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CONSTRUCTION AND TESTING SUMMARY REPORT

Class I Injection Well System

Key Largo Wastewater Treatment District

October 2010

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Construction and Testing Report

Class I Injection Well System,
Key Largo Wastewater Treatment District

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Summary

This document provides the construction and testing results of the Class I injection well (IW1) and associated Floridan-aquifer, dual-zone deep monitor well (MW1) at the Key Largo Wastewater Treatment Plant (WWTP) in Key Largo, Monroe County, Florida. A site location map and a site layout showing the location of the injection well system are presented as **Figure 1 and Figure 2**, respectively.

IW1 has been designed and constructed as a municipal injection well with the capacity to accept up to 5.75 million gallons per day (mgd) of advance-treated domestic wastewater effluent from the Key Largo WWTP. IW1 was constructed with a nominal 16-inch outside diameter (O.D.), Fiberglass Reinforcement Plastic (FRP) injection tubing installed to 2,735 feet below pad level (bpl). The total depth of IW1 is 3,604 feet bpl. The construction detail for IW1 is included in **Figure 3**. Please note that all depth references from pad level in this report are based from the temporary drilling pad level during construction that was set at an elevation of 5.30 feet North American Vertical Datum, 1988 (NAVD 88).

A dual-zone, deep monitor well (MW1) was constructed to monitor for potential upward migration of fluids injected into IW1. The upper monitor zone (from 1,460 feet to 1,494 feet bpl) was installed immediately below the lowermost regional Underground Source of Drinking Water (USDW), the interface defined by the depth at which the total dissolved solids (TDS) concentration of the formation water exceeds 10,000 milligrams per liter (mg/L). The lower monitor zone (from 1,650 feet to 1,702 feet bpl) was installed in a sufficiently transmissive interval below the USDW. The MW1 construction detail also is included in **Figure 3**.

Construction and testing of the wells were performed in accordance with Chapter 62-528, Florida Administrative Code (FAC), the recommendations of the Underground Injection Control (UIC) Technical Advisory Committee (TAC), and the provisions of Florida Department of Environmental Protection (FDEP) Construction Permit No. 272762-001-UC/M1. A copy of the construction permit is provided in **Appendix A**. IW1, MW1 and associated appurtenances were constructed in accordance with the contract documents for the work ("Technical Specifications – KLWTD Injection Well No. 1, November 2008"), which were prepared by ARCADIS.

Youngquist Brothers, Inc. (Contractor) began construction of IW1 in November 2008. The construction of IW1 was completed in March 2009, and the Contractor then mobilized to the MW1 location. Construction and testing of both IW1 and MW1 were

completed in May 2009. A summary of the construction and testing activities is presented as **Table 1**.

Findings

The results of the construction and testing of IW1 and MW1 led to the following conclusions:

- A USDW is present at this location within the confined Upper Floridan Aquifer, with the base of the lowermost regional USDW located at approximately 1,450 feet bpl. A USDW was not identified in the Surficial Aquifer System.

- The primary confining interval above the injection zone occurs between approximately 1,575 feet and 2,816 feet bpl. The top of the uppermost injection zone is located at approximately 2,956 feet bpl.

- As determined by packer-test analysis, the maximum, minimum and mean estimated horizontal hydraulic conductivities of the intervals tested within primary confining units are approximately $8.42x10^{-4}$, $3.37x10^{-5}$ and $2.35x10^{-4}$ centimeters per second (cm/sec), respectively.

- As determined by core analyses, the mean horizontal and vertical hydraulic conductivities of the primary confining interval (between 1,575 feet and 2,816 feet bpl) are $4.24x10^{-6}$ cm/sec and $3.60x10^{-6}$ cm/sec, respectively.

- Based on geophysical logging results, two injection zones are present, an upper zone which is interpreted to be less productive located between 2,956 feet and 2,990 feet bpl and a lower more productive zone between 3,415 and 3,539 feet bpl.

- The average horizontal hydraulic conductivity of the combined injection zone is approximately 705 gallons per day per square foot (gpd/ft^2), which is sufficiently transmissive to accept a maximum sustained injection rate of approximately 6.48 mgd (4,500 gpm) without exceeding the current maximum allowable injection wellhead pressure of 104 pounds per square inch (psi).

- A "breakaway" in injection heads above flows of approximately 4.32 mgd (3,000 gpm) was observed, due primarily to increased formation losses. For

this reason, to ensure a more energy efficient operation, routine injection flows up to 3,000 gpm are recommended with operation at higher peak flows only when required.

- IW1 and MW1 have mechanical integrity based on cement-bond logging, video surveying, hydrostatic pressure testing, high-resolution temperature logging and radioactive tracer survey (RTS) testing.

Data Collection Methods and Results

During well construction, data were collected and interpreted to determine the geologic and hydrogeologic characteristics of the strata intercepted by the boreholes. These data were then used to determine the optimal subsurface design of IW1 and MW1. Data also were collected to ensure both wells were being constructed in accordance with the technical specifications and that regulatory requirements were met. Data-collection methods and results are described below. Daily construction and testing activities were recorded in daily logs and compiled by onsite field personnel during the construction period. As required by the construction permit, weekly construction progress reports were prepared (by ARCADIS) and submitted to FDEP and TAC members. A summary of the events described in the construction progress reports is provided in **Table 1**. Weekly construction reports submitted to FDEP and TAC are included electronically in **Appendix F**.

FDEP approval was required prior to performing certain phases of construction. These construction phases are as follows:

- Setting the 28-inch O.D. intermediate casing in IW1
- Setting the nominal 16-inch O.D. FRP injection casing in IW1
- Setting the upper and lower monitor zones in MW1
- Performing the injection test

Reports requesting approval of the above stated construction phases were previously submitted to FDEP during construction. The text portions of these reports are included electronically in **Appendix F**.

Pilot-Hole Construction and Testing

Pilot holes were constructed when drilling IW1 and MW1, and the data collected during the drilling and testing of the pilot holes provided information that assisted with the final design of the wells. Methods used to collect data during pilot-hole construction and testing and the results obtained are described below.

Lithology and Drilling Conditions

During pilot-hole drilling for both IW1 and MW1, drilled cuttings were collected at 10-foot depth intervals, described by an onsite (ARCADIS) geologist and summarized in

geologic logs. Included with the lithologic descriptions are drilling conditions such as revolutions per minute (RPM) and weight on the bit (WOB). The lithologic summaries (Geologic Logs) and drilling penetration charts for IW1 and MW1 are provided in **Appendix B**. A description of the major geologic and hydrogeologic units encountered during pilot-hole drilling is included in this report under the section titled, "Geology and Hydrogeology". The units also are shown in **Figures 3, 4 and 5**.

Pilot-Hole Water Quality

Water-quality sampling of reverse-air discharge was performed during pilot-hole drilling in both IW1 and MW1. In IW1, sampling was initiated at 1,100 feet bpl and terminated at 2,760 feet bpl. Samples were collected at 30-foot intervals, and between 1,100 feet and 1,750 feet bpl, at drill pipe connections. In MW1 sampling was performed from 1,100 feet to 1,755 feet bpl, and samples were collected at intervals between 12 feet and 38 feet. Water samples were analyzed in the field for temperature, conductivity and chloride concentrations. The reverse-air discharge water-quality summary for IW1 and MW1 is presented as **Table 2**. Associated chloride and conductivity plots for both IW1 and MW1 are included in **Appendix B**.

Pilot-hole water quality reflects a mixture of re-circulated drilling fluids consisting of formation water and freshwater from the drilling-fluid storage tanks. This generally results in muted changes in pilot-hole water quality with depth. Therefore only general water quality trends can be interpreted, with the most reliable water quality samples obtained from packer test intervals.

The chlorides and conductivity trends in IW1generally are similar to the trends for MW1, providing confidence that the trends are reliable and locally representative. The results from the IW1 pilot-hole water quality sampling indicate the following:

- Between 1,100 and 1,190 feet bpl: Water quality remains stable with chloride concentrations between 160 and 180 milligrams per liter (mg/L) and conductivity between 826 and 901 micro Siemens per centimeter (μS/cm). This suggests that the primary contributor to the water quality was freshwater from the drilling–fluid storage tank, i.e. this zone did not contribute to fluid circulation.

- Between 1,190 and 1,352 feet bpl: A sharp increase in concentrations of chloride (to 3,500 mg/L) and conductivity (to 10,040 μS/cm) is observed,

indicating the ratio of formation water to freshwater (used for drilling circulation) increased with depth resulting in an increasing salinity trend.

- Between 1,350 and 1,740 feet bpl: A gradual step-wise increase in chloride concentration and specific conductance values are observed, with chloride concentrations up to 4,500 mg/L and conductivity near 13,000 µS/cm.

- Between 1,740 and 2,520 feet bpl: Much greater variations in salinity are observed. An initial increase in salinity is observed, with a peak in salinity measured at 1,920 feet bpl (chloride concentration 7,500 mg/L and conductivity 21,800 µS/cm), before a reduction in salinity is measured. The very low salinity measured at 2,190 feet bpl (chloride concentration 1,000 mg/L and conductivity 2,160 µS/cm) coincides with the interval when freshwater was added to the circulation. Between 2,220 and 2,310 feet bpl a dramatic increase in salinity is observed, with a maximum chloride concentration of 15,000 mg/L and conductivity of 44,300 µS/cm. This salinity peak is attributed to the saline mix which was introduced during drilling in order to suppress flow from well. This interval is part of a large confinement zone, practically not contributing fluids to drilling circulation, with water quality being greatly influenced by the factors discussed above.

- Between 2,520 and 2,760 feet bpl: Water quality remains practically stable, with chloride concentration averaging 6,000 mg/L and conductivity values around 17,000 uS/cm.

The results from the MW1 pilot-hole water quality sampling indicate the following:

- Between 1,100 feet and 1,280 feet bpl: An increasing trend in chloride concentrations (from 200 to 2,500 mg/L) and conductivity (from 1,204 to 6,530 µS/cm was observed. It is likely that the ratio of formation water to freshwater (used for drilling circulation) increased with depth resulting in an increasing salinity trend.

- Between 1,280 feet and 1,460 feet bpl: Concentrations in chloride and conductivity continued to increase, but the trend was slightly less than the interval above. Chloride concentrations increased from 2,500 mg/L to 3,500 mg/L, and conductivity increased from 6,530 µS/cm to 8,780 µS/cm. A slight decrease in conductivity (from 9,310 µS/cm to 8,780 µS/cm) was observed between 1,443 feet and 1,460 feet bpl. The sample at 1,443 feet bpl was

collected at a drill pipe connection where fluid from the drill stem was allowed to flow for a few minutes. For this reason, the sample result at 1,443 feet bpl was likely more representative of formation waters than the sample result at 1,460 feet bpl. It should be noted that based on packer testing and geophysical logging, the base of the USDW appears to be located at a depth of approximately 1,450 feet bpl.

- Between 1,460 feet and 1,640 feet bpl: An increasing trend is observed in conductivity concentrations (from 8,780 µS/cm to 12,900 µS/cm). Chloride concentrations remain stable between 1,460 feet 1,578 feet bpl at 3,500 mg/L, but increase to 4,500 mg/L between 1,578 feet and 1,640 feet bpl.

- Between 1,640 feet and 1,700 feet bpl: Concentrations in chloride and conductivity generally remained stable. Chloride concentrations remained at 4,500 mg/L and conductivity concentrations ranged between 12,840 µS/cm and 12,900 µS/cm.

- Between 1,700 feet and 1,755 feet bpl: An increase in chloride and conductivity concentrations was observed with a significant increase between 1,700 feet and 1,713 feet bpl. It should be noted that the pilot hole was extended an additional 55 feet (from 1,700 feet to 1,755 feet bpl) after performing packer tests 7 through 10. It is likely that a significant portion of the reverse-air circulation fluids used to drill this portion of the pilot hole originated from formation waters within the packer test intervals. These waters are significantly more saline than freshwater typically used during reverse-air drilling. It is interpreted that this was the primary reason for the abrupt water-quality change.

Based on the chloride and conductivity data from MW1 and IW1 (and data from packer testing), the base of the lowermost USDW is located at approximately 1,450 feet.

Geophysical Logging

Geophysical logging was performed in the pilot-hole intervals of both IW1 and MW1 to correlate drill cuttings and core samples collected during drilling, to correlate vertical offsets between IW1 and MW1, to identify formation boundaries and to obtain specific geologic and hydrogeologic data pertaining to the subsurface formations. These data were then used to assist in the selection of the optimum casing setting depths, determine packer-testing intervals and assist in identifying transmissive and confining

intervals. Reamed-hole caliper logs were performed prior to casing installation to confirm borehole geometry, casing setting depths and provide data for use in calculating theoretical casing-cementing volumes.

Summaries of the geophysical logs performed in IW1 and MW1 are provided as **Table 3**. Copies of the geophysical logs are enclosed in **Volume II**, and electronic copies of these logs are included in **Appendix F** of this report. Borehole televiewer logs were performed in pilot-hole intervals of IW1 between 1,050 feet and 1,737 feet bpl and between 1,724 feet and 3,693 feet bpl. Electronic copies of the borehole televiewer logs are included in **Appendix F**.

Detailed interpretations of the geophysical logs previously were provided in the documents listed below. The text portions of these documents are included electronically in **Appendix F**.

Document Title	Date	Depth Intervals Logged
28-inch Diameter, Intermediate Casing Seat Recommendation	December 2008	IW1: 0 –1,746 feet bpl
Request for Approval of Final Casing-Setting Depth of Proposed Injection Well IW1	February 2009	IW1: 1,746 – 3,693 feet bpl
Request for Approval of Dual-Zone Deep Monitor Well MW1, Upper and Lower Zones	April 2009	MW1: 0 – 1,702 feet bpl*
Injection Test Request	May 2009	IW1: 0-3,604 feet bpl

* Following logging in the pilot hole of MW1, FDEP requested that the pilot hole be extended further to confirm the potential for a lower monitor zone. As requested the pilot hole was extended from 1,700 to 1,755 feet bpl. Additional logging between 1,700 feet and 1,755 feet bpl was not performed.

Coring

Five rock cores were retrieved between 1,729 feet and 2,197 feet bpl during pilot-hole drilling in IW1. The rock-core intervals were selected by the ARCADIS onsite geologist based on evaluation of the drill-cutting samples and observation of drilling conditions. The rock cores were first described onsite and then select sections of the rock cores were sent to "Ardaman & Associates, Inc. - Geotechnical Testing Laboratory" (Fort

Myers, FL) for analyses of horizontal and vertical hydraulic conductivity, porosity, specific gravity, Young's Modulus and Archie cementation exponent and compressive strength. A graphical summary of the coring intervals is included in **Figure 4**. Core descriptions and core-analysis reports are included in **Appendix C**. A summary of the results from the rock-core analyses is provided as **Table 4**.

The core analytical data (with packer-pumping test data) were utilized to assess the potential degree and extent of confinement between the injection zone (at 2,956 feet bpl) and the lowermost regional USDW (located at approximately 1,450 feet). All five rock cores were collected within the primary confining interval (between 1,575 feet and 2,816 feet bpl). As determined by core analyses, the mean horizontal and vertical hydraulic conductivities of the primary confining interval are 4.24×10^{-6} cm/sec and 3.60×10^{-6} cm/sec, respectively.

Packer Testing

Six packer tests were conducted in IW1 between 1,297 feet and 2,622 feet bpl (packer tests 1 through 6), and five packer tests were conducted in MW1 between 1,434 feet and 1,755 feet bpl (packer tests 7 through 11). These tests were performed to determine the water quality and hydrologic properties of the test intervals.

The majority of the packer tests utilized a straddle-packer assembly, and the test intervals were based on the depths of the packer element centerlines. Packer tests 1, 7 and 11 utilized a single packer; the upper packer test boundary was based on the single packer element centerline and the lower test boundary was the base of the pilot hole.

Prior to conducting each packer test, the packer assembly (either single or straddle packer) was installed and the packer element(s) were inflated to isolate the selected interval. Each interval then was pumped (developed) for a specified period of time while monitoring field water-quality parameters (conductivity, temperature and chloride concentrations). After development, the water level (or pressure head) was allowed to recover for a specified period of time.

Following water level recovery after development, the pump was turned back on, and the pumping portion of each test began. The one exception was packer test 11, where only development and recovery after development were performed and recorded. For each test the totalizer on the calibrated flow meter was used to measure total flow volume and flow rate. During tests with low pumping rates, a 1-gallon container and a

stopwatch was used to confirm the accuracy of the flow meter. During testing, water levels were measured using a pressure transducer installed inside the drill pipe and recorded on a data logger. Just prior to terminating the pumping portion of each test, a final water sample was collected for laboratory analysis and a separate sample was collected for submittal to Florida Geological Survey (Hydrogeology Administrator) in Tallahassee. The recovery portion of each test began when the pump was shut off. Water levels were measured during the recovery portion of each test for a specified period of time.

Water-level drawdown (pumping portion data) and recovery data were used to estimate the horizontal hydraulic conductivity and transmissivity of each test interval. These estimates assisted in establishing the boundaries of the confining unit and injection zone. A summary of the hydraulic conductivity estimates from packer testing is presented as **Table 6**.

Packer tests 3, 4, 5, 6, 7 and 11 were performed within the confining unit. Packer test 11 was performed after extending the pilot hole in MW1 from 1,700 to 1,755 feet bpl as directed by FDEP. The reason for extending the pilot hole was to further investigate whether a suitable lower monitor zone was present below 1,700 feet bpl; allowing greater separation between the upper and lower monitor zones. Further discussion of packer test 11 can be found in **Appendix F** (monitor zones recommendation)

The maximum, minimum and mean estimated horizontal hydraulic conductivities of the intervals tested within the primary confining units are approximately $8.42x10^{-4}$, $3.37x10^{-5}$ and $2.35x10^{-4}$ cm/sec, respectively. By comparison, the mean hydraulic conductivities from analyses of the rock cores within the primary confining unit, were approximately 2 orders of magnitude less than the packer-test conductivities. Due to the very low flow rates and the estimated pumping time required for water levels to stabilize, it was not practical to adequately perform the tests for accurately estimating horizontal hydraulic conductivities. Thus, the estimated horizontal hydraulic conductivity values reported in **Table 6** represent the probable "maximum" horizontal hydraulic conductivity for each interval tested

Final water samples were analyzed by a state certified lab for parameters including ammonia-nitrogen, specific conductance, chloride, total phosphorus, sulfate, TDS, total Kjeldahl nitrogen (TKN), and pH to verify the USDW boundary and to establish the background water quality of each test interval. A graphical summary of the packer testing program is included in **Figure 4**. A summary of the water-sample analytical results from packer testing is presented as **Table 5**. Packer test water-quality

summaries and charts are included in **Appendix C**, and electronic packer-test transducer data and laboratory analytical reports for each test are included in **Appendix F**.

Well Construction and Testing

Data were collected during the construction and testing of both IW1 and MW1 to ensure that both wells were being constructed in accordance with the technical specifications and FAC regulatory requirements. The well construction details, including the type, diameter, and setting depth of each casing (or tubing) string for IW1 and MW1 are presented as **Figure 3**. Casing mill certificates for IW1 and MW1, with Fiberglass Reinforced Plastic (FRP) tubing-product sheets for both wells have been scanned and are included electronically in **Appendix F**. The data-collection methods used during the construction and testing of both wells, and the results obtained are described below.

Shallow Pad Monitor Wells

Four shallow containment-pad monitor wells were installed near the northeast and southeast corners of the IW1 drilling pad and the northwest and southwest corners of the MW1 drilling pad. Wells were constructed to depths ranging between 14 feet and 16 feet below land surface with 5 feet of 2-inch diameter, Schedule 40 polyvinyl chloride (PVC) casing attached to 10 feet of 2-inch diameter, 0.020-inch slot, threaded PVC screen.

Following installation of the monitor wells, samples were collected from each well and analyzed to establish background water quality prior to beginning construction of IW1. Two additional separate samples were taken, with the last sample taken on November 23, 2008.

All field analyses confirmed the presence of highly brackish water, with salinities as measured by TDS greater than 10,000 mg/L, indicating that the Surficial Aquifer is not a USDW. Typically shallow pad monitor wells are sampled weekly during construction of a Class I injection well system to ensure brackish (non USDW) water encountered during drilling is not accidently spilled to a surface aquifer that is a USDW. Because the shallow groundwater at the site is not a USDW, a request to discontinue sampling was submitted to and subsequently approved by FDEP.

The results of the pad monitor-well water sampling were included in the corresponding Weekly Construction Progress Reports (Reports 1 and 2). A summary of the pad monitor wells water quality, a site map showing the location of the wells and well completion reports are included in **Appendix D**.

After completing construction and testing of IW1 and MW1, a request to plug and abandon the monitor wells was submitted to FDEP on July 16, 2009 and was approved on the same day. On July 20, 2009, the Contractor properly plugged and abandoned all four monitor wells.

Inclination Surveys

Inclination surveys were performed by the Contractor on IW1 and MW1 at 90-foot intervals during pilot-hole drilling and reaming operations. Inclination surveys were performed to ensure that all casings could be set to the required depths with sufficient annular space for proper cementing. The maximum allowable inclination from vertical at any portion of a hole was 1.0 degree. The maximum allowable difference between any two successive survey points was 0.5 degree.

During construction of IW1 and MW1, all inclination surveys met the above criteria. The maximum deviation (1.0 degree) in IW1 was observed during pilot hole drilling at a depth of 720 feet bpl and the maximum deviation (0.80 degree) in MW1 was observed at a depth of 1,620 feet bpl. The maximum difference between any two successive survey points (0.5 degree) in IW1 was observed at a depth of 720 feet and 810 feet bpl, and the maximum difference (0.5 degree) in MW1 was observed at a depth of 1,440 feet bpl. Summaries of inclination survey results for IW1 and MW1 are presented in **Tables 7 and 8**, respectively.

Cement-Top Temperature Logs

Temperature logs were performed after each casing cementing stage (where cement returns were not observed at surface). The top of the cement for each stage was estimated from the results of each temperature log (temperature increases indicate the heat released from curing cement). The top of cement also was physically tagged after each cementing stage, just prior to the next cementing event, using steel cement tremie pipe inserted inside the annulus. The estimated depth of the top of cement from the temperature log was compared to the physical tag depth (for each stage) to ensure that the formation did not collapse and fall on top of the cement (resulting in cement voids or un-cemented annular sections).

There was a good correlation between the tagged depth for the top of cement and the estimated depth of the top of cement as inferred from the temperature log of each cement stage for IW1 and MW1. "Cement top" temperature logs for IW1 and MW1 are provided in **Volume II** of this report and electronic copies of these logs are included in **Appendix F** of this report. Summaries of the cement stages for IW1 and MW1 are presented as **Tables 9 and 10**, respectively.

Demonstration of Mechanical Integrity

As part of the Key Largo WWTF injection well system construction and testing program, the following testing and logging were performed to demonstrate that both IW1 and MW1 have mechanical integrity:

- Cement-bond log in the 16-inch diameter FRP injection tubing of IW1
- Cement-bond log in the lower monitor zone FRP tubing of MW1 prior to and after cementing
- Video survey in the 16-inch diameter FRP injection tubing and open hole of IW1
- Video survey in the lower monitor zone FRP tubing and open hole of MW1
- Hydrostatic pressure test in the 16-inch diameter FRP injection tubing of IW1
- Hydrostatic pressure test of the lower monitor zone FRP tubing of MW1
- High resolution temperature log in the 16-inch diameter FRP injection tubing and open hole of IW1
- Radioactive tracer survey (RTS) in the completed IW1

Discussions and supporting documentation of the logging and testing noted above are included in a technical memorandum in **Appendix D**. Copies of the cement bond log, high resolution temperature log, and RTS log plots are included in **Volume II** of this report, and electronic copies of these logs are included in **Appendix F**. DVDs of the video surveys also are included in **Volume II** of this report. As noted in the technical memorandum based on the logging and testing noted above, both IW1 and MW1 have mechanical integrity.

Injection Test Water Source

Prior to the injection test, Key Largo Wastewater Treatment District (KLWTD) completed construction of the three Sequencing Batch Reactor (SBR) tanks and the Post-Equalization tank as part of the wastewater treatment plant expansion as seen in **Figure 2**. The timing of this construction was intentionally phased so that potable water from Florida Keys Aqueduct Authority (FKAA) could be pumped into the tanks to provide a source of water for the injection test. Immediately prior to the injection test, this water also was used to test the integrity of the newly constructed tanks, which meant a more environmentally responsible use of the potable water.

In accordance with permit requirements, a water quality analysis performed by FKAA in 2008, which included parameters listed as Florida Primary and Secondary Drinking Water Standards and "municipal minimum-criteria" parameters, was used to demonstrate the quality of water used for the injection test. A copy of this analysis is included electronically in **Appendix F**.

IW1 and MW1 Final Water Quality Results

A water quality sample was collected from the IW1 injection zone on March 2, 2009. IW1 was developed by pumping from the well until field parameters stabilized prior to collecting the final sample. The sample was analyzed for parameters listed as Florida Primary and Secondary Drinking Water Standards and "municipal minimum-criteria" parameters, and the analytical report is included electronically in **Appendix F**.

Water quality samples from MW1 were collected from the lower monitor zone on May 6, 2009 and in the upper monitor zone, on May 7, 2009. The upper and lower monitor zones were developed by pumping water until field parameters stabilized prior to collecting the final samples. The samples were analyzed for parameters listed as Florida Primary and Secondary Drinking Water Standards and "municipal minimum-criteria" parameters and the analytical reports are included electronically in **Appendix F**.

Injection Testing

An injection test was performed in IW1 to demonstrate the ability of the injection well to accept fluid, to test the effectiveness of the confining units between the injection zone and the monitoring zones, and to determine the well hydraulics so that appropriate injection well pumps could be selected.

By May 18, 2009, the Contractor had completed preparations for the injection test and on that day a short preliminary injection test was completed. Preliminary testing was performed to ensure instrumentation was operating correctly, to ensure there were no leaks in the injection test piping, and to obtain preliminary data on the injection well hydraulics so that appropriate pump settings could be determined in advance. During the preliminary testing, four incremental injection rates of 1,250, 3,000, 5,000 and 5,400 gpm were sustained for individual durations between 15 and 30 minutes, with a maximum wellhead pressure at IW1 of 98 psi.

Following preliminary testing, but prior to starting the injection test, the "background" wellhead pressure at IW1, the background pressures at the upper and lower monitoring zones of MW1, and barometric pressure changes, were monitored with pressure transducers for approximately 43 hours to determine baseline conditions. The Contractor began the injection test on May 20, 2009 at 07:00 a.m. The duration of the injection test was 13 hours, with a total of 3,303,500 gallons of potable water injected into IW1. A further period of water level recovery measurement was then undertaken following injection.

Prior to testing, a testing plan was carefully designed, and agreed with FDEP, using different flow rates and durations so as to meet all test objectives, while also taking into account the available freshwater that could be stored and recovered from the three SBR tanks (calculated to be 4.0 million gallons [MG]). Incremental step injection rates of 1,600 and 3,200 gpm for a total of 60 minutes each (steps 1 and 2), followed by an extended injection rate of 5,138 gpm for a minimum of 8 hours (step 3), and finally a maximum injection rate of 5,508 gpm for a duration of 120 minutes (step 4) at the maximum permitted test rate of 7.93 million gallons per day (MGD) was proposed.

Due to conditions encountered in the field, modifications had to be made during testing, in particular test steps 3 and 4 were performed at different injection rates and durations than originally proposed. These changes were made in concurrence and consultation with FDEP and KLWTD representatives. . The actual injection test was performed as follows;

- Step 1: For the first hour of injection (7:00 am to 8:00am) an average flow rate of 1,567 gpm was maintained with a wellhead pressure at IW1 of 46.7 psi.
- Step 2: During the second hour (between 8:00 am and 9:00 am) an average flow rate of 3,184 gpm was maintained with a wellhead pressure at IW1 of 61.5 psi.

- Step 3: During the third hour the injection rate was increased to 5,100 gpm. This rate was maintained for approximately 30 minutes, with an initial injection pressure of approximately 88 psi. However due to steady increases in injection well head pressures from 88 to 94 psi, and reducing suction heads as the SBR tank levels dropped, sustained injection at this rate could not be achieved and some fluctuations in injection rates occurred after this time. Adjustments to the gate valve were made, but higher rates could not be achieved without changing the pump speed. This would have required a short stop in pumping to change gears on the diesel pump, with no guarantee that the increased pump speed could have sustained a higher injection rate. Therefore after three hours of testing, the decision was made to reduce the injection rate rather than continue testing for 8 hours as originally planned. The average injection rate between hours 2 and 5 (9:00 am and 12:00pm) was 4,947 gpm with a wellhead pressure at IW1 of 94 psi.

- Step 4: Between hours 5 and 13 (12:00pm to 8:00pm) the injection rate was reduced to approximately 4,500 gpm, and generally remained stable for the remainder of the test. The average flow rate during the 8 hours was 4,432 gpm, with a wellhead pressure at IW1 of 85 psi.

- Recovery: At 8:00 pm, the Contractor turned the pump off after 13 hours of pumping and the recovery portion of the injection test began. Almost instantaneously, wellhead pressure at IW1 dropped to approximately 40.6 psi, within 7 psi of background levels. Wellhead pressure fully returned to background levels on May 24, 2009 after almost 88 hours of recovery. On May 26, 2009 (after approximately 132 hours of recovery), the Contractor stopped collecting data and completed the recovery portion of the test.

During testing, no significant changes in pressure from "background" levels in the upper and lower monitor zones were observed due to injection into IW1, indicating that the injection of more than 6.4 mgd does not affect the pressures of the MW1 monitor zones. The pressure transducer readings from the upper and lower monitor zones of MW1 remained stable with pressure fluctuations in the upper zone a maximum of 0.19 psi and pressure fluctuations in the lower zone a maximum of 0.07psi. These minor fluctuations throughout the background, testing and recovery periods appear to correspond to changes in barometric pressure and tide (see Figures E-3 through E-6 in **Appendix E**). This supports the interpretation that the monitor zones are isolated from the injection zone by one or more suitable, overlying confining intervals, per Chapter 62-528, FAC requirements.

Test results do indicate however that there are changes in well performance at different injection rates. **Figure 6** plots calculated specific injectivity in gpm per foot of water level change for each of the different injection steps against elapsed time from the start of each step. Note, pressure change corrections for each step due to cumulative impacts of the previous test step were not undertaken, but given the very rapid pressure recovery observed after testing, these corrections if applied are likely to have negligible effect.

In summary, step 1, undertaken at an average injection rate of 1,567 gpm, has a specific injectivity of 60 gpm/ft. However as injection rates increased, reductions in specific injectivities were observed, with a specific injectivity of 36 gpm/ft at the highest test rate of 4,976 gpm (step 3).

Some decline in specific injectivity at increased injection rates is to be expected due to increased friction losses as flow velocities increase, i.e. head losses in the injection casing are greater. However, as more clearly shown in **Figure 7**, which plots injection pressure against injection rate, at injection rates above approximately 3,000 gpm a distinct change in well performance occurs. Note, the data obtained during preliminary testing, also plotted on the same figure, shows the same behavior.

Friction loss for the injection casing at different injection rates (using a Hazen-Williams roughness factor of 150), have been calculated and have been used to then calculate approximate formation loss. Formation loss has been plotted in **Figure 7** and this analysis clearly shows that the reason for a more significant increase in injection pressures and reduction in specific injectivity at injection rates above 3,000 gpm is due primarily to increased head losses in the injection zone. For example, at 2,000 gpm the calculated injection pipe (casing) friction loss is approximately 3.1 psi, while the pressure increase in the injection zone is estimated at 12.4 psi. At 4,000 gpm the calculated injection pipe friction loss is approximately 10.9 psi, while the pressure increase in the injection zone is estimated at 31.1 psi.

This "breakaway" in injection heads above flows of approximately 4.32 mgd (3,000 gpm) makes it a little more challenging for the injection pump design. To ensure a more energy efficient operation, routine injection flows below 3,000 gpm is recommended with operation at higher peak flows only when required.

The hydraulic conductivity of the injection zone has been approximated using a method outlined by Turcan (1963). Based on the estimated formation back-pressure increase of 35.5 psi (and assuming an injection-fluid pressure gradient of approximately 2.31

feet per psi) and an average pumping rate of 4,432 gpm, a specific injectivity of 38.0 gpm/foot was estimated for the injection zone. Assuming an aquifer thickness of 158 feet (estimated thickness of the two injection zones), the average horizontal hydraulic conductivity of the injection zone can be estimated at 705 gallons per day per square foot (gpd/ft^2).

Despite the changes in well performance observed, the collected data still demonstrates that the section of the "Boulder Zone" penetrated by the open hole of IW1 is sufficiently transmissive to accept a sustained injection rate of approximately 6.48 mgd (4,500 gpm). This determination has been made assuming a maximum allowable injection wellhead pressure of 104 pounds per square inch (psi), which is two-thirds of the injection pressure performed during the 60-minute hydrostatic pressure test for the IW1 injection casing, less a "safety margin" to allow for any future possible decline in well performance and possible "operational fluctuation" during injection pump start-up.

A summary of test data, associated charts and calibration certificates are included in **Appendix E**. Electronic injection test transducer data is included in **Appendix F**.

Geology and Hydrogeology

A summary of the geologic and hydrogeologic settings of the area surrounding the Key Largo WTP, updated with the results from the drilling of IW1 and MW1, is provided below. The aquifers encountered during construction of IW1 are described below. The regional geologic and hydrogeologic setting is illustrated on a southwest-northeast hydrostratigraphic cross section in **Figure 5**.

Surficial Aquifer System

The Surficial Aquifer is composed mainly of limestone, interbedded with unconsolidated sand, silt and shell of Pleistocene Age. The very top of the aquifer is interpreted to be part of the Miami Limestone and consists of yellowish grey fossiliferous limestone and sand. Directly underlying the Miami Limestone is the Key Largo Limestone, which is a coralline limestone that is exposed at the surface throughout much of the Keys from Key Largo to Big Pine Key. At this location, white coralline limestone with abundant mollusks was intersected at a depth of approximately 30 feet bpl. This limestone is replaced gradually, at approximately 90 feet bpl, by relatively thick, mostly unconsolidated, siliciclastic deposits of the Long Key Formation of basal Pleistocene Age. The base of the Surficial Aquifer at the site is easily

recognized by the appearance of clayey deposits of the Hawthorn Group at 228 feet bpl.

Proximity of the site to open sea waters, result in high salinity of the Surficial Aquifer and exclude this aquifer system as a potential source of drinking water. During drilling of both IW1 and MW1 high salinities were encountered, with conductivities measured in the shallow pad monitor wells in excess of 40,000 µS/cm.

Miocene Series (Hawthorn Group) and Intermediate Aquifer System

Hawthorn Group generally forms a confining to semi-confining sequence between the Surficial Aquifer and the Oligocene to Eocene limestones and dolomites of the Floridan Aquifer. At the project site, the Hawthorn Group is represented by a sequence of greenish gray clays and yellowish gray marls with limestone near the base. The base of the Hawthorn Group clays, which provides primary confinement to the underlying artesian Floridan Aquifer, is located at a depth of approximately 460 feet bpl.

Underlying these sandy and silty clays is a thick sequence of sediments, comprising of alternating layers of generally fine-grained muddy limestones and marls, which belong to the Arcadia Formation, and are the basal part of the Hawthorn Group. These sediments represent the semi-confining Intermediate Aquifer. The top of the Upper Floridan Aquifer was located at a depth of approximately 1,050 feet bpl. An Underground Source of Drinking Water (USDW) was identified below the base of the surface casing set at 1,066 feet bpl.

Hydrogeology of the Floridan Aquifer System

The Floridan Aquifer includes the thick carbonate sequence of all or part of the Paleocene to lower Miocene Series and in south Florida, serves as a regionally significant water-yielding unit under confined conditions. The Floridan Aquifer underlies all of Florida and southern Georgia and in South Florida includes permeable Miocene age basal Hawthorn Group beds in hydraulic contact with the underlying Oligocene age Suwannee limestone and the Eocene age, Ocala, Avon Park and Oldsmar Formations.

Suwannee Limestone

Underlying the Hawthorn Group at 1,050 feet bpl are limestones of Oligocene age referred to as Suwannee Limestones and are typically represented by a yellowish gray

to white, fine-grained, poorly indurated, fossiliferous, frequently sandy limestone. At the project site, the base of the Suwannee Limestone is located at a depth of approximately 1,300 feet bpl.

Avon Park Formation

Underlying the Suwannee Limestones are the Upper to Middle Eocene age limestones and dolostones referred to as the Avon Park Formation. This formation predominantly consists of yellowish brown limestones and orange to brown dolostones. The uppermost Avon Park Formation contains brown fossiliferous limestone and fine crystalline dolostone. At the project site, the base of the Avon Park Formation is located at a depth of approximately 2,580 feet bpl. The Ocala Formation, which overlies the Avon Park Formation elsewhere, was not positively identified at this location and may be absent.

Oldsmar Formation

Underlying the Avon Park Formation is the Lower Eocene age limestones and dolostones referred to as the Oldsmar Formation. The upper portion of the Oldsmar Formation consists of interbedded limestone and dolomite while the lower portion of the formation is comprised primarily of dolomites that are pale to dark yellowish brown, crystalline to cryptocrystalline, dense and massive with some evidence of dissolution (cavities, vugs, caverns and fractures). The lower part of the formation, between approximately 2,800 feet bpl and 3,670 feet bpl, contains a section of highly permeable dolomite and is known as the "Boulder Zone".

Cedar Keys Formation

The Cedar Keys Formation is subdivided by lithologic character and corresponding geophysical log characteristics into six units. The top three units are classified as Paleocene age. The top of this formation is characterized by presence of light gray to dark gray microcrystalline to chalky dolostone with thin beds of anhydrite. The televiewer log and drill-cutting samples suggest that the top of the Cedar Keys Formation was intercepted at the project site at approximately 3,670 feet bpl and extends below the bottom of the pilot hole (3,693 feet bpl).

Upper Floridan Aquifer (UFA)

The UFA is located directly below the Hawthorn Group. At the project site, the top of the UFA is located at approximately 1,050 feet below land surface. The UFA generally

increases in salinity with increased depth. Production wells in South Florida that withdraw from the Floridan Aquifer typically only extend to the uppermost producing zones in the UFA where higher quality (less saline) water is present. However, potentially usable sources of underground drinking water (referred to as USDWs) are defined as waters containing concentrations of TDS less than 10,000 mg/L. Based on packer testing and geophysical logging, the base of the USDW at the project site is located at 1,450 feet.

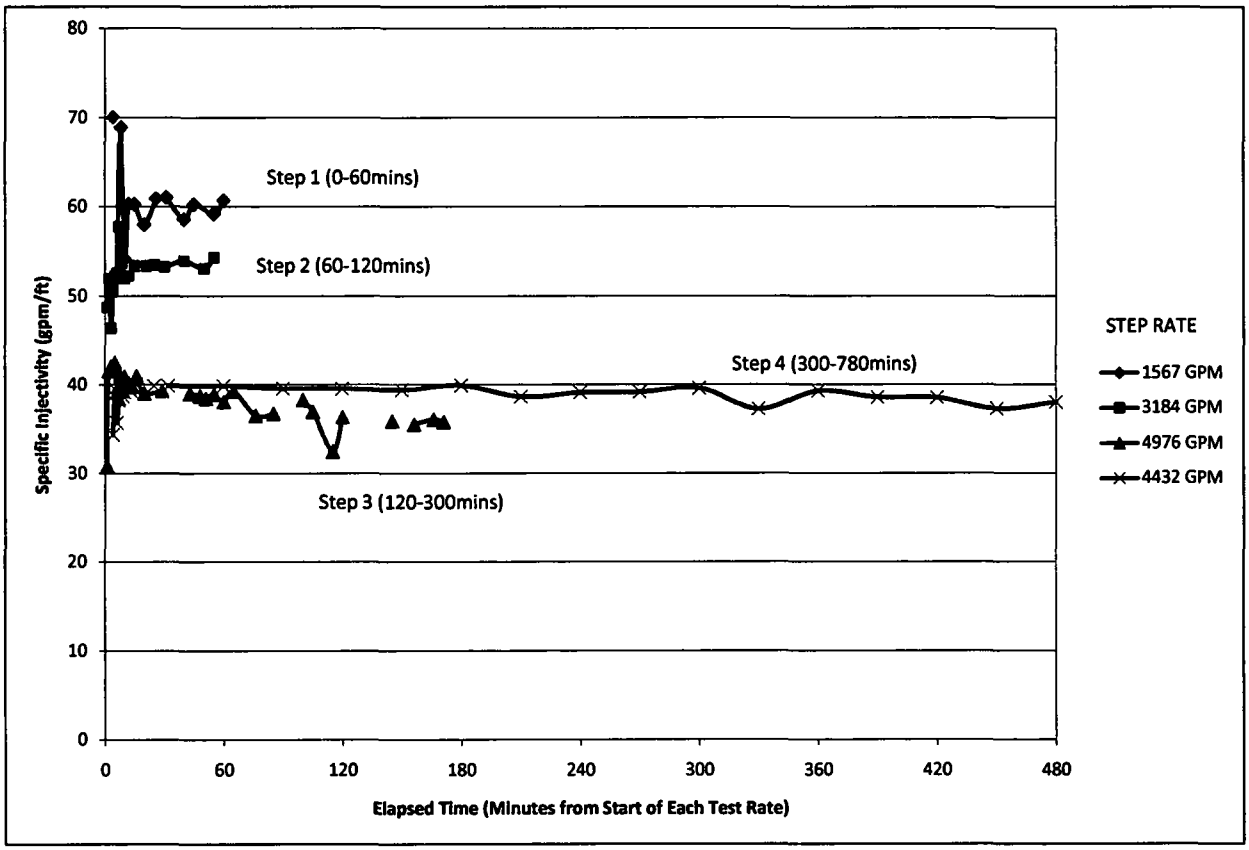
Floridan Aquifer Confining Units

Underlying the UFA and the lowermost USDW are strata, within the mid to lower Avon Park Formation and upper Oldsmar Formation, that are primarily un-fractured limestones and dolostones that have low-permeability. These low-permeability formation intervals will serve as a barrier between the fluids injected in the "Boulder Zone" and the lowermost USDW. Based on the data collected during construction and testing of the injection well system, there appears to be sufficient confining units present at the project site, with the primary confining units between the lowermost USDW and the injection zone between 1,575 feet and 2,816 feet bpl. .

Floridan Aquifer "Boulder Zone"

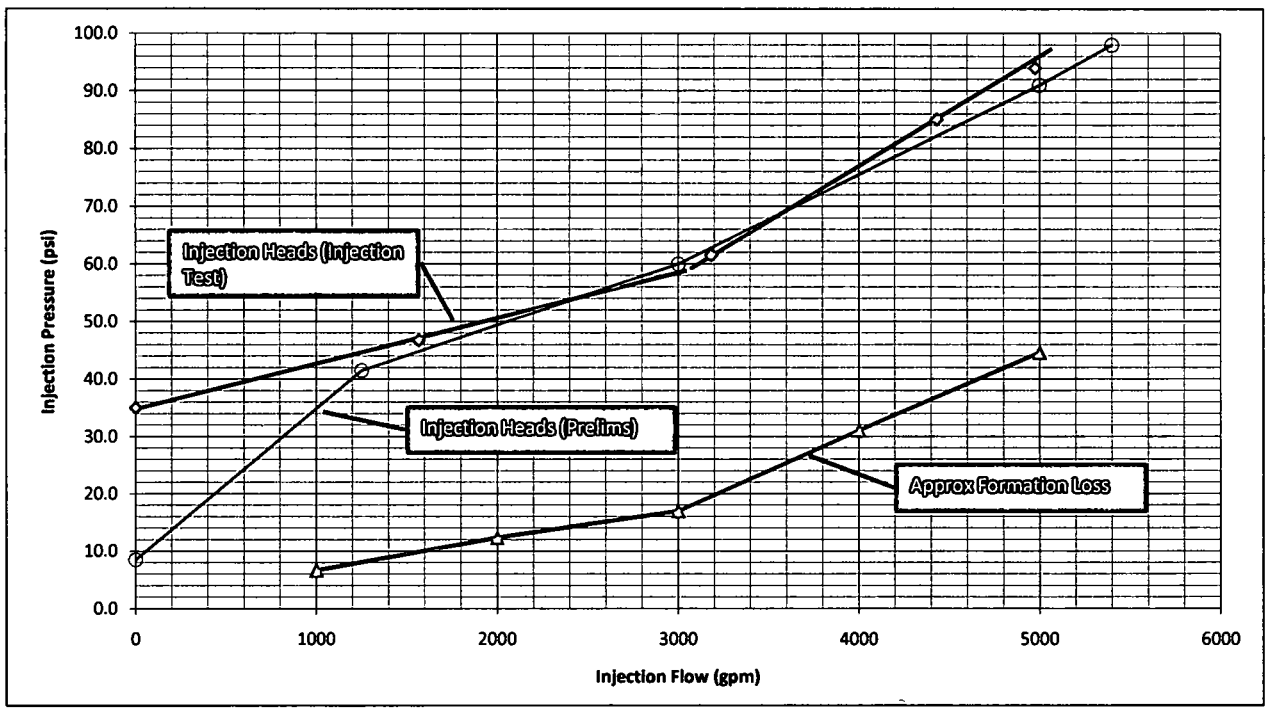
Underlying the confining units within the Floridan Aquifer System is a highly transmissive karst zone known in south Florida as the "Boulder Zone". The absence of a USDW, the presence of overlying confining units, and the high transmissivity provide an ideal formation for underground disposal and storage. Based on geophysical logging (which included televiewer and caliper logs) and the final Video Survey of the open hole, there are two potential injection zone intervals at the project site. The first is located between 2,956 feet and 2,990 feet bpl, where a potential minor injection zone was observed. The second lower zone, and most likely the main injection interval for IW1, exists between 3,415 and 3,539 feet bpl, with two large cavities observed between 3,430 feet and 3,437 feet bpl.

FIGURE 6: KLWTD Injection Well System IW1 Injection Test Specific Injectivity



NOTE: Specific injectivity calculated from Injection Rate GPM / (Injection PSI - Static PSI)

FIGURE 7: KLWTD Injection Well System IW1 Injection Curve



Preliminary Test (5/18/09):

Injection Flow (gpm)	0	1250	3000	5000	5400
Injection pressure (psi)	8.5	41.5	60	91	98

Injection Test (5/20/09):

Injection Flow (gpm)	0	1567	3184	4976	4432
Injection pressure (psi)	35	46.7	61.5	94	85

Approximate Well Losses

Pipe loss*:

Final casing (ft) 2735

Injection Flow (gpm)	1000	2000	3000	4000	5000
Pipe loss (psi)	1.4	3.1	6.6	10.9	16.4

Formation loss**:

Injection Flow (gpm)	1000	2000	3000	4000	5000
Formation loss (psi)	6.6	12.4	16.9	31.1	44.6

* Friction loss for injection tube at a given flow rate, source Future Pipe Industries REDBOX Product Catalogue

** Estimated formation loss for a given flow rate derived from measured injection pressure (5/20/09) less static pressure (35psi) less pipe friction loss

Table 1. Summary of Construction and Testing Activities
KLWTD Injection Well System, Key Largo, Florida

Weekly Report #	Date	Description
Injection Well IW1		
1		Install 4 water-table monitor wells, and perform background sampling
	11/14/08	Begin drilling pilot hole using a 12.25-inch bit
	11/16/08	Complete pilot hole drilling to 214 ft bpl; perform geophysical logging; replace 12.25-inch bit with 60.5-inch bit and begin reaming
2	11/21/08	Complete reamed hole with 60.5-inch bit to 227 ft bpl; perform geophysical logging
	11/23/08	Install and cement 52-inch O.D. conductor casing at 223 ft bpl
3	11/24/08	Begin pilot hole drilling using 12.25-inch bit
	11/28/08	Complete pilot hole drilling to 1160 ft bpl and perform geophysical logging
	11/30/08	Begin reaming pilot hole with 46.5-inch bit
4, 5	12/11/08	Complete reamed hole with 46.5-inch bit to 1070 ft bpl and perform geophysical logging
	12/14/08	Install and cement 36-inch O. D. surface casing at 1066 ft bpl.
6	12/16/08	Begin pilot hole drilling using 12.25-inch bit by the reverse-air drilling method
	12/20/08	Complete pilot hole drilling to 1,745 feet bpl; 1 core retrieved between 1,729 feet and 1,745 feet bpl
		Perform suite of static and dynamic geophysical logging
7	12/23/08	Complete packer test #1 between 1,564-1,746 feet bpl (single packer)
	12/27/08	Complete packer test #2 between 1,279-1,319 feet bpl (straddle packer)
	12/28/08	Because portion of borehole televiewer log unacceptable, a single packer was installed to 1,362 feet bpl, the open hole below the packer was developed and a video survey was performed between 1,362-1,474 feet bpl
	12/29/08	Cement back pilot hole from total depth to 1,214 feet bpl
8	12/29/08	Begin reaming using 34.5-inch bit from base of 36-inch O.D. surface casing
9	01/05/09	Complete reamed hole using 34.5-inch bit to 1,735 feet bpl, perform geophysical logging
	01/09/09	Install and cement 28-inch O.D. intermediate casing to 1,730 feet bpl
	01/10/09	Begin drilling pilot hole using 12.25-inch bit from base of intermediate casing
10, 11	01/22/09	Complete pilot hole drilling to 3,693 ft bpl; 5 cores retrieved during drilling (1,858-1,873 ft bpl, 1,980-1,995 ft bpl, 2,100-2,116 ft bpl and 2,182-2,197 ft bpl)
	01/23/09	Perform suite of static and dynamic geophysical logging
	01/24/09	Install cement basket at 2,777 feet bpl, and establish bridge plug (top of cement of bridge plug tagged at 2,769 feet bpl)
12	01/26/09	Complete packer test #3 between 1,879-1,907 feet bpl (straddle packer)
	01/28/09	Complete packer test #4 between 2,209-2,237 feet bpl (straddle packer)
	01/29/09	Complete packer test #5 between 2,449-2,477 feet bpl (straddle packer)
	01/30/09	Complete packer test #6 between 2,594-2,622 feet bpl (straddle packer)
		Conduct pump test of open hole (1,730-2,759 feet bpl)
	02/01/09	Cement back pilot hole from total depth to 1,869 feet bpl
		Begin reaming using 26.5-inch diameter bit from base of intermediate casing
13, 14	02/09/09	Complete reaming with 26.5-inch bit to 2,737 feet bpl; begin reaming with 20.5-inch bit
15	02/21/09	Complete reaming with 20.5-inch bit to 3,604 feet bpl; perform geophysical logging
16	02/24/09	Install 16-inch O.D. FRP injection casing to 2,736 feet bpl
	02/27/09	Cement 16-inch O.D. FRP injection casing to 507 feet bpl
	03/01/09	Begin injection zone development; perform video survey and CBL
17	03/02/09	Collect water sample of injection zone
	03/03/09	Perform hydrostatic pressure test; cement annulus from 507 feet bpl to pad level
	03/04/09	Begin mobilizing from IW1 to MW1

Table 1. Summary of Construction and Testing Activities
KLWTD Injection Well System, Key Largo, Florida

Weekly Report #	Date	Description
Dual-Zone Deep Monitor Well MW1		
17	03/08/09	Complete mobilizing to MW1; Begin drilling using 42.5-inch bit
18	03/10/09	Complete drilling with 40-inch bit to 228 feet bpl
	03/11/09	Install and cement in place 34-inch O.D. conductor casing to 228 feet bpl
	03/12/09	Begin drilling pilot hole using 12.25-inch bit from base of conductor casing
	03/15/09	Complete pilot-hole drilling to 1,076 feet bpl; perform geophysical logging
		Begin reaming using 32.5-inch bit from base of conductor casing
19	03/21/09	Complete reaming with 32.5-inch bit to 1,062 feet bpl; perform geophysical logging
	03/23/09	Install and cement in place 24-inch O.D. surface casing to 1,058 feet bpl
20	03/26/09	Switch from mud-rotary to reverse-air drilling and begin pilot-hole drilling using 12.25-inch bit from base of surface casing
	03/28/09	Complete pilot hole drilling to 1,700 feet bpl
21	03/30/09	Perform suite of static and dynamic geophysical logging
	04/01/09	Complete packer test #7 between 1,649 and base of pilot hole (single packer)
	04/03/09	Complete packer test #8 between 1,434-1,481 feet bpl (straddle packer)
22	04/06/09	Complete packer test #9 between 1,459-1,486 feet bpl (straddle packer)
	04/07/09	Complete packer test #10 between 1,489-1,516 feet bpl (straddle packer)
	04/10/09	Extend pilot hole an additional 55 feet to 1,755 feet bpl (as suggested by FDEP)
		Complete packer test #11 between 1,699 feet bpl and base of extended pilot hole
23	04/15/09	Cement back pilot hole to 1,700 feet bpl.
	04/16/09	Emplace 50 cubic feet of gravel to 1,640 feet bpl.
		Cement back pilot hole interval between 1,640 feet bpl and 1,506 feet bpl.
	04/17/09	Emplace 90 cubic feet of gravel to 1,431 feet bpl.
		Cap gravel with 6 cubic feet of cement to 1,429 feet bpl.
		Begin to drill nominal 24-inch diameter reamed borehole.
	04/18/09	Complete nominal 24-inch diameter reamed hole to 1,462 feet bpl
24	04/21/09	Perform geophysical logging of the 24-inch borehole (x-y caliper and gamma-rays). Begin intermediate casing installation.
	04/24/09	Install and cement in place 16-inch O.D. intermediate casing to 1,459 feet bpl.
25	04/27/09	Begin to drill nominal 16-inch diameter reamed borehole.
	04/28/09	Complete nominal 16-inch diameter reamed hole to 1,635 feet bpl. Extend depth of the open hole with 12.25-inch diameter bit to 1,702 feet bpl and perform geophysical logging of the borehole.
	05/01/09	Install and cement in place 6.625-inch diameter FRP tubing to 1,650 feet bpl.
26	05/04/09	Perform hydrostatic pressure test.
	05/05/09	Begin Upper and Lower Monitoring Zones development.
	05/06/09	Complete both zones development. Perform video survey and CBL log.
27		Preparation for injection test. Constructing IW1 wellhead and laying down pipeline.
28	05/18/09	Conduct preliminary injection test. Began background data collection.
	05/20/09	Conduct short term injection test. Collect recovery data.
29	05/26/09	Perform Radioactive Tracer Survey (RTS). Inject potable water left in tanks after tests.

Table 2. Water-Quality Sampling Results from Pilot-Hole Reverse-Air Discharge KLWTD Injection Well System, Key Largo, Florida

Date	Depth	Field Analysis		
		Chloride	Conductivity	Temperature
	(feet bpl)	(mg/L)	(µS/cm)	(°C)
INJECTION WELL IW1				
12/16/08	1,100	180	890	27.1
12/16/08	1,130	160	889	28.8
12/16/08	1,160	160	826	27.7
12/17/08	1,173	160	914	31.6
12/17/08	1,190	160	901	25.7
12/17/08	1,220	680	2,510	26.1
12/17/08	1,250	880	2,830	24.1
12/17/08	1,262	1,500	3,600	24.2
12/17/08	1,280	2,000	4,070	26.1
12/17/08	1,310	2,500	5,900	26.6
12/17/08	1,340	3,000	8,040	26.2
12/17/08	1,352	3,500	10,040	26.2
12/17/08	1,370	3,500	9,770	25.8
12/17/08	1,400	3,500	8,960	25.9
12/17/08	1,430	3,500	9,010	25.7
12/17/08	1,442	3,500	9,080	25.4
12/17/08	1,460	3,500	9,350	25.2
12/17/08	1,490	3,500	10,640	25.3
12/17/08	1,520	3,500	10,560	25.0
12/17/08	1,532	3,500	10,300	25.1
12/17/08	1,550	4,000	11,550	24.4
12/17/08	1,580	4,500	11,900	24.8
12/17/08	1,610	4,500	12,480	25.1
12/17/08	1,622	4,500	11,770	25.6
12/17/08	1,640	4,500	12,900	24.8
12/18/08	1,670	4,500	12,850	24.7
12/18/08	1,700	4,500	13,010	24.5
12/18/08	1,712	4,500	12,240	25.2
12/20/08	1,740	4,500	12,920	25.6
01/11/09	1,770	5,000	15,900	26.5
01/11/09	1,800	4,500	13,390	32.2
01/11/09	1,830	4,500	15,070	31.1
01/12/09	1,860	6,500	18,840	27.7
01/12/09	1,890	6,000	17,220	28.5
01/12/09	1,920	7,500	21,800	28.3
01/12/09	1,950	7,500	20,500	26.9
01/12/09	1,980	7,000	19,040	26.4
01/14/09	2,010	6,000	17,220	24.1
01/14/09	2,040	5,500	16,740	23.7
01/14/09	2,070	5,500	16,730	23.1
01/14/09	2,100	6,500	18,320	22.9
01/15/09	2,130	5,500	16,700	22.2
01/15/09	2,160	5,000	15,750	22.3
1/16/2009*	2,190	1,000	2,160	21.8
1/16/2009**	2,220	15,000	44,300	20.9
01/16/09	2,250	15,000	44,200	19.9
01/17/09	2,280	15,000	43,500	17.2
01/17/09	2,310	4,500	14,060	17.1
01/17/09	2,340	4,500	14,020	17.2
01/17/09	2,370	4,500	14,300	17.0
01/17/09	2,400	5,000	17,230	19.0
01/17/09	2,430	5,000	17,100	20.5
01/17/09	2,460	5,500	17,360	23.4
01/17/09	2,490	5,500	17,540	24.7

Table 2. Water-Quality Sampling Results from Pilot-Hole Reverse-Air Discharge KLWTD Injection Well System, Key Largo, Florida

Date	Depth	Field Analysis		
		Chloride	Conductivity	Temperature
	(feet bpl)	(mg/L)	(µS/cm)	(°C)
01/17/09	2,520	6,000	16,780	23.9
01/17/09	2,550	6,000	16,910	24.0
01/17/09	2,580	6,000	16,740	23.8
01/17/09	2,610	6,000	16,960	21.9
01/17/09	2,640	6,000	16,870	22.4
01/17/09	2,670	6,000	16,880	21.9
01/17/09	2,700	6,000	16,910	20.8
01/17/09	2,730	6,000	16,960	19.7
01/17/09	2,760	6,000	16,930	19.0
DUAL-ZONE DEEP MONITOR WELL MW1				
03/26/09	1,100	200	1,204	26.7
03/26/09	1,130	300	1,280	25.8
03/27/09	1,160	580	2,070	26.2
03/27/09	1,190	740	2,690	25.5
03/27/09	1,220	1,280	4,430	25.3
03/27/09	1,250	1,320	4,660	25.2
03/27/09	1,262	2,000	4,860	26.2
03/27/09	1,280	2,500	6,530	25.8
03/27/09	1,308	2,500	7,260	25.6
03/27/09	1,340	2,500	7,460	25.8
03/27/09	1,352	3,000	8,220	25.8
03/27/09	1,370	3,000	8,340	25.6
03/27/09	1,398	3,000	8,390	25.8
03/27/09	1,430	3,000	9,050	25.5
03/27/09	1,443	3,500	9,310	25.6
03/27/09	1,460	3,500	8,780	25.8
03/27/09	1,488	3,500	9,240	26.0
03/27/09	1,520	3,500	9,360	25.6
03/27/09	1,550	3,500	10,040	25.3
03/27/09	1,578	3,500	10,920	25.8
03/27/09	1,610	4,000	11,720	25.2
03/27/09	1,623	4,000	11,840	25.7
03/27/09	1,640	4,500	12,900	25.2
03/27/09	1,678	4,500	12,860	25.6
03/28/09	1,700	4,500	12,840	24.8
04/09/09	1,713	6,000	15,680	25.4
04/09/09	1,730	5,000	13,150	24.5
04/09/09	1,755	5,000	13,160	24.0

"bpl" denotes below pad level

"mg/L" denotes milligrams per liter

"µS/cm" denotes microSiemens per centimeter

"°C" denotes degrees Celsius

Note Low range Chloride Kit was used between 1100 and 1250 ft bpl

* Potable water was introduced into circulation

** Salt was used to supress potentiometric head in well

Table 3. Summary of Geophysical Logs Performed in IW1 and MW1
KLWTD Injection Well System, Key Largo, Florida

Date	Geophysical Survey Performed	Casing Depth (feet bpl)	Open Hole Depth (feet bpl)	Casing/Drilled Hole Diameter (inches)
INJECTION WELL IW1				
11/21/08	X-Y Caliper, Gamma Ray	-	227	60.5
11/23/08	Cement Top Temperature (Stage 1)	223	227	52.0
11/29/08	X-Y Caliper, Gamma Ray	223	1160	12.25
11/29/08	Dual Induction LL3 with SP	223	1160	12 25
11/29/08	Borehole Compensated Sonic w/VDL	223	1160	12.25
12/11/08	X-Y Caliper, Gamma Ray	223	1070	46.50
12/14/09	Cement Top Temperature (Stages 1-2)	1066	1070	36.00
12/20/08	X-Y Caliper, Gamma Ray	1066	1746	12.25
12/20/08	Dual Induction LL3 with SP	1066	1746	12.25
12/20/08	Borehole Compensated Sonic w/VDL & Log Derived TDS	1066	1746	12.25
12/20/08	Fluid Conductivity, Temperature	1066	1746	12.25
12/20/08	Flowmeter	1066	1746	12.25
12/20/08	Borehole Televiewer*	1066	1746	12.25
12/28/08	Pilot Hole 1,362-1,464 ft Video (DVD)			
01/06/09	X-Y Caliper, Gamma Ray	1066	1740	34.50
01/09/09	Cement Top Temperature (Stages 1-4)	1730	1740	28.00
01/22/09	X-Y Caliper, Gamma Ray	1730	3700	12.25
01/22/09	Dual Induction LL3 with SP	1730	3700	12 25
01/22/09	Borehole Compensated Sonic w/VDL & Log Derived TDS	1730	3700	12.25
01/22/09	Fluid Conductivity, Temperature	1730	3700	12 25
01/22/09	Flowmeter	1730	3700	12.25
01/22/09	Borehole Televiewer*	1730	3700	12.25
02/21/09	X-Y Caliper, Gamma Ray	1730	3604	28 & 22
02/27/09	Cement Top Temperature (Stages 1-5)	2736	3604	16.00
03/01/09	Cement Bond Log	2736	3604	16.00
03/01/09	IW1 Final Video (DVD)	2736	3604	16&22
05/26/09	High Resolution Temperature	2736	3604	22.00
05/26/09	Radioactive Tracer Survey	2736	3604	22.00
DUAL-ZONE DEEP MONITOR WELL MW1				
03/11/09	X-Y Caliper, Gamma Ray	-	228	42.5
03/12/09	Cement Top Temperature (Stage 1)	225	228	34.0
03/15/09	X-Y Caliper, Gamma Ray	225	1076	12.25
03/15/09	Dual Induction LL3 with SP	225	1076	12.25
03/15/09	Borehole Compensated Sonic w/VDL	225	1076	12 25
03/21/09	X-Y Caliper, Gamma Ray	225	1062	32.50
03/22/09	Cement Top Temperature (Stage 1)	1058	1062	24 00
03/30/09	X-Y Caliper, Gamma Ray	1058	1703	12.25
03/30/09	Dual Induction LL3 with SP	1058	1703	12.25
03/30/09	Borehole Compensated Sonic w/VDL & Log Derived TDS	1058	1703	12.25
03/30/09	Fluid Conductivity, Temperature	1058	1703	12.25
03/30/09	Flowmeter	1058	1703	12.25
04/21/09	X-Y Caliper, Gamma Ray	1058	1462	22.50
04/24/09	Cement Top Temperature (Stages 1-3)	1459	1462	16 00
04/28/09	X-Y Caliper, Gamma Ray	1459	1703	12.25 & 14.75
04/30/09	Cement Bond Log before cement	1650	1703	6.625
05/01/09	Cement Top Temperature (Stages 1-2)	1650	1703	6.625
05/26/09	Cement Bond Log after cement	1650	1703	6.625
05/26/09	DZMW1 Final Video (DVD)	1650	1703	6 625

"bpl" denotes below (drilling) pad level

"LL3" denotes lateral resistivity

"VDL" denotes a variable density log display

"SP" denotes spontaneous potential

"TDS" ddenotes total dissolved solids

Table 4. Summary of Hydraulic Conductivities and Porosity from Core Analyses for Injection Well IW1
KLWTD Injection Well System, Key Largo, Florida

Core Number	Cored Interval (feet bpl)	Core Sample Interval (feet bpl)	Porosity (%)		Horizontal Hydraulic Conductivity (cm/sec)	Vertical Hydraulic Conductivity (cm/sec)
			Horizontal	Vertical		
1	1729-1745	1729.7-1730.2	15.7	15 7	3.2×10^{-7}	1.2×10^{-7}
		1733 3-1734.55	11.3	11 2	1.3×10^{-8}	5.0×10^{-9}
		1736.1-1737.0	7.3	7 4	3.8×10^{-11}	1.0×10^{-9}
2	1858-1873	1859.5-1860.35	35.4	35 4	3.0×10^{-6}	2.3×10^{-6}
		1862 4-1863.0	41.3	41 0	1.4×10^{-5}	5.2×10^{-6}
		1868.45-1869.2	17.2	18.0	8.7×10^{-8}	1.1×10^{-7}
3	1980-1995	1982.85-1983 8	36.1	35 8	8.5×10^{-6}	6.6×10^{-6}
		1987.85-1988 5	13.6	13 9	8.2×10^{-8}	5.1×10^{-8}
		1990.4-1991.3	26.0	25 7	8.8×10^{-7}	9.1×10^{-7}
4	2100-2116	2102.55-2103.5	35.6	36 1	1.2×10^{-6}	1.2×10^{-6}
		2107.15-2107.8	14.7	15 3	1.5×10^{-7}	1.3×10^{-7}
		2110.9-2111.65	37.5	36 6	3.3×10^{-5}	3.6×10^{-5}
5	2182-2197	2182.35-2182.95	25.3	25 7	5.1×10^{-7}	4.0×10^{-7}
		2187.55-2188 2	31.6	32 3	4.9×10^{-7}	7.4×10^{-8}
		2191.25-2191.8	27.2	27 1	1.4×10^{-6}	9.1×10^{-7}

"bpl" denotes below pad level

"cm/sec" denotes centimeter per second

-Based on logging, testing and core analyses, the primary confining interval between the lowermost USDW and the injection zone is located between 1,575 feet and 2,816 feet bpl.

Table 5 Summary of Packer Test Final Water Sample Analytical Results
KLWTD Injection Well System, Key Largo, Florida

Packer Test Number	Well	Sample Date	Test Interval (feet bpl)	Ammonia Nitrogen (mg/L)	Specific Conductance (µmhos/cm)	Chloride (mg/L)	Total Phosphorus (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)	Total Kjeldahl Nitrogen (mg/L)	pH Lab Result (pH units)
1	IW1	12/22/08	1,565-1,746	0.42	30,800	12,800	0.4	2,640	19,500	0.40	7.33
2	IW1	12/27/08	1,279-1,319	0.14	8,690	2,742	0.13	566	5,124	0.36	7.57
3	IW1	1/26/09	1,879-1,907	0.05	59,200	25,200	0.078	2,920	47,500	0.20	5.93
4	IW1	1/27/09	2,209-2,237	nd	50,500	19,300	0.11	2,650	30,100	0.20	8.22
5	IW1	1/29/09	2,449-2,477	0.08	46,300	20,500	nd	2,670	29,300	0.21	8.58
6	IW1	1/30/09	2,594-2,622	0.39	51,800	20,100	nd	2,620	38,300	0.53	7.46
7	MW1	4/1/09	1,649-1,700	0.43	32,100	11,900	0.160	2,430	21,100	0.55	7.25
8	MW1	4/2/09	1,434-1,481	0.16	9,910	3,070	0.120	366	5,470	0.83	7.54
9	MW1	4/6/09	1,459-1,486	0.29	17,500	5,810	0.110	1,070	10,400	0.34	7.55
10	MW1	4/7/09	1,489-1,516	0.31	18,700	6,030	0.170	998	10,600	0.10	7.53
11	MW1	4/10/09	1,699-1,755	0.46	31,900	11,100	0.100	2,060	19,033	0.45	7.13

"bpl" denotes below pad level

"mg/L" denotes concentration in units of milligrams per liter.

"µmhos/cm" denotes specific conductance in units of micromhos per centimeter.

"nd" denotes analyte not detected

Tests No. 1, 7 and 11 utilized a single-packer, and test intervals were measured from inflation-element centerline to the bottom of the borehole.

The remaining tests utilized a straddle-packer construction and intervals were measured between packers centerlines.

Due to very low pumping rates during PT#3 through #6 (shaded), insufficient water was purged to collect a representative formation water sample.

Table 6. Summary of Packer Test Data and Horizontal Hydraulic Conductivity Estimates KLWTD Injection Well System, Key Largo, Florida

Packer Test	Date	Well	Depth Interval (feet bpl)	Tested Aquifer Thickness (feet)	Pumping Rate (gpm)	Specific Capacity (gpm/ft)	Estimated Transmissivity (gpd/ft)		Estimated Horizontal Hydraulic Conductivity (gpd/sq ft)		Estimated Horizontal Hydraulic Conductivity (cm/sec)		Method of Interpretation
							Drawdown	Recovery	Drawdown	Recovery	Drawdown	Recovery	
1	12/22/08	IW1	1,564-1,746	181	31.0	0.25	600	600	2.8	2.8	1.30E-04	1.30E-04	Turcan (1963)
2	12/27/08	IW1	1,279-1,319	40	51 3	0.45	900	900	22.5	22.5	1.06E-03	1.06E-03	Turcan (1963)
3	1/26/09	IW1	1,879-1,907	28	1.2	0.01	20	20	0.7	0 7	3.37E-05	3.37E-05	Turcan (1963)
4	1/27/09	IW1	2,209-2,237	28	4.0	0.03	60	60	2.1	2.1	1.01E-04	1 01E-04	Turcan (1963)
5	1/29/09	IW1	2,449-2,477	28	4.0	0.05	100	100	3.6	3.6	1 68E-04	1.68E-04	Turcan (1963)
6	1/30/09	IW1	2,594-2,622	28	4.0	0 04	80	80	2.9	2.9	1.35E-04	1.35E-04	Turcan (1963)
7	4/1/09	MW1	1,649-1,700	51	25.5	0.25	500	500	17.9	17.9	8.42E-04	8.42E-04	Turcan (1963)
8	4/2/09	MW1	1,434-1,481	47	82.3	1.27	2,540	2,540	90.7	90 7	4.28E-03	4.28E-03	Turcan (1963)
9	4/6/09	MW1	1,459-1,486	27	78.0	1.27	2,040	2,040	72.9	72.9	3.44E-03	3.44E-03	Turcan (1963)
10	4/7/09	MW1	1,489-1,516	27	66.7	0.61	1,220	1,220	45 2	45.2	2.13E-03	2.13E-03	Turcan (1963)
11	4/10/09	MW1	1,699-1,755	56	6.5	0.06							

bpl denotes below pad level

gpm denotes gallons per minute.

gpm/ft denotes specific capacity in units of "gallons per minute per feet of drawdown"

gpd/ft denotes transmissivity in units of "gallons per day per foot", and is estimated using a method by Turcan.

gpd/sq ft denotes horizontal hydraulic conductivity in "gallons per day per square foot"

cm/sec denotes hydraulic conductivity in units of "centimeters per second"

E denotes scientific notation (ex 1.30E-04 means 1 30 X 10^{-4})

Note The estimated horizontal hydraulic conductivity value was calculated by assuming that the packer interval was the effective aquifer thickness Thus, the estimated horizontal hydraulic conductivity reported represent probable "maximum" horizontal hydraulic coductivity for each interval tested

Table 7. Summary of Inclination Survey Results in Injection Well IW1
KLWTD Injection Well System, Key Largo, Florida

Date	Drill Bit Diameter (inches)	Inclination Survey Depth (feet)	Survey Result (degrees)	
			Deviation Total	Deviation Change
11/21/08	60.5	90	0.80	0.80
11/21/08	60.5	180	0.70	0.10
11/25/08	12.25	270	0.40	0.40
11/25/08	12.25	360	0.40	0.40
11/25/08	12.25	450	0.30	0.30
11/25/08	12.25	540	0.30	0.30
11/25/08	12.25	630	0.50	0.20
11/25/08	12.25	720	1.00	0.50
11/26/08	12.25	810	0.50	0.50
11/26/08	12.25	900	0.40	0.10
11/26/08	12.25	990	0.70	0.30
11/29/08	12.25	1080	0.50	0.20
12/1/08	46.5	290	0.30	0.00
12/1/08	46.5	380	0.50	0.20
12/2/08	46.5	470	0.60	0.10
12/2/08	46.5	560	0.50	0.10
12/4/08	46.5	650	0.50	0.00
12/5/08	46.5	740	0.70	0.20
12/6/08	46.5	830	0.30	0.40
12/7/08	46.5	920	0.50	0.20
12/9/08	46.5	1010	0.60	0.10
12/17/08	12.25	1150	0.20	0.30
12/17/08	12.25	1240	0.60	0.40
12/17/08	12.25	1330	0.40	0.20
12/17/08	12.25	1420	0.30	0.10
12/17/08	12.25	1510	0.30	0.00
12/18/08	12.25	1600	0.40	0.10
12/18/08	12.25	1690	0.70	0.30
12/29/08	34.5	1,150	0.30	0.30
12/30/08	34.5	1,240	0.10	0.20
12/31/08	34.5	1,330	0.50	0.40
12/31/08	34.5	1,420	0.70	0.20
1/4/09	34.5	1,510	0.30	0.40
1/4/09	34.5	1,600	0.75	0.45
1/5/09	34.5	1,690	0.25	0.5
1/11/09	12.25	1760	0.90	0.20
1/13/09	12.25	1850	0.50	0.40
1/13/09	12.25	1940	0.60	0.10
1/14/09	12.25	2030	0.50	0.10
1/15/09	12.25	2120	0.60	0.10
1/17/09	12.25	2210	0.60	0.00
1/17/09	12.25	2300	0.50	0.10

Table 7. Summary of Inclination Survey Results in Injection Well IW1
KLWTD Injection Well System, Key Largo, Florida

Date	Drill Bit Diameter (inches)	Inclination Survey Depth (feet)	Survey Result (degrees)	
			Deviation Total	Deviation Change
1/17/09	12.25	2390	0.20	0.30
1/17/09	12.25	2480	0.20	0.00
1/17/09	12.25	2570	0.05	0.15
1/17/09	12.25	2660	0.25	0.20
1/18/09	12.25	2750	0.60	0.35
2/2/09	26.5	1,820	0.50	0.25
2/3/09	26.5	1,910	0.30	0.20
2/3/09	26.5	2,000	0.20	0.10
2/4/08	26.5	2,090	0.20	0.00
2/5/09	26.5	2,180	0.30	0.10
2/6/09	26.5	2,270	0.15	0.15
2/6/09	26.5	2,360	0.25	0.10
2/7/09	26.5	2,450	0.15	0.10
2/8/09	26.5	2,540	0.40	0.25
2/9/09	26.5	2,630	0.25	0.15
2/9/09	26.5	2,720	0.40	0.15

The maximum allowable deviation from the vertical of any survey point is 1 degree

The maximum allowable difference between any two successive survey points is 0.5 degree.

*bpl *denotes below pad level

Table 8. Summary of Inclination Survey Results in Dual-Zone Deep Monitor Well MW1 KLWTD Injection Well System, Key Largo, Florida

Date	Drll Bit Diameter (inches)	Inclination Survey Depth (feet)	Survey Result (degrees)	
			Deviation Total	Deviation Change
3/9/09	42.5	90	0.30	0.00
3/9/09	42.5	180	0.50	0.20
3/13/09	12.25	270	0.20	0.00
3/13/09	12.25	360	0.20	0.00
3/13/09	12.25	450	0.60	0.40
3/13/09	12.25	540	0.60	0.00
3/13/09	12.25	630	0.40	0.20
3/14/09	12.25	720	0.20	0.20
3/14/09	12.25	810	0.20	0.00
3/14/09	12.25	900	0.20	0.00
3/14/09	12.25	990	0.40	0.20
3/16/09	32.5	270	0.25	0.00
3/16/09	32.5	360	0.15	0.10
3/16/09	32.5	450	0.40	0.25
3/17/09	32.5	540	0.50	0.10
3/17/09	32.5	630	0.40	0.10
3/18/09	32.5	720	0.20	0.20
3/18/09	32.5	810	0.30	0.10
3/19/09	32.5	900	0.45	0.15
3/19/09	32.5	990	0.30	0.15
3/26/09	12.25	1,080	0.20	0.00
3/27/09	12.25	1,170	0.25	0.05
3/27/09	12.25	1,260	0.30	0.05
3/27/09	12.25	1,350	0.50	0.20
3/27/09	12.25	1,440	0.50	0.00
3/27/09	12.25	1,530	0.30	0.20
3/27/09	12.25	1,620	0.15	0.15
4/9/09	12.25	1,710	0.25	0.10
4/17/09	22.5	1,080	0.40	0.00
4/18/09	22.5	1,170	0.30	0.10
4/20/09	22.5	1,260	0.20	0.10
4/20/09	22.5	1,350	0.20	0.00
4/27/09	22.5	1,440	0.70	0.50
4/27/09	14.75	1,530	0.70	0.00
4/28/09	14.75	1,620	0.80	0.10

The maximum allowable deviation from the vertical of any survey point is 1 degree
The maximum allowable difference between any two successive survey points is 0.5 degree.
bpl denotes below pad level

Table 9. Cementing Summary of Injection Well IW1, KLWTD Injection Well System, Key Largo, Florida

Casing String	Outside Diameter (inches)	Inside Diameter (inches)	Casing Depth (feet bpl)	Date	Cement Stage	Type of Cement	Cement Quantity (cubic feet)	Remarks
Pit	64.00	N/A	6	N/A	N/A	N/A	N/A	
Conductor	52.00	51.25	223	11/22/2008	1	Neat	135	Tagged bottom at 227 feet bpl. Pressure grout.
						12% bentonite	3,228	
				11/23/2008	2	12% bentonite	348	Tagged cement top at 45 feet bpl. Cement returns to surface.
Surface	36.00	35.25	1066	12/13/2008	1	6% bentonite	842	Tagged bottom at 1,070 feet bpl. Pressure grout.
						Neat	814	
				12/14/2008	2	6% bentonite	1,044	Tagged cement top at 655 feet bpl. Tremied in place.
						Neat	567	
				12/14/2008	3	6% bentonite	410	Tagged cement top at 302 feet bpl. Cement returns to surface.
						12% bentonite	1,723	
Intermediate	28.00	27.25	1,730	1/7/2009	1	6% bentonite	506	Tagged bottom at 1,740 feet bpl. Pressure grout.
						Neat	759	
				1/8/2009	2	6% bentonite	562	Tagged cement top at 1,286 feet bpl. Tremied in place.
				1/8/2009	3	6% bentonite	225	Tagged cement top at 1,113 feet bpl. Tremied in place.
						12% bentonite	618	
				1/9/2009	4	12% bentonite	1068	Tagged cement top at 849 feet bpl. Tremied in place.
				1/9/2009	5	12% bentonite	1186	Tagged cement top at 438 feet bpl. Cement to surface
Injection FRP Tubing	16.00	14.48	2,736	2/25/2009	Spotting stages 1-2	Neat+3% CaCl	33	Tagged top of funnel plug at 2,736 feet bpl. Tremied in place
				2/25/2009	1	Neat	561	Tagged cement top at 2,725 feet bpl. Tremied in place.
				2/25/2009	2	6% bentonite	1381	Tagged cement top at 2,559 feet bpl. Tremied in place.
				2/26/2008	3	6% bentonite	1684	Tagged cement top at 2,235 feet bpl. Tremied in place.
				2/26/2008	4	6% bentonite	702	Tagged cement top at 1,812 feet bpl Tremied in place.
						12% bentonite	1263	
				2/27/2009	5	12% bentonite	1628	Tagged cement top at 1,115 feet bpl. Tremied in place.
				3/3/2009	6	12% bentonite	1359	Tagged cement top at 507 feet bpl. Cement to surface.
						Total (cubic feet):	**22,646**	

Notes:
"N/A" denotes "data not available"
"bpl" denotes below pad level
Neat cement refers to Portland Type I/II cement with no additives
6% bentonite refers to Portland Type I/II cement with a 6% (by weight) bentonite additive
12% bentonite refers to Portland Type I/II cement with a 12% (by weight) bentonite additive

Table 10. Cementing Summary of Dual-Zone Deep Monitor Well MW1, KLWTD Injection Well System, Key Largo, Florida

Casing String	Outside Diameter (inches)	Inside Diameter (inches)	Casing Depth (feet bpl)	Date	Cement Stage	Type of Cement	Quantity of Cement (cubic feet)	Remarks
Pit	44.00	N/A	6	N/A	N/A	N/A	N/A	
Conductor	34.00	33.25	225	3/11/2009	1	12% bentonite	1,331	Tagged bottom at 228 feet bpl. Pressure grout.
				3/12/2009	2	12% bentonite	382	Tagged cement top at 67 feet bpl, cemented to surface.
Surface	24.00	23.25	1,058	3/22/2009	1	Neat	314	Tagged bottom at 1,062 feet bpl. Pressure grout.
						6% bentonite	1145	
				3/23/2009	2	6% bentonite	1471	Tagged cement top at 409 feet bpl. Cement to surface.
UMZ Casing	16.00	15.00	1,459	4/23/2009	Spot #1	Neat+ 3% CaCl	3	Tagged bottom at 1,465 feet bpl. Tremied in place.
					1	Neat	79	Tagged cement top at 1,463 feet bpl. Tremied in place.
				4/24/2009	2	6% bentonite	758	Tagged cement top at 1,417 feet bpl. Tremied in place.
					3	6% bentonite	842	Tagged cement top at 1,217 feet bpl. Tremied in place.
					4	12% bentonite	1,375	Tagged cement at 854 feet bpl. Cement to surface.
LMZ FRP Tubing	6.625	5.43	1,751	4/30/2009	Spot #1	Neat w/ 3% CaCl	3	Tagged bottom at 1,642 feet bpl. Tremie in place.
				4/30/2009	Spot #2	Neat w/ 3% CaCl	6	Tagged cement top at 1,641 feet bpl. Tremied in place.
				5/1/2009	1	Neat	112	Tagged cement top at 1,630 feet bpl. Tremied in place.
				5/1/2009	2	Neat w/ 3% CaCl	45	Tagged cement top at 1,541 feet bpl. Tremied in place.
				5/1/2009	Spot #3	Neat w/ 3% CaCl	11	Tagged cement top at 1,501 feet bpl. Tremied in place and tagged top of cement at 1,494 feet bpl.
						Total (cubic feet):	**6,546**	

Notes:
"N/A" denotes "data not available"
"bpl" denotes below pad level.
Neat cement refers to Portland Type I/II cement with no additives
6% bentonite refers to Portland Type I/II cement with a 6% (by weight) bentonite additive
12% bentonite refers to Portland Type I/II cement with a 12% (by weight) bentonite additive
"UMZ" denotes Upper Monitor Zone
"LMZ" denotes Lower Monitor Zone
"FRP" denotes fiberglass reinforced plastic.

Appendix A

FDEP Construction Permit

Florida Department of Environmental Protection

South District
P.O. Box 2549
Fort Myers, Florida 33902-2549

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

SENT VIA ELECTRONIC MAIL:

In the Matter of an
Application for Permit by:

January 11, 2008

Mr. Charles F. Fishburn, KLWTD General Manager
Key Largo Wastewater Treatment District.
98880 Overseas Highway, P.O. Box 491

Email: cffishburn@aol.com

Monroe County - UIC
File Number: 272762-001-UC/1M
Key Largo Class I Injection Well IW-1
Class I Injection Well System

NOTICE OF PERMIT

Enclosed is Permit Number 272762-001-UC/1M to construct one (1) Class 1 Injection Well, (IW-1), system, issued pursuant to Section(s) 403.087, Florida Statutes.

Any party to this Order, (Permit), has the right to seek judicial review of the permit pursuant to Section 120.68, Florida Statutes, by filing of a Notice of Appeal pursuant to Rule 9.110, Florida Rules of Appellate Procedure, with the Clerk of the Department in the Office of General Counsel, 3900 Commonwealth Boulevard, Mail Station 35, Tallahassee, Florida 32399-3000; and by filing a copy of the Notice of Appeal accompanied by the applicable filing fees with the appropriate District Court of Appeal. The Notice of Appeal must be filed within 30 days from the date this Notice is filed with the Clerk of the Department.

Executed in Lee County, Florida.

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION

Jon M. Iglehart
Director of District Management

CERTIFICATE OF SERVICE

The undersigned designated clerk hereby certifies that this **NOTICE OF PERMIT** and all copies were mailed before the close of business on January 11, 2008 to the listed persons.

Clerk Stamp

FILING AND ACKNOWLEDGMENT

FILED, on this date, pursuant to Section 120.52, Florida Statutes, with the designated Department Clerk, receipt of which is hereby acknowledged.

1.11.08

Clerk Date

JMI/DR/pr

Enclosure

Cc Nancy Marsh, EPA (marsh.nancy@epa.gov)
Craig Boomgaard, SFWMD (cboomgaa@sfwmd.gov)
Ron Reese, USGS (rsreese@usgs.gov)
Joe Haberfeld, FDEP (joe.haberfeld@dep.state.fl.us)
David K. Smith, P.G. (Davidk.Smith@arcadis-us.com)
Gus Rios, FDEP Marathon (mailto:gus.rios@dep.state.fl.us)

Florida Department of Environmental Protection

South District
P.O. Box 2549
Fort Myers, Florida 33902-2549

PERMIT

PERMITTEE:
Mr. Charles F. Fishburn, KLWTD General Manager
Key Largo Wastewater Treatment District
98880 Overseas Highway, P.O. Box 491
Key Largo, Florida 33037
Email: cffishburn@aol.com

Monroe County - UIC
File Number: 272762-001-UC/1M
Date of Issue: **January 11, 2008**
Expiration Date: **January 10, 2013**
Latitude: 25.0° 06.0' 01.00" N
Longitude: - 80.0° 26.0' 01.00" W
Township/Range/Section: 61S/39E/28
Key Largo Class I Injection Well IW-1
Class I Injection Well System

This permit is issued under the provisions of Chapter 403, Florida Statutes (F.S.), and Florida Administrative Code (F.A.C.) Rules 62-4, 62-520, 62-528, 62-550, 62-600, and 62-601. The above named permittee is hereby authorized to perform the work or operate the facility shown on the application and approved drawing(s), plans, and other documents, attached hereto or on file with the Department and made a part hereof and specifically described as follows:

Construct one, (1), nominal fourteen and fourty-eight hundredths inches (14.48)" diameter Class I injection well, (IW-1), with cemented FRP casing to approximately 2,750 feet below land surface (bls) and a total depth of approximately 3,300 feet bls. Injection is into the Oldsmar Formation for the primary means of disposal of non-hazardous secondary treated domestic wastewater which has received high-level disinfection for a maximum disposal of 7.93 million gallons per day (MGD) at a maximum injection rate of 5508 gpm. One dual zone monitor well (DZMW-1) will be completed from approximately 1,400 to 1,450 feet bls and from approximately 1,590 to 1,650 feet bls.

The Application to Construct/Operate/Abandon Class I, III, or V Injection well System, DEP Form 62-528.900(1), was received January 16, 2007, with supporting documents and additional information last received September 14, 2007. The Certificate of Demonstration of Financial Responsibility was approved September 10, 2007. The project is located at the Key Largo WRF at Key Largo WRF, Key Largo, Florida 33037, Lee County, Florida.

Subject to Specific Conditions 1-13.

SPECIFIC CONDITIONS:

1. GENERAL CRITERIA

   a. Any permit noncompliance constitutes a violation of the Safe Drinking Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

   b. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

   c. The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit.

   d. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures.

   e. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation or reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

   f. When requested by the Department, the permittee shall furnish, within the time specified, any information needed to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit.

   g. Signatories and Certification Requirements

      (1) All reports and other submittals required to comply with this permit shall be signed by a person authorized under Rules 62-528.340(1) or (2), F.A.C.

      (2) In accordance with Rule 62-528.340(4), F.A.C., all reports shall contain the following certification:

      "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based upon my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

   h. The permittee shall notify the Department and obtain approval prior to any physical alterations or additions to the injection or monitor well, including removal of the well head.

   i. The permittee shall give advance notice to the Department of any planned changes in the permitted facility or injection activity that may result in noncompliance with permit requirements.

SPECIFIC CONDITIONS:

j. The permittee shall report any noncompliance that may endanger health or the environment, including:

(1) Any monitoring or other information which indicates that any contaminant may cause an endangerment to an underground source of drinking water; or

(2) Any noncompliance with a permit condition or malfunction of the injection system, which may cause fluid migration into or between underground sources of drinking water.

(3) Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

k. No underground injection is allowed that causes or allows movement of fluid into an underground source of drinking water except as authorized under the federal regulations in 40 CFR 146.15 and 146.16.

l. The permittee shall retain all records of all monitoring information concerning the nature and composition of injected fluid until five years after completion of any plugging and abandonment procedures specified under Rule 62-528.435, F.A.C. The permittee shall deliver the records to the Department office that issued the permit at the conclusion of the retention period unless the permittee elects to continue retention of the records.

m. If injection is to continue beyond the expiration date of this permit the permittee shall apply for, and obtain an operation permit. If necessary to complete the two-year operational testing period, the permittee shall apply for renewal of the construction permit at least 60 days prior to the expiration date of this permit.

2. SITE REQUIREMENTS

a. A drilling pad shall be provided to collect spillage of contaminants and to support the heaviest load that will be encountered during drilling.

b. The disposal of drilling fluids, cuttings, formation water or waste shall be in a sound environmental manner that avoids violation of surface and ground water quality standards. The disposal method shall be approved by the Department prior to start of construction.

c. Specific drilling pad dimensions and design details shall be provided to and approved by the Department prior to commencing construction (and shortly after selection of drilling contractor).

d. The water table monitoring wells surrounding the injection well and monitor well pads shall be sampled and analyzed prior to drilling the injection and monitor wells and then weekly thereafter. Sampling shall include specific conductance, pH, chloride, temperature and water level.

SPECIFIC CONDITIONS:

e. Pursuant to Rule 62-528.455(1)(c)6., F.A.C., a survey indicating the exact location in metes and bounds of all wells authorized by this permit shall be provided prior to issuance of an operating permit.

3. CONSTRUCTION AND TESTING REQUIREMENTS

a. The permittee shall contact the Technical Advisory Committee (TAC) chairman so that he may schedule progress review meetings at appropriate times with the TAC and permittee for the purpose of reviewing the results of tests, geophysical logging, surveys, drilling records and construction problems.

b. All drilling shall be inside a blow out preventer upon penetration of the Floridan Aquifer.

c. Mechanical integrity testing is a two-part demonstration which includes a pressure test to demonstrate that no leaks are present in the casing, tubing or packer and a temperature or noise log and radioactive tracer survey to demonstrate the absence of leaks behind the casing. Verification of pressure gauge calibration must be provided at the scheduled tests.

d. Department approval and Technical Advisory Committee (TAC) review pursuant to F.A.C. Rule 62-528 is required for the following stages of construction:

(1) Intermediate casing seat selection for injection and monitor wells.

(2) Final casing seat selection for injection and monitor wells.

(3) Prior to conducting the short-term injection test.

(4) Prior to operational (long term) testing with effluent.

(5) The permittee shall submit all necessary supporting documentation/data, with interpretation, to the TAC for review.

e. The cementing program, as required in Section 62-528.410(5), Florida Administrative Code, shall be submitted to the Department and the Technical Advisory Committee for review. Cementing shall not commence prior to approval being granted.

f. All temperature surveys (except for mechanical integrity demonstration) shall be run within 48 hours after cementing.

g. TAC meetings are scheduled on the 1st Tuesday of each month subject to a 5 working day prior notice and timely receipt of critical data by all TAC members. Emergency meetings may be arranged when justified to avoid undue construction delay.

h. The Permittee shall insure that safe internal pressures are maintained during the cementing of all casings.

i. The injection zone and monitoring zones shall be sampled for background water quality prior to commencement of any injection testing. Parameters to be measured are the primary and

SPECIFIC CONDITIONS:

secondary drinking water standards (except asbestos, dioxin, epichlorhydrin, and acrylamide) and the minimum criteria for municipal effluent.

j. The injection and monitor well(s) at the site shall be abandoned when no longer usable for their intended purpose, or when posing potential threat to the quality of the waters of the State. Within 180 days of well abandonment, the permittee shall submit to the Department and the TAC the proposed plugging method, pursuant to Rule 62-528.435, F.A.C.

k. All salt used in well drilling shall be stored in an environmentally sound manner. Accurate records shall be kept on the amount of salt used.

l. All dual induction, sonic and caliper geophysical logs run on the pilot holes of the injection well and monitor wells shall be submitted with scales of one inch equals one hundred feet (1"=100'), two inches equals one hundred feet (2"=100'), and five inches equals one hundred feet (5"=100')

m. An engineering drawing showing the drill pad construction (including material used) and locations of the injection well, monitor wells, and the water table monitor wells shall be provided for Department approval prior to pad construction and well construction.

4. QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

a. This permit approval is based upon evaluation of the data contained in the application dated January 16, 2007, and the plans and/or specifications submitted in support of the application. Any proposed modifications to this permit shall be submitted in writing to the Underground Injection Control program manager, the TAC for review and clearance prior to implementation. Changes of negligible impact to the environment and staff time will be reviewed by the program manager, cleared when appropriate and incorporated into this permit. Changes or modifications other than those described above will require submission of a completed application and appropriate processing fee as per Rule 62-4.050, F.A.C.

b. A professional engineer registered pursuant to Chapter 471, Florida Statutes shall be retained throughout the construction period to be responsible for the construction operation and to certify the application, specifications, completion report and other related documents. The Department shall be notified immediately of any change of engineer.

c. Where required by Chapter 471 (P.E.) or Chapter 492 (P.G.) F.S., applicable portions of permit applications and supporting documents that are submitted to the Department for public record shall be signed and sealed by the professional(s) who approved or prepared them.

d. The Department shall be notified immediately of any problems that may seriously hinder compliance with this permit, construction progress, or good construction practice. The Department may require a detailed written report describing the problem, remedial measures taken to assure compliance and measures taken to prevent recurrence of the problem.

e. Issuance of a Class I Test/Injection well construction and testing permit does not obligate the Department to authorize operation of the injection well system, unless the wells qualify for an operation permit applied for by the permittee and issued by the Department.

SPECIFIC CONDITIONS:

5. REPORTING REQUIREMENTS

a. All reports and surveys required by this permit must be submitted concurrently to all the members of the TAC. The TAC consists of representatives from these agencies:

Florida Department of Environmental Protection
South District
P.O. Box 2549
Fort Myers, FL 33902-2549

Florida Department of Environmental Protection
Bureau of Water Facilities Regulation
UIC Program, MS 3530
2600 Blair Stone Rd.
Tallahassee, FL 32399-2400

South Florida Water Management District
P.O. Box 24860
West Palm Beach, FL 33416-4860

United States Geological Survey
9100 NW 36th Street, Suite 107
Miami, FL 33178

b. Members of the TAC shall receive a weekly summary of the daily log kept by the contractor. The reporting period shall run for seven (7) days and reports shall be mailed or emailed within 48 hours of the last day of the reporting period. The report shall include but is not limited to the following:

(1) Description of daily footage drilled by diameter of bit or size of hole opener or reamer being used;

(2) Description of formation and depth encountered; and specific conductance of water samples collected during drilling. Description of work during installation and cementing of casings; include amounts of casing and actual cement used versus calculated volume required.

(3) Lithological description of drill cuttings collected every ten (10) feet or at every change in formation. Description of work and type of testing accomplished, geophysical logging, pumping tests, deviation survey results, and coring results.

(4) Description of any construction problems that develop and their status to include a description of what is being done or has been done to correct the problem.

(5) Description of the amount of salt used.

(6) Results of any water quality analyses performed as required by this permit, including pad monitor wells.

SPECIFIC CONDITIONS:

(7) Copies of the driller's log are to be submitted with the weekly summary.

c. The Department must be notified seventy-two (72) hours prior to all testing for mechanical integrity on the injection well. Testing should begin during daylight hours Monday through Friday.

d. Annotated copies of geophysical logs, lithologic descriptions and logs and water quality data (from drilling and packer tests) must be submitted to TAC, with interpretation, for intermediate and final casing seat selection approvals by the Department.

e. An interpretation of all test results must be submitted with all test data and geophysical logs.

f. After completion of construction and testing, a final report, certified by a P.E. and P.G., shall be submitted to the Department and the TAC. The report shall include, but not be limited to, all information and data collected under Rule 62-528.450(2) and Rule 62-528.450(3), F.A.C., with appropriate interpretations. Mill certificates for the casing(s) shall be included in this report. To the extent possible, the transmissivity of the injection zone and maximum injection rate within safe pressure limits shall be estimated.

6. The construction permit includes a period of temporary injection operation for the purposes of long term testing. Prior to commencement of operational testing:

a. Construction of the injection well shall be complete and the permittee shall submit a notice of completion of construction certified by a P.E. to the Department.

b. Each well shall first be tested for integrity of construction, and shall be followed by a short-term injection test of such duration to allow for the prediction of the operating pressure.

c. The permittee shall submit the following information to each member of the Technical Advisory Committee:

(1) A copy of the borehole television survey(s)

(2) Geophysical logs

(3) Mechanical integrity test data

(4) Data obtained during the short term injection testing conducted pursuant to Rules 62-528.405(3)(a) and 62-528.410(7)(e), and 62-528.450(3)(a)2., F.A.C.

(5) Confining zone data

(6) Background water quality data for the injection and monitor zones

(7) Waste stream analysis

(8) As-built well construction specifications

SPECIFIC CONDITIONS:

(9) Draft operation and maintenance manual with emergency procedures

(10) Other data obtained during well construction needed by the Department to evaluate whether the well will operate in compliance with Department rules.

d. The emergency discharge method shall be fully operational and no emergency discharge shall occur until the permittee has obtained all necessary permits.

e. Any corrective action required under Rule 62-528.300(5)(c)2., F.A.C., has been completed.

f. Written authorization shall be obtained from the Department. Authorization shall be for up to two years or the expiration date of the construction permit, whichever is less, and is nonrenewable. The authorization shall specify the conditions under which operational testing is approved. The authorization shall include:

(1) Injection pressure limitation

(2) Injection flow rate limitation

(3) Monthly specific injectivity testing including pressure fall-off testing

(4) Reporting requirements, and

(5) An expiration date for the operational testing period not to exceed two years.

g. Before authorizing operational testing the Department shall conduct an inspection of the facility to determine if the conditions of the permit have been met.

7. OPERATIONAL TESTING REQUIREMENTS

a. Operational Testing Conditions - Injection Well System

(1) The injection system shall be monitored in accordance with rules 62-528.425(1)(g) and 62-528.430(2), F.A.C.

(2) The effluent from the Key Largo WRF shall be treated with high level disinfection as prescribed by Rules 62-600.440(5)(a) through (f), F.A.C., in accordance with federal regulations in 40 CFR 146.15 and 146.16 governing Class I municipal injection wells in Florida. The following standards shall be met prior to injection:

a. The effluent total suspended solids (TSS) shall be reduced to 5 mg/L or less before the application of the disinfectant. Grab samples are to be taken after filtration and before disinfection.
b. Seventy five (75) percent of the daily fecal coliform values shall be below the detection limit and any single sample shall not exceed 25 per 100 mL in any month.
c. Other high level disinfection requirements are contained in the **Attachment A**, but are not required to be reported under this permit.

SPECIFIC CONDITIONS:

(3) The following injection well performance data shall be recorded and reported at the frequency indicated from the injection well instrumentation in the Monthly Operating Report as indicated below. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

The permittee shall use continuous indicating and recording devices to monitor injection flow rate and injection pressure. In the case of operational failure of any of these instruments for a period of more than 48 hours, the permittee shall report to the Department in writing the remedial action to be taken and the date when the failure will be corrected.

INJECTION WELL IW-1. The proposed specifications for the injection well is as follows:

Casing Diameter (OD)	*Depth (bls) Cased*	*Open Hole (bls)*
46" Steel	220'	
36" Steel	1100'	
28" Steel	1700'	
Nominal 16" O.D. FRP	2750'	2750'-3300'

Injection Well Monitoring Parameters

Parameters	*Reporting Frequency*
Injection Pressure (psi)	Daily/Monthly
Maximum Injection Pressure	Daily/Monthly
Minimum Injection Pressure	Daily/Monthly
Average Injection Pressure	Daily/Monthly
Flow Rate (gpm)	Daily/Monthly
Maximum Flow Rate	Daily/Monthly
Minimum Flow Rate	Daily/Monthly
Average Flow Rate	Daily/Monthly
Total Volume WRF Effluent Injected (gallons)	Daily/Monthly

Injectate Water Quality

WRF Effluent Water Quality

Parameters	*Reporting Frequency*
Ammonia (mg/L)	Monthly
Total Kjeldahl Nitrogen (TKN) (mg/L)	Monthly
Nitrate + Nitrite as N (mg/L)	Monthly
Total Suspended Solids (TSS) (mg/L) *	Daily
Maximum TSS (mg/L) *	Monthly
Average TSS (mg/L) *	Monthly
Fecal Coliform (number/100 mL)	Daily
Fecal Coliform (number/100 mL), Percent Below Detection Limit	Monthly
Fecal Coliform (number/100 mL), Maximum	Monthly

*All TSS samples shall be grab samples. The samples are to be taken after filtration and before disinfection.

SPECIFIC CONDITIONS:

b. Operational Testing Conditions - Monitor Well System.

(1) The monitor well system will consist of two Monitor Wells as described below:

Well Number	*Casing Dia. (OD)*	*Depth (bls) Cased/Total*
UZMW-1 (Upper)	16" Steel	1500'/1550'
LZMW-1 (Lower)	6" Steel	1800'/1900'

(2) All monitor wells shall be monitored in accordance with rule 62-528.425 and 62-528.430, F.A.C. The following monitor well performance data shall be recorded and reported at the frequency indicated from the monitor well instrumentation in the Monthly Operating Report as indicated below. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. The permittee shall use continuous indicating and recording devices to monitor the monitor zone pressures or water levels. In the case of operational failure of any of these instruments for a period of more than 48 hours, the permittee shall report to the Department in writing the remedial action to be taken and the date when the failure will be corrected.

UZMW and LZMW

Parameters	*Reporting Frequency*
Maximum Water Level/Pressure (Ft NAVD or psi)	Daily/Monthly
Minimum Water Level/Pressure (Ft NAVD or psi)	Daily/Monthly
Average Water Level/Pressure	Monthly

Water Quality

Parameters	*Reporting Frequency*
Specific Conductivity (µmhos/cm)	Weekly
Total Dissolved Solids (mg/L)	Weekly
pH (std. units)	Weekly
Chloride (mg/L)	Weekly
Sulfate (mg/L)	Weekly
Field Temperature (°C)	Weekly
Ammonia (mg/L)	Weekly
Total Kjeldahl Nitrogen (TKN) (mg/L)	Weekly
Sodium (mg/L)	Monthly
Calcium (mg/L)	Monthly
Potassium (mg/L)	Monthly
Magnesium (mg/L)	Monthly
Iron (mg/L)	Monthly
Bicarbonate (mg/L)	Monthly

(3) Water quality data may be reduced to monthly analyses after a minimum six months of data if the conditions of Rule 62-528.450(3)(d), F.A.C., have been met and with Department approval.

SPECIFIC CONDITIONS:

c. The permittee shall calibrate all pressure gauge(s), flow meter(s), chart recorder(s), and other related equipment associated with the injection well system on a semi-annual basis. The permittee shall maintain all monitoring equipment and shall ensure that the monitoring equipment is calibrated and in proper operating condition at all times. Laboratory equipment, methods, and quality control will follow EPA guidelines as expressed in Standard Methods for the Examination of Water and Wastewater. The pressure gauge(s), flow meter(s), and chart recorder(s) shall be calibrated using standard engineering methods.

d. The permittee shall submit monthly to the Department the results of all injection well and monitor well data required by this permit no later than the last day of the month immediately following the month of record. The results shall be sent to the Department of Environmental Protection, P.O. Box 2549, Fort Myers, Florida 33902-2549. A copy of this report shall also be sent to the Department of Environmental Protection, Underground Injection Control Program, MS 3530, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.

e. The Engineer of Record or designated qualified representative must be present for the start-up operations and the Department must be notified in writing of the date operational testing commenced for the well.

f. The permit for the Lehigh Acres Domestic Wastewater WWTP shall be modified to allow injection of effluent using high-level disinfection prior to operational testing of this injection well (if not previously modified).

8. ABNORMAL EVENTS

a. In the event the permittee is temporarily unable to comply with any conditions of this permit due to breakdown of equipment, power outages, destruction by hazard of fire, wind, or by other cause, the permittee shall notify the Department. Notification shall be made in person, by telephone or by electronic mail within 24 hours of breakdown or malfunction to the UIC Program staff, South District office.

b. A written report of any noncompliance referenced in 1) above shall be submitted to the South District office within five days after its occurrence. The report shall describe the nature and cause of the breakdown or malfunction, the steps being taken or planned to be taken to correct the problem and prevent its reoccurrence, emergency procedures in use pending correction of the problem, and the time when the facility will again be operating in accordance with permit conditions.

9. EMERGENCY DISPOSAL

a. All applicable federal, state and local permits must be in place to allow for any alternate discharges due to emergency or planned outage conditions.

b. Any changes in emergency disposal methods must be submitted for Technical Advisory Committee (TAC) and USEPA review and Department approval.

c. The permittee shall notify the Department within 24 hours whenever an emergency discharge has occurred (Rule 62-528.415(4)(c)1., F.A.C.). Written notification shall be provided to the

SPECIFIC CONDITIONS:

Department within 5 days after each occurrence. The Permittee shall indicate the location and duration of the discharge and the volume of fluid discharged.

10. FINANCIAL RESPONSIBILITY

a. The permittee shall maintain separately the financial resources necessary to close, plug, and abandon the injection and associated monitor wells, at all times in accordance with Rule 62-528.435(9), F.A.C.

b. The permittee shall update annually the plugging and abandonment cost estimate. A certified (By Professional Geologist or Professional Engineer) copy of the annual update shall be submitted to the Department's Tallahassee UIC Program each year within 60 days after the anniversary date of issuance of this permit to the following addresses:

Underground Injection Control Program
Bureau of Water Facilities Regulation
Department of Environmental Protection
2600 Blair Stone Road, Mail Station #3530
Tallahassee, FL 32399-2400

Underground Injection Control Program
Department of Environmental Protection
South District Office
2295 Victoria Avenue, Ste 364
Ft Myers, FL 33902-2549

c. Upon the occurrence of the annual plugging and abandonment cost estimate exceeding, by 10 percent or more, (Section b. previously), the cost estimate upon which the current financial responsibility is based; the permittee shall submit to the Department certified financial documentation necessary to amend, renew, or otherwise replace the existing financial responsibility pursuant to Rule 62-528.435(9), F.A.C. and the conditions of this permit. Local governments shall include an updated *Certificate of Financial Responsibility* form and the comprehensive annual financial report for the latest completed fiscal year of that local entity.

d. In the event that the mechanism used to demonstrate financial responsibility should become insufficient or invalid for any reason, the permittee shall notify the Department of Environmental Protection in writing within 14 days of such insufficiency or invalidation. The permittee shall within 30 days of said notification submit to the Department for approval new financial documentation certifying either the remedy of current financial insufficiency or resolution of the financial instrument invalidation in order to comply with Rule 62-528.435(9), F.A.C., and the conditions of this permit.

11. MECHANICAL INTEGRITY

a. Injection is prohibited until the permittee affirmatively demonstrates that the well has mechanical integrity. Prior to operational testing the permittee shall establish, and thereafter maintain, mechanical integrity of the well at all times.

b. If the Department determines that the injection well lacks mechanical integrity, written notice shall be given to the permittee.

c. Unless the Department requires the immediate cessation of injection, within 48 hours of receiving written notice from the department that the well lacks mechanical integrity the permittee shall

SPECIFIC CONDITIONS:

cease injection into the well unless the Department allows continued injection pursuant to (d) below.

d. The Department may allow the permittee to continue operation of a well that lacks mechanical integrity if the permittee demonstrates that fluid movement into or between underground sources of drinking water is not occurring.

12. The permittee is reminded of the necessity to comply with the pertinent regulations of any other regulatory agency, as well as any county, municipal, and federal regulations applicable to the project. These regulations may include, but not limited to, those of the Federal Emergency Management Agency in implementing flood control measures. This permit should not be construed to imply compliance with the rules and regulations of other regulatory agencies.

13. The permittee shall be aware of and operate under the general conditions in Rule 62-528.307(1)(a) through (x) and Rule 62-528.307(2)(a) through (f), F.A.C. These general conditions are binding upon the permittee and enforceable pursuant to Chapter 403 of the Florida Statutes.

Note: In the event of an emergency the permittee shall contact the Department by calling (850) 488-1320. During normal business hours, the permittee shall call (239) 332-6975.

Issued this _11_ day of ___Jan____ 2008.

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION

Jon M. Iglehart
Director of District Management

JMI/DR/dr

ATTACHMENT A

Underground Injection Control Systems

1. During the period beginning on the issuance date of the facility domestic wastewater permit and lasting through the expiration date of the facility domestic wastewater permit, the permittee is authorized to discharge effluent to Underground Injection Control System Well IW-1 located at the Key Largo WRF. Such discharge shall be limited and monitored by the permittee as specified below and reported in accordance with the Specific Conditions contained the in facility domestic wastewater permit.

			Effluent Limitations		Monitoring Requirements			
Parameter	Units	Max/Min	Limit	Statistical Basis	Frequency of Analysis	Sample Type	Monitoring Site Number	Notes
Flow	Mgd	Maximum						
BOD, Carbonaceous 5 day, 20C	mg/L	Maximum	20.0 30.0 45.0 60.0	Annual Average Monthly Average Weekly Average Single Sample		Composite as described in the facility domestic waste water permit	As described in the facility domestic waste water permit	
Solids, Total Suspended	mg/L	Maximum	5.0	Single Sample		Grab	Same as Above	
Coliform, Fecal	#/100mL	Maximum	25	Single Sample		Grab	Same as Above	
	Percent	Minimum	75	Percent Less than Detection		Calculated	Same as Above	
pH	s.u.	MinimumMaximum		Single Sample Single Sample		Grab	Same as Above	
Total Residual Chlorine (For Disinfection)	mg/L	Minimum	1.0	Single Sample	Continuous	Grab	Same as Above	

2. Effluent samples shall be taken at the monitoring site locations listed in the facility domestic wastewater permit conditions and as described below:

Monitoring Site Number	Description of Monitoring Site
See Facility permit	As described in the facility wastewater permit
Same as above	Same as above

3. Hourly measurement of pH during the period of required operator attendance may be substituted for continuous measurement unless otherwise noted in the facility domestic wastewater permit.

4. The facility effluent flow measurement shall be as described in the facility domestic wastewater permit

5. To report the "% less than detection," count the number of fecal coliform observations that were less than detection, divide by the total number of fecal coliform observations in the month, and multiply by 100% (round to the nearest integer).

6. Total residual chlorine must be maintained for a minimum contact time of 15 minutes based on peak hourly flow as described in the facility domestic wastewater permit

Sec. 146.15 Class I municipal disposal well alternative authorization in certain parts of Florida.

(a) Existing Class I municipal disposal wells in specific geographic regions as defined in paragraph (f) of this section may continue to inject without violating the regulatory prohibitions in Parts 144 and 146 of this chapter against the movement of injection or formation fluids into a USDW, provided that such wells meet the requirements of this section, even if the Director determines they have caused or may cause fluid movement into a USDW. Nothing in this section excuses such Class I municipal disposal wells from meeting all other applicable State and Federal requirements including 40 CFR 144.12(a).

(b) For purposes of this section, an existing Class I municipal disposal well is defined as a well for which a complete UIC construction permit application was received by the Director on or before December 22, 2005.

(c) For purposes of this section, the determination that a Class I municipal disposal well has caused or may cause movement of injection or formation fluids into a USDW may be made by the Director based on any relevant data available to him/her, including ground water monitoring data generated pursuant to regulatory requirements governing operation of Class I municipal disposal wells.

(d) In order for a Class I municipal disposal well to qualify for authorization to inject pursuant to paragraph (a) of this section, the Owner/Operator of that well shall:

(1) Develop and implement a pretreatment program that is no less stringent than the requirements of Chapter 62-625, Florida Administrative Code, or have no significant industrial users as defined in that chapter.

(2) Treat the injectate using secondary treatment in a manner that is no less stringent than the requirements of Florida Rule 62-600.420(1)(d), and using high-level disinfection in a manner that is no less stringent than the requirements of Florida Rule 62-600.440(5)(a)-(f), within five years after notification by the Director that the well has caused or may cause fluid movement into a USDW.

(e) Where the Director issued such notice for a well prior to December 22, 2005, in order for that well to qualify for authorization to inject pursuant to paragraph (a) of this section, the Owner/Operator shall:

(1) Develop and implement a pretreatment program that is no less stringent than the requirements of Chapter 62-625, Florida Administrative Code, or have no significant industrial users as defined in that chapter; and

(2) Treat the injectate using secondary treatment in a manner that is no less stringent than the requirements of Florida Rule 62-600.420(1)(d), and using high-level disinfection in a manner that is no less stringent than the requirements of Florida Rule 62-600.440(5)(a)-(f), within five years after December 22, 2005.

(f) Authorization to inject wastewater into existing Class I municipal disposal wells pursuant to this section is limited to Class I municipal disposal wells in Florida in the following counties: Brevard, Broward, Charlotte, Collier, Flagler, Glades, Hendry, Highlands, Hillsborough, Indian River, Lee, Manatee, Martin, Miami-Dade, Monroe, Okeechobee, Orange, Osceola, Palm Beach, Pinellas, St. Johns, St. Lucie, Sarasota, and Volusia.

Sec. 146.16 Requirements for new Class I municipal wells in certain parts of Florida.

Prior to commencing injection, any Class I municipal disposal well in one of the counties identified in Sec. 146.15(f) that is not an existing Class I municipal disposal well as defined in Sec. 146.15(b) of this section shall meet all of the requirements for existing wells seeking authorization to inject pursuant to Sec. 146.15.

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Appendix B

Geologic Logs, Drilling Penetration and Weight on Bit Charts, Pilot-Hole Reverse-Air Discharge Water Quality Charts

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
Fill: sand and limerock.		0-2	2.0
SAND, LIMESTONE AND LITTLE ORGANIC MATTER: Sand 50%, yellowish gray (5Y 8/1), calcareous, fine to medium grained, angular to sub-rounded; Limestone, 40%, yellowish gray (5Y 8/1), some light gray (N5), hard, fragments to 2-inches; Organic matter, 10%, brownish black (5YR 2/1), decomposed, some fragments of plants.		2-3	1.0
SAND AND LIMESTONE; Sand, 50%, moderate yellowish brown (10YR 5/4), calcareous, fine- to medium- grained, angular to sub-rounded; Limestone, 50%, yellowish gray (5Y 8/1), some light gray (N5), hard, fragments to 1-inch.		3-5	2.0
SAND, LIMESTONE AND LITTLE CLAY (MARL); Sand, 50%, very light gray (N6), calcareous, very fine- to medium- grained, sub-rounded; Limestone, 40%, yellowish gray (5Y 8/1), fossils fragments (shells), moderately hard, moderately well cemented; Clay, 10%, yellowish gray (5Y 8/1), calcareous (marl), soft, non-plastic, moist to wet.	WOB=5-6K RPM=15	5-15	10.0
SAND, SOME LIMESTONE AND LITTLE SANDSTONE; Sand, 50%, clear, quartz, up to 30% white (N9), calcareous, phosphatic, very fine- to medium- grained, sub-rounded; Limestone, 40%, white (N9), fossiliferous grainstone with occasional shell intraclasts, phosphatic, poorly cemented, soft to very soft, few larger fragments to 5 mm; Sandstone, 10%, very light gray (N8) and clear, quartz with calcareous matrix, phosphatic, fine grained, poorly cemented, soft; Shell, trace, very pale orange (10YR 8/2), fragments 3-5 mm.	WOB=9-10K RPM=28	15-30	15.0
LIMESTONE, SOME SHELL AND LITTLE SAND; Limestone, 70%, white (N9), little yellowish gray (5Y 8/1), oolitic grainstone, fossiliferous, with shell intraclasts (mollusks, corals), slightly phosphatic, moderately well cemented, moderately hard, vuggy; Shell, 20%, white (N9) to medium gray (N5), numerous fragments 3-10 mm, mollusks; Sand, 10%, white (N9) to very light gray (N8), calcareous, very fine- to medium- grained, sub-angular; Phosphate, trace, black, very fine grains.	WOB=9-10K RPM=28	30-40	10
SAND AND SOME LIMESTONE ; Sand, 70%, white (N9), yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), calcareous, very fine- to medium- grained, sub-angular; Limestone, 30%, white (N9), yellowish gray (5Y 8/1) to very light gray (N8), oolitic, very fine- to fine- grained, with little fossils (shell fragments to 2-3 mm), very soft, poorly cemented (fragments 3-5 mm), phosphatic; Clay, trace, yellowish gray, calcareous, chalky, very soft, non- plastic; Phosphate, trace, black, very soft, fine grains.	WOB=9-10K RPM=28	40-60	20
SANDSTONE, SOME SAND AND LIMESTONE; Sandstone, 50%, yellowish gray (5Y 7/2), mostly quartz grains in calcareous matrix, some calcareous nodules, phosphatic, very fine to fine grained, poorly cemented, soft; Sand, 30%, mostly quartz, clear , up to 20% calcareous, yellowish gray (5Y 8/1), very fine- to fine-	WOB=9-10K RPM=28	60-70	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
grained, sub-rounded to sub-angular; Limestone, 20%, very light gray (N8) to white (N9), mudstone, little oolitic, fossiliferous with shell intraclasts, slightly phosphatic, moderately well- to poorly-cemented, moderately hard , vuggy.			
LIMESTONE AND SOME SAND: Limestone, 70%, yellowish gray (5Y 8/1) to white (N9), oolitic grainstone, trace of fossils (1-2 mm shell intraclasts), slightly phosphatic, moderately well- to poorly- cemented, moderately hard , vuggy; Sand, 30%, yellowish gray (5Y 7/2 to 8/1), calcareous, trace quartz, clear, very fine- to medium-grained, sub-angular to sub-rounded	WOB=9-10K RPM=28	70-80	10
SAND AND SOME LIMESTONE; Sand, 70%, yellowish gray (5Y 7/2 to 8/1), mostly calcareous, some (up to 30%) quartz, clear, very fine- to medium-grained, sub-angular to sub-rounded; Limestone, 30%, yellowish gray (5Y 8/1), oolitic grainstone, phosphatic, trace of fossils, poorly cemented, very soft; Clay, trace, white (N9), calcareous, very soft, non plastic.	WOB=12-14K RPM=6-7	80-90	10
SAND; Sand, 100%, clear, quartz, very phosphatic (up to 5% of black phosphate grains), trace calcareous, silty, very fine grained, rounded to sub-rounded, well sorted.	Strong heaving, multiple loses of circulation WOB: 1-2K, RPM: 10-15	90-130	40
SAND AND LITTLE LIMESTONE; Sand, 90%, clear, quartz, little calcareous, phosphatic, very fine grained, sub-rounded, loose; Limestone, 10%, white (N9), trace of fossils, poorly cemented, soft, fragments up to 5 mm.	WOB=1-2K RPM=15 Heaving, rapid mud escape	130-140	10
SAND; Sand, 100%, clear, quartz, very phosphatic (up to 5% of black phosphate grains), trace calcareous, silty, very fine grained, rounded to sub-rounded, well sorted.		140-160	20
SAND; Sand, 100%, clear, quartz, very phosphatic (up to 5% of black phosphate grains), trace calcareous, very silty, very fine grained, rounded to sub-rounded, well sorted; Clay, trace, light olive gray (5Y 6/1), very soft; Shell, trace, very pale orange (10Y 8/2), few tests up to 3mm; Limestone, trace, white (N9), very few small, moderately hard fragments.	WOB=1-2K RPM=15 Heaving, rapid mud escape	160-213	53
SANDY, SILTY CLAY (SILTSTONE); Clay, 70%, dusky yellow green (5GY 5/2), very slightly calcareous, silty, soft to moderately hard, slightly cohesive, low plasticity, trace of black phosphate; Sand, 30%, calcareous, white (N9), very fine to fine grained, sub-rounded;	WOB=1-2K RPM=15	213-214	1
SAND; Sand, 100%, clear, quartz, very phosphatic (up to 5% of black phosphate grains), trace calcareous, very silty, very fine grained, rounded to sub-rounded, well sorted; Clay, trace, light olive gray (5Y 6/1), very soft, non plastic, cohesive; Shell, trace, very pale orange (10Y 8/2), few tests up to 3mm; Limestone, trace, white (N9), single small fragments.	WOB=1-2K RPM=15 Heaving, rapid mud escape	214-222	8
SAND, SOME SANDSTONE, VERY LITTLE FOSSILS AND LIMESTONE; Sand, 60%, clear, quartz, very phosphatic (up to 5% of black phosphate grains), trace calcareous, silty, very fine grained,	WOB=1-2K RPM=15	222-227	5

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
rounded to sub-rounded, well sorted; Sandstone, 30%, light gray (N7), quartz grains in mostly calcareous matrix, phosphatic, with shell intraclasts, very fine grained, poorly- to moderately well-cemented; Fossils, 5%, mostly shell fragments, few whole (up to 5 mm), mollusks, occasional coral fragments; Limestone, 5%, very light gray (N8) to medium dark gray (N4), slightly fossiliferous mudstone, with quartz grains and few shell intraclasts, poorly cemented, soft, more competent material near the bottom of this layer.			
SILTSTONE AND SOME SAND; Siltstone, 70%, medium light gray (N6), with mostly quartz grains, phosphatic, poorly-to moderately well-cemented, brittle; Sand, 30%, clear, quartz, phosphatic, very fine grained, sub-rounded to rounded.	WOB=1-2K RPM=15	227-240	13
SILTY SAND; Sand, 100%, clear, quartz, little calcareous, very silty, phosphatic, very fine grained, sub-rounded to rounded; Siltstone, trace, medium light gray (N6).	WOB=1-2K RPM=15	240-250	10
SILTY SAND, SOME SILTSTONE AND VERY LITTLE SHELL; Sand, 75%, clear, quartz and yellowish gray (5Y 8/1), calcareous, very silty, phosphatic, very fine- to fine -grained, rounded to angular, poorly sorted; Siltstone, 20%, medium light gray (N6) with mostly calcareous grains, phosphatic, poorly cemented, very soft; Shell, 5%, yellowish gray (5Y 8/1), small tests up to 2 mm.	WOB=1-2K RPM=15	250-300	50
SILTY SAND; Sand, 100%, clear, quartz, phosphatic, little calcareous, very silty, very fine grained, sub-rounded to rounded; Siltstone, trace, medium light gray (N6). Trace of very soft clay at the bottom.	WOB=3-4K RPM=17	300-330	30
SAND, SILT AND VERY LITTLE CLAY; Sand, 50%, clear, quartz, trace of calcareous, slightly phosphatic, very fine grained, sub-rounded to rounded; Silt, 45%, medium light gray (N6); Clay, 5%, greenish gray (5GY 6/1), very soft, cohesive, non plastic.	WOB=3-4K RPM=17	330-360	30
SANDY CLAY; Clay, 70%, dark greenish gray (5G 4/1), slightly calcareous, phosphatic, soft to very soft, cohesive, low to medium plasticity; Sand, 30%, quartz, clear, very little calcareous, very pale orange (10YR 8/2), very fine grained, sub-rounded to sub-angular.	WOB=10K RPM=25	360-410	50
CLAYEY SAND; Sand, 85%, clear, quartz, phosphatic, trace calcareous, silty, very fine- to fine- grained, rounded to sub-rounded, well sorted; Clay (Marl), 15%, light olive gray (5Y 6/1), very soft, cohesive, low plasticity.	WOB=10K RPM=25	410-430	20
SANDY CLAY; Clay, 70%, greenish gray (5GY 6/1), slightly calcareous, phosphatic, very soft, cohesive, non-plastic; Sand, 30%, quartz, clear, little calcareous, very pale orange (10YR 8/2), phosphatic, very fine- to fine- grained, rounded to sub-rounded; Shell, trace, very pale orange (10YR 8/2), small tests to 2 mm.	WOB=10K RPM=25	430-440	10
LIMESTONE AND CLAYEY SAND; Limestone, 70%, yellowish gray (5Y 8/1) to medium gray (N5), fossiliferous grainstone with shell and coral intraclasts, phosphatic, poorly- to moderately well-cemented, soft to moderately hard; Sand, 20%, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), calcareous, little quartz, clear,	WOB=10K RPM=25	440-450	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
very fine- to medium- grained, sub-angular to sub-rounded; Clay (Marl), 10%, pale olive (10Y 6/2), calcareous, very soft, cohesive, non-plastic; Shell, trace, tests to 5-10 mm, mollusks.			
SANDY CLAY (MARL) AND SOME LIMESTONE; Clay (Marl), 50%, yellowish gray (5Y 8/1) to greenish gray (5G 6/1), mostly calcareous, phosphatic, chalky, very soft, cohesive, non plastic; Sand, 30%, yellowish gray (5Y 8/1), calcareous, trace of quartz, phosphatic, very fine to medium grained, sub-angular; Limestone, 20%, yellowish gray (5Y 8/1) to medium light gray (N6), fossiliferous grainstone with shell intraclasts, slightly phosphatic, poorly cemented, very soft, vuggy.	WOB=10K RPM=25	450-470	20
LIMESTONE AND LITTLE CLAY(MARL); Limestone, 90%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, fossiliferous with some shell intraclasts, slightly phosphatic, very fine- to fine- grained, poorly- to moderately well-cemented, very soft to soft, (mostly in a form of calcareous sand), vuggy; Clay (Marl), 10%, pale olive (10Y 6/2), calcareous, phosphatic, very soft, cohesive, non plastic; Chert, trace, black (N1), fragments to 5 mm, very hard.	WOB=10-13K RPM=25	470-540	70
LIMESTONE AND SOME SHELL; Limestone, 70%, yellowish gray (5Y7/2), very fossiliferous, mudstone, some grainstone with abundant shell intraclasts, phosphatic, poorly- to moderately-well cemented, soft to moderately hard, slightly vuggy; Shell, 30%, very pale orange (10YR 8/2) to yellowish gray (5Y 8/1), mostly small tests to 3 mm, frequent large fragments to 1.5-inch, mollusks; Clay (Marl), trace, yellowish gray (5Y 7/2), calcareous, very soft, cohesive, non plastic; Sand, trace, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), calcareous, very fine- to medium- grained, sub-angular.	WOB=10-13K RPM=25	540-560	20
LIMESTONE AND LITTLE CLAY(MARL); Limestone, 90%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, fossiliferous with some shell intraclasts (mollusks), slightly phosphatic, very fine- to fine- grained, poorly- to moderately well-cemented, very soft to soft (mostly in a form of calcareous sand), vuggy; Clay (Marl), 10%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, phosphatic, very soft, cohesive, non plastic.	WOB=10-13K RPM=25	560-570	10
LIMESTONE AND SOME CLAY(MARL); Limestone, 70%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, fossiliferous with some shell intraclasts (mollusks), phosphatic, very fine- to fine- grained, poorly cemented, very soft to soft (mostly in a form of calcareous sand), vuggy; Clay (Marl), 30%, pale olive (10Y 6/2), calcareous, phosphatic, very soft, cohesive, non plastic.	WOB=10-13K RPM=25	570-600	30
SAND AND CLAY (MARL); Sand, 60%, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), calcareous, with few larger limestone fragments to3 mm, and shell tests, slightly phosphatic, very fine- to coarse- grained; Clay (Marl), 40%, yellowish gray (5Y	WOB=10-13K RPM=25	600-630	30

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
8/1) to pale olive (10Y 6/2), calcareous, very soft, cohesive, non plastic.			
LIMESTONE AND SOME CLAY(MARL); Limestone, 70%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, fossiliferous with some shell intraclasts, phosphatic, very fine- to fine- grained, poorly cemented, very soft to soft, (mostly in a form of calcareous sand), vuggy; Clay (Marl), 30%, pale olive (10Y 6/2), calcareous, phosphatic, very soft, cohesive, non plastic.	WOB=12-15K RPM=25	630-660	30
SAND AND CLAY (MARL);Sand, 60%, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), calcareous, with few larger limestone fragments to3 mm and shell tests, slightly phosphatic, very fine- to coarse- grained; Clay (Marl), 40%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, very soft, cohesive, non plastic.	WOB=12-15K RPM=25	660-670	10
LIMESTONE AND SOME CLAY (MARL); Limestone, 70%, yellowish gray (5Y 7/2), oolitic grainstone, slightly fossiliferous with some shell intraclasts, phosphatic, very fine- to fine-grained, poorly cemented, very soft, mostly in a form of calcareous sand with larger fragments to3 mm, vuggy; Clay (Marl), 30%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, phosphatic, very soft, cohesive, non plastic.	WOB=10-12K RPM=27	670-700	30
LIMESTONE AND LITTLE CLAY(MARL); Limestone, 90%, yellowish gray (5Y 7/2), oolitic grainstone, fossiliferous with some shell intraclasts, slightly phosphatic, very fine- to fine- grained, poorly- to moderately well-cemented, very soft to moderately hard, vuggy; Clay (Marl), 10%, yellowish gray (5Y 8/1), calcareous, phosphatic, cohesive, very soft, non plastic.	WOB=10-12K RPM=27	700-710	10
LIMESTONE , CLAY (MARL) AND SAND; Limestone, 40%, yellowish gray (5Y 8/1 and 5Y 7/2), fossiliferous grainstone and mudstone, with shell intraclasts, partly slightly dolomitic, very soft to soft, poorly cemented; Sand, 30%, very pale orange (10YR 8/2), calcareous, very fine- to medium- grained, sub-angular; Clay (Marl), 30%, pale olive (10Y 6/2) to yellowish gray (5Y 8/1), calcareous, very phosphatic, very soft, cohesive, non plastic; Shell, trace, very pale orange (10YR 8/2) to yellowish gray (5Y 8/1), mostly small tests up to 3 mm.	WOB=18-20K RPM=27	710-800	90
SAND; Sand, 100%, yellowish gray (5Y 8/1to 5Y 7/2), calcareous, product of disintegrated oolitic limestone, with few shell fragments to 2 mm, trace of phosphate, very fine- to coarse- grained, sub-rounded; Clay (Marl), trace, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, very soft,.	WOB=8-10K RPM=25	800-830	30
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2) to light gray (N7), mostly oolitic, fossiliferous grainstone, with some shell fragments to 2-3 mm, some microcrystalline, trace of phosphate, very fine- to medium-grained, poorly cemented, very soft to soft, but better indurated than above, mostly in a form of calcareous sand; Clay (marl), trace, yellowish gray (5Y 8/1), calcareous, very soft.	WOB=8-10K RPM=25	830-840	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
SAND AND LITTLE CLAY(MARL);SAND, 90%, yellowish gray (5Y 7/2), calcareous, product of disintegrated oolitic limestone, with few shell fragments to 2 mm, trace of phosphate, very fine- to coarse- grained, sub-rounded; Clay (Marl), 10%, yellowish gray (5Y 8/1), calcareous, phosphatic, very soft, cohesive, non plastic.	WOB=8-10K RPM=25	840-860	20
CALCAREOUS SAND AND CLAY (MARL);Sand, 60%, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), calcareous, with few larger limestone fragments to3 mm, trace of phosphate, very fine- to coarse- grained; Clay (Marl), 40%, yellowish gray (5Y 8/1 to 5Y7/2), calcareous, very soft, cohesive, non plastic.	WOB=8-10K RPM=25	860-870	10
LIMESTONE AND SOME CLAY (MARL); Limestone, 70%, yellowish gray (5Y 7/2), oolitic grainstone, slightly fossiliferous with some shell intraclasts, phosphatic, very fine- to fine-grained, poorly cemented, very soft, mostly in a form of calcareous sand with larger fragments to3 mm, vuggy; Clay (Marl), 30%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, phosphatic, very soft, cohesive, non plastic.	WOB=8-10K RPM=25	870-890	20
CALCAREOUS SAND AND SOME CLAY; Sand, 70%, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), calcareous, with few larger limestone fragments to3 mm, trace of phosphate, very fine- to coarse- grained; Clay, 30%, greenish gray (5GY 6/1) slightly calcareous, very soft, cohesive, non plastic.	WOB=8-10K RPM=25	890-900	10
SAND AND LITTLE CLAY; Sand, 90%, yellowish gray (5Y 8/1to 5Y 7/2), calcareous, product of disintegrated oolitic limestone, with trace of shell, fragments to 2 mm, trace of phosphate, very fine- to fine- grained, sub-rounded to sub-angular, few fragments of limestone to 5 mm; Clay (Marl), 10%, yellowish gray (5Y 7/2) to pale olive (10Y 6/2), calcareous, very soft, non plastic,.	WOB=15-20K RPM=27	900-950	50
SANDY CLAY; Clay, 60%, light olive gray (5Y 7/3), partly calcareous, very soft to soft, low plasticity, slightly cohesive; Sand, 40%, calcareous, fine- to medium- grained, sub-angular; Limestone, trace, yellowish gray (5Y 7/2), oolitic grainstone, few fragments to 4 mm, poorly cemented, soft.	WOB=15-20K RPM=27	950-960	10
CLAY; Clay, 100%, pale olive (5Y 6/4), slightly calcareous, very soft, cohesive, low plasticity, trace of calcareous sand, very fine grained.	WOB=15-20K RPM=27	960-980	20
SANDY CLAY (MARL) AND LITTLE LIMESTONE; Clay (Marl), 50%, yellowish gray (5Y 7/2), calcareous, chalky, trace of phosphate, soft, cohesive, non plastic; Sand, 40%, yellowish gray (5Y 7/2 and 5Y 8/1), calcareous, very fine- to medium- grained, sub-angular; Limestone, 10%, yellowish gray (5Y 8/1), oolitic grainstone and arenaceous packstone, fossiliferous with abundant shell intraclasts, very fine grained, moderately well cemented, soft to moderately hard, vuggy.	WOB=15-20K RPM=27	980-1000	20
SAND AND LITTLE CLAY (MARL); Sand, 90%, yellowish gray (5Y 8/1to 5Y 7/2), calcareous, product of disintegrated oolitic limestone, with trace of shell, fragments to 2 mm, trace of	WOB=15-20K RPM=27	1000-1010	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
phosphate, very fine- to fine- grained, sub-rounded to sub-angular, few fragments of limestone to 5 mm; Clay (Marl), 10%, yellowish gray (5Y 7/2) to pale olive (10Y 6/2), calcareous, very soft, cohesive, non plastic,.			
CLAY; Clay, 100%, pale olive (5Y 6/4), slightly calcareous, very soft, low plasticity, cohesive, trace of calcareous sand, very fine grained.	WOB=15-20K RPM=27	1010-1030	20
SANDY CLAY (MARL) AND SOME LIMESTONE; Clay (Marl), 40%, yellowish gray (5Y 7/2), calcareous, chalky, trace of phosphate, very soft, cohesive, non plastic; Sand, 40%, yellowish gray (5Y 7/2 and %Y 8/1), calcareous, very fine- to medium-grained, sub-angular; Limestone, 20%, yellowish gray (5Y 8/1), oolitic grainstone and arenaceous packstone, fossiliferous with abundant shell intraclasts, very fine grained, moderately well cemented, soft to moderately hard, vuggy.	WOB=10K RPM=27	1030-1040	10
CLAY AND VERY LITTLE LIMESTONE; Clay, 95%, pale olive (10Y 6/2), slightly calcareous, with trace of calcareous, very fine grained sand, very soft, low plasticity to non plastic; Limestone, 5%, yellowish gray (5Y 7/2), packstone, fossiliferous, with shell intraclasts, poorly cemented, very soft.	WOB=10K RPM=27	1040-1050	10
LIMESTONE AND SOME CLAY (MARL); Limestone, 70%, pale yellowish brown (10YR 7/4), fossiliferous packstone, arenaceous, with abundant shell intraclasts, some yellowish gray (5Y 7/2) oolitic grainstone, trace of phosphate, very fine grained, poorly- to moderately well- cemented, vuggy, up to 30% in form of calcareous sand; Clay (Marl), 30%, pale yellowish brown (10YR 7/4), calcareous, very soft, cohesive, non plastic.	WOB=10K RPM=27	1050-1060	10
LIMESTONE AND LITTLE CLAY (MARL); Limestone, 90%, pale yellowish brown (10YR 7/4), fossiliferous packstone, arenaceous, with abundant shell intraclasts, little yellowish gray (5Y 7/2), oolitic grainstone, trace of phosphate, very fine grained, moderately well cemented, moderately hard, vuggy, little sandy; Clay (Marl), 10%, pale yellowish brown (10YR 7/4), calcareous, very soft, cohesive, non plastic.	WOB=10K RPM=27	1060-1070	10
SAND AND SOME CLAY (MARL); Sand, 70%, yellowish gray (5Y 7/2) to pale yellowish brown (10YR 7/4), calcareous, product of disintegrated oolitic limestone, trace of phosphate, very fine- to coarse- grained; Clay (Marl), 30%, yellowish gray (5Y 7/2), trace greenish gray (5GY 6/1), calcareous, very soft, cohesive, non plastic.	WOB=10K RPM=27	1070-1120	50
SAND AND LITTLE CLAY (MARL); Sand, 90%, yellowish gray (5Y 8/1to 5Y 7/2), calcareous, product of disintegrated oolitic limestone, trace of shell, fragments to 2 mm, trace of phosphate, very fine- to fine- grained, sub-rounded to sub-angular, few fragments of limestone to 5 mm; Clay (Marl), 10%, yellowish gray (5Y 7/2) to pale olive (10Y 6/2), calcareous, very soft, slightly cohesive, non plastic.	WOB=10K RPM=27	1120-1150	30
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2) to pale		1150-1160	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
yellowish brown (10YR 6/2), fossiliferous mudstone and packstone, little grainstone, numerous shell intraclasts, moderately well cemented, moderately hard, vuggy, trace of phosphate, partly in form of calcareous sand, fine- to coarse- grained; Clay, trace, yellowish gray (5Y 7/2), very soft.			
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2) to pale yellowish brown (10YR 6/2), grainstone and packstone, very fossiliferous, numerous shell fragments and intraclasts (bivalves, corals), slightly dolomitic and calcitic, fine grained, very little light gray (N7), microcrystalline, moderately well cemented, moderately hard, very vuggy to porous.	WOB=8-10K RPM=22	1160-1170	10
LIMESTONE AND LITTLE DOLOSTONE; Limestone, 90%, pale yellowish brown (10YR 6/2), some yellowish gray (5Y 7/2), grainstone and packstone, very fossiliferous with numerous shells (mostly fragments and shell intraclasts to 5mm), slightly dolomitic and calcitic, moderately well cemented, moderately hard, very vuggy to porous; Dolostone, 10%, yellowish gray (5Y 7/2), fine crystalline, slightly vuggy, well cemented, hard.	WOB=8-10K RPM=22	1170-1190	20
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2) to pale yellowish brown (10YR 6/2), grainstone and packstone, very fossiliferous with numerous shell fragments and intraclasts (bivalves, corals), slightly dolomitic and calcitic, very little light gray (N7) and microcrystalline, poorly- to moderately well-cemented, soft to moderately hard, some in a form of calcareous sand, very vuggy to porous.	WOB=8-10K RPM=22	1190-1220	30
LIMESTONE AND SOME DOLOSTONE; Limestone, 80%, pale yellowish brown (10YR 6/2), little yellowish gray (5Y 7/2), grainstone and packstone, very fossiliferous with numerous shell fragments and shell intraclasts to 5mm, dolomitic and calcitic, moderately well cemented, moderately hard, very vuggy to porous; Dolostone, 20%, pale yellowish brown (10YR 6/2), fine crystalline, slightly vuggy, well cemented, hard.	WOB=8-10K RPM=22	1220-1250	30
LIMESTONE AND SOME DOLOSTONE; Limestone, 70%, pale yellowish brown (10YR 6/2), grainstone and packstone, very fossiliferous with numerous shell fragments and shell intraclasts to 5 mm, dolomitic with calcitic matrix, moderately well- to poorly-cemented, soft to moderately hard, some in a form of calcareous sand, very vuggy to porous; Dolostone, 30%, pale yellowish brown (10YR 6/2), fine crystalline, slightly vuggy, well cemented, hard.	WOB=1-2K RPM=20	1250-1270	20
CALCAREOUS AND DOLOMITIC SAND; Sand, 100%, pale yellowish brown (10YR 6/2) to yellowish gray (5Y 7/2), product of poorly cemented, weathered oolitic limestone and dolostone , fine- to medium- grained.	WOB=<1K RPM=20	1270-1290	20
DOLOSTONE AND LITTLE LIMESTONE; Dolostone, 90%, light gray (N7) to medium gray (N6), fine-to micro-crystalline, moderately well cemented, moderately hard, slightly vuggy; Limestone, 10%, pale yellowish brown, packstone, fossiliferous	WOB=1-2K RPM=20	1290-1320	30

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
with shell intraclasts, poorly cemented, soft, vuggy; Clay, trace, medium gray (N6), soft, non-plastic.			
CALCAREOUS AND DOLOMITIC SAND; Sand, 100%, pale yellowish brown (10YR 6/2) to yellowish gray (5Y 7/2), product of poorly cemented, weathered oolitic limestone and dolostone , fine- to medium- grained.	WOB=<1K RPM=20	1320-1330	10
CALCAREOUS SAND; Sand, 100%, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), calcareous, very fine- to medium-grained, product of disintegrated oolitic limestone.	WOB=1-2K RPM=20	1330-1340	10
LIMESTONE: Limestone, 100%, very light gray (N8) to light gray (N7), oolitic grainstone, little fine crystalline and dolomitic, chalky, mostly in a form of calcareous sand, trace of fossils, poorly- to moderately well- cemented; Clay, trace, medium gray (N6), calcareous, soft, non-plastic.	WOB=1K RPM=20	1340-1350	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2) to pale yellowish brown (10YR 6/2), very fossiliferous, oolitic grainstone , slightly dolomitic, with numerous shell intraclasts and trace of forams, poorly- to moderately well- cemented, very soft to soft, some in a form of calcareous sand, vuggy .	WOB=1K RPM=20	1350-1370	20
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2 and 5Y 8/1) , oolitic grainstone, fine grained, with trace of fossils, very soft to soft, poorly cemented, mostly in a form of calcareous sand, vuggy; Dolostone, trace, light gray (N7) to medium gray (N6), microcrystalline, moderately well cemented, moderately hard.	WOB=1K RPM=20	1370-1410	40
CALCAREOUS SAND; Sand, 100%, pale yellowish brown (10YR 6/2) to yellowish gray (5Y 7/2), product of poorly cemented, weathered oolitic limestone, trace of forams and trace of shell fragments, calcitic, fine- to medium- grained, few fragments to 10 mm.	WOB=<1K RPM=22	1410-1460	50
LIMESTONE; Limestone, 100%, yellowish gray (5Y 8/1), little pale yellowish brown (10YR 6/2), slightly dolomitic, fine crystalline, little oolitic grainstone, very fine- to fine- grained, moderately well cemented, moderately hard.	WOB=1-2K RPM=22	1460-1480	20
CALCAREOUS AND DOLOMITIC SAND; Sand, 100%, pale yellowish brown (10YR 6/2), product of poorly cemented, weathered oolitic limestone and dolostone, containing trace of shell fragments, fine grained.	WOB=<1K RPM=22	1480-1490	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), packstone, little oolitic grainstone, very fine- to fine- grained, moderately well- to poorly-cemented, vuggy, soft, up to 20% in a form of calcareous sand.	WOB=<K RPM=22	1490-1500	10
LIMESTONE; Limestone, 100%, pale yellowish brown (10YR 6/2) to yellowish gray (5Y 7/2), oolitic grainstone, some packstone, very fine- to fine- grained, vuggy, poorly-cemented, soft to very soft, up to 60% in a form of calcareous sand.	WOB=<1K RPM=22	1500-1520	20
LIMESTONE AND SOME DOLOSTONE; Limestone, 75%, yellowish gray (5Y 8/1), fine-to micro-crystalline, dolomitic,	WOB=4-5K RPM=22	1520-1530	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
moderately well cemented, moderately hard; Dolostone, 25%, pale yellowish brown (10YR 6/2), microcrystalline, hard.			
LIMESTONE AND LITTLE DOLOSTONE; Limestone,90% , yellowish gray (5Y 7/2), packstone, poorly cemented, soft, up to 60% in a form of calcareous sand; Dolostone, 10%, pale yellowish brown (10YR 6/2), microcrystalline, hard.	WOB=2K RPM=22	1530-1540	10
CALCAREOUS SAND; Sand, 100%, pale yellowish brown (10YR 6/2) to yellowish gray (5Y 7/2), product of poorly cemented, weathered oolitic limestone, trace of fossils (shell fragments), fine- to medium- grained, few fragments to 10 mm.	WOB=<1K RPM=22	1540-1550	10
LIMESTONE; Limestone, 100%, pale yellowish brown (10YR 6/2) to yellowish gray (5Y 7/2), oolitic grainstone, some packstone, trace of fossils (shall fragments), very fine- to fine- grained, vuggy, poorly-to moderately well-cemented, very soft to moderately hard, up to 30% in a form of calcareous sand.	WOB=2K RPM=22	1550-1560	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 8/1), oolitic grainstone, trace of fossils (shell fragments) and trace of phosphate, very fine- to fine- grained, moderately well cemented, moderately hard, slightly vuggy, soft.	WOB=2-4K RPM=22	1560-1570	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, trace of fossils, trace of phosphate, very fine- to fine-grained, very soft to moderately hard, poorly- to moderately- well cemented, some in a form of calcareous sand, few fragments to10 mm, up to 10% of light olive gray (5Y 6/1), dolomitic, fine crystalline, moderately hard, moderately well cemented, slightly vuggy.	WOB=1-2K RPM=22	1570-1590	20
CALCAREOUS SAND; Sand, 100%, pale yellowish brown (10YR 6/2) to yellowish gray (5Y 7/2), product of poorly cemented, weathered oolitic limestone, trace of fossils (shell fragments), very fine- to fine- grained, few fragments to 10 mm.	WOB=1-2K RPM=22	1590-1600	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 8/1), oolitic grainstone, trace of fossils (shell fragments) and trace of phosphate, very fine- to fine- grained, moderately well cemented, moderately hard, slightly vuggy, soft.	WOB=2-4K RPM=22	1600-1610	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), little pale yellowish brown (10YR 6/2), oolitic grainstone, trace of fossils (shall fragments), very fine- to fine- grained, vuggy, poorly-to moderately well-cemented, very soft to moderately hard, up to 30% in a form of calcareous sand	WOB=1-2K RPM=22	1610-1630	20
LIMESTONE AND SOME DOLOSTONE: Limestone, 80%, yellowish gray (5Y 7/2) and pale yellowish brown (10YR 6/2), oolitic grainstone, trace of fossils and trace of phosphate, fine grained, poorly- to moderately well- cemented, up to 40% in a form of calcareous sand, vuggy; Dolostone, 20%, pale yellowish brown fine crystalline, hard.	WOB=2-4K RPM=22	1630-1670	40
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), oolitic grainstone, trace of fossils and trace of phosphate, fine grained, poorly cemented, soft to very soft;	WOB=2-4K RPM=22	1670-1710	40

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
Dolostone, 30%, pale yellowish brown (10YR 6/2), fine- and micro-crystalline, hard , up to 70% in a form of calcareous and dolomitic sand.			
LIMESTONE AND SOME DOLOSTONE: Limestone, 80%, pale yellowish brown (10YR 6/2), little yellowish gray (5Y 7/2), dolomitic, fine crystalline, some oolitic grainstone, trace of fossils (shell fragments), trace of phosphate, poorly- to moderately well-cemented, moderately hard to very soft, up to 30% in a form of calcareous sand; Dolostone, 20%, medium gray (N5) and pale yellowish brown (10YR 6/2), microcrystalline, hard.	WOB=10-15K RPM=22	1710-1720	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), dolomitic, fine crystalline, some oolitic grainstone, trace of fossils (shell fragments), trace of phosphate, moderately well- cemented, moderately hard to soft, up to 10% in a form of calcareous sand; Dolostone, 10%, pale yellowish brown (10YR 6/2), microcrystalline, hard.	WOB=15K RPM=22	1720-1725	5
LIMESTONE AND DOLOSTONE: Limestone, 50%, yellowish gray (5Y 7/2), partly dolomitic, fine crystalline, some oolitic grainstone, trace of fossils (shell fragments), trace of phosphate, moderately well- to poorly- cemented, moderately hard to soft, some in a form of calcareous sand; Dolostone, 50%, pale yellowish brown (10YR 6/2), microcrystalline, hard to very hard, vuggy.	WOB=15-20K RPM=22 Core # 1 interval (1729-1745 ft bpl)	1725-1760	35
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, little fine crystalline, some pale yellowish brown (10YR 6/2) mudstone, very fine grained, trace of fossils (small shell fragments), poorly- to moderately- well cemented, very soft to moderately hard, some in a form of calcareous sand, few fragments to 4-10 mm.	WOB=7-10K RPM=18	1760-1780	20
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, trace of pale yellowish brown (10YR 6/2),fine crystalline, very fine- to fine- grained, vuggy, poorly cemented, very soft to soft, up to 50% in a form of calcareous sand. Slightly more competent in the interval 1800-1810 ft bpl.	WOB=8-10K RPM=18	1780-1820	40
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, some fine crystalline and dolomitic, poorly- to moderately- well cemented, soft to moderately hard, frequent fragments to 0.3-0.5-inch.	WOB=8-10K RPM=18	1820-1840	20
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone and fine crystalline, poorly- to moderately well-cemented, soft to moderately hard, few fragments 2-10 mm, some in a form of calcareous sand; Dolostone, trace, olive gray (5Y 5/6) with lighter calcareous grains, fine crystalline, hard, very vuggy.	WOB=8-10K RPM=18	1840-1850	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 80%, yellowish gray (5Y 7/2), packstone, some mudstone, pale yellowish brown (10YR 6/2), partly dolomitic, moderately well- to well-cemented, moderately hard to hard; Dolostone, 20%, pale yellowish brown (10YR 6/2), with calcareous, yellowish gray (5Y 7/2), irregular intraclasts, fine- to micro- crystalline, hard, vuggy.	WOB=15K RPM=18	1850-1858	8

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
LIMESTONE: Limestone,100%, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), packstone, some mudstone, slightly dolomitic, very fine- to fine- grained, some fine crystalline, trace of fossils (shell fragments to 3 mm) and trace of phosphate, with numerous, irregular, horizontal laminas of darker material, slightly vuggy, moderately well- to well- cemented, moderately hard.	Core #2 in the interval 1858-1873 ft bpl.	1858-1867	9
DOLOSTONE: Dolostone, 100%, yellowish gray (5Y 7/2), microcrystalline, competent, massive, with brighter, irregular calcareous intraclasts, hard to very hard, with some vugs, from 1869 ft bpl gradually becoming light olive gray (5Y 5/2), fine crystalline, with numerous small calcareous inserts, less competent, disintegrating at the bottom and vuggy to very vuggy.	WOB=10-15K RPM=21	1867-1873	6
DOLOSTONE AND SOME LIMESTONE: Dolostone, 70%, dark yellowish brown (10YR 4/2), very fine- to micro-crystalline with irregular, yellowish gray (5Y 7/2) calcareous intraclasts, slightly phosphatic, moderately hard to hard, vuggy; Limestone, 30%, yellowish gray (5Y 7/2), packstone, some oolitic grainstone, phosphatic, very fine- to fine- grained, poorly cemented, very soft, mostly in a form of calcareous sand.	WOB=10K RPM=21	1873-1880	7
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), packstone and grainstone, phosphatic, fine grained , poorly cemented, very soft, mostly in a form of calcareous sand; Dolostone, 10%, dark yellowish brown (10YR 4/2), very fine- to fine- crystalline with irregular, yellowish gray (5Y 7/2) calcareous intraclasts, slightly phosphatic, moderately hard to soft, vuggy; Clay, trace, yellowish gray (5Y 7/2), calcareous, very soft, non plastic.	WOB=7K RPM=21	1880-1890	10
DOLOSTONE AND LITTLE LIMESTONE: Dolostone, 90%, dark yellowish brown (10YR 4/2), very fine- to micro- crystalline with irregular, yellowish gray (5Y 7/2) calcareous intraclasts, slightly phosphatic, moderately hard to hard, vuggy; Limestone, 10%, yellowish gray (5Y 7/2), packstone, some oolitic grainstone, phosphatic, very fine- to fine- grained, poorly cemented, very soft, mostly in a form of calcareous sand.	WOB=7K RPM=21	1890-1900	10
DOLOSTONE AND LITTLE LIMESTONE: Dolostone, 90%, moderate yellowish brown (10YR 5/2), little pale yellowish brown (10YR 6/2), very fine crystalline, slightly phosphatic, moderately hard to hard; Limestone, 10%, yellowish gray (5Y 7/2), packstone, slightly phosphatic, fine grained, poorly cemented, very soft to soft, some in a form of calcareous sand.	WOB=7K RPM=21	1910-1920	10
DOLOSTONE AND SOME LIMESTONE: Dolostone, 70%, moderate yellowish brown (10YR 5/2), light olive gray (5Y 5/2) and medium gray (N5), very fine- to micro- crystalline, slightly phosphatic, moderately hard to hard, some vuggy; Limestone, 30%, yellowish gray (5Y 7/2), grainstone and packstone, very fine- to fine- grained, poorly cemented, soft, little in a form of calcareous sand.	WOB=7K RPM=21	1920-1930	10
DOLOSTONE AND LITTLE LIMESTONE: Dolostone, 90%, light	WOB=7K	1930-1960	30

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
gray (N7) to dark gray(N4), little moderate yellowish brown (10YR 5/2) and light olive gray (5Y 5/2) , very fine- to micro- crystalline, slightly phosphatic, moderately hard to hard, vuggy; Limestone, 10%, yellowish gray (5Y 7/2), grainstone and packstone, very fine- to fine- grained, poorly cemented, soft, little in a form of calcareous sand.	RPM=21		
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 8/1), grainstone, oolitic, some arenaceous, fine- to medium- grained, slightly phosphatic, trace of fossils, soft to moderately hard, poorly- to moderately well- well cemented; Dolostone, 30%, yellowish gray (5Y 7/2), microcrystalline, competent, massive, with brighter, irregular calcareous intraclasts, hard to very hard, with some vugs	Core No. 3 interval from 1980 to 1995 ft bpl.	1960-2000	40
LIMESTONE: Limestone, 100%, yellowish gray (5Y 8/1) to pale yellowish brown (10YR 6/2), oolitic and arenaceous grainstone, fine grained, slightly phosphatic, poorly cemented, very soft, mostly in a form of calcareous sand, few small fragments (3-10 mm) of moderately hard.	WOB=7K RPM=19	2000-2040	40
LIMESTONE AND SOME DOLOSTONE: Limestone, 80%, yellowish gray (5Y 7/2), some pale yellowish brown (10YR 6/2), mostly oolitic grainstone, fine grained, trace of phosphate, poorly- to moderately well-cemented, very soft to soft, some a form of calcareous sand, frequent fragments 5-10 mm; Dolostone, 20%, pale yellowish brown (10YR 6/2), with trace of phosphate, microcrystalline, moderately hard, slightly vuggy.	WOB=7K RPM=19	2040-2070	30
LIMESTONE AND DOLOSTONE: Limestone, 60%, yellowish gray (5Y 7/2), oolitic, arenaceous grainstone, fine grained, with calcite spar, slightly phosphatic, seldom light gray (N7) and micritic, soft to moderately hard, poorly cemented (calcareous sand) to moderately well cemented; Dolostone, 40%, pale yellowish brown (10YR 6/2), with trace of phosphate, microcrystalline, moderately hard, slightly vuggy.	WOB=7K RPM=19	2070-2080	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 8/1) to pale yellowish brown (10YR 6/2), oolitic and arenaceous grainstone, fine grained, slightly phosphatic, poorly cemented, very soft, mostly in a form of calcareous sand, few small fragments 3-10 mm of moderately hard; Dolostone, 10%, pale yellowish brown (10YR 6/2), with trace of phosphate, microcrystalline, moderately hard, slightly vuggy.	WOB=7K RPM=19	2080-2090	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), some pale yellowish brown (10YR 6/2), mostly oolitic grainstone, fine grained, trace of phosphate, poorly- to moderately well-cemented, very soft to soft, some in a form of calcareous sand, frequent fragments 5-10 mm; Dolostone, 30%, light gray (N7) to medium dark gray (N4), microcrystalline, hard, slightly vuggy.	WOB=7K RPM=19	2090-2100	10
LIMESTONE; Limestone,100%, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), mudstone and packstone, with numerous	Core No. 4 interval from	2100-2107	7

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
horizontal laminas of olive gray (5Y 4/1) material, trace of fossils, moderately well- to well- cemented, moderately hard, very fine grained, below 2103.8 ft bpl becoming yellowish gray (5Y 7/2) arenaceous grainstone, less competent, vuggy. 2107.2-2107.8: Gradual transition from limestone into dolostone, rock becoming darker and dolomitic with depth.	2100-2115 ft bpl. WOB=7-9K RPM=20		
DOLOSTONE: Dolostone, 100%, light olive gray (5Y 6/1), fine crystalline, with numerous brighter, irregular intraclasts of yellowish gray (5Y 7/2) and light gray (N7) calcareous material, hard to very hard, with some vugs. 2110.3-2110.7: Gradual transition from olive gray (5Y 4/1) dolostone into yellowish gray (5Y 7/2) limestone.		2107-2110	3
LIMESTONE; Limestone,100%, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), grainstone, fine grained, with trace of fossils and trace of phosphate, vuggy to porous, poorly- moderately well-cemented, soft to moderately hard, fragmented between 2112.3 and 2113.9 ft bpl, and becoming more competent below 2113.9 ft bpl.		2110-2120	10
LIMESTONE AND DOLOSTONE: Limestone, 60%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, some fine crystalline packstone, trace of fossils and phosphate, poorly- to moderately well- cemented, soft, some in a form of calcareous sand; Dolostone, 40%, light olive gray (5Y 4/1) to olive gray (5Y 4/1), fine crystalline, with numerous brighter, irregular intraclasts of calcareous material, hard, vuggy.	WOB=10K RPM=20	2120-2240	20
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, trace of fossils and phosphate, poorly- to moderately well- cemented, soft, mostly in a form of calcareous sand.	WOB=10K RPM=20	2140-2150	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, trace of phosphate, poorly- to moderately well-cemented, very soft to soft, mostly in a form of calcareous sand; Dolostone, 30%, light gray (N7) to medium dark gray (N4), microcrystalline, hard, slightly vuggy.	WOB=10K RPM=20	2150-2160	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, trace of fossils and phosphate, poorly- to moderately well- cemented, soft, mostly in a form of calcareous sand.	WOB=10K RPM=20	2160-2170	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), mostly oolitic grainstone, some packstone, trace of fossils and phosphate, fine grained, moderately well cemented, moderately hard; Dolostone, 10%, yellowish gray (5Y 7/2) to light olive gray (5Y 6/1), fine crystalline, hard, slightly vuggy.	WOB=10K RPM=20	2170-2180	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2 to 8/1), mostly packstone, some grainstone, slightly dolomitic, with trace of fossils and trace of phosphate, very fine- to fine- grained, moderately well cemented, moderately hard to	WOB=12K RPM=20 Core No. 5 interval from	2180-2200	20

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
hard, trace of vugs; Dolostone, 30%, light olive gray (5Y 6/1) to yellowish gray (5Y 7/2), fine crystalline, hard.	2182-2197 ft bpl.		
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), oolitic grainstone, some packstone, trace of fossils and phosphate, fine grained, poorly- to moderately well-cemented, soft to moderately hard, some in a form of calcareous sand; Dolostone, 30%, yellowish gray (5Y 7/2), light olive gray (5Y 6/1), little light gray (N7), fine crystalline, hard.	WOB=15K RPM=19	2200-2250	50
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), mostly oolitic grainstone, some packstone, fine grained, some fine crystalline, some very pale orange (10YR 8/2), dolomitic, trace of fossils and phosphate, moderately well cemented, moderately hard, little calcareous sand; Dolostone, 10%, yellowish gray (5Y 7/2), fine crystalline, hard.	WOB=15K RPM=19	2250-2270	20
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, poorly- to moderately well- cemented, soft to moderately hard, mostly in a form of calcareous sand; Dolostone, 10%, light olive brown (5Y 5/6) to medium gray (N5), fine crystalline, hard; Phosphate, trace, black, fine grained. .	WOB=15K RPM=19	2270-2300	30
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), oolitic grainstone, some packstone, trace of fossils and phosphate, fine grained, poorly- to moderately well-cemented, soft to moderately hard, some in a form of calcareous sand; Dolostone, 30%, yellowish gray (5Y 7/2), light olive gray (5Y 6/1), little light gray (N7), fine crystalline, hard.	WOB=15K RPM=19	2300-2320	20
LIMESTONE AND VERY LITTLE DOLOSTONE: Limestone, 95%, yellowish gray (5Y 7/2), oolitic grainstone, poorly-to moderately well- cemented, mostly soft and in a form of calcareous sand; Dolostone, 5%, medium gray (N5), fine crystalline, hard; Phosphate, trace, black, fine grained	WOB=15K RPM=19	2320-2370	50
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, trace of phosphate, poorly cemented, soft, mostly in a form of calcareous sand; Clay, trace, yellowish gray (5Y 7/2), calcareous, very soft, non plastic.	WOB=10K RPM=19	2370-2380	10
DOLOSTONE AND SOME LIMESTONE: Dolostone, 70%, pale yellowish brown (10YR 6/2), with calcareous intraclasts, fine crystalline, well cemented, hard, vuggy; Limestone, 30%, yellowish gray (5Y 7/2), packstone, trace of fossils and phosphate, fine grained, well cemented, moderately hard.	WOB=10K RPM=19	2380-2390	10
CALCAREOUS SAND; Sand, 100%, pale yellowish brown (10YR 6/2) to yellowish gray (5Y 7/2), product of poorly cemented, weathered oolitic limestone, trace of fossils and phosphate, fine- to medium-grained, few fragments to 10 mm.; Dolostone, trace, medium gray (N5), fine crystalline, moderately hard; Clay, trace, dark greenish gray (5GY 4/1), soft, non plastic.	WOB=10K RPM=19	2390-2400	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%,	WOB=10K	2400-2430	30

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
yellowish gray (5Y 7/2), mostly oolitic grainstone, poorly cemented, very soft and sandy, fine grained, little packstone and microcrystalline, yellowish gray (7/2 8/1), moderately well cemented, moderately hard, slightly vuggy; Dolostone, 30%, light gray (N7) to dark gray (N3), microcrystalline, moderately hard.	RPM=19		
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone with trace of packstone, poorly cemented, very soft, mostly disintegrating into calcareous sand, few larger fragments to 5 mm; Clay, trace, yellowish gray (5Y 8/1), calcareous, chalky, very soft, non plastic.	WOB=10K RPM=19	2430-2530	100
LIMESTONE AND SOME DOLOSTONE: Limestone, 80%, yellowish gray (5Y 7/2), mostly oolitic grainstone, poorly cemented, very soft and sandy, fine grained, little packstone and microcrystalline, yellowish gray (7/2 8/1), moderately well cemented, moderately hard, slightly vuggy; Dolostone, 20%, light gray (N7), microcrystalline, moderately hard.	WOB=10K RPM=19	2530-2550	20
LIMESTONE: Limestone, 100%, pale yellowish brown (10YR 6/2), oolitic grainstone, trace of forams, poorly cemented, very soft, mostly disintegrating into calcareous sand; Dolomitic sand, trace, grayish orange (10YR 7/4).	WOB=10K RPM=19	2550-2560	10
CALCAREOUS SAND; Sand, 100%, yellowish gray (5Y 7/2 to 8/1), product of poorly cemented, weathered oolitic limestone, fine- to medium-grained; Clay, trace, yellowish gray (5Y 8/1), soft, non plastic, chalky.	WOB=10K RPM=19	2560-2580	20
DOLOSTONE AND SOME LIMESTONE: Dolostone, 80%, dark yellowish brown (10YR 4/2), fine crystalline, little saccharoidal, with small (1-3 mm) intraclasts of calcareous material, hard, slightly vuggy; Limestone, 20%, yellowish gray (5Y 7/2), oolitic grainstone, poorly cemented, very soft, fine grained, sandy.	WOB=10K RPM=19	2580-2600	20
DOLOSTONE AND LIMESTONE: Dolostone, 50%, dark yellowish brown (10YR 4/2), fine crystalline, little saccharoidal, with small (1-3 mm) intraclasts of calcareous material, hard, slightly vuggy; Limestone, 50%, yellowish gray (5Y 7/2), oolitic grainstone, poorly cemented, very soft, fine grained, sandy.	WOB=10K RPM=19	2600-2620	20
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), oolitic grainstone, poorly-to moderately well- cemented, mostly very soft, disintegrating into calcareous sand; Dolostone, 10%, medium gray (N5) and dark yellowish brown (10YR 4/2), fine crystalline, hard; Phosphate, trace, black, fine grained.	WOB=10K RPM=19	2620-2630	10
LIMESTONE AND DOLOSTONE: Limestone, 60%, yellowish gray (5Y 7/2), oolitic grainstone, poorly-to moderately well-cemented, mostly very soft, disintegrating into calcareous sand; Dolostone, 40%, medium gray (N5) and dark yellowish brown (10YR 4/2), fine crystalline, hard; Phosphate, trace, black, fine grained	WOB=10K RPM=19	2630-2640	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 80%, yellowish gray (5Y 7/2), oolitic grainstone, poorly-to moderately	WOB=10K RPM=19	2640-2660	20

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
well- cemented, mostly very soft , disintegrating into fine- and medium- grained calcareous sand; Dolostone, 20%, medium gray (N5) and dark yellowish brown (10YR 4/2), fine crystalline, hard; Phosphate, trace, black, fine grained			
LIMESTONE: Limestone, 100%, pale yellowish brown (10YR 6/2), oolitic grainstone, poorly cemented, very soft, mostly disintegrating into fine- to medium- grained calcareous sand; Dolomitic sand, trace, grayish orange (10YR 7/4), fine grained; Clay, trace, yellowish gray (5Y 7/2), calcareous, very soft, non plastic.	WOB=10K RPM=19	2660-2690	30
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, pale yellowish brown (10YR 6/2), packstone, fine grained, poorly-to moderately well- cemented, very soft to moderately hard, some in a form of calcareous sand; Dolostone, 10%, .	WOB=10K RPM=19	2690-2715	25
DOLOSTONE AND VERY LITTLE LIMESTONE: Dolostone, 95%, mostly moderate yellowish brown (10YR 5/4), some pale yellowish brown (10YR 6/2), fine crystalline, little microcrystalline, numerous small (1-2 mm) intraclasts of calcareous material, trace of fossils (coral fragments to 2 mm), moderately well cemented, moderately hard to hard, vuggy, little massive; Limestone, 5%, yellowish gray (5Y 7/2), packstone, moderately well cemented, moderately hard.	WOB=10K RPM=19	2715-2720	5
LIMESTONE AND DOLOSTONE: Limestone, 50%, yellowish gray (5Y 7/2), oolitic grainstone, little microcrystalline, moderately well cemented, soft to moderately hard, some in a form of calcareous sand; Dolostone, 50%, moderate yellowish brown (10YR 5/4), fine crystalline, moderately hard, little soft and sandy, vuggy.	WOB=10K RPM=19	2720-2745	25
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), oolitic grainstone, poorly cemented, very soft to soft, up to 50% in a form of calcareous sand; Dolostone, 10%, medium gray (N5), fine crystalline, hard; Phosphate, trace, black, very fine grained	WOB=10K RPM=19	2745-2750	5
LIMESTONE AND DOLOSTONE: Limestone, 50%, yellowish gray (5Y 7/2), oolitic grainstone, poorly-to moderately well-cemented, soft, mostly in a form of calcareous sand; Dolostone, 50%, medium gray (N5), fine crystalline, hard; Phosphate, trace, black, very fine grained.	WOB=10K RPM=19	2750-2760	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 80%, yellowish gray (5Y 7/2), oolitic grainstone, poorly-to moderately well- cemented, soft, mostly in a form of calcareous sand; Dolostone, 20%, medium light gray (N6) and pale brown (5YR 5/2), fine crystalline, hard; Phosphate, trace, black, very fine grained.	WOB=10K RPM=19	2760-2820	60
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), micritic, well cemented, hard; Dolostone, 30%, medium gray (N5), fine crystalline, hard; Phosphate, trace, black, very fine grained.	WOB=10K RPM=19	2820-2830	10
CALCAREOUS SAND; Sand, 100%, yellowish gray (5Y 7/2 to 8/1), product of poorly cemented, weathered oolitic limestone, fine-to medium-grained; Clay, trace, yellowish gray (5Y 8/1), soft, non	WOB=10K RPM=19	2830-2840	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
plastic, chalky.			
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), mostly oolitic grainstone, fine grained, some packstone, fine crystalline, poorly- to moderately well- cemented, very soft to moderately hard, mostly (up to 70%) in a form of calcareous sand, very few larger fragments to 5 mm; Clay, trace, yellowish gray (5Y 8/1), soft, non plastic, chalky.	WOB=10K RPM=19	2840-2900	60
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), mostly oolitic grainstone, fine grained, some packstone, fine crystalline, poorly cemented, very soft to soft, less competent than above, mostly in a form of calcareous sand, few larger fragments to 10 mm; Clay, trace, yellowish gray (5Y 8/1), soft, non plastic, chalky.	WOB=10K RPM=19	2900-2910	10
LIMESTONE AND VERY LITTLE DOLOSTONE: Limestone, 95%, yellowish gray (5Y 8/1- 7/2), oolitic grainstone, fine grained, little packstone, fine crystalline, trace of phosphate, mostly poorly cemented and very soft in a form of calcareous sand; Dolostone, 5%, very light gray (N8), to microcrystalline, hard, vuggy.	WOB=10K RPM=19	2910-2940	30
DOLOSTONE AND SOME LIMESTONE; Dolostone, 70%, pale yellowish brown (10YR 6/2), some dusky yellowish brown (10YR 2/2), with calcareous intraclasts, fine- to micro-crystalline, slightly phosphatic, hard, vuggy; Limestone, 30%, yellowish gray (5Y 7/2), packstone, little grainstone, fine grained, moderately well cemented, soft to moderately hard.	WOB: 7-10K RPM: 20	2940-2950	10
DOLOSTONE: Dolostone, 100%; pale yellowish brown (10YR 6/2), little dusky yellowish brown (10YR 2/2), with calcareous intraclasts, microcrystalline, hard to very hard, vuggy; Limestone, trace, yellowish gray (5Y 7/2), oolitic grainstone, soft, poorly cemented (some in a form of dolomitic sand).	WOB: 7-10K RPM: 20	2950-2970	20
DOLOSTONE AND LIMESTONE; Dolostone, 50%, pale yellowish brown (10YR 6/2) and dusky yellowish brown (10YR 2/2), with small calcareous intraclasts, fine- to microcrystalline, hard, vuggy; Limestone, 50%, yellowish gray (5Y 7/2), packstone and oolitic grainstone, trace of phosphate, fine grained, moderately well- to poorly- cemented, moderately hard to soft, some in a form of calcareous sand.	WOB: 7-10K RPM: 20	2970-2980	10
DOLOSTONE AND VERY LITTLE LIMESTONE; Dolostone, 95%, pale yellowish brown (10YR 6/2), some dark yellowish brown (10YR 4/2) with small calcareous intraclasts, fine- to micro-crystalline, hard, vuggy; Limestone, 5%, yellowish gray (5Y 7/2), oolitic grainstone, some packstone, fine grained, poorly cemented, soft.	WOB: 7-10K RPM: 20	2980-2990	10
LIMESTONE AND SOME DOLOSTONE; Limestone, 80%, yellowish gray (5Y 8/1), oolitic grainstone, some packstone, trace of forams and phosphate, 70% poorly cemented and very soft in a form of calcareous sand; Dolostone, 20%, light gray (N7) to medium dark gray (N4), fine crystalline, little pale yellowish brown (10YR 6/2), trace of phosphate, hard, vuggy.	WOB: 7-10K RPM: 20	2990-3030	40
CALCAREOUS SAND; Sand, 100%, yellowish gray (5Y 7/2 to	WOB: 7-10K	3030-3040	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
8/1), product of poorly cemented, weathered oolitic limestone, fine- to medium-grained, less than 10% of better consolidated fragments up to 5 mm.	RPM: 20		
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 8/1), oolitic grainstone, fine grained, some packstone, fine crystalline, trace of forams and phosphate, 50% poorly cemented and very soft in a form of calcareous sand; Dolostone, 10%, light gray (N7) and dusky yellowish brown (10YR 6/2), with calcareous intraclasts, fine- to micro-crystalline, hard, vuggy.	WOB: 7-10K RPM: 20	3040-3060	20
LIMESTONE: Limestone, 100%, yellowish gray (5Y 8/1), oolitic grainstone, some packstone, trace of forams and phosphate, 80% poorly cemented and very soft in a form of calcareous sand; Dolostone, trace, light gray (N7) and medium dark gray (N4), microcrystalline, hard, vuggy.	WOB: 7-10K RPM: 20	3060-3070	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 8/1), oolitic grainstone, some packstone, trace of forams and phosphate, poorly- to moderately well cemented, moderately hard; Dolostone, 10%, light gray (N7) and dusky yellowish brown (10YR 6/2), with calcareous intraclasts, fine- to micro-crystalline, hard, vuggy.	WOB: 7-10K RPM: 20	3070-3080	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 8/1), oolitic grainstone and packstone, trace of forams and phosphate, 80% poorly cemented and very soft in a form of calcareous sand; Dolostone, 10%, light gray (N7) and dusky yellowish brown (10YR 6/2), with calcareous intraclasts, fine- to micro- crystalline, hard, vuggy.	WOB: 7-10K RPM: 20	3080-3100	20
LIMESTONE: Limestone, 100%, mostly yellowish gray (5Y 8/1), microcrystalline, dolomitic, moderately well cemented, moderately hard, numerous fragments to 15 mm, up to 10% of yellowish gray (5Y 7/2) packstone, fine grained, poorly cemented, soft, vuggy, trace of forams and phosphate.	WOB: 7-10K RPM: 20	3100-3110	10
CALCAREOUS SAND; Sand, 100%, yellowish gray (5Y 7/2 to 8/1), product of poorly cemented, weathered oolitic limestone, fine- to medium-grained; Clay, trace, yellowish gray (5Y 8/1), soft, non plastic, chalky.	WOB: 7-10K RPM: 20	3110-3120	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2-8/1), oolitic grainstone, trace phosphate, little fine- to micro- crystalline, mostly poorly cemented and very soft, few larger fragments to 10 mm, up to 70% in a form of calcareous sand ; Dolostone, trace, light gray (N7), microcrystalline, hard.	WOB: 7-10K RPM: 20	3120-3220	100
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 8/1), oolitic grainstone, trace of phosphate, 70% poorly cemented, very soft, mostly in a form of calcareous sand; Dolostone, 10%, light gray (N7) to medium gray (N5), microcrystalline, hard, vuggy.	WOB: 10K RPM: 20	3220-3230	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), mostly oolitic grainstone, fine grained, some packstone, fine crystalline,	WOB: 7-10K RPM: 20	3230-3240	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
predominantly moderately well cemented, moderately hard, fragments to 15 mm.			
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), mostly oolitic grainstone, fine grained, some packstone, poorly- to moderately well- cemented, very soft to moderately hard, few larger fragments to 10 mm, but mostly in a form of calcareous sand.	WOB: 7-10K RPM: 20	3240-3250	10
LIMESTONE AND SOME DOLOSTONE; Limestone, 70%, yellowish gray (5Y 8/1), oolitic grainstone, some packstone, trace of phosphate, 30% poorly cemented, very soft, mostly in a form of calcareous sand; Dolostone, 30%, light gray (N7) to medium dark gray (N4), fine crystalline with calcareous intraclasts, some very vuggy.	WOB: 15K RPM: 20	3250-3270	20
DOLOSTONE AND SOME LIMESTONE: Dolostone, 70%, light gray (N7) to medium dark gray (N4), some moderate yellowish brown (10YR 5/4), trace of dusky yellowish brown (10YR 2/2), microcrystalline, very hard, slightly vuggy; Limestone, 30%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, poorly cemented, very soft, mostly in a form of sand, few fragments to10 mm, trace of white (N9), chalky limestone.	WOB: 30K RPM: 20	3270-3280	10
DOLOSTONE AND LITTLE LIMESTONE: Dolostone, 90%, moderate yellowish brown (10YR 5/2), dark yellowish brown (10YR 4/2) and dusky yellowish brown (10YR 2/2), microcrystalline, hard, slightly vuggy; Limestone, 10%, yellowish gray (5Y 8/1), oolitic grainstone, some packstone, trace of phosphate, mostly poorly cemented, very soft, mostly in a form of calcareous sand.	WOB: 30K RPM: 20	3280-3290	10
DOLOSTONE AND SOME LIMESTONE: Dolostone, 80%, moderate yellowish brown (10YR 5/4), trace of dusky yellowish brown (10YR 2/2), microcrystalline, very hard, slightly vuggy; Limestone, 20%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, poorly cemented, very soft, mostly in a form of sand, few fragments to10 mm.	WOB: 30K RPM: 20	3290-3300	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 8/1), mostly oolitic grainstone, slightly dolomitic, fine grained, little packstone, poorly- to moderately well- cemented, very soft to moderately hard, few larger fragments to 10 mm, but mostly (up to 60%) in a form of calcareous sand.	WOB: 20K RPM: 20	3300-3310	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), mostly oolitic grainstone, slightly dolomitic, fine grained, little (up to 10%) packstone, poorly- to moderately well- cemented, very soft to soft, few larger fragments to 15 mm, mostly in a form of calcareous sand.	WOB: 20K RPM: 18	3310-3350	40
LIMESTONE AND SOME DOLOSTONE; Limestone, 80%, yellowish gray (5Y 8/1), oolitic grainstone, some packstone, trace of phosphate, 30% poorly cemented, very soft, in a form of calcareous sand; Dolostone, 20%, dark yellowish brown (10YR 4/2) and dusky yellowish brown (10YR 2/2), little medium gray (N5), microcrystalline, hard, slightly vuggy.	WOB: 20K RPM: 18	3350-3360	10
DOLOSTONE: Dolostone, 100%, light olive gray (5Y 5/2) to olive	WOB: 30K	3360-3370	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
gray (5Y 4/1), little dusky brown (5YR 2/2), fine crystalline, some saccharoidal, moderately hard to very hard, slightly vuggy; Limestone, trace, yellowish gray (5Y 7/2), oolitic grainstone, poorly cemented and very soft.	RPM: 18		
LIMESTONE AND DOLOSTONE: Limestone, 60%, yellowish gray (5Y 8/1), slightly dolomitic oolitic grainstone, poorly cemented, very soft to soft, up to 80% in a form of calcareous and dolomitic sand; Dolostone, 40%, dark yellowish brown (10YR 4/2), fine crystalline and saccharoidal, hard, slightly vuggy.	WOB: 30K RPM: 18	3370-3380	10
DOLOSTONE: Dolostone, 100%, mostly dusky yellowish brown (5YR 2/2) to dark yellowish brown (10YR 4/2), little light gray (N7), fine- to micro- crystalline, little saccharoidal, hard to very hard, slightly vuggy; Limestone, trace, yellowish gray (5Y 7/2), oolitic grainstone, poorly cemented, soft.	WOB: 29K RPM: 16	3380-3390	10
LIMESTONE AND SOME DOLOSTONE; Limestone, 80%, very light gray (N8) to light gray (N7), little yellowish gray (5Y 7/2), packstone, little grainstone, moderately well cemented, moderately hard; Dolostone, 20%, moderate yellowish brown (10YR 5/4), microcrystalline, hard.	WOB: 30K RPM: 16	3390-3400	10
DOLOSTONE AND LITTLE LIMESTONE: Dolostone, 90%, moderate yellowish brown (10YR 5/4), dusky yellowish brown (10YR 2/2) and light gray (N7), microcrystalline, some saccharoidal, very hard, slightly vuggy; Limestone, 10%, yellowish gray (5Y 7/2), grainstone, fine grained, poorly cemented, very soft, mostly in a form of sand.	WOB: 30K RPM: 16	3400-3410	10
DOLOSTONE: Dolostone, 100%, dusky yellowish brown (5YR 2/2) to dark yellowish brown (10YR 4/2), fine crystalline, little microcrystalline, trace of vugs, very hard; Limestone, trace, yellowish gray (5Y 7/2), fine grained, poorly cemented, very soft, sandy. Reported cavities (voids) within this formation (top of boulder zone).	WOB: 30K RPM: 18 Several bit drops reported, bit bouncing and chatter	3410-3430	20
DOLOSTONE: Dolostone, 100%, mostly in darker shades of gray, from medium gray (N5) to medium dark gray (N4), microcrystalline to cryptocrystalline, little dark yellowish brown (10YR 4/2), fine crystalline to saccharoidal, very hard. Cavities (voids) encountered within this formation (boulder zone).	WOB: 30K RPM: 18 Several bit drops reported, bit bouncing and chatter	3430-3450	20
DOLOSTONE: Dolostone, 100%, medium gray (N5) to medium dark gray (N4), microcrystalline to cryptocrystalline and pale yellowish brown (10YR 6/2), fine crystalline, very hard. Apparent voids (cavities) reported (boulder zone).	WOB: 30K RPM: 18 Few bit drops reported, bit bouncing and chatter	3450-3460	10
DOLOSTONE: Dolostone, 100%, medium light gray (N6) to dark gray (N3), fine- to micro-crystalline and moderate yellowish brown (10YR 5/4), fine crystalline, hard to very hard, some saccharoidal, poorly cemented, very vuggy and disintegrating into dolomitic sand. Limestone, trace, yellowish gray (5Y 7/2), fine grained, poorly cemented, very soft, sandy.	WOB: 30K RPM: 22 Some bit chatter and bouncing	3460-3480	20
DOLOSTONE AND SOME LIMESTONE: Dolostone, 70%,	WOB: 20-30K	3480-3510	30

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
medium light gray (N6) to dark gray (N3), fine- to micro-crystalline, little moderate yellowish brown (10YR 5/4), fine crystalline, hard to very hard; Limestone, 30%, predominantly light gray (N7) to very light gray (N8), fine crystalline, up to 20% yellowish gray (5Y 7/2) packstone with occasionally frequent fossils (coral fragments, forams), moderately well cemented, moderately hard to soft, vuggy.	RPM: 22		
DOLOSTONE AND SOME LIMESTONE: Dolostone, 70%, dark yellowish brown (10YR 4/4), little dusky yellowish brown (10YR 2/2), microcrystalline, very hard, slightly vuggy, brittle; Limestone, 30%, yellowish gray (5Y 7/2), mostly oolitic grainstone, some packstone, fine grained, poorly cemented, very soft, mostly in a form of sand.	WOB: 20K RPM: 22	3510-3520	10
DOLOSTONE AND LITTLE LIMESTONE: Dolostone, 90%, medium dark gray (N4), little dark gray (N3) or medium light gray (N6), microcrystalline with some 1-4 mm calcareous intraclasts, very hard; Limestone, 10%, yellowish gray (5Y 7/2), dolomitic packstone, fine crystalline, moderately hard.	WOB: 30-35K RPM: 22	3520-3530	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), yellowish gray (5Y 7/2), dolomitic packstone, slightly phosphatic, fine crystalline, moderately hard; Dolostone, trace, medium dark gray (N4), little medium light gray (N6), microcrystalline with some 1-4 mm calcareous intraclasts, very hard.	WOB: 20K RPM: 22	3530-3540	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), slightly dolomitic packstone, very fine- to fine- crystalline, trace of phosphate, moderately hard; Dolostone, 10%, medium dark gray (N4), little moderate yellowish brown (10YR 5/4), microcrystalline, hard.	WOB: 20K RPM: 22	3540-3560	20
DOLOSTONE AND SOME LIMESTONE: Dolostone, 80%, dark gray (N3), fine crystalline, vuggy to porous, hard; Limestone, 20%, yellowish gray (5Y 7/2), dolomitic packstone, fine crystalline, trace of phosphate, moderately well cemented, moderately hard.	WOB: 30K RPM: 22	3560-3570	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), yellowish gray (5Y 7/2), dolomitic packstone, slightly phosphatic, fine crystalline, moderately hard; Dolostone, trace, medium dark gray (N4), little medium light gray (N6), microcrystalline, hard.	WOB: 20K RPM: 22	3570-3580	10
DOLOSTONE AND SOME LIMESTONE: Dolostone, 70%, light gray (N7) to medium light gray (N6), fine- to micro- crystalline, with numerous calcareous intraclasts 2-3 mm, moderately hard; Limestone, 30%, yellowish gray (5Y 7/2), dolomitic packstone, fine crystalline, trace of phosphate, moderately well cemented, moderately hard.	WOB: 30K RPM: 22	3580-3590	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), slightly dolomitic packstone, fine crystalline, moderately hard; Dolostone, 10%, light gray (N7) to medium light gray (N6), fine- to micro- crystalline, with numerous calcareous intraclasts 2-3 mm, moderately hard to hard.	WOB: 20K RPM: 22	3590-3600	10
DOLOSTONE AND LIMESTONE: Dolostone, 50%, dark gray (N3), fine crystalline, vuggy to porous, hard; Limestone, 50%,	WOB: 30K RPM: 22	3600-3610	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
yellowish gray (5Y 7/2), dolomitic packstone, fine crystalline, trace of phosphate, moderately well cemented, moderately hard.			
LIMESTONE AND DOLOSTONE: Limestone, 60%, yellowish gray (5Y 7/2), dolomitic packstone, very fine crystalline, little grainstone, trace of fossils (shells to 2 mm), poorly cemented, soft; Dolostone, 40%, light gray (N7) to dark gray (N3), microcrystalline, hard.	WOB: 30K RPM: 22	3610-3620	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), yellowish gray (5Y 7/2), dolomitic packstone, trace of phosphate, fine crystalline, moderately well cemented, moderately hard; Dolostone, 30%, medium dark gray (N4) to medium light gray (N6), micro- to fine- crystalline, slightly vuggy with few small calcareous intraclasts <1 mm, hard.	WOB: 20K RPM: 21	3620-3630	10
DOLOSTONE AND LIMESTONE: Dolostone, 60%, medium dark gray (N4), little moderate yellowish brown (10YR 5/4), microcrystalline, hard; Limestone, 40%, yellowish gray (5Y 7/2), packstone, fine crystalline, poorly cemented, soft.	WOB: 20K RPM: 21	3630-3640	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 80%, yellowish gray (5Y 7/2), yellowish gray (5Y 7/2), dolomitic packstone, trace of phosphate, fine crystalline, moderately well cemented, moderately hard; Dolostone, 20%, medium dark gray (N4), little moderate yellowish brown (10YR 5/4), fine crystalline, few small calcareous intraclasts <1 mm, hard.	WOB: 20K RPM: 21	3640-3650	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), yellowish gray (5Y 7/2), dolomitic packstone, fine crystalline, moderately well cemented, moderately hard; Dolostone, 30%, (N6), moderate yellowish brown (10YR 5/4), to dark yellowish brown (10YR 4/2), micro- to fine- crystalline, slightly vuggy with few small calcareous intraclasts <1 mm, hard.	WOB: 20K RPM: 21	3650-3660	10
DOLOSTONE AND SOME LIMESTONE: Dolostone, 80%, medium dark gray (N4) to medium light gray, little moderate yellowish brown (10YR 5/4), fine- to micro- crystalline, hard; Limestone, 40%, yellowish gray (5Y 7/2), packstone, fine crystalline, moderately well cemented, moderately hard; Bituminous shale, trace, black, very fine grained, moderately well cemented, moderately hard, brittle.	WOB: 25K RPM: 22	3660-3670	10
LIMESTONE AND DOLOSTONE: Limestone, 60%, yellowish gray (5Y 7/2), dolomitic packstone, very fine crystalline, moderately well cemented, moderately hard; Dolostone, 40%, light gray (N7) to dark gray (N3), microcrystalline, hard; Chalk, trace, very pale orange (10YR 8/2 to white (N9), cryptocrystalline, silky, few thin (<1 mm) black irregular veins, moderately hard.	WOB: 20K RPM: 22	3670-3680	10
DOLOSTONE, SOME LIMESTONE AND LITTLE CHALK: Dolostone, 60%, grayish black (N2) to medium light gray (N6), fine- to micro- crystalline, slightly vuggy, hard; Limestone, 30%, yellowish gray (5Y 7/2-8/1), fine crystalline, trace of phosphate, hard; Chalk, 10%, very pale orange (10YR 8/2 to white (N9), cryptocrystalline, silky, moderately hard.	WOB: 20K RPM: 22	3680-3693	13

ARCADIS

GEOLOGIC LOG
Key Largo WTD Injection Well System
Monitor Well MW1

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
Fill: sand and limerock.		0-2	2.0
SAND, LIMESTONE AND LITTLE ORGANIC MATTER: Sand 50%, yellowish gray (5Y 8/1), calcareous, fine to medium grained, angular to sub-rounded; Limestone, 40%, yellowish gray (5Y 8/1), some light gray (N5), hard, fragments to 2-inches; Organic matter, 10%, brownish black (5YR 2/1), decomposed, some fragments of plants.		2-3	1.0
SAND AND LIMESTONE: Sand, 50%, moderate yellowish brown (10YR 5/4), calcareous, fine- to medium- grained, angular to sub-rounded; Limestone, 50%, yellowish gray (5Y 8/1), some light gray (N5), hard, fragments to 1-inch.		3-5	2.0
SAND, LIMESTONE AND LITTLE CLAY (MARL): Sand, 50%, very light gray (N6), calcareous, very fine- to medium- grained, sub-rounded; Limestone, 40%, yellowish gray (5Y 8/1), fossils fragments (shells), moderately hard, moderately well cemented; Clay, 10%, yellowish gray (5Y 8/1), calcareous (marl), soft, non-plastic, moist to wet.	WOB=29-31K RPM=7-9	5-15	10.0
SAND, SOME LIMESTONE AND LITTLE SANDSTONE: Sand, 50%, clear, quartz, up to 30% white (N9), calcareous, very phosphatic, very fine- to medium- grained, sub-rounded; Limestone, 40%, white (N9), fossiliferous grainstone with occasional shell intraclasts, phosphatic, poorly cemented, soft to very soft, few larger fragments to 5 mm; Sandstone, 10%, very light gray (N8) and clear, quartz with calcareous matrix, phosphatic, fine grained, poorly cemented, soft; Shell, trace, very pale orange (10YR 8/2), fragments 3-5 mm.	WOB=29-31K RPM=7-9	15-30	15.0
LIMESTONE, SOME SHELL AND SAND: Limestone, 60%, white (N9), little yellowish gray (5Y 8/1), grainstone, fossiliferous, with shell intraclasts (mollusks, corals), slightly phosphatic, poorly- to moderately well- cemented, soft to moderately hard, vuggy; Shell, 20%, white (N9) to medium gray (N5), numerous fragments 3-10 mm, mollusks; Sand, 20%, white (N9) to very light gray (N8), calcareous, very fine- to medium- grained, sub-angular; Phosphate, trace, black, very fine grains.	WOB=29-31K RPM=7-9	30-50	20
LIMESTONE AND LITTLE SAND: Limestone, 90%, white (N9), very pale orange (10YR 8/2) and little yellowish gray (5Y 8/1), boundstone, bioclast with numerous corals and shell fragments, slightly phosphatic, moderately well- to well- cemented, moderately hard to hard, vuggy; Sand, 10%, white (N9) to very light gray (N8), calcareous, very fine- to medium- grained, sub-angular; Phosphate, trace, black, very fine grains.	WOB=29-31K RPM=7-9	50-60	10
LIMESTONE AND LITTLE SAND: Limestone, 90%, very light gray (N8) to white (N9), oolitic grainstone, trace of fossils (1-2 mm shell intraclasts), slightly phosphatic, moderately well- to poorly-cemented, soft to moderately hard , vuggy; Sand, 10%, yellowish gray (5Y 7/2 to 8/1), calcareous, trace quartz, clear, very fine- to medium-grained, sub-angular to sub-rounded.	WOB=29-31K RPM=7-9	60-70	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
LIMESTONE AND SOME SAND: Limestone, 70%, yellowish gray (5Y 8/1) to white (N9), oolitic grainstone, trace of fossils (1-2 mm shell intraclasts), slightly phosphatic, moderately well- to poorly- cemented, moderately hard , vuggy; Sand, 30%, yellowish gray (5Y 7/2 to 8/1), calcareous, trace quartz, clear, very fine- to medium-grained, sub-angular to sub-rounded	WOB=7K RPM=11	70-90	20
SAND AND LITTLE LIMESTONE: Sand, 90%, yellowish gray (5Y 7/2 to 8/1), calcareous, little quartz, clear, very fine- to medium-grained, sub-angular to sub-rounded; Limestone, 10%, yellowish gray (5Y 8/1), oolitic grainstone, phosphatic, trace of fossils, poorly cemented, very soft; Clay, trace, white (N9), calcareous, very soft, non plastic.	WOB=7K RPM=11	90-110	20
SAND AND LITTLE LIMESTONE: Sand, 90%, mostly quartz, clear, some calcareous, yellowish gray (5Y 8/1), very phosphatic, slightly silty, very fine- to medium- grained, rounded to sub-angular; Limestone, 10%, yellowish gray (5Y 8/1), oolitic grainstone, phosphatic, trace of fossils, poorly cemented, very soft; Shell, trace, very pale orange (10Y 8/2), tests to 3 mm.	WOB=7K RPM=11	110-120	10
SAND: Sand, 100%, clear, quartz, little calcareous, phosphatic, very fine grained, sub-rounded; Limestone, trace, white (N9), poorly cemented, soft, fragments up to 5 mm; Shell, trace, very pale orange (10Y 8/2), tests to 6 mm.	WOB=7K RPM=11	120-140	20
SAND AND SOME SANDSTONE: Sand, 70%, clear, quartz, phosphatic, very silty, very fine grained, rounded to sub-rounded, well sorted; Sandstone, 30%, light gray (N7), quartz, fine grained, poorly- to moderately well- cemented; Shell, trace, very pale orange (10Y 8/2), tests to 5 mm.	WOB=7K RPM=12	140-160	20
SAND: Sand, 100%, clear, quartz, phosphatic, trace calcareous, very silty, very fine grained, rounded to sub-rounded, well sorted.	WOB=13-19K RPM=12	160-224	64
LIMESTONE: SANDSTONE, SOME SAND AND SHELL: Limestone, 30%, very light gray (N8) to medium dark gray (N4), slightly fossiliferous mudstone, with quartz grains and few shell intraclasts, moderately well cemented, moderately hard; Sandstone, 30%, light gray (N7), quartz grains in mostly calcareous matrix, phosphatic, with shell intraclasts, very fine grained, poorly- to moderately well- cemented, soft to moderately hard; Sand, 20%, clear, quartz, very phosphatic, trace calcareous, silty, very fine grained, rounded to sub-rounded; Fossils, 20%, shell fragments, few whole shells (up to 1-inch), bivalves, occasional coral fragments.	WOB=11K RPM=12	224-228	4
SANDY CLAY: Clay, 60%, pale olive (10Y 6/2), silty, slightly phosphatic, soft, non-plastic, slightly cohesive; Sand, 40%, quartz, clear, trace calcareous, very fine grained, sub-rounded to sub-angular; Siltstone, trace, olive dark (5Y 2/1), moderately hard, brittle; Shell, trace, light yellowish gray (5Y 8/2), fragments 1-2mm.	WOB=6-7K RPM=21	228-250	22

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
CLAY AND SOME SAND: Clay, 75%, dusky yellowish green (5GY 5/2), slightly silty, trace of phosphate, very soft, medium plasticity; Sand, 25%, quartz, clear, trace calcareous, very fine grained, sub-rounded to sub-angular; Siltstone, trace, olive dark (5Y 2/1), moderately hard, brittle; Shell, trace, light yellowish gray (5Y 8/2), fragments 1-2mm.	WOB=6-7K RPM=21	250-260	10
CLAYEY SAND: Sand, 70%, clear, quartz, phosphatic, trace calcareous, silty, very fine- to fine- grained, rounded to sub-rounded, well sorted; Clay, 30%, dusky yellowish green (5GY 5/2), slightly silty, trace of phosphate, soft, non plastic, lightly cohesive.	WOB=6-7K RPM=21	260-300	40
SANDY CLAY: Clay, 50%, dusky yellowish green (5GY 5/2) to pale olive (10Y 6/2), silty, trace of phosphate, soft, low plasticity, lightly cohesive; Sand, 50%, quartz, clear, very fine grained, sub-rounded to sub-angular; Shell, trace, light yellowish gray (5Y 8/2), fragments 1-2mm,; Limestone, trace, yellowish gray (5Y 7/2), few fragments to 3 mm.	WOB=6-7K RPM=21	300-350	50
CLAY WITH SOME SAND: Clay, 80%, dusky yellowish green (5GY 5/2), trace phosphate, very soft, low plasticity, cohesive; Sand, 20%, quartz, clear, very fine grained, sub-rounded to sub-angular.	WOB=6-7K RPM=21	350-370	20
SANDY CLAY: Clay, 50%, dusky yellowish green (5GY 5/2) to pale olive (10Y 6/2), silty, trace of phosphate, soft, low plasticity, lightly cohesive; Sand, 50%, quartz, clear, very fine grained, sub-rounded to sub-angular.	WOB=6-7K RPM=21	350-440	90
SANDY CLAY (MARL) AND SOME LIMESTONE: Clay (Marl), 40%, yellowish gray (5Y 8/1) to white (N9), little greenish gray (5G 6/1), mostly calcareous, slightly phosphatic, chalky, very soft, cohesive, low plasticity; Sand, 30%, yellowish gray (5Y 8/1), calcareous and quartz, clear, phosphatic, very fine- to medium-grained, sub-angular to sub-rounded; Limestone, 30%, yellowish gray (5Y 8/1) to olive gray (5Y 4/1), packstone, grainstone and mudstone, fossiliferous with shell intraclasts, slightly phosphatic, poorly cemented, very soft, vuggy; Shell, trace, fragments to 0.5-inch.	WOB=10-12K RPM=21	440-460	20
LIMESTONE AND SOME SHELL: Limestone, 70%, yellowish gray (5Y7/2), fossiliferous, mudstone, some grainstone with shell intraclasts, slightly phosphatic, poorly- to moderately-well cemented, soft to moderately hard, slightly vuggy; Shell, 30%, very pale orange (10YR 8/2) to yellowish gray (5Y 8/1), mostly small tests to 3 mm, frequent large fragments or whole fossils (bivalves) to 1-inch; Clay (Marl), trace, yellowish gray (5Y 7/2), calcareous, very soft, cohesive, non plastic; Sand, trace, yellowish gray (5Y 8/1), calcareous, very fine- to medium- grained, sub-angular.	WOB=10-12K RPM=21	460-480	20

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
LIMESTONE AND LITTLE CLAY(MARL): Limestone, 90%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, some mudstone, fossiliferous with some shell intraclasts, slightly phosphatic, very fine- to fine- grained, poorly cemented, very soft to soft; Clay (Marl), 10%, pale olive (10Y 6/2), calcareous, phosphatic, very soft, cohesive, non plastic.	WOB=10-12K RPM=21	480-500	20
LIMESTONE AND SOME SHELL: Limestone, 70%, yellowish gray (5Y7/2), fossiliferous, mudstone, some grainstone with shell intraclasts, slightly phosphatic, poorly- to moderately-well cemented, soft to moderately hard, slightly vuggy; Shell, 30%, very pale orange (10YR 8/2) to yellowish gray (5Y 8/1), mostly small tests to 3 mm, frequent large fragments or whole fossils (bivalves) to 1-inch; Clay (Marl), trace, yellowish gray (5Y 7/2), calcareous, very soft, cohesive, non plastic; Sand, trace, yellowish gray (5Y 8/1), calcareous, very fine- to medium- grained, sub-angular.	WOB=12K RPM=21	500-550	50
LIMESTONE AND SOME CLAY(MARL): Limestone, 75%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, fossiliferous with some shell intraclasts, very fine- to fine- grained, poorly- to moderately well-cemented, very soft to soft, (up to 20% in a form of calcareous sand), vuggy; Clay (Marl), yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB= 15-20K RPM=20	550-580	30
CLAY(MARL) AND LIMESTONE: Clay (Marl), 60%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, trace of phosphate, very soft, cohesive, non plastic; Limestone, 40%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, little packstone, fossiliferous with shell intraclasts (mollusks), very fine- to fine- grained, poorly cemented, very soft to moderately hard (some in a form of calcareous sand).	WOB= 15-20K RPM=20	580-590	10
LIMESTONE AND SOME CLAY(MARL): Limestone, 70%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, some packstone, fossiliferous with shell intraclasts (mollusks), phosphatic, very fine- to fine- grained, poorly cemented, very soft to soft (mostly in a form of calcareous sand), vuggy; Clay (Marl), 30%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB= 15-20K RPM=20	590-600	10
SAND, LITTLE CLAY (MARL) AND LITTLE LIMESTONE: Sand, 80%, yellowish gray (5Y 8/1), calcareous (product of disintegrated oolitic limestone), with few shell tests, very fine- to medium- grained; Clay (Marl), 10%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, trace of phosphate, very soft, cohesive, non plastic; Limestone, 10%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, some packstone, fossiliferous with shell intraclasts (mollusks), very fine- to fine- grained, poorly cemented, few fragments to 3 mm.	WOB= 15-20K RPM=20	600-610	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
SANDY CLAY (MARL) AND VERY LITTLE LIMESTONE: Clay (Marl), 70%, yellowish gray (5Y 8/1), calcareous, chalky, very soft, cohesive, non plastic; Sand, 25%, yellowish gray (5Y 8/1), calcareous, trace of phosphate, very fine to medium grained, sub-angular; Limestone, 5%, yellowish gray (5Y 8/1), fossiliferous grainstone with shell intraclasts, slightly phosphatic, poorly cemented, very soft.	WOB= 15-20K RPM=20	610-620	10
LIMESTONE AND SOME CLAY(MARL): Limestone, 80%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, fossiliferous with some shell intraclasts (mollusks), very fine- to fine- grained, poorly cemented, very soft to soft (mostly in a form of calcareous sand; Clay (Marl), 30%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB=10-13K RPM=22	620-630	10
SAND, SOME LIMESTONE AND LITTLE CLAY (MARL): Sand, 60%, yellowish gray (5Y 8/1), calcareous (product of disintegrated oolitic limestone), with few shell tests, very fine- to medium- grained; Limestone, 30%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, some packstone, fossiliferous with shell intraclasts (mollusks), very fine- to fine-grained, poorly cemented, soft to very soft, mostly as sand, few fragments to 3 mm; Clay (Marl), 10%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, trace of phosphate, very soft, cohesive, non plastic;	WOB=10-13K RPM=22	630-640	10
SANDY CLAY (MARL) AND LIMESTONE: Clay (Marl), 60%, yellowish gray (5Y 8/1), calcareous, chalky, very soft, cohesive, non plastic; Limestone, 40%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, some packstone, fossiliferous with shell intraclasts (mollusks), very fine- to medium- grained, poorly cemented, soft to very soft, mostly as sand, few fragments to 3 mm;	WOB=12-15K RPM=25	640-650	10
LIMESTONE AND LITTLE CLAY(MARL): Limestone, 90%, yellowish gray (5Y 7/2), oolitic grainstone, some packstone, fossiliferous with some shell intraclasts, very fine- to fine- grained, poorly- to moderately well-cemented, very soft to moderately hard, some fragments to 0.5-inch; Clay (Marl), 10%, yellowish gray (5Y 8/1), calcareous, cohesive, very soft, non plastic.	WOB=12-15K RPM=22	650-660	10
SAND, SOME LIMESTONE AND LITTLE CLAY (MARL): Sand, 60%, yellowish gray (5Y 8/1), calcareous (product of disintegrated oolitic limestone), with few shell tests, very fine- to medium- grained; Limestone, 30%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, some packstone, fossiliferous with shell intraclasts (mollusks), very fine- to fine-grained, poorly cemented, soft to very soft, mostly as sand, few fragments to 3 mm; Clay (Marl), 10%, yellowish gray (5Y 8/1) to pale olive (10Y 6/2), calcareous, trace of phosphate, very soft, cohesive, non plastic;	WOB=10-12K RPM=20	660-670	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
SAND, SOME CLAY (MARL) AND LITTLE LIMESTONE: Sand, 65%, yellowish gray (5Y 8/1), calcareous (product of disintegrated oolitic limestone), with few shell tests, very fine- to medium- grained; Clay (Marl), 25%, yellowish gray (5Y 8/1), calcareous, trace of phosphate, very soft, cohesive, non plastic; Limestone, 10%, yellowish gray (5Y 7/2), oolitic grainstone, some packstone, some shell intraclasts (mollusks), very fine- to fine-grained, poorly cemented, soft to very soft, mostly as sand, few fragments to 3 mm.	WOB=10-12K RPM=20	670-690	20
LIMESTONE AND LITTLE CLAY (MARL): Limestone, 90%, yellowish gray (5Y 7/2), oolitic grainstone, highly fossiliferous with shell intraclasts, very fine- to fine-grained, poorly- to moderately well- cemented, very soft to soft, some in a form of calcareous sand with larger fragments to3 mm; Clay (Marl), 10%, yellowish gray (5Y 8/1-7/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB=18-20K RPM=27	690-730	40
CLAY (MARL) AND LITTLE LIMESTONE: Clay (Marl), 80%, yellowish gray (5Y 8/1), calcareous, chalky, very soft, very cohesive, non plastic; Limestone, 20%, yellowish gray (5Y 8/1), fossiliferous grainstone with shell intraclasts, slightly phosphatic, poorly cemented, very soft, up to 50% in a form of calcareous sand..	WOB=8-10K RPM=22	730-760	30
LIMESTONE AND LITTLE CLAY (MARL): Limestone, 90%, yellowish gray (5Y 7/2), oolitic grainstone, highly fossiliferous with shell intraclasts, very fine- to fine-grained, poorly- to moderately well- cemented, very soft to soft, some in a form of calcareous sand with larger fragments to3 mm; Clay (Marl), 10%, yellowish gray (5Y 8/1-7/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB=8-10K RPM=22	760-770	10
SANDY CLAY (MARL) AND LIMESTONE: Clay (Marl), 60%, yellowish gray (5Y 8/1), calcareous, chalky, very soft, very cohesive, non plastic; Limestone, 40%, yellowish gray (5Y 7/2), oolitic grainstone, some packstone, fossiliferous with shell intraclasts (mollusks), trace of phosphate, very fine- to medium-grained, poorly cemented, very soft, up to 50% in form of calcareous sand.	WOB=8-10K RPM=22	770-780	10
SAND AND SOME LIMESTONE: Sand, 70%, yellowish gray (5Y 8/1), calcareous (product of disintegrated oolitic limestone), with few shell tests, very fine- to medium- grained; Limestone, 30%, yellowish gray (5Y 7/2), oolitic grainstone, some packstone, some shell intraclasts (mollusks), very fine- to fine- grained, poorly to moderately well- cemented, soft to moderately hard, few fragments to1/2-inch.	WOB=8-10K RPM=22	780-790	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 8/1), highly fossiliferous oolitic grainstone, poorly cemented (up to 40% in a form of calcareous sand), very soft to soft; Clay (Marl), trace, yellowish gray (5Y 8/1-7/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB=8-10K RPM=22	790-810	20

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
SAND AND VERY LITTLE CLAY: Sand, 95%, yellowish gray (5Y 8/1to 5Y 7/2), calcareous, product of disintegrated oolitic limestone, with trace of shell, fragments to 2 mm, trace of phosphate, very fine- to medium- grained, sub-angular, few fragments of limestone to 5 mm; Clay (Marl), 5%, yellowish gray (5Y 7/2) to pale olive (10Y 6/2), calcareous, very soft, non plastic.	WOB=10-12K RPM=22	810-820	10
LIMESTONE AND VERY LITTLE CLAY: Limestone, 95%, yellowish gray (5Y 8/1), highly fossiliferous oolitic grainstone, poorly cemented (up to 20% in a form of calcareous sand), very soft to soft; Clay (Marl), 5%, yellowish gray (5Y 8/1-7/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB=10-12K RPM=22	820-830	10
LIMESTONE AND SOME CLAY: Limestone, 80%, yellowish gray (5Y 8/1), highly fossiliferous oolitic grainstone, poorly cemented (up to 40% in a form of calcareous sand), very soft to soft; Clay (Marl), 20%, yellowish gray (5Y 8/1-7/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB=20-21K RPM=22	830-840	10
CLAY (MARL) AND SOME LIMESTONE: Clay (Marl), 70%, yellowish gray (5Y 8/1), calcareous, with up to 10% of calcareous sand, chalky, very soft, very cohesive, non plastic; Limestone, 30%, yellowish gray (5Y 7/2) to very pale orange (10YR 8/2), oolitic grainstone, some packstone, fossiliferous with shell intraclasts (mollusks), very fine- to medium- grained, poorly cemented, soft to very soft.	WOB=10-12K RPM=22	840-850	10
CLAY AND LIMESTONE: Clay , 50%, pale olive (5Y 6/4), mostly calcareous (marl), chalky, soft, cohesive, medium plasticity; Limestone, 40%, yellowish gray (5Y 7/2), fossiliferous oolitic grainstone, some packstone, with shell intraclasts (mollusks), very fine- to medium- grained, poorly cemented, very soft, mostly in form of a calcareous sand.	WOB=10-12K RPM=22	850-860	10
SAND AND LITTLE CLAY (MARL): Sand, 90%, yellowish gray (5Y 7/2), calcareous, product of disintegrated oolitic limestone, with trace of shell, fragments to 2 mm, trace of phosphate, very fine- to fine- grained, sub-rounded to sub-angular; Clay (Marl), 10%, yellowish gray (5Y 7/2), calcareous, very soft, cohesive, non plastic.	WOB=10-12K RPM=22	860-880	20
SANDY CLAY (MARL): Clay (Marl), 60%, yellowish gray (5Y 7/2), calcareous, trace of phosphate, very soft, cohesive, non plastic; Sand, 40%, yellowish gray (5Y 7/2), calcareous, product of disintegrated oolitic limestone, with trace of shell, very fine- to fine-grained, sub-rounded to sub-angular.	WOB=10-12K RPM=22	880-890	10
CLAY AND SOME LIMESTONE: Clay , 70%, pale olive (10Y 6/2), mostly calcareous (marl), chalky, soft, cohesive, medium plasticity; Limestone, 30%, yellowish gray (5Y 7/2), fossiliferous oolitic grainstone, some packstone, with shell intraclasts (mollusks), very fine- to medium- grained, poorly cemented, very soft, mostly in form of a calcareous sand.	WOB=10-12K RPM=22	890-900	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
LIMESTONE AND SOME CLAY (MARL): Limestone, 70%, yellowish gray (5Y7/2), fossiliferous oolitic grainstone, numerous shell fragments up to 0.5-inch, mostly poorly cemented (up to 30% in a form of calcareous sand), very soft to soft; Clay (Marl), 30%, yellowish gray (5Y 8/1-7/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB=10-12K RPM=22	900-920	20
SAND AND LITTLE CLAY: Sand, 90%, yellowish gray (5Y 7/2), calcareous, product of disintegrated oolitic limestone, with trace of shell, fragments to 2 mm, trace of phosphate, very fine- to medium-grained, sub-angular, few fragments of limestone to 5 mm; Clay (Marl), 10%, yellowish gray (5Y 7/2), calcareous, very soft, non plastic.	WOB=10-12K RPM=22	920-930	10
LIMESTONE AND SOME CLAY: Limestone, 80%, yellowish gray (5Y 7/2), grainstone and packstone, with few fossils (shell fragments 2-3 mm), poorly cemented (up to 60% in form of calcareous sand), very soft; Clay (Marl), 30%, yellowish gray (5Y 8/1-7/2), calcareous, trace of phosphate, very soft, cohesive, non plastic.	WOB=10-12K RPM=22	930-940	10
CLAY AND SOME LIMESTONE: Clay , 70%, pale olive (10Y 6/2), mostly calcareous (marl), chalky, soft, cohesive, medium plasticity; Limestone, 30%, yellowish gray (5Y 7/2), fossiliferous oolitic grainstone, some packstone, with shell intraclasts (mollusks), very fine- to medium- grained, poorly cemented, very soft, mostly in form of a calcareous sand.	WOB=10-12K RPM=22	940-950	10
CLAY (MARL): Clay (Marl), 100%, yellowish gray (5Y 8/1), calcareous, very soft, highly cohesive, non plastic; Limestone, trace, yellowish gray (5Y 8/1), poorly cemented, very soft.	WOB=10-12K RPM=22	950-960	10
CLAY: Clay, 100%, pale olive (10Y 6/2), partly calcareous (marl), soft with some harder fragments, mostly highly cohesive, non plastic	WOB=10-12K RPM=22	960-970	10
SANDY CLAY (MARL): Clay (Marl), 100%, yellowish gray (5Y 7/2), calcareous, trace of phosphate, with 20% of calcareous sand and traces of limestone fragments, up to 3 mm, very soft, highly cohesive, non plastic.	WOB=20-21K RPM=22	970-990	20
CLAY: Clay , 100%, yellowish gray (5Y 7/2) to pale olive (10Y 6/2), partly calcareous (marl), soft to very soft, highly cohesive, non plastic	WOB=10-12K RPM=22	990-1020	30
CLAY AND VERY LITTLE SAND: Clay, 95%, pale olive (10Y 6/2), slightly calcareous, with 5% of calcareous, very fine grained sand, very soft, cohesive, low plasticity to non plastic; Limestone, trace, yellowish gray (5Y 7/2), packstone, poorly cemented, very soft.	WOB=10-12K RPM=22	1020-1030	10
CLAY AND LITTLE LIMESTONE: Clay, 90%, yellowish gray (5Y 7/2) to pale olive (10Y 6/2), slightly calcareous, with trace of fine grained calcareous sand, very soft, low plasticity to non plastic; Limestone, 10%, yellowish gray (5Y 7/2), packstone, fossiliferous, with shell intraclasts, poorly cemented, very soft.	WOB=10-12K RPM=15	1030-1050	20

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
LIMESTONE AND SOME CLAY (MARL): Limestone, 80%, yellowish gray (5Y 8/1), some pale yellowish brown (10YR 7/4), fossiliferous packstone, grainstone and little fine crystalline, with abundant shell intraclasts, very fine- to fine- grained, poorly- to moderately well- cemented, slightly vuggy; Clay (Marl), 20%, yellowish gray (5Y 7/2), calcareous, very soft, highly cohesive, non plastic	WOB=10-12K RPM=15	1050-1060	10
LIMESTONE AND SOME CLAY (MARL): Limestone, 70%, pale yellowish brown (10YR 7/4), fossiliferous packstone, little yellowish gray (5Y 7/2), oolitic grainstone, abundant shell intraclasts, very fine grained, poorly- to moderately well- cemented, very soft to moderately hard, sandy, trace of vugs; Clay (Marl), 30%, yellowish gray (5Y 7/2), calcareous, chalky, very soft, highly cohesive, non plastic	WOB=10-12K RPM=15	1060-1070	10
CLAY AND LIMESTONE: Clay, 60%, pale olive (10Y 6/2), slightly calcareous, soft, low to medium plasticity; .Limestone, 40%, yellowish gray (5Y 7/2), some pale yellowish brown (10YR 7/4), fossiliferous packstone and grainstone, with shell intraclasts, very fine grained, poorly- to moderately well- cemented.	WOB=10-12K RPM=15	1070-1076	>6
LIMESTONE: Limestone, 100%, yellowish gray (5Y 8/1-7/2), bioclast grainstone, little packstone with numerous shell and coral intraclasts, trace of forams, moderately well- to well- cemented, moderately hard, vuggy.	WOB=10-12K RPM=15	1076-1090	14
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), little pale yellowish brown (10YR 6/2), mostly fine crystalline, dolomitic, some fossiliferous, calcitic packstone, little grainstone with occasional calcite crystals, trace of green glauconite, and numerous shell and coral intraclasts, moderately well cemented, moderately hard, vuggy.	WOB=10-12K RPM=15	1090-1120	30
LIMESTONE: Limestone, 100%, pale yellowish brown (10YR 6/2), fossiliferous, biosparitic, oolitic grainstone with abundant forams and mollusks shell fragments and coral intraclasts, fragments to 1.5-inch, trace microcrystalline, calcitic, fine grained, mostly poorly cemented, and soft, with some as sand, very vuggy to porous.	WOB=10-12K RPM=15	1120-1130	10
LIMESTONE: Limestone, 100%, yellowish gray (5Y 7/2), biosparitic fossiliferous packstone and mudstone, with abundant fossils (shells and coral fragments), moderately well- to poorly-cemented, moderately hard to soft, vuggy.	WOB=10-12K RPM=15	1130-1150	20
LIMESTONE: Limestone, 100%, pale yellowish brown (10YR 6/2), biosparitic fossiliferous mudstone, little fossiliferous micrite with abundant fossils (shells and coral fragments), trace of stromatoporoid, trace of green glauconite, moderately well- to poorly- cemented, moderately hard to soft, vuggy.	WOB=10-12K RPM=15	1150-1170	20
LIMESTONE: Limestone, 100%, pale yellowish brown (10YR 6/2), little yellowish gray (5Y 7/2), biosparitic, calcitic mudstone and packstone, numerous shell and coral intraclasts, moderately well cemented, moderately hard, vuggy.	WOB=10-12K RPM=15	1170-1200	30

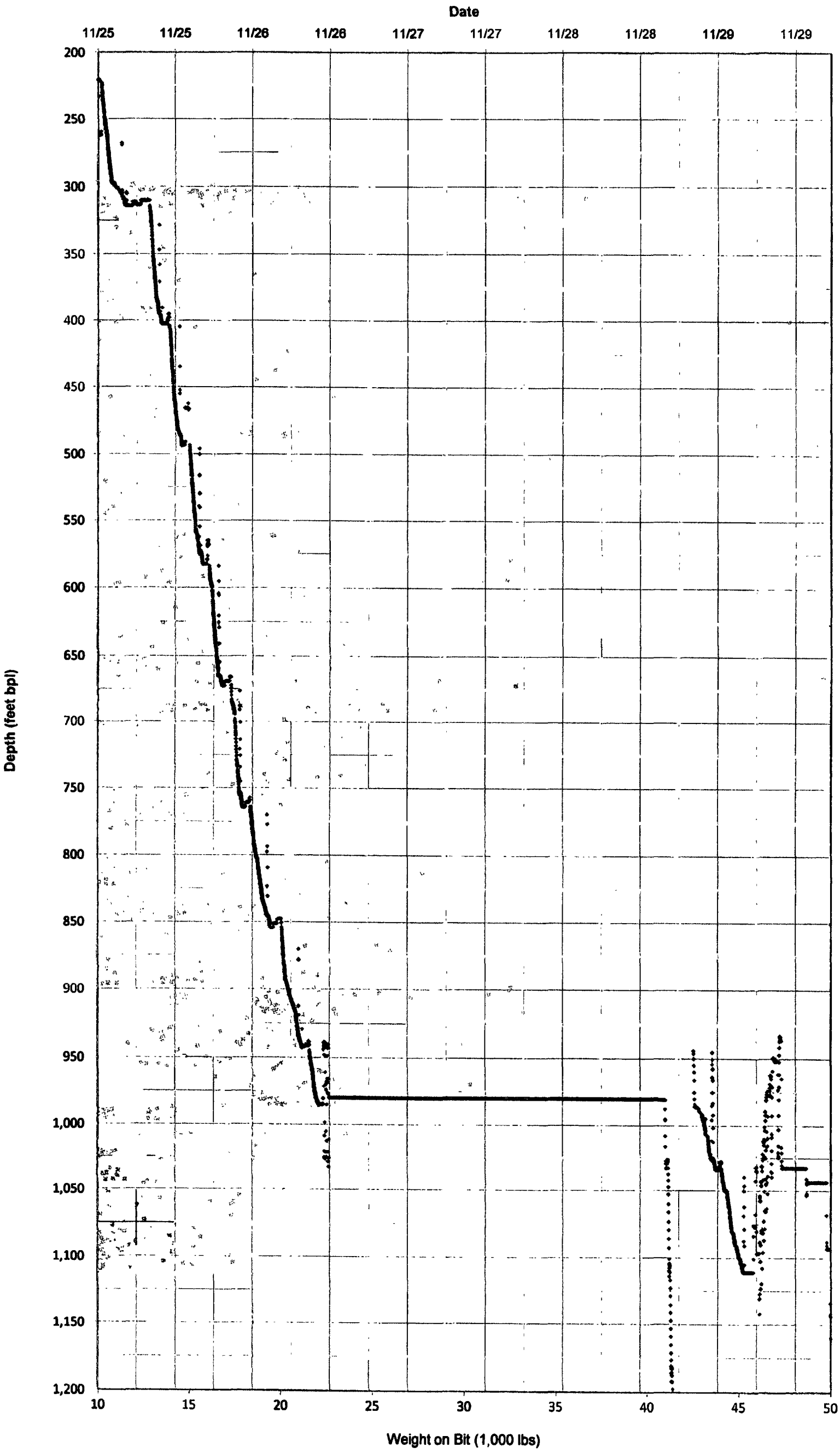
LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
CALCAREOUS SAND: Sand, 90%, light olive gray (5Y 5/2), calcareous, with forams and fossils fragments, very fine- to medium-grained, 10% limestone fragments to 5 mm, mudstone and biosparitic packstone, numerous shell and coral intraclasts, poorly cemented, very soft to soft.	WOB=10-12K RPM=15	1200-1210	10
LIMESTONE: Limestone, 100%, pale yellowish brown (10YR 6/2), biosparitic, calcitic mudstone and packstone, numerous shell and coral intraclasts, trace of light gray (N7), fine crystalline, dolomitic, poorly- to moderately well- cemented, very soft to moderately hard, up to 50% in form of calcareous sand, vuggy.	WOB=10-12K RPM=15	1210-1250	40
LIMESTONE: Limestone, 100%, pale yellowish brown (10YR 6/2), biosparitic, calcitic mudstone and packstone, little grainstone, numerous shell and coral intraclasts, moderately well cemented, moderately hard, vuggy.	WOB=10-12K RPM=15	1250-1270	20
LIMESTONE AND LITTLE DOLOSTONE; Limestone, 90%, pale yellowish brown (10YR 6/2), some yellowish gray (5Y 7/2), oolitic grainstone and packstone, very fossiliferous with numerous shells (mostly fragments and shell intraclasts to 5mm), slightly dolomitic and calcitic, moderately well cemented, moderately hard, very vuggy to porous; Dolostone, 10%, yellowish gray (5Y 7/2), fine crystalline, slightly vuggy, well cemented, hard.	WOB=10-12K RPM=15	1270-1290	20
DOLOSTONE AND SOME LIMESTONE: Dolostone, 80%, light olive gray (5Y 3/2), microcrystalline, moderately hard to hard; Limestone, 20%, yellowish gray (5Y 7/2), fine crystalline, trace of fossils (shell intraclasts), moderately hard, slightly vuggy; Chert, trace, olive gray (5Y 3/2), very hard.	WOB=8-12K RPM=25	1290-1300	10
DOLOSTONE: Dolostone, 100%, yellowish gray (5Y 7/2), micro- to fine- crystalline, moderately hard, slightly vuggy; Limestone, trace, oolitic grainstone, very fine- to fine- grained, poorly cemented, very soft to soft, mostly in form of calcareous sand.	WOB=8-12K RPM=25	1300-1310	10
DOLOSTONE AND SOME LIMESTONE: Dolostone, 80%, medium gray (N5), microcrystalline, moderately hard to hard; Limestone, 20%, yellowish gray (5Y 7/2), fine crystalline, trace of fossils (shell intraclasts), moderately hard, slightly vuggy; Chert, trace, olive gray (5Y 3/2), very hard.	WOB=8-12K RPM=25	1310-1320	10
LIMESTONE AND DOLOSTONE; Limestone, 60%, pale yellowish brown (10YR 6/2), little yellowish gray (5Y 7/2), grainstone and packstone, very fossiliferous with numerous shell intraclasts, poorly- to moderately well- cemented, soft to moderately hard, slightly vuggy; Dolostone, 40%, pale yellowish brown (10YR 6/2), fine crystalline, slightly vuggy, well cemented, hard.	WOB=8-12K RPM=25	1320-1340	20
DOLOSTONE AND LITTLE LIMESTONE; Dolostone, 90%, very light gray (N8) to light gray (N7), fine- to micro- crystalline, moderately hard, slightly vuggy; Limestone, 10%, yellowish gray (5Y 7/2), little pale yellowish brown (10YR 6/2), oolitic grainstone, very fine- to fine- grained, poorly cemented, very soft to soft, mostly in form of calcareous sand.	WOB=8-12K RPM=25	1340-1350	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
MARL AND SOME CALCAREOUS SAND: Marl, 70%, pale yellowish brown (10YR 4/2), moderately hard, non-plastic; Sand, 30%, yellowish gray (5Y 7/2), calcareous, fine to medium gained, product of disintegrated oolitic limestone.	WOB=5-10K RPM=21	1350-1360	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), little pale yellowish brown (10YR 6/2), oolitic grainstone, very fine- to fine- grained, poorly cemented, very soft to soft, mostly in form of calcareous sand.	WOB=5-10K RPM=21	1360-1370	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 8/1), oolitic grainstone, some fine crystalline, trace of fossils (shell fragments), very fine- to fine- grained, moderately well cemented, moderately hard, soft, slightly vuggy; Dolostone, trace, light gray (N7) to medium gray (N6), microcrystalline, moderately well cemented, moderately hard.	WOB=5-10K RPM=21	1370-1380	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, fine grained, with trace of fossils, very soft to soft, poorly cemented, mostly (up to 60%) in a form of calcareous sand, vuggy; Dolostone, trace, light gray (N7) to medium gray (N6), microcrystalline, moderately well cemented, moderately hard.	WOB=5-10K RPM=21	1380-1420	40
CALCAREOUS SAND; Sand, 100%, moderate yellowish brown (10YR 5/4), product of poorly cemented, weathered oolitic limestone, trace of forams and trace of shell fragments, calcitic, fine- to medium- grained, few fragments to 10 mm.	WOB=5-10K RPM=21	1420-1450	30
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, trace of fossils, trace of phosphate, very fine- to fine-grained, poorly- to moderately- well cemented, very soft to soft, mostly in a form of calcareous sand, few fragments to10 mm; Dolostone, trace, light gray (N7), fine crystalline, moderately hard.	WOB=5-10K RPM=21	1450-1470	20
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), oolitic grainstone, trace of phosphate, fine grained, moderately well cemented, moderately hard to soft; Dolostone, 30%, light gray (N7) to medium gray(N5), fine- and micro- crystalline, hard.	WOB=7-12K RPM=22	1470-1480	10
CALCAREOUS SAND; Sand, 100%, yellowish gray (5Y 7/2), product of poorly cemented, weathered oolitic limestone, very fine- to medium- grained, few fragments to 10 mm.	WOB=7-12K RPM=22	1480-1530	50
LIMESTONE; Limestone, 100%, yellowish gray (5Y 8/1-7/2), oolitic grainstone, very fine- to fine- grained, moderately well cemented, moderately hard, slightly vuggy, soft.	WOB=7-12K RPM=22	1530-1540	10
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), oolitic grainstone, very fine- to fine- grained, poorly- to moderately- well cemented, very soft to moderately hard, up to 40% in form of calcareous sand, fragments to10 mm.	WOB=7-12K RPM=22	1540-1560	20
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), packstone, some grainstone, with trace of fossils (shell fragments), very fine- to fine- grained, moderately well cemented, moderately hard, , more competent than above, up to 10% in form of calcareous sand.	WOB=15K RPM=15	1560-1620	60

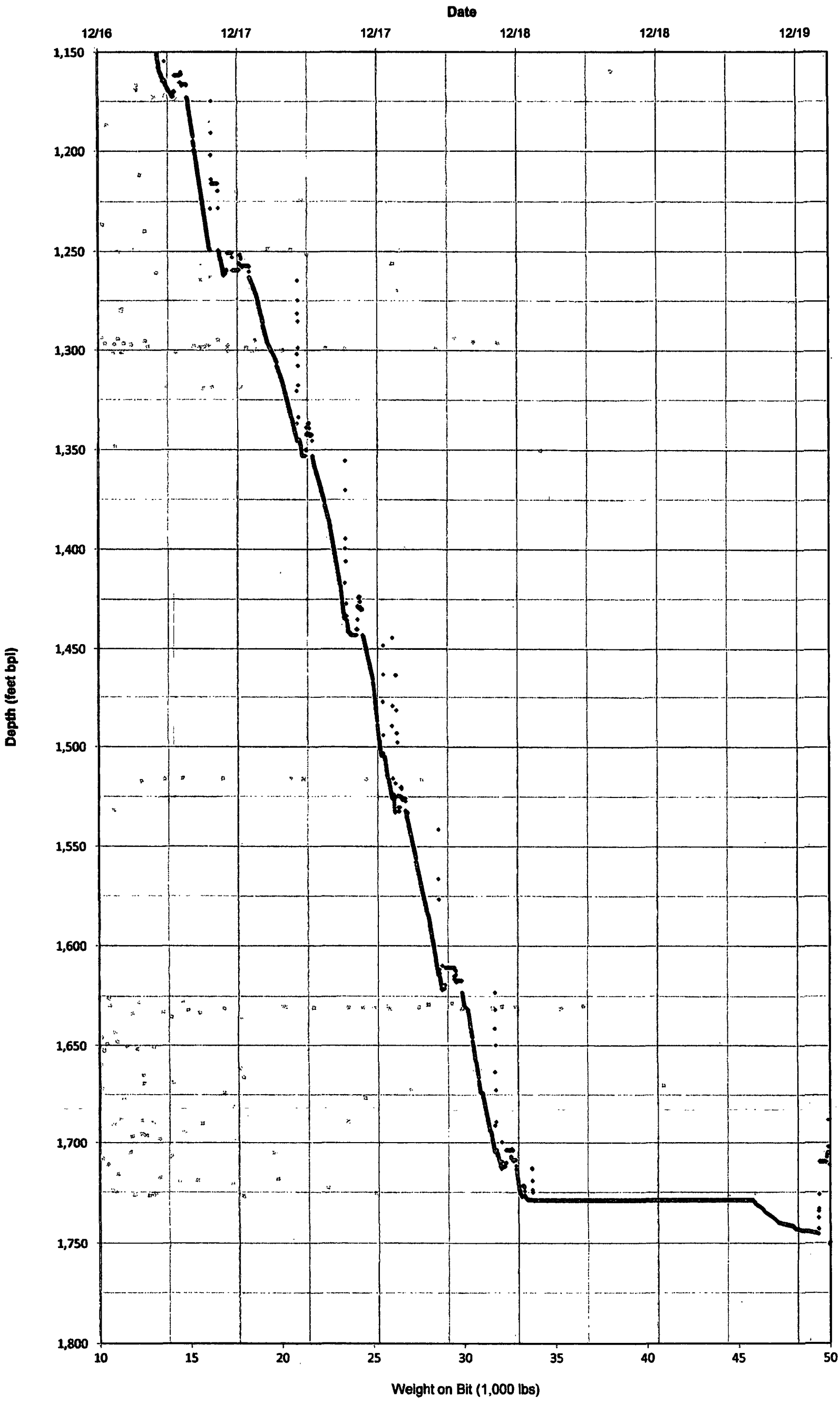
LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
LIMESTONE; Limestone, 100%, yellowish gray (5Y 7/2), little pale yellowish brown (10YR 6/2), grainstone, trace of fossils (shall fragments), very fine- to fine- grained, vuggy, poorly-to moderately well-cemented, very soft to moderately hard, up to 30% in a form of calcareous sand.	WOB=15K RPM=15	1620-1630	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), packstone, some grainstone, trace of fossils and trace of phosphate, fine grained, poorly- to moderately well-cemented, very soft to moderately well-cemented; Dolostone, 10%, pale yellowish brown (10YR 6/2), trace of medium gray (N5), fine- and micro- crystalline, hard; up to 30% in a form of calcareous and dolomitic sand.	WOB=15K RPM=15	1630-1660	30
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), some pale yellowish brown (10YR 6/2), packstone, some grainstone, trace of fossils and trace of phosphate, fine grained, poorly- to moderately well- cemented, soft to moderately hard; Dolostone, 30%, pale yellowish brown (10YR 6/2), fine- and micro- crystalline, hard.	WOB=15K RPM=15	1660-1670	10
LIMESTONE AND DOLOSTONE: Limestone, 50%, yellowish gray (5Y 7/2), packstone and some grainstone, partly dolomitic, fine crystalline, trace of fossils (shell fragments), trace of phosphate, moderately well- to poorly- cemented, moderately hard to very soft; Dolostone, 50%, pale yellowish brown (10YR 6/2), microcrystalline, soft to moderately hard, vuggy; up to 40% of calcareous and dolomitic sand.	WOB=15K RPM=15	1670-1690	20
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), packstone and grainstone, slightly dolomitic, fine grained to fine crystalline, trace of fossils (shell fragments), trace of phosphate, moderately well- cemented, moderately hard to soft, up to 10% in a form of calcareous sand; Dolostone, 10%, pale yellowish brown (10YR 6/2), microcrystalline, hard.	WOB=15K RPM=15	1690-1700	10
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), dolomitic, fine crystalline, trace of oolitic grainstone, trace of phosphate, moderately well cemented, moderately hard, brittle; Dolostone, 30%, pale yellowish brown (10YR 6/2) to olive gray (5Y 3/2), fine- and micro- crystalline, with calcareous intraclasts, hard.	WOB=10-12K RPM=21	1700-1710	10
LIMESTONE AND LITTLE DOLOSTONE: Limestone, 90%, yellowish gray (5Y 7/2), mostly oolitic grainstone, some packstone and fine crystalline, trace of fossils (shell fragments), trace of phosphate, moderately well- to poorly-cemented, moderately hard to soft, up to 20% in a form of calcareous sand; Dolostone, 10%, light olive gray (5Y 5/2) little pale yellowish brown (10YR 6/2), microcrystalline, hard.	WOB=10-12K RPM=21	1710-1720	10

LITHOLOGICAL DESCRIPTION	DRILLING COMMENTS	DEPTH INTERVAL	THICKNESS
LIMESTONE AND SOME DOLOSTONE: Limestone, 70%, yellowish gray (5Y 7/2), dolomitic, fine crystalline, trace of oolitic grainstone, trace of fossils and phosphate, moderately well cemented, moderately hard, brittle; Dolostone, 30%, pale yellowish brown (10YR 6/2) to olive gray (5Y 3/2), fine- and micro-crystalline, with calcareous intraclasts, hard.	WOB=20-22K RPM=21	1720-1740	20
DOLOSTONE AND SOME LIMESTONE: Dolostone, 80%, pale yellowish brown (10YR 6/2), some olive gray (5Y 3/2), micro- to fine-crystalline, with calcareous intraclasts, hard to very hard, slightly vuggy; Limestone, 20%, yellowish gray (5Y 7/2), partly dolomitic, fine crystalline, some oolitic grainstone, moderately well- to poorly- cemented, moderately hard to soft, trace of calcareous sand;	WOB=20-22K RPM=21	1740-1750	10
LIMESTONE AND DOLOSTONE: Limestone, 50%, yellowish gray (5Y 8/1-7/2), dolomitic, packstone, fine crystalline, moderately well cemented, moderately hard, trace of calcareous sand; Dolostone, 50%, pale yellowish brown (10YR 6/2), little olive gray (5Y 3/2), microcrystalline, hard to very hard, vuggy.	WOB=20-22K RPM=21	1750-1755	5

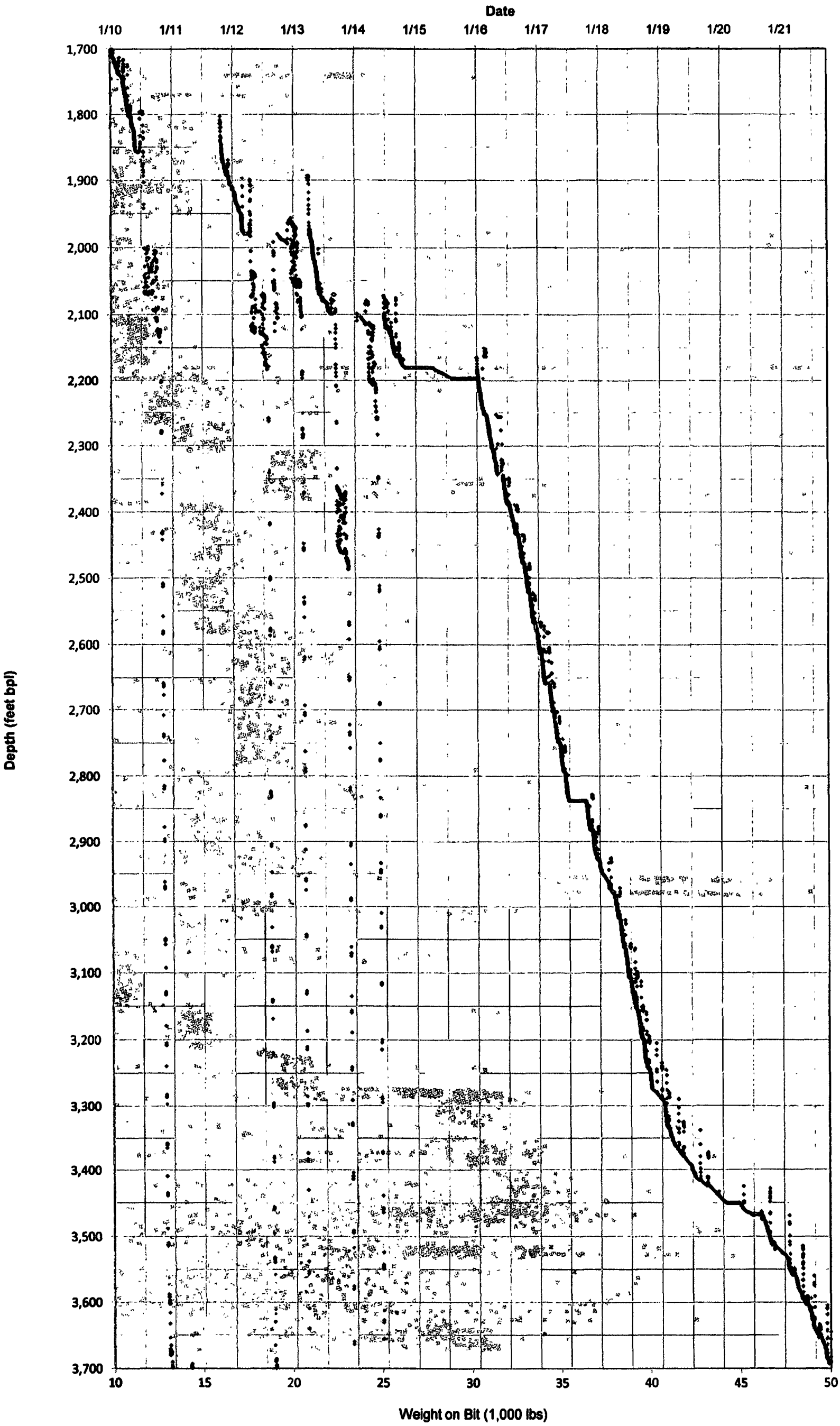
Penetration Rate & Weight on Bit
KLWTD Injection Well IW1
240 - 1,160 Feet BPL



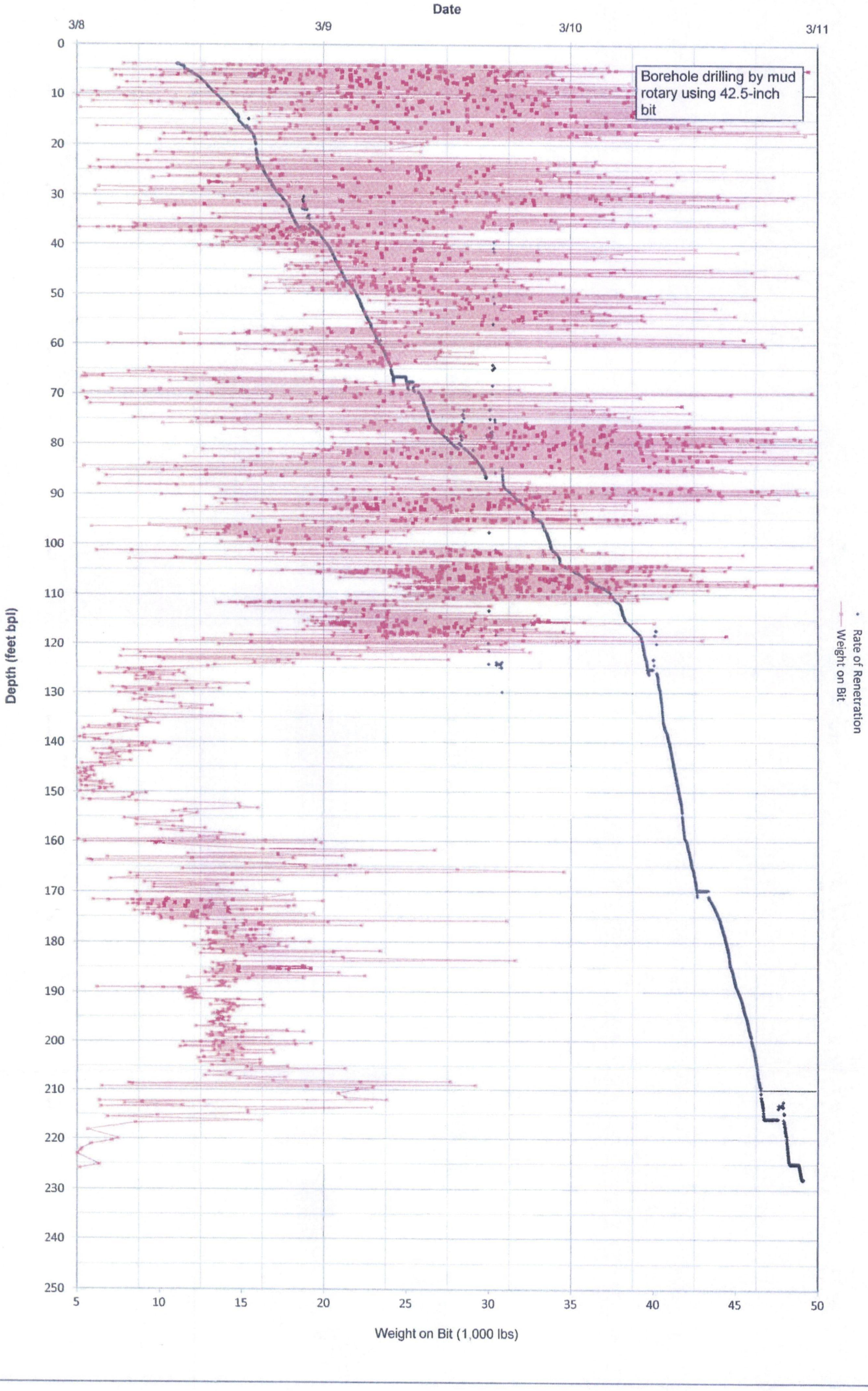
Penetration Rate & Weight on Bit
KLWTD Injection Well IW1
1,160 - 1,750 Feet BPL



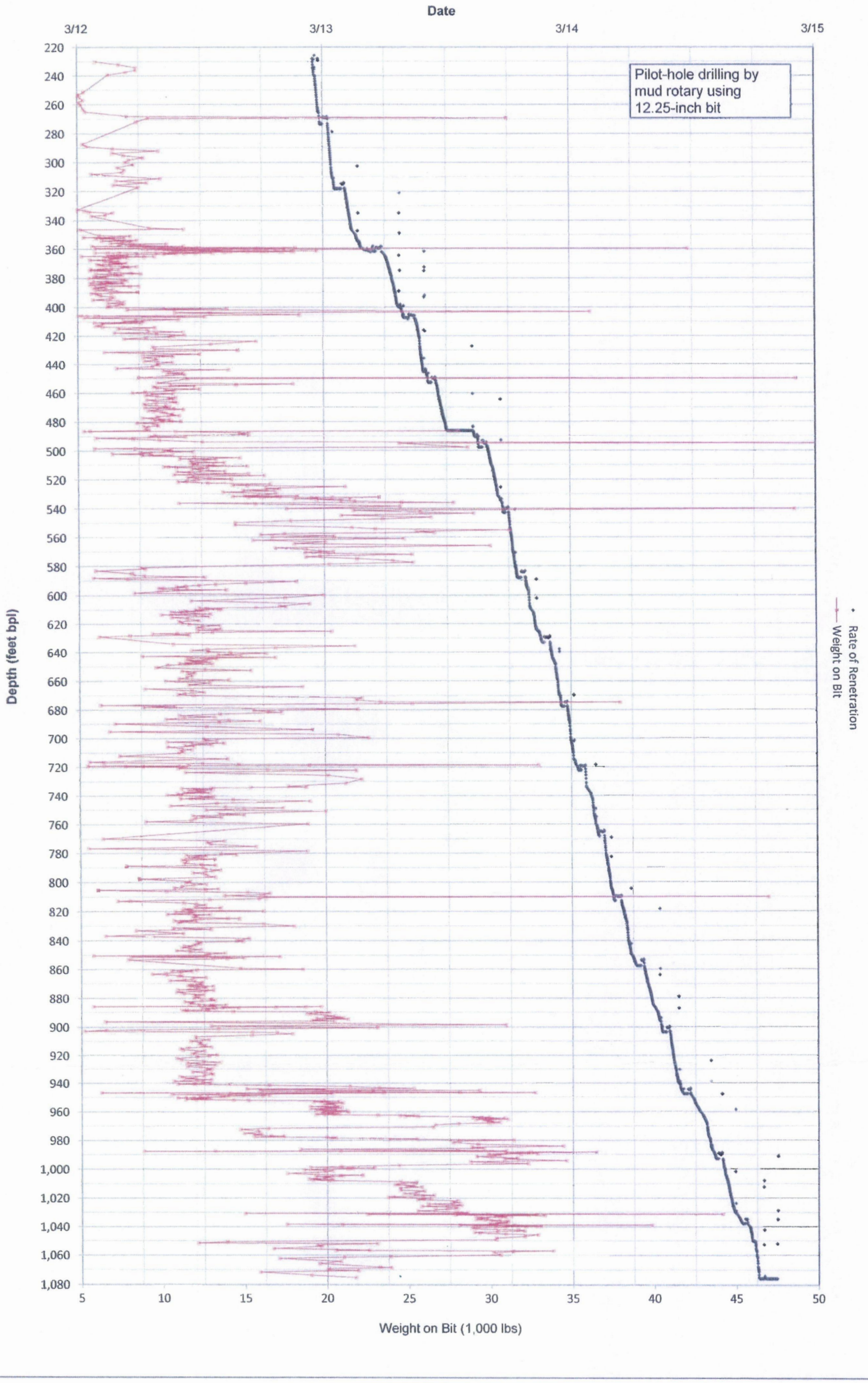
Penetration Rate & Weight on Bit
KLWTD Injection Well IW1
1,750 - 3,693 Feet BPL



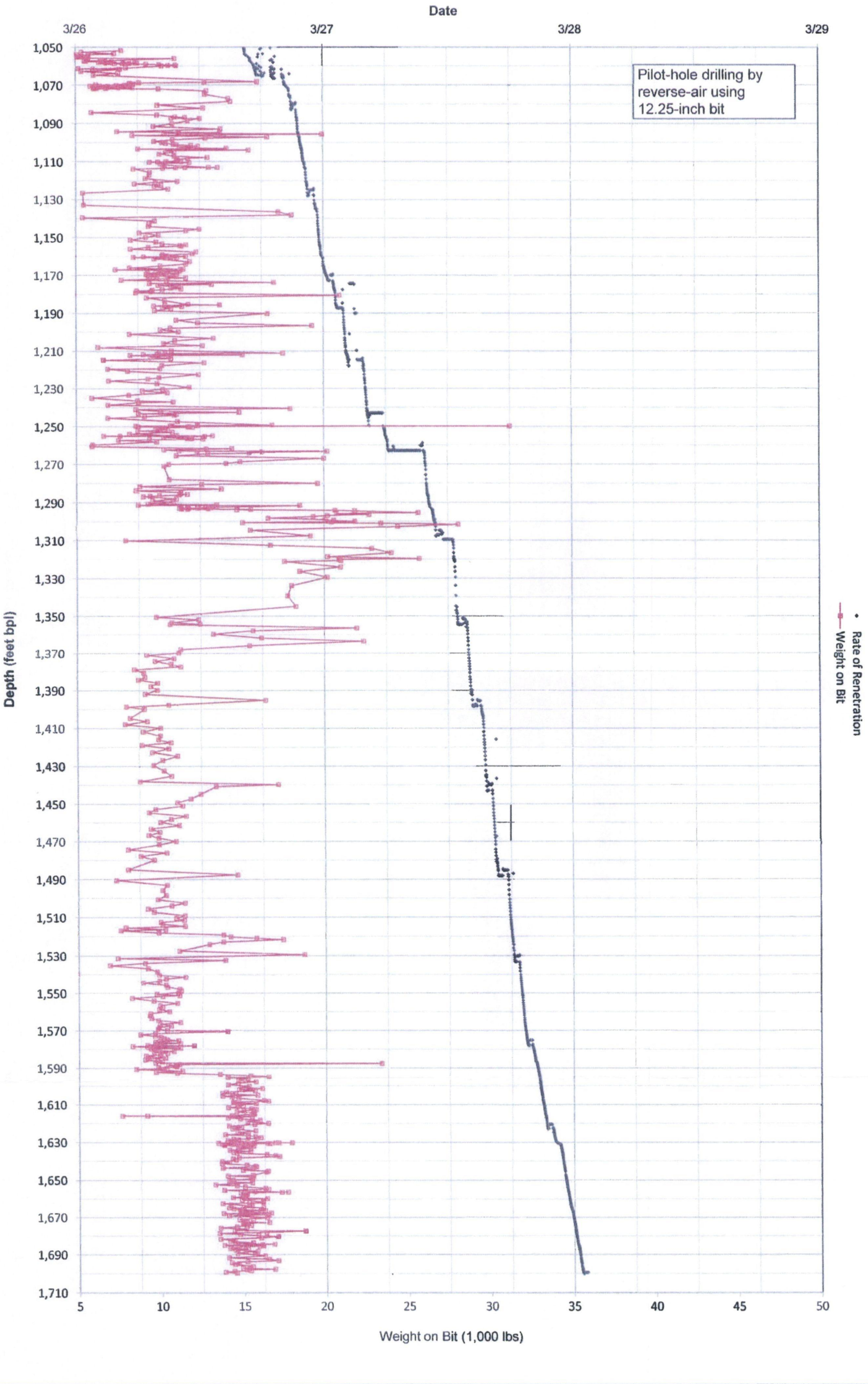
Penetration Rate & Weight on Bit
KLWTD Dual-Zone Deep Monitor Well MW1
0 - 280 Feet BPL



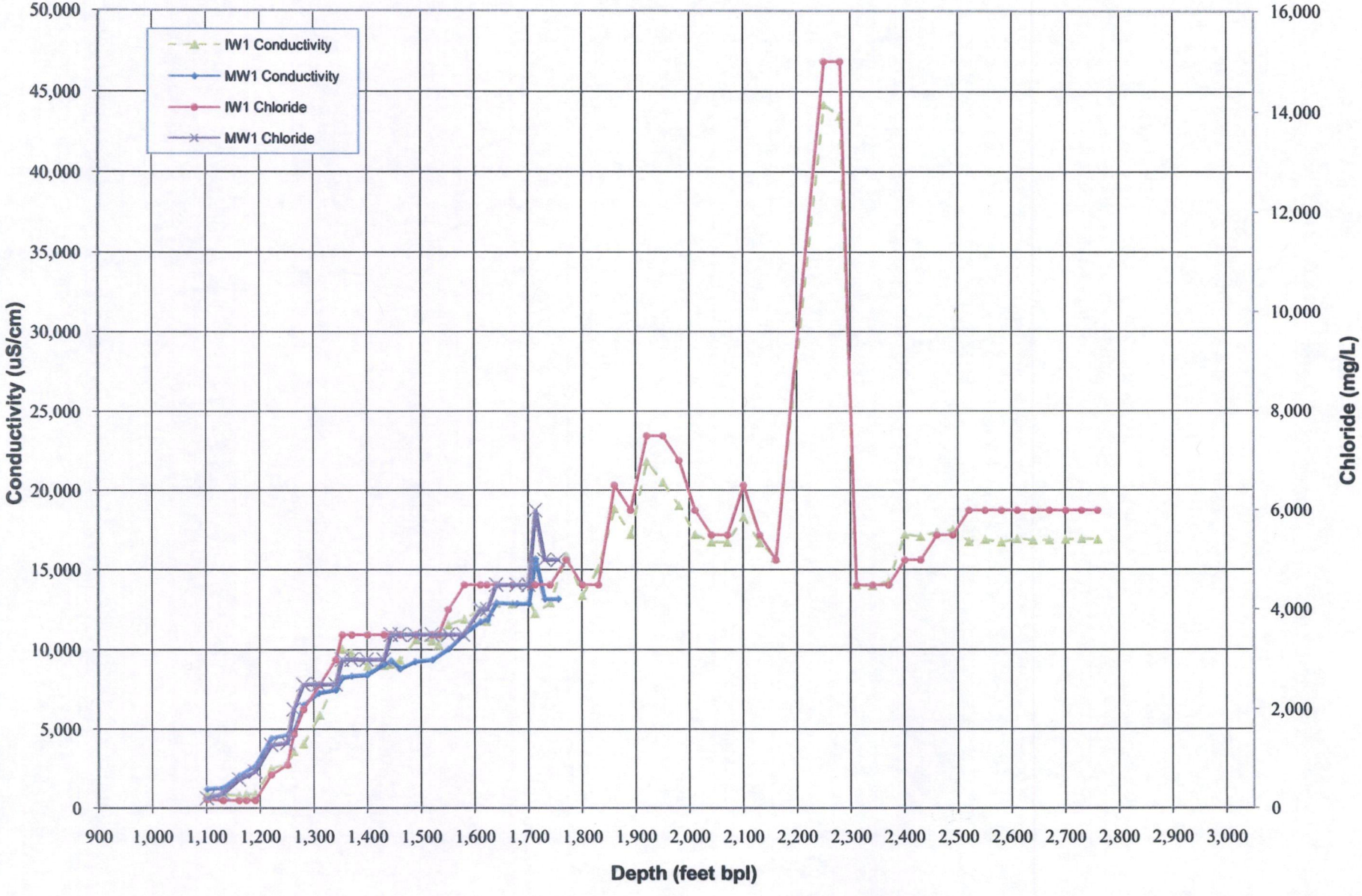
Penetration Rate & Weight on Bit
KLWTD Dual-Zone Deep Monitor Well MW1
280 - 1072 Feet BPL



Penetration Rate & Weight on Bit
KLWTD Dual-Zone Deep Monitor Well MW1
1060 - 1700 Feet BPL



KLWTD Injection Well System
Monitor Well MW1 and Injection Well IW1
Reverse-Air Discharge Water Quality



Appendix C

Core Descriptions, Core Analysis Report and Packer Test Summaries and Charts

Injection Well IW1
Core Laboratory Samples Summary

Core Number	Cored Interval (feet bpl)	Length of Interval Cored (feet)	Total Length of the Retrieved Core (feet)	Percent of Recovery (%)	Core Sample Interval (feet bpl)	Core Sample Length (feet)	Description
1	1729-1745	16	8.0	50.0	1729.7-1730.2	0.50	Ls, solid, v. sl. vuggy
					1733.3-1734.55	1.25	Dls. massive, trace of vugs.
					1736.1-1737.0	0.90	Dls. massive, trace of vugs.
2	1858-1873	15	13.3	80.0	1859.5-1860.35	0.85	Ls, solid, v. sl. vuggy
					1862.4-1863.0	0.60	Ls, massive
					1868.45-1869.2	0.75	Dls. massive, trace of vugs.
3	1980-1995	15	13.3	89	1982.85-1983.8	0.95	Ls, solid, v. sl. vuggy
					1987.85-1988.5	0.65	Dls. massive, trace of vugs.
					1990.4-1991.3	0.90	Ls, massive, hard
4	2100-2116	16	13.9	87.0	2102.55-2103.5	0.95	Ls, massive, hard
					2107.15-2107.8	0.65	Dls/Ls, massive, hard
					2110.9-2111.65	0.75	Ls, solid, sl. vuggy
5	2182-2197	15	14.3	95	2182.35-2182.95	0.60	Ls, massive, hard
					2187.55-2188.2	0.65	Dls. massive,
					2191.25-2191.8	0.55	Ls, dolomitic, massive

"bpl" denotes "below pad level"
pad level is 4 0 feet below rig floor
Core Barrel is 6 75 inches outside diameter (4-inch inside diameter)

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CORE LOG SUMMARY

Key Largo WTD Injection Well System

Key Largo, Florida

Injection Well IW1
Core Sample No. 1

Total Depth Drilled:	16 feet
Core Barrel Length:	30 feet
Core Barrel Diameter ID:	4-inches
Drilling Fluid Used:	water

Date:	12/19/2008
Sampling Interval:	1729-1745 ft bpl
Hole Diameter:	8 inches
Recovery (%):	50

Depth (feet bpl) From	To	Interval Length (feet)	WOB x 1000 lbs	RPM	Pressure (PSI)	ROP (min/ft)	Core Description
1729	1730 0	1	6	13 1-13 6	24-50	6.0	1729 0-1731 0 LIMESTONE, Limestone,100%, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), mudstone, dolomitic, very fine- to fine grained, some fine crystalline, with trace of fossils and trace of phosphate, with irregular, horizontal laminas of darker material, slightly vuggy, moderately well cemented, moderately hard
1730 0	1731 0	1	3.3-5 1	13 2-13.5	24-50	16 0	
1731.0	1732 0	1	3 2-4.2	12 9-13 3	39-51	15 0	1731 0-1732 5 LIMETSTONE; Limestone, 100%, yellowish gray (5Y 8/1-7/2), grainstone, very slightly dolomitic, very fine grained, moderately well- to poorly- cemented, moderately hard to soft. 1732 5-1733 2 LIMESTONE, Limestone, 100%, same as 1729-1731 but more vuggy to porous at the bottom.
1732 0	1733 0	1	2 2-5 1	13-13 4	29-52	10 0	
1733 0	1734 0	1	1-4 4	13 1-13 4	34-57	8 0	1732 5-1733 2. DOLOSTONE, Dolostone, 100%, yellowish gray (5Y 7/2) to light olive gray (5Y 6/1), fine crystalline, with irregular pockets of calcareous material in the bottom 1 5 foot, very hard, massive, with scattered small, shallow vugs
1734 0	1735 0	1	0.5-4 2	13.2-13.4	41-61	13 0	
1735 0	1736 0	1	0 5-5 1	13.1-13 5	37-62	13 0	
1736 0	1737 0	1	1.1-5.5	12.9-13 5	37-101	14 0	
1737 0	1738 0	1	0 9-5.2	13.5	42-82	15 0	
1738.0	1739 0	1	0 8-5.1	13 1-13 4	36-79	7 0	
1739 0	1740 0	1	6 2	13 3	37-82	29 0	
1740 0	1741 0	1	4 3-5 5	13.1-13.4	33-42	49 0	
1741 0	1742 0	1	2 8-4 4	12 8-13 5	28-40	18.0	
1742 0	1743 0	1	6 1	13.2-13.4	27-37	63.0	
1743 0	1744 0	1	4 4	12 9-13 3	32-36	35 0	
1744.0	1745 0	1	3 8	13 3	30-34	22 0	
Total Cored (feet):		**16.0**					

"bpl" denotes below pad level
"RPM" denotes rate per minute of coring barrel
"WOB" denotes weight on coring barrel
"lbs" denotes pounds

ARCADIS

CORE INVENTORY

Key Largo WTD Injection Well System
Key Largo, Florida

Injection Well IW1
Core Sample No. 1

Total Depth Drilled:	16 feet	**Date:**	1/12/2009
Core Barrel Length:	30 feet	**Sampling Interval:**	1729-1737 ft bpl
Core Barrel Diameter ID:	4-inches	**Hole Diameter:**	8 inches
Drilling Fluid Used:	water	**Recovery (%):**	50

Depth (feet bpl)		Interval Length	Core Description
From	To	feet	
1729.00	1729.15	0.15	Limestone fragments up to 1".
1729.15	1729.55	0.40	Limestone solid but vuggy to very vuggy, partly poorly cemented.
1729.55	1729.70	0.15	Same as above, uneven fragment.
1729.70	**1730.20**	**0.50**	**Limestone, solid, hard, very slightly vuggy.**
1730.20	1730.50	0.30	Same as above, uneven fragment.
1730.50	1730.65	0.15	Limestone fragments 1-1.5-inch.
1730.65	1730.90	0.25	Limestone, solid, hard, very slightly vuggy, softer and grainy on top.
1730.90	1731.80	0.90	Limestone, 3-4 inch uneven fragments.
1731.80	1732.20	0.40	Limestone, solid, vuggy, uneven cut.
1732.20	1732.40	0.20	Limestone, irregular fragment.
1732.40	1732.80	0.40	Limestone, solid, moderately hard, slightly vuggy.
1732.80	1733.20	0.40	Limestone, hard, solid but very vuggy to porous.
1733.20	1733.30	0.20	Limestone fragments 1-1.5-inch.
1733.30	**1734.55**	**1.15**	**Dolostone, solid, massive, very hard, very slightly vuggy.**
1734.55	1735.40	0.90	Dolostone, same as above , but vuggy.
1735.40	1736.10	0.70	Dolostone, solid, with calcareous irregular inserts, vuggy to very vuggy.
1736.10	**1737.00**	**0.90**	**Dolostone, same as above , with some shallow vugs.**
Total Core Length (feet):		**8.1**	

"bpl" denotes below pad level

Sections in bold were selected for lab. analyses.

ARCADIS

CORE LOG SUMMARY

Key Largo WTD Injection Well System

Key Largo, Florida

Injection Well IW1

Core Sample No. 2

Total Depth Drilled:	15 feet
Core Barrel Length:	30 feet
Core Barrel Diameter ID:	4-inches
Drilling Fluid Used:	water

Date:	1/11/2009
Sampling Interval:	1858-1873 ft bpl
Hole Diameter:	8 inches
Recovery (%):	89

Depth (feet bpl) From	Depth (feet bpl) To	Interval Length (feet)	WOB x 1000 lbs	RPM	Pressure (PSI)	ROP (min/ft)	Core Description
1858.0	1859.0	1	5	13	21	6	1858.0-1867.1: LIMESTONE; Limestone,100%, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), grainstone, some mudstone and packstone, slightly dolomitic, very fine- to fine grained, some fine crystalline, with trace of fossils and trace of phosphate, with numerous, irregular, horizontal laminas of darker material, slightly vuggy, moderately well- to well- cemented, moderately hard.
1859.0	1860.0	1	5.5	12.9	23	16	
1860.0	1861.0	1	6.1	13.0	25	9	
1861.0	1862.0	1	6.4	12.9	43	10	
1862.0	1863.0	1	6.5	12.9	41	8	
1863.0	1864.0	1	5.4	12.8	48	15	
1864.0	1865.0	1	4.5	12.8	52	11	
1865.0	1866.0	1	5.6	12.8	55	8	
1866.0	1867.0	1	5.2	12.8	45	9	
1867.0	1868.0	1	5.6	12.8	38	10	1867.1-1871.3: DOLOSTONE. Dolostone, 100%, yellowish gray (5Y 7/2), microcrystalline, competent, massive, with brighter, irregular calcareous inclasts, hard to very hard, with some vugs, from 1869 ft bpl gradually becoming light olive gray (5Y 5/2), fine crystalline, with numerous small calcareous inserts, less competent, disintegrating at the bottom, vuggy to very vuggy.
1868.0	1869.0	1	5.3	12.8	38	12	
1869.0	1870.0	1	6.8	13.0	39	33	
1870.0	1871.0	1	7.0	13.0	45	76	
1871.0	1872.0	1	6.6	13.1	37	79	
1872.0	1873.0	1	6.3	13.1	35	67	

Total Cored (feet): 15.0

"bpl" denotes below pad level
"RPM" denotes rate per minute of coring barrel
"WOB" denotes weight on coring barrel
"lbs" denotes pounds

ARCADIS

CORE INVENTORY

Key Largo WTD Injection Well System
Key Largo, Florida

Injection Well IW1
Core Sample No. 2

Total Depth Drilled:	15 feet	**Date:**	1/11/2009
Core Barrel Length:	30 feet	**Sampling Interval:**	1858-1873 ft bpl
Core Barrel Diameter ID:	4-inches	**Hole Diameter:**	8 inches
Drilling Fluid Used:	water	**Recovery (%):**	89

Depth (feet bpl)		Interval Length	Core Description
From	To	feet	
1858.00	1958.10	0.10	Ls; 1-3" fragments
1858.10	1858.40	0.30	Ls, vuggy, uneven cuts on both ends
1958.40	1859.15	0.75	Ls, solid, vuggy
1859.15	1859.50	0.35	Ls, solid, trace of vugs
1859.50	**1860.35**	**0.85**	**Ls, solid, partly vuggy**
1860.35	1860.75	0.40	Ls, solid
1860.75	1861.20	0.45	Ls, solid
1861.20	1861.40	0.20	Ls: 0.5-1" fragments
1861.40	1861.65	0.25	Ls, solid, uneven cuts
1861.65	1861.90	0.25	Ls, solid, uneven cuts
1861.90	1862.40	0.50	Ls, solid , with darker smudges
1862.40	**1863.00**	**0.60**	**Ls, solid, massive**
1863.00	1863.50	0.50	Ls, semi solid
1863.50	1864.00	0.50	Ls, semi solid
1864.00	1864.45	0.45	Ls, partly broken, vuggy
1864.45	1864.80	0.35	Ls, uneven cut, vuggy
1864.80	1865.65	0.85	Ls, multiple vugs
1865.65	1866.00	0.35	Ls, uneven cut, vuggy
1866.00	1866.30	0.30	Ls, uneven cut, vuggy
1866.30	1866.80	0.50	Ls, uneven cut, vuggy
1866.80	1867.10	0.30	Ls, uneven cut, vuggy
1867.10	1867.40	0.30	Dls, with intraclasts, uneven cut
1867.40	1867.70	0.30	Dls, massive, uneven cut
1867.70	1868.45	0.75	Dls, vuggy, healed fractures
1868.45	**1869.20**	**0.75**	**Dls, vuggy**
1869.20	1870.15	0.95	Dls, solid, massive, slightly vuggy
1870.15	1870.60	0.45	Dls, solid, massive, vuggy
1870.60	1971.00	0.40	Dls, fragments 0.5-3"
1871.00	1971.30	0.30	Dls, solid, vuggy
Total Core Length (feet):		**13.3**	

"bpl" denotes below pad level

Sections in bold were selected for lab. analyses.

ARCADIS

CORE LOG SUMMARY

Key Largo WTD Injection Well System

Key Largo, Florida

Injection Well IW1
Core Sample No. 3

Total Depth Drilled:	15 feet
Core Barrel Length:	30 feet
Core Barrel Diameter ID:	4-inches
Drilling Fluid Used:	water

Date:	1/13/2009
Sampling Interval:	1980-1995 ft bpl
Hole Diameter:	8 inches
Recovery (%):	89

Depth (feet bpl) From	Depth (feet bpl) To	Interval Length (feet)	WOB x 1000 lbs	RPM	Pressure (PSI)	ROP (min/ft)	Core Description
1980	1981.0	1	4.0	12.3	18	5	1980.0-1987: LIMESTONE; Limestone,100%, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), mudstone, dolomitic, very fine- to fine grained, some fine crystalline, with trace of fossils and trace of phosphate, with numerucus, irregular, horizontal laminas of darker material, slightly vuggy, moderately well- to well-cemented, moderately hard. From approx. 1988.7 ft bpl gradually becoming more dolomitic and transforming into dolostone
1981.0	1982.0	1	4.5	12.3	20	7	
1982.0	1983.0	1	5.0	12.2	37	14	
1983.0	1984.0	1	5.0	12.2	37	13	
1984 0	1985.0	1	4.5	12 3	33	11	
1985 0	1986.0	1	5.0	12.2	36	10	
1986 0	1987 0	1	4.0	12.2	37	11	
1987 0	1988.0	1	4.0	12.2	43	10	1987-1989: DOLOSTONE: Dolostone, 100%, yellowish gray (5Y 7/2), microcrystalline, competent, massive, with brighter, irregular calcareous intraclasts, hard to very hard, with some vugs
1988.0	1989 0	1	4 5	12.2	43	32	
1989.0	1990.0	1	5.0	12 2	47	47	1989-1993.3: LIMESTONE; Limestone,100%, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), grainstone and mudstone, very fine- to fine grained, with trace of fossils and trace of phosphate, with numerucus, irregular, horizontal laminas of darker material, slightly vuggy, moderately well- to well- cemented, moderately hard.
1990.0	1991.0	1	5.5	12.3	43	18	
1991 0	1992.0	1	5 0	12.3	35	16	
1992.0	1993.0	1	4.5	12.3	40	15	
1993.0	1994.0	1	4.5	12.2	35	11	
1994.0	1995.0	1	5.0	12.2	35	14	
Total Cored (feet):		**15.0**					

"bpl" denotes below pad level
"RPM" denotes rate per minute of coring barrel
"WOB" denotes weight on coring barrel
"lbs" denotes pounds

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CORE INVENTORY

Key Largo WTD Injection Well System
Key Largo, Florida

Injection Well IW1
Core Sample No. 3

Total Depth Drilled:	15 feet	**Date:**	1/13/2009
Core Barrel Length:	30 feet	**Sampling Interval:**	1980-1995 ft bpl
Core Barrel Diameter ID:	4-inches	**Hole Diameter:**	8 inches
Drilling Fluid Used:	water	**Recovery (%):**	89

Depth (feet bpl)		Interval Length	Core Description
From	To	feet	
1980.00	1980.20	0.20	Ls, solid, slightly vuggy
1980.20	1980.60	0.40	Ls, solid, slightly vuggy
1980.60	1981.10	0.50	Ls, fragments 1-2".
1981.10	1981.50	0.40	Ls, solid, vuggy
1981.50	1981.75	0.25	Ls, fragments 0.5-1.5".
1981.75	1982.00	0.25	Ls, solid, slightly vuggy
1982.00	1982.85	0.85	Ls, solid, vuggy
1982.85	**1983.80**	**0.95**	**Ls, solid, massive, slightly vuggy**
1983.80	1984.70	0.90	Ls, solid, massive, very slightly vuggy
1984.70	1984.80	0.10	Ls, solid, uneven cut
1984.80	1985.20	0.40	Ls, solid, uneven cut
1985.20	1985.50	0.30	Ls, solid
1985.50	1985.80	0.30	Ls, solid
1985.80	1986.00	0.20	Ls, solid
1986.00	1986.25	0.25	Ls, solid
1986.25	1986.45	0.20	Ls, solid
1986.45	1987.55	1.10	Ls/ Dls transition, slightly vuggy to vuggy
1987.55	1987.85	0.30	Dls, solid, very slightly vuggy
1987.85	**1988.50**	**0.65**	**Dls, solid, very slightly vuggy**
1988.50	1988.90	0.40	Dls, solid, very slightly vuggy
1988.90	1989.30	0.40	Ls, solid, uneven cut
1989.30	1990.40	1.10	Ls, solid, smudgy, possibly fragile
1990.40	**1991.30**	**0.90**	**Ls, solid, massive**
1991.30	1991.60	0.30	Ls, solid, uneven cut
1991.60	1992.00	0.40	Ls, solid, uneven cut w/ smudges
1992.00	1993.30	1.30	Ls, uneven cut, very smudgy
Total Core Length (feet):		**13.3**	

"bpl" denotes below pad level

Sections in bold were selected for lab. analyses.

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CORE LOG SUMMARY

Key Largo WTD Injection Well System

Key Largo, Florida

Injection Well IW1
Core Sample No. 4

Total Depth Drilled:	16 feet
Core Barrel Length:	30 feet
Core Barrel Diameter ID:	4-inches
Drilling Fluid Used:	water

Date:	1/14/2009
Sampling Interval:	2100-2116 ft bpl
Hole Diameter:	8 inches
Recovery (%):	87

Depth (feet bpl) From	Depth (feet bpl) To	Interval Length (feet)	WOB x 1000 lbs	RPM	Pressure (PSI)	ROP (min/ft)	Core Description
2100 0	2101 0	1	5.0	13.0	30	26	2100.0-2107 2 LIMESTONE; Limestone,100%, yellowish gray (5Y 8/1) to very pale orange (10YR 8/2), mudstone and packstone, with numerous horizontal laminas of olive gray (5Y 4/1) material to 2101.9 ft bpl, trace of fossils, moderately well- to well- cemented, moderately hard, very fine grained, below 2103.8 ft bpl becoming yellowish gray (5Y 7/2) arenaceous grainstone, less competent, vuggy. 2107.2-2107.8: Gradual transition from limestone into dolostone, rock becoming darker and dolomitic with depth.
2101 0	2102.0	1	4 5	13.0	356	21	
2102.0	2103.0	1	4 0	13.0	50	25	
2103.0	2104 0	1	3.5	13 2	65	17	
2104.0	2105.0	1	4.0	13.1	55	10	
2105.0	2106.0	1	3 0	13.1	70	7	
2106.0	2107.0	1	3 0	13.1	65	5	
2107.0	2108 0	1	2 0	13.0	60	8	
2108 0	2109.0	1	4.5	13 1	60	23	2107.8-2110.3: DOLOSTONE. Dolostone, 100%, light olive gray (5Y 4/1), fine crystalline, with numerous brighter, irregular intraclasts of yellowish gray (5Y 7/2) and light gray (N7) calcareous material, hard to very hard, with some vugs. 2110.3-2110.7. Gradual transition from olive gray (5Y 4/1) dolostone into yellowish gray (5Y 7/2) limestone.
2109.0	2110.0	1	4 5	13.1	48	18	
2110.0	2111 0	1	5 0	13.1	52	15	
2111.0	2112.0	1	5.0	13 1	53	7	2110.7-2112.9: LIMESTONE; Limestone,100%, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), grainstone, fine grained, with trace of fossils and trace of phosphate, vuggy to porous, poorly- moderately well- cemented, soft to moderately hard, fragmented between 2112.3 and 2113 9 ft bpl, and becoming more competent below 2113.9 ft bpl.
2112.0	2113.0	1	5.0	13 1	55	5	
2113.0	2114 0	1	5 0	13.1	52	5	
2114.0	2115.0	1	5.0	13.2	50	7	
2115.0	2116.0	1	4 5	13.1	52	5	
Total Cored (feet):		**16.0**					

"bpl" denotes below pad level
"RPM" denotes rate per minute of coring barrel
"WOB" denotes weight on coring barrel
"lbs" denotes pounds

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CORE INVENTORY

Key Largo WTD Injection Well System
Key Largo, Florida

Injection Well IW1
Core Sample No. 4

Total Depth Drilled:	16 feet	**Date:**	1/14/2009
Core Barrel Length:	30 feet	**Sampling Interval:**	2100-2116 ft bpl
Core Barrel Diameter ID:	4-inches	**Hole Diameter:**	8 inches
Drilling Fluid Used:	water	**Recovery (%):**	87

Depth (feet bpl) From	Depth (feet bpl) To	Interval Length feet	Core Description
2100.00	2100.30	0.30	Ls, solid, massive.
2100.30	2100.50	0.20	Ls, solid, massive.
2100.50	2100.80	0.30	Ls, solid, massive.
2100.80	2101.00	0.20	Ls, solid, massive.
2101.00	2101.35	0.35	Ls, solid, massive.
2101.35	2101.70	0.35	Ls, solid, massive.
2101.70	2102.05	0.35	Ls, solid, slightly vuggy.
2102.05	2102.55	0.50	Ls, solid, massive.
2102.55	**2103.50**	**0.95**	**Ls, solid, massive.**
2103.50	2103.80	0.30	Ls, solid, massive.
2103.80	2104.00	0.20	Ls, vuggy, fragile.
2104.00	2104.70	0.70	Ls, vuggy on top half.
2104.70	2105.40	0.70	Ls, very vuggy.
2105.40	2106.40	1.00	Ls, vuggy on top half.
2106.40	2106.85	0.45	Ls, solid, slightly vuggy.
2106.85	2107.15	0.30	Ls, uneven cut on top/bottom.
2107.15	**2107.80**	**0.65**	**Ls/dls transition, solid, v. hard, uneven cut on top.**
2107.80	2108.15	0.35	Dls, uneven cut on top/bottom
2108.15	2108.30	0.15	Dls, uneven cut on top/bottom
2108.30	2108.75	0.45	Dls, solid, massive
2108.75	2109.00	0.25	Dls, uneven cut on top/bottom
2109.00	2109.40	0.40	Dls, uneven cut on top/bottom
2109.40	2109.75	0.35	Dls, uneven cut on top/bottom
2109.75	2110.00	0.25	Dls, uneven cut on top/bottom
2110.00	2110.25	0.25	Ls, dolomitic, solid, massive
2110.25	2110.65	0.40	Ls, dolomitic, solid, vuggy, uneven cut
2110.65	2110.90	0.25	Ls, dolomitic, solid, massive
2110.90	**2111.65**	**0.75**	**Ls, solid, slightly vuggy.**
2111.65	2112.00	0.35	Ls, uneven cut on top/bottom.
2112.00	2112.35	0.35	Ls, vuggy, crumbling
2112.35	2112.80	0.45	Ls, fragments 1-4".
2112.80	2113.40	0.60	Ls, vuggy, crumbling
2113.40	2113.90	0.50	Ls, vuggy, crumbling
Total Core Length (feet):		**13.9**	

"bpl" denotes below pad level

Sections in bold were selected for lab. analyses.

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CORE LOG SUMMARY

Key Largo WTD Injection Well System

Key Largo, Florida

Injection Well IW1
Core Sample No. 5

Total Depth Drilled:	15 feet	**Date:**	1/16/2009
Core Barrel Length:	30 feet	**Sampling Interval:**	2182-2197 ft bpl
Core Barrel Diameter ID:	4-inches	**Hole Diameter:**	8 inches
Drilling Fluid Used:	water	**Recovery (%):**	95

Depth (feet bpl)		Interval Length	WOB	RPM	Pressure	ROP	Core Description
From	To	(feet)	x 1000 lbs		(PSI)	(min/ft)	
2182.0	2183.0	1	5.5	13.0	22	23	2182.0-2184.6 DOLOSTONE AND LIMESTONE; Dolostone, 60%, yellowish gray (5Y 7/2) to light olive gray (5Y 6/1), fine crystalline, slightly vuggy with frequent, large intraclasts of yellowish gray (5Y 8/1) calcareous material of irregular shape,(up to 40%),slightly phosphatic, well cemented, hard.
2183.0	2184.0	1	5.0	13.0	37	26	
2184.0	2185.0	1	6.0	12.9	55	29	2184.6-2188.7: LIMESTONE; Limestone,100%, yellowish gray (5Y 7/2 to 8/1), mostly packstone, some grainstone, slightly dolomitic, with trace of fossils and trace of phosphate, very fine- to fine- grained, competent, with trace of vugs, well- cemented, moderately hard to hard, numerous, horizontal, black (phosphate?) laminas at the bottom.
2185.0	2186.0	1	5.5	13.0	50	26	
2186.0	2187.0	1	5.0	13.0	55	39	
2187.0	2188.0	1	5.5	13.0	50	40	
2188.0	2189.0	1	5.0	12.9	45	35	
2189.0	2190.0	1	5.5	12.9	50	27	2188.7-2189.5: DOLOSTONE: Dolostone, 100%, light olive gray (5Y 6/1), fine crystalline, with frequent, irregular intraclasts of calcareous material (up to 20%), hard.
2190.0	2191.0	1	5.0	12.9	50	33	2189.5-2191.8: LIMESTONE; Limestone,100%, yellowish gray (5Y 7/2 to 8/1), mostly packstone, some grainstone, slightly dolomitic, with trace of fossils and trace of phosphate, very fine- to fine- grained, competent, with laminas of darker material on top and becoming dolomitic from 2191.2 ft bpl.
2191.0	2192.0	1	5.0	12.9	55	19	
2192.0	2193.0	1	4.5	12.9	66	19	2191.8-2193.8: DOLOSTONE: Dolostone, 100%, gray yellowish orange (10YR 7/4) to pale yellowish brown (10YR 6/2), fine crystalline, slightly vuggy to vuggy near bottom, very hard.
2193.0	2194.0	1	4.0	12.9	45	34	
2194.0	2195.0	1	5.0	12.9	50	24	2193.8-2196.3: LIMESTONE; Limestone,100%, yellowish gray (5Y 7/2 to 8/1), mostly packstone, some grainstone, slightly dolomitic, with trace of fossils and trace of phosphate, very fine- to fine- grained, competent, with trace of vugs, well- cemented, moderately hard to hard, numerous, horizontal, black (phosphate?) laminas to 2194.6 ft bpl.
2195.0	2196.0	1	4.5	12.8	50	20	
2196.0	2197 0	1	4.0	12.9	45	19	
	Total Cored (feet):	15.0					

"bpl" denotes below pad level
"RPM" denotes rate per minute of coring barrel
"WOB" denotes weight on coring barrel
"lbs" denotes pounds

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CORE INVENTORY

Key Largo WTD Injection Well System
Key Largo, Florida

Injection Well IW1
Core Sample No. 5

Total Depth Drilled:	15 feet	**Date:**	1/16/2009
Core Barrel Length:	30 feet	**Sampling Interval:**	2182-2197 ft bpl
Core Barrel Diameter ID:	4-inches	**Hole Diameter:**	8 inches
Drilling Fluid Used:	water	**Recovery (%):**	95

Depth (feet bpl) From	Depth (feet bpl) To	Interval Length feet	Core Description
2182.00	2182.35	0.35	Dls, solid, massive, slightly vuggy
2182.35	**2182.95**	**0.60**	**Dls, solid, massive.**
2182.95	2183.20	0.25	Ls, solid, massive.
2183.20	2183.45	0.25	Ls, solid, massive.
2183.45	2183.75	0.30	Ls, solid, massive.
2183.75	2184.15	0.40	Dls, solid, massive, slightly vuggy
2184.15	2184.65	0.50	Dls, solid, uneven cut
2184.65	2185.05	0.40	Ls, solid, vuggy
2185.05	2185.30	0.25	Ls, solid, slightly vuggy
2185.30	2185.70	0.40	Ls, solid, massive.
2185.70	2186.40	0.70	Ls, solid, massive.
2186.40	2186.75	0.35	Ls, solid, massive.
2186.75	2186.90	0.15	Ls, solid, massive.
2186.90	2187.15	0.25	Ls, solid, massive.
2187.15	2187.55	0.40	Ls, solid, massive.
2187.55	**2188.20**	**0.65**	**Ls, solid, massive.**
2188.20	2188.50	0.30	Ls, solid, massive.
2188.50	2188.75	0.25	Ls/Dls, solid
2188.75	2189.35	0.60	Dls, vuggy with calcareous intraclasts
2189.35	2189.70	0.35	Ls/Dls, solid, slightly vuggy
2189.70	2190.95	1.25	Ls, solid, slightly vuggy
2190.95	2191.25	0.30	Ls, vuggy
2191.25	**2191.80**	**0.55**	**Ls, dolomitic, solid, massive.**
2191.80	2192.45	0.65	Dls, uneven cut, sightly vuggy
2192.45	2193.15	0.70	Dls, vuggy with healed fractures
2193.15	2193.75	0.60	Dls, vuggy with calcareous intraclasts
2193.75	2194.05	0.30	Ls, solid, with laminas, partly vuggy
2194.05	2194.65	0.60	Ls, solid, with laminas, vuggy
2194.65	2195.75	1.10	Ls, solid, slightly vuggy
2195.75	2196.30	0.55	Ls, slightly vuggy to vuggy
Total Core Length (feet):		**14.3**	

"bpl" denotes below pad level

Sections in bold were selected for lab. analyses.

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

May 26, 2009
File Number 09-022

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MAY 28 2009

Youngquist Brothers, Inc.
15465 Pine Ridge Road
Ft. Myers, FL 33908

Attention: Wu Fei

Subject: Rock Core Testing, Key Largo WTD Injection Well System

Ms. Fei:

As requested, vertical and horizontal permeability, unconfined compression and specific gravity tests have been completed on limestone rock cores provided for testing by your firm. The samples were received on 01/28/09. The designations of the 15 samples are listed below.

Core	Depth (feet)
1	1729.7-1730.2
	1733.3-1734.55
	1736.1-1737.0
2	1858.5-1860.35
	1862.4-1863.0
	1868.45-1869.2
3	1982.85-1983.8
	1987.85-1988.5
	1990.4-1991.3
4	2102.55-2103.5
	2107.15-2107.8
	2110.9-2111.65
5	2182.35-2182.95
	2187.55-2188.2
	2191.25-2191.8

The permeability tests were performed in general accordance with ASTM Standard D 5084 "Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter" using the constant head test method (Method A). The permeability test results are presented on the attached hydraulic conductivity test reports.

The unconfined compression tests were performed in general accordance with ASTM Standard D 7012 "Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures" using the unconfined test method (Method C). The unconfined compression test results are presented on the attached test reports.

The measured mineral specific gravities are presented on the attached test reports. The specific gravity tests were performed in general accordance with ASTM Standard D 854 "Specific Gravity of Soil Solids by Water Pycnometer" using 45 to 85 gram specimens ground to pass the U.S. Standard No. 40 sieve.

The specimens were reported to be from the samples designated herein. The test results are indicative of only the specimens that were actually tested. The test results presented are based upon accepted industry practice as well as test method(s) listed. Ardaman & Associates, Inc. neither accepts responsibility for, nor makes claims to the final use and purpose of the material.

Archie's cementation exponent and coefficient tests are in-progress. The test results will be submitted as the tests are completed.

Please contact us if you have any questions about the test results or require additional information.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

Thomas S. Ingra, P.E.
Laboratory Director
Florida License No. 31987

TSI/ed

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/02/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 1, 1729.7' - 1730.2'

LABORATORY IDENTIFICATION NO.: 09022/C1AV

SAMPLE DESCRIPTION: Light brown limestone (v. sl. vuggy)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 97 % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 10

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 5.9/4.5* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.72 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_o$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.94	9.97	620.26	6.8	143.1	0.157	100	30	160	37	1.4	2	1422.8	6.8	100	1.2 x 10-7

COMMENTS:(1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_o$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 1, 1729.7' - 1730.2'

LABORATORY IDENTIFICATION NO.: 09022/C1AH

SAMPLE DESCRIPTION: Light brown limestone (v. sl. vuggy)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 98 % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 16

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 5.9/4.5* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.72 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.86	5.05	157.35	6.8	143.1	0.157	99	30	160	26	1.0	2	360.75	6.8	99	3.2 x 10-7

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 07/26/09

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/03/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 1, 1733.3' - 1734.55'

LABORATORY IDENTIFICATION NO.: 09022/C1BV

SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: - % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): -

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 13.9/11.5* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.81 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_o (%)	S (%)	k_{20} (cm/sec)
9.88	10.07	787.10	4.2	155.8	0.112	95	30	160	64	3.3	3	1965.0	4.2	95	5.0 x 10-9

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_o$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 1, 1733.3' - 1734.55'

LABORATORY IDENTIFICATION NO.: 09022/C1BH

SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, fr, vugs)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 40 (stable) % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 13, 18, 26, 30

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 13.9/11.5* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.81 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_o (%)	S (%)	k_{20} (cm/sec)
8.15	5.05	163 45	2.2	155.5	0.113	48	30	160	72	4.3	7	407.33	4.2	94	1.3 x 10-8

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress, u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/01/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 1, 1736.1' - 1737.0'

LABORATORY IDENTIFICATION NO.: 09022/1CV

SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs, one fracture)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 99 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 9

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 10.6/7.7* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.81

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_o (%)	S (%)	k_{20} (cm/sec)
9.42	10.09	753.13	1.4	162.3	0.074	50	30	160	74	1.0	10	1958.8	2.3	80	1.0 x 10-9

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_o from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_o.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 08-195

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/16/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: **Core 1, 1736.1' - 1737.0'**

LABORATORY IDENTIFICATION NO.: 09022/1CH

SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs, one fracture)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 50 (stable) % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 8, 14, 25

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 10.6/7.7* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.81 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.80	5.05	156.53	2.3	162.6	0.073	82	60	130	898	0.73	50	407.83	2.3	82	3.8 x 10-11

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/04/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 2, 1859.5' - 1860.35'

LABORATORY IDENTIFICATION NO.: 09022/C2AV

SAMPLE DESCRIPTION: Light brown limestone (v. sl. vuggy)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 98 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 12

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 9.8/7.7* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.68

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_o (%)	S (%)	k_{20} (cm/sec)
9.87	9.91	761.60	20.3	108.1	0.354	100	30	160	21	14	1	1319.2	20.3	100	2.3 x 10-6

COMMENTS. (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_o from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: **Core 2, 1859.5' - 1860.35'**

LABORATORY IDENTIFICATION NO.: 09022/C2AH

SAMPLE DESCRIPTION: Light brown limestone (v. sl. vuggy)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 96 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 7

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 9.8/7.7* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.68

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.70	5.04	153.90	20.3	108.0	0.354	99	30	160	51	0.4	1	266.40	20.3	99	3.0 x 10-6

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_o$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

Form SR-2B: Rev. 0

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/01/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 2, 1862.4' - 1863.0'

LABORATORY IDENTIFICATION NO.: 09022/C2BV

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 100 % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 8

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 6.7/3.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.70 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.47	9.92	577.37	25.8	99.5	0.410	100	30	160	28	2.0	8	920.41	25.8	100	5.2 x 10-6

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 2, 1862.4' - 1863.0'

LABORATORY IDENTIFICATION NO.: 09022/C2BH

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 86 (stable) % ☒ Beginning of Test; ☐ End of Test

$\Delta\sigma_c$ (psi): 10, 17, 21

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 6.7/3.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.70 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_o (%)	S (%)	k_{20} (cm/sec)
7.34	5.05	146.86	25.8	98.8	0.413	99	30	160	50	3.3	2	232.64	25.8	99	1.4 x 10-5

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/02/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 2, 1868.45' - 1869.2'

LABORATORY IDENTIFICATION NO.: 09022/2CV

SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 97 % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 11

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 8.9/7.2* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.81 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
8.22	10.05	652.38	7.2	143.9	0.180	93	30	160	46	2.1	2	1503.9	7.3	94	1.1 x 10-7

COMMENTS. (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_o from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 2, 1868.45' - 1869.2'

LABORATORY IDENTIFICATION NO.: 09022/2CH

SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 97 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 12

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 8.9/7.2* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.81

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
8.47	5.05	169.84	7.3	145.2	0.172	99	30	160	81	0.69	1	395.32	7.3	99	8.7 x 10-8

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTP Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/04/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 3, 1982.85' - 1983.8'

LABORATORY IDENTIFICATION NO.: 09022/3AV

SAMPLE DESCRIPTION: Light brown limestone (v. sl. vuggy)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 97 % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 8

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 11.6/9.4* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.70 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
8.87	9.78	665.83	20.7	108.1	0.358	100	30	160	24	2.1	2	1153.3	20.7	100	6.6 x 10-6

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: **Core 3, 1982.85' - 1983.8'**

LABORATORY IDENTIFICATION NO.: 09022/3AH

SAMPLE DESCRIPTION: Light brown limestone (v. sl. vuggy)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 98 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 7

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 11.6/9.4* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.70

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_o$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.79	5.05	155.85	20.7	107.7	0.361	99	30	160	31	1.1	1	269.08	20.7	99	8.5 x 10-6

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/08/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 3, 1987.85' - 1988.5'

LABORATORY IDENTIFICATION NO.: 09022/3BV

SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 97 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 16

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 9.2/7.4* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.79

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
8.84	10.08	705.13	5.6	150.0	0.139	98	30	160	71	0.90	1	1694.7	5.6	98	5.1 x 10-8

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 3, 1987.85' - 1988.5'

LABORATORY IDENTIFICATION NO.: 09022/3BH

SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 99 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 15

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 9.2/7.4* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.79

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.84	5.05	157.24	5.6	150.5	0.136	99	30	160	69	1.8	2	379.22	5.6	99	8.2 x 10-8

COMMENTS: (1) *Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.*
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: _____ Date: 09/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/01/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 3, 1990.4' - 1991.3'

LABORATORY IDENTIFICATION NO.: 09022/3CV

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 95 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 20

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 9.3/7.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.79

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
8.26	10.03	651.86	12.0	129.4	0.257	97	30	160	52	0 69	1	1351.3	12.0	97	9.1 x 10-7

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_o.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 3, 1990.4' - 1991.3'

LABORATORY IDENTIFICATION NO.: 09022/3CH

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 95 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 12

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 9.3/7.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.79

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_o (%)	S (%)	k_{20} (cm/sec)
8.21	5.05	164.21	12.0	128.9	0.260	95	30	160	80	2.0	1	339.16	12.0	95	8.8 x 10-7

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 07/26/09

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/04/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 4, 2102.55' - 2103.5'

LABORATORY IDENTIFICATION NO.: 09022/4AV

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 88 (stable) % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 13, 18, 26

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 12.0/10.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.72 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
9.81	9.92	757.94	19.5	108.4	0.361	94	30	160	38	0.57	1	1316.7	19.5	94	1.2 x 10-6

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

Form SR-2B: Rev. 0

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 4, 2102.55' - 2103.5'

LABORATORY IDENTIFICATION NO.: 09022/4AH

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 95 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 10, 17, 21

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 12.0/10.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.72

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
8.28	5.04	165.23	19.5	109.4	0.356	96	30	160	50	0.65	2	289.64	19.5	96	1.2 x 10-6

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM

Date: 05/26/09

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/02/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 4, 2107.15' - 2107.8'

LABORATORY IDENTIFICATION NO.: 09022/4BV

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 100 % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 12

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 7.3/4.7* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.73 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_o (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_o (%)	S (%)	k_{20} (cm/sec)
11.08	9.98	865.85	5.6	144.3	0.153	85	30	160	32	1.5	4	2002.0	5.6	85	1.3 x 10-7

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_o from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_o.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume, WDS = Dry mass; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation, $\bar{\sigma}_c$ = Isotropic effective confining stress, u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity

Checked By: JM Date: 05/26/09

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ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: **Core 4, 2107.15' - 2107.8'**

LABORATORY IDENTIFICATION NO.: 09022/4BH

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: - % ☐ Beginning of Test; ☐ End of Test

$\Delta\sigma_c$ (psi): -

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 7.3/4.7* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.73 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
8.03	5.05	160.90	4.5	145.3	0.147	72	30	160	54	1.3	3	374.67	5.6	89	**1.5 x 10-7**

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/04/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 4, 2110.9' - 2111.65'

LABORATORY IDENTIFICATION NO.: 09022/4CV

SAMPLE DESCRIPTION: Light brown limestone (sl. vuggy)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 100 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 13

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 8.0/6.2* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.71

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
10.07	9.82	762.73	21.3	107.2	0.366	100	30	160	26	4.1	1	1309.6	21.3	100	3.6 x 10-5

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 4, 2110.9' - 2111.65'

LABORATORY IDENTIFICATION NO.: 09022/4CH

SAMPLE DESCRIPTION: Light brown limestone (sl. vuggy)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 99 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 16

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 8.0/6.2* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.71

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.83	5.05	156.76	21.3	105.8	0.375	97	30	160	26	2.4	2	265.67	21.3	97	3.3 x 10-5

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where. H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

Form SR-2B· Rev. 6

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/04/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 5, 2182.35' - 2182.95'

LABORATORY IDENTIFICATION NO.: 09022/5AV

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 100 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 8

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 6.8/5.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.79

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
8.46	9.81	639.78	12.1	129.4	0.257	98	30	160	40	5.9	2	1326.5	12.1	98	4.0 x 10-7

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: PM Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 5, 2182.35' - 2182.95'

LABORATORY IDENTIFICATION NO.: 09022/5AH

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 85 (stable) % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 16, 24, 30

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 6.8/5.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.79 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.84	5.05	156.95	12.1	130.1	0.253	100	30	160	51	7.4	2	327.17	12.1	100	**5.1 x 10-7**

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/01/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 5, 2187.55' - 2188.2'

LABORATORY IDENTIFICATION NO.: 09022/5BV

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD.

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 100 % ☐ Beginning of Test; ☒ End of Test

$\Delta\sigma_c$ (psi): 20

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 7.8/5.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.68 ☐ Assumed ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
6.92	9.65	505.27	16.5	113.3	0.323	93	30	160	45	2.0	1	917.37	16.5	93	7.4 x 10-8

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration, k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: JM Date: 06/26/09

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 5, 2187.55' - 2188.2'

LABORATORY IDENTIFICATION NO.: 09022/5BH

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 100 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 12

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 7.8/5.0* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.68

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.48	5.05	149.79	16.5	114.4	0.316	96	30	160	48	0.50	1	274.66	16.5	96	4.9 x 10-7

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure, i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/02/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 5, 2191.25' - 2191.8'

LABORATORY IDENTIFICATION NO.: 09022/5CV

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 100 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 7

SPECIMEN DATA.

As-Received Diameter (inch): 4 Diameter Trimmed: ☐ Yes ☒ No

As-Received Length (inch): 6.0/4.6* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☒ Vertical ☐ Horizontal

SPECIFIC GRAVITY, G_s: 2.76

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
11.17	9.99	874.82	13.2	125.6	0.271	98	30	160	28	0.69	2	1760.8	13.2	98	9.1 x 10-7

COMMENTS: (1) Core sample selected for permeability testing was cut to length, air-dried, deaired under vacuum for a minimum of 24 hours, and then saturated with deaired tap water from the bottom up while still under vacuum. (2) Final w_c from horizontal permeability test specimen. WDS calculated from measured wet weight and final w_c.
* First length is total sample length Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: _____ Date: 05/26/09

Form SR-2B: Rev. 0

ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
ROCK CORE HYDRAULIC CONDUCTIVITY TEST REPORT

CLIENT: Youngquist Brothers, Inc.

PROJECT: Key Largo WTD Injection Well System

FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09 SET UP: 02/10/09

DATE REPORTED: 05/26/09

INCOMING LABORATORY SAMPLE NO.: Core 5, 2191.25' - 2191.8'

LABORATORY IDENTIFICATION NO.: 09022/5CH

SAMPLE DESCRIPTION: Light brown limestone (massive)

ASTM D 5084 TEST METHOD:

- ☒ A - Constant Head
- ☐ B - Falling Head; Constant Tailwater
- ☐ C - Falling Head; Rising Tailwater
- ☐ F - Constant Volume; Falling Head - Rising Tailwater

B-FACTOR: 97 %

- ☐ Beginning of Test;
- ☒ End of Test

$\Delta\sigma_c$ (psi): 12

SPECIMEN DATA:

As-Received Diameter (inch): 4 Diameter Trimmed: ☒ Yes ☐ No

As-Received Length (inch): 6.0/4.6* Length Trimmed: ☒ Yes ☐ No

TEST SPECIMEN ORIENTATION: ☐ Vertical ☒ Horizontal

SPECIFIC GRAVITY, G_s: 2.76

- ☐ Assumed
- ☒ Measured (ASTM D 854)

PERMEANT: ☒ Deaired Tap Water ☐ Other

Initial Conditions							Test Conditions					Final Conditions			Hydraulic Conductivity
H (cm)	D (cm)	V (cm^3)	w_c (%)	γ_d (pcf)	n	S (%)	$\bar{\sigma}_c$ (psi)	u_b (psi)	i_{avg}	Q (cm^3)	t (days)	WDS (g)	w_c (%)	S (%)	k_{20} (cm/sec)
7.78	5.05	155.57	13.2	125.3	0.272	97	30	160	40	1.7	1	312.45	13.2	97	1.4 x 10-6

COMMENTS: (1) Horizontal permeability test specimen was cross-cored from the corresponding vertical test specimen.
* First length is total sample length. Second length is useable length at full core diameter.

Where: H = Specimen height; D = Specimen diameter; V = Volume; WDS = Dry mass; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\bar{\sigma}_c$ = Isotropic effective confining stress; u_b = Back-pressure; i_{avg} = Average hydraulic gradient; Q = Flow volume; t = Test duration; k_{20} = Saturated hydraulic conductivity at 20°C; n = Total porosity; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

\\Aaloris1\public\Laura Meyer\09-022\youngquist data.wpd

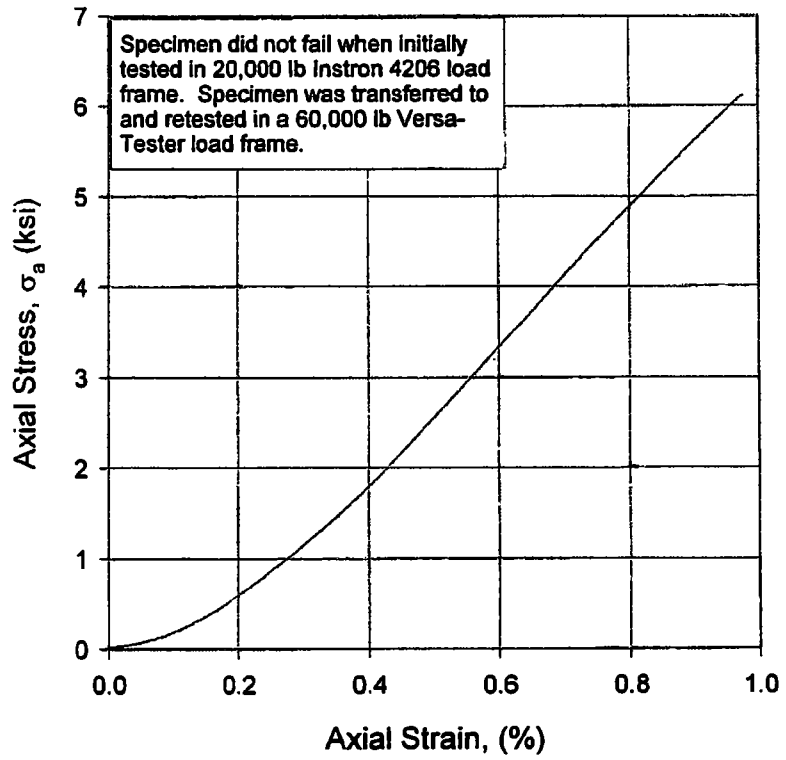
ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
INTACT ROCK CORE UNCONFINED COMPRESSION TEST REPORT

CLIENT: Youngquist Brothers, Inc.
PROJECT: Key Largo WTD Injection Well System
FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09
DATE TEST SET-UP: 02/05/09
DATE REPORTED: 05/26/09

INCOMING SAMPLE NO.: **Core 1**
BORING - SAMPLE **B**
DEPTH 1733.3-1734.55 ☒ ft; ☐ m
LABORATORY IDENTIFICATION NO.: 09022/C1B
SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs)

Specimen Dimensions			Initial Conditions			Rate of Loading		Time to Failure (minutes)	Unconfined Compressive Strength, σ_a(ult) (lb/in^2)	Young's Modulus, E (lb/in^2)
H (cm)	D (cm)	H/D	w_c (%)	γ_d (lb/ft^3)	S (%)	$\dot{\varepsilon}$ (cm/minute)	$\dot{\varepsilon}$ (%/minute)			
10.30	5.05	2.0	1.8	159.7	52	0.013	0.12	11.6	9136	7.6×10^5 at 50% σ_a(ult)



TEST PROCEDURES

☒ ASTM Standard D 7012, Method C

Air Temperature (°C): 19.6

Capping Material: ☐ None ☒ Lab-Stone ☐ Sulfur

Comments: Maximum load in Versa-Tester load frame was 28,384 lb. Rate of loading from Instron 4206 portion of test; time to failure from Versa-Tester portion of test.

SPECIMEN PREPARATION

Original Core Diameter (inch): 4

Specimen Sub-Cored for Testing: ☒ Yes ☐ No

G_s: 2.81 ☐ Assumed ☒ Measured

FAILURE SKETCH

Where: H = Specimen height; D = Specimen diameter; w_c = Moisture content (ASTM D 2216); γ_d = Dry density, S = Saturation; $\dot{\varepsilon}$ = Vertical displacement rate; and G_s = Specific gravity.

Checked By: JWM Date: 05/26/09

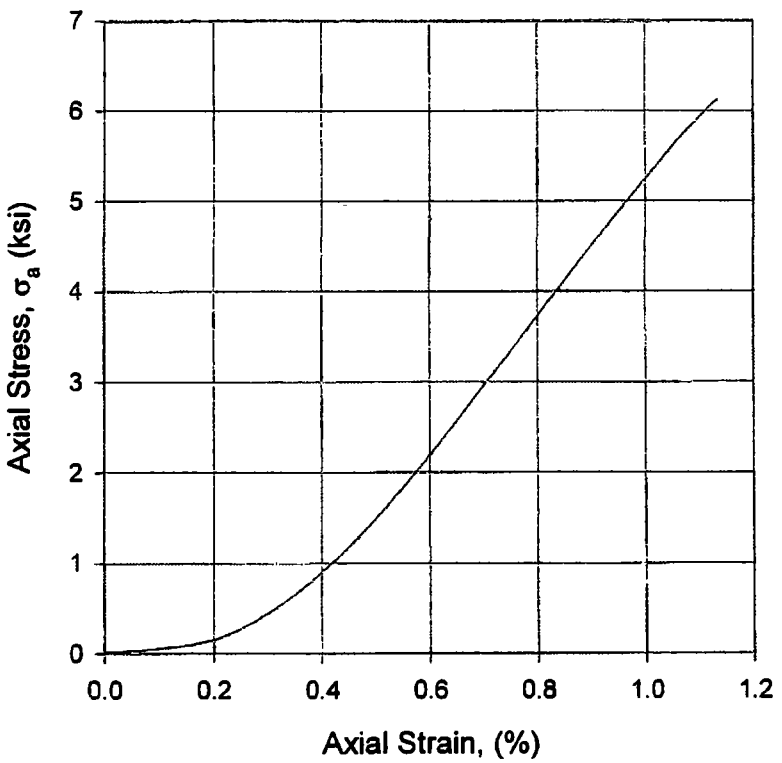
ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
INTACT ROCK CORE UNCONFINED COMPRESSION TEST REPORT

CLIENT: Youngquist Brothers, Inc.
PROJECT: Key Largo WTD Injection Well System
FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09
DATE TEST SET-UP: 02/05/09
DATE REPORTED: 05/26/09

INCOMING SAMPLE NO.: Core 1
BORING - SAMPLE C
DEPTH 1736.1-1737.0 ☒ ft; ☐ m
LABORATORY IDENTIFICATION NO.: 09022/1C
SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs and one crevice)

Specimen Dimensions			Initial Conditions			Rate of Loading		Time to Failure (minutes)	Unconfined Compressive Strength, σ_a(ult) (lb/in^2)	Young's Modulus, E (lb/in^2)
H (cm)	D (cm)	H/D	w_o (%)	γ_d (lb/ft^3)	S (%)	$\dot{\varepsilon}$ (cm/minute)	$\dot{\varepsilon}$ (%/minute)			
10.33	5.05	2.0	2.0	155.7	45	0.013	0.12	9.2	6118	7.7×10^5 at 50% σ_a(ult)



TEST PROCEDURES

☒ ASTM Standard D 7012, Method C

Air Temperature (°C): 19.6

Capping Material: ☐ None ☒ Lab-Stone ☐ Sulfur

Comments: Tested on Instron 4206 with 20,000 lb load cell

SPECIMEN PREPARATION

Original Core Diameter (inch): 4

Specimen Sub-Cored for Testing: ☒ Yes ☐ No

G_s: 2.81 ☐ Assumed ☒ Measured

FAILURE SKETCH

Where: H = Specimen height; D = Specimen diameter; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\dot{\varepsilon}$ = Vertical displacement rate; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

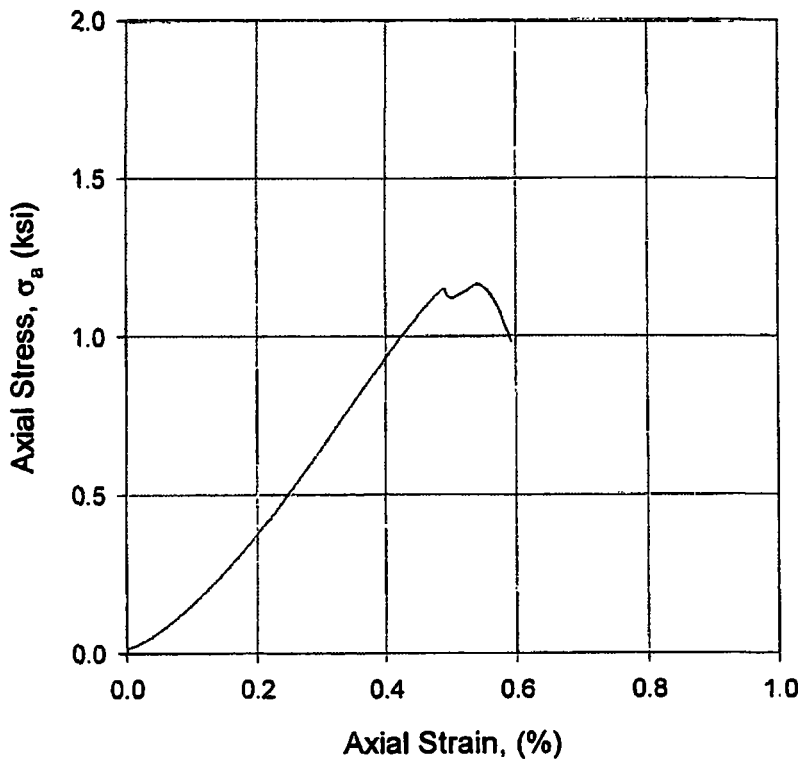
ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
INTACT ROCK CORE UNCONFINED COMPRESSION TEST REPORT

CLIENT: Youngquist Brothers, Inc.
PROJECT: Key Largo WTD Injection Well System
FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09
DATE TEST SET-UP: 02/05/09
DATE REPORTED: 05/26/09

INCOMING SAMPLE NO.: Core 2
BORING - SAMPLE A
DEPTH 1859.5-1860.35 ☒ ft; ☐ m
LABORATORY IDENTIFICATION NO.: 09022/C2A
SAMPLE DESCRIPTION: Light brown limestone (v. sl. vuggy)

Specimen Dimensions			Initial Conditions			Rate of Loading		Time to Failure (minutes)	Unconfined Compressive Strength, σ_a(ult) (lb/in^2)	Young's Modulus, E (lb/in^2)
H (cm)	D (cm)	H/D	w_c (%)	γ_d (lb/ft^3)	S (%)	$\dot{\varepsilon}$ (cm/minute)	$\dot{\varepsilon}$ (%/minute)			
10.43	5.04	2.1	17.4	107.8	85	0.013	0.12	4.0	1150	2.9×10^5 at 50% σ_a(ult)



TEST PROCEDURES

☒ ASTM Standard D 7012, Method C

Air Temperature (°C): 18.9

Capping Material: ☐ None ☒ Lab-Stone ☐ Sulfur

Comments: Tested on Instron 4206 with 20,000 lb load cell

SPECIMEN PREPARATION

Original Core Diameter (inch): 4

Specimen Sub-Cored for Testing: ☒ Yes ☐ No

G_s: 2.68 ☐ Assumed ☒ Measured

FAILURE SKETCH

Where: H = Specimen height; D = Specimen diameter; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\dot{\varepsilon}$ = Vertical displacement rate; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

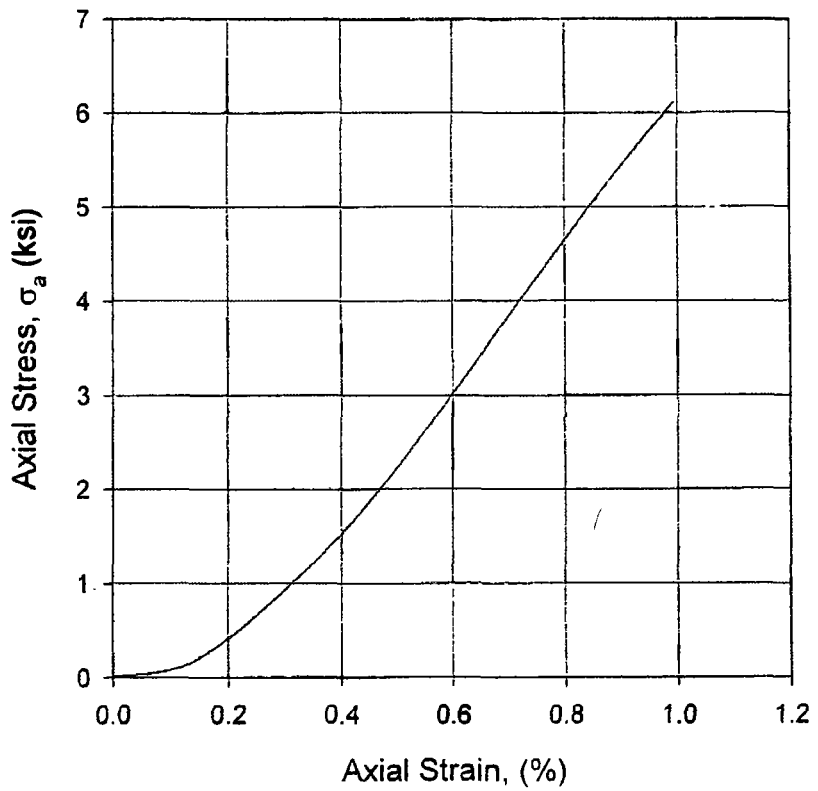
ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
INTACT ROCK CORE UNCONFINED COMPRESSION TEST REPORT

CLIENT: Youngquist Brothers, Inc.
PROJECT: Key Largo WTD Injection Well System
FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09
DATE TEST SET-UP: 02/05/09
DATE REPORTED: 05/26/09

INCOMING SAMPLE NO.: Core 2
BORING - SAMPLE C
DEPTH 1868.45-1869.2 ⊠ ft; □ m
LABORATORY IDENTIFICATION NO.: 09022/2C
SAMPLE DESCRIPTION: Brown dolomitic limestone (massive, tr. vugs)

Specimen Dimensions			Initial Conditions			Rate of Loading		Time to Failure (minutes)	Unconfined Compressive Strength, σ_a(ult) (lb/in^2)	Young's Modulus, E (lb/in^2)
H (cm)	D (cm)	H/D	w_c (%)	γ_d (lb/ft^3)	S (%)	$\dot{\varepsilon}$ (cm/minute)	$\dot{\varepsilon}$ (%/minute)			
10.46	5.05	2.1	3.6	146.0	50	0.013	0.12	8.4	6112	8.1×10^5 at 50% σ_a(ult)



TEST PROCEDURES

⊠ ASTM Standard D 7012, Method C

Air Temperature (°C): 19.6

Capping Material: □ None ⊠ Lab-Stone □ Sulfur

Comments: Tested on Instron 4206 with 20,000 lb load cell

SPECIMEN PREPARATION

Original Core Diameter (inch): 4

Specimen Sub-Cored for Testing: ⊠ Yes □ No

G_s: 2.81 □ Assumed ⊠ Measured

FAILURE SKETCH

Where: H = Specimen height; D = Specimen diameter; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\dot{\varepsilon}$ = Vertical displacement rate; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

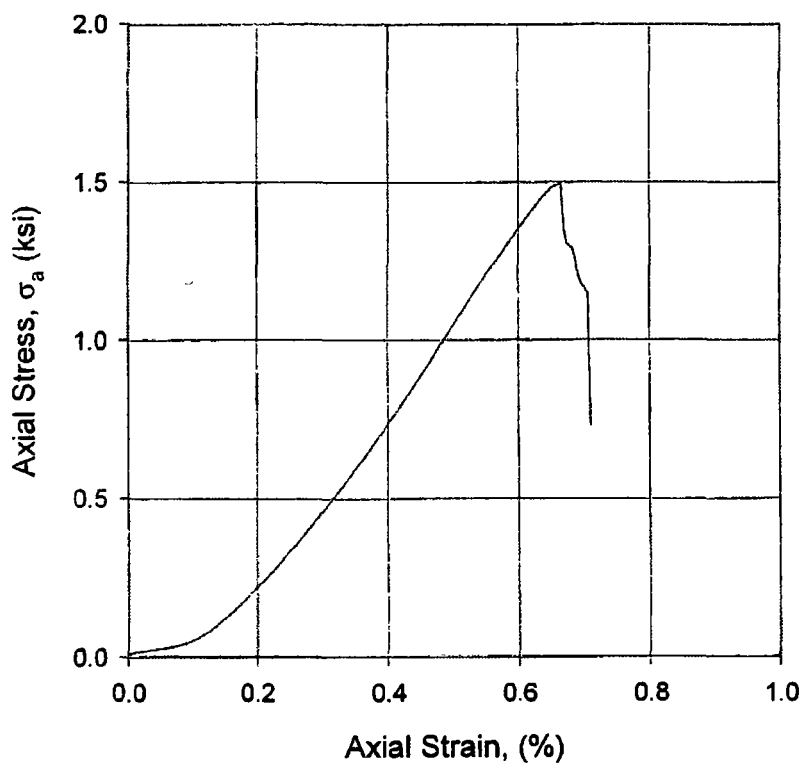
ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
INTACT ROCK CORE UNCONFINED COMPRESSION TEST REPORT

CLIENT: Youngquist Brothers, Inc.
PROJECT: Key Largo WTD Injection Well System
FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09
DATE TEST SET-UP: 02/05/09
DATE REPORTED: 05/26/09

INCOMING SAMPLE NO.: Core 3
BORING - SAMPLE A
DEPTH 1982.85-1983.8 ☒ ft; ☐ m
LABORATORY IDENTIFICATION NO.: 09022/3A
SAMPLE DESCRIPTION: Light brown limestone (v. sl. vuggy)

Specimen Dimensions			Initial Conditions			Rate of Loading		Time to Failure (minutes)	Unconfined Compressive Strength, σ_a(ult) (lb/in^2)	Young's Modulus, E (lb/in^2)
H (cm)	D (cm)	H/D	w_o (%)	γ_d (lb/ft^3)	S (%)	$\dot{\varepsilon}$ (cm/minute)	$\dot{\varepsilon}$ (%/minute)			
10.19	5.04	2.0	16.1	108.9	80	0.013	0.12	5.3	1494	3.0×10^5 at 50% σ_3(ult)



TEST PROCEDURES

☒ ASTM Standard D 7012, Method C

Air Temperature (°C): 18.9

Capping Material: ☐ None ☒ Lab-Stone ☐ Sulfur

Comments: Tested on Instron 4206 with 20,000 lb load cell

SPECIMEN PREPARATION

Original Core Diameter (inch): 4

Specimen Sub-Cored for Testing: ☒ Yes ☐ No

G_s: 2.79 ☐ Assumed ☒ Measured

FAILURE SKETCH

Where: H = Specimen height; D = Specimen diameter; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\dot{\varepsilon}$ = Vertical displacement rate; and G_s = Specific gravity.

Checked By: TM Date: 05/26/09

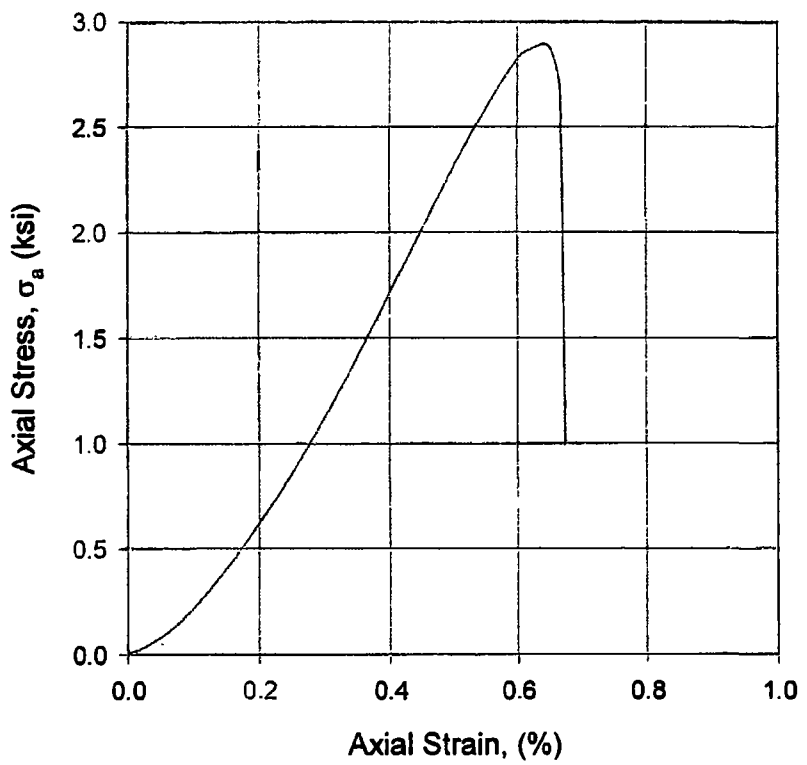
ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
INTACT ROCK CORE UNCONFINED COMPRESSION TEST REPORT

CLIENT: Youngquist Brothers, Inc.
PROJECT: Key Largo WTD Injection Well System
FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09
DATE TEST SET-UP: 02/05/09
DATE REPORTED: 05/26/09

INCOMING SAMPLE NO.: **Core 3**
BORING - SAMPLE **C**
DEPTH 1990.4-1991.3 ☒ ft; ☐ m
LABORATORY IDENTIFICATION NO.: 09022/3C
SAMPLE DESCRIPTION: Light brown limestone (massive)

Specimen Dimensions			Initial Conditions			Rate of Loading		Time to Failure (minutes)	Unconfined Compressive Strength, σ_a(ult) (lb/in^2)	Young's Modulus, E (lb/in^2)
H (cm)	D (cm)	H/D	w_o (%)	γ_d (lb/ft^3)	S (%)	$\dot{\varepsilon}$ (cm/minute)	$\dot{\varepsilon}$ (%/minute)			
10.79	5.04	2.1	8.7	131.2	74	0.013	0.12	5.4	2895	6.0×10^5 at 50% σ_a(ult)



TEST PROCEDURES

☒ ASTM Standard D 7012, Method C

Air Temperature (°C): 18.9

Capping Material: ☐ None ☒ Lab-Stone ☐ Sulfur

Comments: Tested on Instron 4206 with 20,000 lb load cell

SPECIMEN PREPARATION

Original Core Diameter (inch): 4

Specimen Sub-Cored for Testing: ☒ Yes ☐ No

G_s: 2.70 ☐ Assumed ☒ Measured

FAILURE SKETCH

Where: H = Specimen height; D = Specimen diameter; w_o = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\dot{\varepsilon}$ = Vertical displacement rate; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

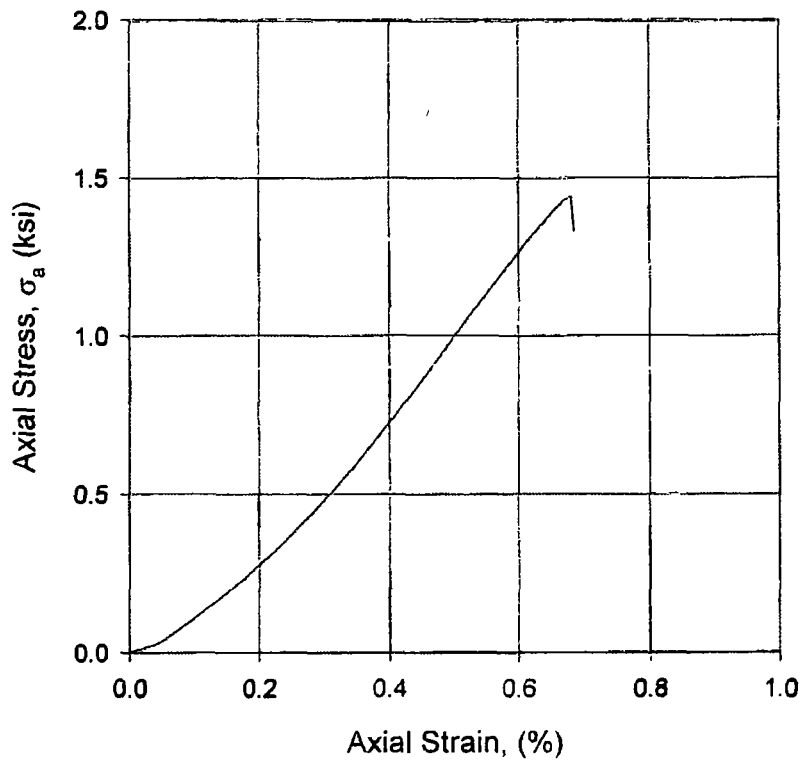
ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
INTACT ROCK CORE UNCONFINED COMPRESSION TEST REPORT

CLIENT: Youngquist Brothers, Inc.
PROJECT: Key Largo WTD Injection Well System
FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09
DATE TEST SET-UP: 02/05/09
DATE REPORTED: 05/26/09

INCOMING SAMPLE NO.: **Core 4**
BORING - SAMPLE **A**
DEPTH 2102.55-2103.5 ☒ ft; ☐ m
LABORATORY IDENTIFICATION NO.: 09022/4A
SAMPLE DESCRIPTION: Light brown limestone (massive)

Specimen Dimensions			Initial Conditions			Rate of Loading		Time to Failure (minutes)	Unconfined Compressive Strength, σ_a(ult) (lb/in^2)	Young's Modulus, E (lb/in^2)
H (cm)	D (cm)	H/D	w_c (%)	γ_d (lb/ft^3)	S (%)	$\dot{\varepsilon}$ (cm/minute)	$\dot{\varepsilon}$ (%/minute)			
10.03	5.04	2.0	16.3	110.1	82	0.013	0.13	5.4	1441	2.6×10^5 at 50% σ_a(ult)



TEST PROCEDURES

☒ ASTM Standard D 7012, Method C

Air Temperature (°C): 18.9

Capping Material: ☐ None ☒ Lab-Stone ☐ Sulfur

Comments: Tested on Instron 4206 with 20,000 lb load cell

SPECIMEN PREPARATION

Original Core Diameter (inch): 4

Specimen Sub-Cored for Testing: ☒ Yes ☐ No

G_s: 2.72 ☐ Assumed ☒ Measured

FAILURE SKETCH

Where: H = Specimen height; D = Specimen diameter; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\dot{\varepsilon}$ = Vertical displacement rate; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

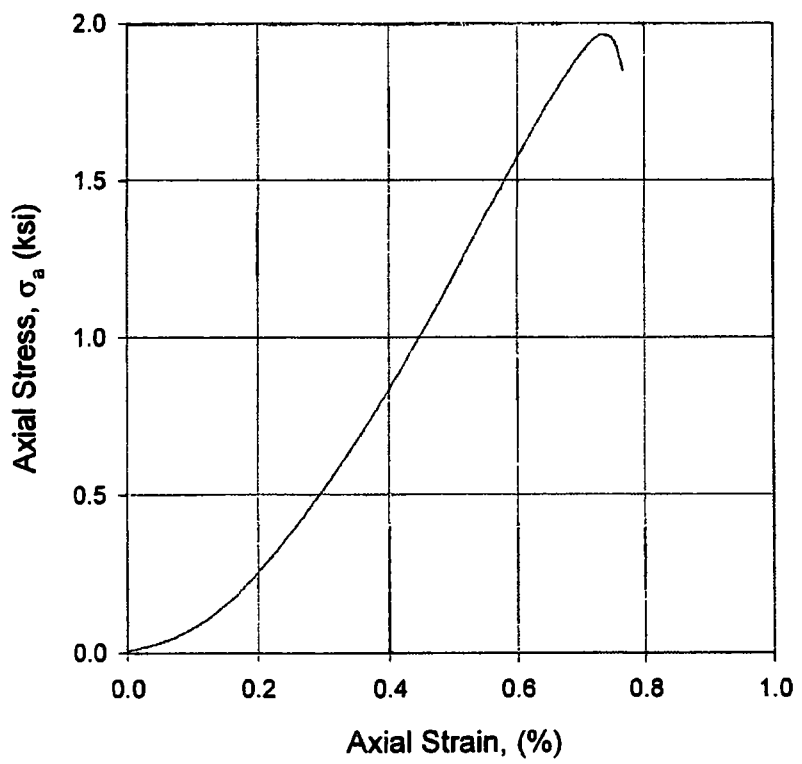
ARDAMAN & ASSOCIATES, INC. GEOTECHNICAL TESTING LABORATORY
INTACT ROCK CORE UNCONFINED COMPRESSION TEST REPORT

CLIENT: Youngquist Brothers, Inc.
PROJECT: Key Largo WTD Injection Well System
FILE NO.: 09-022

DATE SAMPLE RECEIVED: 01/28/09
DATE TEST SET-UP: 02/05/09
DATE REPORTED: 05/26/09

INCOMING SAMPLE NO.: **Core 5**
BORING - SAMPLE **B**
DEPTH 2187.55-2188.2 ☒ ft; ☐ m
LABORATORY IDENTIFICATION NO.: 09022/5B
SAMPLE DESCRIPTION: Light brown limestone (massive)

Specimen Dimensions			Initial Conditions			Rate of Loading		Time to Failure (minutes)	Unconfined Compressive Strength, σ_a(ult) (lb/in^2)	Young's Modulus, E (lb/in^2)
H (cm)	D (cm)	H/D	w_o (%)	γ_d (lb/ft^3)	S (%)	$\dot{\varepsilon}$ (cm/minute)	$\dot{\varepsilon}$ (%/minute)			
10.16	5.05	2.0	12.2	115.9	74	0.013	0.12	5.9	1964	3.6×10^5 at 50% σ_a(ult)



TEST PROCEDURES

☒ ASTM Standard D 7012, Method C

Air Temperature (°C): 20.2

Capping Material: ☐ None ☒ Lab-Stone ☐ Sulfur

Comments: Tested on Instron 4206 with 20,000 lb load cell

SPECIMEN PREPARATION

Original Core Diameter (inch): 4

Specimen Sub-Cored for Testing: ☒ Yes ☐ No

G_s: 2.68 ☐ Assumed ☒ Measured

FAILURE SKETCH

Where: H = Specimen height; D = Specimen diameter; w_c = Moisture content (ASTM D 2216); γ_d = Dry density; S = Saturation; $\dot{\varepsilon}$ = Vertical displacement rate; and G_s = Specific gravity.

Checked By: JM Date: 05/26/09

Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

August 20, 2009
File Number 09-022

Youngquist Brothers, Inc.
15465 Pine Ridge Road
Ft. Myers, FL 33908

Attention: Chris Bannon

Subject: Rock Core Testing, Key Largo WTD Injection Well System

Gentlemen:

As requested, Archie's formation factor and cementation exponent have been measured on seven limestone rock cores provided for testing by your firm. The tests were subcontracted to New England Research, Inc. The designations of the seven samples are listed below. The results of permeability tests performed on the samples were previously submitted on May 26, 2009.

Core	Depth (feet)
1	1729.7-1730.2
1	1733.3-1734.55
2	1862.4-1863.0
3	1982.85-1983.8
4	2102.55-2103.5
4	2110.9-2111.65
5	2182.35-2182.95

The report from New England Research, Inc. is attached.

The specimens were reported to be from the samples designated herein. The test results are indicative of only the specimens that were actually tested. The test results presented are based upon accepted industry practice as well as test method(s) listed. Ardaman & Associates, Inc. neither accepts responsibility for, nor makes claims to the final use and purpose of the material.

If you have any questions about the test results or require additional information, please contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

Thomas S. Ingra, P.E.
Laboratory Director
Florida License No. 31987

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Resistivity of Key Largo Carbonates

Report prepared for
Ardaman and Associates, Inc.
August3, 2009

by

New England Research, Inc.
331 Olcott Drive, Ste L1
White River Junction, VT 05001

Summary

Ardaman and Associates, Inc. delivered seven whole core samples of carbonate for measurement of resistivity. The samples were cored from the Key Largo site. The samples were cored in a depth range of 1729.7 ft to 2182.35 ft.

Seven cylindrical samples were sub-cored from the whole core and were approximately 38 mm in diameter and 43 mm to 50 mm in length. The samples were medium to high porosity carbonates. There were significant textural differences in the samples. The grain densities ranged from 2.27 to 2.88 g/cc. Sample porosity as a volume fraction ranged from 0.13 to 0.39.

All samples were saturated with brine containing 35 grams of sodium chloride per liter of water. Complex impedance of each sample was measured over a frequency range of 0.1 Hz to 100 kHz.

Temperature corrections were applied to the brine conductivity. The frequency response of the samples' impedance was uniform over the frequency range of 0.1 to 100,000 Hz. No cable corrections were applied.

The cementation coefficients for these rocks are approximately 2, with the exception of Core 1.2 and Core 2 that are 3.43 and 1.22 respectively. The higher cementation coefficient of low porosity, high resistivity Core 2 may be a function of the dolomitization and vugginess of the sample of the sample. Core 2 is a zeolitic rock. Core 1.1 is a very heterogeneous rock and its cementation coefficient was 2.76.

With the exception of core sample 1.2, the resistivity of these samples was low. Core 1.2 is somewhat anomalous and this probably due to dolimitization and associated vugs in the sample.

Resistivity of Key Largo Carbonates

Resistivity of Key Largo Carbonates

Introduction

Ardaman and Associates, Inc. delivered seven whole core samples of carbonate for measurement of resistivity. The samples were cored from the Key Largo site. The samples were cored in a depth range of 1729.7 ft to 2182.35 ft.

Procedures and Techniques

Sample Description

The seven samples varied considerably in their appearance and physical properties. Cores 1.1, 1.2 and 2 constituted the lower porosity samples from layers above 1900 feet. Samples 1.1 and 1.2 appear to contain some dolomite. Sample 1.1 was very heterogeneous with prominent bedding in half the sample. Sample 1.2 contains fossils and small vugs and is likely dolomitic. Sample 2 is interesting in that it appears to be from a zeolitic layer. Sample 2 has a very low grain density of 2.26 g/cc, consistent with the density of zeolitic rocks. Sample 3 is a homogeneous limestone. Core 4.1 and 4.2 are homogeneous limestones. Sample 5 is heterogeneous and probably contains dolomite.

Sample Preparation

Seven cylindrical samples were sub-cored from the whole core supplied by Ardaman. The diameter of the sub-cored plugs was 38 mm. The length of the plug samples varied from 43.2mm to 50.4 mm. The ends of the plugs were ground smooth and parallel to within 0.001 inches.

The sample plugs were dried in an oven at 80 degrees centigrade for 24 hours. Sample dimensions and mass were measured and the dry bulk density was computed. The samples were vacuum saturated for 24 hours in brine containing 35 grams of NaCl per liter of distilled water. The grain density of the samples was determined using an Archimedes technique. The porosity was determined from the dry bulk density and average grain density using the formula $\phi=1-(\rho_{dry\text{-}bulk}/\rho_{grain})$.

Petrophysical Data

The average grain density of the samples spanned a large range from 2.27 to 2.88 g/cc. Sample porosity ranged from 13.1 to 38.7 per cent. All sample mass and volumetric data is reported in Table 1.

Resistivity Tests

Four electrode complex electrical impedance measurements were performed on the samples in the AutoLab 1000 system. The saturated sample was jacketed in a viton sleeve and mounted in the four-electrode core holder. Figure 1 diagrams the coreholder used in the four-electrode measurement. The core holder is inserted in the pressure vessel of the AutoLab 1000.

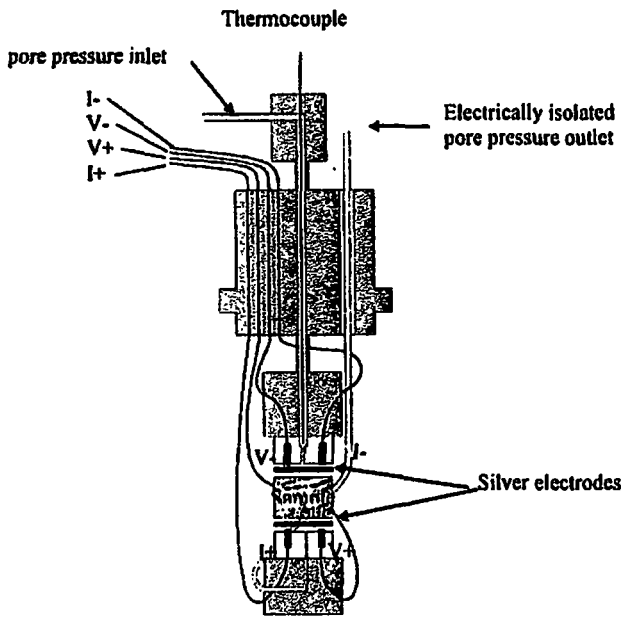

Figure 1. Four-electrode resistivity coreholder

A function generator is used to apply a sinusoidal current across the sample and a reference resistor. The current varied in frequency from 0.1 Hz to 100,000 Hz. The amplitude and phase of the voltage drop across the sample is compared to the amplitude

and phase of the voltage drop across the reference resistor, and the values are used to compute the complex impedance at a given frequency.

The samples were confined at a pressure consistent with their depth, assuming an overburden gradient of approximately 1.0 psi/ft. The pore pressure for all rocks was determined from an assumed normal hydrostatic gradient of 0.46 psi/ft.

Formation Factor and Cementation Coefficient

A cementation factor can be calculated from Archie's empirical formation factor-porosity relationship (Archie, 1942),

$$F = \alpha * \phi^{-m}.$$

F is the formation factor, that is, the ratio of the conductivity of the saturating fluid to the conductivity of the rock-fluid system. α is the tortuosity parameter, ϕ is the porosity and m is the cementation factor. If we assume that the α parameter is 1 (an assumption often made for carbonates) the cementation factor can be computed from the measured porosity and formation factor. Cementation factors are reported in Table 1.

Discussion

Resistivity Data

Resistivity data, formation factors and cementation factors for each sample are compiled in the Table 1 in the Data Section II.

The frequency response of complex resistivity data for these samples was flat over the frequency range. No cable correction was applied since the parasitic impedances were virtually non-existent over the frequency range of 0.1 to 100,000.0 Hz. A temperature correction was applied to the brine conductivity.

The formation factor at a frequency of 20,000 Hz was used to calculate the cementation coefficient. The frequency of 20,000 Hz was chosen to be consistent with past practice; however, any frequency may be used.

The cementation coefficients for these high porosity rocks are close to 2.0 with the exception of Core 1.1, a highly heterogeneous sample, and Core 1.2 the vuggy dolomite that had coefficients of 2.761 and 3.43 respectively. Core 2, which is the zeolite, had a coefficient of 1.23.

Conclusions

Complex impedance was measured on seven samples of carbonate. The frequency response of the impedance was flat for the samples over the measured frequency range. No cable corrections were applied.

The resistivity of these samples was low with the exception of Core 1.2 a low porosity vuggy dolomite. The higher cementation coefficient of Core 1.2 indicates some moldic porosity or vugs in the pore space. Core 2 is a low grain density zeolite.

References

Archie, G. E. "The electrical resistivity log as an aid in determining some reservoir characteristics." Trans., AIME, (1942), **146**, p 54.

Focke, J. W. and Munn D., "Cementation Exponents in Middle Eastern Carbonates," SPE Formation Evaluation 2 (1987), p 155-167.

Lucia, F.J., Carbonate Reservoir Characterization, Springer-Verlag, Berlin, 1999.

Section II: Data

Table 1
Data Summary
Key Largo

	Core Depth Feet	Length (cm)	Diameter (cm)	Bulk Volume (cm^3)	PreTest Dry Mass (g)	PreTest Dry Bulk Density (g/cm^3)	PreTest Sat. Mass (g)	PreTest Sat. Bulk Density (g/cm^3)	Archimedes Mass (g)	Average Grain Density (g/cm^3)	Porosity Vol. Fraction
Core 1_1	1729.7-1730.7	4.321	3.808	49.21	106.62	2.167	117.140	2.380	67.0417	2.788	0.223
Core 1_2	1733.3-1734.55	4.796	3.814	54.79	137.00	2.500	143.280	2.615	87.7000	2.876	0.131
Core 2	1862.4-1863.0	4.462	3.800	50.60	94.01	1.858	102.750	2.030	51.0714	2.266	0.180
Core 3	1982.85-1983.8	4.855	3.800	55.06	91.83	1.668	113.020	2.053	56.9147	2.722	0.387
Core 4_1	2102.55-2103.5	4.703	3.804	53.45	94.37	1.766	112.700	2.109	58.3305	2.710	0.349
Core 4_2	2110.9-2111.65	5.041	3.801	57.20	99.04	1.731	119.47	2.089	61.3301	2.718	0.363
Core 5	2182.35-2182.95	4.418	3.811	50.40	105.79	2.099	118.35	2.348	67.0500	2.826	0.257

	Core Depth Feet	Brine Concentration (g/liter)	Corrected Brine Conductivity (mS/cm)	Resistivity at 100 Hz (ohm-m)	Resistivity at 10000 Hz (ohm-m)	Resistivity at 20 kHz (ohm-m)	Formation Factor at 100 Hz	Formation Factor at 10000 Hz	Formation Factor at 20 kHz		Cementation Factor at 20 kHz
Core 1_1	1729.7-1730.7	35.00	54.60	11.60	11.60	11.60	63.45	63.17	63.06		2.761
Core 1_2	1733.3-1734.55	35.00	52.00	221.00	215.00	206.00	1147.00	1117.00	1074.00		3.430
Core 2	1862.4-1863.0	35.00	53.20	1.55	1.54	1.54	8.23	8.20	8.19		1.227
Core 3	1982.85-1983.8	35.00	53.30	1.20	1.20	1.20	6.36	6.38	6.37		1.952
Core 4_1	2102.55-2103.5	35.00	53.80	1.44	1.44	1.44	7.75	7.74	7.72		1.939
Core 4_2	2110.9-2111.65	35.00	54.40	1.32	1.32	1.32	7.18	7.16	7.16		1.943
Core 5	2182.35-2182.95	35.00	5.52	2.65	2.62	2.62	14.60	14.46	14.43		1.966

Resistivity Measurement Report

Sample and Experiment Information for File Key_Largo_C1.1			
Well:	Key Largo	Organization:	Ardaman
Depth:	527.2 m		
Formation:	Key Largo	Rock type:	Carbonate
Dry bulk density:	2.167	Porosity:	22.3%
Sat. bulk density:	2.380	Pore fluids:	NaCl Brine
Diameter:	38.08 mm	Entered Length:	43.21 mm

Comments: User: ner on elk at Wed Jun 3 16:16:41 EDT 2009
Expt name: 1244059847
Expt date: Wed Jun 03 16:17:48 2009
Print date: Tue Aug 11 13:30:32 2009
A2D File:

Pressure Information for File Key_Largo_C1.1					
Event	System	Conf	Pore	Diff	Temp
		MPa	MPa	kN	°C
0	zmeter4	11.9	5.3	—	25.6

Resistivity for File Key_Largo_C1.1							
	Requested	Actual	Impedance				
Event	Frequency	Frequency	R	X	C	$C_{corrected}$	F
	Hz	Hz	Ωm	Ωm	μS/cm	μS/cm	
0	1.00	0.720	11.8	0.00354	5.39e+04	5.46e+04	64.37
0	10.0	10.0	11.7	-0.0525	5.39e+04	5.46e+04	63.72
0	100.	72.0	11.6	-0.0221	5.39e+04	5.46e+04	63.45
0	1.00e+03	1.00e+03	11.6	-0.0475	5.39e+04	5.46e+04	63.23
0	1.00e+04	7.20e+03	11.6	-0.123	5.39e+04	5.46e+04	63.17
0	2.00e+04	1.39e+04	11.6	-0.219	5.39e+04	5.46e+04	63.06

Resistivity Measurement Report

Sample and Experiment Information for File Key_Largo_C1.2			
Well:	Key Largo	Organization:	Ardaman
Depth:	527.2 m		
Formation:	Key Largo	Rock type:	Carbonate
Dry bulk density:	2.5	Porosity:	13.1%
Sat. bulk density:	2.615	Pore fluids:	NaCl Brine
Diameter:	38.14 mm	Entered Length:	47.96 mm

Comments: User: ner on elk at Wed Jun 3 15:03:41 EDT 2009
Expt name: 1244055821
Expt date: Wed Jun 03 15:16:43 2009
Print date: Tue Aug 11 13:34:32 2009
A2D File:

Pressure Information for File Key_Largo_C1.2					
Event	System	Conf	Pore	Diff	Temp
		MPa	MPa	kN	°C
1	zmeter4	11.9	5.3	—	23.4

Resistivity for File Key_Largo_C1.2							
	Requested	Actual	Impedance				
Event	Frequency	Frequency	R	X	C	$C_{corrected}$	F
	Hz	Hz	Ωm	Ωm	μS/cm	μS/cm	
1	1.00	0.720	221.	-0.863	5.39e+04	5.20e+04	1151.
1	10.0	10.0	221.	-0.597	5.39e+04	5.20e+04	1149.
1	100.	72.0	221.	-0.860	5.39e+04	5.20e+04	1147.
1	1.00e+03	1.00e+03	219.	-4.10	5.39e+04	5.20e+04	1140.
1	1.00e+04	7.20e+03	215.	-23.7	5.39e+04	5.20e+04	1117.
1	2.00e+04	1.39e+04	206.	-42.4	5.39e+04	5.20e+04	1074.

Resistivity Measurement Report

Sample and Experiment Information for File Key_Largo_C2			
Well:	Key Largo	Organization:	Ardaman
Depth:	567.7 m		
Formation:	Key Largo	Rock type:	Zeolite
Dry bulk density:	1.858	Porosity:	18.0%
Sat. bulk density:	2.030	Pore fluids:	NaCl brine
Diameter:	38.00 mm	Entered Length:	44.62 mm

Comments: User: ner on elk at Fri Apr 17 15:05:39 EDT 2009
Expt name: 1244124668
Expt date: Thu Jun 04 10:16:27 2009
Print date: Tue Aug 11 13:38:22 2009
A2D File:

Pressure Information for File Key_Largo_C2					
Event	System	Conf	Pore	Diff	Temp
		MPa	MPa	kN	°C
0	zmeter4	12.9	5.8	—	24.3

Resistivity for File Key_Largo_C2							
	Requested	Actual	Impedance				
Event	Frequency	Frequency	R	X	C	$C_{corrected}$	F
	Hz	Hz	Ωm	Ωm	μS/cm	μS/cm	
0	1.00	0.720	1.53	0.00383	5.40e+04	5.32e+04	8.145
0	10.0	10.0	1.55	0.000930	5.40e+04	5.32e+04	8.246
0	100.	72.0	1.55	-0.00170	5.40e+04	5.32e+04	8.230
0	1.00e+03	1.00e+03	1.54	-0.00247	5.40e+04	5.32e+04	8.214
0	1.00e+04	7.20e+03	1.54	-0.00632	5.40e+04	5.32e+04	8.198
0	2.00e+04	1.39e+04	1.54	-0.00939	5.40e+04	5.32e+04	8.193

Resistivity Measurement Report

Sample and Experiment Information for File Key_Largo_C3			
Well:	Key Largo	Organization:	Ardaman
Depth:	604.4 m		
Formation:	Key Largo	Rock type:	Carbonate
Dry bulk density:	1.668	Porosity:	38.7%
Sat. bulk density:	2.053	Pore fluids:	NaCl brine
Diameter:	38.00 mm	Entered Length:	48.55 mm

Comments: User: ner on elk at 10:56 EDT Thur June 4 2009
Expt name: 1244127549
Expt date: Thu Jun 04 11:00:33 2009
Print date: Wed Jun 10 15:54:54 2009
A2D File:

Pressure Information for File Key_Largo_C3					
Event	System	Conf	Pore	Diff	Temp
		MPa	MPa	kN	°C
0	zmeter4	13.7	6.2	—	24.4

Resistivity for File Key_Largo_C3							
	Requested	Actual	Impedance				
Event	Frequency	Frequency	R	X	C	$C_{corrected}$	F
	Hz	Hz	Ωm	Ωm	μS/cm	μS/cm	
0	1.00	0.720	1.20	0.00848	5.40e+04	5.33e+04	6.369
0	10.0	10.0	1.20	-0.00229	5.40e+04	5.33e+04	6.417
0	100.	72.0	1.20	-0.00216	5.40e+04	5.33e+04	6.391
0	1.00e+03	1.00e+03	1.20	-0.00144	5.40e+04	5.33e+04	6.380
0	1.00e+04	7.20e+03	1.20	-0.00359	5.40e+04	5.33e+04	6.375
0	2.00e+04	1.39e+04	1.20	-0.00574	5.40e+04	5.33e+04	6.369

Resistivity Measurement Report

Sample and Experiment Information for File Key_Largo_C4.1			
Well:	Key Largo	Organization:	Ardaman
Depth:	640.9 m		
Formation:	Key Largo	Rock type:	Carbonate
Dry bulk density:	1.766	Porosity:	34.9%
Sat. bulk density:	2.109	Pore fluids:	NaCl brine
Diameter:	38.04 mm	Entered Length:	47.03 mm

Comments: User: ner on elk at 11.41 EDT Thur June 4 2009
Expt name: 1244130018
Expt date: Thu Jun 04 11:43:22 2009
Print date: Fri Aug 07 08:32:46 2009
A2D File:

Pressure Information for File Key_Largo_C4.1					
Event	System	Conf	Pore	Diff	Temp
		MPa	MPa	kN	°C
0	zmeter4	14.5	6.6	—	24.8

Resistivity for File Key_Largo_C4.1							
	Requested	Actual	Impedance				
Event	Frequency	Frequency	R	X	C	$C_{corrected}$	F
	Hz	Hz	Ωm	Ωm	μS/cm	μS/cm	
0	1.00	0.720	1.40	0.0130	5.40e+04	5.38e+04	7.527
0	10.0	10.0	1.44	0.00678	5.40e+04	5.38e+04	7.758
0	100.	72.0	1.44	-0.000432	5.40e+04	5.38e+04	7.753
0	1.00e+03	1.00e+03	1.44	-0.00158	5.40e+04	5.38e+04	7.742
0	1.00e+04	7.20e+03	1.44	-0.00345	5.40e+04	5.38e+04	7.736
0	2.00e+04	1.39e+04	1.44	-0.00775	5.40e+04	5.38e+04	7.720

Resistivity Measurement Report

Sample and Experiment Information for File Key_Largo_C4.2			
Well:	Key Largo	Organization:	Ardaman
Depth:	640.9 m		
Formation:	Key Largo	Rock type:	Carbonate
Dry bulk density:	1.731	Porosity:	36.3%
Sat. bulk density:	2.089	Pore fluids:	NaCl brine
Diameter:	38.01 mm	Entered Length:	50.41 mm

Comments: User: ner on elk at 11.41 EDT Thur June 4 2009
Expt name: 1244138593
Expt date: Thu Jun 04 14:06:21 2009
Print date: Fri Aug 07 09:22:03 2009
A2D File:

Pressure Information for File Key_Largo_C4.2					
Event	System	Conf	Pore	Diff	Temp
		MPa	MPa	kN	°C
0	zmeter4	14.5	6.6	—	25.4

Resistivity for File Key_Largo_C4.2							
	Requested	Actual	Impedance				
Event	Frequency	Frequency	R	X	C	$C_{corrected}$	F
	Hz	Hz	Ωm	Ωm	μS/cm	μS/cm	
0	1.00	0.720	1.32	0.0101	5.40e+04	5.44e+04	7.208
0	10.0	10.0	1.33	-0.00372	5.40e+04	5.44e+04	7.224
0	100.	72.0	1.32	-0.00251	5.40e+04	5.44e+04	7.181
0	1.00e+03	1.00e+03	1.32	-0.00171	5.40e+04	5.44e+04	7.175
0	1.00e+04	7.20e+03	1.32	-0.00421	5.40e+04	5.44e+04	7.164
0	2.00e+04	1.39e+04	1.32	-0.00671	5.40e+04	5.44e+04	7.159

Resistivity Measurement Report

Sample and Experiment Information for File Key_Largo_C5			
Well:	Key Largo	Organization:	Ardaman
Depth:	665.2 m		
Formation:	Key Largo	Rock type:	Carbonate
Dry bulk density:	2.099	Porosity:	25.7%
Sat. bulk density:	2.348	Pore fluids:	NaCl brine
Diameter:	38.11 mm	Entered Length:	44.18 mm

Comments: User: ner on elk at 14:47 EDT Thur June 4 2009
Expt name: 1244141093
Expt date: Thu Jun 04 14:49:20 2009
Print date: Fri Aug 07 09:22:42 2009
A2D File:

Pressure Information for File Key_Largo_C5					
Event	System	Conf	Pore	Diff	Temp
		MPa	MPa	kN	°C
0	zmeter4	15.0	6.6	—	26.0

Resistivity for File Key_Largo_C5							
	Requested	Actual	Impedance				
Event	Frequency	Frequency	R	X	C	$C_{corrected}$	F
	Hz	Hz	Ωm	Ωm	μS/cm	μS/cm	
0	1.00	0.720	2.67	-0.00160	5.40e+04	5.52e+04	14.72
0	10.0	10.0	2.66	-0.00983	5.40e+04	5.52e+04	14.67
0	100.	72.0	2.65	-0.00899	5.40e+04	5.52e+04	14.60
0	1.00e+03	1.00e+03	2.63	-0.0105	5.40e+04	5.52e+04	14.52
0	1.00e+04	7.20e+03	2.62	-0.0168	5.40e+04	5.52e+04	14.46
0	2.00e+04	1.39e+04	2.62	-0.0246	5.40e+04	5.52e+04	14.43

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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

IW1

Packer Test No.1 (single packer)

Start date: 12/22/2008

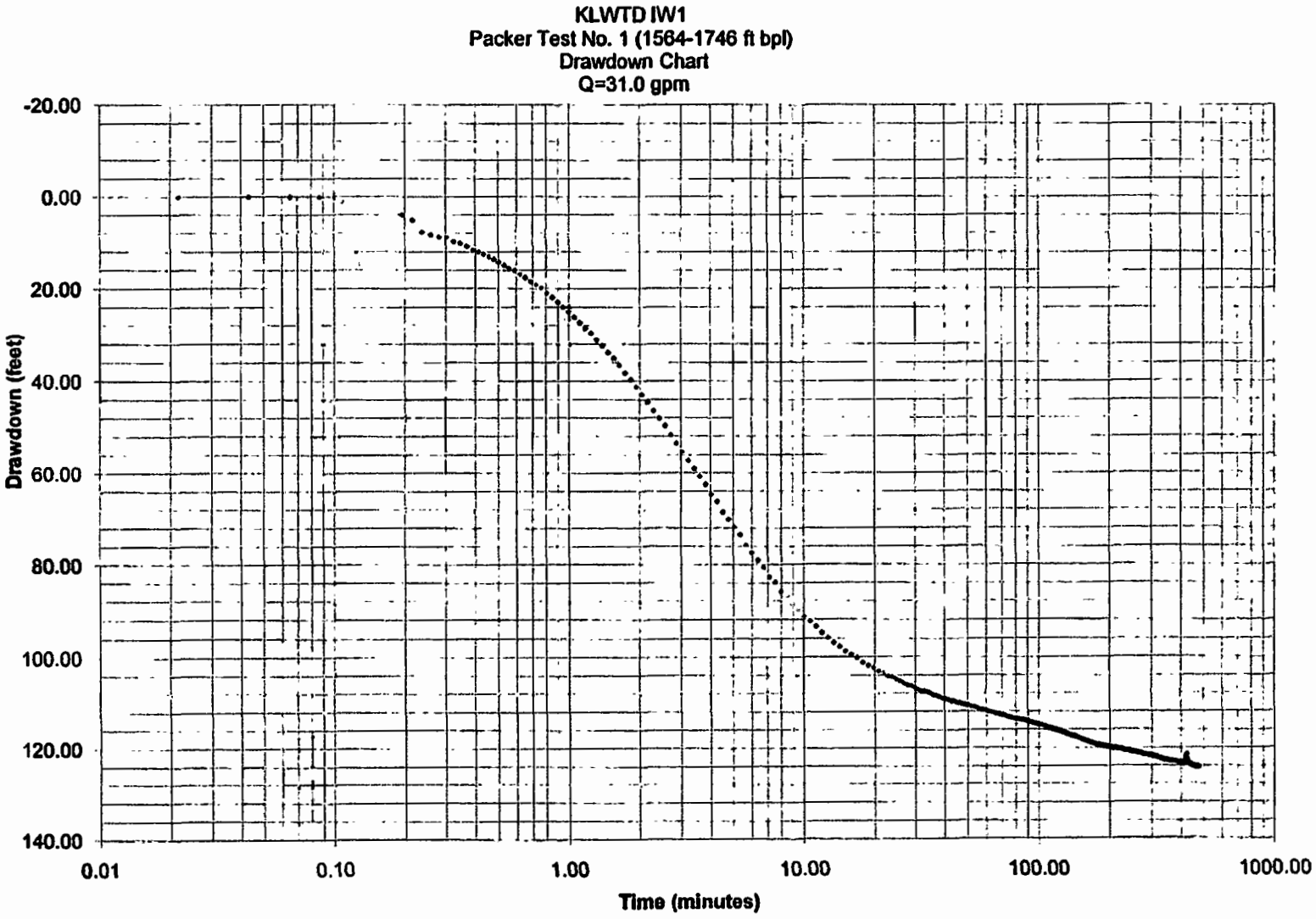
End date: 12/23/2008

Flowmeter Total-Start (gal) :	267845	**Open Hole Total Depth (feet bpl) :**	1,746
Flowmeter Total- End (gal) :	282708*	**Packer Depth Interval (feet bpl):**	1564-1746
Average Test Pumping Rate (gpm) :	31.0	**Pump Setting Depth (feet bpl):**	180.25
Development Duration (min):	561	**Transducer Depth (feet bpl):**	166.25
Pump Test Duration (min):	480	**Pipe and open hole volume:**	2267+1386= 3654 gals.
Static DTW Before Test (feet apl):	15.87	**Maximum Drawdown (feet):**	124

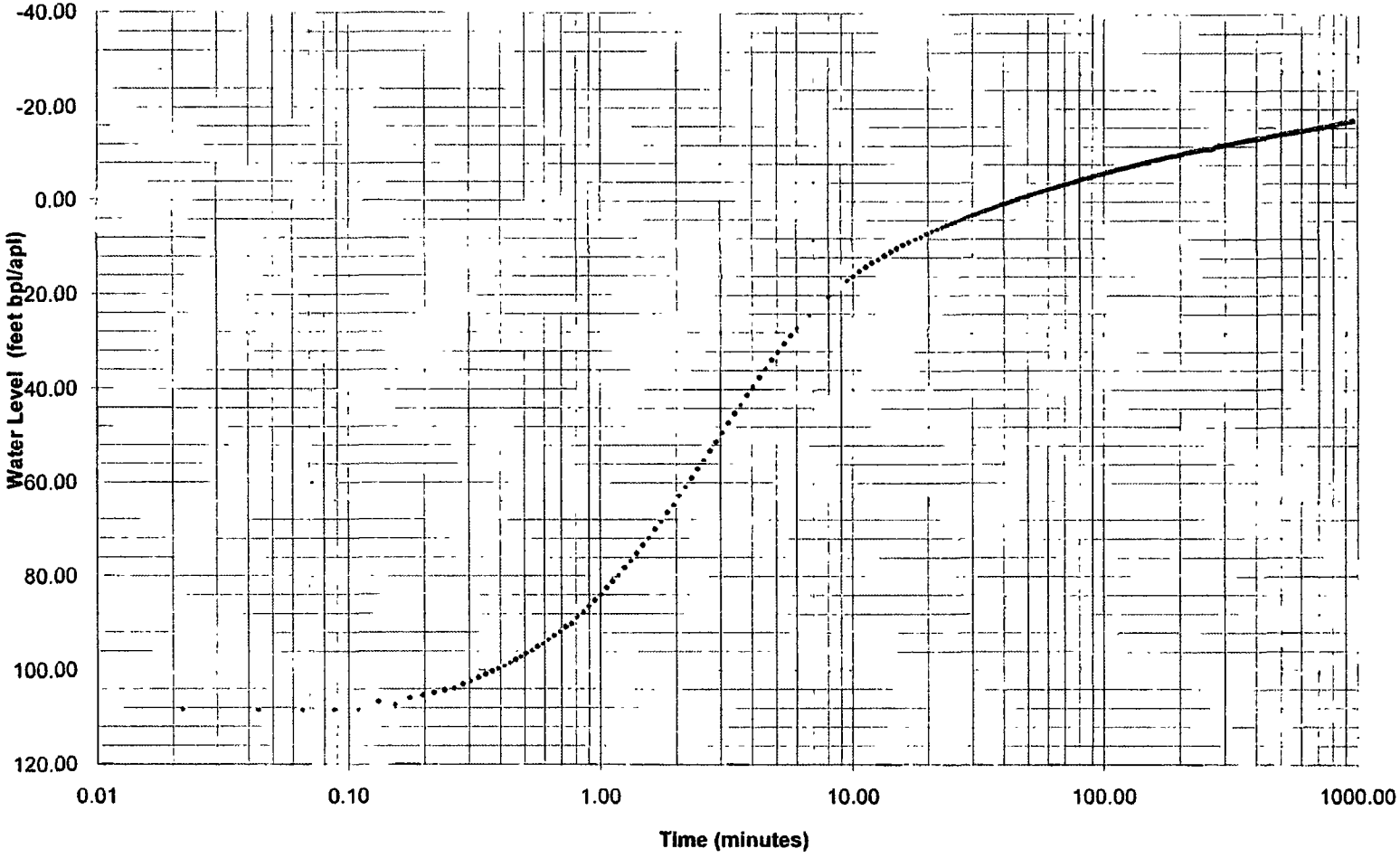
Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet bpl)	Temp. (°C)	Cond. (mS/cm)	Chlorides (mg/L)	Comments
Development									
12/21/08	21:20	0	~10	0					Start air- lifting development. Packer press. 230 psi.
12/21/08	23:50	150	~50	~3700		25.3	25,900	9,000	Stop air lifting, water cloudy. Packer press. 230 psi.
12/22/08	1:19	150	45	3,700	7.23 apl	n/a	n/a	n/a	Start dev. with submersible pump (flow.tot. 255415).
12/22/08	1:48	179	31	4,600	88.15	27.9	26,700	10,000	
12/22/08	2:33	224	31	5,995	98.94	26.8	27,900	10,500	
12/22/08	3:19	270	32	7,255	100.93	26.9	28,100	11,000	
12/22/08	4:03	314	32	8,626	102.26	27.9	28,000	11,000	Packer press. 340 psi.
12/22/08	4:48	359	31	9,990	102.97	27	29,000	11,000	
12/22/08	5:33	404	30	11,340	103.85	27.1	29,100	11,500	
12/22/08	6:18	449	30	12,690	104.47	27.4	29,000	11,500	
12/22/08	7:03	494	31	14,040	105.16	27.2	29,200	11,500	
12/22/08	7:58	549	32	15,745	106.15	27.1	29,200	11,500	Annulus:23.88 ft.
12/22/08	8:10	561	32	16,130	n/a	n/a	n/a	n/a	Pump-off, start pre-test recovery. Packer press. 320 psi.
Pump Test									
12/22/08	16:17	0	35	0	15.87 apl.	n/a	n/a	n/a	Start test: pump-on; packer press. 340 psi. Ann.
12/22/08	16:47	30	33	1,015	n/a	27.4	29,100	10,500	
12/22/08	17:20	63	33	2,095	96.45	27.5	29,200	11,000	Annulus:25.69 ft.
12/22/08	18:02	105	32	3,440	99.02	27.7	29,100	11,500	Packer press. 350 psi.
12/22/08	18:45	148	32	4,755	101.84	28.2	29,100	11,500	Annulus: 25.87 ft
12/22/08	19:33	196	31	6,105	103.81	27.7	29,100	11,000	
12/22/08	20:12	235	30	7,485	104.54	27 6	29,100	11,000	Annulus: 26.02 ft
12/22/08	20:58	281	31	8,875	105.45	27.8	29,200	11,000	
12/22/08	21:44	327	31	10,261	106.37	27.7	29,100	11,000	
12/22/08	22:30	373	31	11,647	108.99	28	29,200	11,000	Annulus: 26.16 ft
12/22/08	23:20	423	31	13,045	107.26	28	29,100	11,000	Packer press. 310 psi.
12/22/08	0:00	463	31	14,165	108.24	27.9	29,100	11,000	
12/23/08	0:15	478	31	14,630	108.31	27.6	29,100	11,000	Annulus:26.46 ft, packer press: 320 psi.
12/23/08	0:17	480	31	14,680	n/a	n/a	n/a	n/a	End pump test, start recovery

Note: Due to flowmeter approximately 5 min. stoppage 150 gallons were added to the totallizer end-reading

"gal" denotes gallons.
"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"°C" denotes degrees celcius
"mS/cm" denotes milliSiemens per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.
"N/M" denotes not measured.
Static depth to water (DTW) wass measured just prior to pumping test startup.


KLWTD IW1
Packer Test No. 1 (1564-1746 ft bpl)
Drawdown Chart
Q=31.0 gpm
-20.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
Drawdown (feet)
0.01
0.10
1.00
10.00
100.00
1000.00
Time (minutes)

KLWTD IW1
Packer Test No. 1 (1564-1746 ft bpl)
Recovery Chart



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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

IW1

Packer Test No.2 (straddle packer)

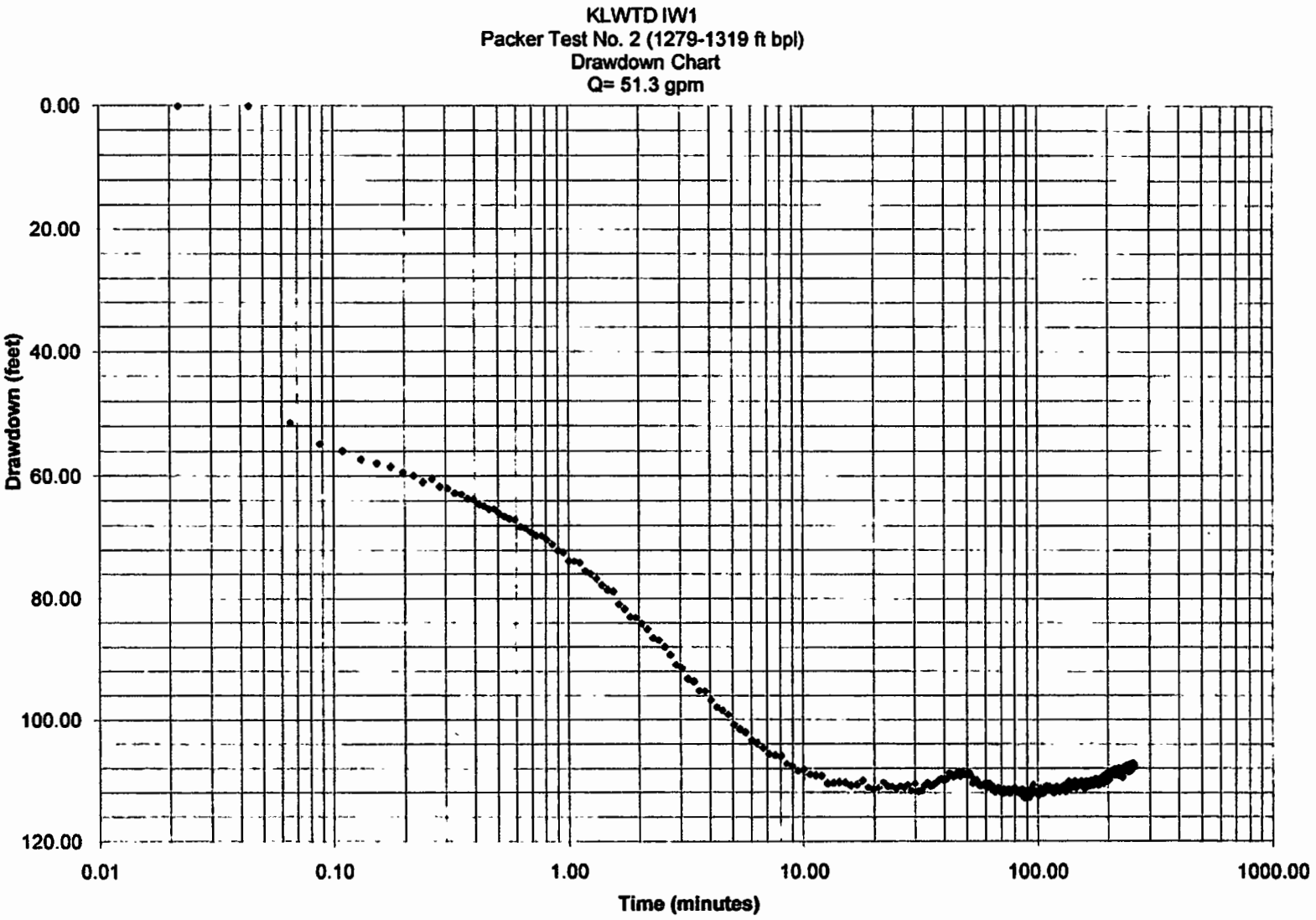
Start date: 12/26/2008

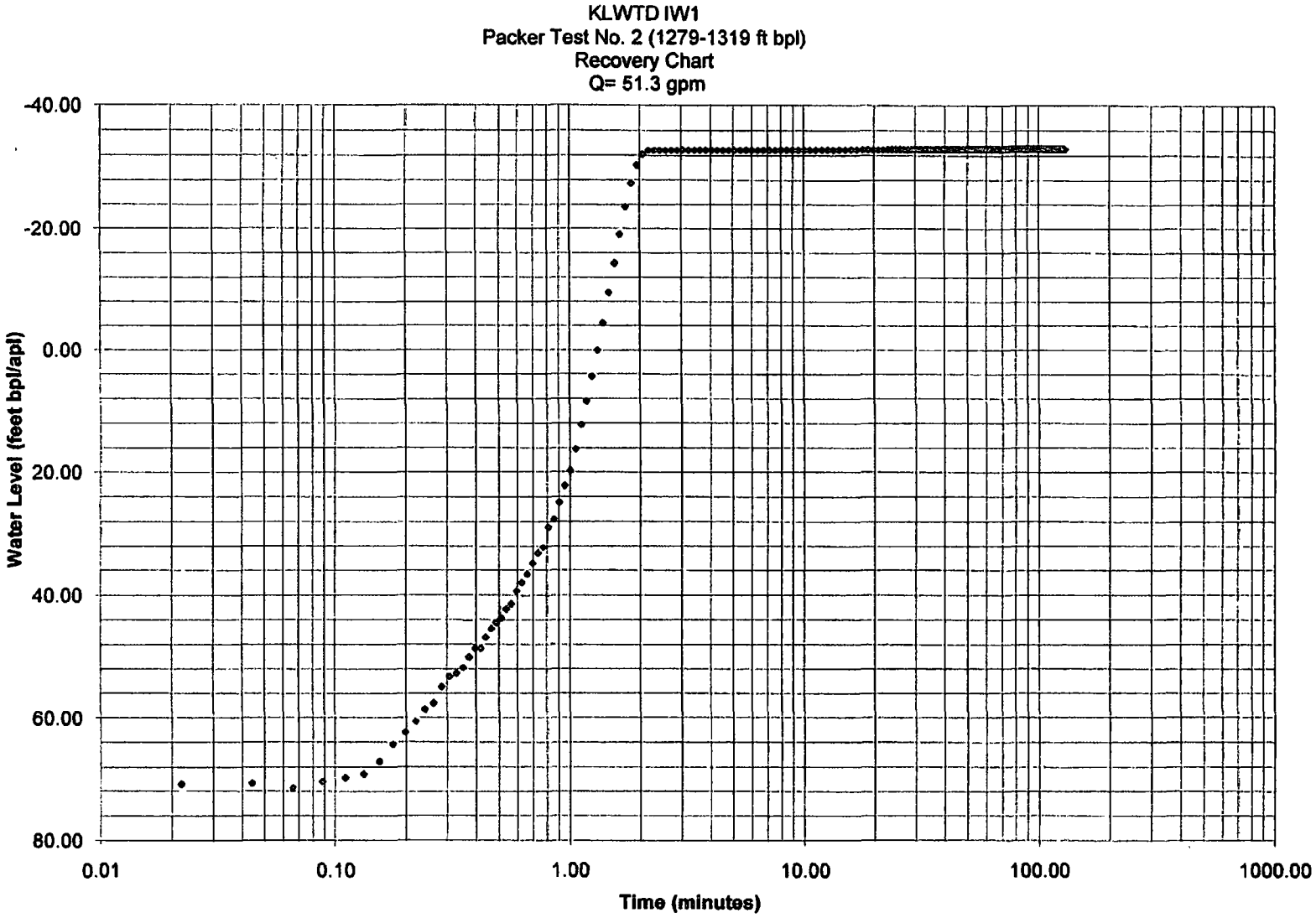
End date: 12/27/2008

Flowmeter Total-Start (gal) :	288,560	Open Hole Total Depth (feet bpl) :	1,746
Flowmeter Total- End (gal) :	301,900	Packer Depth Interval (feet bpl):	1279-1319
Average Test Pumping Rate (gpm) :	51.3	Pump Setting Depth (feet bpl):	180.25
Development Duration (min):	349	Transducer Depth (feet bpl):	141.25
Pump Test Duration (min):	256	Pipe and open hole volume:	1863+252= 2115 gals.
Static DTW Before Test (feet apl):	33.06	Maximum Drawdown (feet):	112.82

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet bpl)	Temp. (°C)	Cond. (mS/cm)	Chlorides (mg/L)	Comments
Development									
12/26/08	13:10	0	~30	0					Start air- lifting development. Packer press. 345 psi.
12/26/08	16:10	180	~35	~6000	n/a	27.1	7,520	3,000	
12/26/08	16:35	205	~35	~7500	n/a	27.2	7,570	3,000	Stop air lifting, water clearing. Packer press. 340 psi.
12/26/08	17:50	230	~40	~8300	n/a	n/a	n/a	n/a	Well flowing at 25 gpm. Shut flow, install pump.
12/26/08	18:13	230	70	Adjusting	n/a	n/a	nn	n/a	Start dev. with submersible pump (flow.tot. 282557).
12/26/08	18:23	240	44	8,800	n/a	27.8	7,780	3,000	
12/26/08	18:41	258	44	9,590	63.00	27.8	7,900	3,500	Increase pumping rate to 50 gpm
12/26/08	19:01	278	50	10,550	74.66	27.8	7,860	3,000	Water cloudy. Annulus: 23.92 psi.
12/26/08	19:20	297	52	11,550	75.69	27.8	7,890	3,000	
12/26/08	19:40	317	52	12,590	72.48	27.8	7,990	3,000	
12/26/08	20:00	337	52	13,680	71.98	27.8	8,000	3,000	Annulus:24.00
12/26/08	20:10	347	51	14,200	71.77	27.8	8,010	3,000	Water slightly turbid.
12/26/08	20:12	349	51	14,302	n/a	n/a	n/a	n/a	Pump-off, start pre-test recovery. Packer press. 320 psi.
Pump Test									
12/26/08	23:33	0	55	0	n/a	n/a	n/a	n/a	Full recovery, pump-on, start test. Annulus:24.42 ft.
12/27/08	0:20	47	52	2490	68.76	27.8	8,050	3,000	Packer press. 340 psi
12/27/08	0:40	67	53	3530	65.99	27.7	8,100	3,000	
12/27/08	1:00	87	52	4590	64.26	27.9	8,120	3,000	
12/27/08	1:20	107	51	5630	65.92	27.8	8,180	3,000	Annulus: 24.49 ft.
12/27/08	1:40	127	52	6650	66.23	28	8,200	3,000	
12/27/08	2:00	147	52	7,690	66.76	27.9	8,220	3,000	Annulus: 24.57 ft, packers: 340 psi
12/27/08	2:20	167	53	8,730	67.12	27.7	8,190	3,000	Water clear
12/27/08	2:40	187	52	9,790	67.85	27.9	8,220	3,000	Annulus: 24.68 psi
12/27/08	3:00	207	53	10,850	68.52	27.8	8,240	3,000	Packer press..340 psi
12/27/08	3:20	227	51	11,910	68.90	28.0	8,240	3,000	Annulus: 24.82 ft.
12/27/08	3:40	247	52	12,930	69.80	27.9	8,250	3,000	Annulus: 24.90 ft.
12/27/08	3:48	255	n/a	13,340	69.72	n/a	n/a	n/a	Pump-off, start recovery after pump test.

"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"°C" denotes degrees celcius
"mS/cm" denotes milliSiemens per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.
"N/M" denotes not measured.
Static depth to water (DTW) wass measured just prior to pumping test startup.


KLWTD IW1
Packer Test No. 2 (1279-1319 ft bpl)
Drawdown Chart
Q= 51.3 gpm
0.00
20.00
40.00
60.00
80.00
100.00
120.00
Drawdown (feet)
0.01
0.10
1.00
10.00
100.00
1000.00
Time (minutes)


KLWTD IW1
Packer Test No. 2 (1279-1319 ft bpl)
Recovery Chart
Q= 51.3 gpm
-40.00
-20.00
0.00
20.00
40.00
60.00
80.00
Water Level (feet bpl/apl)
0.01
0.10
1.00
10.00
100.00
1000.00
Time (minutes)

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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

IW1

Packer Test No.3 (straddle packer)

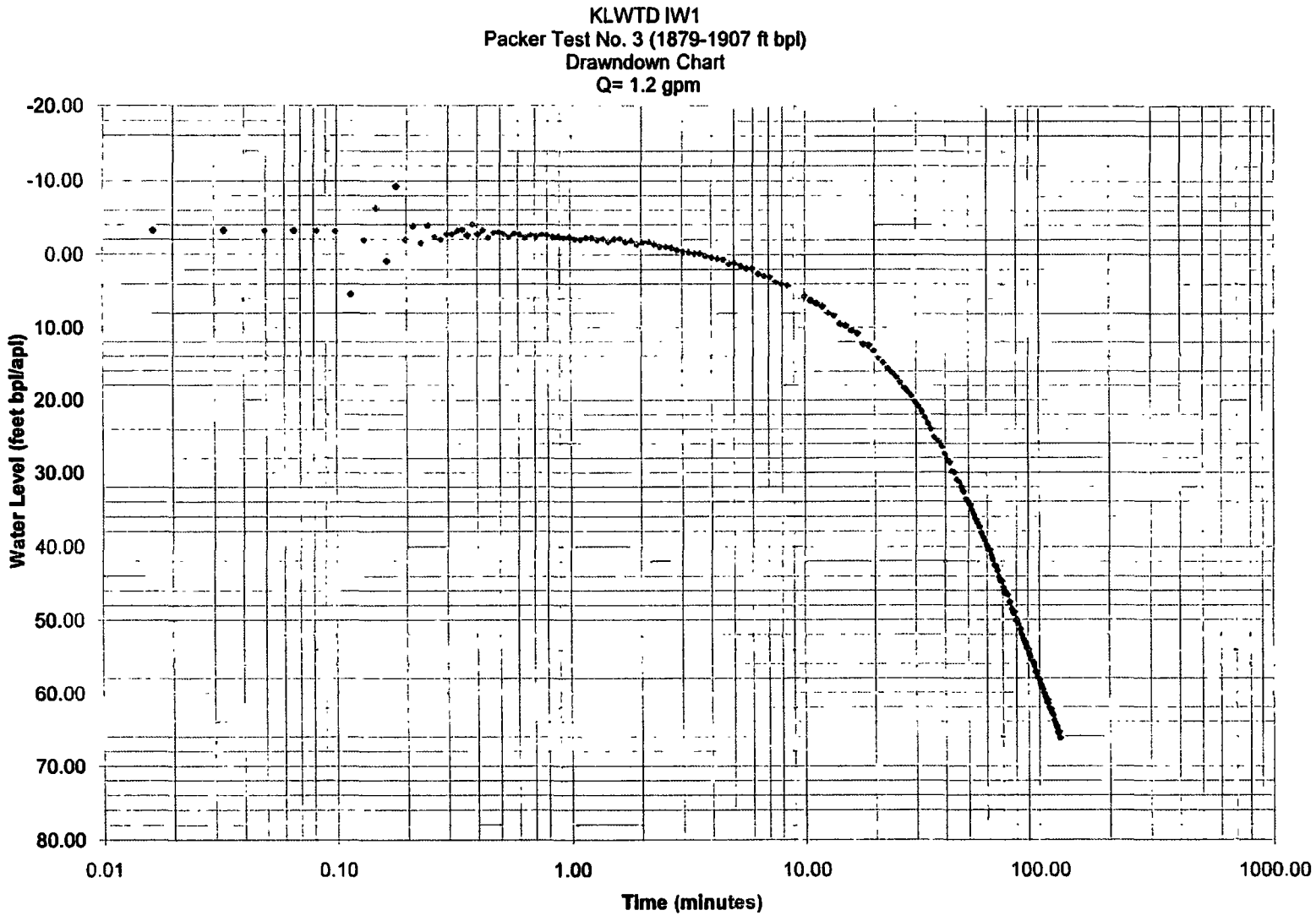
Start date: 1/26/2009

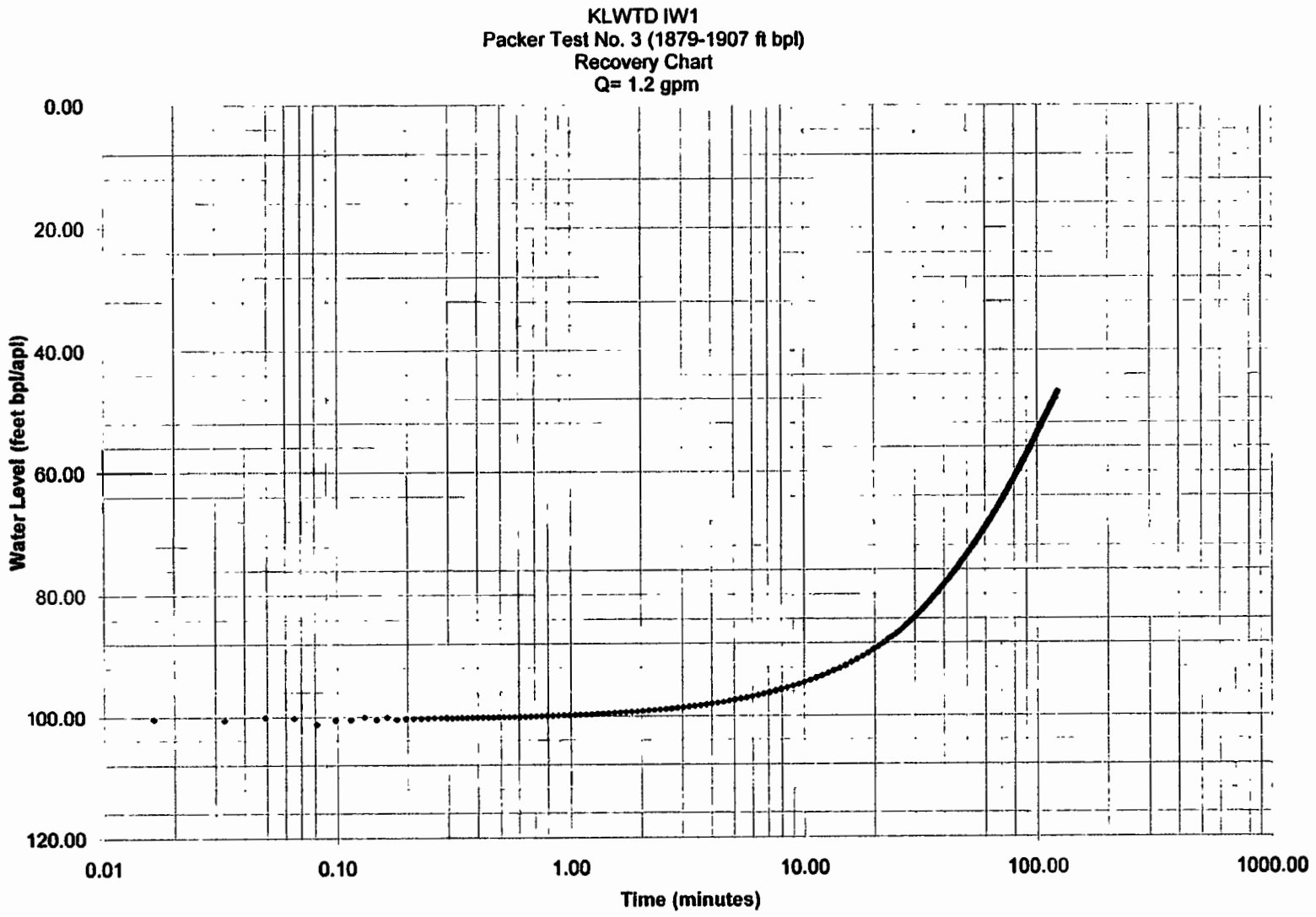
End date: 1/26/2009

Flowmeter Total-Start (gal) : n/a		Open Hole Total Depth (feet bpl) :	3,693
Flowmeter Total- End (gal) : n/a		Packer Depth Interval (feet bpl):	1879-1907
Average Test Pumping Rate (gpm) :	1.2	Pump Setting Depth (feet bpl):	176.08
Development Duration (min):	282	Transducer Depth (feet bpl):	164.84
Pump Test Duration (min): 244	244	Pipe and open hole volume:	2762+210= 2972 gals.
Static DTW Before Test (feet apl):	3.28	Maximum Drawdown (feet):	103.46

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet bpl)	Temp. (°C)	Cond. (mS/cm)	Chlorides (mg/L)	Comments
Development									
1/25/09	8:15	0	10.0	0	3.26 apl	n/a	n/a	n/a	Pump-on, begin development. Transd. At start: 172.25 ft.
1/25/09	8:17	2	4.0	10	0.84	n/a	n/a	n/a	Adjusting rate. Annulus: 28.48 ft. Packer press. 305 psi.
1/25/09	8:25	10	2.0	24	15.40	n/a	n/a	n/a	
1/25/09	8:33	18	1.9	39	29.93	22.6	74,700	28,500	Water brownish-red
1/25/09	8:53	38	1.4	68	58.48	n/a	n/a	n/a	
1/25/09	9:28	73	1.4	117	79.58	23.5	83,400	31,000	
1/25/09	9:53	98	1.4	152	89.20	23.9	81,200	30,000	Water lt. yellow
1/25/09	9:54	99	n/a	n/a	n/a	n/a	n/a	n/a	Begin pre-test electronic data collection.
1/25/09	10:30	135	1.4	204	n/a	24.5	78,200	29,500	
1/25/09	11:00	165	1.3	243	108.79	24.3	74,500	28,000	Annulus: 28.00 ft.
1/25/09	11:30	195	1.4	285	111.08	24.7	71,300	26,500	
1/25/09	12:00	225	1.4	327	120.56	24.8	71,100	26,500	
1/25/09	12:30	255	1.4	369	126.35	24.9	69,900	26,500	Annulus: 27.28 ft.
1/25/09	12:37	282	1.4	380	127.27	n/a	n/a	n/a	Pump-off, begin pre-test recovery.
Pump Test									
1/26/09	8:43	0	0.0	0	3.28 apl	n/a	n/a	n/a	Pump-on, start test: annulus: 27.84 ft.
1/26/09	9:15	32	1.2	38	n/a	24.4	55,200	22,500	
1/26/09	9:45	62	1.2	74	42.57	24.2	56,400	22,500	
1/26/09	10:15	92	1.2	110	55.02	24.4	58,100	24,000	Annulus: 27.88
1/26/09	10:45	122	1.1	144	66.21	24.3	58,800	24,500	
1/26/09	11:05	142	1.1	166	n/a	n/a	n/a	n/a	Adjust rate (dropped >5%)
1/26/09	11:15	152	1.2	178	77.49	24.9	60,000	25,000	Annulus: 27.89
1/26/09	11:45	182	1.2	214	87.9	25.0	61,100	25,000	
1/26/09	12:15	212	1.2	250	94.96	25.3	61,300	25,000	Annulus: 27.87
1/26/09	12:30	227	1.1	266	n/a	n/a	n/a	n/a	Collect lab. Water sample.
1/26/09	12:45	242	1.1	280	100.06	27.5	61,200	25,000	
1/26/09	12:47	244	1.1	282	n/a	n/a	n/a	n/a	Pump-off begin recovery.

"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"°C" denotes degrees celcius.
"mS/cm" denotes milliSiemens per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.
"N/M" denotes not measured.
Static depth to water (DTW) was measured just prior to pumping test startup.
Note, due to very slow pump rate measurements were taken manually and total volume was calculated


KLWTD IW1
Packer Test No. 3 (1879-1907 ft bpl)
Drawndown Chart
Q= 1.2 gpm
-20.00
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Water Level (feet bpl/apl)
0.01
0.10
1.00
10.00
100.00
1000.00
Time (minutes)


KLWTD IW1
Packer Test No. 3 (1879-1907 ft bpl)
Recovery Chart
Q= 1.2 gpm
Water Level (feet bpl/apl)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
0.01
0.10
1.00
10.00
100.00
1000.00
Time (minutes)

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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

IW1

Packer Test No.4 (straddle packer)

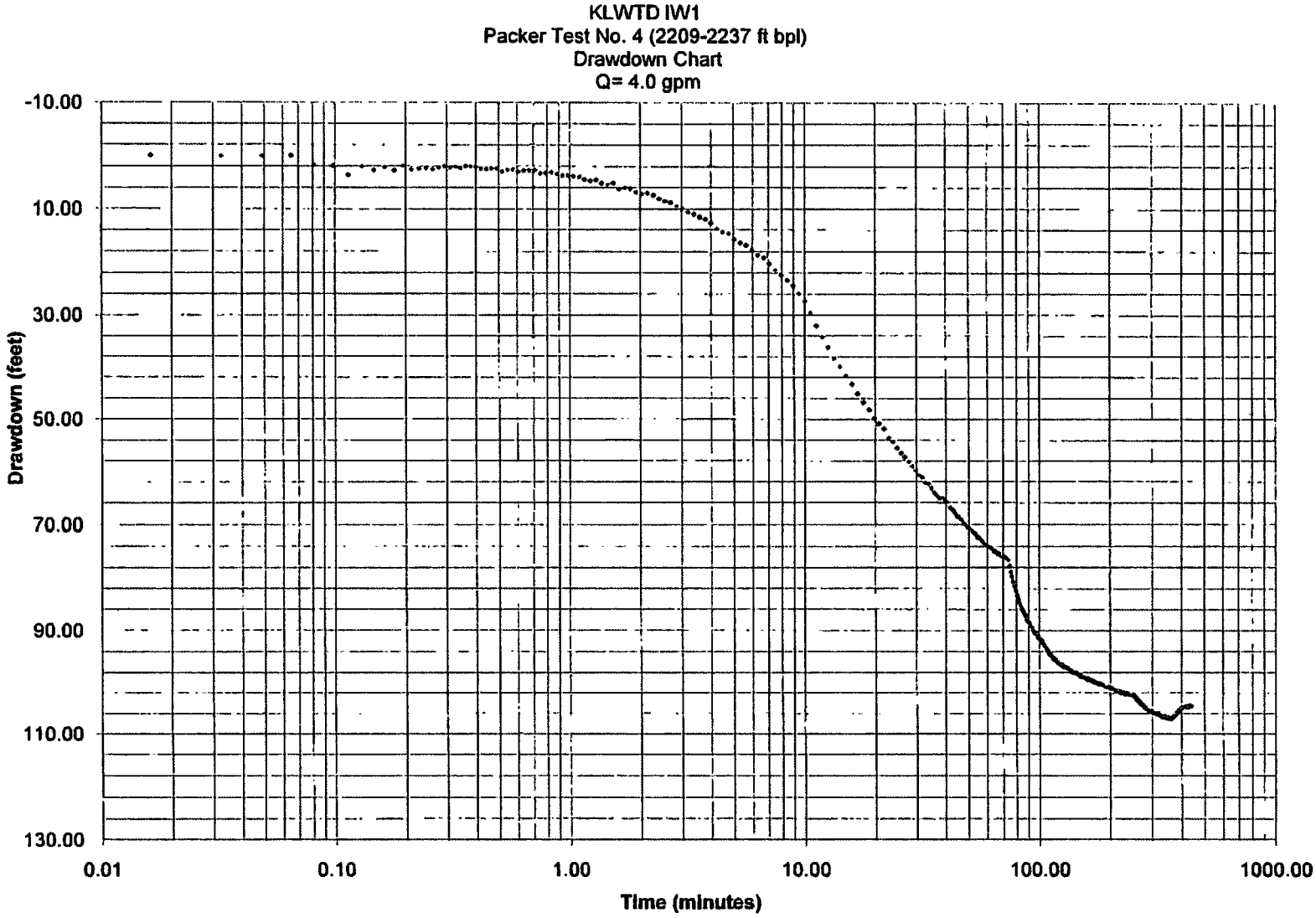
Start date: 1/27/2009

End date: 1/27/2009

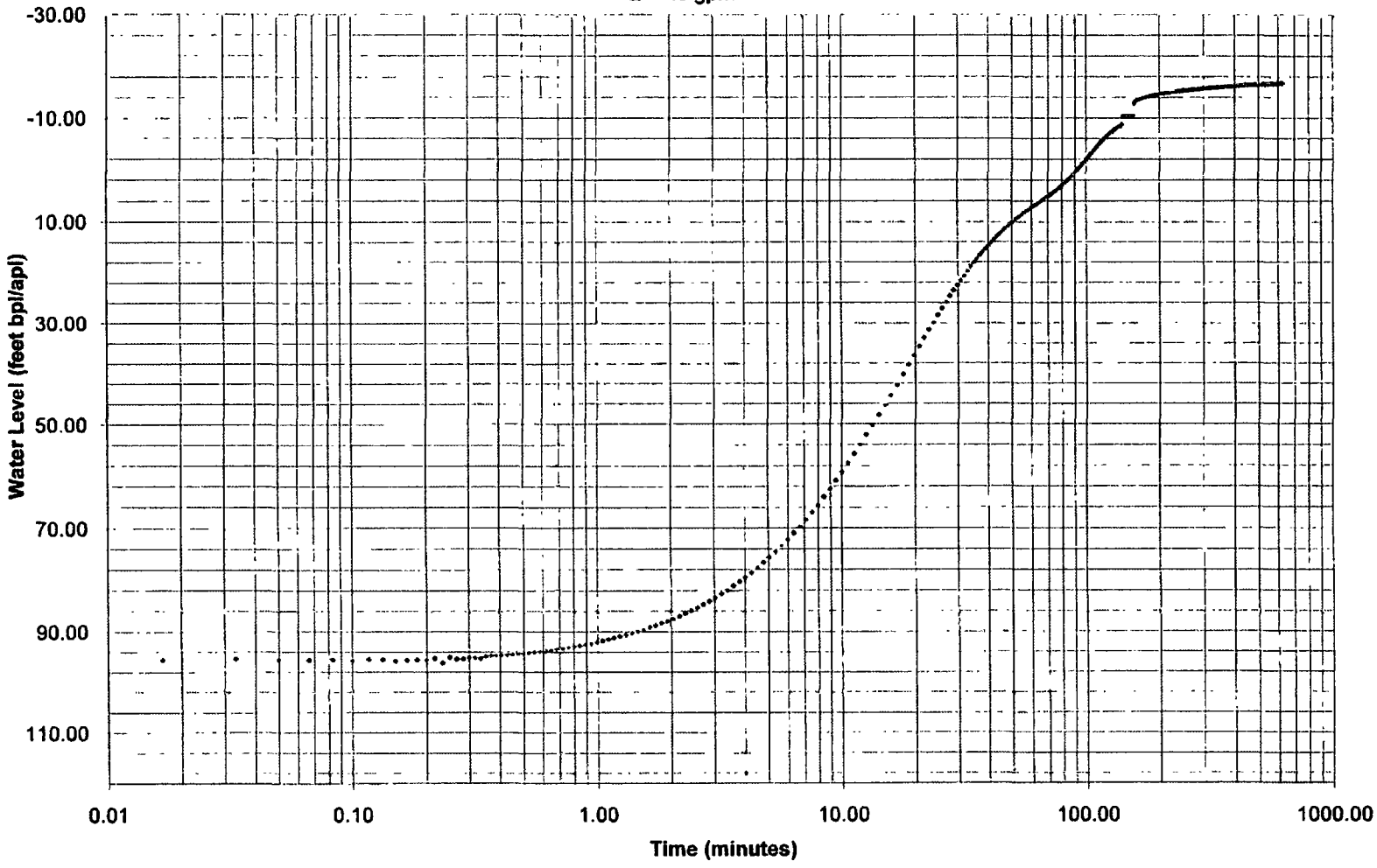
Flowmeter Total-Start (gal) :	19,902	Open Hole Total Depth (feet bpl) :	3,693
Flowmeter Total- End (gal) : n/a	21,664	Packer Depth Interval (feet bpl):	2209-2237
Average Test Pumping Rate (gpm) :	4.0	Pump Setting Depth (feet bpl):	176.08
Development Duration (min):	268	Transducer Depth (feet bpl):	184.84
Pump Test Duration (min):	442	Pipe and open hole volume:	3247+210= 3457 gals.
Static DTW for Test (feet apl):	16.99	Maximum Drawdown (feet):	113.15

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet bpl)	Temp. (°C)	Cond. (mS/cm)	Chlorides (mg/L)	Comments
Development									
1/26/09	21:48	0	2.0	0	5.61 apl	n/a	n/a	n/a	Pump-on, begin development. Transd. At start: 170.51 ft.
1/26/09	21:48	2	1.6	4	n/a	n/a	n/a	n/a	Adjusting rate. Annulus: 28.64 ft. Packer press. 210 psi.
1/26/09	21:54	8	1.6	14	4.61	n/a	n/a	n/a	
1/26/09	22:15	29	1.6	47	20.40	24.6	53,600	20,000	Packer press.: 315 psi, water clear.
1/26/09	22:45	59	1.6	95	32.02	24.4	53,700	20,500	Increase rate to 2.0 gpm. Annulus 27.93 ft
1/26/09	23:25	99	2.0	175	40.15	24.4	53,700	20,500	Increase rate to 3.0 gpm.
1/26/09	0:00	134	3.0	280	55.57	24.8	54,000	20,000	
1/27/09	0:30	164	3.0	370		n/a	n/a	n/a	Leaking pressure line. Suspend development, pump-off.
1/27/09	4:00	164	3.3	370	6.03 apl	Totalizer: 19640 gals			Resume development: packer press. 315 psi.
1/27/09	4:30	194	3.3	470	34.50	25.0	55,000	19,500	Annulus: 28.08 ft., packer press. 305 psi
1/27/09	5:00	224	2.6	570	47.04	24.8	54,900	19,500	Increase rate to 4 gpm.
1/27/09	5:30	254	3.8	720	63.56	25	54,800	19,500	
1/27/09	5:42	266	3.8	765	69.38	n/a	n/a	n/a	Annulus: 28.4 ft, packers press: 308 psi.
1/27/09	5:48	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Pump-off, begin pre-test recovery.
Pump Test									
1/27/09	12:58	0	4.0	0	16.99 apl	n/a	n/a	n/a	Pump-on, start test; annulus: 28.5 ft, packer press: 330psi
1/27/09	13:20	22	4.0	88	n/a	25.70	54,700	18,500	
1/27/09	13:45	47	4.0	188	60.92	60.92	55,400	19,000	Annulus: 28.42 psi
1/27/09	14:15	77	3.8	302	69.90	69.90	55,600	19,000	Packesr press: 325 psi.
1/27/09	14:45	107	4.0	422	77.45	77.45	55,000	19,000	
1/27/09	15:15	137	4.0	542	89.14	89.14	54,900	18,500	Annulus: 28.30 psi
1/27/09	15:45	167	4.0	662	90.89	90.89	54,900	18,500	
1/27/09	16:15	197	4.0	782	91.93	91.93	54,900	18,500	Packers press: 340 psi
1/27/09	16:45	227	3.9	900	93.14	93.14	55,000	19,000	Annulus: 28.29 psi
1/27/09	17:15	257	4.0	1,020	93.70	93.70	53,700	18,500	
1/27/09	17:45	287	4.0	1,140	96.31	96.31	47,400	17,000	Packers press: 320 psi.
1/27/09	18:15	317	4.1	1,262	97.18	97.18	40,000	16,000	Water becoming cloudy. Annulus: 28.32 psi
1/27/09	18:45	347	4.0	1,382	97.97	97.97	36,100	14,000	Water very cloudy.
1/27/09	19:15	377	4.1	1,504	97.18	97.18	49,400	18,000	Annulus: 28.41 psi.
1/27/09	19:45	407	4.0	1,624	96.16	96.16	51,400	18,500	
1/27/09	20:15	437	3.9	1,742	95.70	95.70	50,800	18,500	
1/27/09	20:20	442	4.0	1,762	n/a	n/a	n/a	n/a	Pump-off, begin recovery; annulus: 28.47 ft
									Packer press: 325 psi.

"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"C" denotes degrees celcius.
"mS/cm" denotes milliSiemens per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.
"N/M" denotes not measured.
Static depth to water (DTW) used for calculations was measured after full post-test recovery.


KLWTD IW1
Packer Test No. 4 (2209-2237 ft bpl)
Drawdown Chart
Q= 4.0 gpm
-10.00
10.00
30.00
50.00
70.00
90.00
110.00
130.00
Drawdown (feet)
0.01
0.10
1.00
10.00
100.00
1000.00
Time (minutes)

KLWTD IW1
Packer Test No. 4 (2209- 2236 ft bpl)
Recovery Chart
Q= 4.0 gpm



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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

IW1

Packer Test No.5 (straddle packer)

Start date: 1/29/2009

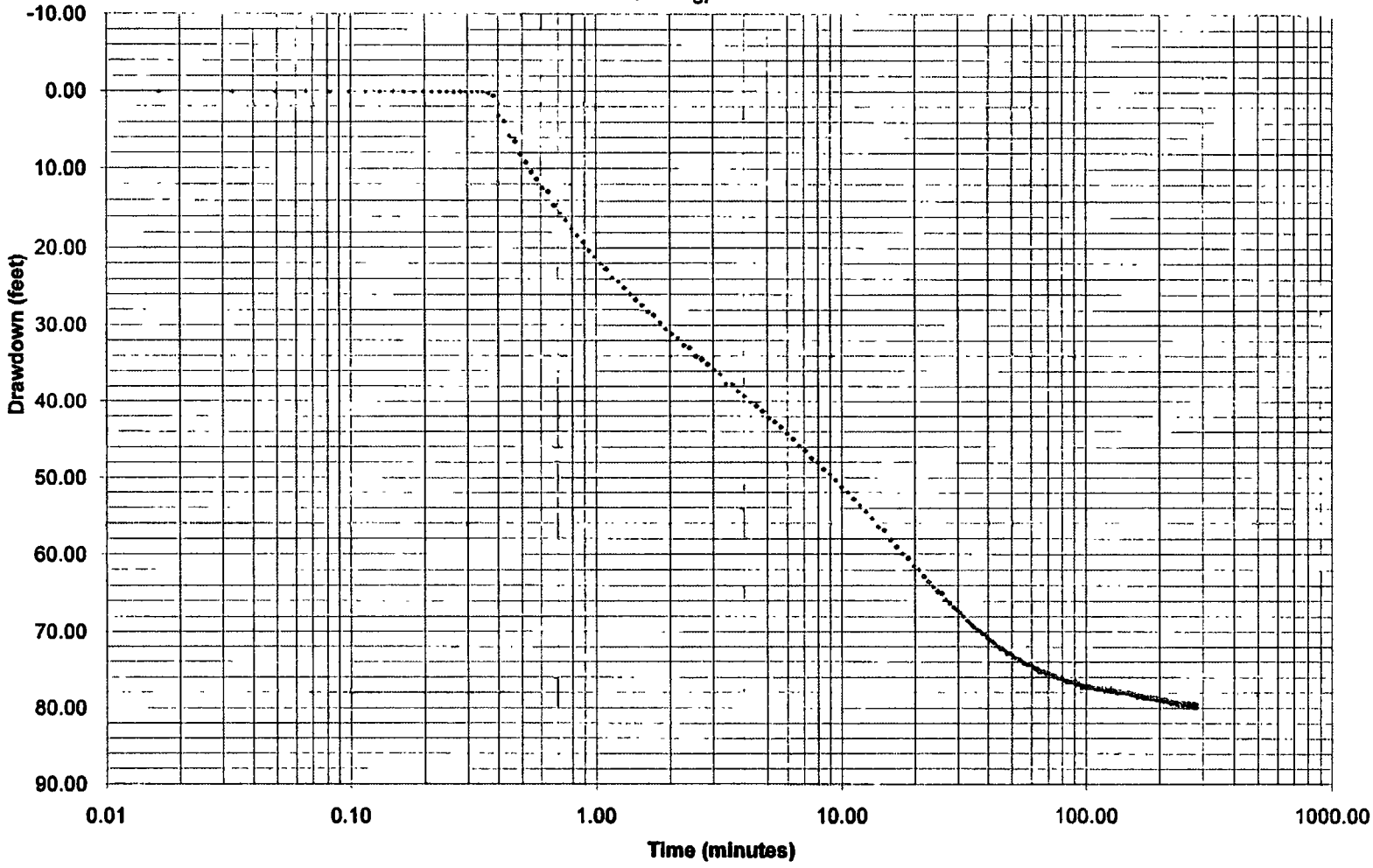
End date: 1/29/2009

Flowmeter Total-Start (gal) :	23,198	**Open Hole Total Depth (feet bpl) :**	3,693
Flowmeter Total- End (gal) : n/a	24,306	**Packer Depth Interval (feet bpl):**	2449-2477
Average Test Pumping Rate (gpm) :	4.0	**Pump Setting Depth (feet bpl):**	176.08
Development Duration (min):	392	**Transducer Depth (feet bpl):**	164.84
Pump Test Duration (min):	274	**Pipe and open hole volume:**	3,600+210= 3457 gals.
Static DTW for Test (feet apl):	14.10	**Maximum Drawdown (feet):**	79.86

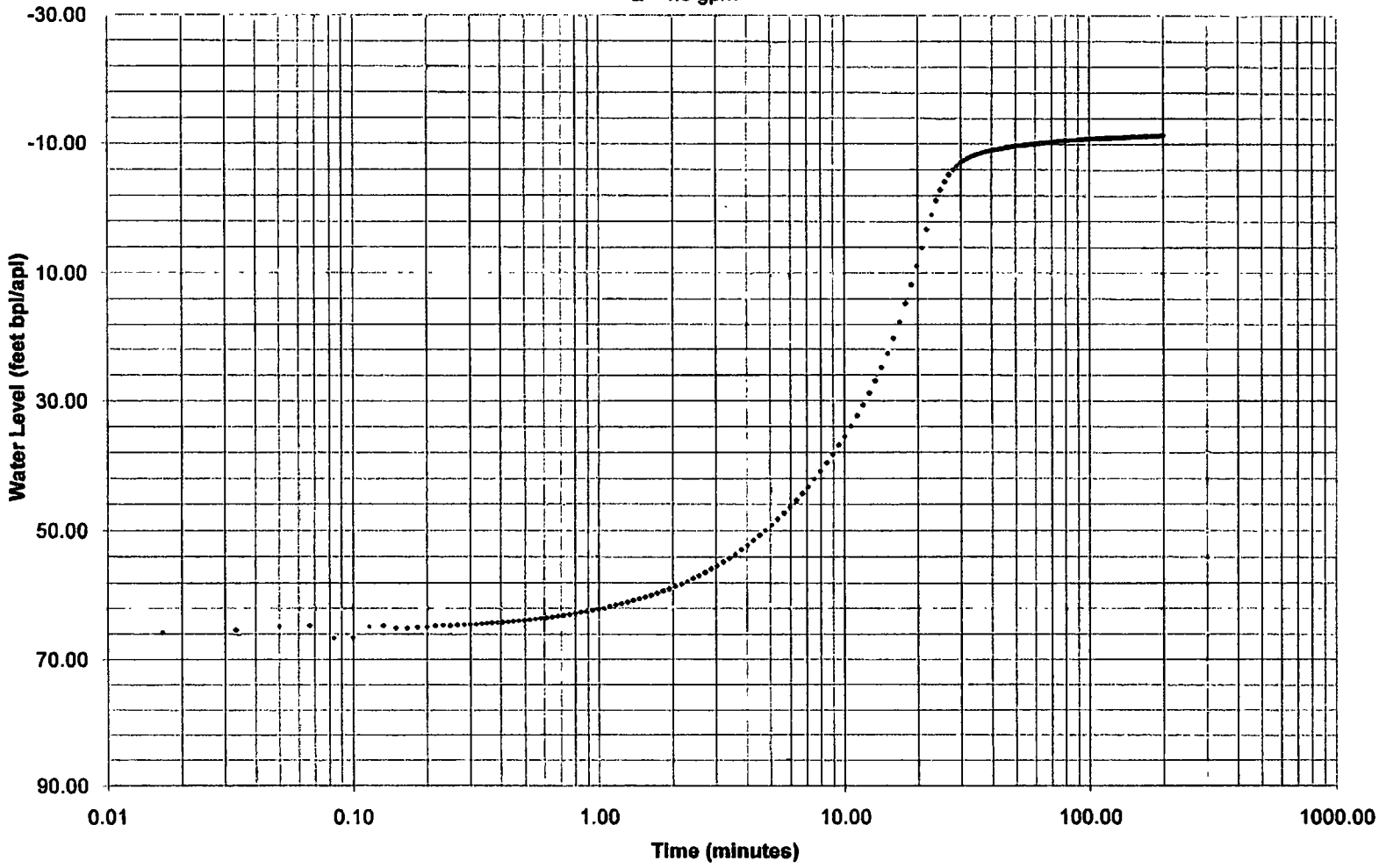
Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet bpl)	Temp. (°C)	Cond. (mS/cm)	Chlorides (mg/L)	Comments
Development									
1/28/09	12:52	0	4.0	0	9.00 apl	n/a	n/a	n/a	Pump-on, begin development. Transd. At start: 173.08 ft.
1/28/09	12:54	2	4.0	4	5 00 apl	n/a	n/a	n/a	Annulus: 23.69 ft. Packer press. 350 psi.
1/28/09	13:03	11	4.0	44	9.64	n/a	n/a	n/a	Water cloudy.
1/28/09	13:32	40	4.0	160	38.52	26.4	45,100	17,500	
1/28/09	14:12	80	4.0	280	50.22	26.5	45,900	17,500	
1/28/09	15:32	160	4.0	640	58.30	26.5	38,400	12,500	Annulus: 23.78 ft. Water v. cloudy
1/28/09	15:52	180	4.0	720	58.85	26.3	39,500	13,500	Increase rate to 6.0 gpm.
1/28/09	16:31	219	6.0	954	71.81	26.1	40,700	14,500	Annulus: 23.74 ft. Water v. cloudy
1/28/09	17:00	248	6.1	1,131	78.65	25.9	41,900	15,000	
1/28/09	17:35	283	6 0	1,365	82.94	26.3	43,700	15,000	Packers press: 345 psi. Annulus: 23.83 ft.
1/28/09	18:07	315	5.9	1,554	88.55	25.9	44,400	15,500	
1/28/09	18:40	348	6.0	1,752	89.93	26.0	45,600	15,500	Packers: 340 psi, Annulus: 23.83 ft.
1/28/09	19:20	388	6.0	1,992	90.45	26.2	44,200	15,500	Adjust pumping rate for test to 4 gpm.
1/28/09	19:24	392	4.0	2,008	n/a	n/a	n/a	n/a	Pump-off, begin pre-test recovery.
									Totalizer: 23198 gals.
Pump Test									
1/29/09	1:04	0	4.0	0	14.1 apl	n/a	n/a	n/a	End recovery, pump-on. Annulus 24.07 ft.
1/29/09	1:45	41	4.0	164	56.98	25.50	38,400	15,000	Packers press: 330 psi.
1/29/09	2:15	71	4.0	275	61.22	25.90	39,200	15,000	Annulus: 24.02 psi.
1/29/09	2:45	101	3.9	407	63.10	25.60	40,700	15,500	
1/29/09	3:15	131	4.0	517	63.60	26.40	43,400	17,500	Packers press: 320 psi. Water clearing-up.
1/29/09	3:45	161	4.0	622	63.99	26.20	43,900	17,500	Annulus: 23.95 psi.
1/29/09	4:15	191	4.0	748	64.62	26.00	46,300	18,500	
1/29/09	4:45	221	4.0	883	64.88	26.40	47,000	18,500	Packers press: 330 psi.
1/29/09	5:15	251	4.0	976	65.26	26.10	47,100	18,500	Annulus: 23.94 ft.
1/29/09	5:45	271	4.0	1,095	65.23	25.90	47,300	18,500	Collecting lab. samples. Water clear
1/29/09	5:48	274	4.0	1,108	n/a	n/a	n/a	n/a	Pump-off, begin recovery. Annulus: 23.86 ft.

"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"°C" denotes degrees celcius.
"mS/cm" denotes milliSiemens per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.
"N/M" denotes not measured.

KLWTD IW1
Packer Test No. 5 (2449-2477 ft bpl)
Drawdown Chart
Q= 4.0 gpm



KLWTD IW1
Packer Test No. 5 (2449- 2477 ft bpl)
Recovery Chart
Q= 4.0 gpm



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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

IW1

Packer Test No.6 (straddle packer)

Start date: 1/30/2009

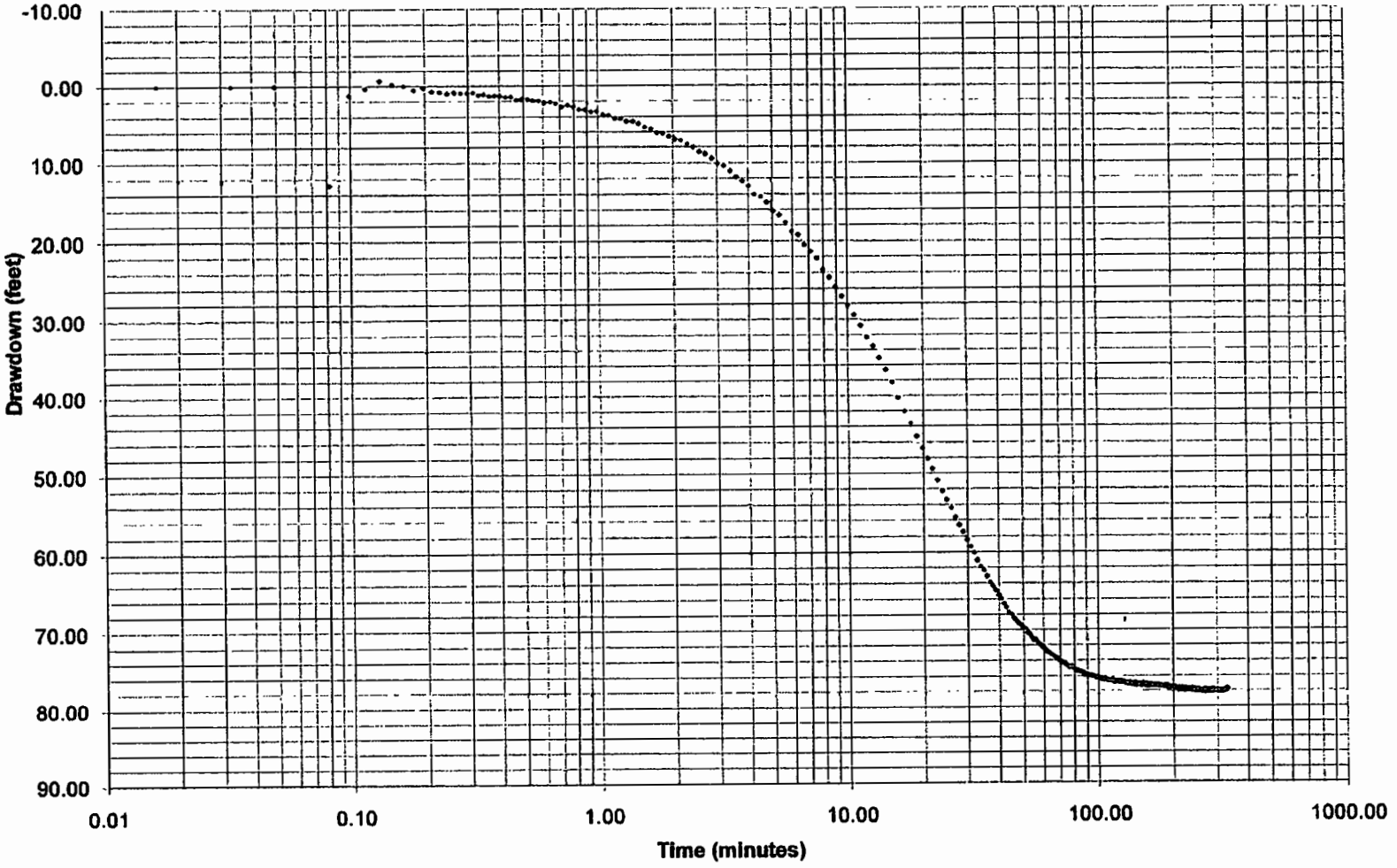
End date: 1/30/2009

Flowmeter Total-Start (gal) :	25,203	**Open Hole Total Depth (feet bpl) :**	3,693
Flowmeter Total- End (gal) : n/a	26,525	**Packer Depth Interval (feet bpl):**	2594-2622
Average Test Pumping Rate (gpm) :	4.0	**Pump Setting Depth (feet bpl):**	176.08
Development Duration (min):	236	**Transducer Depth (feet bpl):**	164.84
Pump Test Duration (min):	332	**Pipe and open hole volume:**	3,814+220= 4034 gals.
Static DTW for Test (feet apl):	12.44	**Maximum Drawdown (feet):**	90.55

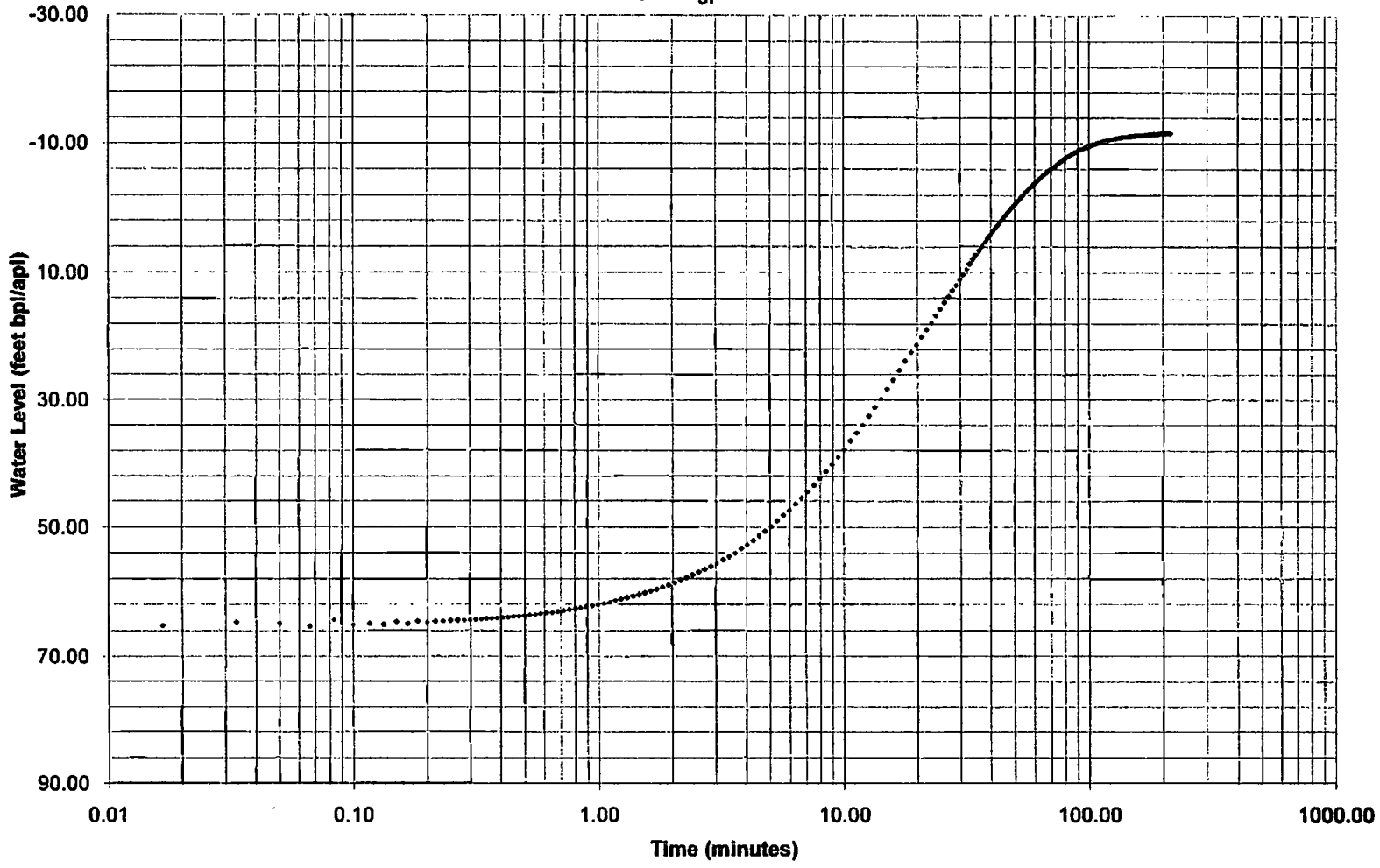
Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet bpl)	Temp. (°C)	Cond. (mS/cm)	Chlorides (mg/L)	Comments
Development									
1/29/09	14:32	0	4.0	0	14.17 apl	n/a	n/a	n/a	Pump-on, begin development. Packers: 360 psi. Ann: 24.47
1/29/09	14:39	7	4.0	28	4.48	n/a	n/a	n/a	
1/29/09	15:00	28	4.0	112	38.20	26.1	47,400	17,500	Annulus: 24.39 ft.
1/29/09	15:32	60	4.0	239	56.38	26	51,900	20,000	Water v. sl. Turbid. Annulus: 24.31ft
1/29/09	16:02	90	4.0	357	61.56	26	51,700	20,000	Annulus: 24.25 ft.
1/29/09	16:32	120	4.0	478	63.09	26	51,900	20,000	Annulus. 24.21 ft.
1/29/09	17:02	150	4.0	556	63.66	25.9	52,200	20,000	Annulus: 24.19 ft.
1/29/09	17:32	180	4.0	674	66.48	26	51,600	19,500	Annulus: 24.18 ft.
1/29/09	18:02	210	4.0	796	65.90	26.1	51,400	19,500	Annulus: 24.17 ft.
1/29/09	18:28	236	4.0	897	65.81	25.9	50,900	19,500	Pump-off, begin pre-test recovery. Annulus: 24.18 ft.
									Totalizer: gals.
Pump Test									
1/30/09	0:30	0	4.0	0	12.44 apl	n/a	n/a	n/a	Pump-on: annulus: 24.61 ft, packers press: 320 psi.
1/30/09	0:46	16	4.0	82	n/a		n/a	n/a	
1/30/09	1:00	30	3.9	141	116.58	25.80	64,200	22,500	Annulus:24.49 ft.
1/30/09	1:30	60	4.0	247	109.78	25.80	57,100	21,000	
1/30/09	2:00	90	4.0	364	101.40	25.70	53,800	20,000	Packers press. 330 psi
1/30/09	2:30	120	4.0	476	100.40	26.00	51,600	19,500	Annulus: 24.39 ft.
1/30/09	3:00	150	4 0	604	100.18	25.90	51,300	19,500	
1/30/09	3:30	180	4.0	723	100.12	25.80	52,000	19,500	Packers press. 340 psi
1/30/09	4:00	210	4.0	838	99.77	26.00	52,100	19,500	
1/30/09	4:30	240	4.0	958	99 68	26.20	52,300	19,500	Annulus: 24.37 ft
1/30/09	5:00	270	4.0	1080	99 14	26.20	52,000	19,500	
1/30/09	5:30	300	4.0	1198	99.58	25.90	52,900	20,000	
1/30/09	6:00	330	4.0	1312	99.55	25.90	53,000	20,000	Annulus: 24.39 ft.
1/30/09	6:02	332	4.0	1,320	n/a	n/a	n/a	n/a	

"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"°C" denotes degrees celcius.
"mS/cm" denotes milliSiemens per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.

KLWTD IW1
Packer Test No. 6 (2594-2622ft bpl)
Drawdown Chart
Q= 4.0 gpm



KLWTD IW1
Packer Test No. 6 (2594- 2622 ft bpl)
Recovery Chart
Q= 4.0 gpm



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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

MW1

Packer Test No.7 (single packer)

Start date: 4/1/2009 **End date:** 4/1/2009

Flowmeter Total-Start (gal) :	2810	Open Hole Total Depth (feet bpl) :	1,700
Flowmeter Total- End (gal) :	21160	Packer Depth Interval (feet bpl):	1649-1700
Average Test Pumping Rate (gpm) :	25.5	Pump Setting Depth (feet bpl):	174.84
Development Duration (min):	483	Transducer Depth (feet bpl):	160.84
Pump Test Duration (min):	720	Pipe and open hole volume:	2400+590= 2990 gals.
Static DTW Before Test (feet apl):	13.57	Maximum Drawdown (feet):	100.8

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet apl/bpl)	Temp. (°C)	Cond. (µS/cm)	Chlorides (mg/L)	Comments
Development									
3/31/09	15:00	0	~20	0	n/a	n/a	n/a	n/a	Start air- lifting development. Packer press.
3/31/09	15:45	45	~20	~900	n/a	n/a	n/a	n/a	Water brownish, clearing. Annulus WL. 9. 5 ft.
3/31/09	16:45	105	~20	~2100	n/a	n/a	n/a	n/a	Muddy water again.
3/31/09	17:30	150	~20	~3000	n/a	n/a	n/a	n/a	Slighly clearing. Packer press. 320 psi. Add to 350 psi.
3/31/09	18:15	195	~20	~3900	n/a	26.8	32,300	11,000	Slightly turbid.
3/31/09	19:00	240	~20	~4800	n/a	26.9	32500	11,000	
3/31/09	19:45	285	~20	~5700	n/a	26.7	32300	11,000	
3/31/09	20:10	310	~20	~6200	n/a	26.5	32400	11,000	End air lifting development. Water only slightly turbid.
3/31/09	21:39	310	8	6,200	11.30 apl	n/a	n/a	n/a	Start dev. with submersible pump (flow.tot. 265170).
3/31/09	21:53	324	20	6,350	43.77	n/a	n/a	n/a	Ann.: 11.93 ft.
3/31/09	22:08	339	20	6,650	58.25	27.5	33,400	11,000	
3/31/09	22:39	370	20	6,950	64.15	n/a	n/a	n/a	Increase rate to 30 gpm
3/31/09	22:50	381	n/a	n/a	85.81	n/a	n/a	n/a	Stop pumping, have to replace flowmeter with 2-inch.
3/31/09	23:05	381	n/a	n/a	n/a	n/a	n/a	n/a	Resume pumping. Adjust rate to 25 gpm.
3/31/09	23:15	391	25	7,200	84.85	27.3	32,900	11,000	
3/31/09	23:44	420	25	7,930	85.30	27.1	32,800	11,000	Ann.: 12.93 ft, packer: 320 psi.
4/1/09	0:14	450	26	8,700	86.00	26.9	32,800	11,000	Packer:320 psi.
4/1/09	0:44	480	26	9,480	86.77	26.6	32,800	11,000	Packer:350 psi. Ann.: 13.38 ft.
4/1/09	0:47	483	26	n/a	n/a	n/a	n/a	n/a	Pump-off, start pre-test recovery. Packer press. 350 psi.
Pump Test									
4/1/09	4:00	0	30	0	13.55 apl	n/a	n/a	n/a	Start test: pump-on; packer press. 340 psi. An
4/1/09	4:30	30	27	820	78.38	27.4	32,800	11,500	Packer press. : 330 psi, ann. WL: 14.34 ft
4/1/09	5:00	60	26	1,590	80.69	27.7	32,700	11,500	
4/1/09	5:30	90	26	2,300	82.26	27.3	32,700	11,500	Packer press. : 350 psi, ann. WL: 14.62 ft
4/1/09	6:00	120	27	3,110	82.96	27.6	32,800	11,500	
4/1/09	6:30	150	26	3,890	83.63	27.4	32,800	11,500	Packer press. : 340 psi, ann. WL: 14.81 ft
4/1/09	7:00	180	25	4,630	84.28	27.0	32,700	11,500	
4/1/09	8:00	240	25	6,160	85.24	27.4	32,600	11,500	Packer press. : 330 psi, ann. WL: 15.17 ft
4/1/09	9:00	300	25	7,700	85.90	27.2	32,700	11,500	

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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

MW1

Packer Test No.7 (single packer)

Start date: 4/1/2009 **End date:** 4/1/2009

Flowmeter Total-Start (gal) :	2810	Open Hole Total Depth (feet bpl) :	1,700
Flowmeter Total- End (gal) :	21150	Packer Depth Interval (feet bpl):	1649-1700
Average Test Pumping Rate (gpm) :	25.5	Pump Setting Depth (feet bpl):	174.84
Development Duration (min):	483	Transducer Depth (feet bpl):	160.84
Pump Test Duration (min):	720	Pipe and open hole volume:	2400+590= 2990 gals.
Static DTW Before Test (feet apl):	13.57	Maximum Drawdown (feet):	100.8

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet apl/bpl)	Temp. (°C)	Cond. (µS/cm)	Chlorides (mg/L)	Comments
4/1/09	10:00	360	26	9,210	86.15	27.2	32,800	11,500	Packer press. : 350 psi, ann. WL: 15.80 ft
4/1/09	11:00	420	25	10,740	86.36	27.2	32,800	11,500	
4/1/09	12:00	480	25	12,310	86.86	27.2	32,700	11,500	Collecting water sample for the lab.
4/1/09	13:04	544	25	13,850	87.23	27.3	32,600	11,500	Annulus: 16.67 ft.
4/1/09	13:30	570	25	14,500	87.26	27.4	32,500	11,500	
4/1/09	14:00	600	26	15,250	87.55	n/a	n/a	11,500	Annulus: 17.23 ft., packer: 330 psi.
4/1/09	14:30	630	26	16,030	87.47	27.5	32,700	11,500	
4/1/09	15:00	660	26	16,780	87.91	n/a	n/a	11,500	Annulus: 17.34 ft
4/1/09	15:30	690	26	17,590	88.08	27.5	32,400	11,500	
4/1/09	15:55	715	26	n/a	n/a	27.3	32,400	11,500	
4/1/09	16:00	720	26	18,240	88.26	n/a	n/a	n/a	Annulus: 17.51ft, packer: 350 psi. Pump-off, start recovery.

"gal" denotes gallons.

"gpm" denotes gallons per minute.

"min" denotes minutes.

"feet bpl" denotes feet below pad level.

"feet apl" denotes feet above pad level.

"°C" denotes degrees celcius.

"µS/cm" denotes milliSiemens per centimeter.

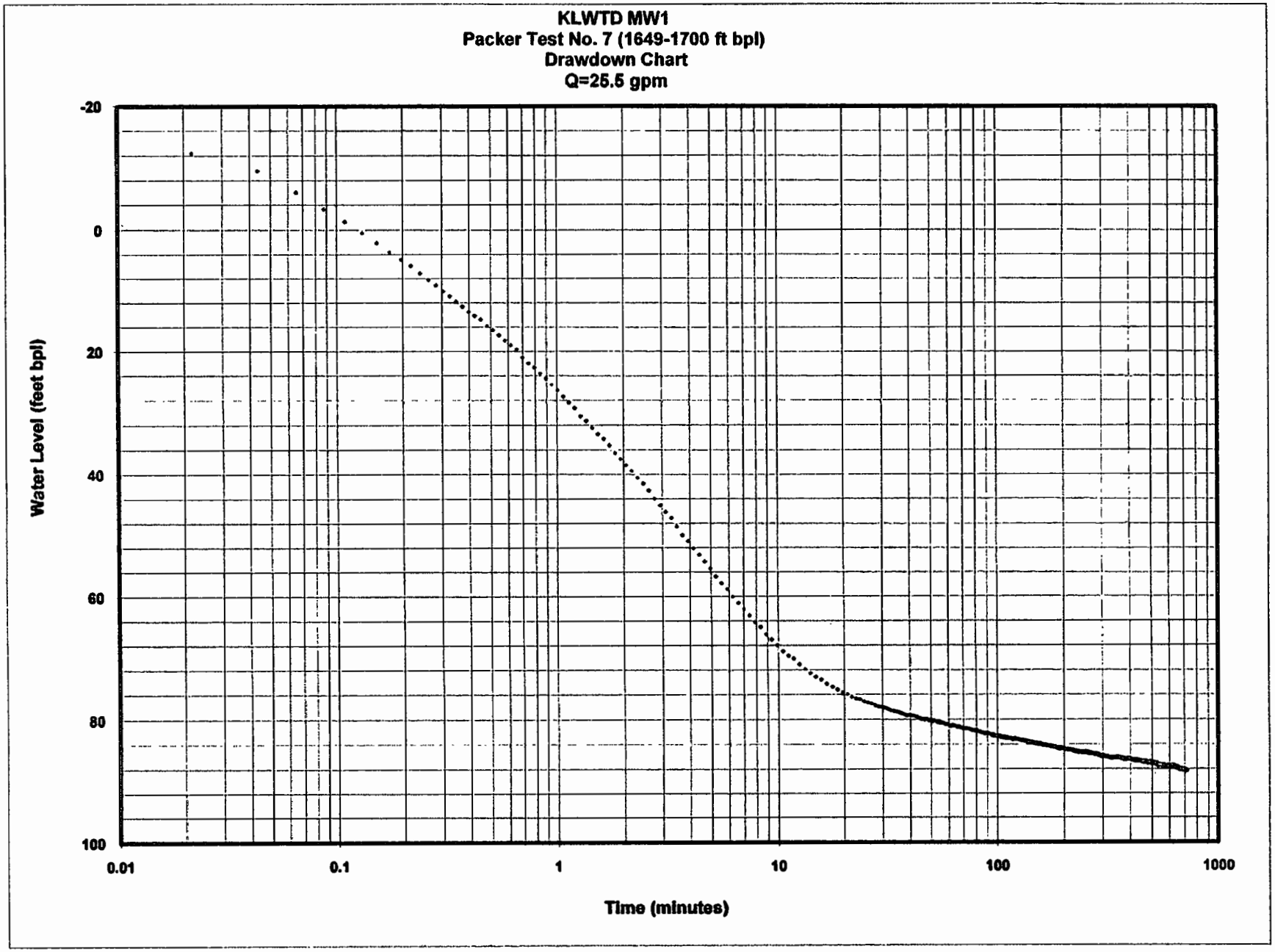
"mg/L" denotes milligrams per liter.

"psi" denotes pressure in pounds per square inch.

"n/a" denotes data not available.

"N/M" denotes not measured.

Static depth to water (DTW) was measured just prior to pumping test startup.



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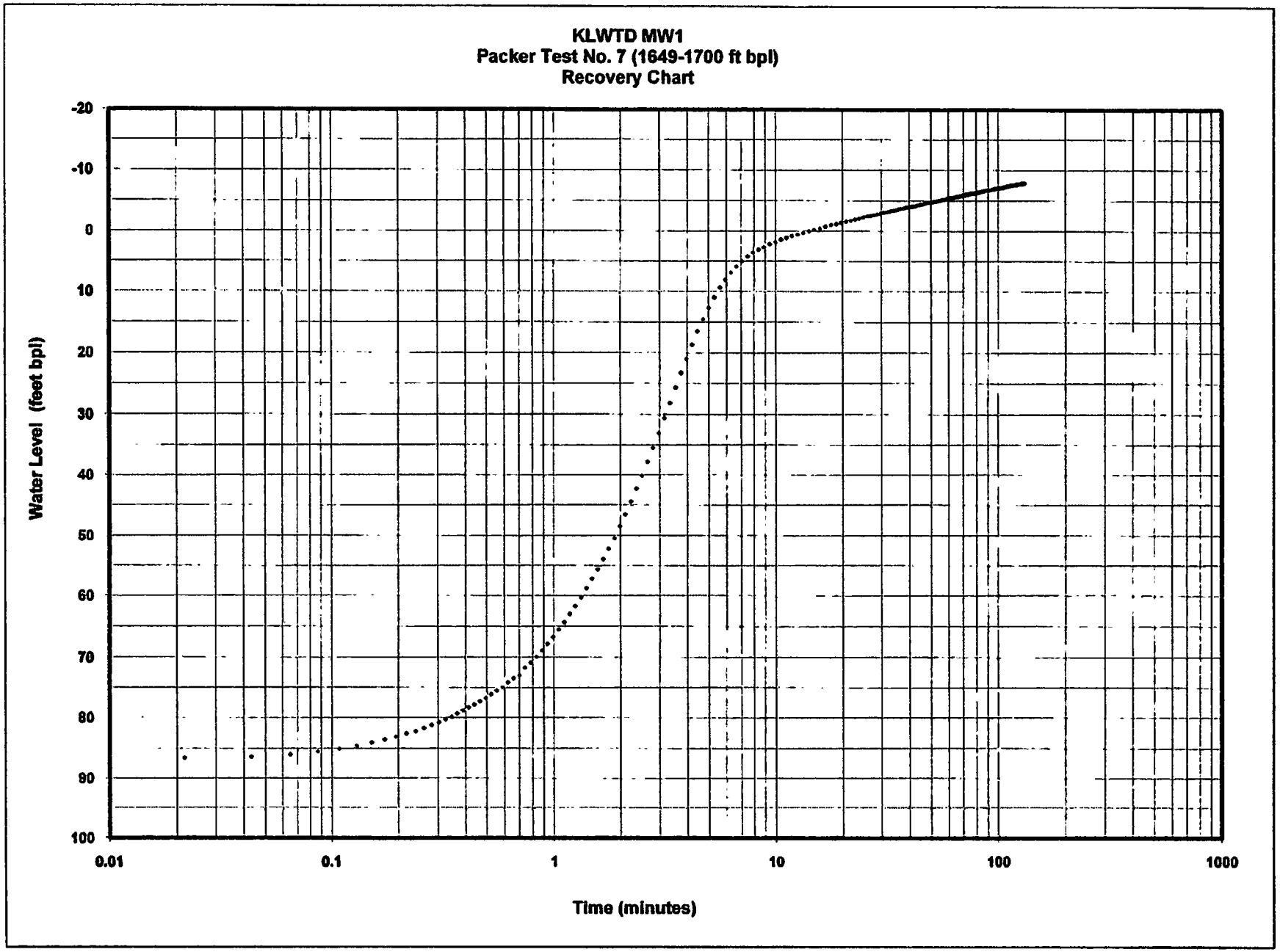

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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

MW1

Packer Test No.8 (straddle packer)

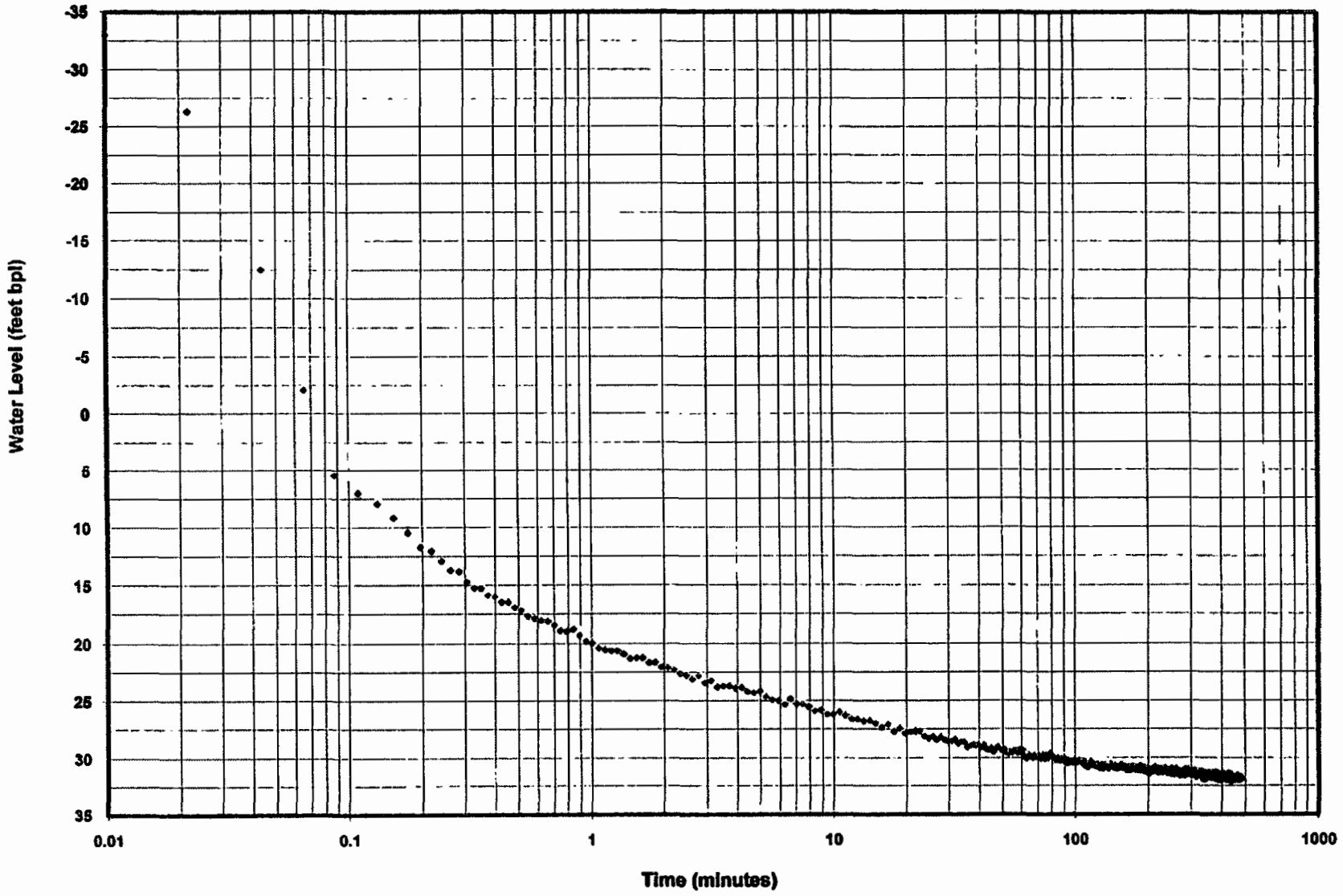
Start date: 4/2/2009 **End date:** 4/2/2009

Flowmeter Total-Start (gal) :	45805	**Open Hole Total Depth (feet bpl):**	1,700
Flowmeter Total- End (gal) :	85400	**Packer Depth Interval (feet bpl):**	1434-1481
Average Test Pumping Rate (gpm):	82.3	**Pump Setting Depth (feet bpl):**	174.84
Development Duration (min):	357	**Transducer Depth (feet bpl):**	160.84
Pump Test Duration (min):	481	**Pipe and open hole volume:**	2100+420= 2520 gals.
Static DTW Before Test (feet apl):	33.01	**Maximum Drawdown (feet):**	65.01

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet apl/bpl)	Temp. (°C)	Cond. (µS/cm)	Chlorides (mg/L)	Comments
Development									
4/2/09	9:35	0	~150	0	n/a	n/a	n/a	n/a	Start air- lifting development. Packer press. 350 psi.
4/2/09	11:45	130	~150	19,500	n/a	26.70	10,440	3,500	End air development, install pump.
4/2/09	12:45	130	94	n/a	n/a	n/a	n/a	n/a	Pump-on, resume development.
4/2/09	13:00	145	88	20,775	27.66	26.40	10,460	3,500	Ann.: 8.2 ft; pack. 360 psi
4/2/09	13:30	175	80	23,085	27.78	26.70	10,440	3,500	Ann.: 8.4 ft.
4/2/09	14:00	205	80	25,395	27.92	26.40	10,470	3,500	Ann.: 8.5 ft; pack. 370 psi
4/2/09	14:30	235	80	27,585	28.14	26.70	10,420	3,500	Ann.: 8.6 ft
4/2/09	15:00	265	80	30,005	27.94	26.30	10,460	3,500	Ann.: 8.7 ft; pack. 370 psi
4/2/09	15:30	295	79	31,920	28.50	26.7	10,440	3,500	Ann.: 8.8 ft; pack.
4/2/09	16:00	325	79	35,060	28.72	26.3	10,440	3,500	Ann.: 9.0 ft; pack. 370 psi
4/2/09	16:30	355	79	37,370	28.72	26.10	10,420	3,500	Ann.: 9.1 ft; pack. 370 psi
4/2/09	16:32	357	79	37,540	n/a	n/a	n/a	n/a	Terminate development, pump-off.
Pump Test									
4/2/09	21:20	0	88	0	32.95 apl.	n/a	n/a	n/a	Pump-on, start test; ann: 9.93 ft.
4/2/09	21:35	15	83	1,275	n/a	26.7	10,380	3,500	
4/2/09	22:10	50	82	4,120	29.30	26.6	10,360	3,500	Ann.: 10.14 ft.
4/2/09	22:42	82	82	6,850	30.08	26.6	10,280	3,500	Ann.: 10.29 ft.
4/2/09	23:30	130	82	10,715	30.52	26.5	10,340	3,500	Ann.: 10.49 ft.
4/2/09	0:45	175	82	14,510	30.78	26.6	10,250	3,500	Ann.: 10.75 ft.
4/2/09	1:00	220	83	18,200	30.92	26.2	10,350	3,500	Ann.: 11.03 ft.
4/2/09	2:00	280	82	23,150	31.00	26.0	10,350	3,500	Ann.: 11.37 ft
4/2/09	2:46	327	82	26,920	31.66	25.9	10,350	3,500	Ann.: 11.59 ft.
4/2/09	3:30	370	82	30,460	31.59	26.0	10,340	3,500	Ann.: 11.78ft.
4/2/09	4:15	415	83	34,230	31.52	25.9	10,330	3,500	Ann.: 11.92 ft.
4/2/09	5:10	470	83	n/a	n/a	26.1	10,310	3,500	Collect lab. Samples.
4/2/09	5:21	480	82	39,600	31.63	n/a	n/a	n/a	Pump-off, begin recovery. Ann. 12.12 ft.

"gal" denotes gallons.
"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"°C" denotes degrees celcius.
"µS/cm" denotes milliSiemans per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.
"N/M" denotes not measured.
Static depth to water (DTW) was measured just prior to pumping test startup.

KLWTD MW1
Packer Test No. 8 (1434-1481ft bpl)
Drawdown Chart
Q=82.3 gpm



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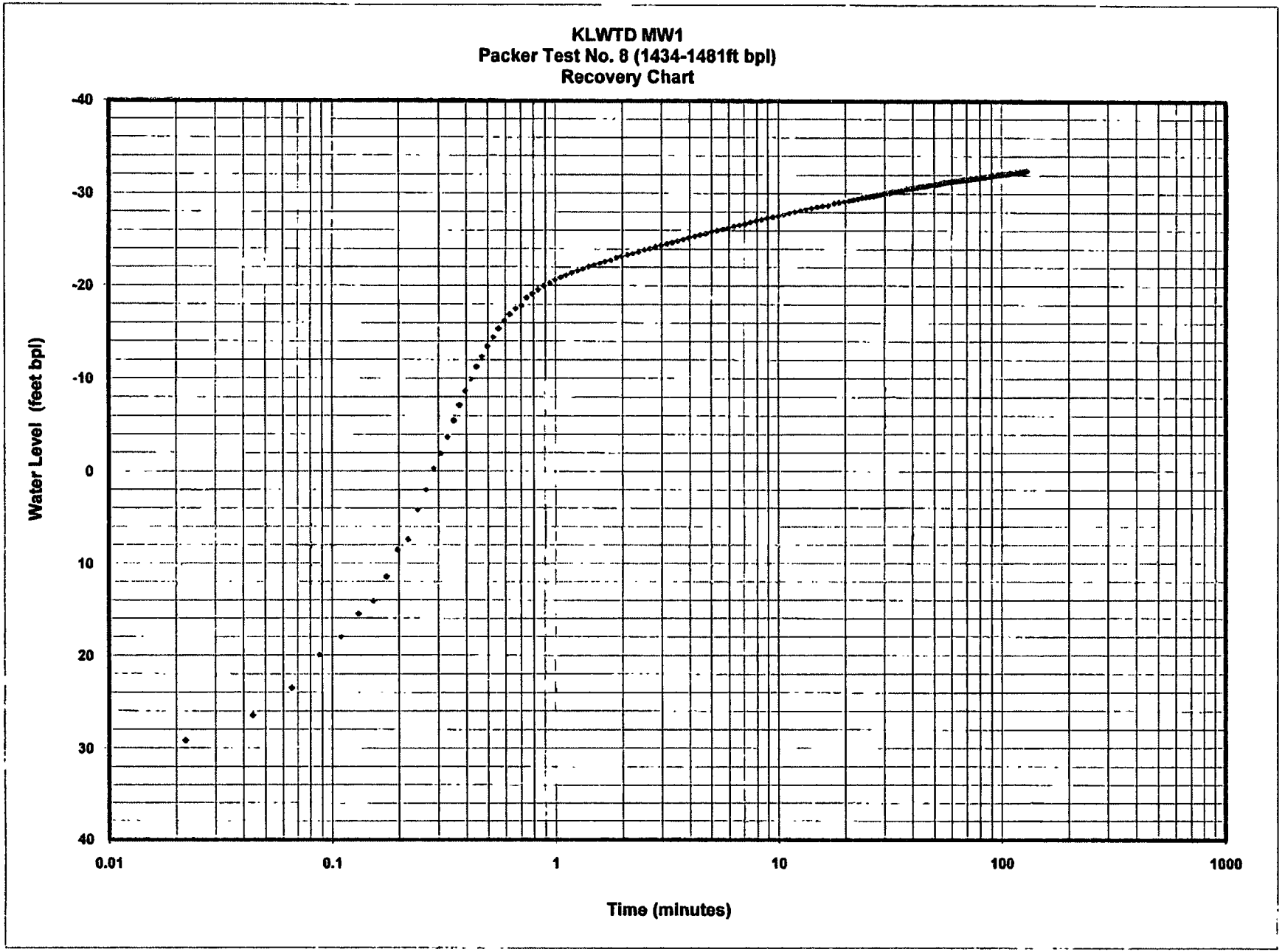

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PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

MW1

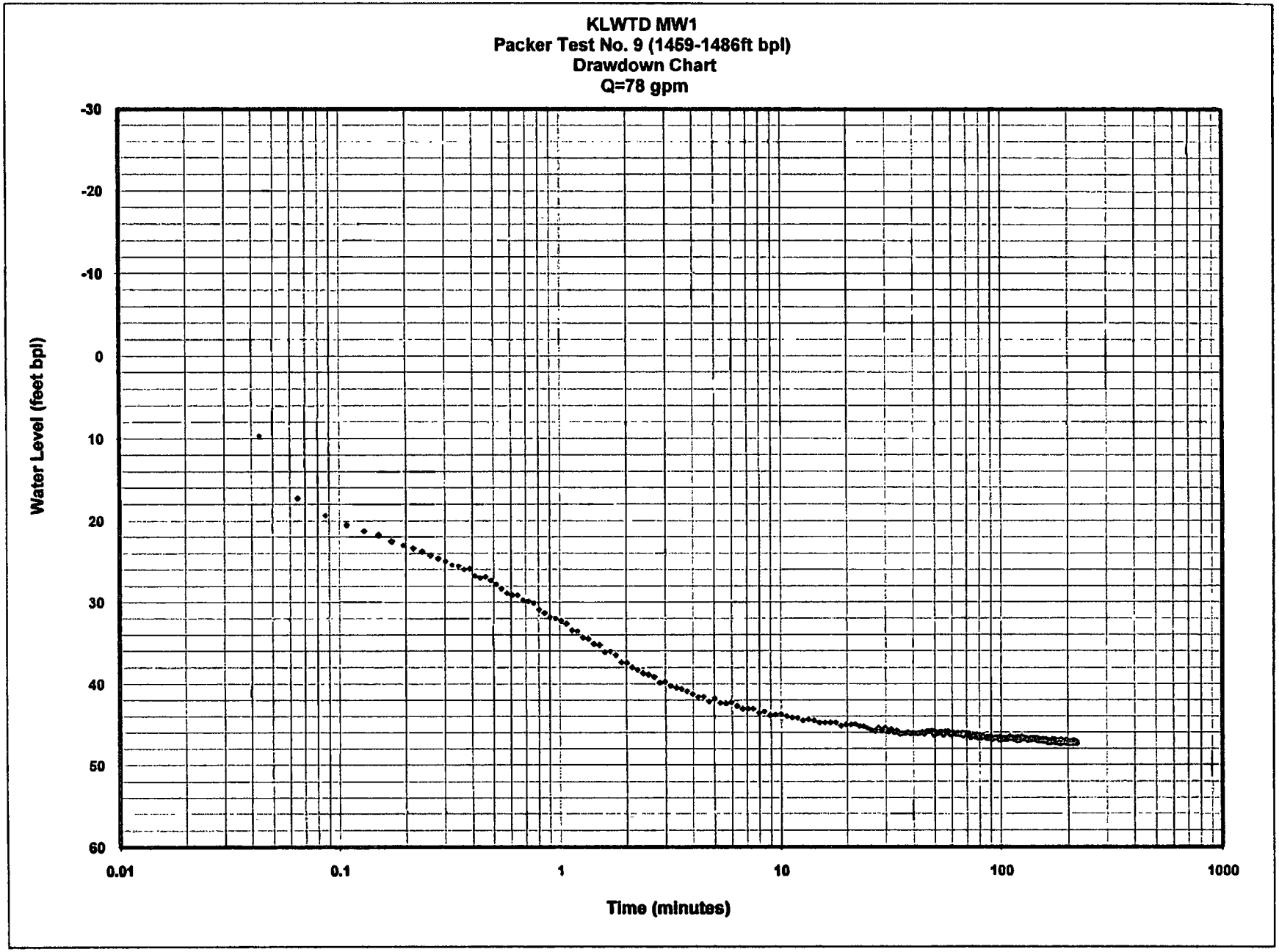
Packer Test No.9 (straddle packer)

Start date: 4/6/2009 **End date:** 4/6/2009

Flowmeter Total-Start (gal):	100330	Open Hole Total Depth (feet bpl):	1,700
Flowmeter Total- End (gal):	118280	Packer Depth Interval (feet bpl):	1459-1486
Average Test Pumping Rate (gpm):	78.0	Pump Setting Depth (feet bpl):	174.84
Development Duration (min):	295	Transducer Depth (feet bpl):	160.84
Pump Test Duration (min):	230	Pipe and open hole volume:	2120+340= 2460 gals.
Static DTW Before Test (feet apl):	33.01	Maximum Drawdown (feet):	76.03

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet apl/bpl)	Temp. (°C)	Cond. (µS/cm)	Chlorides (mg/L)	Comments
Development									
4/6/09	3:05	0	~100	0	n/a	n/a	n/a	n/a	Start air- lifting development. Packer press. 370 psi.
4/6/09	3:35	30	~100	3,000	n/a	n/a	n/a	n/a	Water clearing-up.
4/6/09	3:55	50	~100	5,000	n/a	25.9	17,660	5,500	Packer press.: 350
4/6/09	4:25	80	~100	8,000	n/a	25.7	17,840	5,500	
4/6/09	4:45	100	100	10,000	n/a	25.5	17,900	5,500	End air lifting development.Install submersible pump.
4/6/09	5:57	100	95	10,000	28.91 apl.	n/a	n/a	n/a	Begin pump development. Ann.: 12.85 ft.
4/6/09	6:07	110	95	10,900	51.15	n/a	n/a	n/a	Packers press. : 330 psi
4/6/09	6:25	128	93	12,670	46.97	26.4	18,030	5,500	Ann.:12.98 ft, packer:330 psi. Lower rate to approx. 80 gpm
4/6/09	6:55	158	86	14,880	47.19	26.6	18,010	5,500	Ann.: 13.07 ft.
4/6/09	7:31	194	82	17,900	47.42	26.6	18,050	6,000	Ann.:13.16 ft, packer:320 psi.
4/6/09	8:00	223	81	20,280	47.60	26.5	18,090	6,000	Ann.:13.21 ft, packer:320 psi.
4/6/09	8:30	253	81	22,700	47.74	26.6	18,080	6,000	Ann.: 13.24 ft.
4/6/09	9:00	283	80	n/a	n/a	26.6	18,100	6,000	Packers press. : 320 psi
4/6/09	9:12	295	n/a	26,500	48.07	n/a	n/a	n/a	Pump-off, begin pre-test recovery. Ann. : 13.30 ft.
Pump Test									
4/6/09	15:02	0	84	0	28.65 apl.		n/a	n/a	Pump-on, start test; ann: 14.26 ft.
4/6/09	15:42	40	80	3,220	46.02	27.0	18,090	6,000	Ann.: 14.50 ft, packers: 350 psi.
4/6/09	16:40	98	80	7,890	46.61	26.8	18,100	6,000	Ann.: 14.71 ft.
4/6/09	17:25	143	80	11,490	46.84	26.7	18,090	6,000	Ann.: 14.94 ft.
4/6/09	18:15	193	78	15,390	47.32	26.5	18,050	6,000	Ann.: 15.11 ft. Packers: 340 psi.
4/6/09	18:52	230	77	18,235	47.39	n/a	n/a	n/a	Pump-off, begin recovery. Ann. 15.25 ft.

"gal" denotes gallons.
"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"°C" denotes degrees celcius.
"µS/cm" denotes milliSiemens per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.
"N/M" denotes not measured.
Static depth to water (DTW) was measured just prior to pumping test startup.



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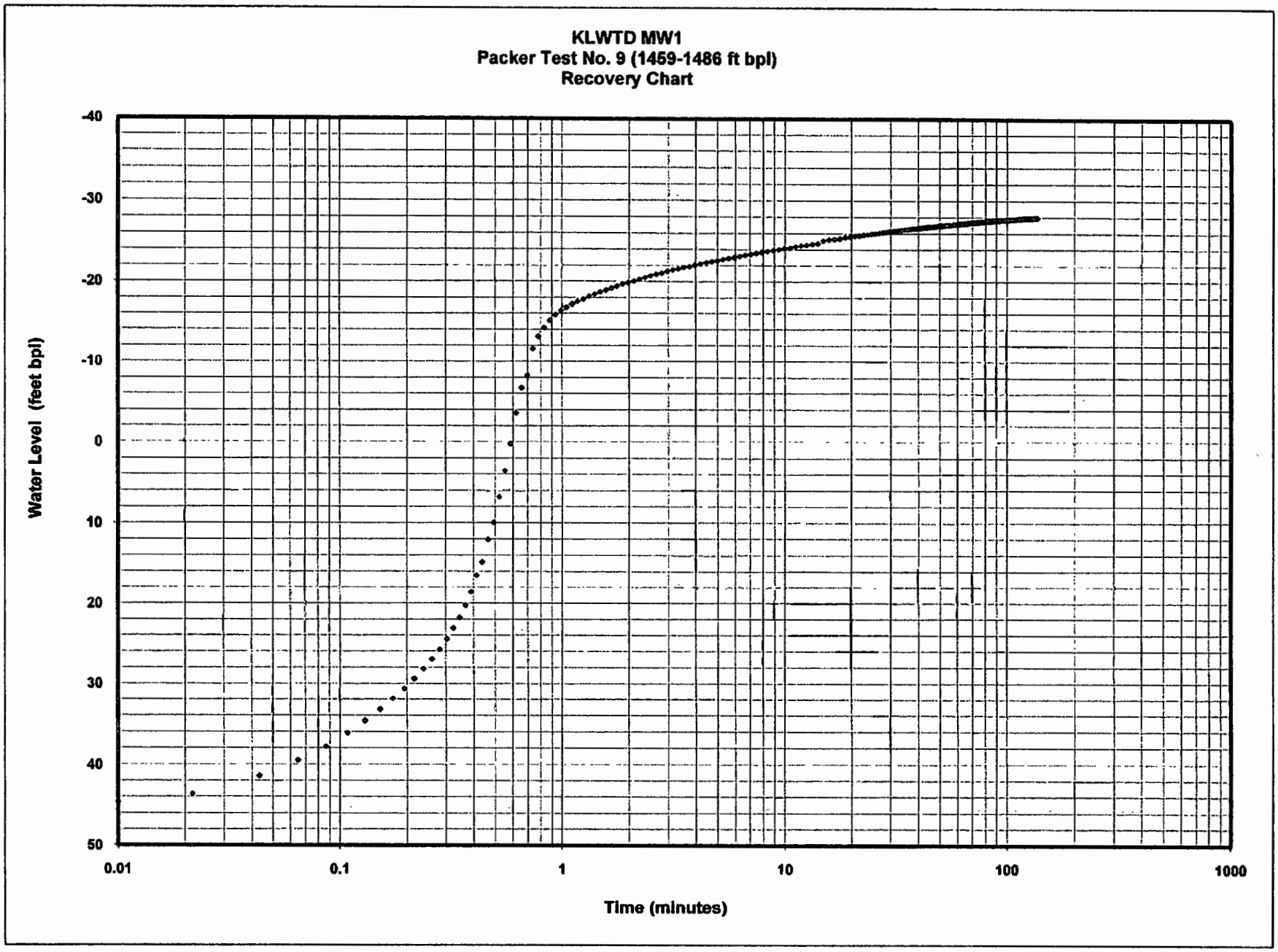

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ARCADIS

PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

MW1

Packer Test No.10 (straddle packer)

Start date: 4/7/2009 **End date:** 4/7/2009

Flowmeter Total-Start (gal):	129600	Open Hole Total Depth (feet bpl):	1,700
Flowmeter Total- End (gal):	153930	Packer Depth Interval (feet bpl):	1489-1516
Average Test Pumping Rate (gpm):	66.7	Pump Setting Depth (feet bpl):	174.84
Development Duration (min):	220	Transducer Depth (feet bpl):	160.84
Pump Test Duration (min):	365	Pipe and open hole volume:	2160+250= 2410 gals.
Static DTW Before Test (feet apl):	27.23	Maximum Drawdown (feet):	108.67

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet apl/bpl)	Temp. (°C)	Cond. (µS/cm)	Chlorides (mg/L)	Comments
Development									
4/7/09	2:05	0	~100	0	n/a	n/a	n/a	n/a	Start air- lifting development. Packer press. 320 psi.
4/7/09	2:55	50	~100	~5,000	n/a	25	20000.000	7000	Water still turbid.
4/7/09	3:40	95	~100	9,500	n/a	24.5	20,000	7,000	Water clearing. Terminate air lifting. Installing pump.
4/7/09	4:45	95	85	9,500	7.40 apl.	n/a	n/a	n/a	Pump-on, resume development. Ann.: 11.99 ft. Packers: 360 psi.
4/7/09	4:50	100	80	10,050	70.36	26.1	20,100	7,000	
4/7/09	5:20	130	80	12,320	64.03	25	20,100	7,000	Ann.: 12.28
4/7/09	5:50	160	78	14,530	63.66	25.5	19,910	6,500	Ann.: 12.37, packers: 340 psi.
4/7/09	6:20	190	78	16,910	63.65	25.7	19,760	6,500	Ann.: 12.65 ft.
4/7/09	6:50	220	78	19,050	63.76	25.6	19,770	6,500	Adjust rate to approx. 70 gpm. Pump-off, begin recovery.
Pump Test									
4/7/09	11:39	0	69	0	27.23 apl.		n/a	n/a	Pump-on, start test; ann: 13.18 ft.
4/7/09	11:56	17	67	1,150	n/a	26.1	19,620	7,500	Packers: 330 psi.
4/7/09	12:42	63	68	4,300	80.11	25.7	19,500	7,500	Ann.: 13.23 ft.
4/7/09	13:18	99	67	6,920	80.50	25.8	19,270	7,500	Ann.: 13.27 ft.
4/7/09	13:52	133	67	9,200	80.86	25.6	19,330	7,500	Packers: 320 psi.
4/7/09	14:37	178	67	12,200	81.12	25.7	19,390	7,500	Ann.: 13.38 ft.
4/7/09	14:58	199	67	13,810	81.26	25.4	19,260	7,500	Packers press.: 320 psi.
4/7/09	15:32	233	67	16,090	81.45	25.6	19,140	7,250	Ann.: 13.60 ft.
4/7/09	16:10	271	67	18,640	81.60	25.8	19,120	7,250	Ann.: 13.78 ft. Packers: 330 psi.
4/7/09	16:57	318	67	21,190	81.50	25.7	19,070	7,250	
4/7/09	17:42	363	68	24,200	81.36	25.6	19,090	7,250	Collecting lab. Sample.
4/7/09	17:44	365	68	24,330	n/a	n/a	n/a	n/a	Pump-off, begin recovery. Ann.: 13.99 ft.

"gal" denotes gallons.

"gpm" denotes gallons per minute.

"min" denotes minutes.

"feet bpl" denotes feet below pad level.

"feet apl" denotes feet above pad level.

"°C" denotes degrees celcius.

"µS/cm" denotes milliSiemans per centimeter.

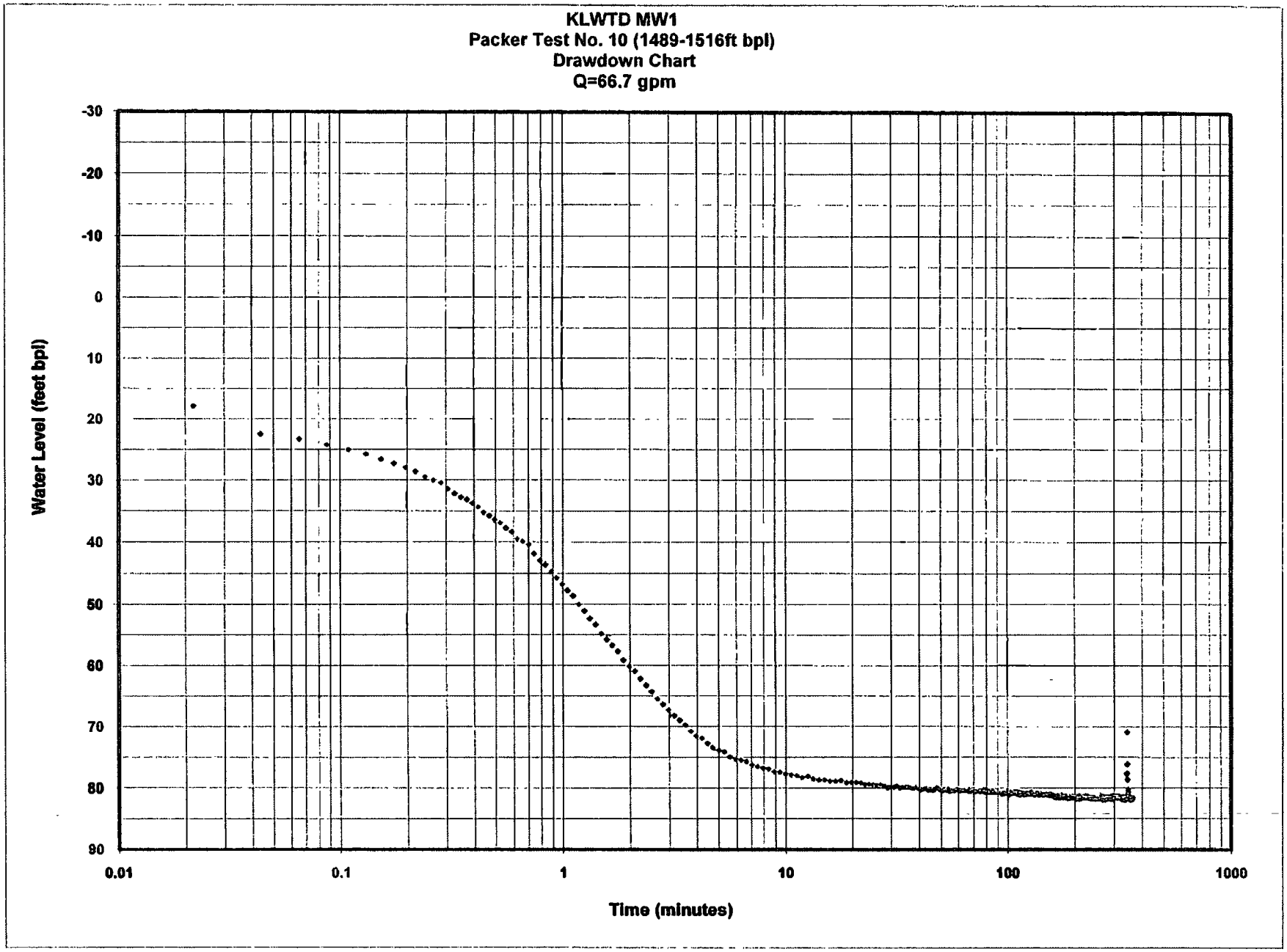
"mg/L" denotes milligrams per liter.

"psi" denotes pressure in pounds per square inch.

"n/a" denotes data not available.

"N/M" denotes not measured.

Static depth to water (DTW) was measured just prior to pumping test startup.



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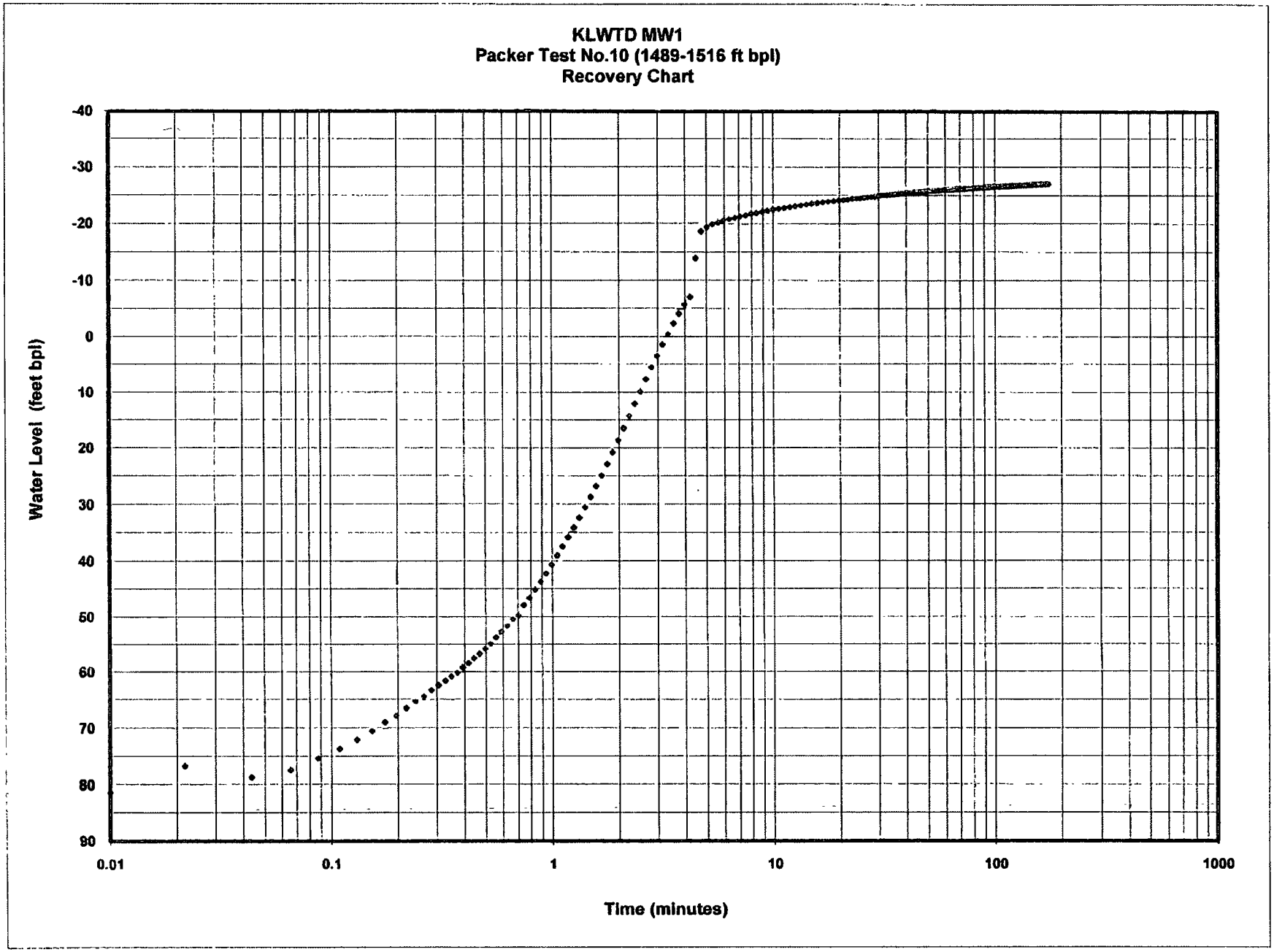

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PT#10 REC xls

ARCADIS

PACKER TEST WATER QUALITY SUMMARY

KLWTD Injection Well System

Key Largo, Florida

MW1

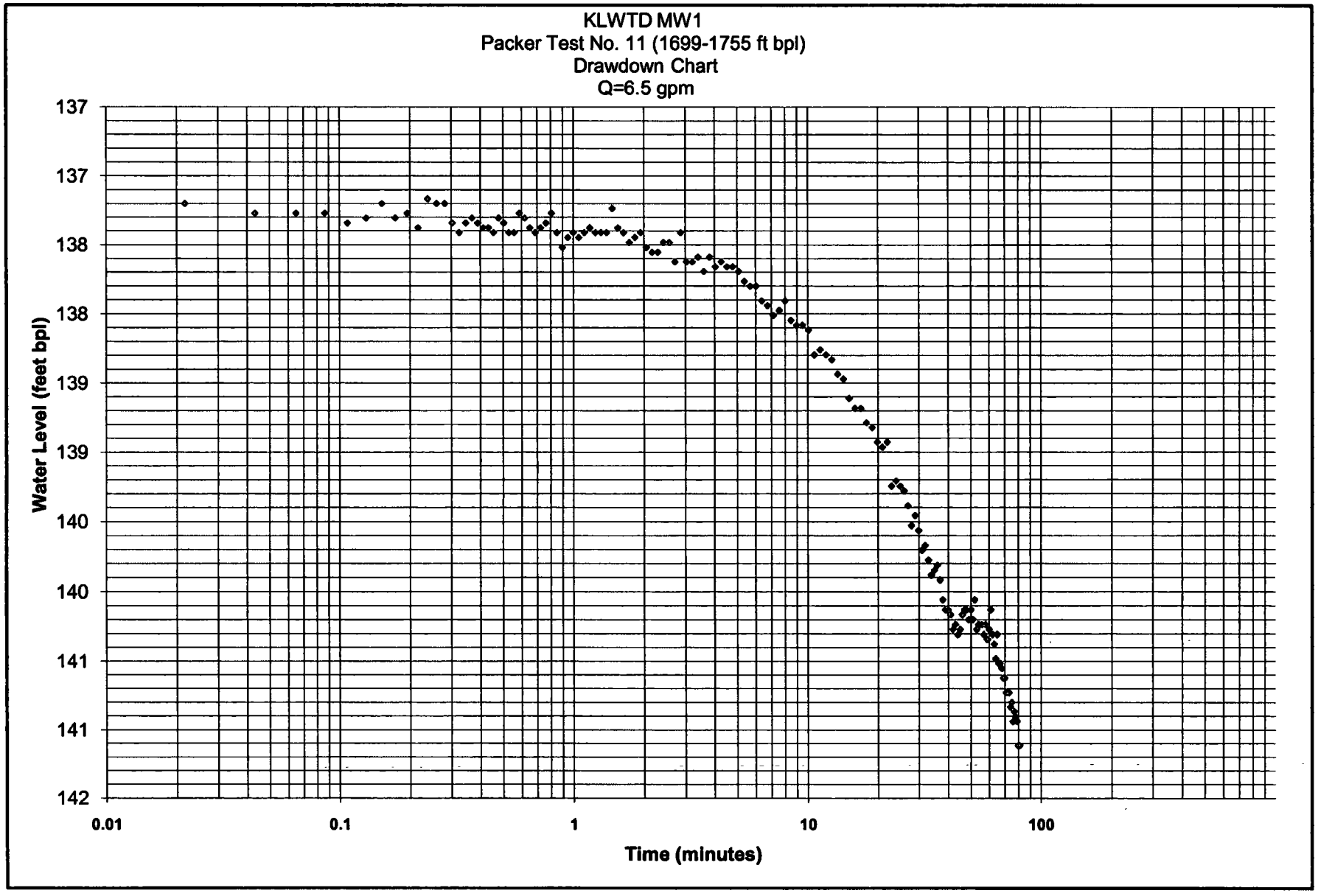
Packer Test No.11 (single packer): development only.

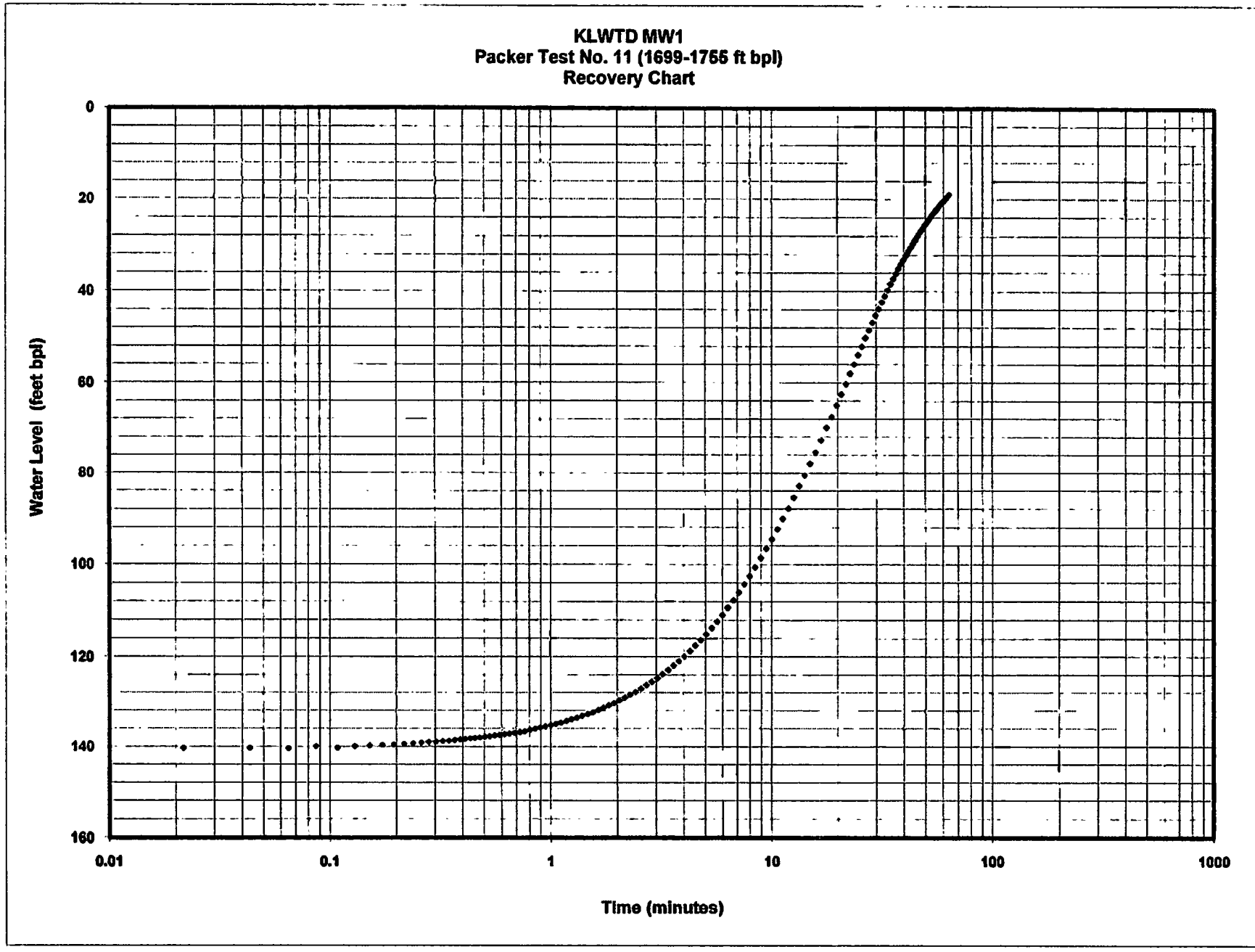
Start date: 4/10/2009 **End date:** 4/10/2009

Flowmeter Total-Start (gal):	n/a	Open Hole Total Depth (feet bpl):	1,755
Flowmeter Total- End (gal):	n/a	Packer Depth Interval (feet bpl):	1699-1755
Average Test Pumping Rate (gpm):	n/a	Pump Setting Depth (feet bpl):	174.84
Development Duration (min):	567	Transducer Depth (feet bpl):	160.84
Pump Test Duration (min):	n/a	Pipe and open hole volume:	2560+250= 2810 gals.
Static DTW Before Test (feet apl):	n/a	Maximum Drawdown (feet):	n/a

Date	Time	Elapsed Time (min)	Pumping Rate (gpm)	Total Volume (gal)	Water Level (feet apl/bpl)	Temp. (°C)	Cond. (µS/cm)	Chlorides (mg/L)	Comments
Development									
4/10/09	4:07	0	~20	0	39.03	n/a	n/a	n/a	Start air- lifting development. Packer press. 360 psi.
4/10/09	4:35	28	~10	~400	138.14	n/a	n/a	n/a	Water brownish, thick with mud.
4/10/09	9:00	293	`10	~2700	n/a	n/a	n/a	n/a	Muddy water, decided to install pump and transducer.
4/10/09	10:04	293	~15	~2700	n/a	n/a	n/a	n/a	Pump-on, resume development. Ann.: 13.37 ft.
4/10/09	10:16	305	5.0	2,800	n/a	n/a	n/a	n/a	Stabilized pump rate at 5 gpm, monitor drawdown.
4/10/09	10:36	325	5.3	2,900	108.71	25.3	21,550	5,500	Water brownish, still thick with mud.
4/10/09	11:30	379	5.5	3,180	112.64	25	23,280	7,000	Ann.: 13.42. ft, packer: 405 psi.
4/10/09	11:58	407	5.6	3,335	110.03	24.9	26,120	9,500	Water brownish, still thick with mud.
4/10/09	12:27	436	5.6	3,410	111.57	n/a	n/a	n/a	Increase rate to 9 gpm, monitor drawdown.
4/10/09	12:56	465	6.9	3,660	132.95	25.7	30,300	10,500	Water clearing. Partly formation water.
4/10/09	13:17	486	6.7	3,700	138.74	n/a	n/a	n/a	Start data collection. Mostly formation water, still v. cloudy.
4/10/09	13:27	496	6.6	3,765	n/a	26.3	31,500	11,000	Dark gray, turbid.
4/10/09	14:10	539	6.5	4,050	139.94	26.5	32,300	11,750	Ann.: 13.41. ft, packer: 405 psi.
4/10/09	14:36	565	6.5	4,220	141.00	26.9	32,400	11,750	Light gray, moderately turbid. Ann.: 13.41
4/10/09	14:38	567	n/a	4,235	n/a	n/a	n/a	n/a	Pump-off, begin recovery.

"gal" denotes gallons.
"gpm" denotes gallons per minute.
"min" denotes minutes.
"feet bpl" denotes feet below pad level.
"feet apl" denotes feet above pad level.
"°C" denotes degrees celcius.
"µS/cm" denotes milliSiemans per centimeter.
"mg/L" denotes milligrams per liter.
"psi" denotes pressure in pounds per square inch.
"n/a" denotes data not available.
"N/M" denotes not measured.
Static depth to water (DTW) was measured just prior to pumping test startup.


KLWTD MW1
Packer Test No. 11 (1699-1755 ft bpl)
Drawdown Chart
Q=6.5 gpm
Water Level (feet bpl)
137
137
138
138
139
139
140
140
141
141
142
0.01
0.1
1
10
100
Time (minutes)



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Appendix D

Surficial Aquifer Pad Monitor Well Data; Technical Memorandum with Mechanical Integrity Results

Summary of Water Table Monitor, Water Quality Data
KLWTD Injection Well System, Key Largo, Florida

Well Location	TOC Elevation	Date	Depth to Water	Water Level Elevation	Temperature	Conductivity	Chloride
	(feet msl)		(feet b.t.o.c.)	(feet msl)	(°C)	(µS/cm)	(mg/L)
PMW-1	7.02	10/31/08	7.00	0.02	27.6	42,500	16,500
T.D.: 16.3		11/14/08	6.95	0.07	26.5	45,900	18,500
(feet btoc)		11/23/08	7.52	-0.50	24.7	43,200	17,000
PMW-2	7.05	10/31/08	6.87	0.18	27.1	40,600	18,500
T.D.: 16.0		11/14/08	6.99	0.06	26.1	40,400	15,500
(feet btoc)		11/23/08	7.58	-0.53	25.2	39,900	15,000
PMW-3	4.68	10/31/08	5.38	-0.70	28.2	41,200	17,000
T.D.: 15.0		11/14/08	4.73	-0.05	25.6	42,600	17,500
(feet btoc)		11/23/08	5.24	-0.56	25.1	41,400	17,000
PMW-4	4.65	10/31/08	5.02	-0.37	27.3	41,700	18,500
T.D.: 14.2		11/14/08	4.72	-0.07	26.4	42,300	18,500
(feet btoc)		11/23/08	5.18	-0.53	25.5	40,800	18,000

"btoc" denotes "below top of casing"

"feet msl" denotes feet relative to mean sea level

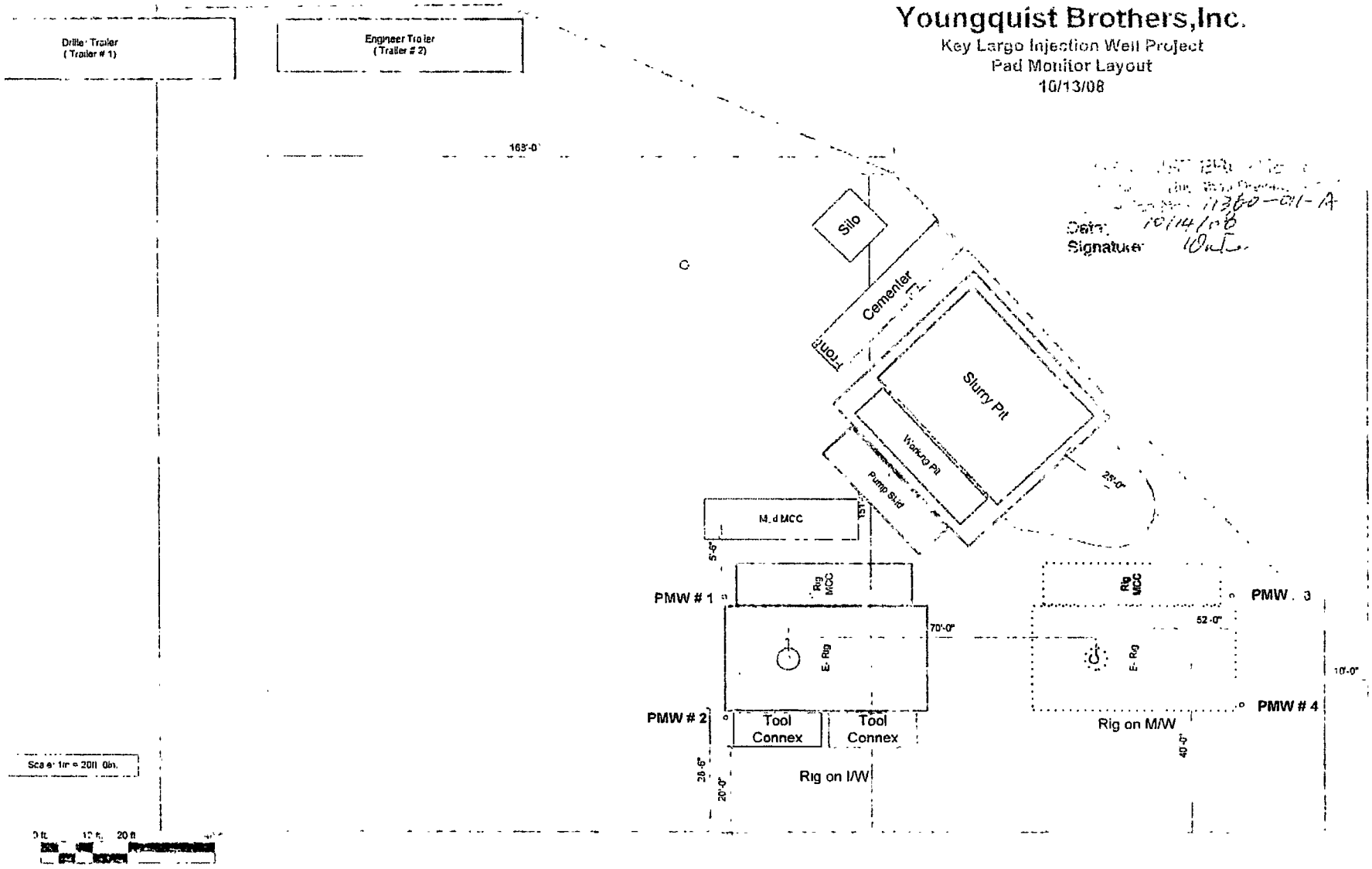
"°C" denotes degrees Celsius

"mS/cm" denotes microSiemens per centimeter

"µg/L" denotes milligrams per Liter

Youngquist Brothers,Inc.

Key Largo Injection Well Project
Pad Monitor Layout
10/13/08



11360-01-A
Date: 10/14/08
Signature

WELL COMPLETION REPORT

FORM 0124
Rev. 11/90

WELL PERMIT NO. _____
SFWMD WATER USE PERMIT NO. _____

KLWTD (Owner) 100300 Overseas Hwy (Address) Key Largo (City) FL (State) 33037 (Zip)

(Contractor's Signature) License No. SLSD11244 Completion Date 10-30-08 Casing Depth 5' Total Depth 15' Well # PMW-1

TYPE OF WORK: Construct ( ) Repair ( ) Abandon ( )
WELL USE: Domestic Well ( ) Public ( ) Monitor (✓) Test ( )
Irrigation ( ) FireWell ( ) Other _____
METHOD: Rotary with MUD ( ) or Air ( ), Cable Tool ( ), Jet ( )
Casing Driven ( ), Other auger
STATIC WATER LEVEL 2' Ft. below top of casing
PUMPING WATER LEVEL ___ Ft. after ___ Hrs. at ___ GPM
PUMP SIZE ___ H.P. CAPACITY ___ GPM
PUMP TYPE ___ INTAKE DEPTH ___ (From top of ground)

LOCATION

Located Near _____

County Monroe

1/4 | 1/4 | Section | Township | Range
N 26° 12' 28.0" / W 80° 5' 41.8"
Latitude-Longitude

Cuttings sent to District? ( ) Yes (✓) No

LOCATE IN SECTION

Note: PWS Wells attach a site map if well location is different from site location on permit application.

Grout Thickness & Depth	Casing & Screen Diameter & Depth	Depth (ft) From	Depth (ft) To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
3"	2"	0		
2'	5" 2"			Limestone Trace Organics
		15		
Number of bags				
1	15"			

Casing: Black Steel ( ) Galv. ( ) PVC (✓) Fiberglass ( )
Screen: Type PVC Slot size .020
Screened from 10 (ft.) to 15 (ft.)
Type of grout with % additives Neat
Water: Clear (✓) Colored ( ) Sulphur ( ) Salty ( ) Iron ( )
Conductivity _____ Chlorides _____ mg/l

WELL COMPLETION REPORT

FORM 0124
Rev. 11/90

WELL PERMIT NO. _____
SFWMD WATER USE PERMIT NO. _____

KLWTD (Owner) 100300 Overseas Hwy (Address) Key Largo (City) FL (State) 33037 (Zip)

(Contractor's Signature) License No. SLSD11244 Completion Date 10-30-08 Casing Depth 5' Total Depth 15' Well # PMW-2

TYPE OF WORK: Construct ( ) Repair ( ) Abandon ( )
WELL USE: Domestic Well ( ) Public ( ) Monitor (✓) Test ( )
Irrigation ( ) FireWell ( ) Other _____
METHOD: Rotary with MUD ( ) or Air ( ), Cable Tool ( ), Jet ( )
Casing Driven ( ), Other auger
STATIC WATER LEVEL 2' Ft. below top of casing
PUMPING WATER LEVEL ___ Ft. after ___ Hrs. at ___ GPM
PUMP SIZE ___ H.P. CAPACITY ___ GPM
PUMP TYPE ___ INTAKE DEPTH ___ (From top of ground)

LOCATION

Located Near _____

County Monroe

1/4 | 1/4 | Section | Township | Range
N 26° 12' 28.0" / W 80° 5' 41.8"
Latitude-Longitude

Cuttings sent to District? ( ) Yes (✓) No

LOCATE IN SECTION

Note: PWS Wells attach a site map if well location is different

Grout Thickness & Depth	Casing & Screen Diameter & Depth	Depth (ft) From	Depth (ft) To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
3"	2"	0		
2'	5" 2"			Limestone Trace Organics
		15		
Number of bags				
1	15"			

Casing: Black Steel ( ) Galv. ( ) PVC (✓) Fiberglass ( )
Screen: Type PVC Slot size .020
Screened from 10 (ft.) to 15 (ft.)
Type of grout with % additives Neat
Water: Clear (✓) Colored ( ) Sulphur ( ) Salty ( ) Iron ( )

WELL COMPLETION REPORT

FORM 0124
Rev. 11/90

WELL PERMIT NO. _____
SFWMD WATER USE PERMIT NO. _____

KLWTD — 100300 Overseas Hwy — Key Largo — FL — 33037
Owner — Address — City — State — Zip

Contractor's Signature — SWD11244 — 10-30-08 — 5' — 15' — PMW-3
License No. — Completion Date — Casing Depth — Total Depth — Well #

TYPE OF WORK: Construct ( ) Repair ( ) Abandon ( )
WELL USE: Domestic Well ( ) Public ( ) Monitor (✓) Test ( )
Irrigation ( ) FireWell ( ) Other _____
METHOD: Rotary with MUD ( ) or Air ( ), Cable Tool ( ), Jet ( )
Casing Driven ( ), Other auger
STATIC WATER LEVEL 5 Ft. below top of casing
PUMPING WATER LEVEL / Ft. after / Hrs. at / GPM
PUMP SIZE / H.P. CAPACITY / GPM
PUMP TYPE / INTAKE DEPTH _____ From top of ground

LOCATION

Located Near _____

County Monroe

1/4 1/4 Section Township Range
N 26° 12' 28.0" / W 80° 8' 41.5"
Latitude-Longitude

Cuttings sent to District? ( ) Yes (✓) No

LOCATE IN SECTION

Note: PWS Wells attach a site map if well location is different from site location on permit application.

Grout Thickness & Depth	Casing & Screen Diameter & Depth	Depth (ft) From	Depth (ft) To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
2"	2"	0		
2'	5' 2"			Limestone Trace Organics
		15'		
Number of bags				
1	15'			

Casing: Black Steel ( ) Galv. ( ) PVC (✓) Fiberglass ( )
Screen: Type PVC Slot size .020
Screened from 10 (ft.) to 15 (ft.)
Type of grout with % additives Neat
Water: Clear (✓) Colored ( ) Sulphur ( ) Salty ( ) Iron ( )
Conductivity _____ Chlorides _____ mg/l

WELL COMPLETION REPORT

FORM 0124
Rev. 11/90

WELL PERMIT NO. _____
SFWMD WATER USE PERMIT NO. _____

KLWTD — 100300 Overseas Hwy — Key Largo — FL — 33037
Owner — Address — City — State — Zip

Contractor's Signature — SWD11244 — 10-30-08 — 5' — 15' — PMW-4
License No. — Completion Date — Casing Depth — Total Depth — Well #

TYPE OF WORK: Construct ( ) Repair ( ) Abandon ( )
WELL USE: Domestic Well ( ) Public ( ) Monitor (✓) Test ( )
Irrigation ( ) FireWell ( ) Other _____
METHOD: Rotary with MUD ( ) or Air ( ), Cable Tool ( ), Jet ( )
Casing Driven ( ), Other auger
STATIC WATER LEVEL 5 Ft. below top of casing
PUMPING WATER LEVEL / Ft. after / Hrs. at / GPM
PUMP SIZE / H.P. CAPACITY / GPM
PUMP TYPE / INTAKE DEPTH _____ From top of ground

LOCATION

Located Near _____

County Monroe

1/4 1/4 Section Township Range
N 26° 12' 28.0" / W 80° 8' 41.8"
Latitude-Longitude

Cuttings sent to District? ( ) Yes (✓) No

LOCATE IN SECTION

Note: PWS Wells attach a site map if well location is different

Grout Thickness & Depth	Casing & Screen Diameter & Depth	Depth (ft) From	Depth (ft) To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
2"	2"	0		
2'	5' 2"			Limestone Trace Organics
		15'		
Number of bags				
1	15'			

Casing: Black Steel ( ) Galv. ( ) PVC (✓) Fiberglass ( )
Screen: Type PVC Slot size .020
Screened from 10 (ft.) to 15 (ft.)
Type of grout with % additives Neat
Water: Clear (✓) Colored ( ) Sulphur ( ) Salty ( ) Iron ( )
Conductivity _____ Chlorides _____ mg/l

DEMONSTRATION OF MECHANICAL INTEGRITY- TECHNICAL MEMORANDUM

KLWTD INJECTION WELL SYSTEM

IW1 Cement-Bond Evaluations

On February 24, 2009, Youngquist Brothers, Inc. (Contractor) completed installation of a 14.48-inch inside diameter (I.D.), 19.20-inch maximum outside diameter (O.D.) at couplings, fiberglass reinforced plastic (FRP) Red Box 1500 "Rough Coat" TC injection casing inside a nominal 28-inch diameter borehole to a depth of 2,735 feet below pad level (bpl). By February 28, 2009, the Contractor cemented the injection casing from the base up to 507 feet bpl. The uppermost 507 feet was left un-cemented to allow the cement-bond log (CBL) tool to be calibrated to the free-pipe signal of the un-cemented portion of the casing.

On March 1, 2009, the Contractor performed a CBL with a variable-density log (VDL) display inside the injection casing. In general the log indicates lower signal amplitudes below the uppermost 507 feet of un-cemented casing which indicates bonding between casing and cement and between cement and formation. Between 150 feet and 1,730 feet bpl (base of 28-inch O.D. intermediate casing), the VDL display indicates the location of the FRP couplings of the injection casing (at depth intervals of approximately 30 feet). Between 2,568 feet and 2,726 feet bpl, higher signal amplitudes were observed.

It should be noted that the Contractor performed small cementing events from the cement packer (attached to the base of the injection casing) to 2,725 feet bpl to establish a cement seal above the cement packer. The Contractor then pumped 561 cubic feet of Portland Type I/II neat cement, and the top of cement following this cement stage (stage #1) was tagged at 2,559 feet bpl. A cement mix of either 6% or 12% bentonite was used for all subsequent cement stages. Although there is no obvious explanation for the increased amplitudes, they appear to coincide with the neat cement installed during stage #1 between 2,725 feet and 2,559 feet bpl.

MW1 Cement-Bond Evaluations

MW1 was constructed to monitor the intervals between 1,460 feet and 1,494 feet bpl (UMZ) and between 1,650 feet and 1,702 feet bpl (LMZ). Therefore, the annulus outside the $6^{5}/_{8}$-inch diameter (5.43-inch inside-diameter) FRP LMZ tubing was cemented from 1,494 feet to 1,702 feet bpl to isolate the two monitoring intervals. A CBL with VDL display was performed on the LMZ tubing before and after the Contractor cemented the tubing in place. The amplitude of the signal is greatly reduced on the post-cementing CBL in the interval between 1,494 feet and 1,650 feet bpl compared to the same interval on the pre-cementing CBL. The reduced signal amplitude indicates good bonding of cement to casing. Additionally, the reduced signal return on the VDL display confirms the cement-to-tubing bond, and indicates that there is good cement to formation bond. It should be noted that FRP sections within the open hole had a sand-impregnated rough coat surface to enhance the cement-to-tubing bond.

Final TV Surveys

On March 1, 2009 the Contractor performed a color television survey of the IW1 FRP injection casing from pad level to the total depth of the borehole at approximately 3,606 feet bpl. The FRP injection casing

sections appear to be in good condition. The top of the cement packer interior wall was visible at 2,740 feet bpl. Throughout the open-hole interval between 2,742 feet (base of cement packer joint) and 3,410 feet, occasional minor fractures and cavities are present. More numerous and larger fractures and cavities are present between 3,410 feet and 3,540 feet bpl. No obstructions were observed in the open hole between the base of the injection casing and the total video depth.

On May 6, 2009 the Contractor performed a color television survey of the MW1 LMZ tubing and open hole. The FRP tubing sections appear in good condition. The cement packer attached to the base of the FRP tubing string was observed at 1,653 feet bpl. In the open hole section between 1,653 feet and 1,701 feet bpl, minor cavities/vugs are seen (primarily located within the bottom half of the open hole).

Narrative summaries of the IWI injection casing and open-hole final TV survey and MW1 LMZ tubing and open hole final TV survey are included with this memorandum. DVD copies of both TV surveys are included in **Volume II, Section 10** of the report.

IW1 and MW1 Hydrostatic Pressure Testing

The Contractor performed hydrostatic pressure tests of the following to demonstrate mechanical integrity:

- The 14.48-inch I.D. FRP injection casing of IW1
- The LMZ tubing ($6^5/_8$-inch diameter FRP) of MW1

On March 1, 2009, the Contractor installed an inflatable packer into the IW1 injection casing and set the packer at 2,714 feet bpl. On March 3, 2009, a 60-minute hydrostatic pressure test was performed. The test was witnessed by Lech Kwapinski and David Smith of ARCADIS and David Rhodes of FDEP. The casing was pressurized to 158 psi and changes in the pressure were observed. After 60 minutes, the pressure had changed by 3.5 psi and had increased to 161.5 psi (2.2% increase). This pressure change met the FDEP requirement of less than 5%, therefore the test was considered successful. The casing then was depressurized (to 0 psi) and approximately 22.5 gallons of water were released. A summary of the pressure test and a copy of the pressure gauge calibration certificate are included with this memorandum.

On May 4, 2008, the Contractor performed a 60-minute hydrostatic pressure test of the MW1 LMZ tubing. The hydrostatic pressure test was performed using a permanently-set External Casing Packer with Interior Sheer Plug (ECPISP) attached to the base of the tubing string. The ECPISP included a plug at the base which was still intact after the tubing string was cemented in place. This allowed the Contractor to successfully pressurize the inside of the tubing. The tubing was pressurized to 109.5 psi. After 60 minutes, the pressure decreased less than 1.5 psi (approximately a 1.4% decrease). Because the pressure change was less than 5%, the test was considered successful. The tubing was then depressurized (to 0 psi) and approximately 13 gallons of water were released. A summary of the pressure test and a copy of the pressure gauge calibration certificate are included with this memorandum.

High Resolution Temperature Logging and Radioactive Tracer survey Testing

On May 20, 2009, Youngquist Brothers Inc. (Contractor) performed a short-term injection test by injecting approximately 3.3 million gallons of potable water into injection well IW1. The test was performed for 13

establish a freshwater "bubble" below the final casing prior to performing high-resolution temperature logging and radioactive tracer survey (RTS). Temperature logging and RTS testing are described below.

High Resolution Temperature Logging

Following injection testing, IW1 was shut-in for 6 days. On May 26, 2009, the Contractor performed a high-resolution temperature log in IW1 from land surface to the total open-hole depth of 3,603 feet below land surface (bls). The temperature inside the injection casing is a function of a combination of factors, including the water temperature of the formation, and the diameter and wall thickness of the casings. During temperature logging the following was observed:

- Between 0 feet and 70 feet bls: The temperature remained stable at 86 degrees Fahrenheit (°F).
- Between 70 feet and 250 feet bls: The temperature increased to 87.5 °F and then decreased back to 86 °F.
- Between 250 feet and 1,200 feet bls: Temperatures generally remained stable between 85.7 °F and 86.1 °F.
- Between 1,200 feet and 1,800 feet bls: A small increase in temperature was observed with minor variations in temperature between 86.1 °F and 86.9 °F.
- Between 1,800 feet and 2,715 feet bls: A gradual increase in temperature was observed from 86.1 °F to 88.9 °F. Between 2,715 feet and 2,940 feet bls: A decrease in temperature from 88.9 °F to 87.8 °F with generally stable temperatures near the base of the final casing was observed.
- Between 2,940 feet and Total Depth (3,603) feet bls: Minor temperature variations between 88.3 °F and 89.2 °F was observed.

In general the temperatures in IW1 remained stable with only minor variations. This is likely attributed to the large volume of potable water that was injected into the well on May 20, 2009, and the extended shut-in duration which allowed ample time for the fluid temperatures in IW1 to stabilize. Based on the temperature log, there is no indication that IW1 lacks mechanical integrity.

Radioactive Tracer Survey Testing

Immediately following high-resolution temperature logging, RTS testing was performed to determine whether IW1 had external mechanical integrity (including the integrity of the cement sheath and adjacent formation). The RTS logging tool used for the survey consisted of three gamma-ray detectors: one near the top (GRT), the middle (GRM) and bottom (GRB) of the tool. Readings from the detectors are reported in GAPI units (Note: GAPI units are standard American Petroleum Institute units; 16.5 GAPI units are equivalent to 1 microgram ra-eq/ton). The RTS logging-tool ejector port is located between the GRT and the GRM. A tool diagram is included on the RTS log plot. A magnetic casing-collar locator (CCL), attached to the base of the RTS logging tool, indicated that the base of the 16-inch diameter final casing was located at a depth of approximately 2,741 feet bls. Please note that the final casing is comprised of fiberglass reinforced plastic (FRP) with external cement packer (composed of steel and rubber) attached at the base between approximately 2,740 feet and 2,742 feet bls.

Background Gamma-ray Log

Following completion of the high-resolution temperature log, a gamma-ray log was performed as an "out-of-position" background log on the upward pass. The background gamma-ray log serves as a means of comparison for each of the subsequent out-of-position log passes. An out-of-position log pass refers to the RTS tool traveling up the well at a nearly constant speed while recording. The background gamma-ray log was conducted from 3,603 feet bls to land surface. During out-of-position logging, readings were collected from each of the detectors (GRT, GRM and GRB).

Monitoring Test #1: Dynamic Monitoring

Starting from the bottom section of the RTS log plot, the various surveys are discussed in the same sequence as they were performed. Following the background log, the RTS tool ejector port was loaded with 6.0 millicuries (mCi) of Iodine 131. The Iodine 131 assay label is included with this memorandum. For Monitoring Test #1 (labeled "Dynamic Test #1" on the log plot), the Contractor set the ejector of the RTS tool at a depth of 2,736 feet bls, approximately 5 feet above the base of the final casing (as recorded by the CCL), and established a constant injection flow rate of 43 gpm using potable water. A copy of the flowmeter calibration certificate is included with this memorandum. During dynamic ("time-drive") monitoring, the RTS tool remained stationary, and "time-drive logging" was shown on the log plot. The vertical segments of the time-drive log indicate time in 20-second intervals and the horizontal segments (for each detector) indicate the change in GAPI units. For other RTS survey logs (background, out-of-position and final gamma-ray logs), the vertical segments of the log plot indicate a change in depth.

After setting the RTS tool and monitoring for 1 minute, the Contractor ejected a 1.0 mCi slug of Iodine 131 and continued "time-drive monitoring" of gamma-ray levels for 60 minutes after the release. The time at which the tracer slug was ejected is noted on the log. The Iodine 131 was first detected by the GRM within approximately 20 seconds after ejection (1.0 mCi of Iodine 131 takes approximately 7.0 seconds to eject). The maximum reading at the GRM (approximately 2,184 GAPI) occurred between 30 seconds and 1 minute after ejecting. Approximately 5½ minutes after ejection, the readings at the GRM decreased to near background levels. Approximately 1 minute, 50 seconds after ejection, the tracer was detected in the GRB and reached a maximum level (approximately 2,140 GAPI) between 2 minutes, 30 seconds and 5 minutes, 20 seconds after ejection. After approximately 25 minutes, the GRB readings stabilized. The tracer was not detected in the GRT during Dynamic Test #1.

Monitoring Test #1: Out-of-Position Log

After 60 minutes of dynamic logging, the Contractor performed an out-of-position log (labeled "LOP #1" on the log plot for Log Out of Position) from the base of the final casing to a depth of 2,544 feet bls. The injection flow rate during the out-of-position log remained at approximately 43 gpm. Except for slightly elevated readings in GRB and GRM just above the base of the final casing, the recorded readings from the GRT, GRM and GRB detectors closely resemble the recorded readings from the background gamma-ray log.

After conducting the out-of-position log, the Contractor lowered the RTS tool back down to 2,736 feet bls (original ejector depth). Because no residual Iodine 131 was observed on the RTS tool or casing, it was unnecessary to flush the well with potable water following the out-of-position log.

Monitoring Test #2: Dynamic Monitoring

For Monitoring Test #2 (labeled "Dynamic Test #2" on the log plot), the Contractor again set the RTS tool with the ejector at a depth of 2,736 feet bls and established an injection flow rate of approximately 43 gpm. The Contractor monitored gamma-ray levels for one minute before ejecting a 1.5 mCi slug of Iodine 131. After ejecting the tracer material, the Contractor monitored levels for 60 minutes. The Iodine 131 was first detected by the GRM within approximately 18 seconds after the ejection. A high GRM reading occurred between 30 seconds and 2 minutes, 10 seconds after ejecting. Between 7 minutes and 25 minutes after ejection, GRM readings gradually decreased from 326 GAPI to 143 GAPI. GRM readings generally remained stable for the remainder of dynamic testing. Approximately 1 minute, 50 seconds after ejection, the tracer was detected in the GRB and it reached maximum levels (approximately 2,140 GAPI) between 2 minutes, 20 seconds and 9 minutes after ejection. Readings at the GRB then began decreasing, and between 31 minutes and 60 minutes after ejection, the readings generally remained stable at approximately 40 GAPI units. As during the previous test, tracer was not detected in the GRT.

Monitoring Test #2: Out-of-Position Log

After dynamic logging, the Contractor performed an out-of-position log (LOP #2) up to 2,540 feet bls. The injection flow rate during the out-of-position log remained at 43 gpm. The readings from the GRT, GRM and GRB closely resemble the recorded readings from the background gamma-ray log with the exception of elevated GRM and GRB readings at the base of the casing.

Final Gamma-Ray Log

After conducting the out-of-position log, IW1 was flushed using potable water to remove any excess Iodine 131 from the RTS tool and the inside of the casing. The injection flow rate was approximately 2,750 gpm. The tool then was lowered to 2,905 feet bls and the remaining 3.5 mCi of Iodine 131 was ejected. The Contractor then lowered the tool to 3,603 feet bls (total depth) and (after flushing for approximately 30 minutes) performed gamma-ray logging from 3,603 feet bls to land surface. Inside the final casing from land surface to 2,741 feet bls, readings from GRT, GRM and GRB closely resembled the recorded readings from the background gamma-ray log. The one exception was between 2,270 feet and 2,400 feet bls where readings were slightly elevated compared to background readings by approximately 10 GAPI. Below the base of casing, between 3,065 feet and 3,280 feet bls, slightly elevated readings (compared to background) were observed in all three detectors. At 3,540 feet bls, a significant increase was observed in all 3 detectors. This suggests a major flow zone at this depth which is consistent with a fracture zone identified on the borehole televiewer log.

RTS Interpretation

During dynamic monitoring, potable water pumped down the well forced the Iodine 131 tracer material downward where it was detected by the GRM and GRB (located below the ejector). The GRT can detect the Iodine 131 if the Iodine 131 moves upward outside the final casing (due to spaces between the cement and casing or the cement and formation, or if fractures exist in the formation near the well).

The primary purpose of the out-of-position logs and the final gamma-ray log was to determine the extent (if any) of upward migration of Iodine 131 through the formation or through annuli adjacent to the well

bore or casing. Because the recorded readings of all three detectors from each out-of-position log and the final gamma-ray log resembled the recorded readings of the background gamma-ray log (with the exception between 2,280 feet and 2,400 feet bls noted above), and because the GRT did not record any elevated readings after ejection during either dynamic monitoring tests, we conclude that the cement sheath around the injection casing is intact and an adequate bond is present between the cement and the formation, as well as between the casing and the cement.

Key Largo WTD Injection Well System **Injection Well IW1**
Key Largo, Florida

Final TV Survey Observation Table

Date: 03/01/2009

PROJECT LOCATION: Key Largo WWTF
OWNER: KLWTD
VIDEO CONTRACTOR: Youngquist Brothers, Inc.
COUNTY: Monroe County, Florida
DEPTH: 3,695 feet bpl
DESCRIPTION BY: Lech Kwapinski

Depth (feet below pad)		Description of Features
From	To	
		Major Features
0.0	6.0	Stainless steel casing.
6.0	2740.0	16-inch diameter FRP casing
2,740.0	2742.0	Bottom landing joint.
2,742.0	3606.8	Open borehole.
		Minor Features (connections and open hole description)
23.0		FRP tubing connection.
52.5		FRP tubing connection.
81.6		FRP tubing connection.
110.9		FRP tubing connection.
140.3		FRP tubing connection.
169.7		FRP tubing connection.
198.7		FRP tubing connection.
227.9		FRP tubing connection.
257.2		FRP tubing connection.
286.0		FRP tubing connection.
315.5		FRP tubing connection.
344.7		FRP tubing connection.
373.9		FRP tubing connection.
403.3		FRP tubing connection.
432.3		FRP tubing connection.
459.0		FRP tubing connection.
488.0		FRP tubing connection.
517.0		FRP tubing connection.
546.0		FRP tubing connection.
577.0		FRP tubing connection.
606.0		FRP tubing connection.
635.0		FRP tubing connection.
664.0		FRP tubing connection.
693.0		FRP tubing connection.
722.0		FRP tubing connection.
751.0		FRP tubing connection.
781.0		FRP tubing connection.

Key Largo WTD Injection Well System **Injection Well IW1**
Key Largo, Florida

Final TV Survey Observation Table

Date: 03/01/2009

PROJECT LOCATION: Key Largo WWTF
OWNER: KLWTD
VIDEO CONTRACTOR: Youngquist Brothers, Inc.
COUNTY: Monroe County, Florida
DEPTH: 3,695 feet bpl
DESCRIPTION BY: Lech Kwapinski

Depth (feet below pad)		Description of Features
From	To	
810.0		FRP tubing connection.
839.0		FRP tubing connection.
868.0		FRP tubing connection.
898.0		FRP tubing connection.
927.0		FRP tubing connection.
957 0		FRP tubing connection.
986 0		FRP tubing connection.
1,015.0		FRP tubing connection.
1,044.0		FRP tubing connection.
1,074.0		FRP tubing connection.
1,103 0		FRP tubing connection.
1,132 0		FRP tubing connection.
1,162 0		FRP tubing connection.
1,191 0		FRP tubing connection.
1,220.0		FRP tubing connection.
1,249.0		FRP tubing connection.
1,279 0		FRP tubing connection.
1,308.0		FRP tubing connection.
1,337.0		FRP tubing connection.
1,366 0		FRP tubing connection.
1,395 0		FRP tubing connection.
1,425.0		FRP tubing connection.
1,454 0		FRP tubing connection.
1,483 0		FRP tubing connection.
1,512.0		FRP tubing connection.
1,541 0		FRP tubing connection.
1,571.0		FRP tubing connection.
1,600.0		FRP tubing connection.
1,629.0		FRP tubing connection.
1,658.0		FRP tubing connection.
1,687.0		FRP tubing connection.
1,716.0		FRP tubing connection.
1,755.0		FRP tubing connection.
1,784 0		FRP tubing connection.

Key Largo WTD Injection Well System **Injection Well IW1**
Key Largo, Florida

Final TV Survey Observation Table

Date: 03/01/2009

PROJECT LOCATION: Key Largo WWTF
OWNER: KLWTD
VIDEO CONTRACTOR: Youngquist Brothers, Inc.
COUNTY: Monroe County, Florida
DEPTH: 3,695 feet bpl
DESCRIPTION BY: Lech Kwapinski

Depth (feet below pad)		Description of Features
From	To	
1,804.0		FRP tubing connection.
1,833 0		FRP tubing connection.
1,863.0		FRP tubing connection.
1,892.0		FRP tubing connection.
1,921.0		FRP tubing connection.
1,950 0		FRP tubing connection.
1,979.0		FRP tubing connection.
2,008.0		FRP tubing connection.
2,037 0		FRP tubing connection.
2,066 0		FRP tubing connection.
2,096.0		FRP tubing connection.
2,125.0		FRP tubing connection.
2,154.0		FRP tubing connection.
2,184 0		FRP tubing connection.
2,213 0		FRP tubing connection.
2,242.0		FRP tubing connection.
2,271.0		FRP tubing connection.
2,300 0		FRP tubing connection.
2,330 0		FRP tubing connection.
2,359.0		FRP tubing connection.
2,388.0		FRP tubing connection.
2,418.0		FRP tubing connection.
2,447 0		FRP tubing connection.
2,477 0		FRP tubing connection.
2,506.0		FRP tubing connection.
2,535.0		FRP tubing connection.
2,564 0		FRP tubing connection.
2,594.0		FRP tubing connection.
2,623 0		FRP tubing connection.
2,652.0		FRP tubing connection.
2,681.0		FRP tubing connection.
2,710.0		FRP tubing connection.
2,740 0		Bottom of FRP tubing. Top of landing joint.
2,742.0		Bottom of landing joint, top of the open hole.

Key Largo WTD Injection Well System **Injection Well IW1**
Key Largo, Florida

Final TV Survey Observation Table

Date: 03/01/2009

PROJECT LOCATION: Key Largo WWTF
OWNER: KLWTD
VIDEO CONTRACTOR: Youngquist Brothers, Inc.
COUNTY: Monroe County, Florida
DEPTH: 3,695 feet bpl
DESCRIPTION BY: Lech Kwapinski

Depth (feet below pad)		Description of Features
From	To	
2,742.0	2963.0	Massive formation with only few, small shallow cavities and vugs.
2,963.0	2966.0	Frequent fractures.
2,966.0	3355.0	Massive formation with only few, small shallow cavities and vugs.
3,355.0	3403.0	Frequent, larger cavities, isolated fractures in zones 2-3 feet wide separated by solid rock.
3,408.0	3428.0	Frequency of cavities and fractures increase, but still of rather shallow appearance.
3,430.5	3434.5	Large cavity (cavern), possibly major injection fixture.
3,435.5	3437.5	Large cavity (cavern), another major injection fixture.
3,438.0	3460.0	Numerous fractures and cavities; extension of an injection zone.
3,460.0	3490.0	Occasional fractures and cavities.
3,490.0	3492.0	Cavity or cavern of a smaller volume.
3,492.0	3498.0	Occasional fractures and cavities.
3,498.0	3540.0	Very few cavities and vugs, mostly massive, solid formation. Very limited fluid movement.
3,540.0	3606.8	Massive, solid formation; occasional shallow cavity. Worsening visibility indicating lack of fluid movement.
3,606.8		Bottom of the borehole.

KLWTD Injection Well System
Key Largo, Florida

Monitor Well MW1

TV Survey Observation Table

PROJECT LOCATION: Key Largo Wastewater Treatment Plant
OWNER: KLWTD
VIDEO CONTRACTOR: Youngquist Brothers, Inc.
COUNTY: Monroe County, Florida
DEPTH: 1,702 feet bpl
DESCRIPTION BY: L. Kwapinski Date: 05/06/2009

Depth (feet below pad)		Description of Features
From	To	
		Major Features
0.0	16.5	Stainless Steel landing section.
16.5	1,646.0	FRP Tubing (all connections identified, inside of the tubing found in exellent condition).
1,646.0	1,653.5	California Packer.
1,653.5	1,701.0	Open hole. Final depth could not be determined due to extremely poor visibility.
		Minor Features (connections and open hole description)
16.5		Stainless Steel casing/ FRP tubing connection.
46.0		FRP tubing connection.
45.5		FRP tubing connection.
75.0		FRP tubing connection.
105.0		FRP tubing connection.
135.0		FRP tubing connection.
165.0		FRP tubing connection.
195.0		FRP tubing connection.
225.0		FRP tubing connection.
255.0		FRP tubing connection.
285.0		FRP tubing connection.
315.0		FRP tubing connection.
345.0		FRP tubing connection.
374.0		FRP tubing connection.
404.0		FRP tubing connection.
434.0		FRP tubing connection.
463.0		FRP tubing connection.
493.0		FRP tubing connection.
522.0		FRP tubing connection.
552.0		FRP tubing connection.
581.0		FRP tubing connection.
611.0		FRP tubing connection.
640.0		FRP tubing connection.
670.0		FRP tubing connection.
700.0		FRP tubing connection.
729.0		FRP tubing connection.
759.0		FRP tubing connection.

Depth (feet below pad)		Description of Features
From	To	
789.0		FRP tubing connection.
818.0		FRP tubing connection.
848.0		FRP tubing connection.
877.0		FRP tubing connection.
907.0		FRP tubing connection.
936.0		FRP tubing connection.
966.0		FRP tubing connection.
996.0		FRP tubing connection.
1,025.0		FRP tubing connection.
1,055.0		FRP tubing connection.
1,085.0		FRP tubing connection.
1,115.0		FRP tubing connection.
1,144.0		FRP tubing connection.
1,174.0		FRP tubing connection.
1,203.0		FRP tubing connection.
1,233.0		FRP tubing connection.
1,262.0		FRP tubing connection.
1,292.0		FRP tubing connection.
1,322.0		FRP tubing connection.
1,351.0		FRP tubing connection.
1,381.0		FRP tubing connection.
1,410.0		FRP tubing connection.
1,440.0		FRP tubing connection.
1,469.0		FRP tubing connection.
1,499.0		FRP tubing connection.
1,528.0		FRP tubing connection.
1,558.0		FRP tubing connection.
1,587.0		FRP tubing connection.
1,617.0		FRP tubing connection.
1,646.0		Connection FRP/ California Packer.
1,653.5		Bottom of the California packer, top of the open hole.
1,653.5	1,701.0	Open hole interval: borehole mostly massive with only few larger vugs or cavities scattered along bottom half of the borehole wall.
1,701.0		Visiblity worsening fast below 1698 feet bpl: unable to proceed deeper with the survey.

ARCADIS

HYDROSTATIC PRESSURE-TEST DATA
KEY LARGO WASTEWATER TREATMENT DISTRICT
INJECTION WELL SYSTEM
INJECTION WELL IW1
MONROE COUNTY, FLORIDA

Injection Casing Pressure Test

Date: March, 3, 2009
Project Site: Key Largo Wastewater Treatment Plant

ARCADIS Project No. : WF156000.0000

Time (hours)	Delta Time (min.)	Pressure (psi)
10:15	0	158.0
10:20	5	158.2
10:25	10	158.7
10:30	15	159.0
10:35	20	159.2
10:40	25	159.5
10:45	30	159.7
10:50	35	160.2
10:55	40	160.8
11:00	45	160.8
11:05	50	161.1
11:10	55	161.3
11:15	60	161.5

The 0 - 300 pound-per-square-inch, 6-inch Mc Daniel brand pressure gauge (KELI I.D. No.KEL-130133) was calibrated on October 08, 2008.

Certificate of Calibration

 # KELC-57259

Kimball Electronic Laboratory, Inc.

Precision Measurement Equipment Specialists

Purchase Order # N/A

Calibration Performed By:

KIMBALL ELECTRONIC LABORATORY, INC
8081 W 21 LANE
HIALEAH, FL. 33016

Jon YOUNG

YOUNGQUIST BROTHERS, INC.
15465 PINE RIDGE ROAD
FT MYERS FL 33908

Equipment Information KELI I.D.: KEL-130133

Description: PRESSURE GAUGE
Manufacturer: MCDANIEL CONTROLS
Model Number: 300 PSI
Part Number: N/A
Range: 0-300 PSI

Serial Number: N/A
Customer I.D.: 050808-1
Cust. Barcode: N/A
Cust. Location: N/A
Specifications: +/- 0.25 % FS

Cal Date: 07-Oct-08
Cal. Due Date: 07-Jan-09
Cal. Interval: 3 MONTHS
Received: IN TOLERANCE
Calibration Result: PASS
Environmental Conditions: 72 DEG F / 50 % RH
Performed By: YAIRON ALVAREZ
Procedure: SYN54

This is to certify that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure at the points tested (unless otherwise noted). It has been calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration is in accordance with Kimball Electonic Laboratory, Inc Quality Assurance Manual. KELI's Quality system is A2LA-Accredited to ISO/IEC-17025 and compliant with MIL-STD-45662A and ANSI/NCSL Z540-1-1994. TURS when applicable are greater than or equal to 4:1; with expanded uncertainty used to calculate the Test Uncertainty Ratio, with a coverage factor of K=2 at a confidence level of approximately 95%, unless otherwise noted.

Any number of factors may cause the calibration item to drift out of calibration before the recommended interval has expired.

Calibration Remarks:

THIS UNIT WAS FOUND TO BE IN TOLERANCE AT THE TIME OF CALIBRATION.
PERFORMED ROUTINE CAL. NO ADJUSTMENTS REQUIRED

Standards Used To Calibrate Equipment

Company	I.D.	Description	Last Cal.	Cal. Due Date
KIM001	391	EATON UPS 3000BAA PRESSURE INDICATOR	20-Nov-07	30-Nov-09

Signatures:

Certified by: YAIRON ALVAREZ 07-Oct-08 9:05:36 AM

Approved By: JAVIER BALCEIRO 07-Oct-08 9:05:57 AM

8081 W. 21 LANE
HIALEAH, FL. 33016
PH # 305-822-5792
FAX # 305-362-3125

CONTROL # : KEL-130133

CUSTOMER YOU410

CALIBRATION DATA FORM

MFR:	McDANIEL CONTROLS	DESCRIPTION :	PRESSURE GAUGE
MODEL # :	300 PSI - .25%	TECHNICIAN	122
SERIAL # :	N/A	CAL DATE :	07-OCT-08
CUST ID #:	050808-1	DUE DATE :	07-JAN-09

* IF NO "AS LEFT" READING IS SHOWN ON THIS CHART, IT MEANS THE UNIT WAS IN TOLERANCE AND THERE WERE NO ADJUSTMENTS MADE TO IT.

RANGE	NOMINAL	AS FOUND	AS LEFT *	LOW LIMIT	HIGH LIMIT
300 PSI					
	50	49.8		49.25	50.75
	100	100.0		99.25	100.75
	150	150.0		149.25	150.75
	200	200.0		199.25	200.75
	300	299.8		299.25	300.75

FORM 300PSI-.25%

ARCADIS

HYDROSTATIC PRESSURE-TEST DATA
KEY LARGO WASTEWATER TREATMENT DISTRICT
INJECTION WELL SYSTEM
MONITOR WELL MW1
MONROE COUNTY, FLORIDA

Lower Monitoring Zone FRP Tubing Pressure Test

Date: May 4, 2009
Project Site: Key Largo Wastewater Treatment Plant

ARCADIS Project No. : WF156000.0000

Time (hours)	Delta Time (min.)	Pressure (psi)
09:00	0	109.5
09:05	5	109.2
09:10	10	109.2
09:15	15	109.0
09:20	20	108.8
09:25	25	108.8
09:30	30	108.8
09:35	35	108.7
09:40	40	108.5
09:45	45	108.3
09:50	50	108.0
09:55	55	108.0
10:00	60	107.9

The 0 - 300 pound-per-square-inch, 6-inch Mc Daniel brand pressure gauge (S/N 050808-1) was calibrated on March 25, 2009.

Certificate of Calibration

OZONE INDUSTRIES CORPORATION
15465 PINE RIDGE ROAD
FORT MYERS, FL 33908

Ozone Industries, Inc.
Precision Measurement Equipment Division

Purchase Order #

Calibration Performed By:
OZONE INDUSTRIES, INC.
15551 PINE RIDGE RD.
FORT MYERS, FL 33908

For:
YOUNGQUIST BROTHERS, INC.
15465 PINE RIDGE RD.
FORT MYERS, FL 33908

EQUIPMENT INFORMATION:

Description: PRESSURE GAUGE
Manufacter: MCDANIELS
Model Number: 300PSI
Part Number: N/A
Range: 0-300 PSI

Serial Number: 050808-1
Customer I.D.:
Cust. Barcode: N/A
Cust. Location: N/A
Specifications: +/- 0.25% FS

Cal Date: 3/25/2009
Cal. Due Date: 3/25/2010
Cal. Interval 12 MONTHS
Received: IN TOLERANCE
Calibration Result: PASS
Environmental Conditions: 74 DEG F / 20% H
Performed By: B.E.M

Procedure: STANDARD

This is to certify that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure at the points tested (unless otherwise noted). It has been Calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration is in accordance with Ozone Industries, Inc Quality Assurance Manual. Any number of factors may cause the calibration item to drift out of calibration before the recommended interval has expired.

Calibration Remarks:
THIS UNIT WAS FOUND TO BE IN TOLERANCE AT THE TIME OF CALIBRATION.
PERFORMED ROUTINE CALIBRATION / CERTIFICATION

Standards Used to Calibrate Equipment:

Company	I.D.	Description	Last Cal.	Cal. Due Date
OZONE	A1731	EATON UPC5000 PNEUMATIC CALIBRATOR	10/30/2008	10/30/2009

Signatures:

Certified by: Blake McCullers
Print: Blake McCullers
Date: 03/25/09

Approved by: Blake McCullers
Print: Blake McCullers
Date: 03/25/09

ØZONE
INDUSTRIES
CORPORATION
15465 PINE RIDGE ROAD
FORT MYERS, FL 33908

PH: 239-433-3400
FAX: 239-489-3877

CONTROL NO: 032509-1

CUSTOMER: YBI15465

CALIBRATION DATA FORM

MFR:	MCDANIELS	DESCRIPTION	PRESSURE GAUGE
MODEL NO:	300 PSI .25%	TECHNICIAN:	0030
SERIAL NO:	050808-1	CAL. DATE:	03/25/09
CUST. ID:	N/A	DUE DATE:	03/25/10

* IF NO "AS LEFT" READING IS SHOWN ON THIS CHART, IT MEANS THE UNIT WAS IN TOLERANCE AND THERE WERE NO ADJUSTMENTS MADE TO IT.

RANGE: 0-300 PSI

NOMINAL	AS FOUND	AS LEFT *	LOW LIMIT	HIGH LIMIT
50	50.4		49.25	50.75
100	100.6		99.25	100.75
150	150.55		149.25	150.75
200	199.75		199.25	200.75
300	299.6		299.25	300.75

WATER METER
ACCURACY TEST REPORT

2/16/2009

#	MAKE	SERIAL#	LOW FLOW	INT. FLOW	HIGH FLOW
1	2"	6908720	97.0	99.5	99.0
2	USG	6908721	102.4	99.5	100.0
3	DIALOG				
4	METERS		2 GPM	8 GPM	65 GPM
5					
6		USAGE			
7		187200			
8		153240			
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MASTER METER

101 Regency Parkway
Mansfield ,Texas
817 -842-8000
(800) 765-6518
FAX# 817-842-8100

RMA# 21908

CUSTOMER: YOUNGQUIST BROTHERS

TEST DATE: 2/13/2009

TESTER: STEVE WHITE

NOTE:
Accuracy limits according to AWWA C708-96

*** 97% - 103% for Low Flows**

*** 98.5% - 101.5% for Intermediate and High Flows**

***Accuracy limits for meters removed from service according to M-6 Manual Table 5-1**

***90% - 103.0% for Low Flows**

***98.5%- 101.5% for Intermediate and High Flows**

PD Meters 98.5% - 101.5% for Intermediate and High Flow
90% - 101.5% Low Flow

Key Largo Wastewater Treatment District, Injection Well IW1

RTS Flowmeter Calibration Certificate

RX#295161
I-131 Liquid
Youngquist Brothers Inc.
12 mCi **10:00**
MEDICINAL GRADE
05/26/2009 10:00
Box: 06:00-2

CAUTION
RADIOACTIVE MATERIALS

RX#295161
I-131 Liquid
12 mCi
Cal Date 05/26/2009
Cal Time 10:00
MEDICINAL GRADE

Triad Isotopes (239) 277-0890 (800) 690-9081
1840 Boy Scout Drive, Unit A Fort Myers, FL 33907
RX#295161
Account Name: Youngquist Brothers Inc.
Delivery O/T: 05/26/2009 06:00 Container:2
Patient ——: MEDICINAL GRADE
Product ——: I-131 Liquid
Procedure ——: Pipe Leak Test
Physician ——: Clay Ferguson
Ordered Amount: 12 mCi Quantity: 1 Adm. Amt: _____ mCi
Cal Date/Time-: 05/26/2009 10:00
Actual Amount-: 12.288 mCi Quantity: 1 Volume: 10.00 ml (1.22 mCi/ml)
Exp Date/Time -: 06/04/2009 23:59
Filled By: Chris Fisher
Lot #(s): I0425890 0.091
NOTES: BLUE. NA THIO. FINAL 10CC. MEDICINAL GRADE

CAUTION: TO BE USED UNDER THE DIRECT SUPERVISION OF A PHYSICIAN

Appendix E

Injection Test Data, Charts and Calibration Certificates

ARCADIS

Injection Test Summary Table

KLWTD Injection Well System
Key Largo, Florida

Date: 05/20/09
Time Start: 0700

Injection Well IW1

Static IW1 Wellhead Pressure (PSI). 35
Static Upper Zone Pressure (PSI) 12.0
Static Lower Zone Pressure (PSI). 6.8

Totalizer Reading (start): 5266.00
Totalizer Reading (finish): 5597.15
Average pumping rate (gpm): 4246

Time	Time Elapsed (min)	Flow Rate (gpm)	Injection Pressure at Wellhead (PSI)	UMZ Wellhead Pressure (psi)	LMZ Wellhead Pressure (psi)	Totalizer (Thousand Gallons)	Calculated Flow Rate (gpm)	Remarks
0650				11.0	6.8			pre-test data, start of logging
0700	0	0	35.0	11.0	6.8	5266.00	0.00	
0701	1	2000	45.0					
0702	2	1300	40.0					
0703	3	1500	42.5					
0704	4	1500	43.5			5266.55	1375	
0705	5	1700		11.0	6.8	5266.68	1300	
0706	6	1600	45.0			5266.80	1200	
0708	8	1600	46.0			5267.11	1550	T=74°C
0710	10	1500	46.2	11.0	6.8	5267.43	1600	
0712	12	1650	46.5			5267.75	1600	
0715	15	1600	46.5	11.0	6.8	5268.23	1600	T=74°C
0720	20	1940 (?)	46.5	1580		5269	1540	T=74°C
0726	26	1290	46.5			5269.97	1617	T=74°C
0730	30			11.0	6.8			
0731	31	1620	46.5			5270.78	1620	adjust flow
0740	40	1555	46.5			5272.18	1556	T=74°C, adjust flow
0745	45	1600	46.5			5272.98	1600	
0755	55	1600	46.7			5274.58	1600	T=74°C
0800	60	1600	46.7	11.0	6.8	5275.40	1640	average flow rate during Q1 = 1567gpm
0801	1	3000	59.0		6.8	5275.67	2700	pump rate step increase
0802	2	3000	60.0			5275.97	3000	
0803	3	3000	63.0			5276.27	3000	
0804	4	3500	65.0			5276.62	3500	
0805	5	3500	64.0	11.0	6.8	5276.97	3500	adjust flow down
0806	6	3400	63.0			5277.31	3400	
0807	7	3000	57.5			5277.61	3000	adjust up
0808	8	3000	58.0			5277.91	3000	adjust up
0809	9	3100	60.0			5278.22	3100	
0810	10	3000	60.0	11.0	6.8	5278.52	3000	adjust up
0811	11	3200	61.5			5278.84	3200	T=74°C
0812	12	3200	61.5			5279.16	3200	
0815	15	3250	61.5	11.0	6.8	5280.14	3267	T=74°C
0821	21		61.5			5282.1	3267	
0825	25	3270	61.5			5283.41	3275	
0830	30	3260	61.5	11.0	6.6	5285.04	3260	T=76°C - well head in sun
0840	40	3240	61.0			5288.28	3240	minor adjust up

Time	Time Elapsed (min)	Flow Rate (gpm)	Injection Pressure at Wellhead (PSI)	UMZ Wellhead Pressure (psi)	LMZ Wellhead Pressure (psi)	Totalizer (Thousand Gallons)	Calculated Flow Rate (gpm)	Remarks
0850	50		61.5		6.3	5291.53	3250	T=76°C
0855	55		61.3			5293.18	3300	
0900	60		61.5	11.0	6.3			average flow during Q2 = 3233 gpm
0901	1	4400	84.0			5295.27	3483	increase flow to approx 5200 gpm
0902	2	4800	85.0			5295.75	4800	
0903	3	5000	86.5			5296.25	5000	
0904	4	5000	86.5			5296.75	5000	
0905	5	5200	88.0	11.0	6.3	5297.27	5200	well head shaded
0906	6	4800 (?)	88.0			5297.75	4800	
0907	7	4800	89.0			5298.23	4800	
0908	8	5200	90.0			5298.75	5200	
0909	9	5000	90.0			5299.25	5000	
0910	10	5200	90.0	11.0		5299.77	5200	T=77°C
0912	12	5200	90.0			5300.79	5100	minor adjust up
0914	14	5200	90.5			5301.81	5100	
0915	15			11.0	6.3			
0916	16	5300	91.0			5302.87	5300	
0920	20		91.0			5304.89	5050	Commissioner. Higgins on-site
0929	29		91.0			5309.47	5089	
0930	30			11.0	6.3			
0943	43	5090 (?)	91.5			5316.60	5093	
0948	48	5060	91.5			5319.13	5060	T=77 adjust up
0951	51	5070	92.0			5320.65	5067	adjust up
0955	55	5125	92.0			5322.7	5125	adjust up
1000	60	5000	92.5	11.0	6.3	5325.23	5060	further flow adjustment not possible
1005	65		92.5			5327.84	5220	
1016	76	4510 (?)	94.0	11.0	6.3	5333.20	4981	
1025	85	4970	93.5			5337.67	4967	
1030	90			11.0	6.3			
1040	100	4920	94.0			5345.50	5220	
1045	105	4920	94.0			5348.02	5040	
1055	115	4922	94.0			5352.45	4430	
1100	120	5020	94.0	11.0	6.3	5354.93	4960	T=79°C
1105	125			11.0	6.3			
1110	130			11.0	6.2			
1115	145			11.0	6.2			
1125	145	5020	94.0		6.2	5367.17	4896	SBR tank level approx 7.7' below top (34')
1130	150			11.0	6.2			
1136	156		94.0			5372.50	4845	
1146	166		94.0			5377.42	4920	T=79°C
1151	171	4880	94.0			5379.86	4880	average flow during Q3 = 4947 gpm
1200	0			11.0	6.2		4947	flow rate reduced to approx 4500 gpm
1203	3		93.0			5385.72	1127	reduce flow
1204	4	4600	93.0			5386.18	4600	reduce flow
1205	5	5200	92.0	11.0	6.2	5386.70	5200	reduce flow
1206	6	4700	92.0			5387.17	4700	reduce flow
1207	7	4800	90.5			5387.66	4900	reduce flow

Time	Time Elapsed (min)	Flow Rate (gpm)	Injection Pressure at Wellhead (PSI)	UMZ Wellhead Pressure (psi)	LMZ Wellhead Pressure (psi)	Totalizer (Thousand Gallons)	Calculated Flow Rate (gpm)	Remarks
1209	9		87.0			5388.59	4650	
1210	10	4700	87.0	11.0	6.2	5389.06	4700	
1213	13	4500	86.0			5390.45	4633	
1215	15	4600	86.0	11.0	6.2			
1216	16	4500	85.5			5391.85	4667	adjust flow down
1220	20	4500	84.5					adjust flow down
1225	25	4500	84.0			5395.91	4511	
1230	30			10.8	6.2			
1232	32	4500	84.5	10.8	6.2	5399.10	4557	
1300	60	4500	84.0	10.8	6.0	5411.73	4511	T=80°C
1330	90	4500	84.0	10.8	6.0	5425.17	4480	T=80°C
1400	120	4500	84.0	10.8	6.0	5438.61	4480	
1430	150	4500	84.0	10.8	6.0	5452.00	4463	T=80°C
1500	180	4450	83.8	10.8	6.0	5465.50	4500	increase flow (minor adjustment)
1530	210	4500	84.0	10.8	5.8	5478.62	4373	
1600	240	4500	84.0	10.8	5.8	5491.90	4427	
1630	270	4450	83.8	10.8	5.8	5505.15	4417	minor adjust up 4500gpm
1700	300	4500	84.0	10.8	5.6	5518.60	4483	tank level 14.5" 15'6" 18+' close
1730	330	4400	84.0	10.8	5.6	5531.25	4217	SBR tank levels @ 17:40 16.4' 17.5' 19.6'
1800	0	4500	84.2	10.8	5.8	5544.65	4467	T=79°C
1830	30	4450	84.0	11.0	5.8	5557.75	4367	adjust up, SBR tanks 17.7' 18.8' 20.3'
1900	0	4500	85.0	11.2	5.8	5571.1	4450	
1935	35	4400	85.0	11.2	5.8	5586.17	4306	T=79.5 open tank 3 valve 21.1 20.3 19.3
2000	0		85.0	11.2	6.0	5597.15	4392	average flow during Q4 = 4432 gpm

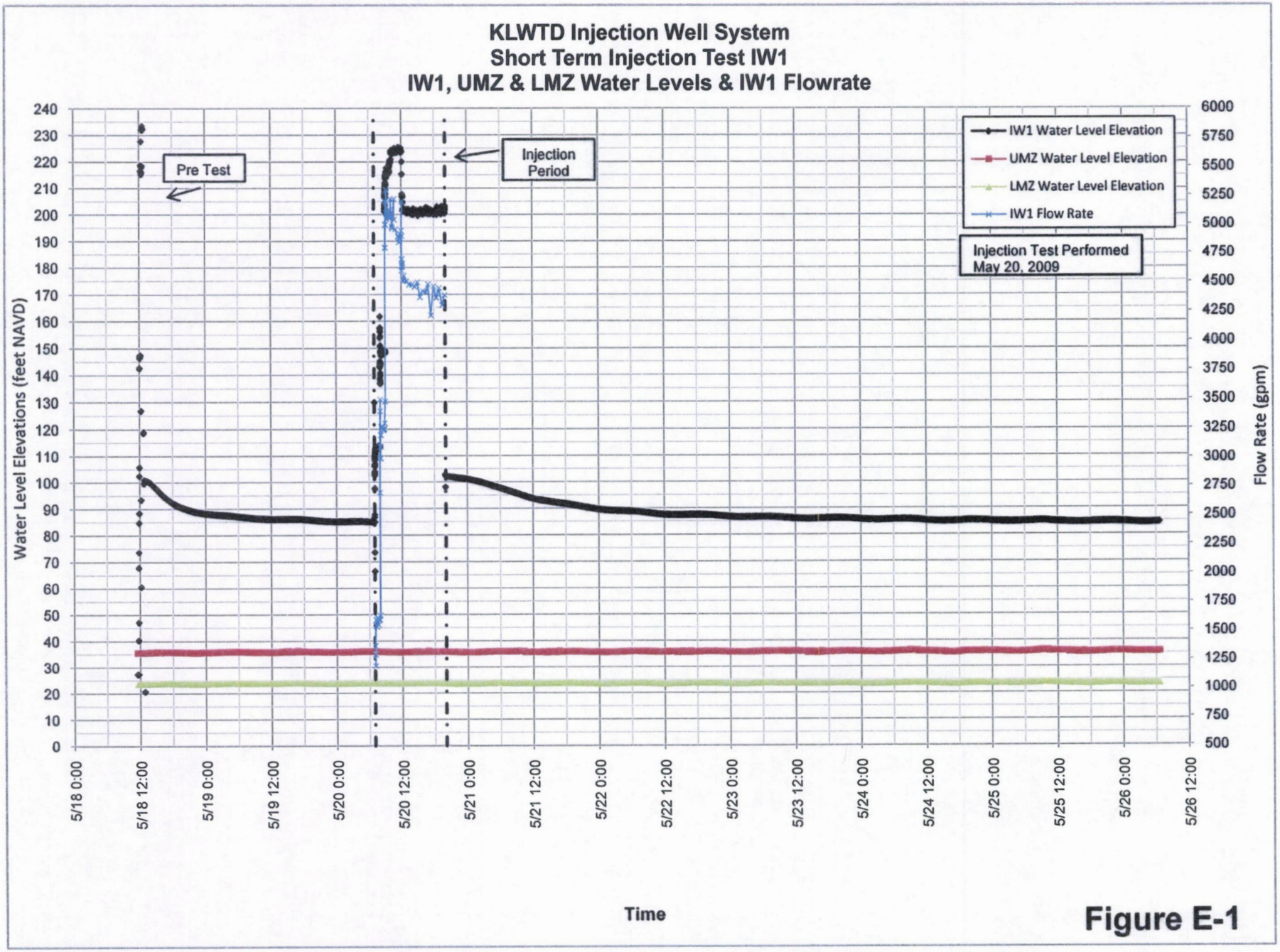

Figure E-1

\\FI6fp\data\AProjects\WR\WF PROJECTS\156000-KEY LARGO IW1\Injection test\Combined Data.xls

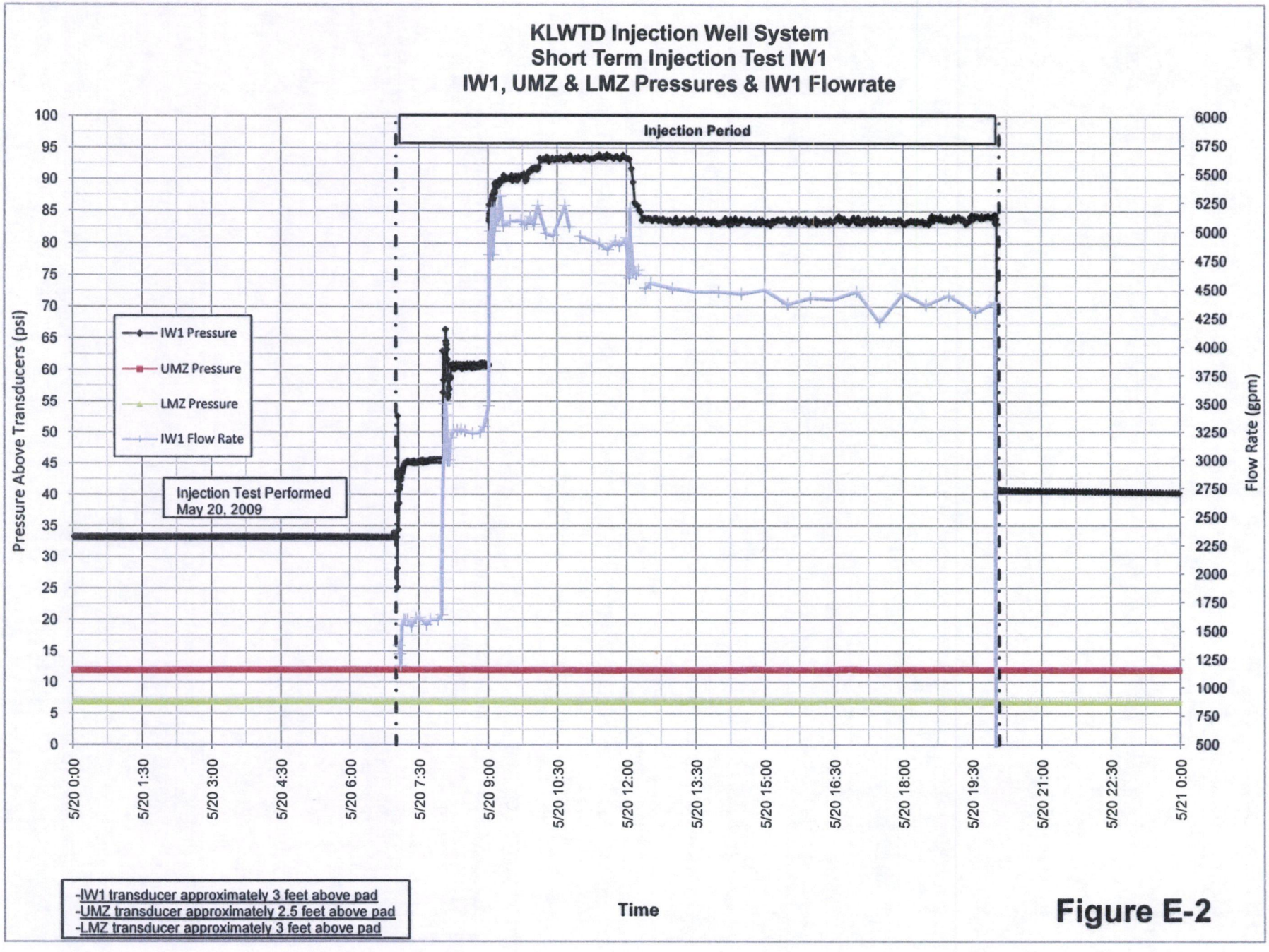

Figure E-2

\\FI6fp\data\AProjects\WR\WF PROJECTS\156000-KEY LARGO IW1\Injection test\Combined Data.xls

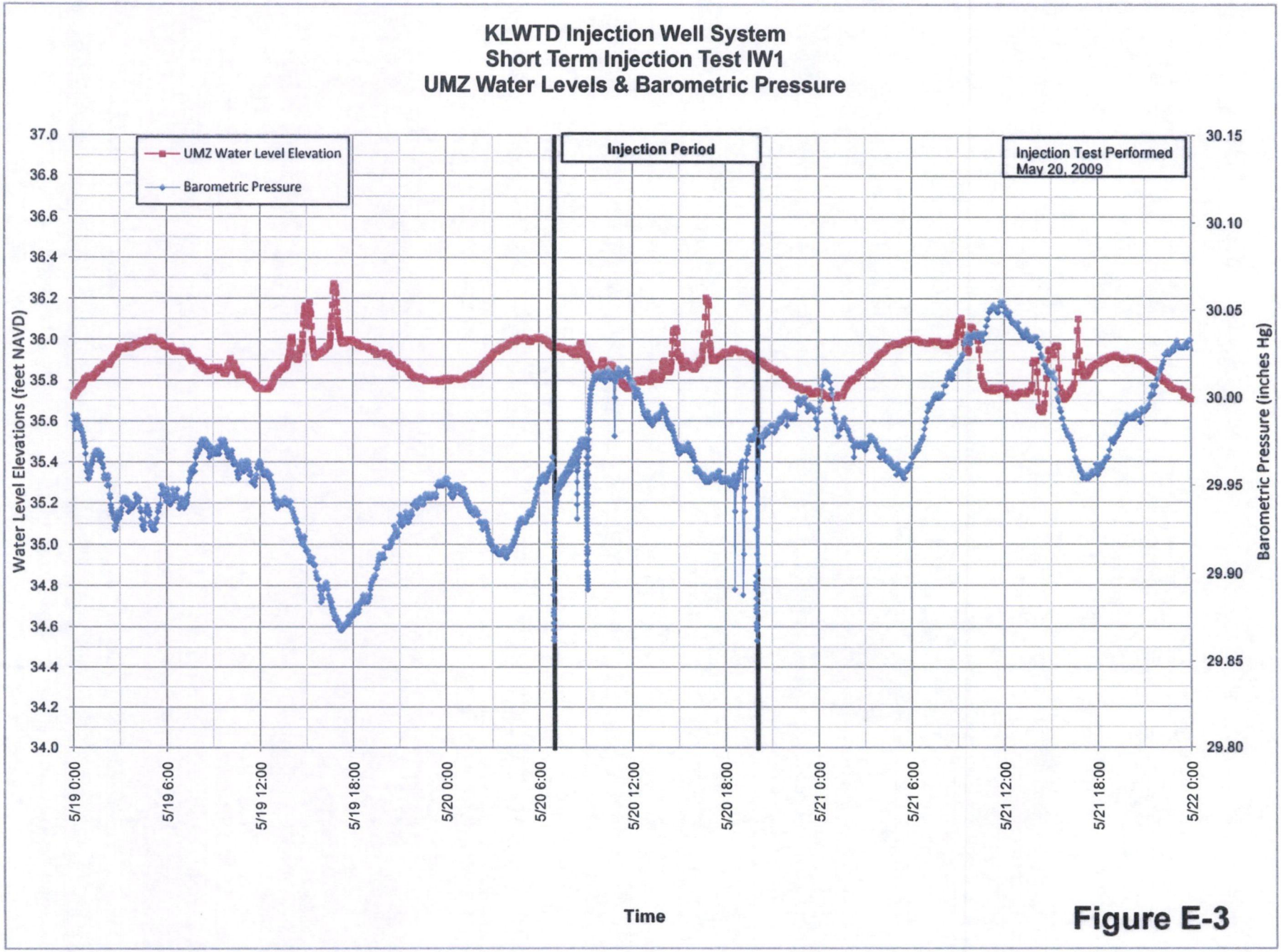

Figure E-3

\\FI6fp\data\AProjects\WR\WF PROJECTS\156000-KEY LARGO IW1\Injection test\Combined Data.xls

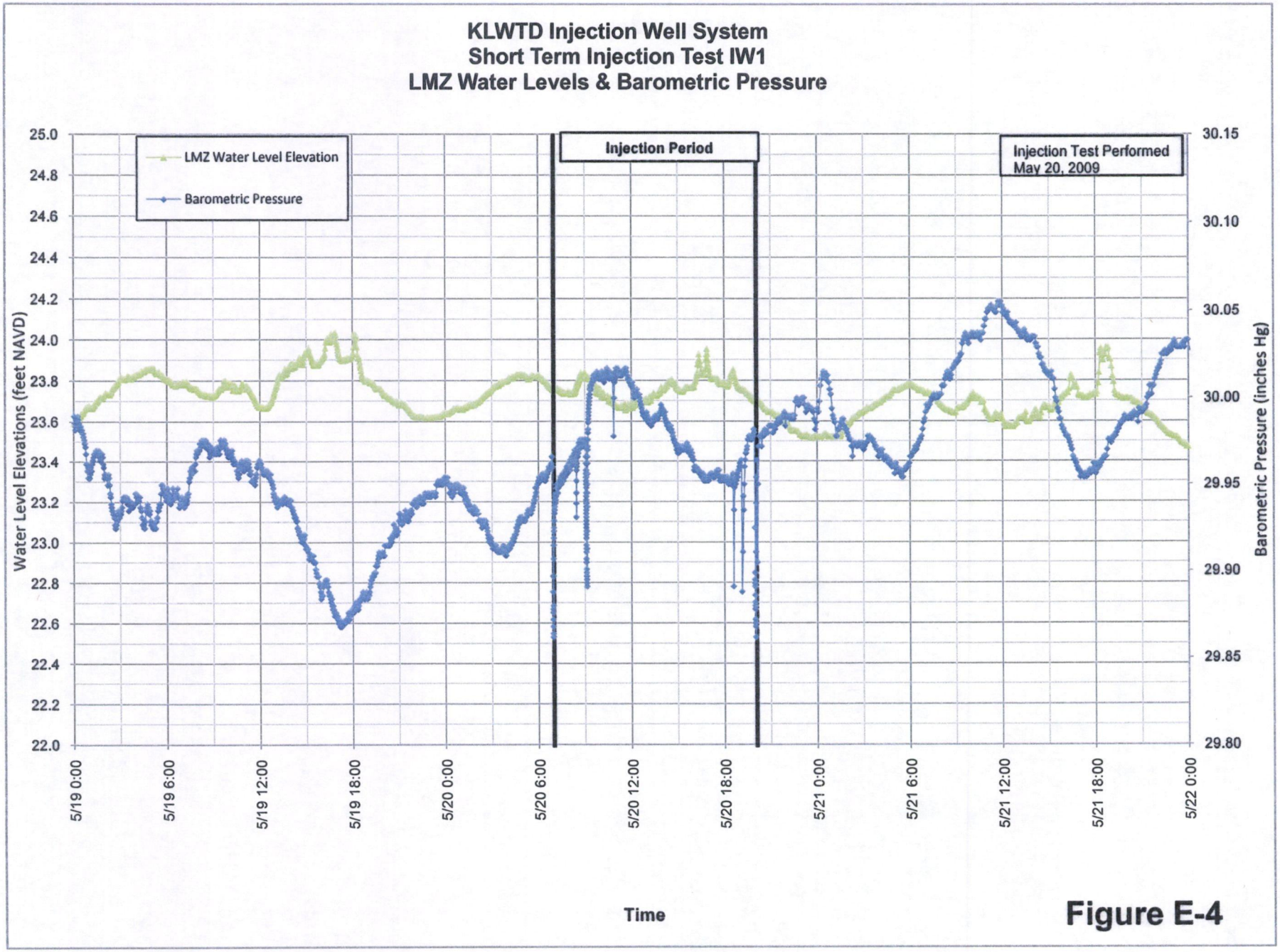

Figure E-4

\\FI6fp\data\AProjects\WR\WF PROJECTS\156000-KEY LARGO IW1\Injection test\Combined Data.xls

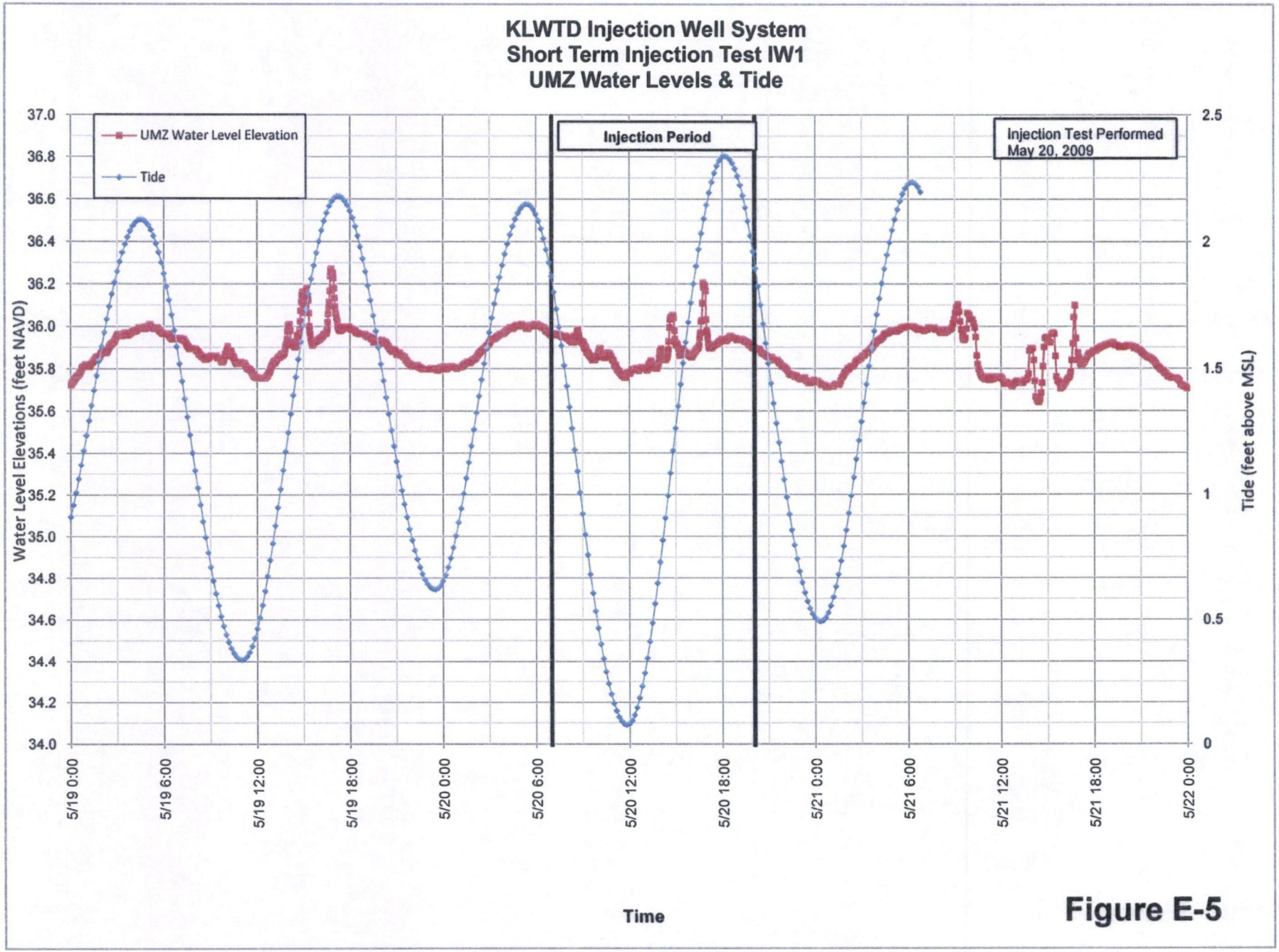

Figure E-5

\\FI6fp\data\AProjects\WR\WF PROJECTS\156000-KEY LARGO IW1\Injection test\Combined Data.xls

Certificate of Calibration

ØZONE INDUSTRIES CORPORATION
15465 PINE RIDGE ROAD
FORT MYERS, FL 33908

Ozone Industries, Inc.
Precision Measurement Equipment Division

Purchase Order #

Calibration Performed By:
OZONE INDUSTRIES, INC.
15551 PINE RIDGE RD.
FORT MYERS, FL 33908

For:
YOUNGQUIST BROTHERS, INC.
15465 PINE RIDGE RD.
FORT MYERS, FL 33908

EQUIPMENT INFORMATION:

Description: PRESSURE GAUGE
Manufacter: MCDANIELS
Model Number: 300PSI
Part Number: N/A
Range: 0-300 PSI

Serial Number: 050808-1
Customer I.D.:
Cust Barcode: N/A
Cust. Location: N/A
Specifications: +/- 0.25% FS

Cal Date: 3/25/2009
Cal. Due Date: 3/25/2010
Cal. Interval: 12 MONTHS
Received: IN TOLERANCE
Calibration Result: PASS
Environmental Conditions: 74 DEG F / 20% H
Performed By: B.E.M

Procedure: STANDARD

This is to certify that the above listed instrument meets or exceeds all specifications as stated in the referenced procedure at the points tested (unless otherwise noted). It has been Calibrated using measurement standards traceable to the National Institute of Standards and Technology (NIST), or to NIST accepted intrinsic standards of measurement, or derived by the ratio type of self-calibration techniques. This calibration is in accordance with Ozone Industries, Inc Quality Assurance Manual. Any number of factors may cause the calibration item to drift out of calibration before the recommended interval has expired.

Calibration Remarks:
THIS UNIT WAS FOUND TO BE IN TOLERANCE AT THE TIME OF CALIBRATION.
PERFORMED ROUTINE CALIBRATION / CERTIFICATION

Standards Used to Calibrate Equipment:

Company	I.D.	Description	Last Cal.	Cal. Due Date
OZONE	A1731	EATON UPC5000 PNEUMATIC CALIBRATOR	10/30/2008	10/30/2009

Signatures:

Certified by: Blake McCullers
Print: Blake McCullers
Date: 03/25/09

Approved by: Blake McCullers
Print: Blake McCullers
Date: 03/25/09

OZONE
INDUSTRIES
CORPORATION
15465 PINE RIDGE ROAD
FORT MYERS, FL 33908

PH: 239-433-3400
FAX: 239-489-3877

CONTROL NO: 032509-1

CUSTOMER: YBI15465

CALIBRATION DATA FORM

MFR:	MCDANIELS	DESCRIPTION	PRESSURE GAUGE
MODEL NO:	300 PSI .25%	TECHNICIAN:	0030
SERIAL NO:	050808-1	CAL. DATE:	03/25/09
CUST. ID:	N/A	DUE DATE:	03/25/10

* IF NO "AS LEFT" READING IS SHOWN ON THIS CHART, IT MEANS THE UNIT WAS IN TOLERANCE AND THERE WERE NO ADJUSTMENTS MADE TO IT.

RANGE: 0-300 PSI

NOMINAL	AS FOUND	AS LEFT *	LOW LIMIT	HIGH LIMIT
50	50.4		49.25	50.75
100	100.6		99.25	100.75
150	150.55		149.25	150.75
200	199.75		199.25	200.75
300	299.6		299.25	300.75

CERTIFIED TEST REPORT

CUSTOMER: YOUNGQUIST BROTHERS

MODEL NO: ML04-20

METER SERIAL NO: 841404

CONFIGURATION

METER INSIDE DIAMETER: 19.22

DIAL: GAL X 0/1

GEARS: /

ACTUAL METER INDEX:

TEST DATE: 4/8/2009

TEST FACILITY: Volumetric

CALIBRATION DATA

	FLOW RATE GPM	% ACCURACY
1	8304.60	101.15
2	3817.33	100.45
3	989.80	100.18

CERTIFIED BY: Paul Hobbs DATE: 4/8/2009

This calibration was performed on a primary or secondary test facility, traceable to the National Institute of Standards and Technology, USA. The estimated flow measurement uncertainty of the calibration facilities are:
Primary +/- 0.15% Secondary +/- 0.5%

McCROMETER
3255 WEST STETSON AVENUE
HEMET, CA 92545 USA
PHONE (951) 652-6811 / FAX (951) 652-3078
WEB SITE: http://www.mccrometer.com E-MAIL: info@mccrometer.com


841404

Transducer

In-Situ Inc.

Calibration Report

221 E. Lincoln Ave, Fort Collins, CO 80524 USA, 970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 970-498-1598
Visit us on the Internet at www.in-situ.com!

Report Number: 2008110913005342 **Calibration Result:** PASSED

Calibration Date:	2008-11-09
Model:	PXD-261
Full Scale Pressure Range:	689.5 kPa (100 PSI) Gauge
Manufacturer:	In-Situ
Serial Number:	5342

Calibration Procedures and Equipment Used:

Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Digital Multi-Meter, HP 3457A, s/n 3114A15076
2. Multi-Channel Thermometer, Instrulab 4312A-15, s/n 41039
3. Platinum RTD, Instrulab 832, s/n 12084
4. 300/100 PSIG Pressure Controller - Sensor 1, Mensor PCS-400, s/n 180226
5. Automated software calibration procedures used

Range of Applied Temperatures: 4.54 C to 29.61 C

Range of Applied Pressures: -0.0345 kPa (-0.0050 PSI) to 689.4895 kPa (100.0020 PSI)

Calibration Coefficients:

Linearity	0.3830
Scale	99.2077
Offset	-0.5661

PASS/FAIL Criteria:

	Applied Pressure	Current mA	
Zero Response	-0.0345 kPa (-0.0050 PSI)	4.092	PASSED
Full Scale Response	689.4895 kPa (100.0020 PSI)	20.156	PASSED

	Minimum	Maximum	
Temperature Stability (%FS)	-0.144	0.127	PASSED
Repeatability at 15 C (%FS)	-0.003	0.009	PASSED

Hysteresis (%FS)	0.005	PASSED
Thermal Hysteresis (%FS)	0.009	PASSED

Test Performed By: wr' Test Verified By:

This calibration report shall not be reproduced, except in full, without the written approval of In-Situ, Inc.

Transducer

In-Situ Inc.

Calibration Report

221 E. Lincoln Ave, Fort Collins, CO 80524 USA, 970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 970-498-1598

Visit us on the Internet at www.in-situ.com!

Report Number: 2008080208000320 **Calibration Result:** PASSED

Calibration Date:	2008-08-02
Model:	PXD-261
Full Scale Pressure Range:	206.8 kPa (30 PSI) Gauge
Manufacturer:	In-Situ
Serial Number:	320

Calibration Procedures and Equipment Used:

Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Digital Multi-Meter, HP 3457A, s/n 3114A15076
2. Multi-Channel Thermometer, Instrulab 4312A-15, s/n 41039
3. Platinum RTD, Instrulab 832, s/n 12084
4. 100 PSIG/A - Pressure Controller, Ruska 7215xi, s/n 55556
5. Automated software calibration procedures used

Range of Applied Temperatures: 4.74 C to 29.80 C

Range of Applied Pressures: -0.0003 kPa (-0.0000 PSI) to 206.8443 kPa (30.0002 PSI)

Calibration Coefficients:

Linearity	0.2767
Scale	29.7542
Offset	-0.0716

PASS/FAIL Criteria:

	Applied Pressure	Current mA	
Zero Response	-0.0003 kPa (-0.0000 PSI)	4.039	PASSED
Full Scale Response	206.8443 kPa (30.0002 PSI)	20.021	PASSED

	Minimum	Maximum	
Temperature Stability (%FS)	-0.067	0.062	PASSED
Repeatability at 15 C (%FS)	-0.016	0.010	PASSED

Hysteresis (%FS)	0.021	PASSED
Thermal Hysteresis (%FS)	0.017	PASSED

Test Performed By: wr Test Verified By:

Transducer

In-Situ Inc.

Calibration Report

221 E. Lincoln Ave, Fort Collins, CO 80524 USA, 970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 970-498-1598
Visit us on the Internet at www.In-situ.com!

Report Number: 2008080208005110 **Calibration Result:** PASSED

Calibration Date:	2008-08-02
Model:	PXD-261
Full Scale Pressure Range:	206.8 kPa (30 PSI) Gauge
Manufacturer:	In-Situ
Serial Number:	5110

Calibration Procedures and Equipment Used:

Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Digital Multi-Meter, HP 3457A, s/n 3114A15076
2. Multi-Channel Thermometer, Instrulab 4312A-15, s/n 41039
3. Platinum RTD, Instrulab 832, s/n 12084
4. 100 PSIG/A - Pressure Controller, Ruska 7215xi, s/n 55556
5. Automated software calibration procedures used

Range of Applied Temperatures: 4.74 C to 29.80 C

Range of Applied Pressures: -0.0003 kPa (-0.0000 PSI) to 206.8454 kPa (30.0004 PSI)

Calibration Coefficients:

Linearity	0.2672
Scale	29.8380
Offset	-0.0114

PASS/FAIL Criteria:

	Applied Pressure	Current mA	
Zero Response	-0.0003 kPa (-0.0000 PSI)	4.007	PASSED
Full Scale Response	206.8454 kPa (30.0004 PSI)	19.950	PASSED

	Minimum	Maximum	
Temperature Stability (%FS)	-0.049	0.100	PASSED
Repeatability at 15 C (%FS)	-0.012	0.009	PASSED

Hysteresis (%FS)	0.015	PASSED
Thermal Hysteresis (%FS)	0.020	PASSED

Test Performed By: wr' Test Verified By:

This calibration report shall not be reproduced, except in full, without the written approval of In-Situ, Inc.

In-Situ Inc.

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Calibration Report

Understanding the Transducer Calibration Report

Page 1 provides calibration information for your In-Situ pressure transducer. Page 2 provides an explanation of the results and a brief description of our rigid test procedures. We include this information so that you may have a better understanding of our calibration procedures relative to the high accuracy of our products. We take our published specifications seriously, and in most cases, the actual results of our calibration report exceed those specifications.

The Calibration Procedure

We run six separate cycles (nominally 5°C, 15°C, 30°C, 15°C, 15°C, and 15°C) to test the transducer's performance and ability to repeat readings at constant temperatures. For each cycle, the transducer is temperature-stabilized, then pressure readings are taken from 0 to full scale (FS) pressure and back to 0 in 10% FS steps (22 data points).

The transducer is optimized for operation at 15°C, a temperature that characterizes a majority of groundwater applications.

Calibration Coefficients

The transducer's coefficients are also found on the probe's data tag. These are the coefficients to enter into In-Situ's data loggers before running a test. Instructions for programming Linearity, Scale, and Offset may be found in the data logger operator's manual.

PASS/FAIL Criteria

"Deviation" refers to the difference between the transducer readings and our NIST-traceable (National Institute of Standards and Technology) pressure standard. mA = milliAmps, FS = Full Scale.

Zero Response: Response of the probe, in mA, when 0 PSI pressure is applied.

Full Scale Response: Response of the probe, in mA, when full scale pressure is applied.

Temperature Stability: Minimum and maximum % FS deviation over the first four cycles.

Repeatability at 15°C: Minimum and maximum % FS deviation over the last three cycles.

Hysteresis: Maximum difference between % FS deviations over the last three cycles.

Thermal Hysteresis: Maximum difference between % FS deviations between the first two 15°C cycles.

Appendix F

Electronic Files of:

-Weekly Construction Reports

-Casing Seats, Monitor Zone Intervals and Injection Test Requests (Text Only)

-Geophysical Logs

-Mill Certifications and FRP Product Sheets

-Packer Testing Data and Analytical Reports

-Water Quality Analytical Reports

-Injection Test Raw Data