic Discharge Permit groundwater samples were collected on April 1, 2010 for the parameters listed in Table 1 of the permit.

The laboratory analysis results did not identify any exceedances above the screening values for the parameters included in Table 1 of the Generic Discharge Permit for the groundwater sample collected on August 11, 2009 or on April 1, 2010. The groundwater samples collected on September 16, 2009 did show an exceedance above the screening value for copper. An additional groundwater sample was collected on October 30, 2009, and submitted for laboratory analysis of copper. This sample did not show any detection of copper and confirmed our theory that the sample collected on September 16, 2009 was likely contaminated by Kopr-Kote, a tool joint and drill collar lubricant, primarily used on the drill pipe threads by the drilling contractor. The Generic Discharge Permit water quality results are summarized on **Table 2-21**. The laboratory analytical reports for the Generic Discharge Permit water quality results are provided in **Appendix F.4**.

2.3.3.4 Well Disinfection and Bacteriological Testing

Following completion of well construction and testing, FDD disinfected each onsite UFA and LFA monitor well to remove bacteriological contamination in accordance with AWWA Standards A100-06 and ANSI/AWWA C654. A disinfectant solution with a minimum concentration of 50 mg/L of available chlorine was applied to each monitor well for the entire depth of the wells. The disinfectant solution was allowed to remain in the wells for a minimum of 2 hours and pumped to waste to remove the disinfectant solution.

To demonstrate that any bacteriological contamination that may have been introduced during drilling had been eliminated, FDD conducted field testing of samples from well UFMW-A1 and TPW-A1 to ensure that zero residual chlorine remained prior to collection of groundwater samples for laboratory analysis of total coliform and heterotrophic plate count (HPC). Two samples per day for five consecutive days were collected to demonstrate proper well disinfection. FDD collected two groundwater samples per day, at least six hours apart, from well UFMW-A1 and well TPW-A1 from September 27, 2010 to October 1, 2010.

With the exception of samples collected from well UFMW-A1 and TPW-A1 from the first day of sampling, the remainder of samples collected for the parameters above did not show any detection of total coliform bacteria. The detection of total coliform bacteria at well UFMW-A1 and TPW-A1 from the first day of sampling is likely due to poor well sampling procedure. Total coliform was not reported in laboratory results for the last four days of sampling. This demonstrates that the wells were properly disinfected. The laboratory analytical reports for the well disinfection and bacteriological groundwater testing are provided in **Appendix F.5**.

2.3.4 Inflatable Packer Tests

From November 20, 2009 to January 15, 2010 six packer tests were performed in well TPW-A1 the following intervals: 1,138 to 1,200 feet BLS, 1,240 to 1,352 feet BLS, 1,430 to 1,520 feet BLS, 1,820 to 1,885 feet BLS, 1,924 to 2,150 feet BLS, and 2,305 to 2,362 feet BLS. Packer intervals were selected based on drill cuttings and water quality results from the drill-stem samples collected during pilot borehole drilling at TPW-A1. The intervals from 1,136 to 1,290 feet BLS, 1,240 to 1,350 feet BLS, 1,430 to 1,510 feet BLS, and 1,920 to 2,140 feet BLS were chosen to isolate and identify water quality within these intervals. The intervals from 1,820 to 1,885 feet BLS and 2,305 to 2,362 feet BLS were chosen to isolate and define confinement and water quality below the production zone.

The drilling contractor conducted the packer tests using an 11-inch diameter 77-inch long single element inflatable packer assembly, with a maximum inflation diameter of over 15-inches. The drill string was lowered until the packer element was at a selected depth, the drill string was dogged, the packer element was inflated with water to an element pressure of 100 psig, or more, and the Kelly was removed. A 4-inch submersible test pump for purging and packer testing was set on 120 feet of discharge riser with 4-inch diameter discharge pipe and an insertion-type totalizing flow meter. Water level changes inside and outside of the drill string were recorded using data loggers and pressure transducers. Each interval was pumped at the maximum rate that the interval and pump could sustain until all field water quality parameters (pH, redox potential (mV), temperature, conductivity, salinity, and turbidity) had stabilized. Pumping was stopped, and when water levels in the drill string had recovered to static conditions, the data loggers were started and each interval was pumped for a period of four hours.

Drawdown during packer testing ranged from 4.90 feet at interval 2,305 to 2,362 feet BLS (BZ) to 67.47 feet at interval 1,820 to 1,885 feet BLS with pump rates ranging from less than 1 gpm to 127.4 gpm. However, the remaining packer testing intervals produced drawdowns of 25.90 to 67.47 feet. The specific capacities at these intervals range from 0.02 gallons per minute per foot (gpm/ft) at interval 1,820 to 1,885 feet BLS (LC1) to 22.49 gpm/ft at interval 2,305 to 2,362 feet BLS (in the BZ). A summary of the packer testing data is provided in **Table 2-22**.

Tetra Tech geologists collected groundwater samples near the end of each packer test and submitted the samples for laboratory analysis of the following analytes:

specific conductance	temperature	pH
turbidity	ORP	chloride
hardness	iron	Bicarbonate alkalinity
manganese	hydrogen sulfide	total dissolved solids
sulfate	sodium	potassium
calcium	magnesium	fluoride
hydrogen sulfide	barium	Total arsenic
^{18}oxygen	deuterium	Gross alpha
	radiocarbon (packer tests #2 and #6 only)	

In all six intervals there was at least one exceedance of the FDEP MCL and the water quality MCL exceedance increased with depth. Water quality results from each packer test are listed in **Table 2-23**. The laboratory analytical reports for the groundwater samples collected during the inflatable packer testing are in **Appendix F.6**.

2.3.5 Geophysical Logging

MV Geophysical performed all of the geophysical and borehole video logs with the exception of the X-Y caliper log run for borehole volume calculations on well LFMW-A2, which was conducted by All Webbs Enterprises, Inc. (All Webbs). Video and geophysical logs were run following well development or aquifer testing to ensure that water in the borehole was clear, but a sufficient time after pumping to allow borehole water quality to equilibrate. For all wells, the standard suite of logs comprises:

- 4-arm caliper run (33-inch maximum extension) with the natural gamma log.
- Borehole compensated sonic with variable density log
- Dual induction (resistivity) with SP log
- Fluid conductivity, temperature, and temperature differential (static and pumping)
- Flowmeter logs (static and pumping)

- Color borehole video with side view log

At well LFMW-A3, the large diameter and extensive interval of several cavities required use of the 55-inch arm-length caliper log. Consequently, the gamma-ray log was run separately, which produced gamma-ray responses that differed noticeably from those of other wells.

UFMW-A1

The geophysical logging was conducted throughout the casing and open-hole sections of UFMW-A1 to a depth of 600 feet BLS on September 15, 2009. The purpose of the logging was to inspect the well casing and borehole, to delineate potential water production zones, and to provide information that would aid interpretation of the lithology and identification of hydrogeologic units, and to assist in well construction prior to casing installation and during grouting. Logging was conducted after the completion of the step drawdown test (SDT). The geophysical logs included caliper, static (non-pumping) and dynamic (pumping) flow, gamma ray, spontaneous potential, resistivity, acoustic, and static and dynamic temperature. Copies of these logs are included in **Appendix H.1**.

The caliper log is used to get a cross sectional measurement of the borehole and can indicate zones of fracturing or spalling, and areas of smooth rock. In UFMW-A1, the caliper log indicates a washout zone or small cavity below the casing from 315 to 322 feet BLS, and general widening of the borehole extending down to about 444 feet BLS. Below 444 feet the borehole is generally close to the diameter of the drill bit (about 5.75 inches).

The gamma ray activity was very consistent throughout most of the open borehole. The steel surface casing and cement attenuate the natural gamma radiation from the rocks and clays. This minimizes the gamma signature of the Hawthorn Group, which is evident based on its elevated gamma ray signature, between roughly 195 and 358 feet BLS. The gamma ray activity from 360 to 600 feet BLS remained relatively low.

The borehole compensated sonic with variable density log (acoustic) indicates areas of high apparent porosity from just below the casing (315 feet BLS) to a depth of 360 feet BLS, and consistent apparent porosity from 475 to 520 feet BLS.

The dual induction resistivity log measures the ability of the borehole fluids and borehole formation material to resist the flow of electricity. This response can be used to estimate the resistivity of the water and the relative porosity of the rock. Generally, in fresh water formations, resistivity decreases as porosity increases due to increased flow of groundwater; resistivity also decreases as ionic concentration (TDS) increases in groundwater. The resistivity log at UFMW-A1 used three detectors with spacings of 20, 82 and 127 inches. The increasing spacing yields resistivity readings that penetrated deeper (estimated from 6-10 inches up to 10 feet into the formation) into the water and rock. The resistivity logs showed a spike in resistivity from 362 to 373 feet BLS that corresponds to an interval of porous but well indurated formation and higher flow in the Upper Floridan aquifer. The resistivity was stable from 373 feet BLS to the bottom of the well at a depth of approximately 600 feet BLS.

The temperature and static flow logs were very stable; temperature remained below 78 degrees Fahrenheit (ºF), and barely rose above 77.3ºF near the bottom of the well. The flow logs showed movement of the water within the well from just below the casing to a depth of 370 feet BLS. The dynamic flow log was conducted at a flow rate of approximately 150 gpm and showed a gradual decrease in flow in the borehole with increasing depth. Most of the flow within the well appears to be from the depth interval between 375 feet and 430 feet BLS.

<u>TPW-A1</u>

The geophysical logging runs were conducted throughout the casing and borehole sections of TPW-A1 at the following depths: 0 to 1,200 feet BLS in September 2009 (Run No. 1); 0 to 1,106 feet BLS in October 2009 (Run No. 2), and only included caliper logging prior to installation of the 24-inch intermediate casing; 1,012 to 2,360 feet BLS in October 2009 (Run No. 3); and 1,350 to 1,635 feet BLS in March 2010 (Run No. 4). The purpose of the logging was to inspect the well casing and borehole, to delineate potential water production zones, for interpretation of lithology, and to assist in well construction prior to casing installation and during grouting. The suites of geophysical logs performed were caliper, natural gamma, spontaneous potential, dual induction, temperature (static and dynamic), fluid conductivity (static and dynamic), flow (static and dynamic), and a borehole compensated sonic with variable density log. Copies of these logs are included in **Appendix H.2**.

Caliper logs provide a continuous profile of borehole diameter with depth. Caliper log results from the Run No. 1 logging (0 to 1,200 feet BLS) indicate borehole diameters between 9.4 and 29.7 inches from 300 to 1,200 feet BLS at TPW-A1. Borehole diameters ranged from 14 to 22 inches between 700 and 780 feet BLS, and remained near bit size from 13 to 15 inches in the interval between 940 to 1,120 feet BLS.

Caliper log results from the Run No. 3 logging (1,012 to 2,360 feet BLS) indicate well-defined borehole diameters from 14 to 17 inches between 1,197 and 1,305 feet BLS that correlates well with the MC2. Borehole diameters ranged from 14 to 16 inches between 1,360 and 1,555 feet BLS, which correlate to areas of higher porosity or fracture within the production zone (LF1) of the LFA. Caliper logs indicate that borehole diameters were largest between 1,970 and 2,232 feet BLS, ranging from 29.2 to 17 inches, which occurred in the BZ. Straight gauge borehole diameters of less than 13 inches were encountered below the production zone from 1,650 to 1,742 feet BLS, and 1,755 to 1,965 feet BLS in uniform well to very well indurated strata in the dolomitic limestones of the Avon Park and Oldsmar Formations.

The natural gamma ray count of the carbonate sediments of the Avon Park Formation is fairly consistent and low, as shown on the combination gamma-ray and X-Y caliper log from 0 to 1,200 feet BLS (Run No. 1). High gamma ray counts occurred at 658.5 feet (19.2 cps) BLS and 680.75 feet (17.9 cps) BLS near the bottom of the middle semi-confining unit (MC1). The increase in gamma between 1,864 and 1,897 feet BLS, marks the contact between the Avon Park Formation and the underlying Oldsmar Formation, and is likely due to the presence of glauconite (naturally radioactive mineral) in the carbonate sediments. The highest gamma counts occurred at 1,867 feet BLS (42.1 cps) and 1,897 feet BLS (35.8 cps) near the Avon Park and Oldsmar Formation contact, between 2,181 to 2,193 feet BLS (37.7 to 40.1 cps), and between 2,332 to 2,345 feet BLS (30.7 to 39.2 cps) within the Oldsmar Formation. **Figure 2-5** provides the construction detail, stratigraphic units, hydrostratigraphic units, lithology, and gamma log for the TPW-A1.

The borehole compensated sonic with variable density log (acoustic) indicates areas of low apparent porosity from 551 to 706 feet BLS, and from 1,162 to 1,280 feet BLS, that correlates well with the top and bottom of the middle semi-confining unit (MC1 and MC2). Areas of high apparent porosity were identified from 710 to 1,162 feet BLS in the acoustic log that correlates well to the APPZ. Areas of high apparent porosity were identified in the production zone (LF1) of the LFA from 1,364 to 1,610 feet BLS. The acoustic log at TPW-A1 indicates areas of apparent low porosity exists from 1,612 to 1,720 feet BLS, and from 1,786 to 1,920 feet BLS which correlates well to areas of confinement (LC1) below the production zone in the LFAS. Areas of apparent high porosity were identified on the acoustic log from 1,965 to 2,238 feet BLS that occur in the BZ of the Oldsmar Formation.

The short normal induction log showed a spike in resistivity from 365 to 380 feet BLS, and likely corresponds to an area of higher flow in the Upper Floridan aquifer, during Run No. 1, the resistivity was stable from 380 feet BLS to a depth of approximately 630 feet BLS, and high peaks were measured from 1,025 to 1,214 feet BLS. The high peak depths noted above, correspond to sections of narrow cavities or fractures in an otherwise small diameter borehole as shown on the caliper log, and also correspond to areas of high fracturing and increased water flow within the APPZ.

In the borehole section below 1,350 feet BLS, high peak readings appeared at depths from 1,428 to 1,468 feet BLS, which correspond well to areas of higher porosity and increased water flow in the production zone of the LFA. The highest recorded resistivity values were identified at depths of 1,884 feet BLS, 1,950 feet BLS, 1,990 feet BLS, 2,140 feet BLS, 2,174 feet BLS, 2,223 feet BLS, 2,313 feet BLS. The fluctuation of resistance between 1,990 and 2,313 feet BLS coincides with openings of the borehole that are identified with the BZ.

The dynamic temperature log documented a stable temperature of 78.3ºF from just below the bottom of the casing (300 feet BLS) during logging Run No.1 to a depth of 697 feet BLS, where it increased to 78.5 ºF, which correlates to an increase in fluid conductivity in the borehole. The increase in fluid conductivity and temperature at 697 feet BLS correlates well with the bottom of the MC1 and the top of the APPZ of the UFAS. Below 700 feet, the temperature continued to increase to a depth of 825 feet BLS, where it increased to 78.5 ºF, and also correlates to an increase in fluid conductivity to a depth of 850 feet BLS. The temperature log continued to show increasing temperatures to 79.9 ºF and increasing fluid conductivity to a depth of 1,100 feet BLS. The increase in fluid conductivity and temperature from 825 to 1,100 feet BLS correlates well with the APPZ of the UFAF. The dynamic temperature log documented a stable temperature of 81.6ºF to 81.7 ºF from just below the bottom of the casing (1,012 feet BLS) during logging Run No. 3 to a depth of 1,390 feet BLS, which correlates to an increase in fluid conductivity, and increased flow within the production zone of the LFA. Temperature and fluid conductivity continued to increase at depths of 2,000 feet BLS and 2,146 feet BLS, which correlates to increases in fluid conductivity within the boulder zone (LF2).

An analysis of the Run No. 4 dynamic flow log for well TPW-A1 (1,350 to 1,635 feet BLS) pumped at 2,170 gpm shows that the entire interval of the open borehole is contributing flow to the well.

2.3.6 Video Logging

UFMW-A1

A video log was conducted throughout the borehole section at a depth of 315 to 600 feet BLS on September 15, 2009. The logging was conducted after the completion of the SDT. The video log was conducted under dymanic (pumping) conditions at an approximate pump rate of 150 gpm. Copies of these logs are included on DVD in **Appendix H.1**.

On the video log the casing and casing joints were inspected, as was the borehole portion of the well. Particular attention was paid to the joints, to the bottom of the casing, and to fracture, cavities, or possible flow zones. The casing and joints appear to be in good shape, without distortion, cracks or leaks. The casing bottom is visible at 315 feet BLS. The casing appears to be well supported by cement and there did not appear to be any leakage from around the casing. In the borehole section of the well several areas of fracturing and jointing were detected that could be sources of flow to the well. In addition, several layers within the rock show varied resistance, creating narrow open areas. The bottom of the well was encountered at 600 feet BLS and a layer of soft dark colored sediment had slowly built up in the well. **Figure 2-6** shows a borehole image from the TPW-A1 video log taken while in the UFA.

TPW-A1

The geophysical and video logging was conducted throughout the casing and borehole sections at depths of 0 to 1,200 feet BLS in September 2009 (Run No. 1), 1,012 to 2,360 feet BLS in October 2009 (Run No. 2), and 1,350 to 1,635 feet BLS in March 2010 (Run No. 3). The purpose of the logging was to inspect the well casing and borehole, delineate potential water production zones, and interpretation of the penetrated lithology. Copies of these logs are included on DVD in **Appendix H.2**.

The Run No. 1 video log was used to inspect the condition of interior casing (land surface to 315 feet BLS) and the borehole section of the well (315 to 1,200 feet BLS). Particular attention was paid to the casing joints, the grout seal at the bottom of the casing, and areas of fracture and/or flow zones within the borehole section of the well. The casing and joints were found to be in good shape, without distortion, cracks or leaks. The casing bottom was detected at 315 feet depth, it appeared to be well supported by cement and there did not appear to be any leakage around the casing. Areas of fracturing were identified at depths of 630 to 633 feet BLS, from 654 to 657 feet BLS within the MC1; **Figure 2-6** shows a borehole image from the TPW-A1 video log taken while in the MC1. Areas of high porosity and vertical fracturing were identified at depths of 697 to 719 feet BLS, 780 to 850 feet BLS, and 891 to 960 feet BLS that correlates well with the APPZ. **Figure 2-7** shows a borehole image from the TPW-A1 video log taken while in the APPZ.

The Run No. 2 video log was used to inspect the condition of interior casing (land surface to 1,012 feet BLS) and the borehole section of the well (1,012 to 2,360 feet BLS). Particular attention was paid to the casing joints, the grout seal at the bottom of the casing, and areas of fracture and/or flow zones within the borehole section of the well. The casing and joints were found to be in good shape, without distortion, cracks or leaks. The casing bottom was detected at 1,012 feet depth, since a Halliburton cement basket was used during installation, a grout seal was not observed during the video log, but there also did not appear to be any leakage from just above the bottom of the casing. Areas of low porosity with little to no fracturing were identified at depths of 1,210 to 1,281 feet BLS, that correlate well with the MC2. **Figure 2-7** shows a borehole image from the TPW-A1 video log taken while in the MC2. Areas of high porosity (vuggy), cavities, and vertical fracturing were identified at depths of 1,308 to 1,320 feet BLS, 1,324 to 1,330 feet BLS, 1,365 to 1,390 feet BLS, 1,425 to 1,477 feet BLS, 1,492 to 1,518 feet BLS, and 1,548 to 1,608 feet BLS that correlates well with the production zone (LF1) of the LFA. Areas of low porosity (confinement) with little to no fracturing or secondary porosity (cavities, vugs, etc.) were identified at depths of 1,821 to 1,883 feet BLS that correlates well with the LC1 of the LFA. **Figure 2-8** shows a borehole image from the TPW-A1 video log taken while in the LF1 and LC1. Areas of high fracturing with large to moderate cavities were identified at depths of 1,965 to 1,970 feet BLS, 1,993 to 1,998 feet BLS, 2,022 to 2,025 feet BLS, 2,142 to 2,180 feet, 2,226 to 2,230 feet. The areas identified above correlates well with the BZ within the Oldsmar Formation. **Figure 2-9** shows a borehole image from the TPW-A1 video log taken while in the BZ The bottom of the borehole was encountered at 2,358 feet BLS and there appeared to be several limestone/dolostone rock fragments that had slowly built up in the borehole.

The Run No. 3 video log was used to inspect the condition of interior casing (land surface to 1,350 feet BLS) and the borehole section of the well (1,350 to 1,560 feet BLS). Particular attention was paid to the casing joints, the grout seal at the bottom of the casing, and areas of fracture and/or flow zones within the borehole section of the well. The casing and joints were found to be in good shape, without distortion, cracks or leaks. The casing bottom was detected at 1,350 feet depth, since a Halliburton cement basket was used during installation, a grout seal was not observed during the video log, but there also did not appear to be any leakage from just above the bottom of the casing.

2.4 Interpretation of Hydrogeologic Units

The geophysical and video logs recorded on January 13, 2010 (Run No. 3) at TPW-A1, drill-stem water quality results, daily water level measurements from UFMW-A1 and TPW-A1, and drilling cuttings were reviewed to identify the depths of contacts between hydrostratigraphic units of the LFAS and UFAS. This data was used to decide the depth to set the final well casing well TPW-A1, and the depth interval of the open borehole (production zone). We identified areas of resistant formation wherein the bit drilled a cylindrical borehole, and which was absent cavities or apparent fractures. This interval also appeared to have low porosity and low flow into the borehole from the formation. From this information, we called the depth range of MC2 from 1,254 to 1,305 feet BLS. The underlying interval is characterized by larger borehole diameter due to cavities, friable formation, and spalling, higher apparent porosity, and greater flow into the borehole from the formation. We identified the interval from 1,305 to 1,610 feet BLS as the upper flow zone of the lower Floridan aquifer (LF1). Although the borehole includes zones of larger diameter and apparent high porosity from 1,560 to 1,610 feet BLS, this interval was backfilled to 1,557 to minimize the deterioration of water quality that could result from pumping from a cavity identified between 1,602 and 1,610 feet BLS.

Tetra Tech and Toho provided geophysical and video logging results from the Chapman site to Emily Richardson, PG (SFWMD) in January 2010. Ms. Richardson did not agree with Tetra Tech's identification (at that time) of the MC2 (1,190 to ca 1,300 feet BLS) and the production zone within the LFA (1,300 to 1,610 feet BLS). Ms. Richardson and representatives of the SJRWMD and SWFWMD based on their review of the geophysical, lithologic, and drill stem water quality results from TPW-A1, determined that the top of the LFA at the Chapman site is between 1,350 and 1,365 feet BLS. As they described it, determination of the top of the LFA by the WMD staff was primarily based on geophysical logs and dynamic flow logs below 1,012 feet BLS. The determination of the top of the LFA by WMD staff admittedly did not include quantitative use of the borehole compensated sonic with variable density log (acoustic), the borehole video log at TPW-A1 conducted on January 13, 2010 (Run No. 3), or the normalized head borehole head graph (**Figure 2-3** of this report). The acoustic log shows an increase in porosity between 1,280 and 1,330 feet BLS, while the video log shows areas of higher secondary porosity from 1,281 to 1,286 feet BLS, and from 1,305 to 1,320 feet BLS.

SECTION 3
AQUIFER TESTING

3.1 Upper Floridan Aquifer

In its simplest form, a constant rate discharge test (CRDT) produces basic information used to determine local aquifer hydraulic properties (transmissivity, storativity, and leakance) by pumping a well and observing the drawdown response at surrounding observation wells. That is the basic plan for determining the aquifer parameters at the Chapman site. The scope of this phase of AWS testing, however, includes three such tests to measure response in three aquifer units within the multilayer Floridan aquifer system.

We used two 24-hour CRDT in the Upper Floridan aquifer system (UFAS) at the Chapman site to estimate aquifer parameters in the UFA and APPZ aquifers. UFA testing was conducted, in part, in response to a request and funding support from the SFWMD. Design of the UFAS test design and procedures were submitted to the SFWMD for review and comment prior to bidding for well construction and testing.

3.1.1 Step Drawdown Testing

A step-drawdown test (SDT) was conducted to evaluate the well efficiency (ratio of formation head loss to total head loss) and to determine the appropriate setting depth for normal pump operation. Results from step-drawdown testing distinguish observed drawdown in the pumping well from actual drawdown within the aquifer outside the well borehole.

3.1.1.1 UFMW-A1

On September 1, 2009, Tetra Tech conducted a SDT at the UFMW-A1 to determine specific capacity and well efficiency. Well UFMW-A1 was open to a depth of 600 feet below land surface (BLS) with a 6-inch steel final casing to a depth of 315 feet BLS. The SDT was performed at four discrete discharge rates, representing discharge steps of 60-minute duration and rates of 209, 283, 354 and 412 gallons per minute (gpm) followed by 60 minutes of recovery monitoring. The total continuous pumping time for the test was four hours with exactly one hour of pumping for each of the four steps. The pump was run for an additional 26 minutes to collect water samples. Specific capacities were calculated at 16.1 gallons per minute per foot (gpm/ft) at a discharge of 209 gpm and drawdown of 13.01 feet, 14.7 gpm/ft at a discharge of 283 gpm and drawdown of 19.21 feet, 13.5 gpm/ft at a discharge of 354 gpm and drawdown of 26.17 feet, and 12.7 gpm/ft at a discharge of 412 gpm and drawdown of 32.33 feet.

The Hantush-Bierschenk method (Kruseman and de Ridder, 1991) was used for evaluating well efficiency. The Hantush-Bierschenk method relates observed drawdown to a component of aquifer and linear well losses, and to a component of non-linear well losses. The method assumes a fully penetrating well and a confined aquifer; both assumptions are reasonable for the duration of each step for the SDT of the UFMW-A1 based on lithologic inspection and subsequent aquifer testing. The pumped well efficiency values calculated using the Hantush-Bierschenk method for the four pumping steps range from 73% at 209 gpm to 58% at 412 gpm. A certificate of calibration for the flow meter is included in **Appendix I.1**. The SDT results and well efficiency graphs, along with the well efficiency calculations and hand measurements for UFMW-A1 are provided in **Appendix J.1**.

3.1.2 Constant Rate Discharge Test (TPW-A1 UFA)

The pumping portion of a 24-hour, UFA CRDT was started at 11:30 A.M. on September 3, 2009 and terminated at 11:31 A.M. on September 4, 2009. Well TPW-A1 (constructed to a depth of 600 feet BLS and cased to a depth of 315 feet BLS) was pumped at an average discharge for the duration of the test of 1,354 gpm. Water levels in one additional UFA well (UFMW-A1) and one surficial aquifer well (SMW-A1) were monitored during background, pumping, and recovery phases of the test. The SFWMD records water levels in a UFA well located approximately one mile east of the Chapman site (well OSF-66). We obtained water level data from the period before, during, and after the CRDT from the District's DBHYDRO website. Water from the CRDT was discharged to land surface approximately 200 feet from well TPW-A1. Discharge water drained by overland flow to a roadside drainage swale that drained southeast to a drainage ditch. A copy of the flow meter certificate of calibration is provided in **Appendix I.2**. The location of the discharge point as well as all on-site observation wells are illustrated in **Figure 3-1**.

Rainfall and barometric pressure were recorded during the 24-hour CRDT. A barometric pressure logger ("barologger") recorded barometric pressure at 5-minute intervals during the test, and a plastic non-recording rain gauge was inspected daily. Water level measurements during the recovery period were collected manually for more than an hour following the conclusion of the test and electronically using water level loggers in the TPW-A1, UFMW-A1, and SMW-A1 until the morning of September 8, 2009, a period of four days. Field data from the CRDT, including, discharge recorded at the totalizer and discharge recorded by pressure transducer and data logger at the orifice weir, manual water level measurements, and field measured discharge turbidity, are provided in **Appendix K.1.** Water levels and drawdown are illustrated in hydrographs (**Appendix K.2**), and CRDT recorded data are tabulated in **Appendix K.3**.

3.1.2.1 Water Level Data Logger Deployment

Vented pressure transducers with data loggers were used to record water levels, and a barologger was deployed at the test location to record barometric pressure during the period of observation. Tetra Tech initiated collection of background water level readings on the Monday (August 31, 2009) before the start of pumping, and CRDT monitoring using an escalating recording interval was started approximately 10 minutes prior to initiating the CRDT. Water level readings were recorded throughout the duration of the 24-hour CRDT, and the loggers were downloaded and reset shortly before the end of pumping to record the recovery response of the pumped and observation wells.

Onsite observation wells used during the CRDT are:

- Surficial aquifer well SMW-A1;
- Upper Floridan aquifer well UFMW-A1.

Table 3-1 summarizes the distances of the wells monitored during the CRDT from the TPW-A1 and the observation intervals during the test.

3.1.3 Analyses (TPW-A1 UFA)

Data from the CRDT were analyzed to estimate transmissivity, storativity, and leakance at the Chapman site. Two closed-form analytical methods were applied: Jacob-Cooper time drawdown semi-log approximation solution for the non-equilibrium equation (Copper-Jacob, 1946), and the Hantush-Jacob leaky aquifer method (Hantush-Jacob, 1955).

3.1.3.1 Hydrographs and Time-Series Graphs

The wells used to determine the aquifer parameters include the pumping well, TPW-A1, the UFA observation well, UFMW-A1, and SFWMD UFA monitor well OSF-66. Graphs of time-series data for those three wells along with well SMW-A1, barometric pressure recorded by the barologger, and Chapman site rainfall are provided in **Appendix K.2**. The background, pumping, and recovery portions of the CRDT are marked on the hydrographs for reference. Manual measurements, identified with a "+" symbol, are also illustrated on the hydrographs. During the period of the CRDT, water levels in well SMW-A1 appear to have responded only to evapotranspiration, rainfall, and drainage.

3.1.3.2 Analytical Methods

The closed-form analytical methods used for evaluating aquifer tests in a semi-confined aquifer have the following assumptions and conditions (Kruseman and de Ridder, 1990 and Dawson and Istok, 1991):

- The aquifer is leaky;
- The aquifer and the aquitard have a seemingly infinite areal extent;
- The aquifer and the aquitard are homogenous, isotropic and of uniform thickness over the area influenced by the test;
- Prior to pumping, the piezometric surface and water table are horizontal over the area that will be influenced by the test;
- The aquifer is pumped at a constant discharge rate;
- The well penetrates the entire thickness of the aquifer and thus receives water by horizontal flow;
- The flow in the aquitard is vertical;
- The drawdown in the source aquifer (or in the aquitard, if there is no un-pumped aquifer) is negligible.

Analytical methods used in the determination of the hydrogeologic properties include the Cooper-Jacob straight-line method, the Hantush-Jacob and Hantush-Walton methods, the

Cooper-Jacob time-distance-drawdown method, and the Cooper-Jacob distance-drawdown method. The Cooper-Jacob straight-line method is used to determine the transmissivity and storativity of a confined or semi-confined aquifer with time plotted along a logarithmic X-axis and drawdown plotted along a linear Y-axis. The earliest time data is excluded from the analysis due to well storage effects. In semi-confined aquifers the later time data is excluded when leakance of water from adjacent aquifers begins to offset drawdown and the drawdown hydrograph deviates from a straight-line response. This method can be applied to the pumping well as an observation well in an aquifer performance test to determine transmissivity, but it cannot be used to determine storativity due to energy losses within the pumping well that results in the head in the aquifer being higher than the water level in the pumping well (Kruseman and de Ridder, 1990 and Dawson and Istok, 1991).

The Hantush-Jacob (or Hantush-Walton) method is used to determine transmissivity, storativity, and leakance values for a semi-confined aquifer with time plotted on a logarithmic X-axis and drawdown plotted along a logarithmic Y-axis. This method uses type-curves developed by Walton to match to the plotted corrected drawdown. As leakance values increase in the aquifer, the drawdown curves deviate further from the Theis non-equilibrium type curve. Match points determined from the method help in the calculation of transmissivity and storativity values, and the r/B value selected for the matched type curve is used in the calculation of the leakance value (Kruseman and de Ridder, 1990 and Dawson and Istok, 1991).

The Cooper-Jacob time-distance-drawdown method is used to determine transmissivity and storativity of a confined or semi-confined aquifer with the ratio of time and radial distance squared (t/r^2) plotted along a logarithmic X-axis and drawdown plotted along a linear Y-axis. Another alternate Cooper-Jacob method used to determine transmissivity and storativity of a confined or semi-confined aquifer is the distance-drawdown method. This method uses drawdown data at specific early times with distance plotted along a logarithmic X-axis and drawdown plotted along a linear Y-axis (Kruseman and de Ridder, 1990 and Dawson and Istok, 1991).

Tetra Tech also employs a spreadsheet solution technique that couples the Cooper-Jacob time-drawdown ("straight-line") method and the Hantush-Walton method to arrive at a single solution that satisfies both equations. Cleveland (1996), independently, describes the spreadsheet solutions.

We assume that testing data is sufficiently accurate to assure reliability to two significant digits. We base this on our estimation that accuracy in aquifer testing is limited by the accuracy and reliability of flow measurement and recording.

3.1.3.3 Calculations

The data from the UFA CRDT used to calculate the aquifer hydraulic properties are provided in **Appendix K.3**, and the solutions are summarized in **Table 3-2**. The mean value of transmissivity ("transmissivity", hereafter) for the UFA calculated using the onsite wells, is approximately 9,100 ft^2/day, the mean storativity is approximately 0.00087, and the mean leakance is approximately 0.00087 ft/day/ft. The mean transmissivity for the UFA calculated using the onsite wells and well OSF-66, is approximately 18,600 ft^2/day, the mean storativity is approximately 0.00012, and the mean leakance value is approximately 0.00020 ft/day/ft.

3.1.4 Constant Rate Discharge Test (TPW-A1 APPZ)

A second 24-hour, UFAS CRDT was started at 3:00 P.M. on October 29, 2009 and terminated at 3:00 P.M. on October 30, 2009. The second CRDT was run after the TPW-A1 had been drilled to 1,015 feet BLS and cased to a depth of 315 feet BLS. Well TPW-A1 was pumped at an overall weighted average discharge for the duration of the test of 3,080 gpm. Water levels at wells UFMW-A1 and SMW-A1 were monitored during the background, pumping, and recovery periods. In addition to the onsite wells listed above, water levels at SFWMD well OSF-66 were plotted, but not otherwise used in our analyses. Discharge during the second CRDT was the same as the first. A certificate of calibration for the flow meter is included in **Appendix I.2**. The location of the discharge point, as well as the locations of all on-site observation wells is illustrated in **Figure 3-1**.

Field data, including hand measurements, discharge recorded by the totalizing meter and the orifice weir, and turbidity, are provided in **Appendix K.1.** Water levels were recorded manually for approximately half an hour after the conclusion of the test (3:00 P.M. on October 30, 2009) and electronically using water level loggers in the TPW-A1, UFMW-A1, and SMW-A1 until the morning of November 2, 2009.

3.1.4.1 Water Level Data Logger Deployment

Vented pressure transducers with data loggers were used to measure water level changes, and a logger was deployed at the test location to record barometric pressure during the period of observation. Tetra Tech initiated collection of background water level readings on October 13, 2009 in well UFMW-A1, approximately 16 days before the start of pumping. CRDT monitoring using an escalating recording interval was started approximately 10 minutes prior to initiating the CRDT. Water level readings were recorded throughout the duration of the 24-hour CRDT, and the loggers were downloaded and reset shortly before the end of pumping to record the recovery response of the pumped and observation wells.

Onsite observation wells used during the second CRDT are:

- Surficial aquifer well SMW-A1;
- Upper Floridan aquifer well UFMW-A1.

Table 3-1 summarizes the distances of the wells monitored during the CRDT from the TPW-A1 and the observation intervals during the test.

3.1.5 Analyses (TPW-A1 APPZ)

The second CRDT was, in effect, a single-well test. The Jacob-Cooper time-drawdown solution for the non-equilibrium equation was used to calculate a transmissivity from the drawdown data. Water level data indicate that head in the UFA at the Chapman site had not reached equilibrium, and analysis of the recovery data would not produce reliable results.

3.1.5.1 Hydrographs and Time-Series Graphs

Wells used to determine aquifer hydraulic parameters include TPW-A1, UFMW-A1, and SFWMD OSF-66. Graphs of the time-series data for those wells along with well SMW-A1, barometric pressure recorded by the barologger, and rainfall are provided in **Appendix K.2**. The background, pumping, and recovery portions of the CRDT are marked on the hydrographs for reference. Manual measurements, identified with a “+” symbol, are also illustrated on the graphs.

During the period of the second CRDT, water levels in well SMW-A1 appear to have responded only to evapotranspiration, rainfall, and drainage.

3.1.5.2 Calculations

The data used to calculate the aquifer hydraulic parameters from the second (APPZ) CRDT are provided in **Appendix K.3**, and are summarized in **Table 3-2**. The mean transmissivity for the UFAS (including the APPZ) calculated using only drawdown data at well TPW-A1, is approximately 150,000 ft^2/day. Storativity and leakance could not be calculated from this test since no observation wells monitored the same interval as the pumping well. Recovery data were not used because the aquifer at the Chapman site had not reached equilibrium at the end of the 24-hour CRDT, and use of recovery data would not provide reliable results.

3.2 Lower Floridan Aquifer

Prediction of drawdown impacts from the proposed Cypress Lake AWS wellfield will require accurate estimates of aquifer hydraulic properties. Calibration of the model will also require time-series records of drawdown responses to known pumping stresses. A 14-day CRDT was used to obtain these data for the LFAS at the Chapman Site. Tetra Tech designed the LFA test and provided a summary of the testing procedures to the SFWMD for review prior to bidding of the well construction and testing for the project.

3.2.1 Step Drawdown Testing

Step drawdown testing was conducted on well TPW-A1 and both LFA monitor wells (LFMWA2 and LFMW-A3) after the final casing had been installed in each. A copy of the flow meter certificate of calibration is provided in **Appendix I.1**.

3.2.1.1 TPW-A1

On March 4, 2010, Tetra Tech conducted a SDT at the TPW-A1 to determine specific capacity and well efficiency. The open borehole was at a depth of 1,636 feet BLS and the well was cased to a depth of 1,350 feet BLS. The SDT was performed at four discrete discharge rates, representing discharge steps of 60-minute duration and rates of 500, 2,105, 2,570, and 3,085 gpm followed by 60 minutes of recovery monitoring. The total continuous pumping time for the test was four hours with exactly one hour of pumping for each of the four steps. In the first step of the SDT the contractor's acoustic flow meter failed to accurately report flow, and consequently, the flow rate was incorrect for the first step, therefore making the associated specific capacity and well efficiency calculations inaccurate for the first step. Specific capacities were calculated at 101.7 gpm/ft at a pumping rate of 2,108 gpm and a drawdown of 20.70 feet, 94.5 gpm/ft at a pumping rate of 2,570 gpm, and a drawdown of 27.20 feet, and 87.1 gpm/ft at a pumping rate of 3,085 gpm and a drawdown of 35.40 feet.

As described in **Section 3.1.1.1**, Tetra Tech employed the Hantush-Bierschenk method to evaluate well efficiency. The well efficiency values using the Hantush-Bierschenk method for the last three pumping steps range from 64% at 2,105 gpm to 55% at 3,085 gpm. The SDT results and well efficiency graphs, along with the well efficiency calculations and hand measurements for the TPW-A1 are provided in **Appendix J.2**.

3.2.1.2 LFMW-A2

On April 20, 2010, Tetra Tech conducted a SDT at the LFMW-A2 to determine specific capacity and well efficiency. Well LFMW-A2 was open to a depth of 1,560 feet BLS with an 8-inch steel final casing to a depth of 1,350 feet BLS. The SDT was performed at four discrete discharge rates, representing discharge steps of 60-minute duration and rates of 268, 313, 373, and 423 gpm followed by 60 minutes of recovery monitoring. The total continuous pumping time for the test was four hours with exactly one hour of pumping for each of the four steps. Specific capacities were calculated at 48.7 gpm/ft at a pumping rate of 268 gpm and a drawdown of 5.50 feet, 45.7 gpm/ft at a pumping rate of 313 gpm and a drawdown of 6.85 feet, 44.4 gpm/ft at a pumping rate of 373 gpm and a drawdown of 8.40 feet, and 41.7 gpm/ft at a pumping rate of 423 gpm and a drawdown of 10.15.

The pumped well efficiency values calculated using the Hantush-Bierschenk method for the four pumping steps range from 73% at 268 gpm, to 63% at 423 gpm. The SDT results and well efficiency graphs, along with the well efficiency calculations and hand measurements for the LFMW-A2 are provided in **Appendix J.3**.

3.2.1.3 LFMW-A3

On July 14, 2010, Tetra Tech conducted a SDT at the LFMW-A3 to determine specific capacity and well efficiency. Well LFMW-A3 was open to a depth of 1,560 feet BLS with an 8-inch steel final casing to a depth of 1,350 feet BLS. The SDT was performed at four discrete discharge rates, representing discharge steps of 60-minute duration and rates of 298, 347, 405, and 440 gpm followed by 60 minutes of recovery monitoring. The total continuous pumping time for the test was four hours with exactly one hour of pumping for each of the four steps. Specific capacities were calculated at 41.1 gpm/ft at a pumping rate of 298 gpm and a drawdown of 7.25 feet, 37.7 gpm/ft at a pumping rate of 347 gpm and a drawdown of 9.20 feet, 36.2 gpm/ft at a pumping rate of 405 gpm and a drawdown of 11.20 feet, and 34.4 gpm/ft at a pumping rate of 440 gpm and a drawdown of 12.80 feet.

The pumped well efficiency values calculated using the Hantush-Bierschenk method for the four pumping steps ranged from 62% at 298 gpm to 52% at 440 gpm. The SDT results and well efficiency graphs, along with the well efficiency calculations and hand measurements for the LFMW-A3 are provided in **Appendix J.4**.

3.2.2 Constant Rate Discharge Test (TPW-A1 LF1)

A 14-day, LF1 CRDT was started at 1:30 P.M. on July 22, 2010 and terminated at 1:30 P.M. on August 5, 2010. Well TPW-A1 (constructed with the open borehole to a depth of 1,557 feet BLS and cased to a depth of 1,350 feet BLS) was pumped at an overall weighted average discharge for the duration of the test of 2,179 gpm.

Water levels were recorded at the following wells:

- TPW-A1 (UFA annular monitoring zone and LF1 production zone);
- UFMW-A1 (UFA)
- LFMW-A2 (LF1)
- LFMW-A3 (LF1)
- TZMW-A1 (APPZ, LF1, LC1)
- SMW-A1, SMW-A2, and SMW-A3 (SAS)

Water levels were monitored in each of these wells during the background, pumping, and recovery phases of the test. For long-term regional monitoring, the SFWMD records water levels in UFA well OSF-66 using a recording interval of 15 minutes. For the pumping portion of the 14-day CRDT, the SFWMD recorded UFA water levels at well OSF-66 using a recording interval of one minute. Water pumped during the CRDT was discharged to land surface approximately 200 feet from well TPW-A1. Discharge water drained by overland flow to a roadside drainage swale that drained southeast to a drainage ditch. A copy of the flow meter certificate of calibration is provided in **Appendix I.2**. The location of the discharge point as well as all on-site observation wells are illustrated in **Figure 3-1**.

Rainfall and barometric pressure were recorded during the 14-day CRDT. A barometric pressure logger ("barologger") recorded barometric pressure using an escalating recording interval during the test, and a plastic non-recording rain gauge was inspected daily. Water level measurements during the recovery period were collected manually for more than an hour following the conclusion of the test and electronically using water level loggers in the wells mentioned above until the morning of August 20, 2010, a period of nearly fifteen days. Field data from the CRDT, including, discharge recorded at the totalizer and discharge recorded by pressure transducer and data logger at the orifice weir, manual water level measurements, and field measured water quality parameters, are provided in **Appendix L.1**. Water levels and drawdown are illustrated in hydrographs (**Appendix K.2**), and CRDT recorded data are tabulated in **Appendix K.3**.

On August 5, 2010, a water quality sample was collected from well TPW-A1 for laboratory analysis of the following analytes:

arsenic	barium	sodium
chloride	fluoride	iron
sulfate	pH	TDS
total alkalinity	bicarbonate alkalinity	calcium
specific conductance	sulfide	hydrogen sulfide
HPC	magnesium	potassium
TOC		

The sample was delivered to TestAmerica Laboratories, Inc. for analysis. Lab results provided in **Appendix L.2** indicate that only three of the parameters listed above were in exceedance of the Florida Department of Environmental Protection's (FDEP) Primary and Secondary Drinking

Water Standards for sodium, chloride and TDS. Sodium concentration was reported to be 270 mg/L compared to the Primary Standard MCL of 160 mg/L; chloride concentration was reported to be 440 mg/L compared to the Secondary Standard MCL of 250 mg/L; and TDS concentration was reported to be 960 mg/L compared to the Secondary Standard MCL of 500 mg/L. All other concentrations tested were within the FDEP Drinking Water Standards. The laboratory results for the parameters analyzed in this sample are similar to results for the primary and secondary drinking water standards on March 3, 2010.

3.2.2.1 Water Level Data Logger Deployment

Vented pressure transducers with data loggers were used to record water levels, and a barologger was deployed at the test location to record barometric pressure during the period of observation. Tetra Tech initiated collection of background water level readings on July 15, 2010, approximately one week before the start of pumping. CRDT monitoring using an escalating recording interval was started approximately 10 minutes prior to initiating the CRDT. Water levels were recorded throughout the duration of the 14-day CRDT, and the loggers were downloaded and reset shortly before the end of pumping to record the recovery response of the pumped and observation wells.

Grouped by aquifer interval, observation wells monitored during the CRDT are:

- Surficial aquifer – wells SMW-A1, SMW-A2 and SMW-A3;
- Upper Floridan aquifer system – wells TPW-A1 (UFA), UFMW-A1 (UFA) and TZMW-A1 (APPZ);
- Lower Floridan aquifer system – wells TPW-A1 (LF1), TZMW-A1 (LF1), LFMW-A2 (LF1), LFMW-A3 (LF1), and TZMW-A1 (LC1).

Table 3-1 summarizes the radial distances from each observation well to test/production well TPW-A1, and the observation intervals during the test.

3.2.3 Analyses (TPW-A1 LF1)

Transmissivity, storativity, and total leakance values for LF1 at the Chapman site were calculated using the Cooper-Jacob time drawdown method, the Hantush-Jacob leaky aquifer method, the Cooper-Jacob distance drawdown method, and a spreadsheet method that couples the Cooper-Jacob solution to the Hantush-Walton solution.

3.2.3.1 Hydrographs and Time-Series Graphs

Wells monitoring LF1 that were used to determine the aquifer hydraulic properties that comprise the pumping well, TPW-A1, TZMW-A1, LFMW-A2, and LFMW-A3. Graphs of time-series data for these four wells along with well SMW-A1, SMW-A2, SMW-A3, SAS-4, TPW-A1 (UFA), UFMW-A1, OSF-66, TZMW-A1 (APPZ), TZMW-A1 (LC1), Bronson site well DZMW-1 (LC1), the Chapman site barologger, the Bronson site barologger, and Chapman site rainfall are provided in **Appendix L.3**. For reference, lines designating the breaks between the background, pumping, and recovery periods of the CRDT are illustrated on the time-series plots. Manual measurements, identified with a "+" symbol, are also illustrated on the hydrographs.

3.2.3.2 Corrections

The water level data from for all four wells constructed in LF1 were used estimating transmissivity, storativity coefficient, and total leakance. Data from each time series were examined for indications of antecedent or regional trends that could bias the analyses. Antecedent trends and regional effects appear to influence water levels prior to and during the 14-day CRDT. We judged that all of the data had trends that should be removed of external influences.

The method employed is similar to that described by Halford (2006) and the method used to analyze test data from the Bronson site (Tetra Tech, 2008). Data from several time-series were combined to mimic the water levels observed in the subject well. Three or four time series were used for the corrections:

- Bronson UFA observation UFMW-1
- SFWMD well OSF-104M
- Barologger at the Chapman site
- Synthetic earth tide calculated using the Tsoft code (Van Camp and Vauterin, 2005)
- Air temperature at the Chapman site
- Calculated linear trend

Using the spreadsheet (**Appendix L.4**), we scaled the amplitude and shifted the phase of each time series to best fit the observed data. We used implicit indicators, the slope and standard deviation of the antecedent interval of the corrected data series, for evaluating the closeness of the fit between synthetic and observed water levels. Each data series had different interferences and not all interferences are regular or repeated. Consequently, the closeness of fit deemed acceptable varied from well to well.

Air temperature trends would not be expected to be a component of head in the Floridan aquifer, but all of the data were collected using pressure transducers, and "vented" transducers were used in a few wells. In some cases, the vent line on the transducer may become partially obstructed and the transducer then incorporates a temperature-proportional trend into the data. Other temperature influences may be possible, but temperature trends exhibit a single systematic cycle of rising and falling water level that is lowest near the warmest time of day and highest near the coolest time. UFA well OSF-66 exhibits that pattern.

The regional wells used for extraction of regional trends were OSF-104M and UFMW-1 (Bronson Site, **Figure 3-2**). The regional trends observed during the CRDT at the Chapman site most closely resembled UFMW-1, and it was this well that was most frequently used to extract the regional trends from the observed data. The field data and corrected data are plotted on the potentiometric head change graphs provided in **Figure 3-3** through **Figure 3-6**. The corrected data were the data used to calculate the hydrogeologic parameters and are provided in **Appendix L.4**.

3.2.3.3 Summary of Results

Aquifer hydraulic properties

The data used to calculate the hydrogeologic parameters from the LFA CRDT are in **Appendix L.4**, and the aquifer hydraulic properties of LF1 are listed in **Table 3-3**. The mean LFA transmissivity calculated from all of the analyses is approximately 37,000 ft^2/day, the mean storativity calculated from all of the analyses is 8.22×10^{-5}, and the mean leakance calculated from all of the analyses is 4.06×10^{-4}, ft/day/ft.

Equilibrium drawdown

At a discharge of 2,179 gpm from well TPW-1A, the equilibrium drawdown in LF1 at a distance of 124 feet is approximately 8.2 feet; at a distance of 732 feet it is approximately 5.0 feet; and at a distance of 1,982 feet it is approximately 3.1 feet. The CRDT was performed at the discharge designed for each well of the proposed Cypress Lake wellfield. The observed equilibrium drawdown can be projected to the distance of each well in the wellfield, and the cumulative drawdown effects (interference) calculated. Calculating interference from the observed response, the maximum interference at any LF1 well in the Cypress Lake wellfield will be 9.0 feet.

The water level time-series for the LC1 interval in well TZMW-A1 did not clearly indicate that drawdown was recorded at that depth. The corrected data may show almost 0.1 feet of delayed drawdown that starts seven days after the start of the CRDT, and that reached equilibrium 10½ or 11 days after the test started. We did not recognize drawdown in the Upper Floridan aquifer at either of the UFA monitoring wells: UFMW-A1 or the UFA observation interval of well TPW-A1. In contrast, the APPZ monitoring zone of TZMW-A1 recorded a nearly instantaneous drawdown response to the start of the CRDT. Drawdown in the APPZ stabilized at 0.1 feet after 2½ days of pumping. A similar recovery response was evident. The clear drawdown response to pumping in the APPZ indicates that during long-term pumping, leakage into the production interval (LF1) will be predominantly from the APPZ zone of the UFA rather than from the lower (saline) portions of the LFA (LC1 or BZ). The relatively rapid equilibration of head in LF1 also indicates that leakage into the pumped aquifer reached equilibrium with pumpage within 2½ days, and that the source of water is close to the pumped well, rather than distant.

SECTION 4
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

4.1 Summary

One test/production well and three monitor wells were constructed into the Lower Floridan aquifer system (LFAS), one monitor well was constructed into the Upper Floridan aquifer, and three monitor wells constructed into the surficial aquifer to evaluate the aquifer hydraulic properties of the UFAS and LFAS at the south end of the proposed Cypress Lake wellfield (Chapman site). The Chapman site is located at the southern end of the proposed Cypress Lake wellfield, approximately seven miles southeast of the initial exploratory well site (Bronson site).

Overall, the testing program at Chapman comprised:

- Construction and logging of an UFA observation well;
- Construction and logging of an LFA exploratory test/production well;
- Construction and logging of an LFAS tri-zone observation well (originally designed as a dual-zone monitor well) completed in the Avon Park permeable zone (APPZ), in the production zone (LF1), and in the underlying lower confining unit (LC1);
- Drill-stem sampling for field and laboratory water quality analysis of groundwater;
- Sampling and analysis of groundwater from selected intervals during packer tests;
- Construction and logging of two additional LF1 production zone observation wells;
- Execution and analysis of constant rate discharge tests in the UFA (including the APPZ) and in the LFA;
- Construction of three surficial aquifer monitor wells;
- Sampling for field and laboratory analysis of groundwater during the LFA CRDT;

- Analysis of aquifer testing data to determine aquifer hydraulic properties.

The well drilling sequence and aquifer testing was conducted in three phases to allow targeted determination of important aquifer hydraulic properties of the UFA, the overlying intermediate confining unit (ICU), the underlying APPZ, the middle semi-confining unit (MC1), the LFA, and the LC1. Each aquifer testing phase followed completion of the test production well to the expected base of significant aquifer units. The first phase ended with a 24-hour CRDT in the UFA; the second phase ended with a 24-hour CRDT in the UFA and APPZ; and the third phase ended with the 14-day CRDT in the LFA.

Well construction and aquifer testing at the Chapman Site provided hydrogeologic data that was previously unavailable for this portion of Osceola County. Hydrogeologic data obtained from well construction and aquifer testing of the wells at the Chapman site includes the following:

- The top of the Floridan aquifer system (FAS) is at a depth of 310 feet below land surface (BLS) at the Chapman Site.

- The mean (or average) transmissivity value for the UFA (not including the APPZ) using only onsite wells TPW-A1 and UFMW-A1 is approximately 9,100 ft2/day, the mean storativity value is approximately 8.7 x 10-5 (commonly shown as dimensionless) and the mean combined leakance value of the overlying and underlying confining units is approximately 8.7 x 10-5 ft/day/ft. The mean transmissivity value for the UFA calculated using the onsite wells and OSF-66, is approximately 19,000 ft2/day, the mean storativity value is approximately 0.00012 and the mean leakance value is approximately 0.00020 ft/day/ft.

- The MC1 occurs from 440 to 697 feet BLS.

- The APPZ occurs from 697 to 1,190 feet BLS.

- The mean transmissivity value for the UFAS (including the APPZ) calculated using only drawdown data at well TPW-A1 is approximately 150,000 ft2/day. Storativity and leakance values could not be calculated from this test since no observation wells monitored the same interval as the pumping well.

- The MC2 occurs from 1,190 to 1,305 feet BLS.

- Aquifer performance testing, lithologic logs, geophysical logs, and borehole video logs indicate that the Upper Floridan aquifer system (UFA and APPZ), has good production capacity with a correspondingly high value of transmissivity. Specific capacity values from the UFMW-A1 SDT (UFA) range from 13 to 16 gpm/ft at pumping rates between 209 and 412 gpm and with measured drawdown between 13.01 to 32.33 feet. Specific capacity from CRDT No. 1 (UFA and APPZ) indicates 25 gpm/ft at a pumping rate of 1,350 gpm and with measured drawdown of 53 feet.

- The top of the LFAS, as indicated by lithologic and geophysical logs occurs at a depth of 1,305 feet BLS, and units of the lower Floridan aquifer extended to the deepest penetration of the pilot hole boring at a depth of 2,362 feet BLS (with open intervals of the BZ present from 1,965 to 2,235feet BLS).

- Aquifer performance testing, lithologic logs, geophysical logs, and borehole video logs indicate that the production zone (LF1) of the LFAS at the Chapman Site (1,305 to 1,610 feet BLS) has very good production capacity with a correspondingly high value transmissivity.

- Testing of well TPW-A1 while open in Lower Floridan aquifer (LF1) indicates a specific capacity value of 62 gpm/ft at a pumping rate of 2,179 gpm with measured drawdown of 35 feet.

- At a discharge of 2,179 gpm from the LFA test/production well (TPW-1A), equilibrium drawdown in the observation well at a distance of 124 feet is approximately 8.2 feet; at a distance of 732 feet is approximately 5.0 feet; and at 1,982 feet is approximately 3.1 feet. Extrapolating drawdown over the extent of the proposed Cypress Lake wellfield, the maximum interference at any well will be approximately nine feet.

- The mean (or average) LF1 transmissivity is approximately 37,000 ft2/day, the mean storativity is 0.000082, and the mean leakance of the overlying and underlying semi confining units is 0.00041 ft/day/ft.

- Drawdown was not detected in the LC1 during the 14-day CRDT at the tri-zone monitor well (TZMW-A1) at a distance of 124 feet.

- Drawdown in the UFA at well UFMW-A1 and in the UFA observation interval of well TPW-A1 was not detected during the 14-day constant rate discharge test.

- The APPZ zone of tri-zone monitoring well TZMW-A1 recorded an immediate response to pumping, which reached equilibrium after approximately 2½ days of pumping. The equilibrium drawdown was 0.1 feet.

- Groundwater collection and laboratory analysis at the Chapman site produced the following results:

Hydrogeologic Unit	Well ID	Chloride (mg/L)	TDS (mg/L)	Iron (mg/L)
Upper Floridan	UFMW-A1	15	160	0.27
APPZ	*TPW-A1	46	360	0.26
LF1	TPW-A1	470	1,100	0.039

*Results from Packer Test #1 at TPW-A1

4.2 Conclusions

From these results, the following can be asserted:

- The absence of drawdown in LC1 and the rapid response to pumping in APPZ indicates that APPZ is the source bed for leakage into LF1 during pumping.

- The absence of drawdown response in LC1 indicates there is little potential for upconing of saline water into the production zone.

- Absence of drawdown response after 14 days in wells at the Bronson site indicates discharge of water from the production zone during pumping may have reached equilibrium with a local source of leakage.

- The testing results at the Chapman site near the southern end of the proposed Cypress Lake wellfield differ from the Lower Floridan aquifer results at the Bronson site near the northern end with respect to water quality identified during well construction, packer testing, and during aquifer testing. Water quality results identified higher chloride, sulfate, specific conductance, and TDS at the Chapman site that subsequently will require additional treatment to meet public supply standards.

Water quality testing indicates that groundwater in the proposed LF1 production zone will require treatment to meet public supply standards. It is feasible for the proposed Cypress Lake wellfield to sustain a long-term discharge of 3 million gallons per day per production well, therefore, evaluation of treatment options is recommended.

The results of this exploratory and testing program will be incorporated as aquifer parameters and calibration targets into the Cypress Lake MODFLOW model constructed in support of the Cypress Lake AWS Wellfield WUP application. Changes to the Cypress Lake MODFLOW model, and the results of modeling of wellfield impacts using the revised model, are addressed in a separate modeling report.

4.3 Recommendations

Based on the results of the Upper and Lower Floridan aquifer performance tests and water quality testing from the Lower Floridan aquifer (LF1), Tetra Tech recommends design and construction (total depth and final casing depth) of future Cypress Lake production wells to a depth similar to the production well at the Chapman site.

Initial discussions with Toho have identified a preliminary wellfield alignment beginning at the Bronson (north end of the Cypress Lake wellfield) exploratory well site and extending approximately seven miles south along Canoe Creek Road to the Chapman site with production wells spaced approximately 0.5 miles apart.

Treatment of water from LF1 to public supply standards will concomitantly produce a by-product disposal requirement. We recommend that Toho evaluate by-product disposal options such as by deep injection wells or other alternatives. Disposal by deep injection well is a likely option, and the permitting and exploratory well program for a deep injection well requires longer than 1 year to complete. Further, because of the long time frames associated with deep injection well investigations, Tetra Tech recommends contacting the FDEP to discuss permitting requirements for an exploratory well program, and initiating deep injection well investigations at the earliest possible date.

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TABLES

TABLE 2-1
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

WELL CONSTRUCTION SUMMARY

WELL ID	WELL CONSTRUCTION PERMIT #	WELL COMPLETION DATE	WELL COMPLETION REPORT #	HYDRO-GEOLOGIC UNIT	WELL TYPE	FINAL CASING DEPTH (ft bls)	CASING MATERIAL	TOTAL DEPTH (ft bls)	TOP OF CASING (ft NGVD)	DEPTH TO WATER* (ft btoc)	GROUND-WATER ELEVATION* (ft NGVD)	LOCATION COORDINATES (SPE83 ft)	
												EASTING	NORTHING
UFMW-A1	49-59-07883	09/24/2009	4959-07883	UFA	6" Open Hole	315	Steel	600	73.51	26.83	46.68	589662.666	1343156.605
TPW-A1	49-59-07882	08/30/2010	4959-07882	LF1	15" Open Hole	1,350	PVC	1,557**	73.87	27.00	46.87	589648.035	1343056.546
SMW-A1	49-59-07928	08/12/2009	--	SAS	2" Screened	10.00	PVC	20.00	73.22	4.64	68.58	589621.709	1343039.206
TZMW-A1	49-59-07884	07/15/2010	4959-07884	APPZ	2" Screened	820	Steel	840	72.07	25.38	46.69	589721.42	1342956.709
	49-59-07884	07/15/2010	4959-07884	LF1	14" Open Hole	1,350	Steel	1,560	72.93	29.11	43.82	589721.42	1342956.709
	49-59-07884	07/15/2010	4959-07884	LC1	8" Open Hole	1,880	Steel	1,930	73.47	25.46	48.01	589721.42	1342956.709
LFMW-A2	49-59-07886	04/21/2010	4959-07886	LF1	8" Open Hole	1,350	Steel	1,560	71.82	24.62	47.20	589075.765	1342565.624
SMW-A2	49-59-07928	10/21/2009	--	SAS	2" Screened	9.94	PVC	19.94	70.91	4.13	66.78	589095.563	1342576.044
LFMW-A3	49-59-07885	07/14/2010	4959-07885	LF1	8" Open Hole	1,350	Steel	1,560	72.82	25.17	47.65	588030.433	1344201.671
SMW-A3	49-59-07928	10/22/2009	--	SAS	2" Screened	9.60	PVC	19.60	71.28	5.39	65.89	588011.998	1344173.289

SAS - Surficial Aquifer System
UFA - Upper Floridan Aquifer
APPZ - Avon Park Permeable Zone
LF1 - Lower Floridan Aquifer - upper zone
LC1 - Lower Confining Unit1
*Water levels measured on 08/20/2010.
**Pilot hole drilled to a depth of 2,632 ft bls and back-plugged to a final depth of 1,557 ft bls.

TABLE 2-2
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UFMW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
PIT CASING									
1		07/28/2009	18	42.00	42.00		MAG		FDD-WWS / Bruce Balmer
2	(Header)	07/28/2009	18	22.00	64.00		MAG		FDD-WWS / Bruce Balmer
*Stick-up is 9 feet, total depth for the pit casing is 55 feet.									
SURFACE CASING									
1	H0814979	07/30/2009	12	42.09	42.09	09:01	BW	Yes	FDD-WWS / Bruce Balmer
2	J14708	07/30/2009	12	42.15	84.24	09:34	BW	Yes	FDD-WWS / Bruce Balmer
3	O3C15214	07/30/2009	12	25.76	110.00	10:02	BW	Yes	FDD-WWS / Bruce Balmer
*Stick-up is 3 feet, total depth for the surface casing is 107 feet.									
FINAL CASING									
1	G020739	08/6/2009	6	42.17	42.17	09:01	WBL	Yes	FDD-WWS / Bruce Balmer
2	G020739	08/6/2009	6	42.15	84.32	09:15	WBL	Yes	FDD-WWS / Bruce Balmer
3	G020739	08/6/2009	6	42.15	126.47	09:22	WBL	Yes	FDD-WWS / Bruce Balmer
4	G020739	08/6/2009	6	42.15	168.62	09:30	WBL	Yes	FDD-WWS / Bruce Balmer
5	G020739	08/6/2009	6	42.17	210.79	09:40	WBL	Yes	FDD-WWS / Bruce Balmer
6	G020739	08/6/2009	6	42.18	252.97	09:54	WBL	Yes	FDD-WWS / Bruce Balmer
7	G020739	08/6/2009	6	42.15	295.12	10:06	WBL	Yes	FDD-WWS / Bruce Balmer
8	36350008	08/6/2009	6	25.25	320.37	10:20	WBL	Yes	FDD-WWS / Bruce Balmer
*Stick-up is 5.37 feet, total depth for the final casing is 315 feet.									

TABLE 2-3
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UFMW-A1 GROUT SUMMARY

STAGE NO.	DATE	MIX	CASING TYPE	CASING DIAMETER (IN)	WEIGHT (LBS/GAL)	SACKS	BARRELS	CUBIC FEET	CUBIC YARDS	START DEPTH (FT)	STOP DEPTH (FT)	ACTUAL FILL (FT)
						PUMPED						
PIT CASING GROUT												
1	07/28/09	NEAT (on site)	Steel	18	15.50	63.82	13.41	75.31	2.79	60	0	60
				TOTALS		**63.82**	**13.41**	**75.31**	**2.79**			**60**
SURFACE CASING GROUT												
1	07/30/09	NEAT (on site)	Steel	12	15.50	95.73	20.12	112.96	4.18	110	0	110
				TOTALS		**95.73**	**20.12**	**112.96**	**4.18**			**110**
FINAL CASING GROUT												
1	08/06/09	NEAT (on site)	Steel	6	15.45	95.73	20.12	112.96	4.18	315	81	234
2	08/10/09	NEAT (on site)	Steel	6	15.20	34.04	7.15	40.17	1.49	81	0	81
				TOTALS		**129.77**	**27.27**	**153.13**	**5.67**			**315**

TABLE 2-4
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
PIT CASING									
1		07/23/2009	42	55.00	55.00	14:00	BW		FDD-WWS / Bruce Balmer
2	(Header)	07/23/2009	42	13.00	68.00	14:17	BW		FDD-WWS / Bruce Balmer
*Stick-up is 13 feet, total depth for the pit casing is 55 feet.									
SURFACE CASING									
1	P1236A	08/17/2009	30	7.00	7.00	07:35	BW	Yes	FDD / Adrian Padron
2	P1278A	08/17/2009	30	40.09	47.09	08:48	BW	Yes	FDD / Adrian Padron
3	P1278A	08/17/2009	30	39.12	86.21	09:46	BW	Yes	FDD / Adrian Padron
4	P0477A	08/17/2009	30	38.55	124.76	10:47	BW	Yes	FDD / Adrian Padron
5	H810549	08/17/2009	30	40.10	164.86	11:36	BW	Yes	FDD / Adrian Padron
6	P0477A	08/17/2009	30	39.20	204.06	12:17	BW	Yes	FDD / Adrian Padron
7	P0477A	08/17/2009	30	39.00	243.06	13:03	BW	Yes	FDD / Adrian Padron
8	H820431	08/17/2009	30	39.00	282.06	13:43	BW	Yes	FDD / Adrian Padron
9	(Header)	08/17/2009	30	34.90	316.96	14:32	BW	Yes	FDD / Adrian Padron
*Stick-up is 1 foot & eye beam is 0.96 feet, total depth for the surface casing is 315 feet.									
INTERMEDIATE CASING									
1	C826024	11/4/2009	24	21.08	21.08	09:15	MAG	Yes	FDD / Adrian Padron
2	C836683	11/4/2009	24	42.12	63.20	10:20	MAG	Yes	FDD / Adrian Padron
3	C836684	11/4/2009	24	42.09	105.29	10:55	MAG	Yes	FDD / Adrian Padron
4	C836684	11/4/2009	24	42.11	147.40	11:26	MAG	Yes	FDD / Adrian Padron
5	C836683	11/4/2009	24	42.09	189.49	11:58	MAG	Yes	FDD / Adrian Padron
6	C836682	11/4/2009	24	42.09	231.58	12:25	MAG	Yes	FDD / Adrian Padron
7	C836684	11/4/2009	24	42.07	273.65	12:54	MAG	Yes	FDD / Adrian Padron
8	C836684	11/4/2009	24	42.09	315.74	13:21	MAG	Yes	FDD / Adrian Padron
9	C836684	11/4/2009	24	42.09	357.83	13:50	MAG	Yes	FDD / Adrian Padron
10	C836684	11/4/2009	24	42.08	399.91	14:29	MAG	Yes	FDD / Adrian Padron
11	C836684	11/4/2009	24	42.09	442.00	15:01	MAG	Yes	FDD / Adrian Padron

TABLE 2-4 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
INTERMEDIATE CASING (CONTINUED)									
12	C836682	11/4/2009	24	42.10	484.10	15:30	MAG	Yes	FDD / Adrian Padron
13	C836683	11/4/2009	24	42.09	526.19	16:03	MAG	Yes	FDD / Adrian Padron
14	C836684	11/4/2009	24	42.07	568.26	16:35	MAG	Yes	FDD / Adrian Padron
15	C836682	11/4/2009	24	42.07	610.33	17:08	MAG	Yes	FDD / Adrian Padron
16	C836684	11/4/2009	24	42.10	652.43	17:41	MAG	Yes	FDD / Adrian Padron
17	C836684	11/5/2009	24	42.06	694.49	07:20	WBL	Yes	FDD / Adrian Padron
18	C832615	11/5/2009	24	42.07	736.56	07:40	WBL	Yes	FDD / Adrian Padron
19	C832615	11/5/2009	24	40.07	776.63	08:12	WBL	Yes	FDD / Adrian Padron
20	C832614	11/5/2009	24	40.08	816.71	08:45	WBL	Yes	FDD / Adrian Padron
21	C832615	11/5/2009	24	40.06	856.77	09:14	WBL	Yes	FDD / Adrian Padron
22	C832615	11/5/2009	24	40.06	896.83	09:46	WBL	Yes	FDD / Adrian Padron
23	C832615	11/5/2009	24	40.06	936.89	10:17	WBL	Yes	FDD / Adrian Padron
24	C832615	11/5/2009	24	40.08	976.97	11:40	WBL	Yes	FDD / Adrian Padron
25	(Header)	11/5/2009	24	42.05	1019.02	12:14	WBL	Yes	FDD / Adrian Padron
*Stick-up is 7.02 feet, total depth for the intermediate casing is 1,012 feet.									
FINAL CASING									
1	NA	02/18/2010	17.4	20.00	20.00	10:45	BW	Yes	FDD / Adrian Padron
2	NA	02/18/2010	17.4	20.00	40.00	11:11	BW	No	FDD / Adrian Padron
3	NA	02/18/2010	17.4	20.00	60.00	11:19	BW	Yes	FDD / Adrian Padron
4	NA	02/18/2010	17.4	20.00	80.00	11:26	BW	No	FDD / Adrian Padron
5	NA	02/18/2010	17.4	20.00	100.00	11:32	BW	Yes	FDD / Adrian Padron
6	NA	02/18/2010	17.4	20.00	120.00	11:36	BW	No	FDD / Adrian Padron
7	NA	02/18/2010	17.4	20.00	140.00	11:43	BW	Yes	FDD / Adrian Padron
8	NA	02/18/2010	17.4	20.00	160.00	11:48	BW	No	FDD / Adrian Padron
9	NA	02/18/2010	17.4	20.00	180.00	11:53	BW	Yes	FDD / Adrian Padron
10	NA	02/18/2010	17.4	20.00	200.00	11:58	BW	No	FDD / Adrian Padron
11	NA	02/18/2010	17.4	20.00	220.00	13:04	BW	Yes	FDD / Adrian Padron
12	NA	02/18/2010	17.4	20.00	240.00	13:08	BW	No	FDD / Adrian Padron
13	NA	02/18/2010	17.4	20.00	260.00	13:13	BW	Yes	FDD / Adrian Padron
14	NA	02/18/2010	17.4	20.00	280.00	13:18	BW	No	FDD / Adrian Padron

TABLE 2-4 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
FINAL CASING (CONTINUED)									
15	NA	02/18/2010	17.4	20.00	300.00	13:23	BW	Yes	FDD / Adrian Padron
16	NA	02/18/2010	17.4	20.00	320.00	13:27	BW	No	FDD / Adrian Padron
17	NA	02/18/2010	17.4	20.00	340.00	13:33	BW	Yes	FDD / Adrian Padron
18	NA	02/18/2010	17.4	20.00	360.00	13:40	BW	No	FDD / Adrian Padron
19	NA	02/18/2010	17.4	20.00	380.00	13:49	BW	Yes	FDD / Adrian Padron
20	NA	02/18/2010	17.4	20.00	400.00	13:53	BW	No	FDD / Adrian Padron
21	NA	02/18/2010	17.4	20.00	420.00	14:06	BW	Yes	FDD / Adrian Padron
22	NA	02/18/2010	17.4	20.00	440.00	14:11	BW	No	FDD / Adrian Padron
23	NA	02/18/2010	17.4	20.00	460.00	14:15	BW	Yes	FDD / Adrian Padron
24	NA	02/18/2010	17.4	20.00	480.00	14:18	BW	No	FDD / Adrian Padron
25	NA	02/18/2010	17.4	20.00	500.00	14:24	BW	Yes	FDD / Adrian Padron
26	NA	02/18/2010	17.4	20.00	520.00	14:29	BW	No	FDD / Adrian Padron
27	NA	02/18/2010	17.4	20.00	540.00	14:35	BW	Yes	FDD / Adrian Padron
28	NA	02/18/2010	17.4	20.00	560.00	14:40	BW	No	FDD / Adrian Padron
29	NA	02/18/2010	17.4	20.00	580.00	14:45	BW	Yes	FDD / Adrian Padron
30	NA	02/18/2010	17.4	20.00	600.00	14:51	BW	No	FDD / Adrian Padron
31	NA	02/18/2010	17.4	20.00	620.00	14:55	BW	Yes	FDD / Adrian Padron
32	NA	02/18/2010	17.4	20.00	640.00	15:00	BW	No	FDD / Adrian Padron
33	NA	02/18/2010	17.4	20.00	660.00	15:28	BW	Yes	FDD / Adrian Padron
34	NA	02/18/2010	17.4	20.00	680.00	15:33	BW	No	FDD / Adrian Padron
35	NA	02/18/2010	17.4	20.00	700.00	15:40	BW	Yes	FDD / Adrian Padron
36	NA	02/18/2010	17.4	20.00	720.00	15:44	BW	No	FDD / Adrian Padron
37	NA	02/18/2010	17.4	20.00	740.00	15:49	BW	Yes	FDD / Adrian Padron
38	NA	02/18/2010	17.4	20.00	760.00	15:53	BW	No	FDD / Adrian Padron
39	NA	02/18/2010	17.4	20.00	780.00	15:58	BW	Yes	FDD / Adrian Padron
40	NA	02/18/2010	17.4	20.00	800.00	16:03	BW	No	FDD / Adrian Padron
41	NA	02/18/2010	17.4	20.00	820.00	16:09	BW	Yes	FDD / Adrian Padron
42	NA	02/18/2010	17.4	20.00	840.00	16:13	BW	No	FDD / Adrian Padron
43	NA	02/18/2010	17.4	20.00	860.00	16:19	BW	Yes	FDD / Adrian Padron
44	NA	02/18/2010	17.4	20.00	880.00	16:24	BW	No	FDD / Adrian Padron
45	NA	02/18/2010	17.4	20.00	900.00	16:29	BW	Yes	FDD / Adrian Padron
46	NA	02/18/2010	17.4	20.00	920.00	16:34	BW	No	FDD / Adrian Padron
47	NA	02/18/2010	17.4	20.00	940.00	16:40	BW	Yes	FDD / Adrian Padron

TABLE 2-4 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
FINAL CASING (CONTINUED)									
48	NA	02/18/2010	17.4	20.00	960.00	17:17	BW	No	FDD / Adrian Padron
49	NA	02/18/2010	17.4	20.00	980.00	17:22	BW	Yes	FDD / Adrian Padron
50	NA	02/18/2010	17.4	20.00	1000.00	17:26	BW	No	FDD / Adrian Padron
51	NA	02/18/2010	17.4	20.00	1020.00	17:32	BW	Yes	FDD / Adrian Padron
52	NA	02/18/2010	17.4	20.00	1040.00	17:36	BW	No	FDD / Adrian Padron
53	NA	02/18/2010	17.4	20.00	1060.00	17:40	BW	Yes	FDD / Adrian Padron
54	NA	02/18/2010	17.4	20.00	1080.00	17:43	BW	No	FDD / Adrian Padron
55	NA	02/18/2010	17.4	20.00	1100.00	17:47	BW	Yes	FDD / Adrian Padron
56	NA	02/18/2010	17.4	20.00	1120.00	17:52	BW	No	FDD / Adrian Padron
57	NA	02/18/2010	17.4	20.00	1140.00	17:57	BW	Yes	FDD / Adrian Padron
58	NA	02/18/2010	17.4	20.00	1160.00	18:02	BW	No	FDD / Adrian Padron
59	NA	02/19/2010	17.4	20.00	1180.00	08:35	MAG	Yes	FDD / Adrian Padron
60	NA	02/19/2010	17.4	20.00	1200.00	08:41	MAG	No	FDD / Adrian Padron
61	NA	02/19/2010	17.4	20.00	1220.00	08:47	MAG	Yes	FDD / Adrian Padron
62	NA	02/19/2010	17.4	20.00	1240.00	08:52	MAG	No	FDD / Adrian Padron
63	NA	02/19/2010	17.4	20.00	1260.00	09:07	MAG	Yes	FDD / Adrian Padron
64	NA	02/19/2010	17.4	20.00	1280.00	09:12	MAG	No	FDD / Adrian Padron
65	NA	02/19/2010	17.4	20.00	1300.00	09:21	MAG	Yes	FDD / Adrian Padron
66	NA	02/19/2010	17.4	20.00	1320.00	09:27	MAG	No	FDD / Adrian Padron
67	NA	02/19/2010	17.4	20.00	1340.00	09:33	MAG	Yes	FDD / Adrian Padron
68	NA	02/19/2010	17.4	20.00	1360.00	09:50	MAG	Yes	FDD / Adrian Padron
*Stick-up is 10 feet, total depth for the final casing is 1,350 feet.									

TABLE 2-5
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 GROUT SUMMARY

STAGE NO.	DATE	MIX	CASING TYPE	CASING DIAMETER (IN)	WEIGHT (LBS/GAL)	SACKS	BARRELS	CUBIC FEET	CUBIC YARDS	START DEPTH (FT)	STOP DEPTH (FT)	ACTUAL FILL (FT)
						PUMPED						
PIT CASING GROUT												
1	07/23/09	NEAT (on site)	Steel	42	15.40	63.82	13.41	75.31	2.79	55	0	55
				TOTALS		**63.82**	**13.41**	**75.31**	**2.79**			**55**
SURFACE CASING GROUT												
1	08/17/09	NEAT (Rinker Truck #1)	Steel	30	15.00	183.05	38.47	216.00	8.00	315	--	--
	08/17/09	NEAT (Rinker Truck #2)	Steel	30	15.40	183.05	38.47	216.00	8.00	--	--	--
	08/17/09	NEAT (Rinker Truck #3)	Steel	30	15.50	183.05	38.47	216.00	8.00	--	131	184
2	08/18/09	NEAT (Rinker Truck #1)	Steel	30	15.30	183.05	38.47	216.00	8.00	131	--	--
	08/18/09	NEAT (Rinker Truck #2)	Steel	30	15.30	183.05	38.47	216.00	8.00	--	--	--
	08/18/09	NEAT (Rinker Truck #3)	Steel	30	15.00	183.05	38.47	216.00	8.00	--	0	131
				TOTALS		**1098.31**	**230.81**	**1296.00**	**48.00**			**315**
INTERMEDIATE CASING GROUT												
1	11/06/09	NEAT (Rinker Truck #1)	Steel	24	14.80	183.05	38.47	216.00	8.00	1012	--	--
	11/06/09	NEAT (Rinker Truck #2)	Steel	24	14.90	68.64	14.43	81.00	3.00	--	788	224
2	11/09/09	NEAT (Rinker Truck #1)	Steel	24	14.90	183.05	38.47	216.00	8.00	788	--	--
	11/09/09	NEAT (Rinker Truck #2)	Steel	24	14.80	183.05	38.47	216.00	8.00	--	788	0
3	11/10/09	6/20 SAND	Steel	24	--	107.54	22.60	126.90	4.70	788	788	0
4	11/11/09	PEA GRAVEL	Steel	24	--	153.31	32.22	180.90	6.70	788	781	7
5	11/12/09	NEAT (Rinker Truck #1)	Steel	24	14.80	183.05	38.47	216.00	8.00	781	--	--
	11/12/09	NEAT (Rinker Truck #2)	Steel	24	14.60	183.05	38.47	216.00	8.00	--	716	65
6	11/13/09	PEA GRAVEL	Steel	24	--	128.14	26.93	151.20	5.60	716	656	60
	11/13/09	NEAT (Rinker Truck #1)	Steel	24	14.70	183.05	38.47	216.00	8.00	656	--	--
	11/13/09	NEAT (Rinker Truck #2)	Steel	24	14.80	183.05	38.47	216.00	8.00	--	656	0
7	11/16/09	NEAT (Rinker Truck #1)	Steel	24	15.30	183.05	38.47	216.00	8.00	656	--	--
	11/16/09	NEAT (Rinker Truck #2)	Steel	24	14.90	137.29	28.85	162.00	6.00	--	405	251
8	08/27/10	NEAT (Inland Truck #1)	Steel	24	14.90	183.05	38.47	216.00	8.00	405	--	--
	08/27/10	NEAT (Inland Truck #2)	Steel	24	14.90	183.05	38.47	216.00	8.00	--	135	270
9	08/30/10	NEAT (Inland Truck #1)	Steel	24	14.90	85.81	18.03	101.25	3.75	135	--	--
	08/30/10	NEAT (Inland Truck #2)	Steel	24	14.90	85.81	18.03	101.25	3.75	--	0	135
				TOTALS		**2597.03**	**545.77**	**3064.50**	**113.50**			**1012**

TABLE 2-5 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 GROUT SUMMARY

STAGE NO.	DATE	MIX	CASING TYPE	CASING DIAMETER (IN)	WEIGHT (LBS/GAL)	SACKS	BARRELS	CUBIC FEET	CUBIC YARDS	START DEPTH (FT)	STOP DEPTH (FT)	ACTUAL FILL (FT)
						PUMPED						
FINAL CASING GROUT												
1	02/19/10	Bentonite Chips	PVC	17.4	--	1.69	0.36	2.00	0.07	1350	--	--
	02/19/10	PEA GRAVEL (1/4-1/8")	PVC	17.4	--	10.17	2.14	12.00	0.44	--	1347	3
2	02/22/10	PEA GRAVEL (1/4-1/8")	PVC	17.4	--	4.35	0.91	5.13	0.19	1347	1344	3
	02/22/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/2	PVC	17.4	13.00	68.64	14.43	81.00	3.00	1344	1298	46
3	02/23/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.00	137.29	28.85	162.00	6.00	1298	--	--
	02/23/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.00	137.29	28.85	162.00	6.00	--	1130	168
4	02/24/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	14.60	137.29	28.85	162.00	6.00	1130	--	--
	02/24/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.10	137.29	28.85	162.00	6.00	--	915	215
5	02/25/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.80	137.29	28.85	162.00	6.00	915	--	--
	02/25/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.00	137.29	28.85	162.00	6.00	--	520	395
6	02/26/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.20	137.29	28.85	162.00	6.00	520	--	--
	02/26/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.20	137.29	28.85	162.00	6.00	--	216	304
7	03/01/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.30	137.29	28.85	162.00	6.00	216	--	--
	03/01/10	Bentonite Pre Mix (on site) & Type II (Inland) 2/4	PVC	17.4	13.60	68.64	14.43	81.00	3.00	--	8	208
				TOTALS		1389.09	291.92	1639.13	60.71			1342

TABLE 2-5 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 GROUT SUMMARY

STAGE NO.	DATE	MIX	CASING TYPE	CASING DIAMETER (IN)	WEIGHT (LBS/GAL)	SACKS	BARRELS	CUBIC FEET	CUBIC YARDS	START DEPTH (FT)	STOP DEPTH (FT)	ACTUAL FILL (FT)
						PUMPED						
BACKPLUG BOREHOLE												
1	01/19/10	NEAT (Williams)	NA	NA	14.90	183.05	38.47	216.00	8.00	2,362	2,350	12
2	01/20/10	GRAVEL	NA	NA	--	25.40	5.34	29.97	1.11	2,350	--	--
	01/20/10	NEAT (Williams)	NA	NA	14.90	91.53	19.23	108.00	4.00	--	--	--
	01/20/10	GRAVEL	NA	NA	--	14.42	3.03	17.01	0.63	--	2,310	40
3	01/21/10	GRAVEL	NA	NA	--	10.98	2.31	12.96	0.48	2,310	2,279	31
	01/21/10	NEAT (Williams)	NA	NA	15.00	91.53	19.23	108.00	4.00	2,279	2,258	21
4	01/22/10	GRAVEL	NA	NA	--	22.88	4.81	27.00	1.00	2,258	2,222	36
	01/22/10	NEAT (Williams)	NA	NA	15.00	91.53	19.23	108.00	4.00	2,222	2,207	15
5	--	BOREHOLE CUTTINGS	NA	NA	--	--	--	--	--	2,207	2,107	100
6	02/15/10	GRAVEL	NA	NA	--	178.47	37.51	210.60	7.80	2,107	1,942	165
	02/15/10	NEAT (Williams)	NA	NA	--	137.29	28.85	162.00	6.00	1,942	1,801	141
7	02/16/10	NEAT (Williams)	NA	NA	15.10	183.05	38.47	216.00	8.00	1,801	1,731	70
8	02/17/10	NEAT (Williams)	NA	NA	15.00	114.41	24.04	135.00	5.00	1,731	1,636	95
9	03/08/10	GRAVEL	NA	NA	--	50.80	10.68	59.94	2.22	1,636	1,604	32
10	03/09/10	NEAT (Williams Truck #1)	NA	NA	15.80	57.66	12.12	68.04	2.52	1,604	--	--
	03/09/10	NEAT (Williams Truck #2)	NA	NA	15.60	11.44	2.40	13.50	0.50	--	1,557	47
				TOTALS		**1264.42**	**265.72**	**1492.02**	**55.26**			**805**

TABLE 2-6
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TZMW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
PIT CASING									
1	P1236A	08/18/2009	30	39.05	39.05	14:34	BW	Yes	FDD-WWS / Bruce Balmer
2	P1252A	08/18/2009	30	16.95	56.00	14:58	BW	Yes	FDD-WWS / Bruce Balmer
*Stick-up is 1 foot, total depth for the pit casing is 55 feet.									
SURFACE CASING									
1	C815947	09/2/2009	20	21.06	21.06	08:05	BW	Yes	FDD-WWS / Bruce Balmer
2	C815947	09/2/2009	20	21.06	42.12	08:23	BW	No	FDD-WWS / Bruce Balmer
3	C815947	09/2/2009	20	21.06	63.18	08:38	BW	Yes	FDD-WWS / Bruce Balmer
4	C815947	09/2/2009	20	21.10	84.28	08:52	BW	No	FDD-WWS / Bruce Balmer
5	C836447	09/2/2009	20	21.10	105.38	09:07	BW	Yes	FDD-WWS / Bruce Balmer
6	C836447	09/2/2009	20	21.10	126.48	09:33	BW	No	FDD-WWS / Bruce Balmer
7	C713246	09/2/2009	20	21.08	147.56	10:00	BW	Yes	FDD-WWS / Bruce Balmer
8	C825893	09/2/2009	20	21.05	168.61	10:18	BW	No	FDD-WWS / Bruce Balmer
9	C713246	09/2/2009	20	21.06	189.67	10:35	BW	Yes	FDD-WWS / Bruce Balmer
10	C825843	09/2/2009	20	21.15	210.82	10:59	BW	No	FDD-WWS / Bruce Balmer
11	C713247	09/2/2009	20	21.13	231.95	11:15	BW	Yes	FDD-WWS / Bruce Balmer
12	C825843	09/2/2009	20	21.16	253.11	11:32	BW	No	FDD-WWS / Bruce Balmer
13	C825843	09/2/2009	20	21.17	274.28	11:51	BW	Yes	FDD-WWS / Bruce Balmer
14	C825843	09/2/2009	20	21.05	295.33	12:06	BW	No	FDD-WWS / Bruce Balmer
15	C836552	09/2/2009	20	4.67	300.00	12:22	BW	Yes	FDD-WWS / Bruce Balmer

TABLE 2-6 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TZMW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
INTERMEDIATE CASING									
1	HT-D2387	05/10/2010	8	14.64	14.64	11:04	MAG	Yes	FDD / Adrian Padron
2	HT-D2455	05/10/2010	8	42.08	56.72	11:40	MAG	Yes	FDD / Adrian Padron
3	HT-D2455	05/10/2010	8	42.08	98.80	12:54	MAG	Yes	FDD / Adrian Padron
4	HT-D2455	05/10/2010	8	42.13	140.93	13:12	MAG	Yes	FDD / Adrian Padron
5	HT-D2455	05/10/2010	8	42.13	183.06	13:35	MAG	Yes	FDD / Adrian Padron
6	HT-D2455	05/10/2010	8	42.16	225.22	13:56	MAG	Yes	FDD / Adrian Padron
7	HT-D2387	05/10/2010	8	42.10	267.32	14:37	MAG	Yes	FDD / Adrian Padron
8	HT-D2455	05/10/2010	8	42.12	309.44	15:00	MAG	Yes	FDD / Adrian Padron
9	HT-D2455	05/10/2010	8	42.12	351.56	15:35	MAG	Yes	FDD / Adrian Padron
10	HT-D2455	05/10/2010	8	42.13	393.69	15:55	MAG	Yes	FDD / Adrian Padron
11	HT-D2387	05/10/2010	8	42.08	435.77	16:14	MAG	Yes	FDD / Adrian Padron
12	HT-D2455	05/10/2010	8	42.15	477.92	16:36	MAG	Yes	FDD / Adrian Padron
13	HT-D2455	05/10/2010	8	42.14	520.06	16:58	MAG	Yes	FDD / Adrian Padron
14	HT-D2455	05/10/2010	8	42.05	562.11	17:20	MAG	Yes	FDD / Adrian Padron
15	HT-D2455	05/11/2010	8	42.11	604.22	08:00	AMM	Yes	FDD / Adrian Padron
16	HT-D2455	05/11/2010	8	42.12	646.34	08:05	AMM	Yes	FDD / Adrian Padron
17	HT-D2455	05/11/2010	8	42.14	688.48	08:10	AMM	Yes	FDD / Adrian Padron
18	HT-D2387	05/11/2010	8	42.01	730.49	08:30	AMM	Yes	FDD / Adrian Padron
19	HT-D2387	05/11/2010	8	42.10	772.59	09:00	AMM	Yes	FDD / Adrian Padron
20	HT-D2387	05/11/2010	8	42.09	814.68	09:15	AMM	Yes	FDD / Adrian Padron
21	HT-D2387	05/11/2010	8	42.15	856.83	09:35	AMM	Yes	FDD / Adrian Padron
22	HT-D2387	05/11/2010	8	42.10	898.93	10:00	AMM	Yes	FDD / Adrian Padron
23	HT-D2455	05/11/2010	8	42.12	941.05	10:30	AMM	Yes	FDD / Adrian Padron
24	HT-D2387	05/11/2010	8	42.16	983.21	11:10	AMM	Yes	FDD / Adrian Padron
25	HT-D2455	05/11/2010	8	42.10	1025.31	12:30	AMM	Yes	FDD / Adrian Padron
26	HT-D2387	05/11/2010	8	42.16	1067.47	13:00	AMM	Yes	FDD / Adrian Padron
27	HT-D2455	05/11/2010	8	42.07	1109.54	13:20	AMM	Yes	FDD / Adrian Padron
28	HT-D2455	05/11/2010	8	42.09	1151.63	13:50	AMM	Yes	FDD / Adrian Padron
29	HT-D2455	05/11/2010	8	42.10	1193.73	14:30	AMM	Yes	FDD / Adrian Padron
30	HT-D2387	05/11/2010	8	42.13	1235.86	14:55	AMM	Yes	FDD / Adrian Padron
31	HT-D2455	05/11/2010	8	42.11	1277.97	15:20	AMM	Yes	FDD / Adrian Padron
32	HT-D2455	05/11/2010	8	42.13	1320.10	16:00	AMM	Yes	FDD / Adrian Padron
33	HT-D2455	05/11/2010	8	42.15	1362.25	16:20	AMM	Yes	FDD / Adrian Padron

*Stick-up is 12.25 feet, total depth for the intermediate casing is 1,350 feet.

TABLE 2-6 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TZMW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
AVON PARK PRODUCING ZONE CASING									
1	10832560	05/18/2010	2	20.00	20.00	13:10	MAG		FDD / Adrian Padron
2	10832560	05/18/2010	2	42.25	62.25	13:15	MAG		FDD / Adrian Padron
3	10832560	05/18/2010	2	42.25	104.50	13:20	MAG		FDD / Adrian Padron
4	10832560	05/18/2010	2	42.25	146.75	13:26	MAG		FDD / Adrian Padron
5	10832560	05/18/2010	2	42.25	189.00	13:34	MAG		FDD / Adrian Padron
6	10832560	05/18/2010	2	42.25	231.25	13:40	MAG		FDD / Adrian Padron
7	10832560	05/18/2010	2	42.25	273.50	13:43	MAG		FDD / Adrian Padron
8	10832560	05/18/2010	2	42.25	315.75	13:47	MAG		FDD / Adrian Padron
9	10832560	05/18/2010	2	42.25	358.00	13:50	MAG		FDD / Adrian Padron
10	10832560	05/18/2010	2	42.25	400.25	13:55	MAG		FDD / Adrian Padron
11	10832560	05/18/2010	2	42.25	442.50	13:59	MAG		FDD / Adrian Padron
12	10832560	05/18/2010	2	42.25	484.75	14:11	MAG		FDD / Adrian Padron
13	10832560	05/18/2010	2	42.25	527.00	14:15	MAG		FDD / Adrian Padron
14	10832560	05/18/2010	2	42.25	569.25	14:18	MAG		FDD / Adrian Padron
15	10832560	05/18/2010	2	42.25	611.50	14:23	MAG		FDD / Adrian Padron
16	10832560	05/18/2010	2	42.25	653.75	14:26	MAG		FDD / Adrian Padron
17	10832560	05/18/2010	2	42.25	696.00	14:33	MAG		FDD / Adrian Padron
18	10832560	05/18/2010	2	42.25	738.25	14:38	MAG		FDD / Adrian Padron
19	10832560	05/18/2010	2	42.25	780.50	14:44	MAG		FDD / Adrian Padron
20	10832560	05/18/2010	2	42.25	822.75	14:49	MAG		FDD / Adrian Padron
21	10832560	05/18/2010	2	42.25	865.00	14:53	MAG		FDD / Adrian Padron
*Stick-up is 25 feet, total depth for the APPZ casing is 840 feet with 20 feet of slotted screen.									
FINAL CASING									
1	87310787902	05/27/2010	3.5	42.09	42.09	08:45	AMM	Yes	FDD / Adrian Padron
2	87310787902	05/27/2010	3.5	42.09	84.18	09:05	AMM	Yes	FDD / Adrian Padron
3	72B439	05/27/2010	3.5	42.14	126.32	09:10	AMM	Yes	FDD / Adrian Padron
4	72B439	05/27/2010	3.5	42.06	168.38	09:20	AMM	Yes	FDD / Adrian Padron
5	72B439	05/27/2010	3.5	42.09	210.47	09:27	AMM	Yes	FDD / Adrian Padron
6	72B439	05/27/2010	3.5	42.09	252.56	09:33	AMM	Yes	FDD / Adrian Padron
7	72B439	05/27/2010	3.5	42.09	294.65	09:40	AMM	Yes	FDD / Adrian Padron
8	72B439	05/27/2010	3.5	42.08	336.73	09:43	AMM	Yes	FDD / Adrian Padron
9	72B439	05/27/2010	3.5	42.08	378.81	09:45	AMM	Yes	FDD / Adrian Padron
10	72B439	05/27/2010	3.5	42.12	420.93	09:50	AMM	Yes	FDD / Adrian Padron
11	72B439	05/27/2010	3.5	42.06	462.99	10:05	AMM	Yes	FDD / Adrian Padron
12	72B439	05/27/2010	3.5	42.07	505.06	10:11	AMM	Yes	FDD / Adrian Padron
13	72B439	05/27/2010	3.5	42.10	547.16	10:15	AMM	Yes	FDD / Adrian Padron

TABLE 2-6 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TZMW-A1 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
FINAL CASING (CONTINUED)									
14	72B441	05/27/2010	3.5	42.14	589.30	10:25	AMM	Yes	FDD / Adrian Padron
15	72B439	05/27/2010	3.5	42.05	631.35	10:32	AMM	Yes	FDD / Adrian Padron
16	72B439	05/27/2010	3.5	42.09	673.44	10:35	AMM	Yes	FDD / Adrian Padron
17	72B439	05/27/2010	3.5	42.04	715.48	10:43	AMM	Yes	FDD / Adrian Padron
18	72B441	05/27/2010	3.5	42.06	757.54	10:48	AMM	Yes	FDD / Adrian Padron
19	72B441	05/27/2010	3.5	42.10	799.64	10:55	AMM	Yes	FDD / Adrian Padron
20	72B441	05/27/2010	3.5	42.10	841.74	11:15	AMM	Yes	FDD / Adrian Padron
21	72B441	05/27/2010	3.5	42.09	883.83	11:22	AMM	Yes	FDD / Adrian Padron
22	72B441	05/27/2010	3.5	42.11	925.94	11:32	AMM	Yes	FDD / Adrian Padron
23	72B439	05/27/2010	3.5	42.14	968.08	11:37	AMM	Yes	FDD / Adrian Padron
24	72B439	05/27/2010	3.5	42.06	1010.14	12:15	AMM	Yes	FDD / Adrian Padron
25	72B439	05/27/2010	3.5	42.07	1052.21	12:26	AMM	Yes	FDD / Adrian Padron
26	72B439	05/27/2010	3.5	42.11	1094.32	12:33	AMM	Yes	FDD / Adrian Padron
27	72B439	05/27/2010	3.5	42.08	1136.40	12:40	AMM	Yes	FDD / Adrian Padron
28	72B441	05/27/2010	3.5	42.08	1178.48	12:47	AMM	Yes	FDD / Adrian Padron
29	72B439	05/27/2010	3.5	42.10	1220.58	12:53	AMM	Yes	FDD / Adrian Padron
30	72B439	05/27/2010	3.5	42.13	1262.71	12:57	AMM	Yes	FDD / Adrian Padron
31	72B441	05/27/2010	3.5	42.14	1304.85	13:05	AMM	Yes	FDD / Adrian Padron
32	72B441	05/27/2010	3.5	42.12	1346.97	13:10	AMM	Yes	FDD / Adrian Padron
33	72B439	05/27/2010	3.5	42.12	1389.09	13:15	AMM	Yes	FDD / Adrian Padron
34	72B439	05/27/2010	3.5	42.09	1431.18	13:18	AMM	Yes	FDD / Adrian Padron
35	72B439	05/27/2010	3.5	42.18	1473.36	13:21	AMM	Yes	FDD / Adrian Padron
36	72B441	05/27/2010	3.5	42.18	1515.54	13:25	AMM	Yes	FDD / Adrian Padron
37	72B439	05/27/2010	3.5	42.00	1557.54	13:43	AMM	Yes	FDD / Adrian Padron
38	72B651	05/27/2010	3.5	42.12	1599.66	13:46	AMM	Yes	FDD / Adrian Padron
39	72B651	05/27/2010	3.5	42.13	1641.79	14:00	AMM	Yes	FDD / Adrian Padron
40	72B651	05/27/2010	3.5	42.15	1683.94	14:05	AMM	Yes	FDD / Adrian Padron
41	72B441	05/27/2010	3.5	42.08	1726.02	14:10	AMM	Yes	FDD / Adrian Padron
42	72B441	05/27/2010	3.5	42.11	1768.13	14:16	AMM	Yes	FDD / Adrian Padron
43	72B441	05/27/2010	3.5	42.11	1810.24	14:22	AMM	Yes	FDD / Adrian Padron
44	72B441	05/27/2010	3.5	42.19	1852.43	14:26	AMM	Yes	FDD / Adrian Padron
45	72B651	05/27/2010	3.5	42.09	1894.52	14:30	AMM	Yes	FDD / Adrian Padron

*Stick-up is 14.52 feet, total depth for the final casing is 1,880 feet.

TABLE 2-7
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TZMW-A1 GROUT SUMMARY

STAGE NO.	DATE	MIX	CASING TYPE	CASING DIAMETER (IN)	WEIGHT (LBS/GAL)	SACKS	BARRELS	CUBIC FEET	CUBIC YARDS	START DEPTH (FT)	STOP DEPTH (FT)	ACTUAL FILL (FT)
						PUMPED						
PIT CASING GROUT												
1	08/18/09	NEAT (on site)	Steel	30	15.40	159.55	33.53	188.27	6.97	55	0	55
				TOTALS		**159.55**	**33.53**	**188.27**	**6.97**			**55**
SURFACE CASING GROUT												
1	09/02/09	NEAT (on site)	Steel	20	15.30	223.37	46.94	263.58	9.76	305	163	142
2	09/03/09	NEAT (on site)	Steel	20	15.50	255.28	53.65	301.23	11.16	163	0	163
				TOTALS		**478.65**	**100.59**	**564.81**	**20.92**			**305**
INTERMEDIATE CASING GROUT												
1	05/12/10	GRAVEL	Steel	8	--	3.43	0.72	4.05	0.15	1344	1337	7
	05/12/10	NEAT (Williams)	Steel	8	14.90	52.63	11.06	62.10	2.30	1337	1291	46
2	05/13/10	6% Bentonite	Steel	8	13.20	165.43	34.77	195.21	7.23	1291	--	--
	05/13/10	6% Bentonite	Steel	8	13.40	177.79	37.36	209.79	7.77	--	1066	225
3	05/17/10	6% Bentonite	Steel	8	13.50	131.34	27.60	154.98	5.74	1066	958	108
4	05/18/10	GRAVEL	Steel	8	--	118.98	25.00	140.40	5.20	958	783	175
5	05/19/10	6% Bentonite	Steel	8	13.30	190.83	40.10	225.18	8.34	783	--	--
	05/19/10	6% Bentonite	Steel	8	13.50	213.48	44.86	251.91	9.33	--	--	--
	05/19/10	6% Bentonite	Steel	8	13.40	202.73	42.60	239.22	8.86	--	541	242
6	05/20/10	6% Bentonite	Steel	8	13.40	235.45	49.48	277.83	10.29	541	--	--
	05/20/10	6% Bentonite	Steel	8	13.50	210.74	44.29	248.67	9.21	--	--	--
	05/20/10	6% Bentonite	Steel	8	13.50	224.24	47.12	264.60	9.80	--	394	147
7	05/21/10	6% Bentonite	Steel	8	13.40	205.93	43.28	243.00	9.00	394	--	--
	05/21/10	6% Bentonite	Steel	8	13.50	199.98	42.03	235.98	8.74	--	--	--
	05/21/10	6% Bentonite	Steel	8	13.40	135.00	28.37	159.30	5.90	--	0	394
				TOTALS		**2467.98**	**518.65**	**2912.22**	**107.86**			**1344**
FINAL CASING GROUT												
1	05/28/10	GRAVEL	Steel	3.5	--	3.43	0.72	4.05	0.15	1874	1870	4
	05/28/10	NEAT (on site)	Steel	3.5	14.90	13.50	2.84	15.93	0.59	1870	1840	30
2	06/01/10	NEAT (Williams)	Steel	3.5	15.20	102.51	21.54	120.96	4.48	1840	1760	80
3	06/02/10	NEAT (Williams)	Steel	3.5	15.30	99.31	20.87	117.18	4.34	1760	1615	145
4	06/04/10	NEAT (Williams)	Steel	3.5	15.30	37.98	7.98	44.82	1.66	1615	1569	46
				TOTALS		**256.73**	**53.95**	**302.94**	**11.22**			**305**

TABLE 2-8
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A2 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
PIT CASING									
1	P1204A	09/10/2009	30	39.05	39.05	15:10	WBL	Yes	FDD-WWS / Bruce Balmer
2	P1272A	09/10/2009	30	16.95	56.00	15:30	WBL	Yes	FDD-WWS / Bruce Balmer
*Stick-up is 1 foot, total depth for the pit casing is 55 feet.									
SURFACE CASING									
1	08302919	09/22/2009	20	42.08	42.08	10:04	BW	Yes	FDD-WWS / Bruce Balmer
2	08302919	09/22/2009	20	42.05	84.13	10:36	BW	Yes	FDD-WWS / Bruce Balmer
3	08302919	09/22/2009	20	42.03	126.16	10:51	BW	Yes	FDD-WWS / Bruce Balmer
4	08302919	09/22/2009	20	42.10	168.26	11:21	BW	Yes	FDD-WWS / Bruce Balmer
5	08102352	09/22/2009	20	42.13	210.39	11:47	BW	Yes	FDD-WWS / Bruce Balmer
6	08102352	09/22/2009	20	42.13	252.52	12:06	BW	Yes	FDD-WWS / Bruce Balmer
7	08102352	09/22/2009	20	42.10	294.62	12:28	BW	Yes	FDD-WWS / Bruce Balmer
*Stick-up is 4.62 feet, total depth for the surface casing is 290 feet.									
FINAL CASING									
1	HT-D2455	03/22/2010	8	42.09	42.09	15:06	MAG	Yes	FDD / Ryan Hall
2	HT-D2455	03/22/2010	8	42.11	84.20	15:33	MAG	Yes	FDD / Ryan Hall
3	HT-D2455	03/22/2010	8	42.05	126.25	16:00	MAG	Yes	FDD / Ryan Hall
4	HT-D2387	03/22/2010	8	42.10	168.35	15:06	MAG	Yes	FDD / Ryan Hall
5	HT-D2455	03/22/2010	8	42.10	210.45	16:35	MAG	Yes	FDD / Ryan Hall
6	HT-D2455	03/22/2010	8	42.07	252.52	16:50	MAG	Yes	FDD / Ryan Hall
7	HT-D2455	03/22/2010	8	42.12	294.64	17:05	MAG	Yes	FDD / Ryan Hall
8	HT-D2455	03/22/2010	8	42.16	336.80	17:24	MAG	Yes	FDD / Ryan Hall
9	HT-D2455	03/22/2010	8	42.12	378.92	17:43	MAG	Yes	FDD / Ryan Hall
10	HT-D2455	03/22/2010	8	42.08	421.00	18:04	MAG	Yes	FDD / Ryan Hall
11	HT-D2387	03/22/2010	8	42.07	463.07	18:26	MAG	Yes	FDD / Ryan Hall
12	HT-D2455	03/23/2010	8	41.98	505.05	08:00	MAG	Yes	FDD / Ryan Hall
13	HT-D2455	03/23/2010	8	42.10	547.15	08:19	MAG	Yes	FDD / Ryan Hall
14	HT-D2455	03/23/2010	8	42.09	589.24	08:44	MAG	Yes	FDD / Ryan Hall

LFMW-A2 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
FINAL CASING (CONTINUED)									
15	HT-D2455	03/23/2010	8	42.16	631.40	09:13	MAG	Yes	FDD / Ryan Hall
16	HT-D2455	03/23/2010	8	42.17	673.57	09:38	MAG	Yes	FDD / Ryan Hall
17	HT-D2455	03/23/2010	8	42.09	715.66	10:00	MAG	Yes	FDD / Ryan Hall
18	HT-D2455	03/23/2010	8	42.06	757.72	10:21	MAG	Yes	FDD / Ryan Hall
19	HT-D2387	03/23/2010	8	42.18	799.90	10:43	MAG	Yes	FDD / Ryan Hall
20	HT-D2387	03/23/2010	8	42.08	841.98	11:05	MAG	Yes	FDD / Ryan Hall
21	HT-D2455	03/23/2010	8	42.12	884.10	11:24	MAG	Yes	FDD / Ryan Hall
22	HT-D2455	03/23/2010	8	42.07	926.17	11:46	MAG	Yes	FDD / Ryan Hall
23	HT-D2455	03/23/2010	8	42.10	968.27	12:07	MAG	Yes	FDD / Ryan Hall
24	HT-D2455	03/23/2010	8	42.01	1010.28	12:25	MAG	Yes	FDD / Ryan Hall
25	HT-D2455	03/23/2010	8	42.12	1052.40	12:45	MAG	Yes	FDD / Ryan Hall
26	HT-D2455	03/23/2010	8	42.12	1094.52	13:06	MAG	Yes	FDD / Ryan Hall
27	HT-D2455	03/23/2010	8	42.16	1136.68	13:40	MAG	Yes	FDD / Ryan Hall
28	HT-D2455	03/23/2010	8	42.14	1178.82	14:02	MAG	Yes	FDD / Ryan Hall
29	HT-D2455	03/23/2010	8	42.14	1220.96	14:21	MAG	Yes	FDD / Ryan Hall
30	HT-D2455	03/23/2010	8	42.04	1263.00	14:42	MAG	Yes	FDD / Ryan Hall
31	HT-D2455	03/23/2010	8	42.02	1305.02	15:04	MAG	Yes	FDD / Ryan Hall
32	HT-D2455	03/23/2010	8	42.13	1347.15	15:23	MAG	Yes	FDD / Ryan Hall
33	HT-D2455	03/23/2010	8	42.15	1389.30	15:45	MAG	Yes	FDD / Ryan Hall
*Stick-up is 39.28 feet, total depth for the final casing is 1,350 feet.									

TABLE 2-9
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A2 GROUT SUMMARY

STAGE NO.	DATE	MIX	CASING TYPE	CASING DIAMETER (IN)	WEIGHT (LBS/GAL)	SACKS	BARRELS	CUBIC FEET	CUBIC YARDS	START DEPTH (FT)	STOP DEPTH (FT)	ACTUAL FILL (FT)
						PUMPED						
PIT CASING GROUT												
1	09/10/09	NEAT (on site)	Steel	30	--	159.55	33.53	188.27	6.97	55	0	55
				TOTALS		**159.55**	**33.53**	**188.27**	**6.97**			**55**
SURFACE CASING GROUT												
1	09/22/09	NEAT (on site)	Steel	20	15.40	255.28	53.65	301.23	11.16	295	180	115
2	09/23/09	NEAT (on site)	Steel	20	15.20	351.01	73.77	414.19	15.34	180	0	180
				TOTALS		**606.29**	**127.41**	**715.42**	**26.50**			**295**
FINAL CASING GROUT												
1	03/24/10	NEAT (on site)	Steel	8	15.30	155.59	32.70	183.60	6.80	1350	1246	104
2	03/25/10	6% Bentonite	Steel	8	13.70	185.34	38.95	218.70	8.10	1246	--	--
	03/25/10	6% Bentonite	Steel	8	13.70	165.89	34.86	195.75	7.25	--	931	315
3	03/26/10	GRAVEL	Steel	8	--	406.78	85.49	480.00	17.78	931	910	21
	03/26/10	6% Bentonite	Steel	8	13.60	221.95	46.64	261.90	9.70	910	910	0
4	03/29/10	GRAVEL	Steel	8	--	101.69	21.37	120.00	4.44	910	889	21
5	03/30/10	6% Bentonite	Steel	8	13.20	151.02	31.74	178.20	6.60	889	814	75
	03/30/10	GRAVEL	Steel	8	--	25.42	5.34	30.00	1.11	814	807	7
6	03/31/10	GRAVEL	Steel	8	--	203.39	42.74	240.00	8.89	807	778	29
	03/31/10	6% Bentonite	Steel	8	13.40	221.95	46.64	261.90	9.70	778	--	--
	03/31/10	6% Bentonite	Steel	8	13.30	219.66	46.16	259.20	9.60	--	--	--
	03/31/10	6% Bentonite	Steel	8	13.60	212.80	44.72	251.10	9.30	--	564	214
7	04/01/10	6% Bentonite	Steel	8	13.40	221.95	46.64	261.90	9.70	564	--	--
	04/01/10	6% Bentonite	Steel	8	13.30	210.51	44.24	248.40	9.20	--	--	--
	04/01/10	6% Bentonite	Steel	8	13.30	215.08	45.20	253.80	9.40	--	394	170
8	04/05/10	6% Bentonite	Steel	8	13.30	216.23	45.44	255.15	9.45	394	--	--
	04/05/10	6% Bentonite	Steel	8	13.20	211.42	44.43	249.48	9.24	--	--	--
	04/05/10	6% Bentonite	Steel	8	13.30	208.22	43.76	245.70	9.10	--	115	279
9	04/06/10	6% Bentonite	Steel	8	13.30	160.17	33.66	189.00	7.00	115	0	115
				TOTALS		**3715.07**	**780.73**	**4383.78**	**162.36**			**1350**

TABLE 2-10
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A3 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
PIT CASING									
1	P1289A	09/28/2009	30	39.05	39.05	16:47	BW	Yes	FDD-WWS / Bruce Balmer
2	O5C4179	09/28/2009	30	19.15	58.20	17:05	BW	Yes	FDD-WWS / Bruce Balmer
*Stick-up is 3.20 feet, total depth for the pit casing is 55 feet.									
SURFACE CASING									
1	08102359	10/6/2009	20	42.05	42.05	08:25	MAG	Yes	FDD-WWS / Bruce Balmer
2	08102352	10/6/2009	20	42.10	84.15	09:00	MAG	Yes	FDD-WWS / Bruce Balmer
3	08102359	10/6/2009	20	42.14	126.29	09:22	MAG	Yes	FDD-WWS / Bruce Balmer
4	08302914	10/6/2009	20	42.18	168.47	09:40	MAG	Yes	FDD-WWS / Bruce Balmer
5	08302914	10/6/2009	20	42.15	210.62	10:05	MAG	Yes	FDD-WWS / Bruce Balmer
6	08102352	10/6/2009	20	42.05	252.67	10:31	MAG	Yes	FDD-WWS / Bruce Balmer
7	08302914	10/6/2009	20	32.33	285.00	10:52	MAG	Yes	FDD-WWS / Bruce Balmer
*Stick-up is 0 feet, total depth for the surface casing is 285 feet.									
FINAL CASING									
1	HT-D2455	06/24/2010	8	42.16	42.16	07:53	MAG	Yes	FDD / Ryan Hall
2	HT-D2455	06/24/2010	8	42.12	84.28	08:05	MAG	Yes	FDD / Ryan Hall
3	HT-D2387	06/24/2010	8	42.15	126.43	08:15	MAG	Yes	FDD / Ryan Hall
4	HT-D2387	06/24/2010	8	42.14	168.57	09:03	MAG	Yes	FDD / Ryan Hall
5	HT-D2455	06/24/2010	8	42.15	210.72	09:21	MAG	Yes	FDD / Ryan Hall
6	HT-D2387	06/24/2010	8	42.16	252.88	09:37	MAG	Yes	FDD / Ryan Hall
7	HT-D2387	06/24/2010	8	42.12	295.00	09:55	MAG	Yes	FDD / Ryan Hall
8	HT-D2387	06/24/2010	8	42.14	337.14	10:13	MAG	Yes	FDD / Ryan Hall
9	HT-D2387	06/24/2010	8	42.06	379.20	10:34	MAG	Yes	FDD / Ryan Hall
10	HT-D2387	06/24/2010	8	42.10	421.30	10:52	MAG	Yes	FDD / Ryan Hall
11	HT-D2455	06/24/2010	8	42.16	463.46	11:12	MAG	Yes	FDD / Ryan Hall
12	HT-D2387	06/24/2010	8	42.13	505.59	11:31	MAG	Yes	FDD / Ryan Hall
13	HT-D2387	06/24/2010	8	42.15	547.74	11:48	MAG	Yes	FDD / Ryan Hall
14	HT-D2387	06/24/2010	8	42.22	589.96	12:07	MAG	Yes	FDD / Ryan Hall

TABLE 2-10 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A3 CASING SUMMARY

CASING JOINT NO.	HEAT NUMBER	DATE	CASING DIAMETER (IN)	CASING JOINT LENGTH (FT)	CUMULATIVE LENGTH (FT)	TIME DOWN	WITNESS	CENTRALIZER	CONTRACTOR / SUPERVISOR
FINAL CASING (CONTINUED)									
15	HT-D2387	06/24/2010	8	42.16	632.12	12:27	MAG	Yes	FDD / Ryan Hall
16	HT-D2387	06/24/2010	8	42.12	674.24	13:07	MAG	Yes	FDD / Ryan Hall
17	HT-D2387	06/24/2010	8	42.14	716.38	13:28	MAG	Yes	FDD / Ryan Hall
18	HT-D2387	06/24/2010	8	42.06	758.44	13:49	MAG	Yes	FDD / Ryan Hall
19	HT-D2387	06/24/2010	8	42.16	800.60	14:07	MAG	Yes	FDD / Ryan Hall
20	HT-D2387	06/24/2010	8	42.15	842.75	14:34	MAG	Yes	FDD / Ryan Hall
21	HT-D2387	06/24/2010	8	42.16	884.91	14:54	MAG	Yes	FDD / Ryan Hall
22	HT-D2387	06/24/2010	8	41.98	926.89	15:17	MAG	Yes	FDD / Ryan Hall
23	ZX2062	06/24/2010	8	42.05	968.94	15:38	MAG	Yes	FDD / Ryan Hall
24	ZX2062	06/24/2010	8	42.07	1011.01	15:58	MAG	Yes	FDD / Ryan Hall
25	ZX2062	06/24/2010	8	42.06	1053.07	16:18	MAG	Yes	FDD / Ryan Hall
26	ZX2062	06/24/2010	8	42.05	1095.12	16:39	MAG	Yes	FDD / Ryan Hall
27	ZX2062	06/24/2010	8	42.07	1137.19	17:00	MAG	Yes	FDD / Ryan Hall
28	SB58420	06/24/2010	8	42.06	1179.25	17:17	MAG	Yes	FDD / Ryan Hall
29	SB58420	06/24/2010	8	42.05	1221.30	17:40	MAG	Yes	FDD / Ryan Hall
30	SB58420	06/24/2010	8	42.07	1263.37	17:58	MAG	Yes	FDD / Ryan Hall
31	SB58420	06/24/2010	8	42.07	1305.44	18:17	MAG	Yes	FDD / Ryan Hall
32	SB58420	06/24/2010	8	42.07	1347.51	18:52	MAG	Yes	FDD / Ryan Hall
33	HT-D2455	06/24/2010	8	16.55	1364.06	19:20	MAG	Yes	FDD / Ryan Hall
*Stick-up is 14.06 feet, total depth for the final casing is 1,350 feet.									

TABLE 2-11
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A3 GROUT SUMMARY

STAGE NO.	DATE	MIX	CASING TYPE	CASING DIAMETER (IN)	WEIGHT (LBS/GAL)	SACKS	BARRELS	CUBIC FEET	CUBIC YARDS	START DEPTH (FT)	STOP DEPTH (FT)	ACTUAL FILL (FT)
						PUMPED						
PIT CASING GROUT												
1	09/28/09	NEAT (on site)	Steel	30	15.35	191.46	40.24	225.92	8.37	55	21	34
2	09/29/09	NEAT (on site)	Steel	30	--	63.82	13.41	75.31	2.79	21	0	21
				TOTALS		**255.28**	**53.65**	**301.23**	**11.16**			**55**
1	10/06/09	NEAT (on site)	Steel	20	15.50	255.28	53.65	301.23	11.16	295	180	115
2	10/07/09	NEAT (on site)	Steel	20	15.60	287.19	60.35	338.88	12.55	180	0	180
				TOTALS		**542.47**	**114.00**	**640.11**	**23.71**			**295**
FINAL CASING GROUT												
1	06/28/10	GRAVEL	Steel	8	--	4.23	0.89	5.00	0.19	1345	1339	6
	06/28/10	NEAT (Williams)	Steel	8	15.20	25.38	5.33	29.95	1.11	1339	1314	25
2	06/29/10	6% Bentonite	Steel	8	13.30	194.87	40.95	229.95	8.52	1314	--	--
	06/29/10	6% Bentonite	Steel	8	13.40	209.37	44.00	247.06	9.15	--	--	--
	06/29/10	6% Bentonite	Steel	8	13.50	179.57	37.74	211.90	7.85	--	1177	137
3	06/30/10	GRAVEL	Steel	8	--	108.46	22.79	127.98	4.74	1177	1051	126
	06/30/10	6% Bentonite	Steel	8	13.30	169.72	35.67	200.27	7.42	1051	982	69
4	07/01/10	GRAVEL	Steel	8	--	81.46	17.12	96.12	3.56	982	858	124
	07/01/10	4% Bentonite	Steel	8	14.30	76.82	16.14	90.64	3.36	858	832	26
5	07/02/10	GRAVEL	Steel	8	--	54.23	11.40	63.99	2.37	832	781	51
	07/02/10	6% Bentonite	Steel	8	13.30	168.59	35.43	198.93	7.37	781	--	--
	07/02/10	4% Bentonite	Steel	8	14.70	128.48	27.00	151.60	5.61	--	726	55
6	07/06/10	GRAVEL	Steel	8	--	108.46	22.79	127.98	4.74	726	632	94
	07/06/10	4% Bentonite	Steel	8	14.20	217.19	45.64	256.28	9.49	632	539	93
7	07/07/10	GRAVEL	Steel	8	--	27.23	5.72	32.13	1.19	539	530	9
	07/07/10	4% Bentonite	Steel	8	14.10	233.28	49.02	275.27	10.20	530	--	--
	07/07/10	4% Bentonite	Steel	8	14.20	222.63	46.79	262.70	9.73	--	--	--
	07/07/10	4% Bentonite	Steel	8	14.40	207.67	43.64	245.05	9.08	--	393	137
8	07/08/10	4% Bentonite	Steel	8	14.30	150.91	31.71	178.07	6.60	393	--	--
	07/08/10	4% Bentonite	Steel	8	14.20	161.90	34.02	191.04	7.08	--	330	63
9	07/09/10	GRAVEL	Steel	8	--	94.04	19.76	110.97	4.11	330	314	16
	07/09/10	4% Bentonite	Steel	8	14.20	180.14	37.86	212.57	7.87	314	--	--
	07/09/10	4% Bentonite	Steel	8	14.00	196.68	41.33	232.09	8.60	--	92	222
10	07/12/10	NEAT (Williams)	Steel	8	15.10	121.57	25.55	143.45	5.31	92	0	92
				TOTALS		**3322.87**	**698.31**	**3920.98**	**145.22**			**1345**

TABLE 2-12
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

CONSTANT HEAD PERMEABILITY ANALYSIS

Well ID	Sample No.	Sample Depth (ft)	Date	Soil Description	Permeability (ft/day)	Moisture Content (%)	Wash 200% Passing (%)
SMW-A1	SPT-1	37 - 39	08/12/09	Green, Gray Clayey Sand with Shells	1.9×10^{-4}	31.1	47.5
SMW-A1	SPT-1	75 - 77	08/12/09	Green, Gray Clayey Sand SC	1.6×10^{-2}	32.9	42.7
SMW-A2	SPT-2	46.5 - 48.5	10/21/09	Green, Gray Clayey Sand SC	*	70.4	74.1
SMW-A2	SPT-2	66.5 - 68.5	10/21/09	Light Green, Gray Silty Clayey Fine Sand with Shells	6.6×10^{-3}	49.8	21.4
SMW-A3	SPT-3	37 - 39	10/22/09	Gray, Brown Silty, Clayey Fine Sand with Phosphates	1.4×10^{-2}	27.1	7.3
SMW-A3	SPT-3	77.5 - 79.5	10/22/09	Gray, Green Clayey Sand with Shells	2.4×10^{-2}	32.1	18.4

*Could not be determined by test method requested.

TABLE 2-13
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 FIELD DRILL STEM WATER QUALITY RESULTS

Sample No.	Depth	Date	Time	pH	Mv	Temperature	Conductivity	Turbidity	Chloride	Iron	Hydrogen Sulfide	Manganese	Hardness	Alkalinity
	(ft)			(SU)		(°C)	(µS/cm)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
1	630	09/08/09	17:40	6.49	-2.40	22.7	276	9.99	10	0.30	0.00	0	85	120
2	660	09/08/09	19:35	7.49	-58.30	22.6	616	10.01	32	0.25	0.00	0	123	120
3	690	09/09/09	8:10	7.70	-71.70	24.3	566	19.30	40	0.25	0.00	0	148	120
4	720	09/09/09	12:20	7.96	-85.50	24.7	706	25.30	34	0.25	0.00	0	148	120
*5	755	09/10/09	10:00	7.03	-31.70	24.2	711	15.60	31	0.20	0.35	0	93	100
6	790	09/10/09	14:50	7.77	-75.90	22.2	717	41.40	29	0.05	0.65	0	110	105
7	820	09/11/09	10:10	7.82	-88.60	21.2	712	15.60	40	0.05	0.32	0	109	360
8	850	09/14/09	09:25	7.63	-76.30	24.1	866	6.03	40	0.03	0.24	0	113	120
9	880	09/14/09	14:10	8.07	-89.00	23.9	740	2.14	42	0.00	0.24	0	108	100
10	910	09/14/09	18:10	8.05	-95.20	26.6	706	15.70	38	0.00	0.21	0	85	100
*11	940	09/15/09	12:00	8.08	-94.90	28.1	330	12.50	48	0.00	0.22	0	48	120
12	970	09/15/09	13:50	8.17	-95.30	26.5	330	20.50	39	0.00	0.26	0	178	100
13	1,010	09/15/09	16:15	8.22	-101.60	26.1	390	12.50	51	0.00	0.24	0	152	120
14	1,040	09/15/09	18:00	8.02	-89.40	25.2	370	16.50	49	0.00	0.22	0	153	100
15	1,070	09/15/09	20:30	8.03	-89.90	24.1	400	17.60	55	0.00	0.22	0	167	100
16	1,100	09/16/09	09:45	8.28	-104.40	25.7	410	18.30	51	0.00	0.24	0	169	100
17	1,130	09/16/09	13:30	8.22	-101.50	26.8	420	19.60	53	0.00	0.24	0	174	100
18	1,160	09/16/09	15:30	8.17	-98.70	22.6	420	16.90	54	0.00	0.24	0	186	120
19	1,190	09/16/09	19:45	8.22	-100.50	24.8	450	31.60	67	0.20	0.27	0	182	120
20	1,220	11/23/09	10:30	8.20	NA	25.8	620	16.50	79	0.25	0.02	0	286	140
21	1,250	11/23/09	12:45	8.40	NA	25.4	640	18.50	83	0.20	0.02	0	374	140
22	1,290	11/23/09	14:55	8.40	NA	25.3	680	13.50	97	0.15	0.04	0	432	140
23	1,320	11/23/09	17:30	8.30	NA	25.4	850	16.40	127	0.05	0.04	0	432	140
24	1,350	11/24/09	09:50	8.30	NA	25.9	1,000	12.80	142	0.01	0.05	0	480	140
25	1,380	11/30/09	16:10	8.20	NA	25.6	1,140	9.63	486	0.30	0.02	0	792	120
26	1,410	12/01/09	09:35	8.30	NA	24.8	1,240	6.72	460	0.08	0.04	0	610	120
27	1,450	12/01/09	14:35	8.40	NA	26.4	1,240	3.65	254	0.08	0.06	0	535	120

TABLE 2-13 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 FIELD DRILL STEM WATER QUALITY RESULTS

Sample No.	Depth	Date	Time	pH	Mv	Temperature	Conductivity	Turbidity	Chloride	Iron	Hydrogen Sulfide	Manganese	Hardness	Alkalinity
	(ft)			(SU)		(°C)	(µS/cm)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
28	1,480	12/02/09	10:45	8.20	NA	25.3	1,450	19.00	330	> 1.20	0.50	0	350	120
29	1,510	12/02/09	15:20	8.20	NA	27.0	1,410	10.00	362	0.65	0.15	0	254	120
30	1,530	12/04/09	16:00	8.20	NA	24.4	1,600	13.80	380	0.25	0.25	0	394	120
31	1,570	12/07/09	10:20	8.20	NA	25.6	1,850	19.20	434	0.15	0.20	0	436	120
32	1,600	12/07/09	14:20	8.20	NA	26.3	2,000	13.20	498	0.25	0.35	0	456	100
33	1,630	12/07/09	17:30	8.10	NA	27.4	2,100	14.30	646	0.30	0.20	0	496	100
34	1,670	12/08/09	09:25	8.10	NA	25.4	2,300	17.90	598	0.35	0.20	0	510	100
35	1,700	12/08/09	11:05	8.20	NA	26.1	2,200	16.70	578	0.40	0.20	0	482	100
36	1,730	12/08/09	13:55	8.10	NA	24.6	2,400	9.09	648	0.20	0.25	0	538	100
37	1,760	12/08/09	17:52	8.10	NA	26.6	2,600	12.60	686	0.25	0.25	0	532	100
38	1,790	12/09/09	09:10	8.20	NA	27.3	3,100	8.20	860	0.20	0.30	0	476	100
39	1,820	12/09/09	13:45	8.10	NA	27.2	3,100	8.20	855	0.20	0.25	0	456	100
40	1,850	12/09/09	18:00	8.10	NA	26.4	3,000	9.30	800	0.20	0.10	0	508	100
41	1,885	12/10/09	12:10	8.20	NA	26.0	3,100	12.70	885	0.20	0.04	0	564	100
42	1,920	12/15/09	9:50	8.00	NA	26.4	3,100	8.67	850	0.14	0.01	0	636	100
43	1,950	12/15/09	14:00	8.10	NA	25.9	3,100	7.36	840	0.07	0.01	0	520	100
44	1,980	12/15/09	17:30	7.90	NA	26.0	11,900	6.49	4,030	0.20	0.06	0	1,580	80
45	2,010	12/16/09	09:25	7.80	NA	26.1	16,500	5.10	6,100	0.11	0.65	0	1,530	100
46	2,040	12/17/09	15:40	7.80	NA	25.7	17,500	12.50	5,980	> 2.20	0.50	0	2,780	120
47	2,080	12/18/09	13:30	7.80	NA	26.4	18,500	13.50	6,740	> 2.20	0.50	0	2,420	120
48	2,110	12/21/09	13:10	7.90	NA	21.4	18,600	15.70	7,180	> 2.20	0.00	0	2,860	100
49	2,140	12/21/09	17:25	7.80	NA	24.5	over 20,000	15.70	9,400	> 2.20	0.00	0	3,840	100
50	2,150	12/30/09	13:00	7.60	NA	25.8	23,000	16.40	13,120	1.20	0.00	0	5,520	120
51	2,170	12/31/09	9:00	7.70	NA	25.0	31,000	0.67	15,720	<0.2	0.02	0	5,590	140
52	2,200	01/04/10	17:15	7.60	NA	26.0	31,000	20.90	19,120	4.50	0.50	0	6,160	140
53	2,230	01/05/10	11:55	7.60	NA	25.5	35,000	22.50	21,140	5.50	0.50	0	6,550	140
54	2,260	01/05/10	16:25	7.60	NA	26.0	31,000	21.90	17,800	4.40	0.00	0	6,570	120

TABLE 2-13 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 FIELD DRILL STEM WATER QUALITY RESULTS

Sample No.	Depth	Date	Time	pH	Mv	Temperature	Conductivity	Turbidity	Chloride	Iron	Hydrogen Sulfide	Manganese	Hardness	Alkalinity
	(ft)			(SU)		(°C)	(µS/cm)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
55	2,280	01/06/10	15:50	7.60	NA	25.2	31,000	18.80	18,420	3.20	0.01	0	7,600	120
56	2,320	01/07/10	10:54	7.60	NA	24.0	23,000	17.50	18,960	4.20	0.00	0	7,480	140
57	2,360	01/07/10	17:10	7.60	NA	23.3	28,000	15.10	20,100	5.10	0.00	0	8,150	140

*5 - Bad Conductivity and pH meter.
*11 - Switched out the Conductivity meter.

TABLE 2-14
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UFMW-A1 DRILL STEM WATER QUALITY RESULTS

Sample No.	Depth	Date	Time	pH	Conductivity	Chloride	Total Dissolved Solids	Iron	Hydrogen Sulfide	Potassium	Sulfate	Magnesium	Barium	Calcium	Fluoride	Sodium	Arsenic	Bicarbonate Alkalinity	Alkalinity
	(ft)			(SU)	(µS/cm)	(mg/L)	(mg/L)	(ug/L)	(mg/L)	(ug/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
1	342	08/11/09	14:50	7.77	580	75	360	1,100	<1.0	2,400	3.6	17,000	6.7	60,000	1.6	37,000	<4.2	180	180
2*	370	08/11/09	17:20	7.90	380	39	250	1,400	<1.0	1,700	5.4	14,000	9.2	43,000	1.6	19,000	<4.2	180	180
3	400	08/11/09	19:30	7.98	260	17	160	1,100	<1.0	1,500	7.1	11,000	13	32,000	1.5	9,800	<4.2	100	100
4	430	08/12/09	09:00	7.96	260	16	150	1,000	1.1	1,300	8.6	10,000	13	31,000	1.5	9,700	<4.2	100	100
5	460	08/12/09	11:20	7.93	260	16	140	730	<1.0	1,300	8.7	10,000	13	31,000	1.5	9,600	<4.2	100	100
6	490	08/12/09	13:30	7.42	260	16	150	780	1.1	1,200	8.9	10,000	13	30,000	1.5	9,300	<4.2	100	100
7	520	08/12/09	15:40	7.59	260	15	150	780	<1.0	1,200	8.4	10,000	12	30,000	1.5	9,300	<4.2	100	100
8	550	08/12/09	18:00	7.40	250	16	140	670	<1.0	1,200	8.9	10,000	13	30,000	1.5	9,200	<4.2	100	100
9*	580	08/12/09	20:05	7.96	250	15	140	1,000	1.1	1,300	7.7	12,000	14	35,000	1.5	9,200	<4.2	100	100
10	600	08/13/09	09:45	7.98	260	16	150	1,500	1.3	1,300	8.2	11,000	14	31,000	1.5	9,300	<4.2	130	130

Note*: Samples re-analyzed at the laboratory for possible errors.
Alkalinity value at Sample No. 2 corrected.

TABLE 2-15
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 DRILL STEM WATER QUALITY RESULTS

Sample No.	Depth	Date	Time	pH	Conductivity	Chloride	Total Dissolved Solids	Iron	Hydrogen Sulfide	Potassium	Sulfate	Magnesium	Barium	Calcium	Fluoride	Sodium	Arsenic	Bicarbonate Alkalinity	Alkalinity
	(ft)			(SU)	(µS/cm)	(mg/L)	(mg/L)	(ug/L)	(mg/L)	(ug/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
1	630	09/08/09	17:40	7.80	240	13	150	540	1.30	1,100	9.4	16,000	23	64,000	1.5	8,600	<4.2	100	100
2	660	09/08/09	19:35	8.08	260	18	150	550	1.10	1,200	11	15,000	52	140,000	1.4	11,000	<4.2	100	100
3	690	09/09/09	8:10	8.01	280	22	160	380	<1.0	1,300	13	12,000	87	54,000	1	13,000	<4.2	100	100
4	720	09/09/09	12:20	8.08	300	27	180	200	<1.0	1,200	16	12,000	110	40,000	0.85	15,000	<4.2	110	110
5	755	09/10/09	10:00	8.08	310	28	200	180	1.80	1,400	16.0	13,000	120	36,000	0.74	15,000	<4.2	97	97
6	790	09/10/09	14:50	8.08	300	28	190	650	1.6	1,500	16.0	15,000	110	48,000	0.84	15,000	<4.2	100	100
7	820	09/11/09	10:10	8.07	330	36	180	220	1.3	1,500	20.0	13,000	100	38,000	0.64	18,000	<4.2	95	95
8	850	09/14/09	09:25	8.04	320	34	200	280	1.3	1,300	19.0	11,000	93	30,000	0.66	17,000	4.7	96	96
9	880	09/14/09	14:10	8.27	320	32	190	<4.6	<1.0	1,700	17.0	12,000	85	29,000	0.67	16,000	<4.2	97	97
10	910	09/14/09	18:10	8.30	310	30	190	8	<1.0	1,600	16.0	12,000	80	32,000	0.79	16,000	<4.2	90	90
11	940	09/15/09	12:00	8.27	310	29	200	36	<1.0	1,300	15	12,000	81	41,000	0.83	14,000	<4.2	97	97
12	970	09/15/09	13:50	8.27	310	29	200	13	<1.0	1,300	15	12,000	81	35,000	0.82	15,000	<4.2	92	92
13	1,010	09/15/09	16:15	8.26	360	41	220	220	<1.0	1,400	20	12,000	91	32,000	0.71	20,000	<4.2	96	96
14	1,040	09/15/09	18:00	8.12	350	38	210	8	<1.0	1,400	19	12,000	90	31,000	0.75	19,000	<4.2	94	94
15	1,070	09/15/09	20:30	8.17	370	45	230	35	<1.0	1,500	21.0	12,000	96	36,000	0.62	23,000	<4.2	91	91
16	1,100	09/16/09	09:45	8.24	370	45	230	44	<1.0	1,500	21.0	13,000	98	36,000	0.63	23,000	<4.2	98	98
17	1,130	09/16/09	13:30	8.26	400	50	240	32	<1.0	1,500	25.0	12,000	100	35,000	0.58	25,000	<4.2	97	97
18	1,160	09/16/09	15:30	8.26	390	48	230	26	<1.0	1,900	24.0	12,000	100	32,000	0.61	24,000	<4.2	95	95
19	1,190	09/16/09	19:45	8.22	420	54	250	210	1.1	1,700	27.0	13,000	110	39,000	0.52	27,000	<4.2	94	94
20	1,220	11/23/09	10:30	8.22	570	69	360	290	<1.0	2,200	89.0	16,000	130	45,000	0.6	29,000	<4.2	110	110
21	1,250	11/23/09	12:45	8.29	600	75	380	110	<1.0	2,300	94	20,000	130	53,000	0.56	34,000	4.9 I	110	110
22	1,290	11/23/09	14:55	8.30	640	79	390	83	<1.0	2,400	110	20,000	120	53,000	0.59	33,000	<4.2	110	110
23	1,320	11/23/09	17:30	8.22	800	110	490	77	<1.0	2,600	130	22,000	100	66,000	0.88	50,000	<4.2	110	110
24	1,350	11/24/09	09:50	8.17	920	160	560	20	<1.0	2,700	130	22,000	91	65,000	1.4	72,000	<4.2	110	110
25	1,380	11/30/09	16:10	8.08	1,200	220	610	93	<1.0	3,000	120.0	25,000	88	66,000	1.7	110,000	<4.2	110	110
26	1,410	12/01/09	09:35	8.10	1,300	270	690	35	<1.0	3,800	97.0	24,000	83	62,000	1.5	130,000	<4.2	100	100

TABLE 2-15 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 DRILL STEM WATER QUALITY RESULTS

Sample No.	Depth	Date	Time	pH	Conductivity	Chloride	Total Dissolved Solids	Iron	Hydrogen Sulfide	Potassium	Sulfate	Magnesium	Barium	Calcium	Fluoride	Sodium	Arsenic	Bicarbonate Alkalinity	Alkalinity
	(ft)			(SU)	(µS/cm)	(mg/L)	(mg/L)	(ug/L)	(mg/L)	(ug/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
27	1,450	12/02/09	14:35	8.08	1,300	270	670	100	<1.0	4,100	96.0	24,000	80	62,000	1.2	140,000	<4.2	100	100
28	1,480	12/02/09	10:45	7.99	1,500	340	740	670	1.3	6,200	89.0	29,000	75	63,000	0.67	180,000	<4.2	94	94
29	1,510	12/02/09	15:20	8.00	1,500	340	770	120	<1.0	6,400	92.0	27,000	74	59,000	0.66	190,000	<4.2	94	94
30	1,530	12/04/09	16:00	8.03	1,600	390	740	82	<1.0	7,600	95	31,000	72	60,000	0.38	210,000	<4.2	92	92
31	1,570	12/07/09	10:20	8.10	1,800	470	820	130	<1.0	9,900	110	35,000	80	63,000	0.28	270,000	<4.2	90	90
32	1,600	12/07/09	14:20	8.07	2,000	500	1,000	420	<1.0	11,000	120	42,000	87	71,000	0.27	300,000	<4.2	91	91
33	1,630	12/07/09	17:30	8.07	2,100	550	1,100	460	<1.0	12,000	120	41,000	87	68,000	0.24	320,000	<4.2	90	90
34	1,670	12/08/09	09:25	8.07	2,300	580	1,100	400	<1.0	13,000	130	42,000	89	68,000	0.23	340,000	<4.2	90	90
35	1,700	12/08/09	11:05	8.07	2,200	580	1,100	500	<1.0	13,000	130.0	41,000	88	67,000	0.27	340,000	<4.2	90	90
36	1,730	12/08/09	13:55	8.06	2,400	650	1,200	210	<1.0	14,000	140.0	44,000	93	70,000	0.25	370,000	<4.2	91	91
37	1,760	12/08/09	17:52	8.03	2,600	700	1,400	270	<1.0	16,000	150.0	49,000	98	74,000	0.24	410,000	<4.2	91	91
38	1,790	12/09/09	09:10	8.00	3,100	840	1,600	140	<1.0	19,000	170.0	57,000	100	81,000	0.21	490,000	<4.2	90	90
39	1,820	12/09/09	13:45	7.74	3,200	840	1,600	91	<1.0	15,000	170.0	57,000	110	81,000	0.21	450,000	<4.2	91	91
40	1,850	12/09/09	18:00	7.93	3,200	810	1,600	71	<1.0	15,000	180	56,000	110	81,000	0.29	450,000	<4.2	92	92
41	1,885	12/10/09	12:10	7.92	3,200	830	1,500	230	<1.0	16,000	180	57,000	110	80,000	0.22	460,000	<4.2	91	91
42	1,920	12/15/09	9:50	7.96	3,300	850	1,600	400	<1.0	16,000	170	58,000	110	82,000	0.19	460,000	<4.2	92	92
43	1,950	12/15/09	14:00	7.94	3,300	870	1,600	210	<1.0	16,000	170	58,000	100	81,000	0.2	460,000	<4.2	92	92
44	1,980	12/15/09	17:30	7.73	14,000	3,700	6,500	240	<1.0	93,000	650.0	250,000	98	200,000	0.039	2,100,000	7.1	92	92
45	2,010	12/16/09	09:25	7.72	19,000	5,000	9,300	160	<1.0	150,000	880.0	350,000	84	250,000	<0.023	3,500,000	5.8	94	94
46	2,040	12/17/09	15:40	7.76	20,000	6,500	9,800	280	<1.0	200,000	950.0	380,000	80	270,000	<0.023	4,600,000	6.2	97	97
47	2,080	12/18/09	13:30	7.77	20,000	6,100	11,000	350	<1.0	160,000	940.0	400,000	80	270,000	<0.023	3,600,000	<4.2	96	96
48	2,110	12/21/09	13:10	7.82	21,000	5,700	10,000	770	<1.0	160,000	990.0	390,000	78	260,000	<0.023	3,600,000	<4.2	96	96
49	2,140	12/21/09	17:25	7.72	27,000	7,500	12,000	1,500	<1.0	220,000	1200.0	520,000	73	330,000	<0.023	5,100,000	7	100	100
50	2,150	12/30/09	13:00	7.30	35,000	13,000	18,000	1,500	<1.0	290,000	1900	820,000	68	510,000	<0.023	7,700,000	10	110	110
51	2,170	12/31/09	9:00	7.42	43,000	16,000	23,000	68	<1.0	400,000	2300	1,100,000	65	650,000	<0.023	11,000,000	8.1	110	110
52	2,200	01/04/10	17:15	7..47	49,000	19,000	26,000	5,300	<1.0	400,000	2600	1,200,000	64	620,000	<0.023	11,000,000	<4.2	110	110

TABLE 2-15 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 DRILL STEM WATER QUALITY RESULTS

Sample No.	Depth	Date	Time	pH	Conductivity	Chloride	Total Dissolved Solids	Iron	Hydrogen Sulfide	Potassium	Sulfate	Magnesium	Barium	Calcium	Fluoride	Sodium	Arsenic	Bicarbonate Alkalinity	Alkalinity
	(ft)			(SU)	(µS/cm)	(mg/L)	(mg/L)	(ug/L)	(mg/L)	(ug/L)	(mg/L)	(ug/L)	(ug/L)	(ug/L)	(mg/L)	(ug/L)	(ug/L)	(mg/L)	(mg/L)
53	2,230	01/05/10	11:55	7.26	50,000	20,000	29,000	6,900	<1.0	420,000	2600	1,200,000	63	650,000	<0.023	11,000,000	<4.2	110	110
54	2,260	01/05/10	16:25	7.37	50,000	20,000	28,000	5,600	<1.0	420,000	2600.0	1,200,000	64	640,000	<0.023	11,000,000	<4.2	110	110
55	2,280	01/06/10	15:50	7.40	50,000	20,000	27,000	5,100	<1.0	420,000	2700.0	1,200,000	62	660,000	<0.023	11,000,000	<4.2	110	110
56	2,320	01/07/10	10:54	7.43	50,000	20,000	28,000	5,100	<1.0	420,000	2700.0	1,200,000	62	650,000	<0.023	11,000,000	<4.2	110	110
57	2,360	01/07/10	17:10	7.44	50,000	20,000	27,000	5,400	<1.0	400,000	2600.0	1,200,000	63	620,000	<0.023	11,000,000	<4.2	110	110

Note: Charge balance results out of tolerance, Test America is re-checking results.

Note: Result appears incorrect, Test America is re-checking results.

TABLE 2-16
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UFMW-A1

PRIMARY DRINKING WATER STANDARDS
MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CONTAMINANTS
Reference: 62-550.310(1)

				TestAmerica Laboratories, Inc.	Columbia Analytical Laboratory
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	UFMW-A1 9/01/09	UFMW-A1 9/01/09
1074	Antimony	0.006	mg/L	< 0.00040	NR
1005	Arsenic	0.010	mg/L	< 0.00037	NR
1010	Barium	2.000	mg/L	0.012	0.012
1075	Beryllium	0.004	mg/L	< 0.00015	NR
1015	Cadmium	0.005	mg/L	< 0.000043	NR
1020	Chromium	0.100	mg/L	< 0.0010	NR
1024	Cyanide	0.200	mg/L	I 0.0041	NR
1025	Fluoride	4.000	mg/L	1.6	NR
1030	Lead	0.015	mg/L	< 0.000060	NR
1035	Mercury	0.002	mg/L	< 0.000058	NR
1036	Nickel	0.100	mg/L	< 0.0040	NR
1040	Nitrate (as N)	10.000	mg/L	< 0.015	NR
1041	Nitrite (as N)	1.000	mg/L	< 0.015	NR
N/A	Total Nitrate/Nitrite (as N)	10.000	mg/L	NA	NR
1045	Selenium	0.050	mg/L	< 0.00058	NR
1052	Sodium	160.000	mg/L	NA	NR
1085	Thallium	0.002	mg/L	< 0.00010	NR

MAXIMUM CONTAMINANT LEVELS FOR DISINFECTION BYPRODUCTS
Reference: 62-550.310(3)

				TestAmerica Laboratories, Inc.	Columbia Analytical Laboratory
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	UFMW-A1 9/01/09	UFMW-A1 9/01/09
1011	Bromate	10	μg/L	< 2.6	NR
1009	Chlorite	1,000	μg/L	< 3.7	NR

2454	Dibromoacetic Acid	N/A	μg/L	NA	NR
2451	Dichloroacetic Acid	N/A	μg/L	NA	NR
2453	Monobromoacetic Acid	N/A	μg/L	NA	NR
2450	Monochloroacetic Acid	N/A	μg/L	NA	NR
2452	Trichloroacetic Acid	N/A	μg/L	NA	NR
2456	Total Haloacetic Acids (HAA5)	60	μg/L	NA	NR

2943	Bromodichloromethane (Dichlorobromomethane)	N/A	μg/L	NA	NR
2942	Bromoform	N/A	μg/L	NA	NR
2941	Chloroform	N/A	μg/L	NA	NR
2944	Dibromochloromethane (Chlorodibromomethane)	N/A	μg/L	NA	NR
2950	Total Trihalomethanes (THM)	80	μg/L	NA	NR

TABLE 2-16 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UFMW-A1

MAXIMUM CONTAMINANT LIMITS FOR VOLATILE ORGANICS
Reference: 62-550.310(4)(a)

				UFMW-A1 9/01/09	UFMW-A1 9/01/09
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TPW-1 8/20/08	TPW-1 8/26/08
2977	1,1-Dichloroethylene	7	μg/L	< 0.32	NR
2981	1,1,1-Trichloroethane	200	μg/L	< 0.27	NR
2985	1,1,2-Trichloroethane	5	μg/L	< 0.22	NR
2980	1,2-Dichloroethane	3	μg/L	< 0.17	NR
2983	1,2-Dichloropropane	5	μg/L	< 0.45	NR
2378	1,2,4-Tricholorobenzene	70	μg/L	< 0.18	NR
2990	Benzene	1	μg/L	< 0.18	NR
2982	Carbon tetrachloride	3	μg/L	< 0.22	NR
2380	cis-1,2-Dichloroethylene	70	μg/L	< 0.37	NR
2964	Dichloromethane (Methylene chloride)	5	μg/L	< 0.36	NR
2992	Ethylbenzene	700	μg/L	< 0.12	NR
2989	Monochlorobenzene (chlorobenzene)	100	μg/L	< 0.27	NR
2968	o-Dichlorobenzene (1,2-dicholorobenzene)	600	μg/L	< 0.17	NR
2969	para-Dichlorobenzene (1,4-dicholorobenzene)	75	μg/L	< 0.18	NR
2996	Styrene	100	μg/L	< 0.28	NR
2987	Tetrachloroethylene	3	μg/L	< 0.30	NR
2991	Toluene	1,000	μg/L	< 0.23	NR
2979	trans-1,2-Dichloroethylene	100	μg/L	< 0.24	NR
2984	Trichloroethylene	3	μg/L	< 0.37	NR
2976	Vinyl chloride	1	μg/L	< 0.33	NR
2955	Xylenes (total)	10,000	μg/L	< 0.27	NR

TABLE 2-16 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UFMW-A1

MAXIMUM CONTAMINANT LEVELS FOR SYNTHETIC ORGANICS
Reference: 62-550.310(4)(b)

				TestAmerica Laboratories, Inc.	Columbia Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**UFMW-A1 9/01/09**	**UFMW-A1 9/01/09**
2063	2,3,7,8-TCDD (Dioxin)	30	pg/L	< 4.47	NR
2105	2,4-D	70.00	µg/L	< 0.036	NR
2110	2,4,5-TP (Silvex)	50.00	µg/L	< 0.058	NR
2051	Alachlor	2.00	µg/L	< 0.032	NR
2050	Atrazine	3.00	µg/L	< 0.0210	NR
2306	Benzo(a)pyrene	0.20	µg/L	< 0.028	NR
2046	Carbofuran	40.00	µg/L	< 0.43	NR
2959	Chlordane	2.00	µg/L	< 0.12	NR
2031	Dalapon	200.00	µg/L	< 0.97	NR
2035	Di(2-ethylhexyl)adipate	400.00	µg/L	< 0.59	NR
2039	Di(2-ethylhexyl)phthalate	6.00	µg/L	< 0.59	NR
2931	Dibromochloropropane (1,2-dibromo-3-chloropropane)	0.20	µg/L	< 0.0030	NR
2041	Dinoseb	7.00	µg/L	< 0.15	NR
2032	Diquat	20.00	µg/L	< 0.40	NR
2033	Endothall	100.00	µg/L	< 6.3	NR
2005	Endrin	2.00	µg/L	< 0.070	NR
2946	Ethylene Dibromide (EDB or 1,2-dibromoethane)	0.02	µg/L	< 0.0073	NR
2034	Glyphosate	700.00	µg/L	< 2.5	NR
2065	Heptachlor	0.40	µg/L	**NA**	NR
2067	Heptachlor Epoxide	0.20	µg/L	**NA**	NR
2274	Hexachlorobenzene	1.00	µg/L	< 0.040	NR
2042	Hexachlorocyclopentadiene	50.00	µg/L	< 0.041	NR
2010	Lindane (gamma-BHC)	0.20	µg/L	**NA**	NR
2015	Methoxychlor	40.00	µg/L	**NA**	NR
2036	Oxamyl (Vydate)	200.00	µg/L	< 0.35	NR
2326	Pentachlorophenol	1.00	µg/L	< 0.037	NR
2040	Picloram	500.00	µg/L	< 0.075	NR
2383	Polychlorinated biphenyl (PCB)	0.50	µg/L	< 0.045	NR
2037	Simazine	4.00	µg/L	< 0.034	NR
2020	Toxaphene	3.00	µg/L	< 0.058	NR

MAXIMUM CONTAMINANT LEVELS FOR RADIONUCLIDES
Reference: 62-550.310(6)

				TestAmerica Laboratories, Inc.	Columbia Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**UFMW-A1 9/01/09**	**UFMW-A1 9/01/09**
4000	Gross Alpha (Excl Uranium)	15**	pCi/L	1.9	NR
4002	Gross Alpha (Incl Uranium)	***	pCi/L	--	NR
4006	Combined Uranium (U-234, U-235, & U-238)	30****	pCi/L	< 0.259	NR
4020	Radium-226	5	pCi/L	0.50	NR
4030	Radium-228	5	pCi/L	< 0.03	NR
NA	Gross Beta	NA	pCi/L	< 0.64	NR
NA	Radon-222	NA	pCi/L	262.0 +/- 27.0	311.0 +/- 30.0

** If the results exceed 5 pCi/L, a measurement for radium-226 is required.
*** If the results exceed 5 pCi/L, a measurements for radium-226 is required. If the results exceed 15 pCi/L, measurements for radium-226 and uranium are required.
**** If uranium (U) is reported as a measurement of activity (pCi/L) it will be converted to a mass measurement (µg/L) by multiplying the result by 1.5.

TABLE 2-16 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UFMW-A1

SECONDARY DRINKING WATER STANDARDS
Reference: 62-550.320

				TestAmerica Laboratories, Inc.	Columbia Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**UFMW-A1 9/01/09**	**UFMW-A1 9/01/09**
1002	Aluminum	0.20	mg/L	< 0.100	NR
1017	Chloride	250.00	mg/L	15	15
1022	Copper	1.00	mg/L	< 0.0005	NR
1025	Fluoride	2.00	mg/L	1.6	NR
2905	Foaming Agents (Surfactants as LAS)	0.50	mg/L	< 0.10	NR
1028	Iron	0.30	mg/L	I 0.027	NR
1032	Manganese	0.05	mg/L	< 0.0030	NR
1050	Silver	0.10	mg/L	< 0.00097	NR
1055	Sulfate	250.00	mg/L	7.3	NR
1095	Zinc	5.00	mg/L	< 0.0063	NR
1905	Color	15.00	CU	**20**	NR
1920	Odor	3.00	TON	2.0	NR
1925	pH	6.50 - 8.50	SU	Q 7.78	NR
1930	Total Dissolved Solids	500.00	mg/L	160	150

ADDITIONAL CONTAMINANTS ANALYZED

				TestAmerica Laboratories, Inc.	Columbia Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**UFMW-A1 9/01/09**	**UFMW-A1 9/01/09**
N/A	Alkalinity, Total (as $CaCO_3$)	N/A	mg/L	100	NR
N/A	Ammonia (as N)	N/A	mg/L	**NA**	NR
N/A	BOD5	N/A	mg/L	2.0	NR
N/A	Bicarbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	100	NR
N/A	Bromide	N/A	mg/L	< 1.0	0.053
N/A	COD	N/A	mg/L	I 7.8	NR
N/A	Calcium - ICP Method	N/A	mg/L	27.000	NR
N/A	Calcium Hardness (as $CaCO_3$)	N/A	mg/L	68	NR
N/A	Carbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	< 5.0	NR
N/A	Chlorine, Residual	N/A	mg/L	< 1.0	NR
N/A	Conductivity (Specific Conductance)	N/A	µmhos/cm	250	NR
N/A	Hardness, Total (as $CaCO_3$)	N/A	mg/L	110	NR
N/A	Heterotrophic Plate Count	N/A	CFU/mL	12	NR
N/A	Hydrogen Sulfide	N/A	mg/L	**NA**	**NA**
N/A	Magnesium (ICP Method)	N/A	mg/L	9.900	NR
N/A	OrthoPhosphate - ICP Method (as PO_4)	N/A	mg/L	< 0.016	NR
N/A	Phosphorus, Total (as P)	N/A	mg/L	< 0.0044	NR
N/A	Potassium (ICP Method)	N/A	mg/L	1.100	NR
N/A	Silica (as SiO_2)	N/A	mg/L	20.000	NR
N/A	Strontium	N/A	mg/L	0.500	NR
N/A	Sulfide	N/A	mg/L	**NA**	1.1
N/A	Total Carbon Dioxide	N/A	mg/L	< 5.0	NR
N/A	Total Kjeldahl Nitrogen	N/A	mg/L	**NA**	NR
N/A	Total Organic Carbon	N/A	mg/L	2.1	V 2.6
N/A	Turbidity	N/A	NTU	0.15	NR
N/A	UV254 Absorbance	N/A	cm-1	NA	NR

TABLE 2-16 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UFMW-A1

DISINFECTION BY-PRODUCT FORMATION POTENTIAL

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. UFMW-A1 9/01/09	Columbia Analytical Laboratory UFMW-A1 9/01/09
2454	Dibromoacetic Acid	N/A	µg/L	1.2	< 1.0
2451	Dichloroacetic Acid	N/A	µg/L	37	< 1.0
2453	Monobromoacetic Acid	N/A	µg/L	< 1.0	< 1.0
2450	Monochloroacetic Acid	N/A	µg/L	3.5	< 2.0
2452	Trichloroacetic Acid	N/A	µg/L	44	< 1.0
2456	Total Haloacetic Acids (HAA5)	N/A	µg/L	85.7	**NA**
2943	Bromodichloromethane	N/A	µg/L	22	22
2942	Bromoform	N/A	µg/L	< 0.5	< 0.50
2941	Dibromochloromethane	N/A	µg/L	83	85
2944	Chloroform	N/A	µg/L	4.6	4.6
2950	Total Trihalomethanes (THM)	N/A	µg/L	109.6	**NA**

RADIOCARBON AGE DETERMINATION / DETERIUM / OXYGEN 18

AGE = 22,900 ± 160 ^{14}C years BP (^{13}C corrected)

5.8 ± 0.1% of the modern (1950) ^{14}C activity

$\delta^{13}C_{PDB}$ = -7.8%o

δD*	$\delta^{18}O$*
-12, -13**	-2.6

*Analyses are reported in %o notation and are computed as follows:

**Duplicate analyses on separate alliquots of the original sample.

$$\delta R_{sample}\ \%o = \left[\frac{R_{sample}}{R_{standard}} - 1\right] \times 1000$$

I: The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.

Q: Sample held beyond the accepted holding time.

NA: Not available at time of submittal.

NR: Not required for laboratory analysis.

Bold and Highlighted: Exceeds Maximum Contaminant Level.

TABLE 2-17
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1

PRIMARY DRINKING WATER STANDARDS
MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CONTAMINANTS
Reference: 62-550.310(1)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-A1 3/10/10**	**TPW-A1 3/10/10**	**TPW-A1 8/05/10**
1074	Antimony	0.006	mg/L	< 0.00040	NR	NR
1005	Arsenic	0.010	mg/L	I **0.99**	NR	NR
1010	Barium	2.000	mg/L	**77**	0.080	NR
1075	Beryllium	0.004	mg/L	< 0.00015	NR	NR
1015	Cadmium	0.005	mg/L	< 0.000043	NR	NR
1020	Chromium	0.100	mg/L	< 0.0010	NR	NR
1024	Cyanide	0.200	mg/L	< 0.0025	NR	NR
1025	Fluoride	4.000	mg/L	0.36	NR	NR
1030	Lead	0.015	mg/L	I 0.000077	NR	NR
1035	Mercury	0.002	mg/L	< 0.000058	NR	NR
1036	Nickel	0.100	mg/L	< 0.0040	NR	NR
1040	Nitrate (as N)	10.000	mg/L	I 0.038	NR	NR
1041	Nitrite (as N)	1.000	mg/L	< 0.015	NR	NR
N/A	Total Nitrate/Nitrite (as N)	10.000	mg/L	I 0.038	NR	NR
1045	Selenium	0.050	mg/L	0.0023	NR	NR
1052	Sodium	160.000	mg/L	**230**	NR	NR
1085	Thallium	0.002	mg/L	< 0.00010	NR	NR

MAXIMUM CONTAMINANT LEVELS FOR DISINFECTION BYPRODUCTS
Reference: 62-550.310(3)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-A1 3/10/10**	**TPW-A1 3/10/10**	**TPW-A1 8/05/10**
1011	Bromate	10	μg/L	< 2.6	NR	NR
1009	Chlorite	1,000	μg/L	< 3.7	NR	NR
2454	Dibromoacetic Acid	N/A	μg/L	**NA**	< 0.61	NR
2451	Dichloroacetic Acid	N/A	μg/L	**NA**	< 0.61	NR
2453	Monobromoacetic Acid	N/A	μg/L	**NA**	< 0.61	NR
2450	Monochloroacetic Acid	N/A	μg/L	**NA**	< 0.61	NR
2452	Trichloroacetic Acid	N/A	μg/L	**NA**	< 0.61	NR
2456	Total Haloacetic Acids (HAA5)	60	μg/L	**NA**	< 0.61	NR
2943	Bromodichloromethane (Dichlorobromomethane)	N/A	μg/L	< 0.54	< 0.25	< 0.25
2942	Bromoform	N/A	μg/L	< 0.39	< 0.25	< 0.25
2941	Chloroform	N/A	μg/L	< 0.29	< 0.25	< 0.25
2944	Dibromochloromethane (Chlorodibromomethane)	N/A	μg/L	< 0.43	< 0.25	< 0.25
2950	Total Trihalomethanes (THM)	80	μg/L	< 0.29	< 0.25	< 0.25

TABLE 2-17 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1

MAXIMUM CONTAMINANT LIMITS FOR VOLATILE ORGANICS
Reference: 62-550.310(4)(a)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-A1 3/10/10**	**TPW-A1 3/10/10**	**TPW-A1 8/05/10**
2977	1,1-Dichloroethylene	7	μg/L	< 0.32	NR	NR
2981	1,1,1-Trichloroethane	200	μg/L	< 0.27	NR	NR
2985	1,1,2-Trichloroethane	5	μg/L	< 0.22	NR	NR
2980	1,2-Dichloroethane	3	μg/L	< 0.17	NR	NR
2983	1,2-Dichloropropane	5	μg/L	< 0.45	NR	NR
2378	1,2,4-Tricholorobenzene	70	μg/L	< 0.18	NR	NR
2990	Benzene	1	μg/L	< 0.18	NR	NR
2982	Carbon tetrachloride	3	μg/L	< 0.22	NR	NR
2380	cis-1,2-Dichloroethylene	70	μg/L	< 0.37	NR	NR
2964	Dichloromethane (Methylene chloride)	5	μg/L	< 0.36	NR	NR
2992	Ethylbenzene	700	μg/L	< 0.12	NR	NR
2989	Monochlorobenzene (chlorobenzene)	100	μg/L	< 0.27	NR	NR
2968	o-Dichlorobenzene (1,2-dicholorobenzene)	600	μg/L	< 0.17	NR	NR
2969	para-Dichlorobenzene (1,4-dicholorobenzene)	75	μg/L	< 0.18	NR	NR
2996	Styrene	100	μg/L	< 0.28	NR	NR
2987	Tetrachloroethylene	3	μg/L	< 0.30	NR	NR
2991	Toluene	1,000	μg/L	< 0.23	NR	NR
2979	trans-1,2-Dichloroethylene	100	μg/L	< 0.24	NR	NR
2984	Trichloroethylene	3	μg/L	< 0.37	NR	NR
2976	Vinyl chloride	1	μg/L	< 0.33	NR	NR
2955	Xylenes (total)	10,000	μg/L	< 0.27	NR	NR

TABLE 2-17 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1

MAXIMUM CONTAMINANT LEVELS FOR SYNTHETIC ORGANICS
Reference: 62-550.310(4)(b)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-A1 3/10/10**	**TPW-A1 3/10/10**	**TPW-A1 8/05/10**
2063	2,3,7,8-TCDD (Dioxin)	30	pg/L	< 3.10x10-6	NR	NR
2105	2,4-D	70.00	μg/L	< 0.037	NR	NR
2110	2,4,5-TP (Silvex)	50.00	μg/L	< 0.060	NR	NR
2051	Alachlor	2.00	μg/L	< 0.032	NR	NR
2050	Atrazine	3.00	μg/L	< 0.021	NR	NR
2306	Benzo(a)pyrene	0.20	μg/L	< 0.028	NR	NR
2046	Carbofuran	40.00	μg/L	< 0.43	NR	NR
2959	Chlordane	2.00	μg/L	< 0.12	NR	NR
2031	Dalapon	200.00	μg/L	< 1.0	NR	NR
2035	Di(2-ethylhexyl)adipate	400.00	μg/L	< 0.57	NR	NR
2039	Di(2-ethylhexyl)phthalate	6.00	μg/L	< 0.57	NR	NR
2931	Dibromochloropropane (1,2-dibromo-3-chloropropane)	0.20	μg/L	< 0.0032	NR	NR
2041	Dinoseb	7.00	μg/L	< 0.15	NR	NR
2032	Diquat	20.00	μg/L	< 0.40	NR	NR
2033	Endothall	100.00	μg/L	< 6.3	NR	NR
2005	Endrin	2.00	μg/L	< 0.069	NR	NR
2946	Ethylene Dibromide (EDB or 1,2-dibromoethane)	0.02	μg/L	< 0.0078	NR	NR
2034	Glyphosate	700.00	μg/L	< 2.5	NR	NR
2065	Heptachlor	0.40	μg/L	< 0.052	NR	NR
2067	Heptachlor Epoxide	0.20	μg/L	< 0.17	NR	NR
2274	Hexachlorobenzene	1.00	μg/L	< 0.039	NR	NR
2042	Hexachlorocyclopentadiene	50.00	μg/L	< 0.040	NR	NR
2010	Lindane (gamma-BHC)	0.20	μg/L	< 0.078	NR	NR
2015	Methoxychlor	40.00	μg/L	< 0.041	NR	NR
2036	Oxamyl (Vydate)	200.00	μg/L	< 0.35	NR	NR
2326	Pentachlorophenol	1.00	μg/L	< 0.038	NR	NR
2040	Picloram	500.00	μg/L	< 0.077	NR	NR
2383	Polychlorinated biphenyl (PCB)	0.50	μg/L	< 0.045	NR	NR
2037	Simazine	4.00	μg/L	< 0.033	NR	NR
2020	Toxaphene	3.00	μg/L	< 0.058	NR	NR

MAXIMUM CONTAMINANT LEVELS FOR RADIONUCLIDES
Reference: 62-550.310(6)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TPW-A1 3/10/10**	**TPW-A1 3/10/10**	**TPW-A1 8/05/10**
4000	Gross Alpha (Excl Uranium)	15**	pCi/L	9.5	NR	NR
4002	Gross Alpha (Incl Uranium)	***	pCi/L	--	NR	NR
4006	Combined Uranium (U-234, U-235, & U-238)	30****	pCi/L	< 0.258	NR	NR
4020	Radium-226	5	pCi/L	4.03	NR	NR
4030	Radium-228	5	pCi/L	< 0.5	NR	NR
NA	Gross Beta	NA	pCi/L	11.7	NR	NR
NA	Radon-222	NA	pCi/L	109.0+/-56.0	NR	NR

** If the results exceed 5 pCi/L, a measurement for radium-226 is required.
*** If the results exceed 5 pCi/L, a measurements for radium-226 is required. If the results exceed 15 pCi/L, measurements for radium-226 and uranium are required.

**** If uranium (U) is reported as a measurement of activity (pCi/L) it will be converted to a mass measurement (μg/L) by multiplying the result by 1.5.

TABLE 2-17 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1

SECONDARY DRINKING WATER STANDARDS
Reference: 62-550.320

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. TPW-A1 3/10/10	Pace Analytical Laboratory TPW-A1 3/10/10	Pace Analytical Laboratory TPW-A1 8/05/10
1002	Aluminum	0.20	mg/L	< 0.10	NR	NR
1017	Chloride	250.00	mg/L	**470**	**454**	NR
1022	Copper	1.00	mg/L	< 0.0050	NR	NR
1025	Fluoride	2.00	mg/L	0.36	NR	NR
2905	Foaming Agents (Surfactants as LAS)	0.50	mg/L	< 0.10	NR	NR
1028	Iron	0.30	mg/L	I 0.039	NR	NR
1032	Manganese	0.05	mg/L	< 0.0030	NR	NR
1050	Silver	0.10	mg/L	< 0.00097	NR	NR
1055	Sulfate	250.00	mg/L	100	NR	NR
1095	Zinc	5.00	mg/L	I 0.00066	NR	NR
1905	Color	15.00	CU	< 5.0	NR	NR
1920	Odor	3.00	TON	< 1.0	NR	NR
1925	pH	6.50 - 8.50	SU	Q 8.05	NR	NR
1930	Total Dissolved Solids	500.00	mg/L	**1,100**	**3,790**	**970**

ADDITIONAL CONTAMINANTS ANALYZED

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. TPW-A1 3/10/10	Pace Analytical Laboratory TPW-A1 3/10/10	Pace Analytical Laboratory TPW-A1 8/05/10
N/A	Alkalinity, Total (as $CaCO_3$)	N/A	mg/L	89	NR	NR
N/A	Ammonia (as N)	N/A	mg/L	0.16	NR	NR
N/A	BOD5	N/A	mg/L	< 2.0	NR	NR
N/A	Bicarbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	88	NR	NR
N/A	Bromide	N/A	mg/L	< 1.0	1.9	NR
N/A	COD	N/A	mg/L	I 13	NR	NR
N/A	Calcium - ICP Method	N/A	mg/L	62.000	NR	NR
N/A	Calcium Hardness (as $CaCO_3$)	N/A	mg/L	290	NR	NR
N/A	Carbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	< 5.0	NR	NR
N/A	Chlorine, Residual	N/A	mg/L	< 1.0	NR	NR
N/A	Conductivity (Specific Conductance)	N/A	µmhos/cm	1,700	NR	NR
N/A	Hardness, Total (as $CaCO_3$)	N/A	mg/L	150	NR	NR
N/A	Heterotrophic Plate Count	N/A	CFU/mL	46	NR	NR
N/A	Hydrogen Sulfide	N/A	mg/L	NA	< 1.0	NR
N/A	Magnesium (ICP Method)	N/A	mg/L	33.000	NR	NR
N/A	OrthoPhosphate - ICP Method (as PO_4)	N/A	mg/L	< 0.016	NR	NR
N/A	Phosphorus, Total (as P)	N/A	mg/L	0.067	NR	NR
N/A	Potassium (ICP Method)	N/A	mg/L	9.200	NR	NR
N/A	Silica (as SiO_2)	N/A	mg/L	120.00	NR	NR
N/A	Strontium	N/A	mg/L	9.400	NR	NR
N/A	Sulfide	N/A	mg/L	< 1.0	NR	NR
N/A	Total Carbon Dioxide	N/A	mg/L	< 5.0	NR	NR
N/A	Total Kjeldahl Nitrogen	N/A	mg/L	0.24	NR	NR
N/A	Total Organic Carbon	N/A	mg/L	I 0.57	I 0.84	NR
N/A	Turbidity	N/A	NTU	0.15	NR	NR

TABLE 2-17 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1

DISINFECTION BY-PRODUCT FORMATION POTENTIAL

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. TPW-A1 3/10/10	Pace Analytical Laboratory TPW-A1 3/10/10	Pace Analytical Laboratory TPW-A1 8/05/10
2454	Dibromoacetic Acid	N/A	µg/L	11.0	< 7.5	NR
2451	Dichloroacetic Acid	N/A	µg/L	3.3	< 3.2	NR
2453	Monobromoacetic Acid	N/A	µg/L	1.4	< 0.61	NR
2450	Monochloroacetic Acid	N/A	µg/L	6.5	< 0.61	NR
2452	Trichloroacetic Acid	N/A	µg/L	< 1.0	< 1.9	NR
2456	Total Haloacetic Acids (HAA5)	N/A	µg/L	22.2	< 12.7	NR
2943	Bromodichloromethane	N/A	µg/L	11	NA	13.7
2942	Bromoform	N/A	µg/L	64	NA	43.1
2941	Dibromochloromethane	N/A	µg/L	44	NA	40.4
2944	Chloroform	N/A	µg/L	1.2	NA	2.6
2950	Total Trihalomethanes (THM)	N/A	µg/L	120.2	NA	99.8

RADIOCARBON AGE DETERMINATION / DETERIUM / OXYGEN 18

AGE = 31,600 ± 500 ^{14}C years BP (^{13}C corrected)

2.0 ± 0.1% of the modern (1950) ^{14}C activity

$\delta^{13}C_{PDB}$ = -6.8‰

δD*	$\delta^{18}O$*
-8	-2

*Analyses are reported in ‰ notation and are computed as follows:

$$\delta R_{sample}\ ‰ = \left[\frac{R_{sample}}{R_{standard}} - 1\right] \times 1000$$

I: The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.
Q: Sample held beyond the accepted holding time.
NA: Not available at time of submittal.
NR: Not required for laboratory analysis.
Bold and Highlighted: Exceeds Maximum Contaminant Level.

TABLE 2-18
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTIOIN AND TESTING SUMMARY REPORT

TZMW-A1

PRIMARY DRINKING WATER STANDARDS
MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CONTAMINANTS
Reference: 62-550.310(1)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TZMW-A1 7/15/10	TZMW-A1 7/15/10
1074	Antimony	0.006	mg/L	< 0.00040	NR
1005	Arsenic	0.010	mg/L	< 0.00037	NR
1010	Barium	2.000	mg/L	0.13	0.11
1075	Beryllium	0.004	mg/L	< 0.00015	NR
1015	Cadmium	0.005	mg/L	< 0.000043	NR
1020	Chromium	0.100	mg/L	< 0.0010	NR
1024	Cyanide	0.200	mg/L	< 0.0025	NR
1025	Fluoride	4.000	mg/L	I 0.42	NR
1030	Lead	0.015	mg/L	< 0.000060	NR
1035	Mercury	0.002	mg/L	< 0.000058	NR
1036	Nickel	0.100	mg/L	< 0.0040	NR
1040	Nitrate (as N)	10.000	mg/L	< 0.015	NR
1041	Nitrite (as N)	1.000	mg/L	< 0.015	NR
N/A	Total Nitrate/Nitrite (as N)	10.000	mg/L	< 0.030	NR
1045	Selenium	0.050	mg/L	I 0.0014	NR
1052	Sodium	160.000	mg/L	**1,000**	NR
1085	Thallium	0.002	mg/L	< 0.00010	NR

MAXIMUM CONTAMINANT LEVELS FOR DISINFECTION BYPRODUCTS
Reference: 62-550.310(3)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TZMW-A1 7/15/10	TZMW-A1 7/15/10
1011	Bromate	10	μg/L	**< 260**	NR
1009	Chlorite	1,000	μg/L	**< 370**	NR

2454	Dibromoacetic Acid	N/A	μg/L	< 0.38	< 0.61
2451	Dichloroacetic Acid	N/A	μg/L	< 0.98	< 0.61
2453	Monobromoacetic Acid	N/A	μg/L	< 0.75	< 0.61
2450	Monochloroacetic Acid	N/A	μg/L	< 0.40	< 0.61
2452	Trichloroacetic Acid	N/A	μg/L	< 0.38	< 0.61
2456	Total Haloacetic Acids (HAA5)	60	μg/L	< 0.38	< 0.61

2943	Bromodichloromethane (Dichlorobromomethane)	N/A	μg/L	< 0.54	< 0.25
2942	Bromoform	N/A	μg/L	< 0.39	< 0.25
2941	Chloroform	N/A	μg/L	< 0.29	< 0.25
2944	Dibromochloromethane (Chlorodibromomethane)	N/A	μg/L	< 0.43	< 0.25
2950	Total Trihalomethanes (THM)	80	μg/L	< 0.29	< 0.25

TABLE 2-18 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTIOIN AND TESTING SUMMARY REPORT

TZMW-A1

MAXIMUM CONTAMINANT LIMITS FOR VOLATILE ORGANICS
Reference: 62-550.310(4)(a)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TZMW-A1 7/15/10	TZMW-A1 7/15/10
2977	1,1-Dichloroethylene	7	μg/L	< 0.32	NR
2981	1,1,1-Trichloroethane	200	μg/L	< 0.27	NR
2985	1,1,2-Trichloroethane	5	μg/L	< 0.22	NR
2980	1,2-Dichloroethane	3	μg/L	< 0.17	NR
2983	1,2-Dichloropropane	5	μg/L	< 0.45	NR
2378	1,2,4-Tricholorobenzene	70	μg/L	< 0.18	NR
2990	Benzene	1	μg/L	< 0.18	NR
2982	Carbon tetrachloride	3	μg/L	< 0.22	NR
2380	cis-1,2-Dichloroethylene	70	μg/L	< 0.37	NR
2964	Dichloromethane (Methylene chloride)	5	μg/L	< 0.36	NR
2992	Ethylbenzene	700	μg/L	< 0.12	NR
2989	Monochlorobenzene (chlorobenzene)	100	μg/L	< 0.27	NR
2968	o-Dichlorobenzene (1,2-dicholorobenzene)	600	μg/L	< 0.17	NR
2969	para-Dichlorobenzene (1,4-dicholorobenzene)	75	μg/L	< 0.18	NR
2996	Styrene	100	μg/L	< 0.28	NR
2987	Tetrachloroethylene	3	μg/L	< 0.30	NR
2991	Toluene	1,000	μg/L	< 0.34	NR
2979	trans-1,2-Dichloroethylene	100	μg/L	< 0.24	NR
2984	Trichloroethylene	3	μg/L	< 0.37	NR
2976	Vinyl chloride	1	μg/L	< 0.33	NR
2955	Xylenes (total)	10,000	μg/L	< 0.27	NR

TABLE 2-18 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTIOIN AND TESTING SUMMARY REPORT

TZMW-A1

MAXIMUM CONTAMINANT LEVELS FOR SYNTHETIC ORGANICS
Reference: 62-550.310(4)(b)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TZMW-A1 7/15/10**	**TZMW-A1 7/15/10**
2063	2,3,7,8-TCDD (Dioxin)	30	pg/L	< 2.04x10-6	NR
2105	2,4-D	70.00	µg/L	< 0.036	NR
2110	2,4,5-TP (Silvex)	50.00	µg/L	< 0.059	NR
2051	Alachlor	2.00	µg/L	< 0.039	NR
2050	Atrazine	3.00	µg/L	< 0.026	NR
2306	Benzo(a)pyrene	0.20	µg/L	< 0.034	NR
2046	Carbofuran	40.00	µg/L	< 0.43	NR
2959	Chlordane	2.00	µg/L	< 0.11	NR
2031	Dalapon	200.00	µg/L	< 0.98	NR
2035	Di(2-ethylhexyl)adipate	400.00	µg/L	< 0.71	NR
2039	Di(2-ethylhexyl)phthalate	6.00	µg/L	< 0.76	NR
2931	Dibromochloropropane (1,2-dibromo-3-chloropropane)	0.20	µg/L	< 0.0032	NR
2041	Dinoseb	7.00	µg/L	< 0.15	NR
2032	Diquat	20.00	µg/L	< 0.40	NR
2033	Endothall	100.00	µg/L	< 6.3	NR
2005	Endrin	2.00	µg/L	< 0.085	NR
2946	Ethylene Dibromide (EDB or 1,2-dibromoethane)	0.02	µg/L	< 0.0077	NR
2034	Glyphosate	700.00	µg/L	< 2.5	NR
2065	Heptachlor	0.40	µg/L	< 0.064	NR
2067	Heptachlor Epoxide	0.20	µg/L	< 0.21	NR
2274	Hexachlorobenzene	1.00	µg/L	< 0.048	NR
2042	Hexachlorocyclopentadiene	50.00	µg/L	< 0.049	NR
2010	Lindane (gamma-BHC)	0.20	µg/L	< 0.095	NR
2015	Methoxychlor	40.00	µg/L	< 0.051	NR
2036	Oxamyl (Vydate)	200.00	µg/L	< 0.35	NR
2326	Pentachlorophenol	1.00	µg/L	< 0.037	NR
2040	Picloram	500.00	µg/L	< 0.075	NR
2383	Polychlorinated biphenyl (PCB)	0.50	µg/L	< 0.043	NR
2037	Simazine	4.00	µg/L	< 0.041	NR
2020	Toxaphene	3.00	µg/L	< 0.055	NR

MAXIMUM CONTAMINANT LEVELS FOR RADIONUCLIDES
Reference: 62-550.310(6)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TZMW-A1 7/15/10**	**TZMW-A1 7/15/10**
4000	Gross Alpha (Excl Uranium)	15**	pCi/L	38+/-24	NR
4002	Gross Alpha (Incl Uranium)	***	pCi/L	--	NR
4006	Combined Uranium (U-234, U-235, & U-238)	30****	pCi/L	< 0.281+/-0.036	NR
4020	Radium-226	5	pCi/L	**14.9+/-1.5**	NR
4030	Radium-228	5	pCi/L	0.46+/-0.26	NR
NA	Gross Beta	NA	pCi/L	< 11.3+/-9.5	NR
NA	Radon-222	NA	pCi/L	252.0+/-36.0	NR

** If the results exceed 5 pCi/L, a measurement for radium-226 is required.
*** If the results exceed 5 pCi/L, a measurements for radium-226 is required. If the results exceed 15 pCi/L, measurements for radium-226 and uranium are required.
**** If uranium (U) is reported as a measurement of activity (pCi/L) it will be converted to a mass measurement (µg/L) by multiplying the result by 1.5.

TABLE 2-18 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTIOIN AND TESTING SUMMARY REPORT

TZMW-A1

SECONDARY DRINKING WATER STANDARDS
Reference: 62-550.320

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TZMW-A1 7/15/10**	**TZMW-A1 7/15/10**
1002	Aluminum	0.20	mg/L	< 0.10	NR
1017	Chloride	250.00	mg/L	**2,000**	**1,700**
1022	Copper	1.00	mg/L	< 0.0050	NR
1025	Fluoride	2.00	mg/L	I 0.42	NR
2905	Foaming Agents (Surfactants as LAS)	0.50	mg/L	I 0.12	NR
1028	Iron	0.30	mg/L	**4.8**	NR
1032	Manganese	0.05	mg/L	0.045	NR
1050	Silver	0.10	mg/L	< 0.00097	NR
1055	Sulfate	250.00	mg/L	**380**	NR
1095	Zinc	5.00	mg/L	0.040	NR
1905	Color	15.00	CU	**40**	NR
1920	Odor	3.00	TON	< 1.0	NR
1925	pH	6.50 - 8.50	SU	Q 7.83	NR
1930	Total Dissolved Solids	500.00	mg/L	**3,800**	**4,060**

ADDITIONAL CONTAMINANTS ANALYZED

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**TZMW-A1 7/15/10**	**TZMW-A1 7/15/10**
N/A	Alkalinity, Total (as $CaCO_3$)	N/A	mg/L	82	NR
N/A	Ammonia (as N)	N/A	mg/L	0.28	NR
N/A	BOD5	N/A	mg/L	< 2.0	NR
N/A	Bicarbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	82	NR
N/A	Bromide	N/A	mg/L	5.2	31.2
N/A	COD	N/A	mg/L	220	NR
N/A	Calcium - ICP Method	N/A	mg/L	180.000	NR
N/A	Calcium Hardness (as $CaCO_3$)	N/A	mg/L	440	NR
N/A	Carbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	< 5.0	NR
N/A	Chlorine, Residual	N/A	mg/L	< 1.0	NR
N/A	Conductivity (Specific Conductance)	N/A	µmhos/cm	6,100	NR
N/A	Hardness, Total (as $CaCO_3$)	N/A	mg/L	1,000	NR
N/A	Heterotrophic Plate Count	N/A	CFU/mL	31	NR
N/A	Hydrogen Sulfide	N/A	mg/L	2.3	< 1.0
N/A	Magnesium (ICP Method)	N/A	mg/L	150.000	NR
N/A	OrthoPhosphate - ICP Method (as PO_4)	N/A	mg/L	< 0.016	NR
N/A	Phosphorus, Total (as P)	N/A	mg/L	0.11	NR
N/A	Potassium (ICP Method)	N/A	mg/L	31.000	NR
N/A	Silica (as SiO_2)	N/A	mg/L	10.000	NR
N/A	Strontium	N/A	mg/L	8.400	NR
N/A	Sulfide	N/A	mg/L	2.1	NR
N/A	Total Carbon Dioxide	N/A	mg/L	< 5.0	NR
N/A	Total Kjeldahl Nitrogen	N/A	mg/L	I 0.19	NR
N/A	Total Organic Carbon	N/A	mg/L	I 0.83	2.1
N/A	Turbidity	N/A	NTU	30	NR

TABLE 2-18 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTIOIN AND TESTING SUMMARY REPORT

TZMW-A1

DISINFECTION BY-PRODUCT FORMATION POTENTIAL

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. TZMW-A1 7/15/10	Pace Analytical Laboratory TZMW-A1 7/15/10
2454	Dibromoacetic Acid	N/A	µg/L	22	21.1
2451	Dichloroacetic Acid	N/A	µg/L	< 1.0	< 0.61
2453	Monobromoacetic Acid	N/A	µg/L	2.2	3.7
2450	Monochloroacetic Acid	N/A	µg/L	< 2.0	< 0.61
2452	Trichloroacetic Acid	N/A	µg/L	< 1.0	< 0.61
2456	Total Haloacetic Acids (HAA5)	N/A	µg/L	24.2	24.8
2943	Bromodichloromethane	N/A	µg/L	0.9	2.3
2942	Bromoform	N/A	µg/L	160	116
2941	Dibromochloromethane	N/A	µg/L	11	21.4
2944	Chloroform	N/A	µg/L	< 0.5	0.99
2950	Total Trihalomethanes (THM)	N/A	µg/L	171.9	141

RADIOCARBON AGE DETERMINATION / DETERIUM / OXYGEN 18

AGE = 34,800 ± 1,500 ^{14}C years BP (^{13}C corrected)

1.30 ± 0.2% of the modern (1950) ^{14}C activity

$\delta^{13}C_{PDB}$ = -5.5%o

δD*	δ^{18}O*
-7, -6**	-2.3

*Analyses are reported in %o notation and are computed as follows:

**Duplicate analyses on separate alliquots of the original sample.

$$\delta R_{sample}\ \%o = \left[\frac{R_{sample}}{R_{standard}} - 1\right] \times 1000$$

I: The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.
Q: Sample held beyond the accepted holding time.
NR: Not required for laboratory analysis.
Bold and Highlighted: Exceeds Maximum Contaminant Level.

TABLE 2-19
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A2

PRIMARY DRINKING WATER STANDARDS
MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CONTAMINANTS
Reference: 62-550.310(1)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**LFMW-A2 4/20/10**	**LFMW-A2 4/20/10**
1074	Antimony	0.006	mg/L	< 0.00040	NR
1005	Arsenic	0.010	mg/L	< 0.00037	NR
1010	Barium	2.000	mg/L	0.076	0.074
1075	Beryllium	0.004	mg/L	< 0.00015	NR
1015	Cadmium	0.005	mg/L	< 0.000043	NR
1020	Chromium	0.100	mg/L	< 0.0010	NR
1024	Cyanide	0.200	mg/L	I 0.0053	NR
1025	Fluoride	4.000	mg/L	0.85	NR
1030	Lead	0.015	mg/L	< 0.000060	NR
1035	Mercury	0.002	mg/L	< 0.000058	NR
1036	Nickel	0.100	mg/L	< 0.0040	NR
1040	Nitrate (as N)	10.000	mg/L	< 0.015	NR
1041	Nitrite (as N)	1.000	mg/L	< 0.015	NR
N/A	Total Nitrate/Nitrite (as N)	10.000	mg/L	< 0.015	NR
1045	Selenium	0.050	mg/L	0.00058	NR
1052	Sodium	160.000	mg/L	**190**	NR
1085	Thallium	0.002	mg/L	< 0.00010	NR

MAXIMUM CONTAMINANT LEVELS FOR DISINFECTION BYPRODUCTS
Reference: 62-550.310(3)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**LFMW-A2 4/20/10**	**LFMW-A2 4/20/10**
1011	Bromate	10	μg/L	< 2.6	NR
1009	Chlorite	1,000	μg/L	< 3.7	NR

2454	Dibromoacetic Acid	N/A	μg/L	< 0.38	< 0.61
2451	Dichloroacetic Acid	N/A	μg/L	< 0.98	< 0.61
2453	Monobromoacetic Acid	N/A	μg/L	< 0.75	< 0.61
2450	Monochloroacetic Acid	N/A	μg/L	< 0.40	< 0.61
2452	Trichloroacetic Acid	N/A	μg/L	< 0.38	< 0.61
2456	Total Haloacetic Acids (HAA5)	60	μg/L	< 0.38	< 0.61

2943	Bromodichloromethane (Dichlorobromomethane)	N/A	μg/L	< 0.54	< 0.25
2942	Bromoform	N/A	μg/L	< 0.39	< 0.25
2941	Chloroform	N/A	μg/L	< 0.29	< 0.25
2944	Dibromochloromethane (Chlorodibromomethane)	N/A	μg/L	< 0.43	< 0.25
2950	Total Trihalomethanes (THM)	80	μg/L	< 0.29	< 0.25

TABLE 2-19 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A2

MAXIMUM CONTAMINANT LIMITS FOR VOLATILE ORGANICS
Reference: 62-550.310(4)(a)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	LFMW-A2 4/20/10	LFMW-A2 4/20/10
2977	1,1-Dichloroethylene	7	µg/L	< 0.32	NR
2981	1,1,1-Trichloroethane	200	µg/L	< 0.27	NR
2985	1,1,2-Trichloroethane	5	µg/L	< 0.22	NR
2980	1,2-Dichloroethane	3	µg/L	< 0.17	NR
2983	1,2-Dichloropropane	5	µg/L	< 0.45	NR
2378	1,2,4-Tricholorobenzene	70	µg/L	< 0.18	NR
2990	Benzene	1	µg/L	< 0.18	NR
2982	Carbon tetrachloride	3	µg/L	< 0.22	NR
2380	cis-1,2-Dichloroethylene	70	µg/L	< 0.37	NR
2964	Dichloromethane (Methylene chloride)	5	µg/L	< 0.54	NR
2992	Ethylbenzene	700	µg/L	< 0.12	NR
2989	Monochlorobenzene (chlorobenzene)	100	µg/L	< 0.27	NR
2968	o-Dichlorobenzene (1,2-dicholorobenzene)	600	µg/L	< 0.17	NR
2969	para-Dichlorobenzene (1,4-dicholorobenzene)	75	µg/L	< 0.18	NR
2996	Styrene	100	µg/L	< 0.28	NR
2987	Tetrachloroethylene	3	µg/L	< 0.30	NR
2991	Toluene	1,000	µg/L	< 0.23	NR
2979	trans-1,2-Dichloroethylene	100	µg/L	< 0.24	NR
2984	Trichloroethylene	3	µg/L	< 0.37	NR
2976	Vinyl chloride	1	µg/L	< 0.33	NR
2955	Xylenes (total)	10,000	µg/L	< 0.27	NR

TABLE 2-19 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A2

MAXIMUM CONTAMINANT LEVELS FOR SYNTHETIC ORGANICS
Reference: 62-550.310(4)(b)

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. LFMW-A2 4/20/10	Pace Analytical Laboratory LFMW-A2 4/20/10
2063	2,3,7,8-TCDD (Dioxin)	30	pg/L	< 2.0x10-6	NR
2105	2,4-D	70.00	µg/L	< 0.037	NR
2110	2,4,5-TP (Silvex)	50.00	µg/L	< 0.060	NR
2051	Alachlor	2.00	µg/L	< 0.032	NR
2050	Atrazine	3.00	µg/L	< 0.021	NR
2306	Benzo(a)pyrene	0.20	µg/L	< 0.028	NR
2046	Carbofuran	40.00	µg/L	< 0.43	NR
2959	Chlordane	2.00	µg/L	< 0.12	NR
2031	Dalapon	200.00	µg/L	< 1.0	NR
2035	Di(2-ethylhexyl)adipate	400.00	µg/L	< 0.028	NR
2039	Di(2-ethylhexyl)phthalate	6.00	µg/L	< 0.58	NR
2931	Dibromochloropropane (1,2-dibromo-3-chloropropane)	0.20	µg/L	< 0.0032	NR
2041	Dinoseb	7.00	µg/L	< 0.15	NR
2032	Diquat	20.00	µg/L	< 0.40	NR
2033	Endothall	100.00	µg/L	< 6.3	NR
2005	Endrin	2.00	µg/L	< 0.070	NR
2946	Ethylene Dibromide (EDB or 1,2-dibromoethane)	0.02	µg/L	< 0.0077	NR
2034	Glyphosate	700.00	µg/L	< 2.5	NR
2065	Heptachlor	0.40	µg/L	< 0.052	NR
2067	Heptachlor Epoxide	0.20	µg/L	< 0.17	NR
2274	Hexachlorobenzene	1.00	µg/L	< 0.040	NR
2042	Hexachlorocyclopentadiene	50.00	µg/L	< 0.041	NR
2010	Lindane (gamma-BHC)	0.20	µg/L	< 0.079	NR
2015	Methoxychlor	40.00	µg/L	< 0.042	NR
2036	Oxamyl (Vydate)	200.00	µg/L	< 0.35	NR
2326	Pentachlorophenol	1.00	µg/L	< 0.038	NR
2040	Picloram	500.00	µg/L	< 0.077	NR
2383	Polychlorinated biphenyl (PCB)	0.50	µg/L	< 0.045	NR
2037	Simazine	4.00	µg/L	< 0.034	NR
2020	Toxaphene	3.00	µg/L	< 0.058	NR

MAXIMUM CONTAMINANT LEVELS FOR RADIONUCLIDES
Reference: 62-550.310(6)

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. LFMW-A2 4/20/10	Pace Analytical Laboratory LFMW-A2 4/20/10
4000	Gross Alpha (Excl Uranium)	15**	pCi/L	8.4+/-4.7	NR
4002	Gross Alpha (Incl Uranium)	***	pCi/L	--	NR
4006	Combined Uranium (U-234, U-235, & U-238)	30****	pCi/L	J 0.358+/-0.045	NR
4020	Radium-226	5	pCi/L	3.83+/-0.50	NR
4030	Radium-228	5	pCi/L	J 0.55+/-0.31	NR
NA	Gross Beta	NA	pCi/L	4.5+/-2.3	NR
NA	Radon-222	NA	pCi/L	153+/-27	NR

** If the results exceed 5 pCi/L, a measurement for radium-226 is required.
*** If the results exceed 5 pCi/L, a measurements for radium-226 is required. If the results exceed 15 pCi/L, measurements for radium-226 and uranium are required.
**** If uranium (U) is reported as a measurement of activity (pCi/L) it will be converted to a mass measurement (µg/L) by multiplying the result by 1.5.

TABLE 2-19 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A2

SECONDARY DRINKING WATER STANDARDS
Reference: 62-550.320

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. LFMW-A2 4/20/10	Pace Analytical Laboratory LFMW-A2 4/20/10
1002	Aluminum	0.20	mg/L	< 0.100	NR
1017	Chloride	250.00	mg/L	**390**	**307**
1022	Copper	1.00	mg/L	I 0.0010	NR
1025	Fluoride	2.00	mg/L	0.85	NR
2905	Foaming Agents (Surfactants as LAS)	0.50	mg/L	I 0.11	NR
1028	Iron	0.30	mg/L	0.110	NR
1032	Manganese	0.05	mg/L	< 0.0030	NR
1050	Silver	0.10	mg/L	< 0.00097	NR
1055	Sulfate	250.00	mg/L	97	NR
1095	Zinc	5.00	mg/L	I 0.0076	NR
1905	Color	15.00	CU	< 5.0	NR
1920	Odor	3.00	TON	< 1.0	NR
1925	pH	6.50 - 8.50	SU	Q 8.00	NR
1930	Total Dissolved Solids	500.00	mg/L	**840**	**888**

ADDITIONAL CONTAMINANTS ANALYZED

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. LFMW-A2 4/20/10	Pace Analytical Laboratory LFMW-A2 4/20/10
N/A	Alkalinity, Total (as $CaCO_3$)	N/A	mg/L	90	NR
N/A	Ammonia (as N)	N/A	mg/L	0.25	NR
N/A	BOD5	N/A	mg/L	J 30.0	NR
N/A	Bicarbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	89	NR
N/A	Bromide	N/A	mg/L	I 2.8	1.1
N/A	COD	N/A	mg/L	U 6.3	NR
N/A	Calcium - ICP Method	N/A	mg/L	64.000	NR
N/A	Calcium Hardness (as $CaCO_3$)	N/A	mg/L	0.16	NR
N/A	Carbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	< 5.0	NR
N/A	Chlorine, Residual	N/A	mg/L	< 1.0	NR
N/A	Conductivity (Specific Conductance)	N/A	µmhos/cm	1600	NR
N/A	Hardness, Total (as $CaCO_3$)	N/A	mg/L	0.29	NR
N/A	Heterotrophic Plate Count	N/A	CFU/mL	5	NR
N/A	Hydrogen Sulfide	N/A	mg/L	NA	< 1.0
N/A	Magnesium (ICP Method)	N/A	mg/L	31.000	NR
N/A	OrthoPhosphate - ICP Method (as PO_4)	N/A	mg/L	I 0.025	NR
N/A	Phosphorus, Total (as P)	N/A	mg/L	< 0.024	NR
N/A	Potassium (ICP Method)	N/A	mg/L	7.300	NR
N/A	Silica (as SiO_2)	N/A	mg/L	12.000	NR
N/A	Strontium	N/A	mg/L	16.000	NR
N/A	Sulfide	N/A	mg/L	1.1	NR
N/A	Total Carbon Dioxide	N/A	mg/L	< 5.0	NR
N/A	Total Kjeldahl Nitrogen	N/A	mg/L	I 0.17	NR
N/A	Total Organic Carbon	N/A	mg/L	I 0.60	I 0.69
N/A	Turbidity	N/A	NTU	1.6	NR

TABLE 2-19 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A2

DISINFECTION BY-PRODUCT FORMATION POTENTIAL

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. LFMW-A2 4/20/10	Pace Analytical Laboratory LFMW-A2 4/20/10
2454	Dibromoacetic Acid	N/A	µg/L	12	4.4
2451	Dichloroacetic Acid	N/A	µg/L	4.2	< 0.61
2453	Monobromoacetic Acid	N/A	µg/L	< 1.0	4.1
2450	Monochloroacetic Acid	N/A	µg/L	< 2.0	< 0.61
2452	Trichloroacetic Acid	N/A	µg/L	< 1.0	< 0.61
2456	Total Haloacetic Acids (HAA5)	N/A	µg/L	16.2	8.4
2943	Bromodichloromethane	N/A	µg/L	8.6	3.7
2942	Bromoform	N/A	µg/L	60	75.5
2941	Dibromochloromethane	N/A	µg/L	37	18.5
2944	Chloroform	N/A	µg/L	0.9	0.74
2950	Total Trihalomethanes (THM)	N/A	µg/L	106.5	98.5

RADIOCARBON AGE DETERMINATION / DETERIUM / OXYGEN 18

AGE = 34,00 ± 600 ^{14}C years BP (^{13}C corrected)

1.5 ± 0.1% of the modern (1950) ^{14}C activity

$\delta^{13}C_{PDB}$ = -6.1%o

δD*	$\delta^{18}O$*
-10	-2.5

*Analyses are reported in %o notation and are computed as follows:

$$\delta R_{sample}\ \%o = \left[\frac{R_{sample}}{R_{standard}} - 1\right] \times 1000$$

I: The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.

Q: Sample held beyond the accepted holding time.

NA: Not available at time of submittal.

NR: Not required for laboratory analysis.

Bold and Highlighted: Exceeds Maximum Contaminant Level.

TABLE 2-20
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A3

PRIMARY DRINKING WATER STANDARDS
MAXIMUM CONTAMINANT LEVELS FOR INORGANIC CONTAMINANTS
Reference: 62-550.310(1)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	LFMW-A3 7/14/10	LFMW-A3 7/14/10
1074	Antimony	0.006	mg/L	< 0.00040	NR
1005	Arsenic	0.010	mg/L	< 0.00037	NR
1010	Barium	2.000	mg/L	0.080	0.078
1075	Beryllium	0.004	mg/L	< 0.00015	NR
1015	Cadmium	0.005	mg/L	< 0.000043	NR
1020	Chromium	0.100	mg/L	< 0.0010	NR
1024	Cyanide	0.200	mg/L	< 0.0025	NR
1025	Fluoride	4.000	mg/L	0.60	NR
1030	Lead	0.015	mg/L	< 0.000060	NR
1035	Mercury	0.002	mg/L	< 0.000058	NR
1036	Nickel	0.100	mg/L	< 0.0040	NR
1040	Nitrate (as N)	10.000	mg/L	< 0.015	NR
1041	Nitrite (as N)	1.000	mg/L	< 0.015	NR
N/A	Total Nitrate/Nitrite (as N)	10.000	mg/L	< 0.030	NR
1045	Selenium	0.050	mg/L	< 0.00058	NR
1052	Sodium	160.000	mg/L	**180**	NR
1085	Thallium	0.002	mg/L	< 0.00010	NR

MAXIMUM CONTAMINANT LEVELS FOR DISINFECTION BYPRODUCTS
Reference: 62-550.310(3)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	LFMW-A3 7/14/10	LFMW-A3 7/14/10
1011	Bromate	10	μg/L	< 2.6	NR
1009	Chlorite	1,000	μg/L	< 3.7	NR
2454	Dibromoacetic Acid	N/A	μg/L	< 0.38	< 0.61
2451	Dichloroacetic Acid	N/A	μg/L	< 0.98	< 0.61
2453	Monobromoacetic Acid	N/A	μg/L	< 0.75	< 0.61
2450	Monochloroacetic Acid	N/A	μg/L	< 0.40	< 0.61
2452	Trichloroacetic Acid	N/A	μg/L	< 0.38	< 0.61
2456	Total Haloacetic Acids (HAA5)	60	μg/L	< 0.38	< 0.61
2943	Bromodichloromethane (Dichlorobromomethane)	N/A	μg/L	< 0.54	< 0.25
2942	Bromoform	N/A	μg/L	< 0.39	< 0.25
2941	Chloroform	N/A	μg/L	< 0.29	< 0.25
2944	Dibromochloromethane (Chlorodibromomethane)	N/A	μg/L	< 0.43	< 0.25
2950	Total Trihalomethanes (THM)	80	μg/L	< 0.29	< 0.25

TABLE 2-20 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A3

MAXIMUM CONTAMINANT LIMITS FOR VOLATILE ORGANICS
Reference: 62-550.310(4)(a)

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**LFMW-A3 7/14/10**	**LFMW-A3 7/14/10**
2977	1,1-Dichloroethylene	7	µg/L	< 0.32	NR
2981	1,1,1-Trichloroethane	200	µg/L	< 0.27	NR
2985	1,1,2-Trichloroethane	5	µg/L	< 0.22	NR
2980	1,2-Dichloroethane	3	µg/L	< 0.17	NR
2983	1,2-Dichloropropane	5	µg/L	< 0.45	NR
2378	1,2,4-Tricholorobenzene	70	µg/L	< 0.18	NR
2990	Benzene	1	µg/L	< 0.18	NR
2982	Carbon tetrachloride	3	µg/L	< 0.22	NR
2380	cis-1,2-Dichloroethylene	70	µg/L	< 0.37	NR
2964	Dichloromethane (Methylene chloride)	5	µg/L	< 0.36	NR
2992	Ethylbenzene	700	µg/L	< 0.46	NR
2989	Monochlorobenzene (chlorobenzene)	100	µg/L	< 0.27	NR
2968	o-Dichlorobenzene (1,2-dicholorobenzene)	600	µg/L	< 0.17	NR
2969	para-Dichlorobenzene (1,4-dicholorobenzene)	75	µg/L	< 0.18	NR
2996	Styrene	100	µg/L	< 0.28	NR
2987	Tetrachloroethylene	3	µg/L	< 0.30	NR
2991	Toluene	1,000	µg/L	0.92	NR
2979	trans-1,2-Dichloroethylene	100	µg/L	< 0.24	NR
2984	Trichloroethylene	3	µg/L	< 0.37	NR
2976	Vinyl chloride	1	µg/L	< 0.33	NR
2955	Xylenes (total)	10,000	µg/L	2.7	NR

TABLE 2-20 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A3

MAXIMUM CONTAMINANT LEVELS FOR SYNTHETIC ORGANICS
Reference: 62-550.310(4)(b)

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
				LFMW-A3 7/14/10	LFMW-A3 7/14/10
2063	2,3,7,8-TCDD (Dioxin)	30	pg/L	< 3.08x10-6	NR
2105	2,4-D	70.00	µg/L	< 0.037	NR
2110	2,4,5-TP (Silvex)	50.00	µg/L	< 0.060	NR
2051	Alachlor	2.00	µg/L	< 0.033	NR
2050	Atrazine	3.00	µg/L	< 0.022	NR
2306	Benzo(a)pyrene	0.20	µg/L	< 0.029	NR
2046	Carbofuran	40.00	µg/L	< 0.43	NR
2959	Chlordane	2.00	µg/L	< 0.11	NR
2031	Dalapon	200.00	µg/L	< 1.0	NR
2035	Di(2-ethylhexyl)adipate	400.00	µg/L	< 0.60	NR
2039	Di(2-ethylhexyl)phthalate	6.00	µg/L	< 0.60	NR
2931	Dibromochloropropane (1,2-dibromo-3-chloropropane)	0.20	µg/L	< 0.0031	NR
2041	Dinoseb	7.00	µg/L	< 0.15	NR
2032	Diquat	20.00	µg/L	< 0.40	NR
2033	Endothall	100.00	µg/L	< 6.3	NR
2005	Endrin	2.00	µg/L	< 0.072	NR
2946	Ethylene Dibromide (EDB or 1,2-dibromoethane)	0.02	µg/L	< 0.0075	NR
2034	Glyphosate	700.00	µg/L	< 2.5	NR
2065	Heptachlor	0.40	µg/L	< 0.054	NR
2067	Heptachlor Epoxide	0.20	µg/L	< 0.18	NR
2274	Hexachlorobenzene	1.00	µg/L	< 0.041	NR
2042	Hexachlorocyclopentadiene	50.00	µg/L	< 0.042	NR
2010	Lindane (gamma-BHC)	0.20	µg/L	< 0.081	NR
2015	Methoxychlor	40.00	µg/L	< 0.043	NR
2036	Oxamyl (Vydate)	200.00	µg/L	< 0.35	NR
2326	Pentachlorophenol	1.00	µg/L	< 0.038	NR
2040	Picloram	500.00	µg/L	< 0.077	NR
2383	Polychlorinated biphenyl (PCB)	0.50	µg/L	< 0.042	NR
2037	Simazine	4.00	µg/L	< 0.035	NR
2020	Toxaphene	3.00	µg/L	< 0.055	NR

MAXIMUM CONTAMINANT LEVELS FOR RADIONUCLIDES
Reference: 62-550.310(6)

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
				LFMW-A3 7/14/10	LFMW-A3 7/14/10
4000	Gross Alpha (Excl Uranium)	15**	pCi/L	< 5.6+/-5.0	NR
4002	Gross Alpha (Incl Uranium)	***	pCi/L	--	NR
4006	Combined Uranium (U-234, U-235, & U-238)	30****	pCi/L	< 0.206+/-0.025	NR
4020	Radium-226	5	pCi/L	3.10+/-0.47	NR
4030	Radium-228	5	pCi/L	< 0.33+/-0.29	NR
NA	Gross Beta	NA	pCi/L	5.6+/-2.8	NR
NA	Radon-222	NA	pCi/L	LE	NR

** If the results exceed 5 pCi/L, a measurement for radium-226 is required.
*** If the results exceed 5 pCi/L, a measurements for radium-226 is required. If the results exceed 15 pCi/L, measurements for radium-226 and uranium are required.
**** If uranium (U) is reported as a measurement of activity (pCi/L) it will be converted to a mass measurement (µg/L) by multiplying the result by 1.5.

TABLE 2-20 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A3

SECONDARY DRINKING WATER STANDARDS
Reference: 62-550.320

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**LFMW-A3 7/14/10**	**LFMW-A3 7/14/10**
1002	Aluminum	0.20	mg/L	< 0.10	NR
1017	Chloride	250.00	mg/L	**360**	**266**
1022	Copper	1.00	mg/L	< 0.0050	NR
1025	Fluoride	2.00	mg/L	0.60	NR
2905	Foaming Agents (Surfactants as LAS)	0.50	mg/L	< 0.12	NR
1028	Iron	0.30	mg/L	0.22	NR
1032	Manganese	0.05	mg/L	< 0.0030	NR
1050	Silver	0.10	mg/L	< 0.00097	NR
1055	Sulfate	250.00	mg/L	85	NR
1095	Zinc	5.00	mg/L	< 0.0063	NR
1905	Color	15.00	CU	10	NR
1920	Odor	3.00	TON	< 1.0	NR
1925	pH	6.50 - 8.50	SU	Q 7.99	NR
1930	Total Dissolved Solids	500.00	mg/L	**860**	**744**

ADDITIONAL CONTAMINANTS ANALYZED

				TestAmerica Laboratories, Inc.	Pace Analytical Laboratory
CONTAMINANT ID	**CONTAMINANT**	**MAXIMUM CONTAMINANT LEVEL**	**UNITS**	**LFMW-A3 7/14/10**	**LFMW-A3 7/14/10**
N/A	Alkalinity, Total (as $CaCO_3$)	N/A	mg/L	95	NR
N/A	Ammonia (as N)	N/A	mg/L	0.24	NR
N/A	BOD5	N/A	mg/L	< 2.0	NR
N/A	Bicarbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	95	NR
N/A	Bromide	N/A	mg/L	< 1.0	3.3
N/A	COD	N/A	mg/L	55	NR
N/A	Calcium - ICP Method	N/A	mg/L	60	NR
N/A	Calcium Hardness (as $CaCO_3$)	N/A	mg/L	150	NR
N/A	Carbonate Alkalinity (as $CaCO_3$)	N/A	mg/L	< 5.0	NR
N/A	Chlorine, Residual	N/A	mg/L	< 1.0	NR
N/A	Conductivity (Specific Conductance)	N/A	μmhos/cm	1,400	NR
N/A	Hardness, Total (as $CaCO_3$)	N/A	mg/L	270	NR
N/A	Heterotrophic Plate Count	N/A	CFU/mL	< 1	NR
N/A	Hydrogen Sulfide	N/A	mg/L	< 1.1	< 1.0
N/A	Magnesium (ICP Method)	N/A	mg/L	28	NR
N/A	OrthoPhosphate - ICP Method (as PO_4)	N/A	mg/L	< 0.016	NR
N/A	Phosphorus, Total (as P)	N/A	mg/L	I 0.086	NR
N/A	Potassium (ICP Method)	N/A	mg/L	7.100	NR
N/A	Silica (as SiO_2)	N/A	mg/L	11.000	NR
N/A	Strontium	N/A	mg/L	17.000	NR
N/A	Sulfide	N/A	mg/L	U 1.0	NR
N/A	Total Carbon Dioxide	N/A	mg/L	< 5.0	NR
N/A	Total Kjeldahl Nitrogen	N/A	mg/L	0.24	NR
N/A	Total Organic Carbon	N/A	mg/L	I 0.60	1.6
N/A	Turbidity	N/A	NTU	0.86	NR

TABLE 2-20 (CONTINUED)
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LFMW-A3

DISINFECTION BY-PRODUCT FORMATION POTENTIAL

CONTAMINANT ID	CONTAMINANT	MAXIMUM CONTAMINANT LEVEL	UNITS	TestAmerica Laboratories, Inc. LFMW-A3 7/14/10	Pace Analytical Laboratory LFMW-A3 7/14/10
2454	Dibromoacetic Acid	N/A	µg/L	12	10.1
2451	Dichloroacetic Acid	N/A	µg/L	2.9	2.1
2453	Monobromoacetic Acid	N/A	µg/L	1.3	2.8
2450	Monochloroacetic Acid	N/A	µg/L	< 2.0	< 0.61
2452	Trichloroacetic Acid	N/A	µg/L	< 1.0	< 0.61
2456	Total Haloacetic Acids (HAA5)	N/A	µg/L	16.2	15.1
2943	Bromodichloromethane	N/A	µg/L	9.2	21.4
2942	Bromoform	N/A	µg/L	53	29.2
2941	Dibromochloromethane	N/A	µg/L	35	49.9
2944	Chloroform	N/A	µg/L	1.1	4.5
2950	Total Trihalomethanes (THM)	N/A	µg/L	98.3	105

RADIOCARBON AGE DETERMINATION / DETERIUM / OXYGEN 18

AGE = 31,50 ± 900 ^{14}C years BP (^{13}C corrected)

2.0 ± 0.2% of the modern (1950) ^{14}C activity

$\delta^{13}C_{PDB}$ = -6.5‰

δD*	$\delta^{18}O$*
-10	-2.2

*Analyses are reported in ‰ notation and are computed as follows:

$$\delta R_{sample}\ \text{‰} = \left[\frac{R_{sample}}{R_{standard}} - 1 \right] \times 1000$$

I: The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.

Q: Sample held beyond the accepted holding time.

LE: The vials for Radon analysis did not make it to the Test America laboratory, no results avaliable.

NR: Not required for laboratory analysis.

Bold and Highlighted: Exceeds Maximum Contaminant Level.

TABLE 2-21
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

GENERIC DISCHARGE PERMIT WATER QUALITY RESULTS

GENERIC PERMIT FOR THE DISCHARGE OF PRODUCED GROUND WATER FROM ANY NON-CONTAMINATED SITE ACTIVITY

Reference: 62-621.300(2)

				TestAmerica Laboratories, Inc.	TestAmerica Laboratories, Inc.	TestAmerica Laboratories, Inc.	TestAmerica Laboratories, Inc.
CONTAMINANT ID	**CONTAMINANT**	**Screening Values for Discharges into Fresh Waters**	**UNITS**	**UFMW-A1 8-11-09**	**TPW-A1 9-16-09**	**TPW-A1 10-30-09**	**UFMW-A1 4-01-10**
NA	Total Organic Carbon (TOC)	10.0	mg/L	4.0	1.9	NA	2.4
1925	pH	6.50 - 8.50	S.U.	7.93	7.12	NA	8.40
1035	Total Recoverable Mercury	0.012	µg/L	< 0.00020	0.0038	NA	I 0.00024
1015	Total Recoverable Cadmium	9.3	µg/L	< 0.095	< 0.095	NA	< 0.095
1022	Total Recoverable Copper	2.9	µg/L	< 1.1	I 3.4	< 0.30	< 1.1
1030	Total Recoverable Lead	0.03	mg/L	0.00030	0.00047	NA	< 0.00020
1095	Total Recoverable Zinc	86.0	µg/L	8.3	I 12.0	NA	< 8.3
1020	Total Recoverable Chromium (Hex.)	11.0	mg/L	< 0.0014	< 0.0014	NA	I 0.0040
2990	Benzene	1.0	µg/L	< 0.18	< 0.28	NA	< 0.50
1041	Naphthalene	100.0	µg/L	< 0.50	< 0.48	NA	< 0.23

NA: Not analyzed.

Bold and Highlighted: Exceeds Screening Values for Discharges into Fresh Waters.

TABLE 2-22
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 PACKER TESTING SUMMARY

Packer No.	Packer Element Depth	Total Depth	Date	Pump Rate	Drawdown	Specific Capacity
	(ft)	(ft)		(gpm)	(ft)	(gpm/ft)
1	1,138	1,200	11/20/09	80.1	51.77	1.55
2	1,240	1,352	11/25/09	127.4	35.03	3.64
3	1,430	1,520	12/03/09	171.3	25.90	6.61
4	1,820	1,885	12/11/09	1.6*	67.47	0.02
5	1,924	2,150	12/23/09	221.3*	50.13**	4.41
6	2,305	2,362	01/15/10	110.2*	4.90***	22.49

*Low flow during testing, orifice weir pipe not full, totalizer might have been affected.
**Due to high salinity, water levels have been adjusted to equivalent freshwater head
*** Static head measured after drill string was at isolated interval salinity

TABLE 2-23
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 PACKER TESTING WATER QUALITY RESULTS

Packer No.	Packer Element Depth	Total Depth	Date	Time	pH	Conductivity	Chloride	Total Dissolved Solids	Iron	Hydrogen Sulfide	Potassium	Sulfate	Magnesium	Barium	Calcium	Fluoride	Sodium	Arsenic	Bicarbonate Alkalinity	Alkalinity	Gross Alpha	Oxygen 18	Deuterium	Radiocarbon
Maximum Contaminant Level (MCL)					**6.50 - 8.50**	**--**	**250.00**	**500.00**	**300**	**--**	**--**	**250.00**	**--**	**2,000**	**--**	**2.00**	**160,000**	**10**	**--**	**--**	**15**	**--**	**--**	**--**
	(ft)	**(ft)**			**(SU)**	**(µS/cm)**	**(mg/L)**	**(mg/L)**	**(ug/L)**	**(mg/L)**	**(ug/L)**	**(mg/L)**	**(ug/L)**	**(ug/L)**	**(ug/L)**	**(mg/L)**	**(ug/L)**	**(ug/L)**	**(mg/L)**	**(mg/L)**	**(pCi/L)**			**(Years)**
1	1,138	1,200	11/20/09	17:00	7.99	540	46	360	260	1.80	1,700	95	15,000	73	44,000	0.53	20,000	<4.2	120	120	3.2	-1.7	-7	NA
2	1,240	1,352	11/25/09	14:30	7.71	1,400	240	730	360	1.10	2,700	190	28,000	50	81,000	2.1	110,000	<4.2	110	110	6.8	-1.8	-10	27,500 +/- 330
3	1,430	1,520	12/03/09	15:40	7.90	1,600	370	760	13	1.40	26,000	90	6,600	15	70,000	0.34	370,000	<4.2	92	92	10.1	-2.1	-8	NA
4	1,820	1,885	12/11/09	14:10	8.05	740	150	390	4,400	<1.0	7,300	71	9,800	52	33,000	0.66	73,000	<4.2	29	29	<3.0	-2.1	-12	NA
5	1,924	2,150	12/23/09	12:20	5.51	19,000	5,700	9,500	1,300	1.3	120,000	880	360,000	87	260,000	<0.023	3,400,000	<4.2	97	97	<26	-1.4	-11	NA
6	2,305	2,362	01/15/10	14:00	6.97	49,000	20,000	30,000	7,100	<1.0	500,000	2,700	1,300,000	65	660,000	<1.0	12,000,000	8.1	96	96	<180	0.4	2	31,000 +/- 400

NA is Not Analyzed.
Highlighted: Exceeds Maximum Contaminant Level.

TABLE 3-1
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

MONITOR WELL RADIAL DISTANCES AND OBSERVATION INTERVALS

UFA CRDT No. 1

WELL ID	HYDROSTRATI-GRAPHIC UNIT	DISTANCE FROM TPW-A1 (ft)
TPW-A1	aquifer (UFA)	0.00
UFMW-A1	aquifer (UFA)	101.12
OSF-66	aquifer (UFA)	5,316.53
SMW-A1	aquifer (SAS)	31.54

APPZ CRDT No. 2

WELL ID	HYDROSTRATI-GRAPHIC UNIT	DISTANCE FROM TPW-A1 (ft)
TPW-A1	aquifer (APPZ)	0.00
UFMW-A1	aquifer (UFA)	101.12
OSF-66	aquifer (UFA)	5,316.53
SMW-A1	aquifer (SAS)	31.54

LF1 CRDT No. 3

WELL ID	HYDROSTRATI-GRAPHIC UNIT	DISTANCE FROM TPW-A1 (ft)
TPW-A1	aquifer (LF1)	0.00
TZMW-A1	aquifer (LF1)	123.90
LFMW-A2	aquifer (LF1)	732.21
LFMW-A3	aquifer (LF1)	1,981.92
*DZMW-1 (Upper)	aquifer (LF1)	36,379.29
TZMW-A1	confining unit (LC1)	123.90
DZMW-1 (Lower)	confining unit (LC1)	36,379.29
TZMW-A1	confining unit (APPZ)	123.90
TPW-A1	aquifer (UFA)	0.00
UFMW-A1	aquifer (UFA)	101.12
*UFMW-1	aquifer (UFA)	36,377.66
OSF-66	aquifer (UFA)	5,316.53
SMW-A1	aquifer (SAS)	31.54
SMW-A2	aquifer (SAS)	754.00
SMW-A3	aquifer (SAS)	1,980.86
*SAS-4	aquifer (SAS)	36,378.48

*Wells located at the Bronson Site.

TABLE 3-2
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

UPPER FLORIDAN AQUIFER SYSTEM HYDROGEOLOGIC PARAMETER RESULTS

CRDT No. 1 UFA - September 3, 2009

Observation Well	Distance (feet)	Transmissivity (ft^2/day)	Mean Transmissivity (ft^2/day)	Storage Coefficient	Mean Storage Coefficient	Leakance (ft/day/ft)	Mean Leakance (ft/day/ft)	Analysis Method	Test Phase	Solution Reference
TPW-A1 (UFA)	0.00	8,510	8,505	--	--	--	--	Copper-Jacob Straight Line	Drawdown	Aquifer Test Pro
		8,500		--	--	--	--	Copper-Jacob Straight Line	Drawdown	Tt Cooper-Jacob Spreadsheet
UFMW-A1	101.12	9,780	9,527	2.40E-05	8.67E-05	--	8.67E-05	Copper-Jacob Straight Line	Drawdown	Aquifer Test Pro
		9,000		3.62E-05		1.13E-04		Leaky - Hantush-Jacob (Walton)	Drawdown	Aquifer Test Pro
		9,800		2.00E-04		--		Copper-Jacob Straight Line	Drawdown	Tt Coupled Solution Spreadsheet
		--		--		6.00E-05		Hantush-Walton	Drawdown	Tt Coupled Solution Spreadsheet
OSF-66	5,316.53	59,400	53,733	1.05E-04	1.14E-04	--	4.33E-05	Copper-Jacob Straight Line	Recovery	Aquifer Test Pro
		42,600		1.31E-04		6.96E-05		Leaky - Hantush-Jacob (Walton)	Recovery	Aquifer Test Pro
		59,200		1.05E-04		--		Copper-Jacob Straight Line	Recovery	Tt Coupled Solution Spreadsheet
		--		--		1.70E-05		Hantush-Walton	Recovery	Tt Coupled Solution Spreadsheet

	Transmissivity	Storage Coefficient	Leakance
Mean Values*	9,118	8.67E-05	8.67E-05
Mean Values	25,849	1.00E-04	6.50E-05

CRDT No. 2 APPZ - October 29, 2009

Observation Well	Distance (feet)	Transmissivity (ft^2/day)	Mean Transmissivity (ft^2/day)	Storage Coefficient	Mean Storage Coefficient	Leakance (ft/day/ft)	Mean Leakance (ft/day/ft)	Analysis Method	Test Phase	Solution Reference
TPW-A1 (UFAS)	0.00	155,000	154,800	--	--	--	--	Copper-Jacob Straight Line	Drawdown	Aquifer Test Pro
		154,600		--	--	--	--	Copper-Jacob Straight Line	Drawdown	Tt Cooper-Jacob Spreadsheet

	Transmissivity	Storage Coefficient	Leakance
Mean Values*	154,800	--	--
UFAS - UFA* = APPZ	145,682	--	--
UFAS - UFA = APPZ	128,951	--	--

*Includes only onsite wells.

References: The Copper-Jacob (1946) Method
Hantush-Jacob (1955)
Cleveland, Theodore G., Type Curve Matching Using a Spreadsheet (1996)

TABLE 3-3
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

LOWER FLORIDAN AQUIFER HYDROGEOLOGIC PARAMETER RESULTS

CRDT No. 3 LF1 - July 22, 2010 to August 5, 2010

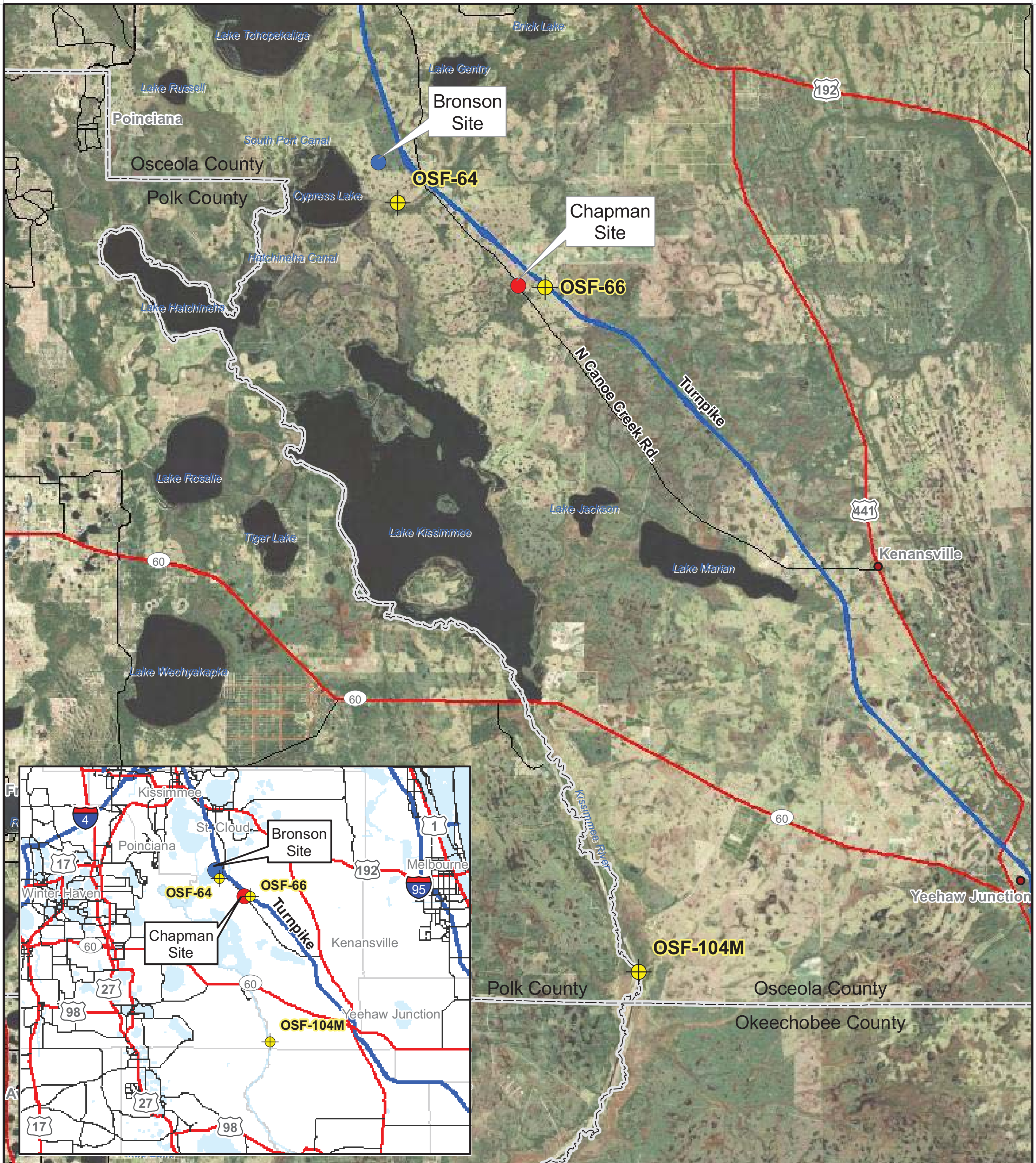
Observation Well	Distance (feet)	Transmissibility (ft^2/day)	Mean Transmissivity (ft^2/day)	Storage Coefficient	Mean Storage Coefficient	Leakance (ft/day/ft)	Mean Leakance (ft/day/ft)	Analysis Method	Test Phase	Solution Reference	Time (days)
TPW-A1 (LF1)	0.00	37,800	37,225	--	--	--	--	Copper-Jacob Straight Line	Drawdown	Aquifer Test Pro	--
		37,200		--	--	--	--	Copper-Jacob Straight Line	Drawdown	Tt Cooper-Jacob Spreadsheet	--
		37,400		--	--	--	--	Copper-Jacob Straight Line	Recovery	Aquifer Test Pro	--
		36,500		--	--	--	--	Copper-Jacob Straight Line	Recovery	Tt Cooper-Jacob Spreadsheet	--
TZMW-A1 (LF1)	123.90	37,000	37,238	4.33E-05	4.65E-05	--	3.32E-04	Copper-Jacob Straight Line	Drawdown	Aquifer Test Pro	--
		39,700		2.77E-05		2.06E-04		Leaky - Hantush-Jacob (Walton)	Drawdown	Aquifer Test Pro	--
		35,400		5.78E-05		--		Copper-Jacob Time-Distance-Drawdown	Drawdown	Aquifer Test Pro	--
		35,500		6.00E-05		5.20E-04		Hantush-Jacob Time-Distance-Drawdown	Drawdown	Aquifer Test Pro	--
		35,500		6.00E-05		--		Copper-Jacob Straight Line	Drawdown	Tt Coupled Solution Spreadsheet	--
		--		--		3.30E-04		Hantush-Walton	Drawdown	Tt Coupled Solution Spreadsheet	--
		38,200		4.33E-05		--		Copper-Jacob Straight Line	Recovery	Aquifer Test Pro	--
		38,300		4.00E-05		3.02E-04		Leaky - Hantush-Jacob (Walton)	Recovery	Aquifer Test Pro	--
		38,300		4.00E-05		--		Copper-Jacob Straight Line	Recovery	Tt Coupled Solution Spreadsheet	--
		--		--		3.00E-04		Hantush-Walton	Recovery	Tt Coupled Solution Spreadsheet	--
LFMW-A2	732.21	33,400	34,213	1.03E-04	9.75E-05	--	5.29E-04	Copper-Jacob Straight Line	Drawdown	Aquifer Test Pro	--
		32,200		1.16E-04		6.37E-04		Leaky - Hantush-Jacob (Walton)	Drawdown	Aquifer Test Pro	--
		33,400		1.03E-04		--		Copper-Jacob Time-Distance-Drawdown	Drawdown	Aquifer Test Pro	--
		32,000		1.17E-04		6.64E-04		Hantush-Jacob Time-Distance-Drawdown	Drawdown	Aquifer Test Pro	--
		33,400		1.00E-04		--		Copper-Jacob Straight Line	Drawdown	Tt Coupled Solution Spreadsheet	--
		--		--		5.60E-04		Hantush-Walton	Drawdown	Tt Coupled Solution Spreadsheet	--
		36,400		8.01E-05		--		Copper-Jacob Straight Line	Recovery	Aquifer Test Pro	--
		36,400		8.05E-05		4.06E-04		Leaky - Hantush-Jacob (Walton)	Recovery	Aquifer Test Pro	--
		36,500		8.00E-05		--		Copper-Jacob Straight Line	Recovery	Tt Coupled Solution Spreadsheet	--
		--		--		3.80E-04		Hantush-Walton	Recovery	Tt Coupled Solution Spreadsheet	--
LFMW-A3	1,981.92	43,000	40,725	8.00E-05	8.48E-05	--	3.56E-04	Copper-Jacob Straight Line	Drawdown	Aquifer Test Pro	--
		37,300		1.00E-04		4.02E-04		Leaky - Hantush-Jacob (Walton)	Drawdown	Aquifer Test Pro	--
		43,000		8.02E-05		--		Copper-Jacob Time-Distance-Drawdown	Drawdown	Aquifer Test Pro	--
		37,200		1.00E-04		4.03E-04		Hantush-Jacob Time-Distance-Drawdown	Drawdown	Aquifer Test Pro	--
		43,000		8.00E-05		--		Copper-Jacob Straight Line	Drawdown	Tt Coupled Solution Spreadsheet	--
		--		--		2.60E-04		Hantush-Walton	Drawdown	Tt Coupled Solution Spreadsheet	--
		42,700		7.45E-05		--		Copper-Jacob Straight Line	Recovery	Aquifer Test Pro	--
		36,800		9.35E-05		4.36E-04		Leaky - Hantush-Jacob (Walton)	Recovery	Aquifer Test Pro	--
		42,800		7.00E-05		--		Copper-Jacob Straight Line	Recovery	Tt Coupled Solution Spreadsheet	--
		--		--		2.80E-04		Hantush-Walton	Recovery	Tt Coupled Solution Spreadsheet	--
TZMW-A1 (LF1), LFMW-A2 & LFMW-A3	123.90	35,413	33,950	2.00E-04	1.30E-04	--	--	Copper-Jacob Distance-Drawdown	Drawdown	TT Spreadsheet	0.0034
	732.21	33,459		1.20E-04		--	--	Copper-Jacob Distance-Drawdown	Drawdown	TT Spreadsheet	0.0069
	1,981.92	32,979		7.00E-05		--	--	Copper-Jacob Distance-Drawdown	Drawdown	TT Spreadsheet	0.014
Mean Values		37,037		8.22E-05		4.06E-04					

References: The Copper-Jacob (1946) Method

Hantush-Jacob (1955)

Cleveland, Theodore G., Type Curve Matching Using a Spreadsheet (1996)

FIGURES



Source: Microsoft Virtual Earth

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LEGEND

- Chapman Site
- Bronson Site
- Regional Observation Well

TETRA TECH

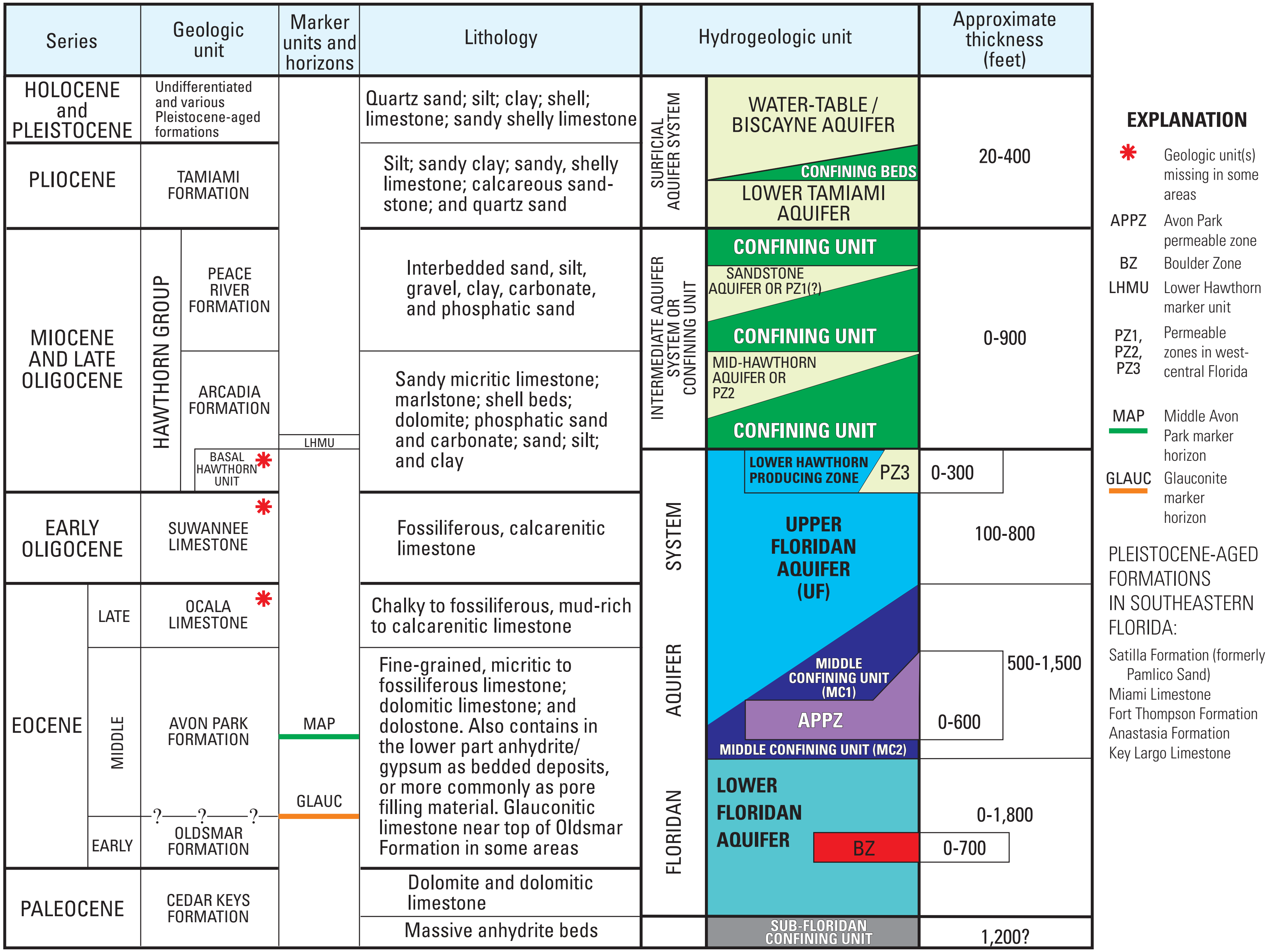
0 N 5
Miles

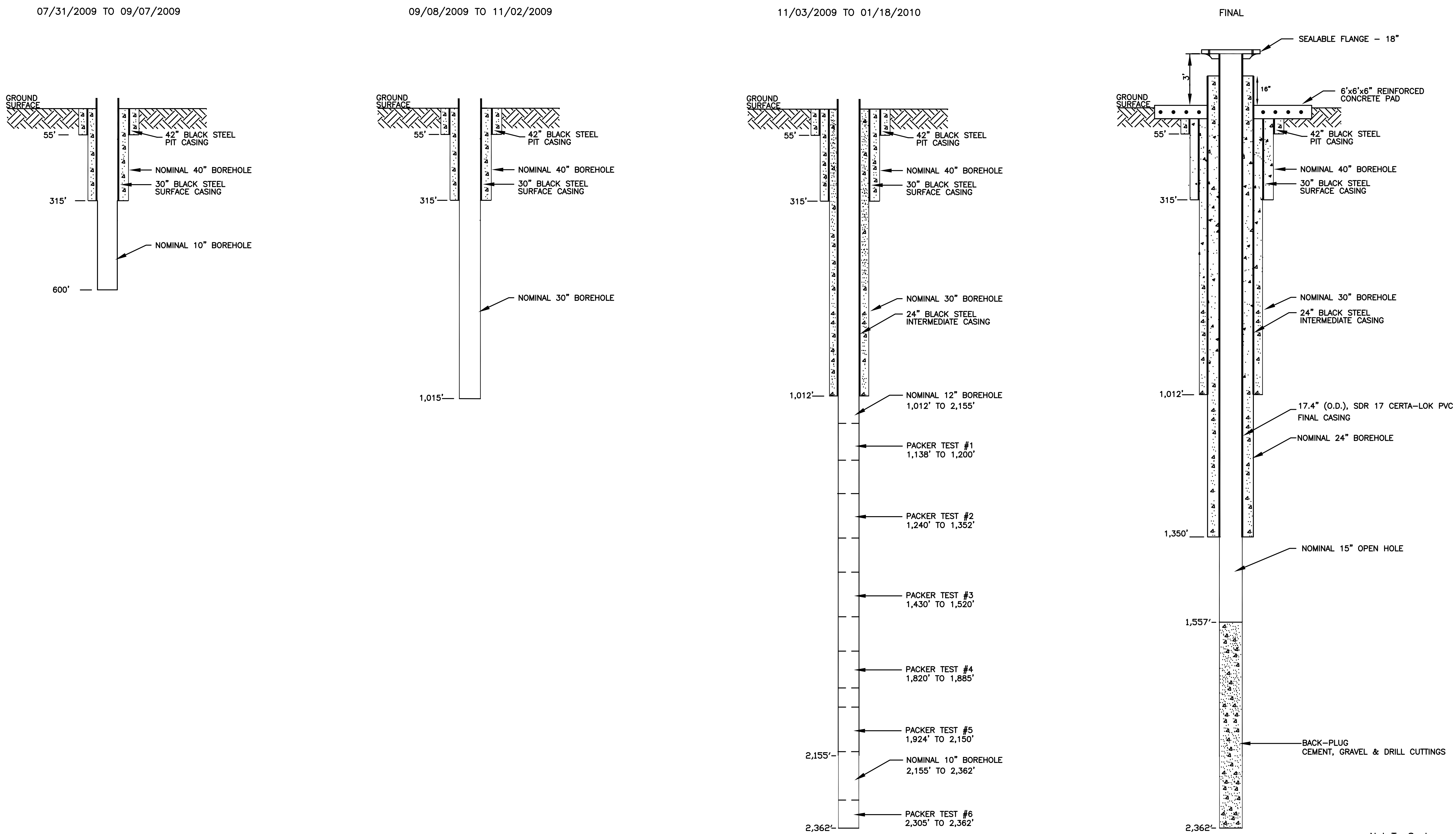
CHAPMAN AND BRONSON SITES LOCATION MAP
TOHOPEKALIGA WATER AUTHORITY
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

FIGURE 1 - 1

FIGURE 1-2
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING REPORT

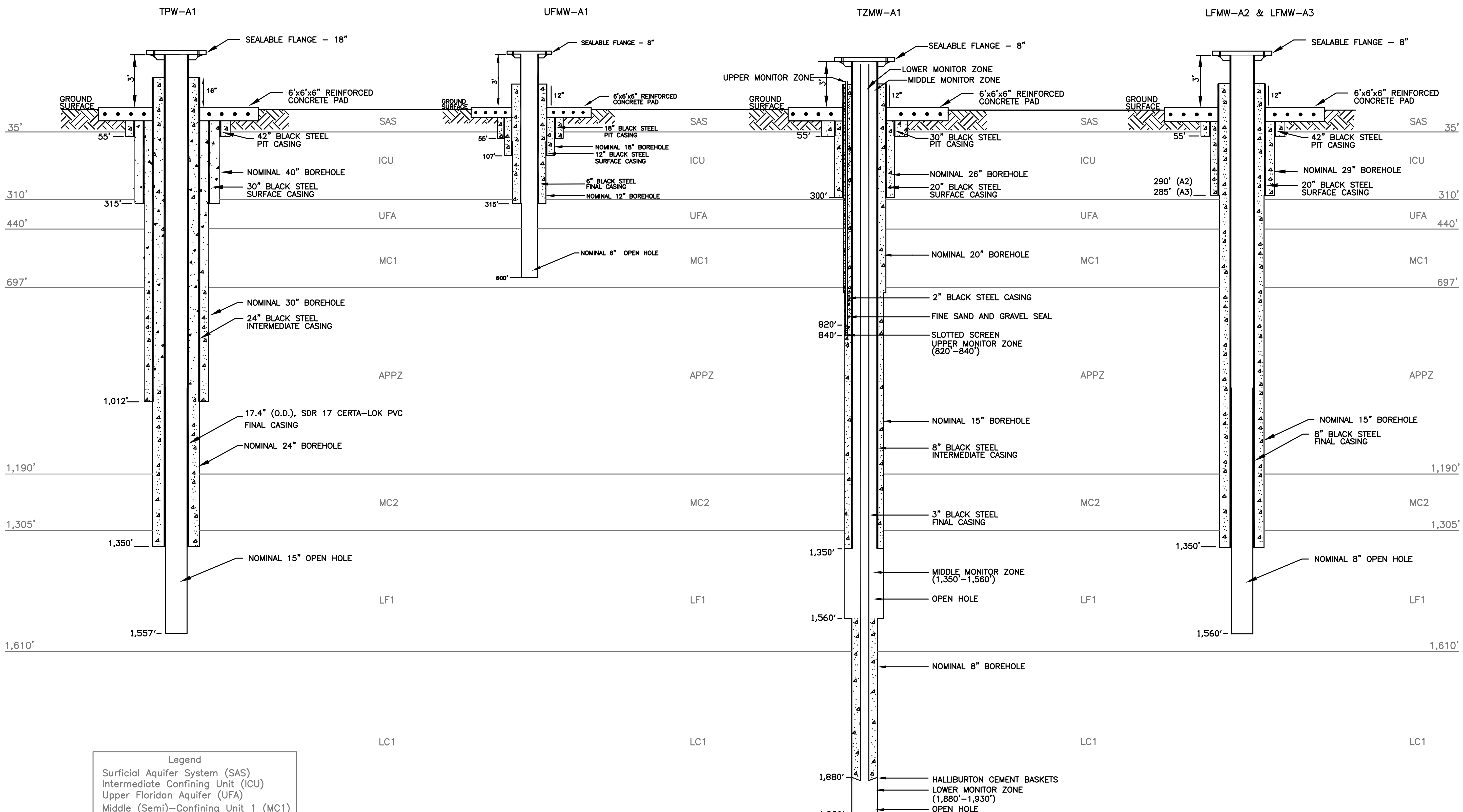
HYDROGEOLOGIC UNITS, GEOLOGIC UNITS AND LITHOLOGY IN CENTRAL AND SOUTHERN FLORIDA
From Reese, R.S. and E. Richardson (2007)





10/15/2010 1:28:19 PM - L:\ORLANDO\HYDRO\TOHO\AWS\CHAPMAN SITE\FIELD WORK\REPORT\DRAFT\FIGURES\WBL_REVIEW_100810\FIG2_1.DWG - WOOD, JENNIFER

TETRA TECH www.tetratech.com 201 East Pine Street, Suite 1000 Orlando, FL 32801 PHONE: 407-839-3955 FAX: 407-839-3790	TOHOPEKALIGA WATER AUTHORITY CHAPMAN SITE EXPLORATORY TEST WELLS WELL CONSTRUCTION AND TESTING SUMMARY REPORT	Project No.: 200-08466-08014 Date: 09/27/2010 Designed By: B.Wood
	TPW-A1 WELL CONSTRUCTION	FIGURE 2-1



Legend
Surficial Aquifer System (SAS)
Intermediate Confining Unit (ICU)
Upper Floridan Aquifer (UFA)
Middle (Semi)–Confining Unit 1 (MC1)
Avon Park Permeable Zone (APPZ)
Middle Semi–Confining Unit 2 (MC2)
Lower Floridan Aquifer (LF1)
Lower Confining Unit (LC1)

Not To Scale

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TOHOPEKALIGA WATER AUTHORITY

CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

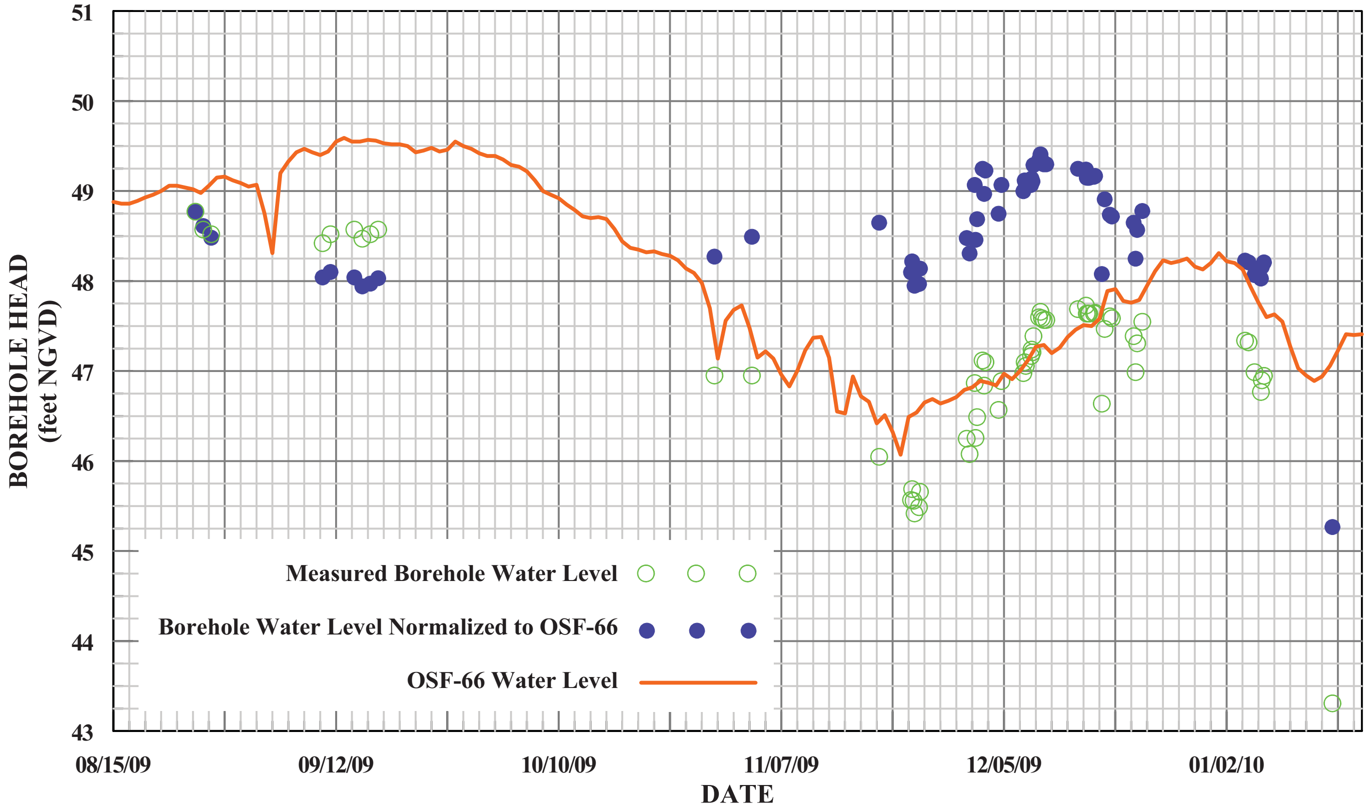
WELL DETAILS AND HYDROGEOLOGY

Project No.:	200-08466-08014
Date:	09/27/2010
Designed By:	B.Wood

FIGURE
2-2

FIGURE 2-3
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

A. TPW-A1 BOREHOLE HEAD vs. TIME



B. TPW-A1 NORMALIZED BOREHOLE HEAD vs. DEPTH

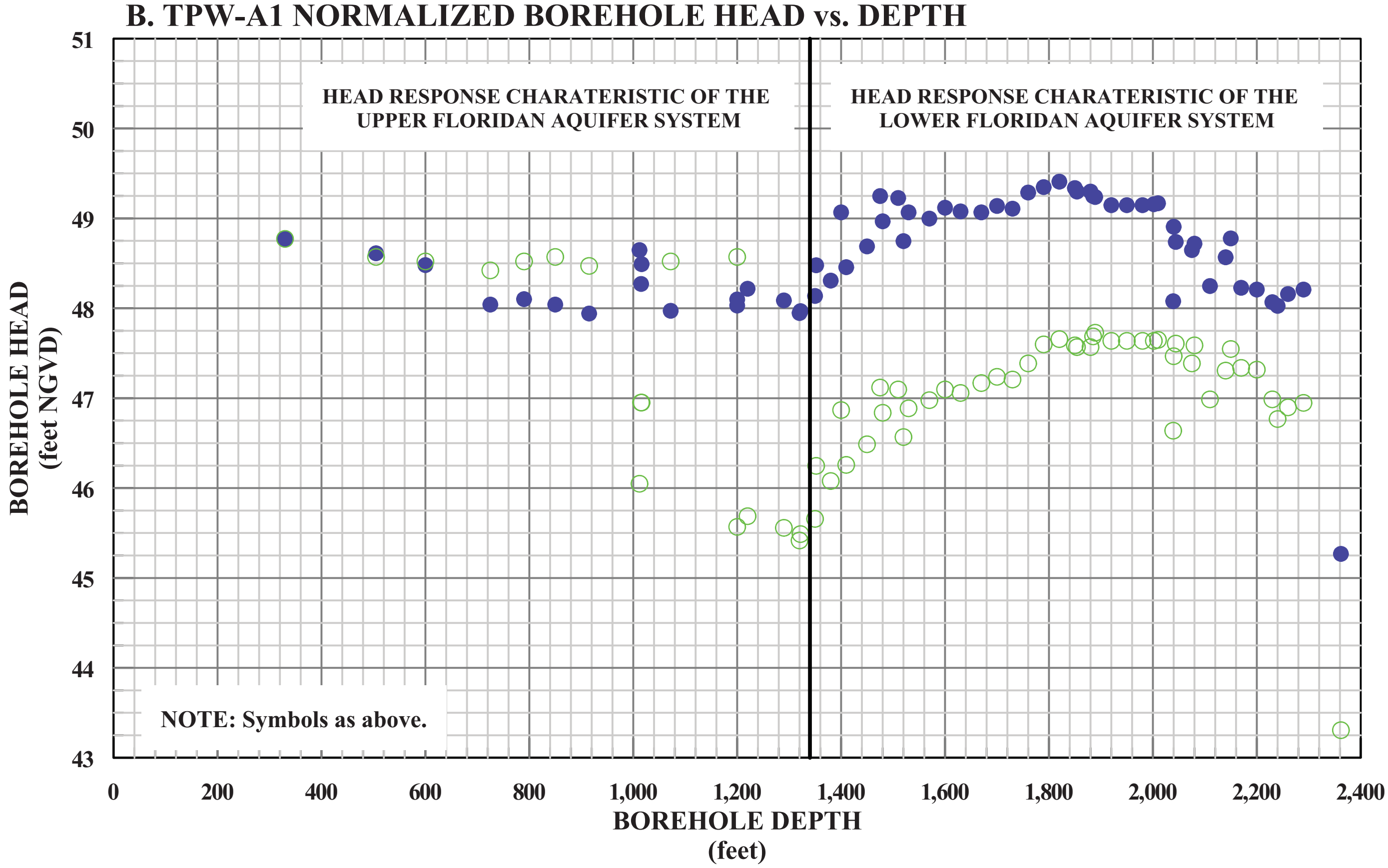


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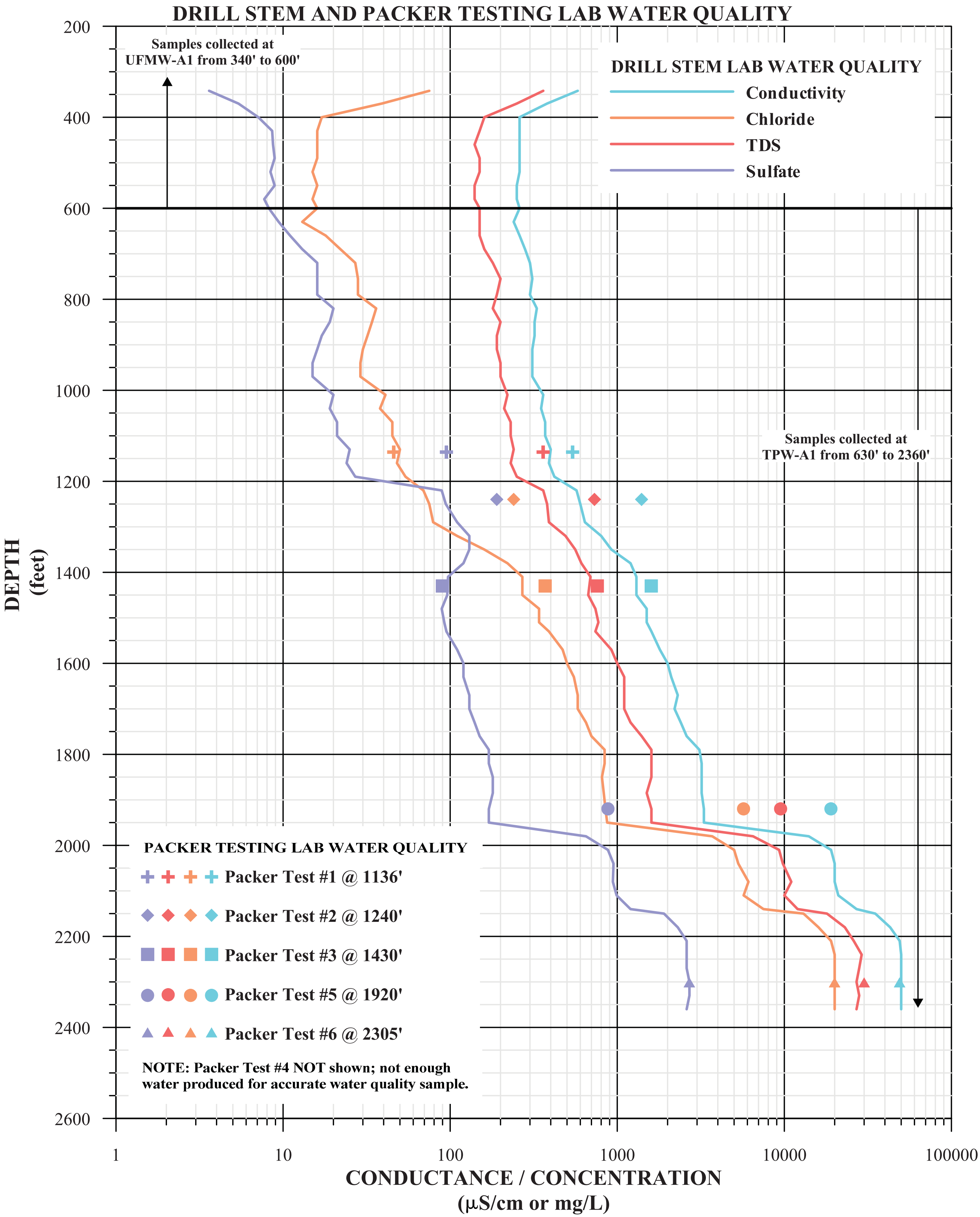
FIGURE 2-4
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING REPORT



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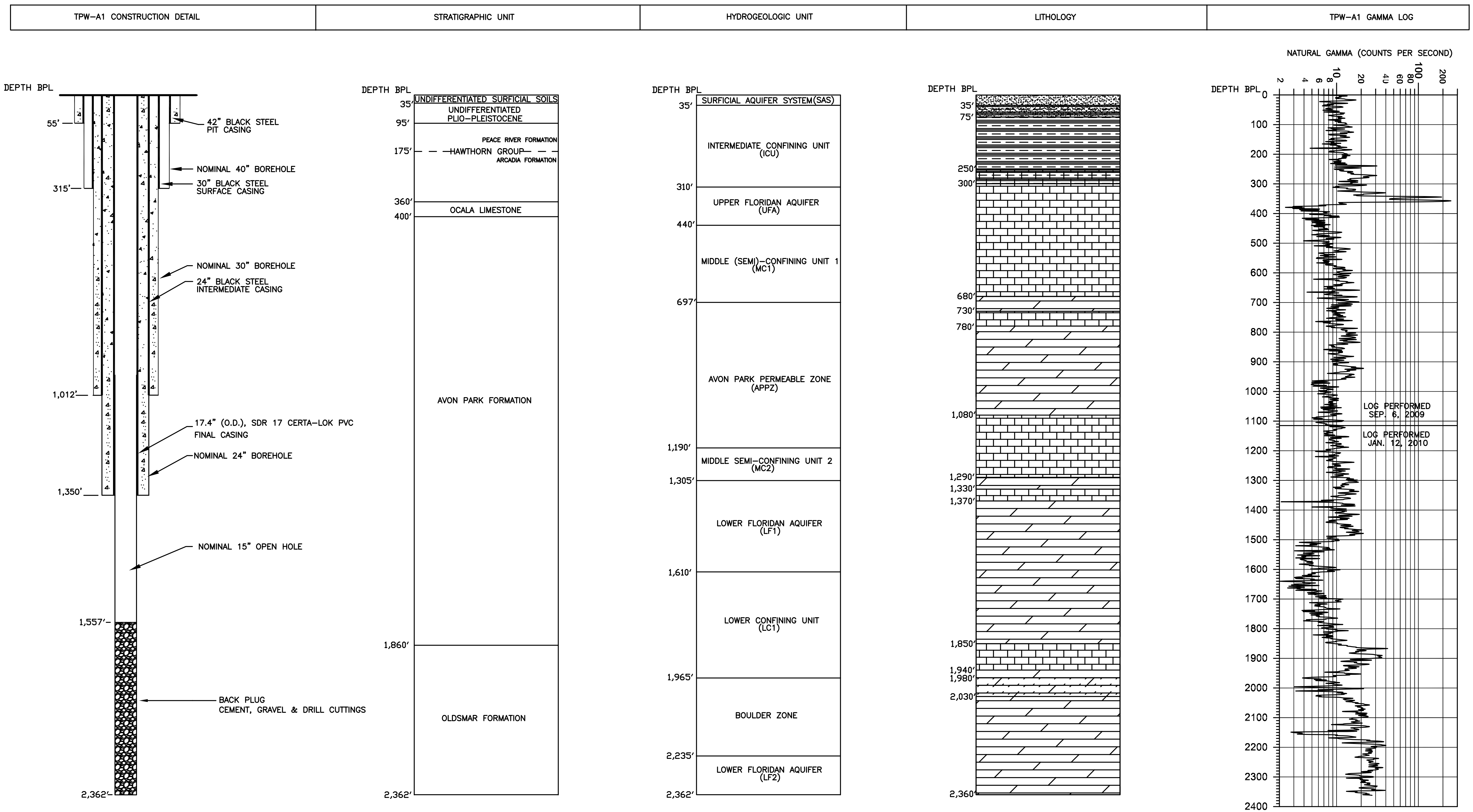

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CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 DETAIL AND HYDROGEOLOGY

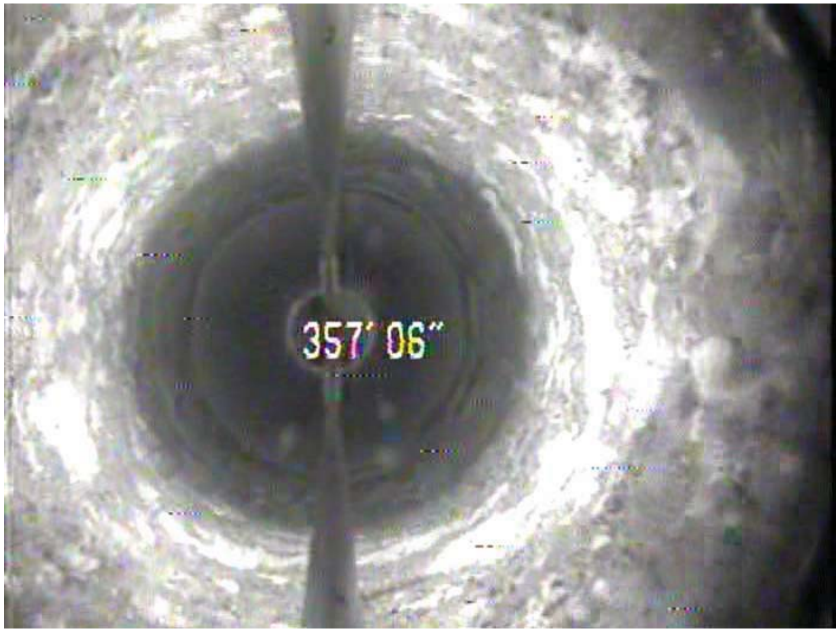
Project No.: 200-08466-08014
Date: 09/27/2010
Designed By: A. Montalvo

FIGURE
2-5

FIGURE 2-6
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

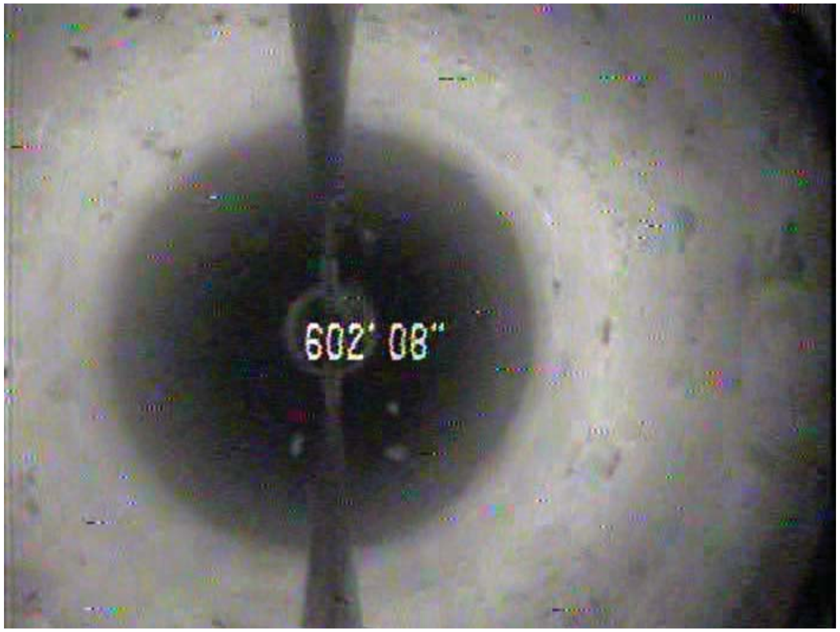
TPW-A1 VIDEO LOG WELL BORE IMAGE

Upper Floridan Aquifer (UFA)
310’ to 440’



Snapshot at a depth of 357 feet bls; nominal 30-inch borehole.

Middle Confining Unit (MC1)
440’ to 700’

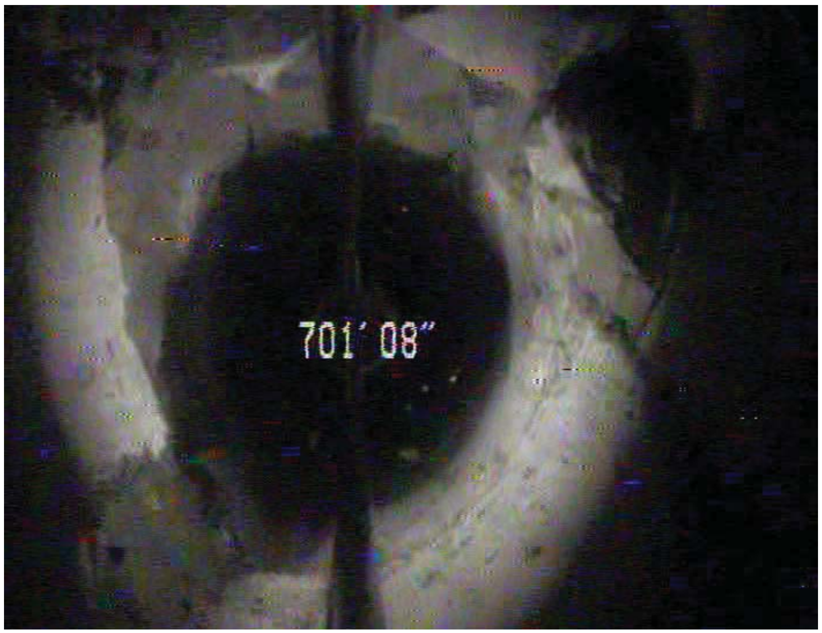


Snapshot at a depth of 602 feet bls; nominal 30-inch borehole.

FIGURE 2-7
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

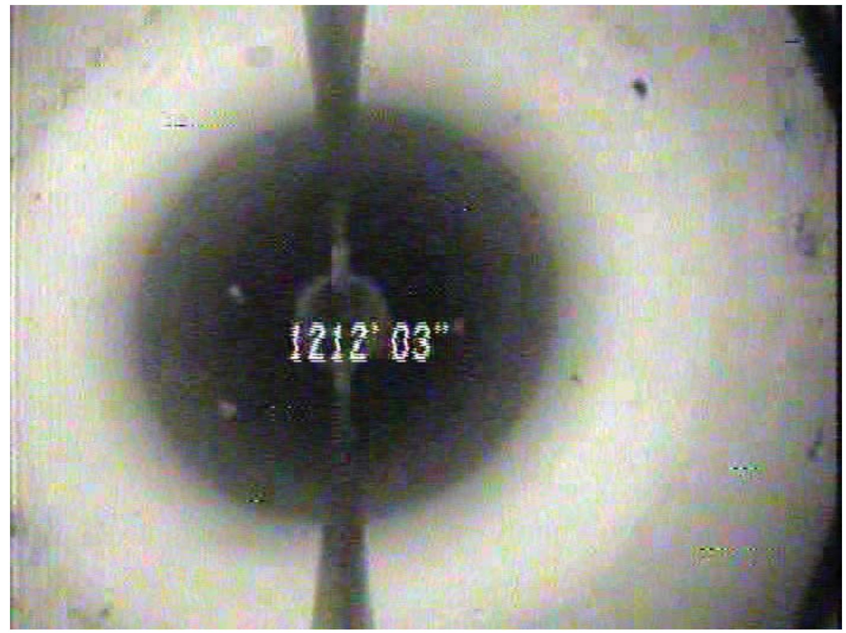
TPW-A1 VIDEO LOG WELL BORE IMAGE

Avon Park Permeable Zone (APPZ)
700' to 1,190'



Snapshot at a depth of 701 feet bls; nominal 30-inch borehole.

Middle Confining Unit (MC2)
1,190' to 1,300'

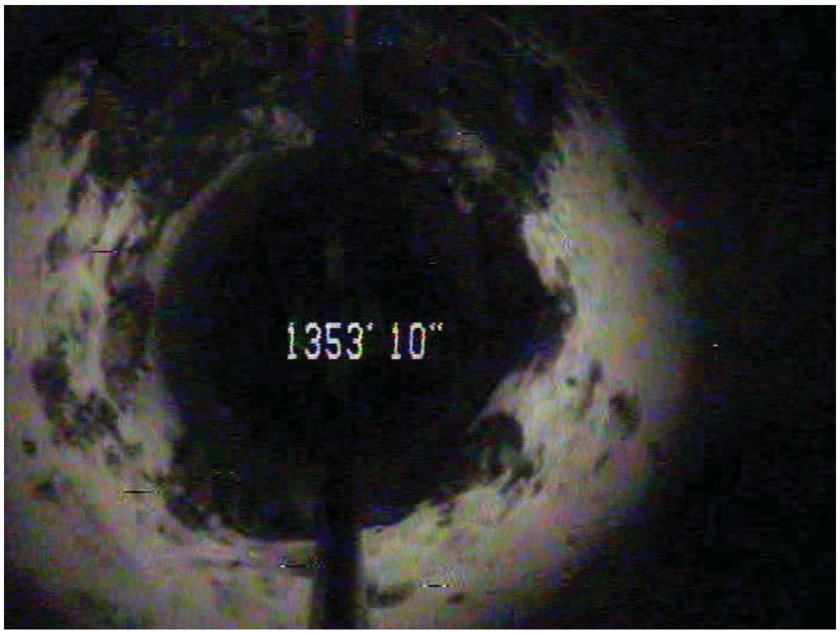


Snapshot at a depth of 1,212 feet bls; nominal 12-inch borehole.

FIGURE 2-8
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

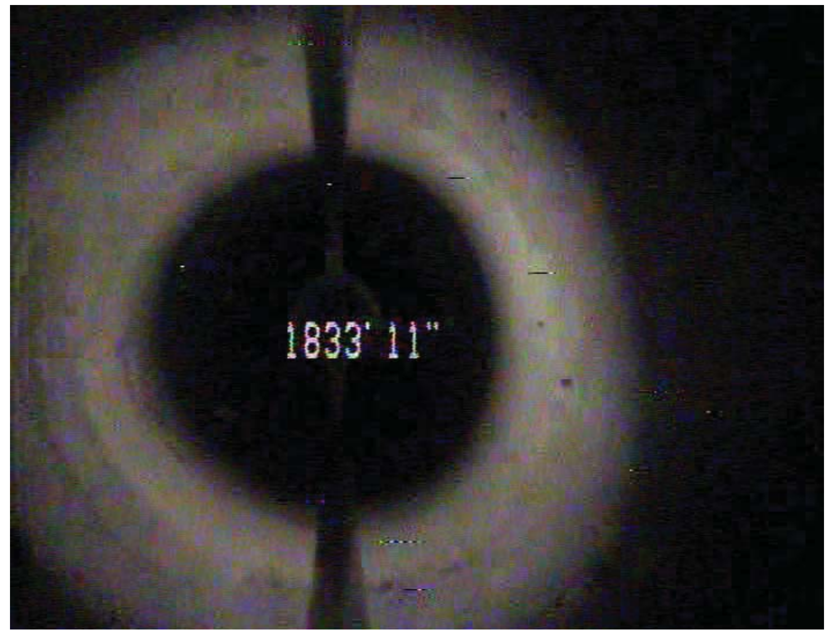
TPW-A1 VIDEO LOG WELL BORE IMAGE

Lower Floridan Aquifer (LF1)
1,300' to 1,610'



Snapshot at a depth of 1,353 feet bls; nominal 12-inch borehole.

Lower Confining Unit (LC1)
1,610' to 1,965'



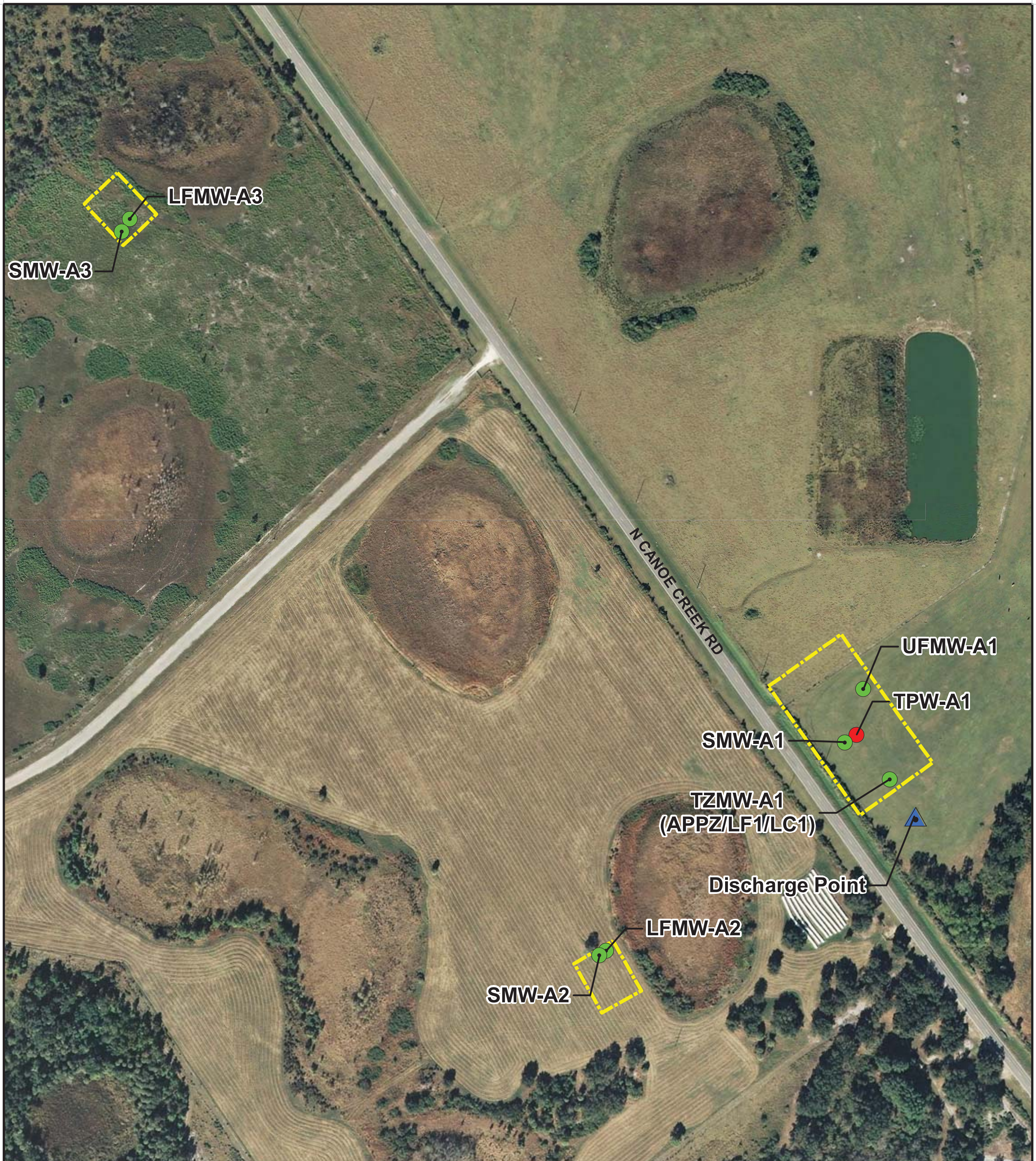
Snapshot at a depth of 1,833 feet bls; nominal 12-inch borehole.

FIGURE 2-9
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

TPW-A1 VIDEO LOG WELL BORE IMAGE

Boulder Zone
1,965' to 2,360'

Snapshot at a depth of 1,970 feet bls; nominal 12-inch borehole.



Source: Oscoela County 2008 Aerial Imagery

LEGEND

- Test Production Well
- Monitor Well
- Discharge Point
- Site Boundary

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TETRA TECH

0 N 300
Feet

CHAPMAN SITE WELL LOCATION MAP
TOHOPEKALIGA WATER AUTHORITY
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

FIGURE 3 - 1

Source: Oscoela County 2008 Aerial Imagery

LEGEND

- Monitor Well Locations
- Site Boundary

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TETRA TECH

N

0 60

Feet

BRONSON SITE OBSERVATION WELL LOCATION MAP
TOHOPEKALIGA WATER AUTHORITY
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

FIGURE 3 - 2

FIGURE 3-3
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

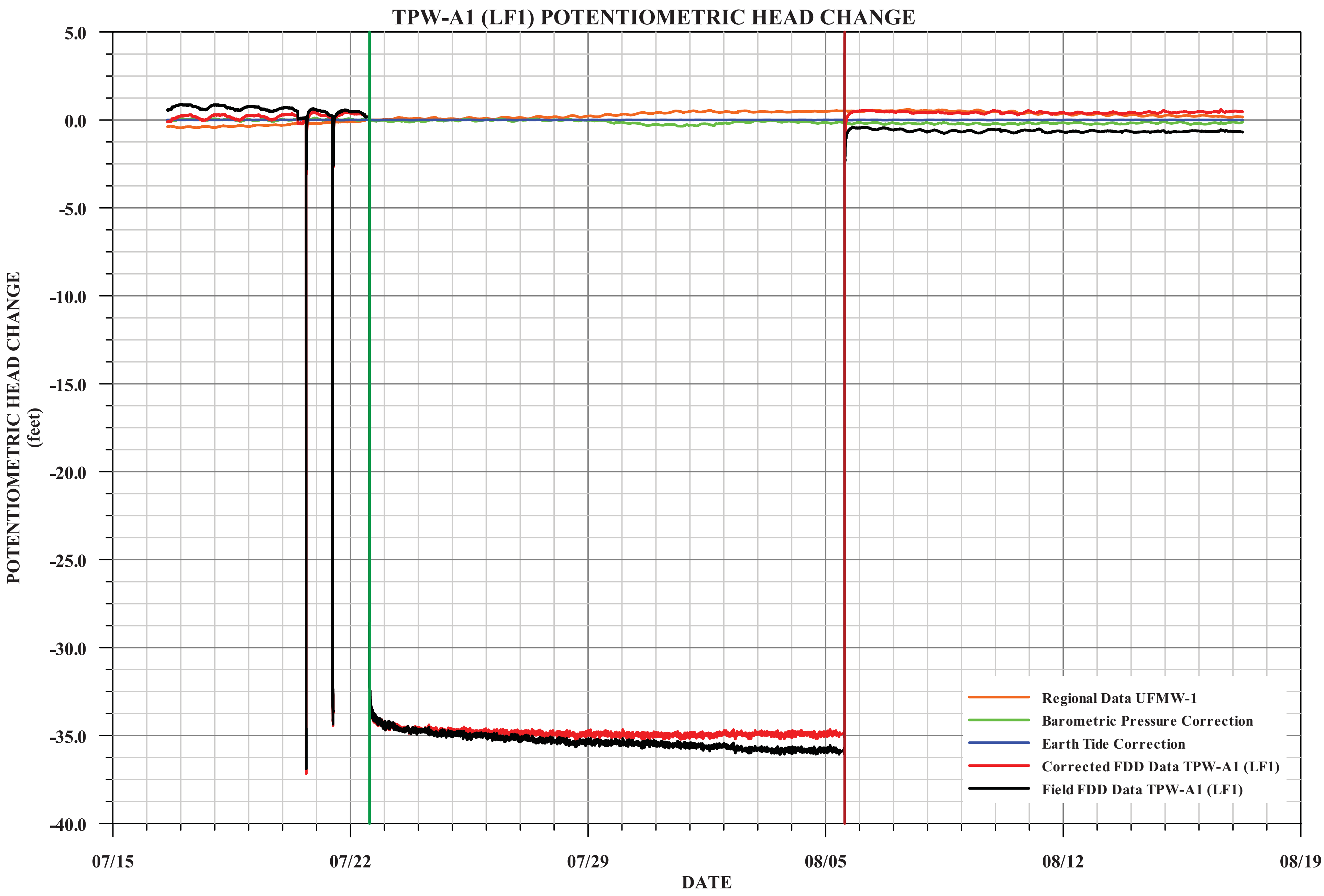

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FIGURE 3-4
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

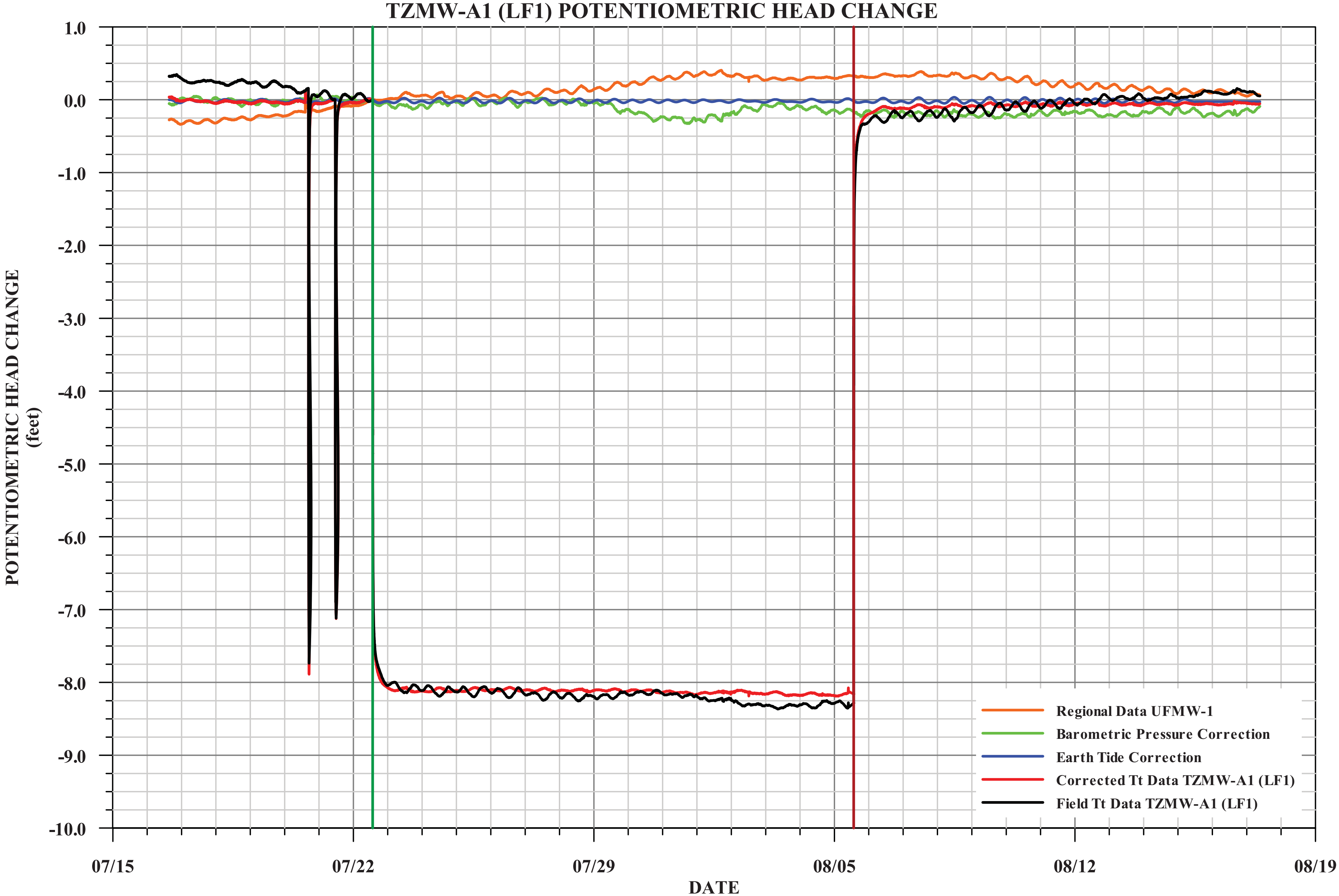

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FIGURE 3-5
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT

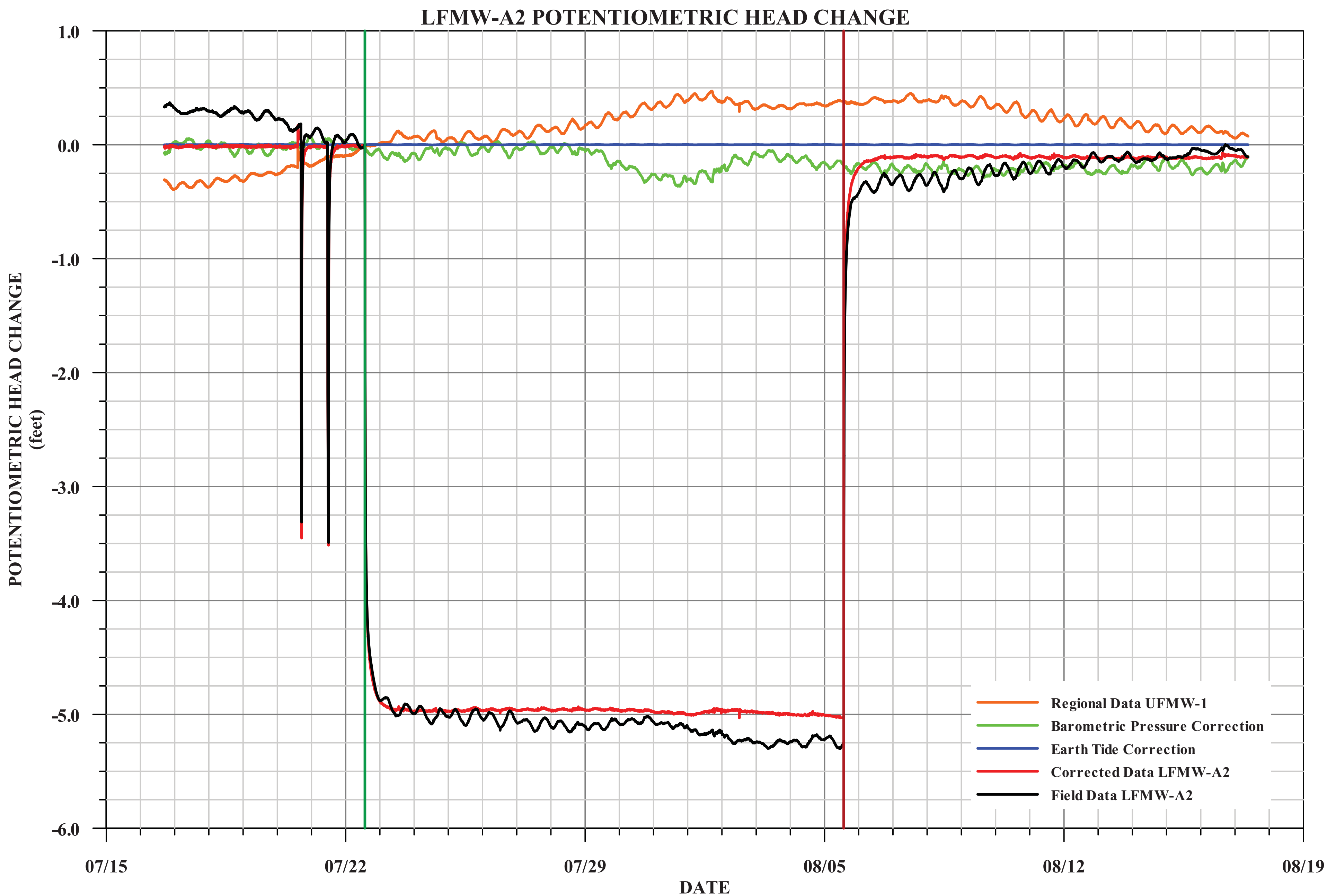

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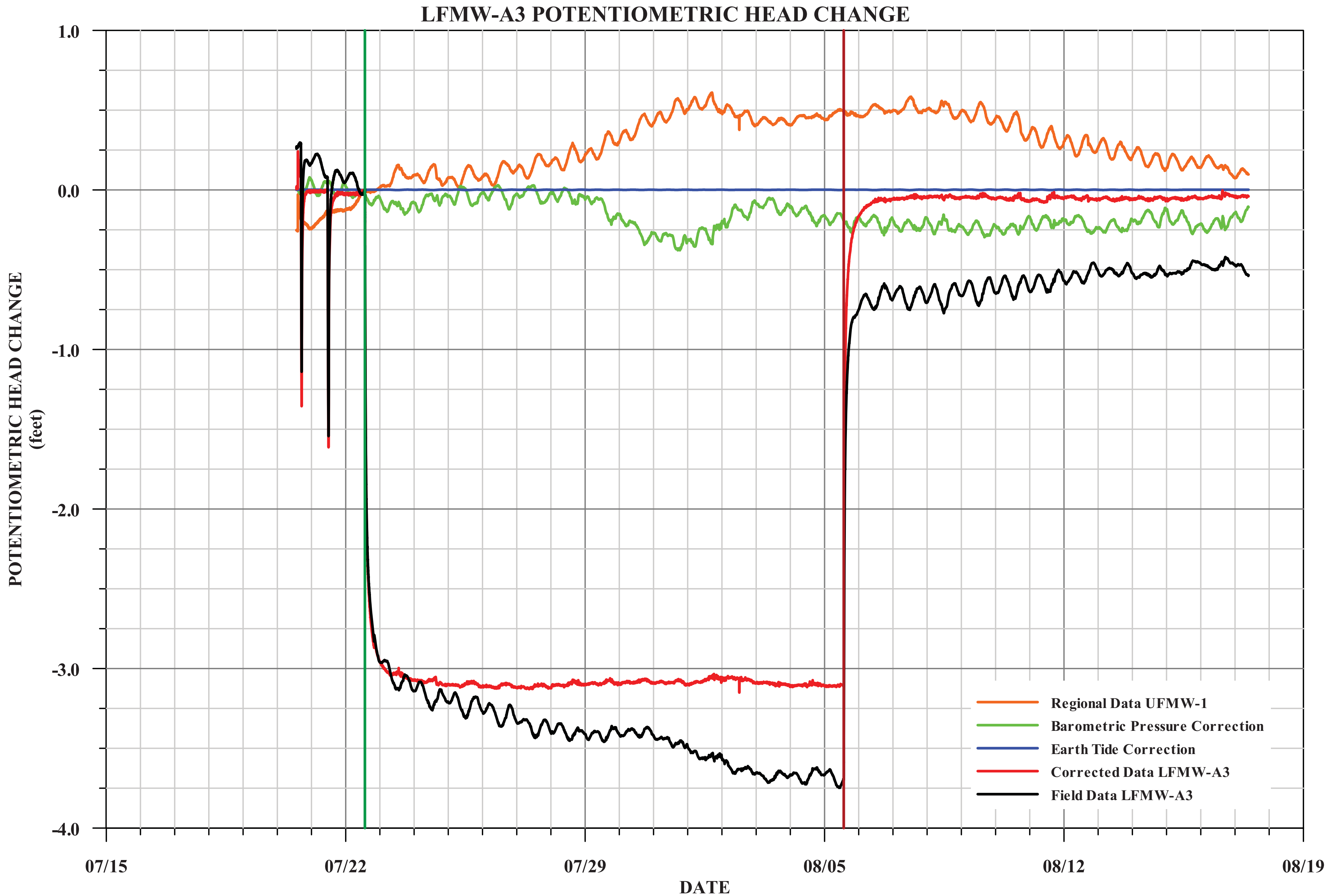
FIGURE 3-6
CHAPMAN SITE EXPLORATORY TEST WELLS
WELL CONSTRUCTION AND TESTING SUMMARY REPORT



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