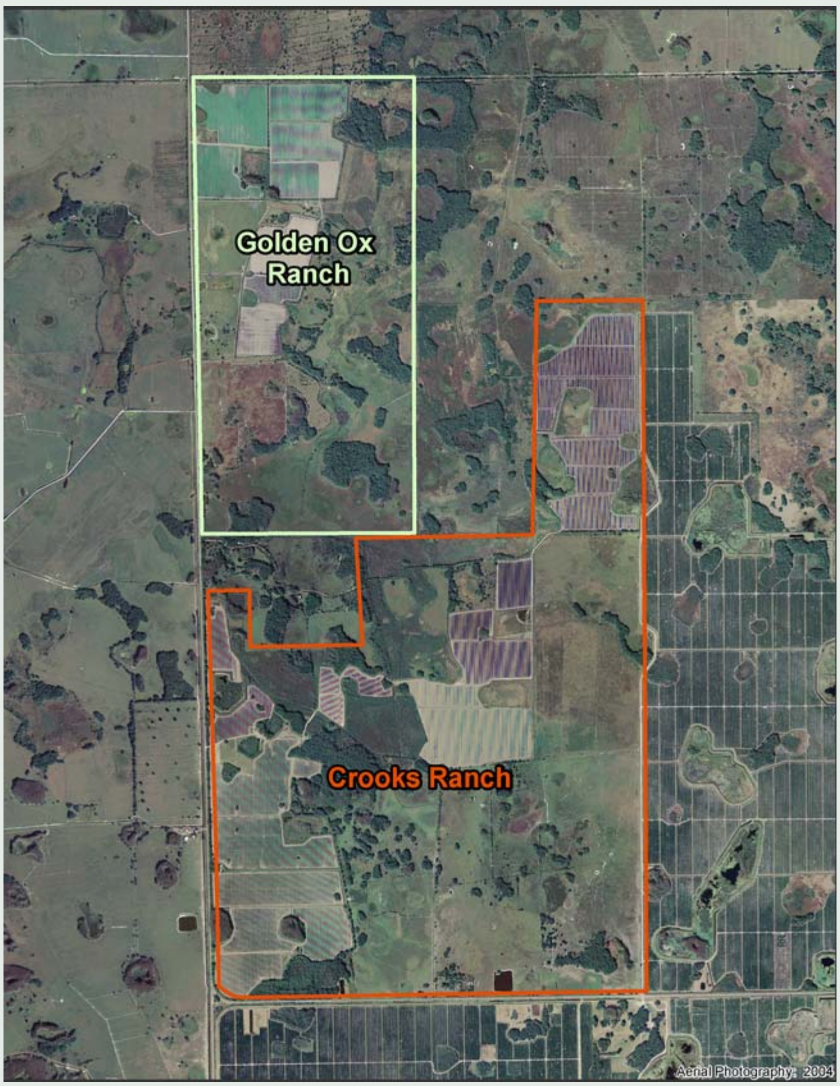
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Hydrogeologic Assessment of
CROOKS AND GOLDEN OX RANCHES
Hendry County, Florida

Technical Publication WS-28



by
SFWMD Water Supply Department Staff

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Executive Summary

The purpose of this report is to document the data collection, analysis, and results derived from a hydrogeologic assessment conducted on Crooks Ranch and Golden Ox Ranch in central Hendry County. In this area, significant groundwater quantities for irrigation are withdrawn primarily from the semi-confined Lower Tamiami aquifer (LTA), which appears to be hydraulically connected to the overlying WTA, and, in turn, to the numerous isolated wetland systems in the region. The two ranches are located in the C-139 Basin, where there are approximately 565 LTA agricultural irrigation wells and another 256 proposed.

Crooks Ranch submitted a water use permit application seeking to significantly expand irrigated acreage from 135 acres to 1,597 acres by installing 10 LTA wells in addition to the existing 10 permitted WTA wells. In response to this water use permit application, the South Florida Water Management District Governing Board issued two consent orders, one for Crooks Ranch, and another for the adjacent Golden Ox Ranch. Golden Ox Ranch is an existing farm that has no water use permit. Golden Ox irrigates 474 acres of vegetables using 14 wells constructed into the LTA. The objectives of this hydrogeologic assessment, as outlined in the consent orders, are to help gather information about the following: aquifer properties and hydrologic interaction between pumping from the LTA and WTA; effects of proposed seepage irrigation on the hydrology of the adjacent wetlands; impacts of seasonal demands of the proposed crops on the hydroperiods of wetlands; and effects of construction and operation of stormwater reservoirs on protecting wetlands from groundwater withdrawals.

Geologic and hydrogeologic information was obtained during the construction of 19 test and monitor wells (HES-1 through HES-19) at seven sites on Crooks and Golden Ox Ranches. These wells were used to monitor water levels in the LTA and WTA and to assess the effects of water use in each aquifer and on the overlying wetlands. Each of the seven sites has a WTA and a LTA monitor well. Five of the seven sites have a stilling well (screened across the land surface) to measure the water level in a wetland adjacent to the groundwater monitor wells. The two sites that did not have a stilling well are located near the southern and western boundaries of Crooks Ranch to show the impacts of water use off-site. The monitor and stilling wells served a dual purpose – to monitor water levels during aquifer performance testing, and to monitor long-term water level trends.

Two pumping test wells (HES-20 and HES-21) were also constructed for use in aquifer performance tests (APTs) in order to determine aquifer characteristics. One APT was run on Crooks Ranch and the other on Golden Ox Ranch. The APTs showed that the LTA is a leaky-type, semi-confined aquifer and that withdrawals from the LTA affect the WTA. At Crooks Ranch, it appears the

APT also affected the water level in the nearby wetland. At Golden Ox Ranch, the location of the discharge line for the APT may have affected the water level in the nearby wetland, as the wetland water level rose during the test.

The long-term water level data collected during this investigation indicate there is a hydraulic connection between the WTA and the LTA. Evidence of this connection can be seen in both the APTs and in the long-term water level monitoring data. The degree of connection varies across the study area, but it is apparent that water use in the LTA affects water levels in the WTA. An evaluation of the hydraulic gradient between the WTA and the LTA shows the gradient between the two aquifers is steepest during the dry season and flattens out or reverses during the wet season. This observation is confirmed by long-term hydrographs, which show water levels in the LTA rise during the wet season, presumably because pumpage from the aquifer decreases. The hydraulic gradient at the Golden Ox Ranch site (Site 6) remains relatively flat, and the long-term hydrograph for this site shows the water levels in the WTA and LTA correspond very closely. Both of these factors indicate there is a strong hydraulic connection between the two aquifers at this site.

At all of the study sites with stilling wells, the wetland water level data correspond very closely to the water level in the WTA. In some cases, the WTA water level is higher than that of the wetland. As the wetland water levels respond in a similar manner to the WTA water levels, and the data show a connection between water levels in the WTA and the LTA, there is some hydraulic connection among all three – the wetland, WTA, and LTA. The Golden Ox Ranch site shows a high degree of hydraulic connection between the three water levels, as the level in the wetlands generally corresponds to the water level in the WTA. It is not apparent if rainfall or cessation of water use from the LTA has an impact on raising the water levels in the wetlands.

All of the objectives of this hydrogeologic assessment were met. Technical and specific recommendations related to augmenting the existing monitoring program and ideas for additional data collection and analysis needs are provided at the end of this report. These recommendations can be implemented to enhance the findings of this study. Ultimately, the information gathered from this study can be used to help protect wetlands, improve water quality, and address limited water availability for farming in the C-139 Basin.

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1 Introduction

1.1 PURPOSE

The purpose of this report is to document the data collection, analysis, and results derived from a hydrogeologic assessment conducted on Crooks Ranch and Golden Ox Ranch in central Hendry County. In this area, significant groundwater quantities for irrigation are withdrawn primarily from the semi-confined Lower Tamiami aquifer (LTA). The LTA, positioned beneath the water table aquifer (WTA), is the primary agricultural water source in this portion of Hendry County for irrigation, especially to the south and east of Crooks Ranch.

The two ranches are located in the C-139 Basin, where there are approximately 565 LTA agricultural irrigation wells and another 256 proposed. The LTA appears to be hydraulically connected to the overlying WTA, and, in turn, to the numerous isolated wetland systems in the region. The LTA and the WTA together compose the surficial aquifer system (SAS).

Crooks Ranch submitted a water use permit application seeking to significantly expand irrigated acreage from 135 acres to 1,597 acres by installing 10 LTA wells in addition to the existing 10 permitted WTA wells. In response to this water use permit application, the South Florida Water Management District (SFWMD or District) Governing Board issued two consent orders, one for Crooks Ranch, and another for the adjacent Golden Ox Ranch. Golden Ox Ranch is an existing farm that has no water use permit, but irrigates 474 acres of vegetables using 14 wells constructed into the LTA. Outlined in the consent orders are the objectives of this hydrogeologic assessment, which are to help gather information about:

1. Aquifer properties to determine the hydrologic interaction between pumping from the LTA and WTA.
2. Effects of proposed seepage irrigation on the hydrology of the adjacent wetlands.
3. Impacts of seasonal demands of the proposed crops on the hydroperiods of wetlands.
4. Effects of construction and operation of stormwater reservoirs on protecting wetlands from groundwater withdrawals.

This hydrogeological assessment fulfills item 1 listed above, providing information about the impacts of agricultural groundwater withdrawals from the

LTA on the WTA and local wetlands. **Appendix A** includes the Crooks Ranch consent order (2004-182 CO WU), and **Appendix B** includes the Golden Ox Ranch consent order (2005-003 CO WU).

1.2 SITE LOCATION

The study area is located in central Hendry County, Florida, inside the C-139 Basin, shown in **Figure 1**. The sites are approximately 20 miles southwest of Clewiston and consist of two adjacent properties known as Crooks Ranch and Golden Ox Ranch, or Devil's Garden.

Crooks Ranch is located in Township 46 South, Range 32 East, Sections 11, 14, 15, 22, and 23, and comprises approximately 2,677 acres. Land surface elevation ranges from approximately 26 feet above the National Geodetic Vertical Datum of 1929 (NGVD 1929 or NGVD) in the northern portion of the Ranch, to approximately 25 feet NGVD in the south. The highest area of Crooks Ranch (approximately 28 feet NGVD) occurs in the western central part of the site.

Golden Ox Ranch is located in Township 46 South, Range 32 East, Sections 3 and 10, and comprises approximately 1,284 acres. Land surface elevations range from approximately 29 feet NGVD in the north to approximately 25 feet NGVD in the south. **Figure 2** presents a site location map.

Figure 3 shows the locations of wetland habitats on both Crooks and Golden Ox Ranches in relation to the monitoring sites installed by the District. The wetland locations are based on the National Wetlands Inventory (1990). The study area contains a significant number of wetlands; however, this investigation did not include a comprehensive review of the onsite wetlands, nor were the wetlands evaluated for Florida Department of Environmental Protection (FDEP) wetland criteria.

During the aquifer performance test (APT) setup and monitoring, it was determined there was likely impacts from adjacent users. Examination of the background groundwater levels shows the drawdowns were inconsistent and varied with time. A post-APT evaluation of permitted users indicates there are a large number of permitted users surrounding the properties. **Figure 4** shows the locations of all the permitted water use wells within 5 miles of Crooks and Golden Ox Ranches. The reporting of pumpages from local permitted users is not required under many of the consumptive use permits so it was not possible to determine the major users of water during the APT investigation.

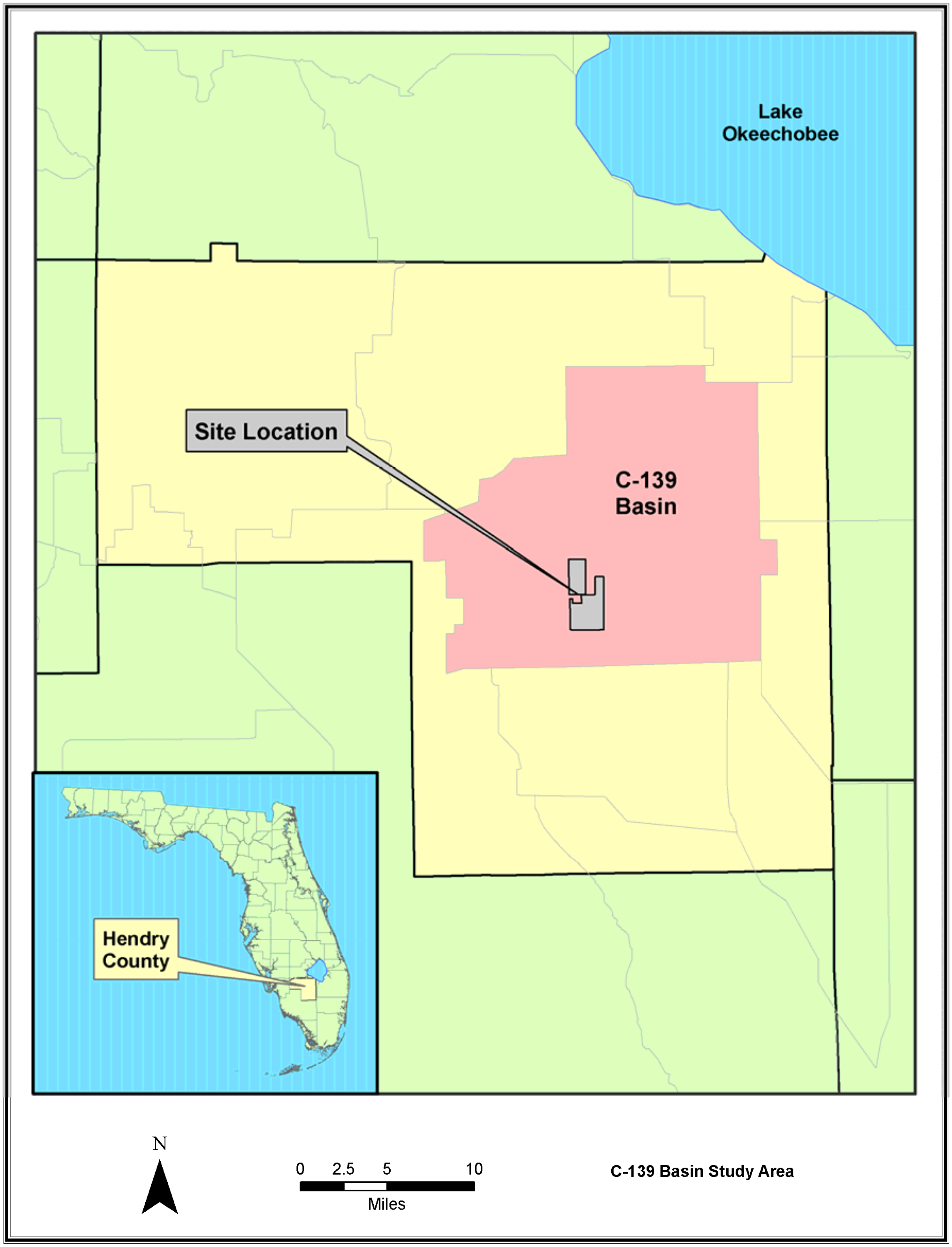

Figure 1. C-139 Basin study area.

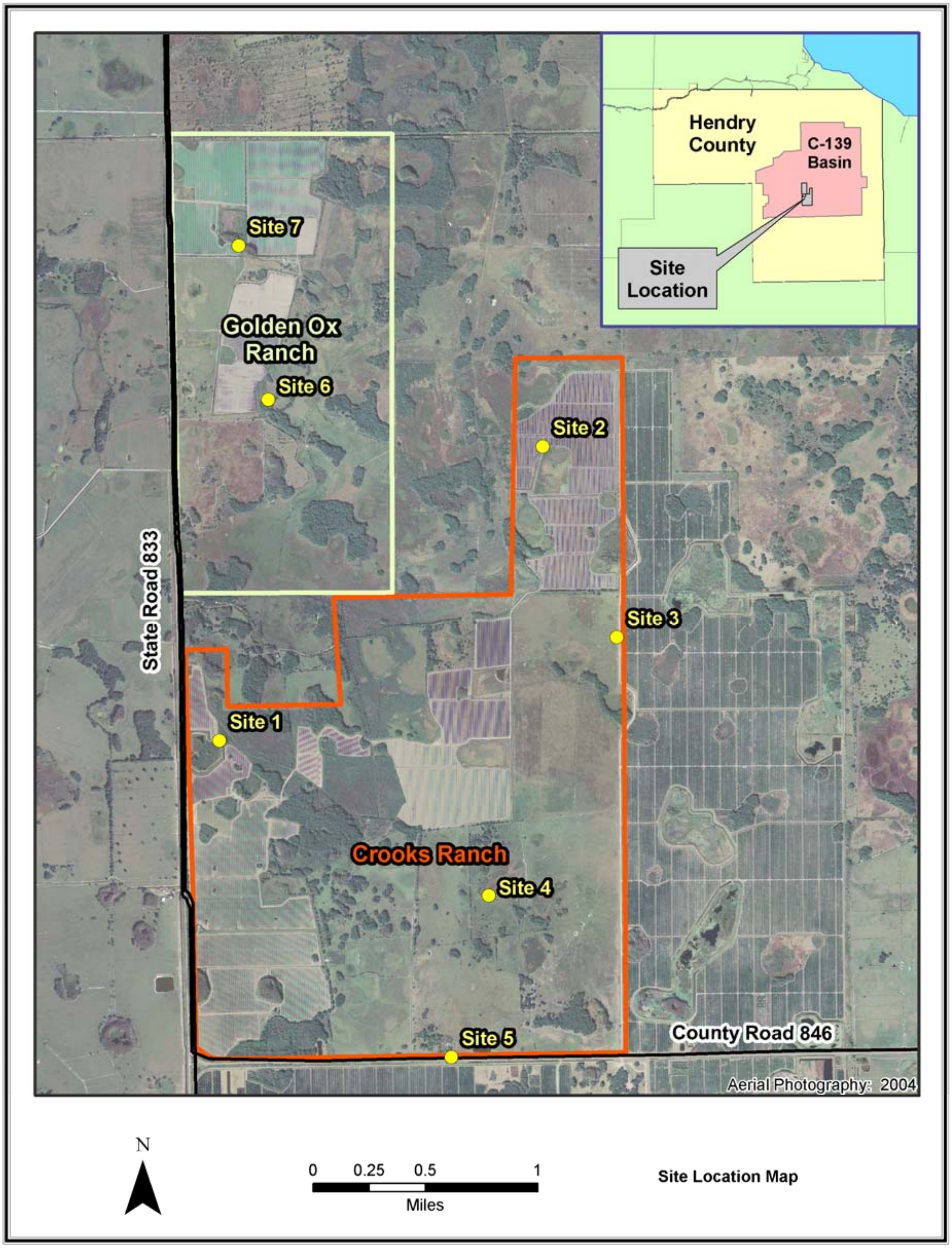

Figure 2. Site location map.

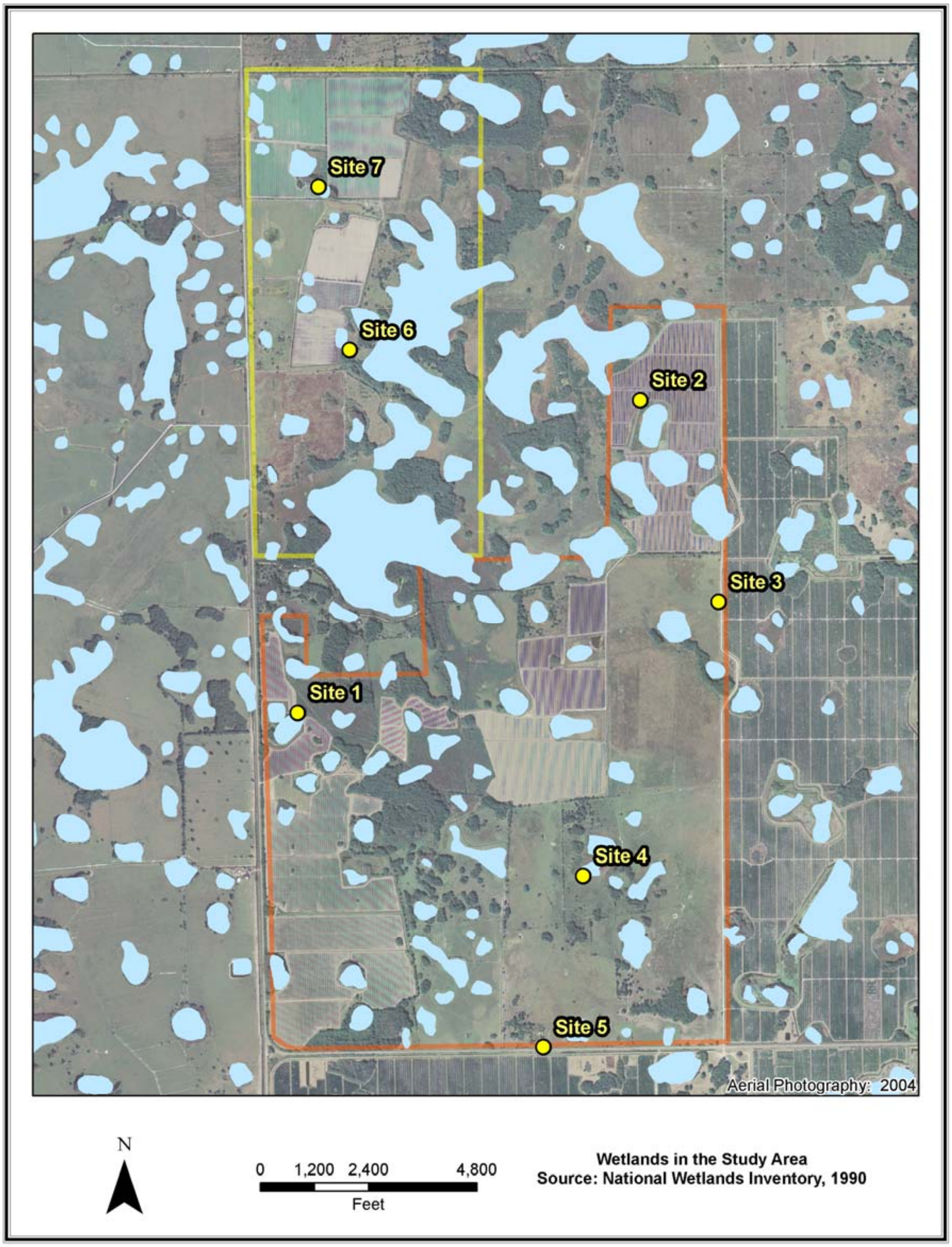

Figure 3. Wetlands in the study area and District monitoring sites.

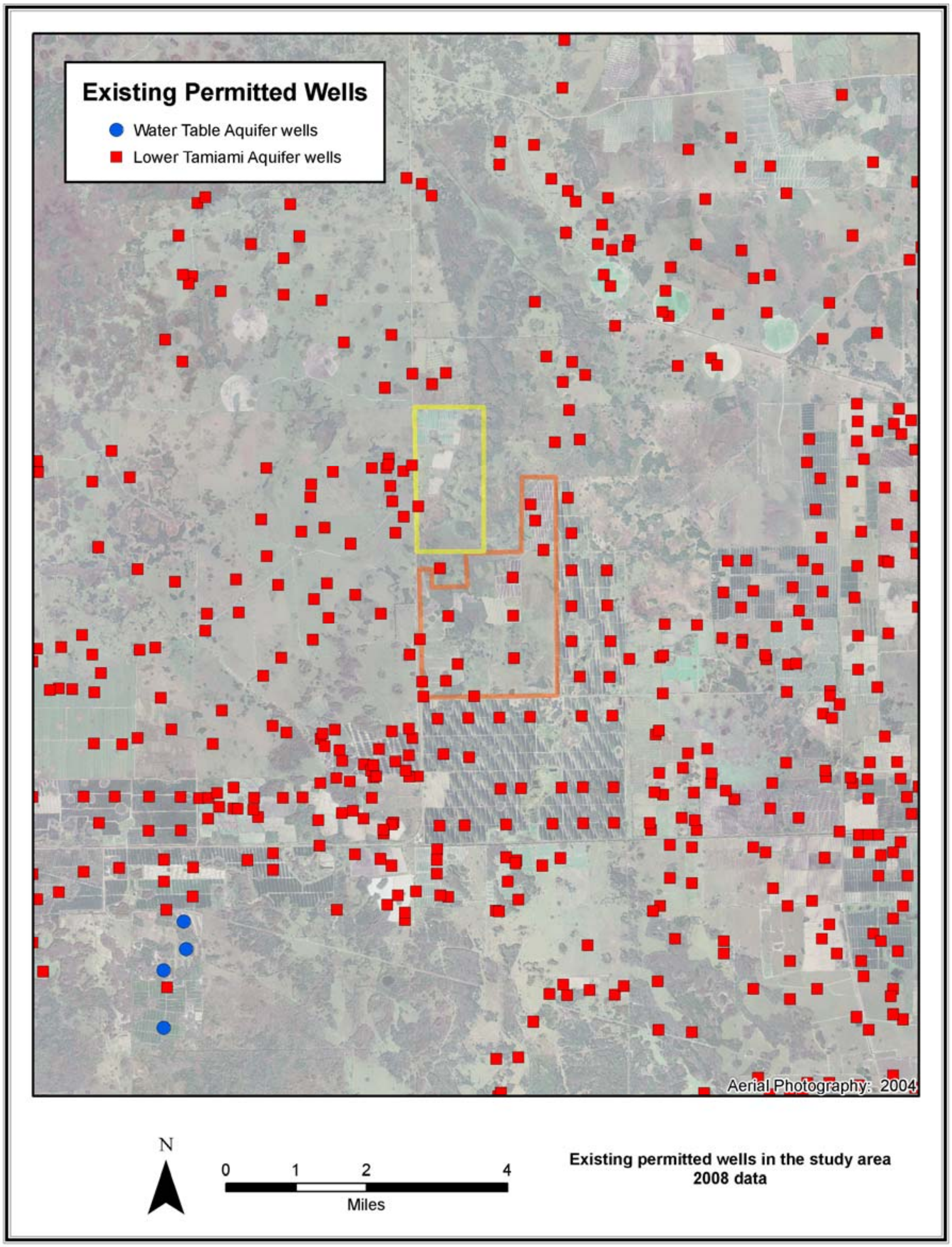

Figure 4. Existing permitted wells in the study area (2008).

2

Well Construction

Hydrogeologic information was obtained during the construction of 19 test and monitor wells (HES-1 through HES-19) at seven sites on Crooks and Golden Ox Ranches (**Figure 5**). These wells were used to monitor water levels in the LTA and WTA and to assess the effects of water use in each aquifer and on the overlying wetlands. Two test (pumping) wells (HES-20 and HES-21) were also constructed for use in aquifer performance tests (APTs) to determine aquifer characteristics.

2.1 WELL DESIGN

Sites 1, 2, 4, 6, and 7 are adjacent to wetlands and consist of three wells each: one completed into the WTA, one completed into the underlying LTA, and a single "stilling well" sited within a wetland. Stilling wells enable measurement of water levels in the wetlands when water levels are either above or below land surface (bls). Sites 3 and 5 are not associated with wetlands, but were constructed at the south and east perimeters of the properties to better define water levels at these boundaries and to help assess any off-site water use by adjacent citrus growers. Typical well designs are shown in **Figures 6** and **7**. The wells constructed for this assessment were designed to provide the hydraulic information necessary to determine the interactions between the WTA and LTA, as well as within the wetlands. In addition, a rainfall gauge (tipping bucket design) was installed near Site 1 at the time of well construction. In January 2007, additional rain gauges were installed at Sites 3, 5, and 7.

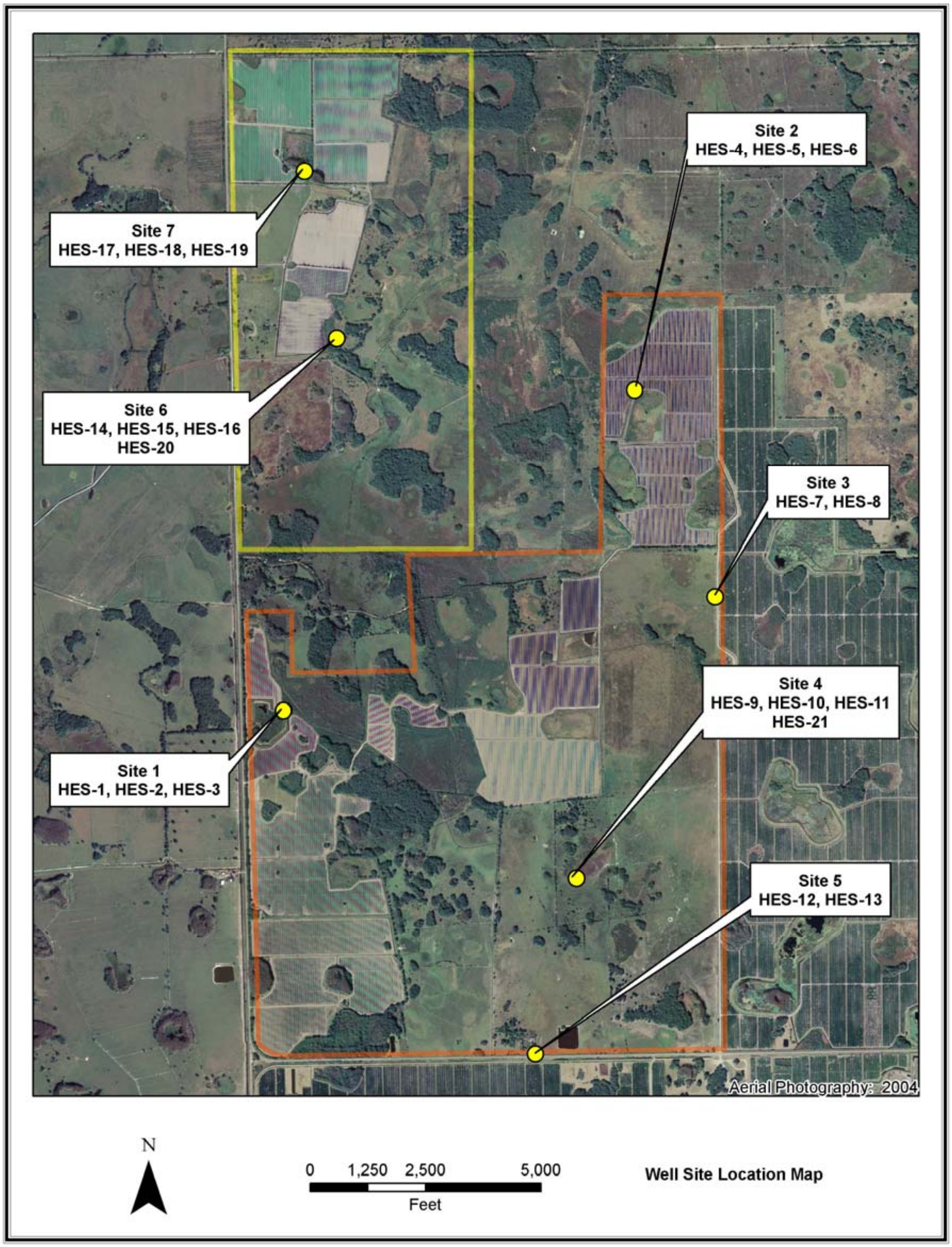

Figure 5. Well site location map.

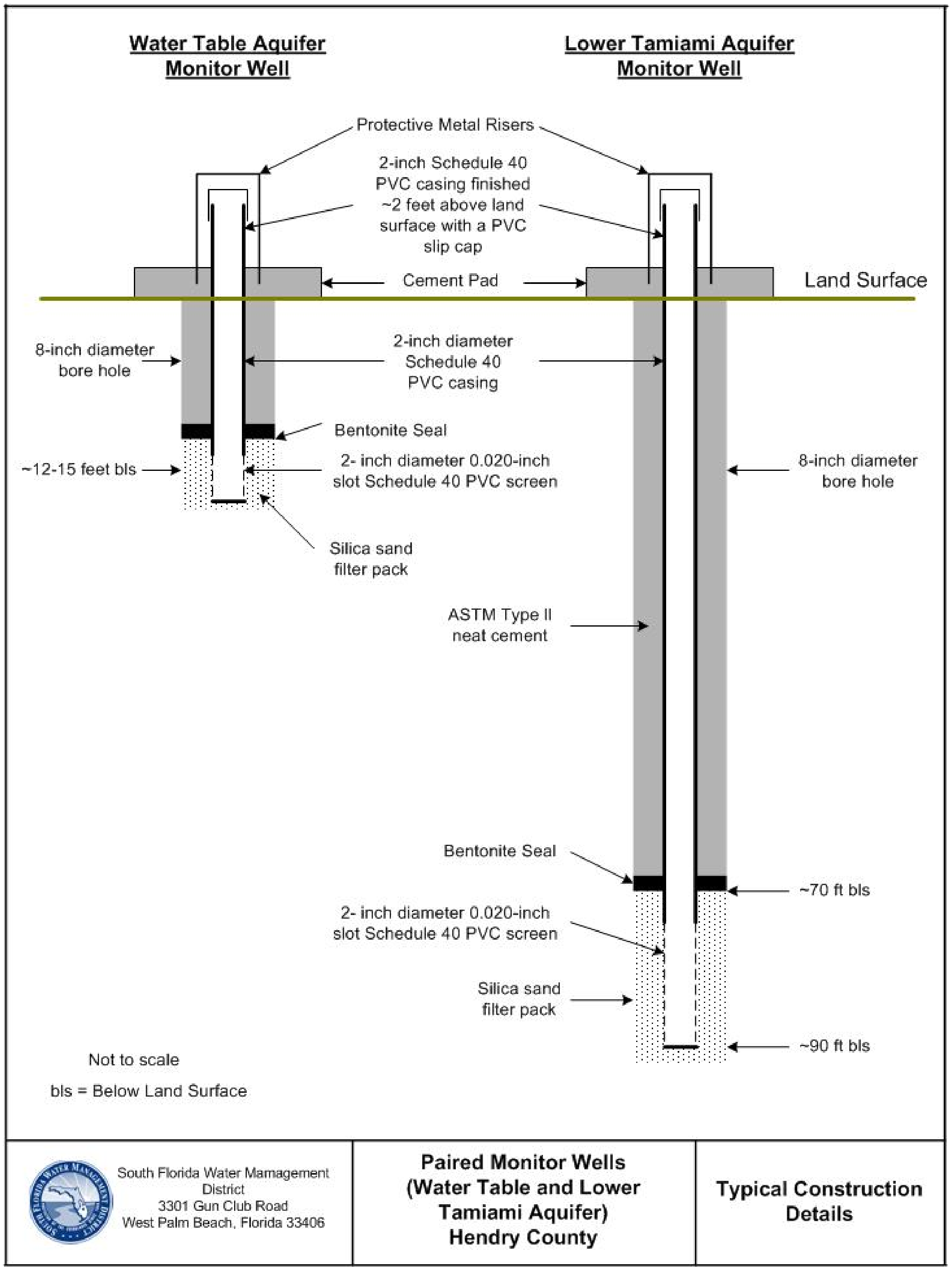

Figure 6. Typical well pair construction used at Crooks Ranch and Golden Ox Ranch.

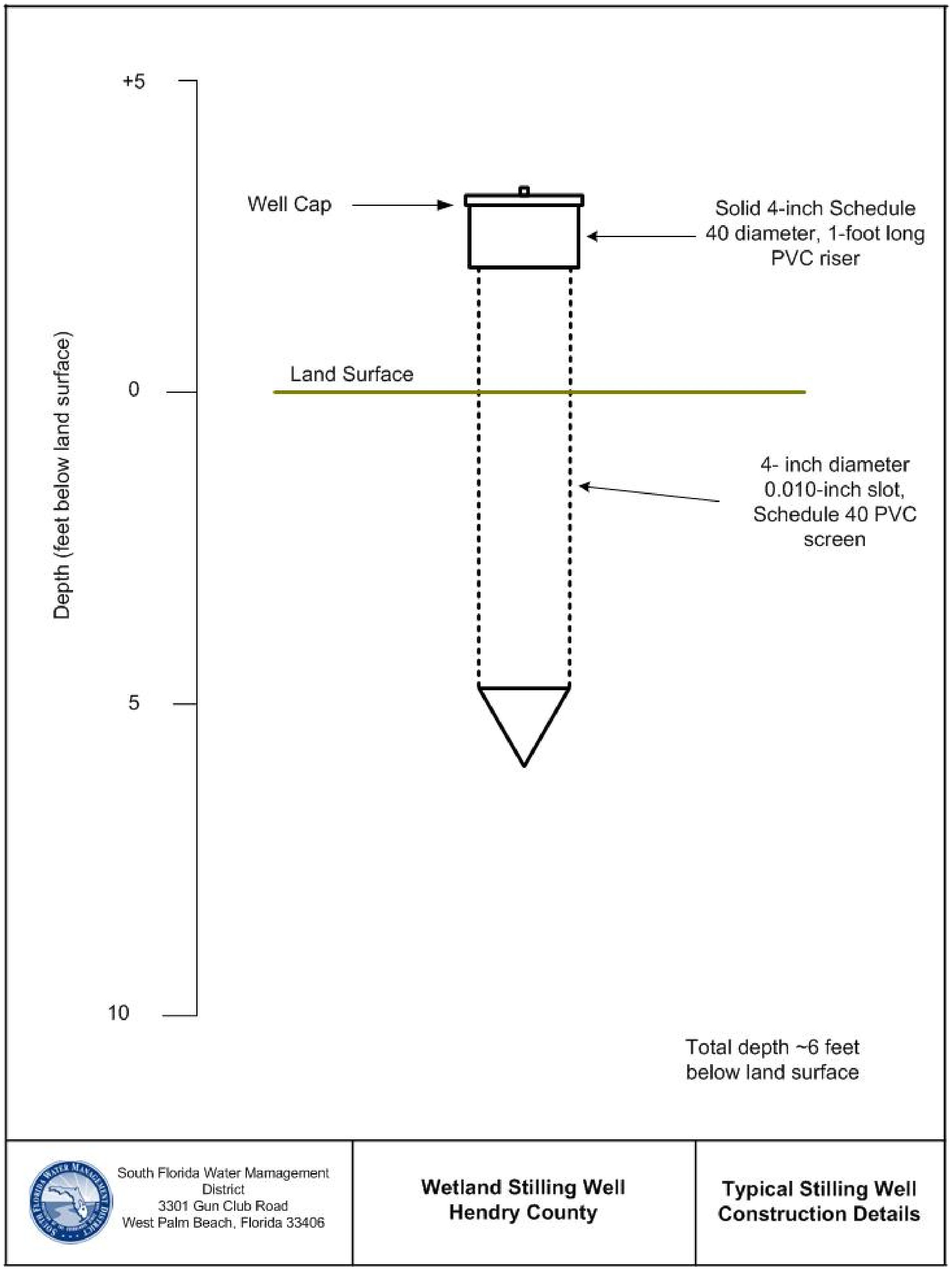

Figure 7. Typical wetland stilling well construction.

2.2 WELL CONSTRUCTION

Advanced Well Drilling, Inc. (AWD) was contracted by the SFWMD to complete well drilling, coring, APT assistance, construction, and survey work. District site geologists were present during construction and testing of all wells and made decisions on casing and screen depths based on field information collected during drilling (cuttings, drilling characteristics, logs, etc.).

All but the stilling wells were constructed using the mud-rotary drilling method. The shallow stilling wells were installed using a motorized hand auger. All wells were developed by overpumping methods until visible particulate matter was removed from the produced formation water. **Table 1** lists the final as-built well construction information for all the wells.

District staff provided contract management, well site geology, APTs, and documentation of findings. Subsequent long-term water level monitoring commenced in March 2005 and continued into October 2007. District contractor Aquae Sulis, Inc. performed data collection, equipment maintenance, and an analysis of the water level data from March 16, 2005 through April 01, 2006 (**Appendix C**). Quality assurance of the water level data for the period of March 2005 through October 2007 was performed by Adamski Geological Consulting, Inc. in 2008. Portions of this report pertaining to Crooks and Golden Ox Ranches are available in **Appendix D**.

Table 1. As-built well construction information.

Well ID	Install/ Complete Date	Well Casing	Total Depth of Well (feet bls)	Screen Length (feet)	Screen Slot Size (inch)	Depth at Top of Well Screen (feet bls)	Depth at Bottom of Well Screen (feet bls)
HES-1	02/15/2005	2-in PVC	15.0	10.0	0.0	5.0	15.0
HES-2	02/15/2005	2-in PVC	78.0	25.0	0.0	53.0	78.0
HES-3	02/09/2005	4-in PVC	4.0	6.5	0.0	-2.5	4.0
HES-4	02/14/2005	2-in PVC	15.0	10.0	0.0	5.0	15.0
HES-5	02/14/2005	2-in PVC	61.0	20.0	0.0	41.0	61.0
HES-6	02/09/2005	4-in PVC	4.0	6.5	0.0	-2.5	4.0
HES-7	02/11/2005	2-in PVC	16.0	10.0	0.0	6.0	16.0
HES-8	02/11/2005	2-in PVC	87.0	20.0	0.0	67.0	87.0
HES-9	02/10/2005	2-in PVC	14.0	10.0	0.0	4.0	14.0
HES-10	02/10/2005	2-in PVC	91.0	20.0	0.0	71.0	91.0
HES-11	02/09/2005	4-in PVC	5.0	7.5	0.0	-2.5	5.0
HES-12	02/08/2005	2-in PVC	31.0	10.0	0.0	21.0	31.0
HES-13	02/07/2005	2-in PVC	88.0	20.0	0.0	68.0	88.0
HES-14	03/08/2005	2-in PVC	20.0	5.0	0.0	15.0	20.0
HES-15	03/08/2005	2-in PVC	71.0	20.0	0.0	51.0	71.0
HES-16	02/09/2005	4-in PVC	5.0	7.5	0.0	-2.5	5.0
HES-17	02/09/2005	2-in PVC	10.0	2.0	0.0	2.0	10.0
HES-18	02/09/2005	2-in PVC	56.0	20.0	0.0	36.0	56.0
HES-19	02/09/2005	4-in PVC	5.0	7.5	0.0	-2.5	5.0
HES-20	03/07/2005	10-in PVC	80.0	25.0	open hole	55.0	80.0
HES-21	03/14/2005	10-in PVC	105.0	35.0	open hole	70.0	105.0

2.2.1 Paired Wells

Paired wells, consisting of one LTA monitor well and one WTA monitor well, were installed at seven sites, for a total of 14 wells. The paired wells were constructed using 2-inch diameter, Schedule 40, polyvinyl chloride (PVC) well casing, and 2-inch diameter, 0.020-inch slot, PVC well screen. AWD completed each well with a concrete pad. The concrete well pads were sized at 2 feet x 2 feet x 6 inches and included a brass survey marker. **Appendix E** presents final as-built well construction diagrams for the paired monitor wells. Photographs of the paired wells are provided in **Appendix F**.

2.2.2 Stilling Wells

Stilling wells were installed at five of the monitor well sites. The stilling wells were constructed using 4-inch diameter, PVC casing, and 0.010-inch slot, PVC well screen. The entire length of the screen was encased in a fabric sock to inhibit plugging by debris. A 1-foot long, PVC riser with a top cap was extended above the well screen. Stilling well construction diagrams are given in **Appendix G**. **Appendix H** provides photographs of the stilling wells.

2.2.3 APT Test Wells

APT test wells (pumping wells) were installed at two sites (Sites 4 and 6) for use in aquifer performance testing. The pilot holes for these wells were cored and reamed to accommodate 10-inch diameter, Schedule 80, PVC casing to the top of the LTA. After the casing was set, both pumping wells were completed with an open-hole. **Appendix I** provides as-built construction diagrams for the two pumping wells.

2.2.4 Survey Locations

AWD subcontracted all survey work to Johnson-Prewitt & Associates, Inc., land surveyors from Clewiston, Florida. Elevation surveys were conducted in June/July 2005. All 21 wells were surveyed for vertical control using the North American Vertical Datum of 1988 (NAVD 1988) datum. Brass survey markers imbedded in each well pad were used to calculate measuring points so that all water levels could be referenced to the same datum. For the purposes of this report and to retain consistency, the survey elevations were converted to NGVD 1929 using Corpscon, Version 6.0.1, a MS-Windows-based program, which allows vertical conversions to and from NGVD 1929 and the NAVD 1988. **Table 2** presents well survey information.

Table 2. Well survey information.

Well ID	Site	Ranch	Aquifer	Well Location Coordinates		State Planar Coordinates		Ground Surface Elevation (feet NGVD)	Measuring Point: Top of Casing (feet NGVD)
				Latitude	Longitude	Easting (feet)	Northing (feet)		
HES-1	1	Crooks	WTA	26° 28′ 48.1″	81° 07′ 20.6″	616132.77	780184.19	28.55	31.17
HES-2			LTA	26° 28′ 48.0″	81° 07′ 20.6″	616132.76	780174.09	28.34	31.02
HES-3			(wetland)	26° 28′ 46.5″	81° 07′ 22.2″	615987.24	780022.78	26.48	30.48
HES-4	2	Crooks	WTA	26° 29′ 56.8″	81° 05′ 57.0″	623734.21	787114.06	28.66	31.49
HES-5			LTA	26° 29′ 56.8″	81° 05′ 57.0″	623734.21	787114.06	28.74	31.65
HES-6			(wetland)	26° 29′ 56.8″	81° 05′ 56.7″	*623761.47	*787114.04	*27.79	29.27
HES-7	3	Crooks	WTA	26° 29′ 12.3″	81° 05′ 37.8″	625475.20	782619.73	28.23	31.42
HES-8			LTA	26° 29′ 12.5″	81° 05′ 37.8″	625475.21	782639.92	28.31	31.48
HES-9	4	Crooks	WTA	26° 28′ 12.1″	81° 06′ 10.9″	622462.96	776543.83	27.51	30.39
HES-10			LTA	26° 28′ 12.1″	81° 06′ 10.8″	622472.05	776543.83	27.55	30.43
HES-11			(wetland)	26° 28′ 13.9″	81° 06′ 11.6″	622399.50	776725.63	26.86	30.63
HES-12	5	Crooks	WTA	26° 27′ 34.4″	81° 06′ 20.5″	621587.48	772738.11	27.13	30.26
HES-13			LTA	26° 27′ 34.4″	81° 06′ 20.5″	621587.48	772738.11	27.34	30.28
HES-14	6	Golden Ox	WTA	26° 30′ 07.6″	81° 07′ 08.0″	617285.07	788209.98	25.39	27.22
HES-15			LTA	26° 30′ 07.8″	81° 07′ 08.0″	617285.08	788230.18	25.95	28.80
HES-16			(wetland)	26° 30′ 14.5″	81° 07′ 03.2″	617721.76	788906.25	25.05	31.29
HES-17	7	Golden Ox	WTA	26° 30′ 43.5″	81° 07′ 15.7″	616588.98	791835.36	30.93	34.11
HES-18			LTA	26° 30′ 43.7″	81° 07′ 15.7″	616589.00	791855.55	30.26	33.51
HES-19			(wetland)	26° 30′ 45.0″	81° 07′ 16.2″	616543.70	791986.85	29.95	33.87
HES-20	6	Golden Ox	LTA	26° 30′ 11.3″	81° 07′ 06.2″	*617448.93	*788583.41	*	31.29
HES-21	4	Crooks	LTA	26° 28′ 11.6″	81° 06′ 14.3″	622153.96	776493.60	*	29.30

* Unverified data.

3 Hydrogeologic Testing and Analyses

Aquifer testing was conducted in the study area to assess the geologic and hydraulic characteristics of the WTA and LTA, as well as the semi-confining unit between them. This was accomplished by collecting well cuttings and cores during drilling, and by conducting two APTs. In addition, continuous recorders were installed on all monitor well sites, and one rainfall measuring station was installed. Testing methods are discussed in further detail as follows.

3.1 ROCK CORES

Rock cores were obtained at each of the two APT sites (Sites 4 and 6). Cores were recovered from just below land surface to a depth of approximately 10 feet below the top of the LTA. At Site 6, the core barrel became stuck in the hole at 70 feet bls, and consequently the core barrel and drill pipe were lost. The pilot hole was properly abandoned with cement, and coring ceased after reaching the top of the LTA to prevent loss of the core barrel and drill pipe. A new pumping well was drilled at Site 6.

Core samples were stored in 5-foot long, 6-inch high, and approximately 12-inch wide wooden boxes. The boxes were labeled with the site name, date of collection, and depths of the samples contained in the box. Once packaged, all boxes were sent to the Florida Geological Survey (FGS) for a detailed lithologic description. When FGS provides the results, these analyses will be loaded into the SFWMD's environmental database (DBHydro). Photos of select cores are shown in **Appendix J**.

3.2 DRILL CUTTINGS

During drilling of each of the wells at all seven sites, geologic formation samples (well cuttings) were collected from land surface to the total depth of each well, washed, and described (using the Dunham 1962 classification scheme) based on their dominant lithologic or textural characteristics and, to a lesser extent, color. Field descriptions are provided in **Appendix K**. **Table 3** shows the depths of the aquifers as determined in the well cuttings.

Table 3. Aquifer depths and elevations as determined from drill cuttings in this investigation.

Site	WTA bottom (feet bls)	WTA bottom (feet NGVD)	LTA top (feet bls)	LTA top (feet NGVD)	Semi-Confining Unit thickness (feet)
1	22	6	55	-27	33
2	18	11	40	-11	22
3	17	11	66	-38	49
4	13	15	71	-43	58
5	36	-9	66	-39	30
6	20	6	50	-24	30
7	10	20	33	-3	23

The WTA consists primarily of Holocene and Pleistocene-aged unconsolidated quartz sands, terrigenous mudstones, shell beds, and quartz sandstone. This aquifer extends from the undifferentiated deposits at land surface to the top of semi-confining beds, which are part of the Tamiami Formation. The WTA is unconfined in nature.

The semi-confining unit between the WTA and the LTA is part of the Tamiami Formation and consists of gray to greenish-gray mudstone or clay with sand and silt. These sediments are usually unconsolidated. The unit sediments are plastic, sticky, and often silty, with locally abundant shell fragments.

The LTA is composed primarily of late Pliocene-aged, Tamiami Formation sediments consisting of moderately- to well-consolidated shell beds and sandy limestone to quartz sandstone. This aquifer is generally semi-confined and extends from below the overlying semi-confining unit to a depth of approximately 120 feet bls. Beneath the LTA are the confining, Miocene-aged sediments of the Hawthorn Group, which were not penetrated in this investigation.

3.3 HYDROGEOLOGIC CORRELATIONS

Smith and Adams (1988) previously mapped the top of the LTA and the thickness of the semi-confining unit above the LTA in Hendry County. A comparison of the data from this study shows a close correlation with that of Smith and Adams (cf., Smith and Adams, Figure 10, page 15 and Figure 11, page 16). In general, based on the data obtained for this report, the top of the LTA dips southward from 35 feet bls in the north to 71 feet bls in the south. A contour map showing the top of the LTA across the study area is portrayed in **Figure 8**. The thickness of the semi-confining unit increases to the south, ranging from 22 feet in the north to 58 feet in the south. The thickness of the semi-confining unit above the LTA is illustrated in **Figure 9**. A local north to south hydrostratigraphic cross-section was constructed using data from the wells drilled for this assessment. **Figure 10** displays the location of the cross-section, and **Figure 11** shows the cross-section.

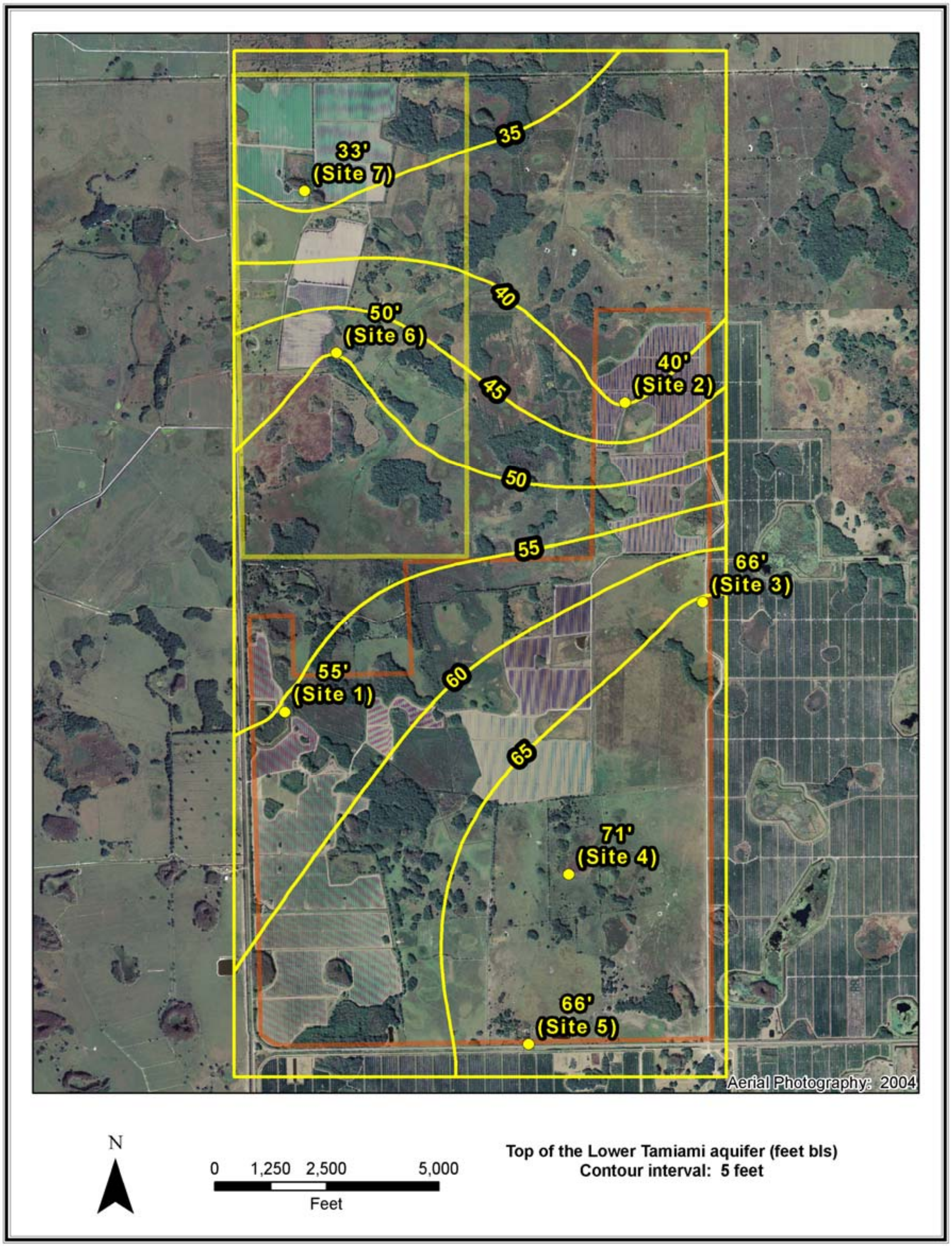

Figure 8. Top of the Lower Tamiami aquifer (LTA) in feet below land surface (bls) in the study area.

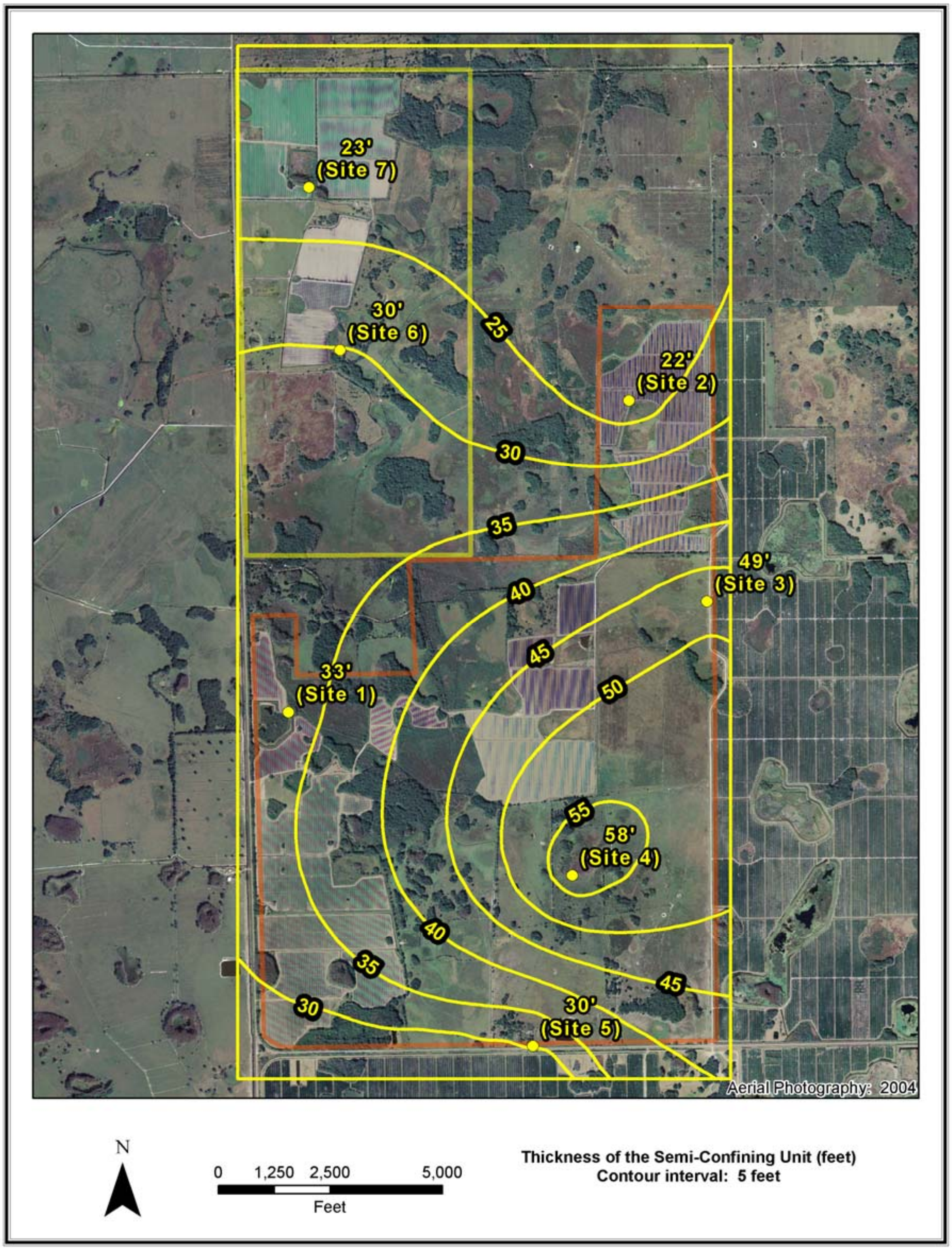

Figure 9. Thickness in feet of the semi-confining unit above the Lower Tamiami aquifer (LTA) in the study area.

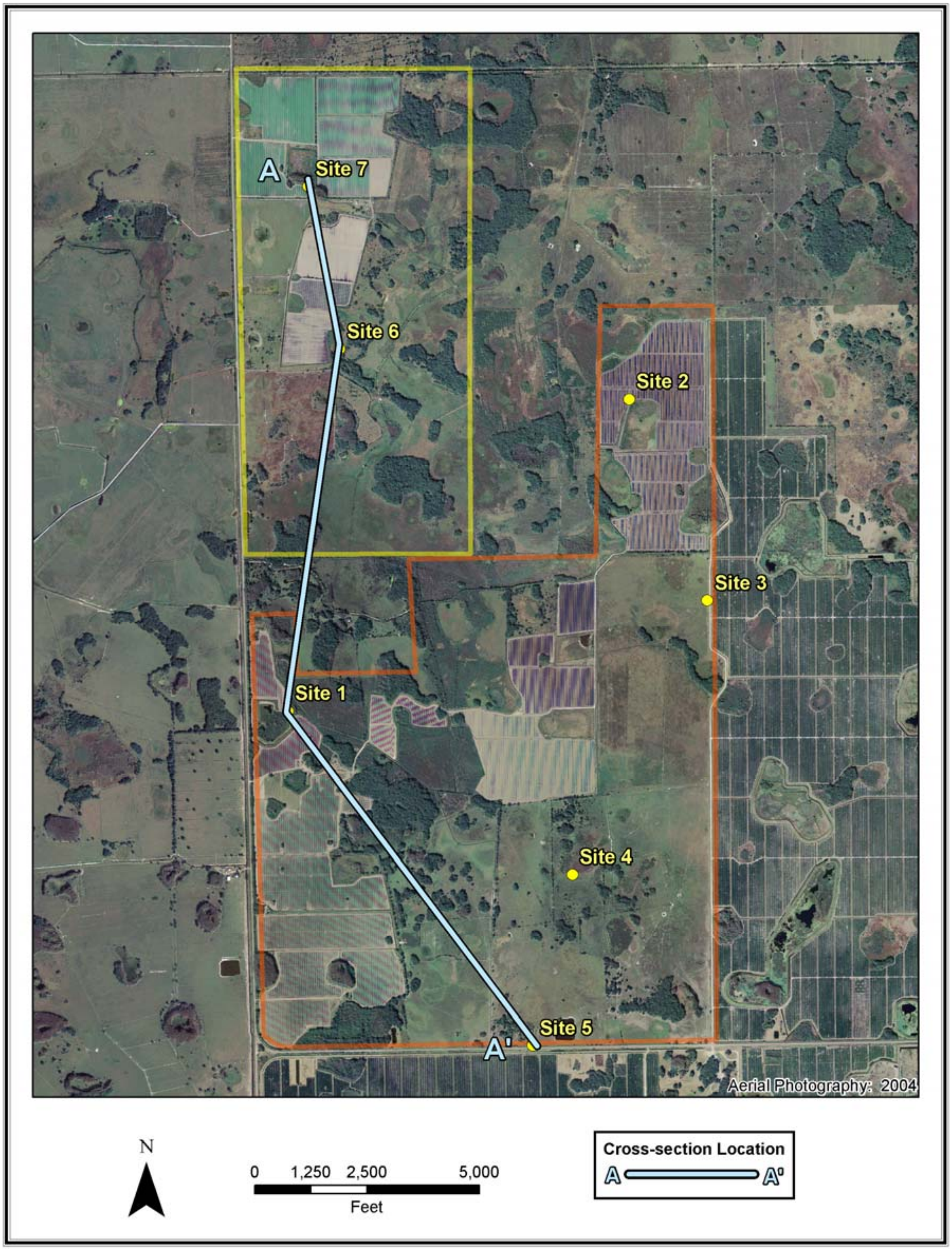

Figure 10. Cross-section location map.

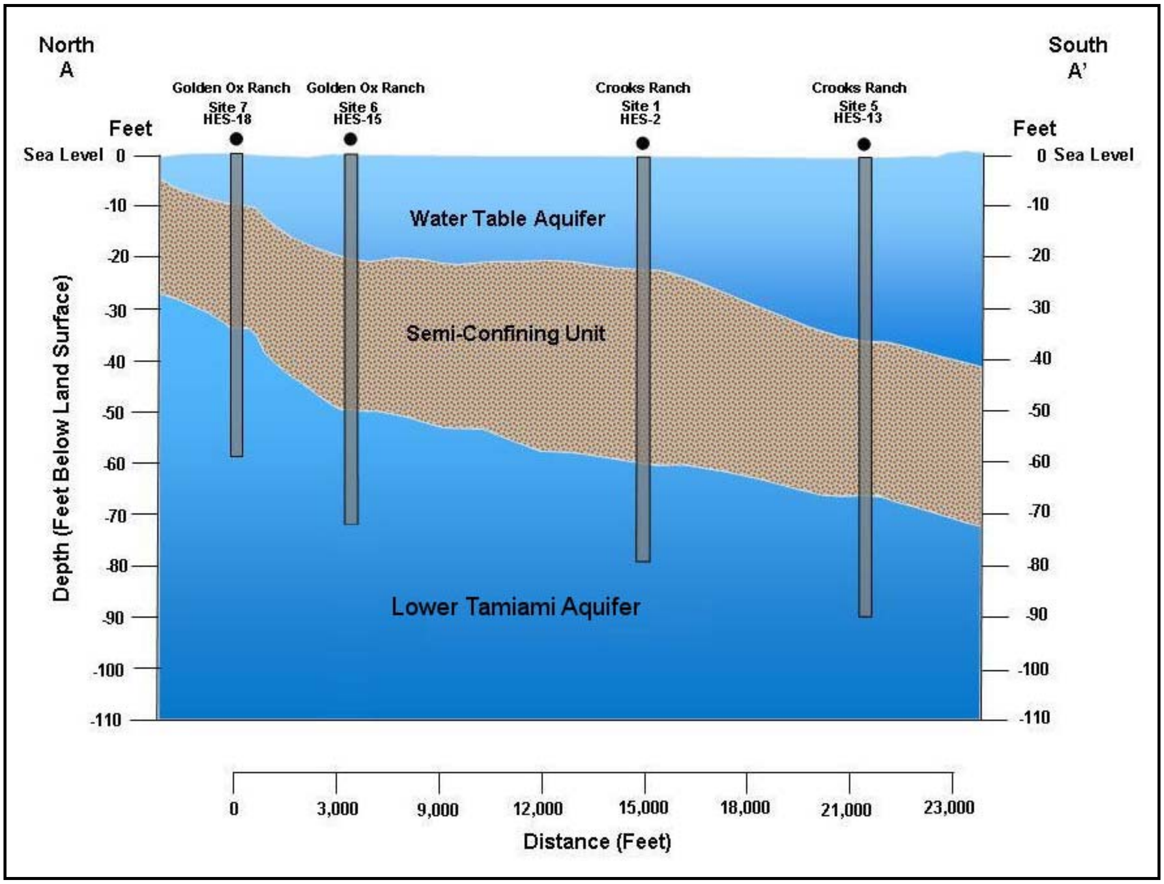

Figure 11. North-south cross-section through the study area.

3.4 AQUIFER PERFORMANCE TESTS

The District conducted two APTs for this study; one at Golden Ox Ranch (Site 6) and one at Crooks Ranch (Site 4). The data from these APTs were used to determine the hydraulic properties of the LTA and the overlying semi-confining unit at the sites. **Table 4** lists the results of the hydraulic analyses for both APTs. Electronic copies of the original drawdown and recovery data for each APT are archived and available in the SFWMD's DBHydro database.

Table 4. Results of the two aquifer performance tests at Sites 4 and 6.

Site	4	6
Ranch	Crooks	Golden Ox
Pumping Well	HES-21	HES-20
Monitor Well used in Analysis	HES-10	HES-15
Distance from Pumping Well (feet)	312	358
Pumping Rate (gpm)	503	390
Pumping Time (hours)	72 (only 5.5 used for analysis)	72
LTA Monitor Well Maximum Drawdown (feet)	1.7	1.5
Transmissivity (gpd/ft)	162,600	140,867
Storativity (dimensionless)	2.46×10^{-4}	1.85×10^{-4}
Leakance (day^{-1})	0.0026	0.0015
Method of Analysis	Hantush-Jacob	Hantush-Jacob

3.4.1 Site 6: APT 1, Northern Site

The District used three wells and a stilling well at Golden Ox Ranch Site 6 for the APT – one pumping well (HES-20), one LTA monitor well (HES-15), one WTA monitor well (HES-16), and one wetland stilling well (HES-16). The distance between the pumping well and the LTA/WTA monitor wells is approximately 358 feet to the southwest at this site. The wetland stilling well is located approximately 490 feet northeast of the pumping well. During the APT, an In-Situ, Inc. Hermit 3000 data logger and In-Situ, Inc. PXD-261 pressure transducers in each well collected water level data during the drawdown and recovery phases of the test. The SFWMD programmed the data logger to record water level data on a logarithmic scale so that the instrument could quickly collect data points rapidly during the first 10 minutes of drawdown, which occurs rapidly. After 10 minutes, the data logger collected data every minute. Before the test, the SFWMD collected background water level data in each well on a linear scale every hour. In addition, a specific capacity test conducted on HES-21 allowed the District to determine the optimal discharge rate for the APT.

AWD installed an 8-inch diameter, Schedule 40, PVC drop pipe into HES-20. The drop pipe was attached to a centrifugal pump, and a 6-inch diameter, Schedule 40, PVC pipe carried the discharge water away from the pumping well. AWD installed a 4-inch orifice plate on the end of the 6-inch discharge pipe. This configuration allowed the District to determine the discharge rate during the APT from the manometer connected near the end of the discharge line. The manometer had a double-end fitting, allowing the connection of a pressure transducer and a manometer tube adjacent to a measuring stick. The SFWMD collected discharge readings using a PXD-261 pressure transducer, which were verified with manual readings on the manometer tube. A calibrated, in-line flow meter verified the manometer readings.

3.4.1.1 Background Water Levels

Prior to the APT, water levels were recorded for approximately two weeks in the monitor and stilling wells at Site 6 (HES-14, HES-15, and HES-16). The purpose of the background data was to determine the timing and magnitude of pumping from wells in the LTA adjacent to the study area. The background water level data allowed the District to determine the pumping schedule of the adjacent users and determine the length of the APT to minimize interference from area pumpages. As shown in **Figure 12**, water levels in the monitor wells rose and fell during this period in response to irrigation withdrawals from adjacent wells. Water levels in the WTA reflect those in the LTA, although the magnitude of fluctuations is greater in the latter. This indicates the two aquifers are connected hydraulically through the leaky, semi-confining unit. **Section 4** of this report contains a more detailed water level analysis for this site.

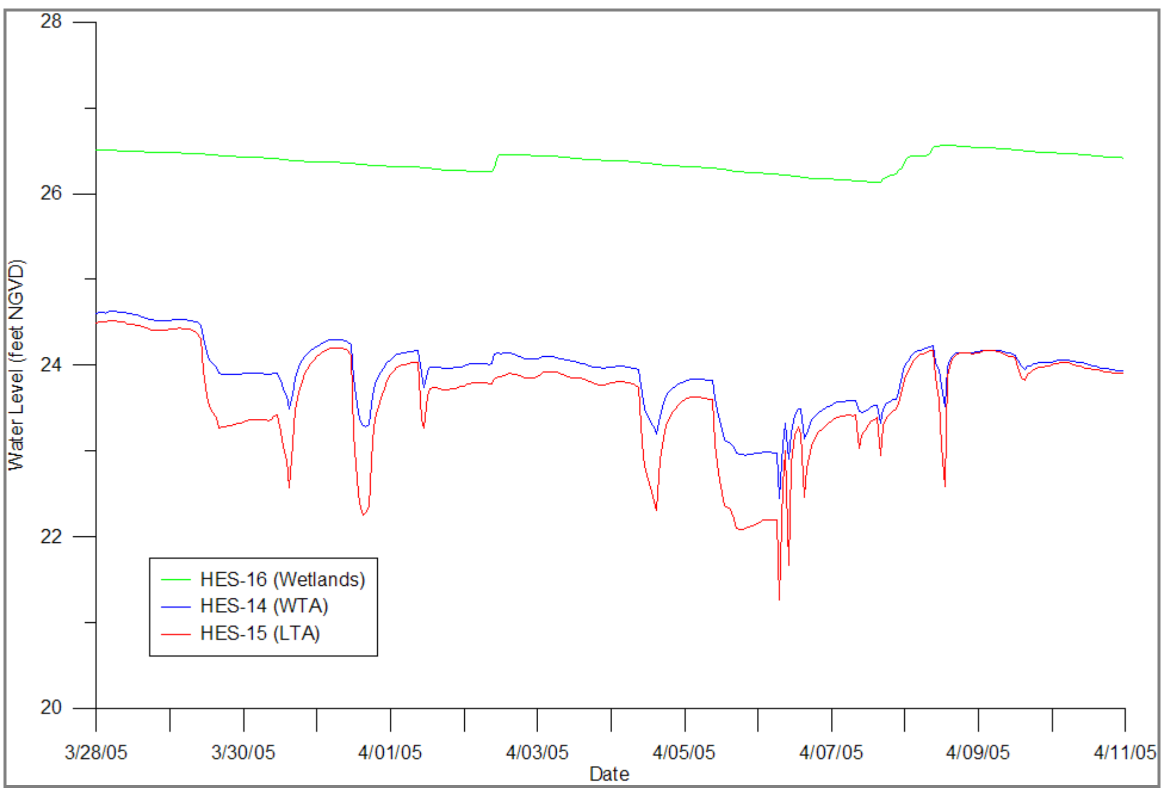

Figure 12. Site 6, APT background water levels prior to the APT.

3.4.1.2 Step-Drawdown Test

Following equipment setup and background recordings, the District conducted a step-drawdown test to determine the maximum sustainable pumping rate for the APT. The SFWMD ran four steps for this test, each 40 minutes long. In a step-drawdown test, a well is pumped at a low constant discharge rate until drawdown in the well stabilizes. The pumping rate is then increased to a higher constant discharge rate and again, drawdown in the well is allowed to stabilize. This process was repeated for four steps and a total duration of 160 minutes. **Figure 13** shows the drawdown data collected during the step-drawdown test.

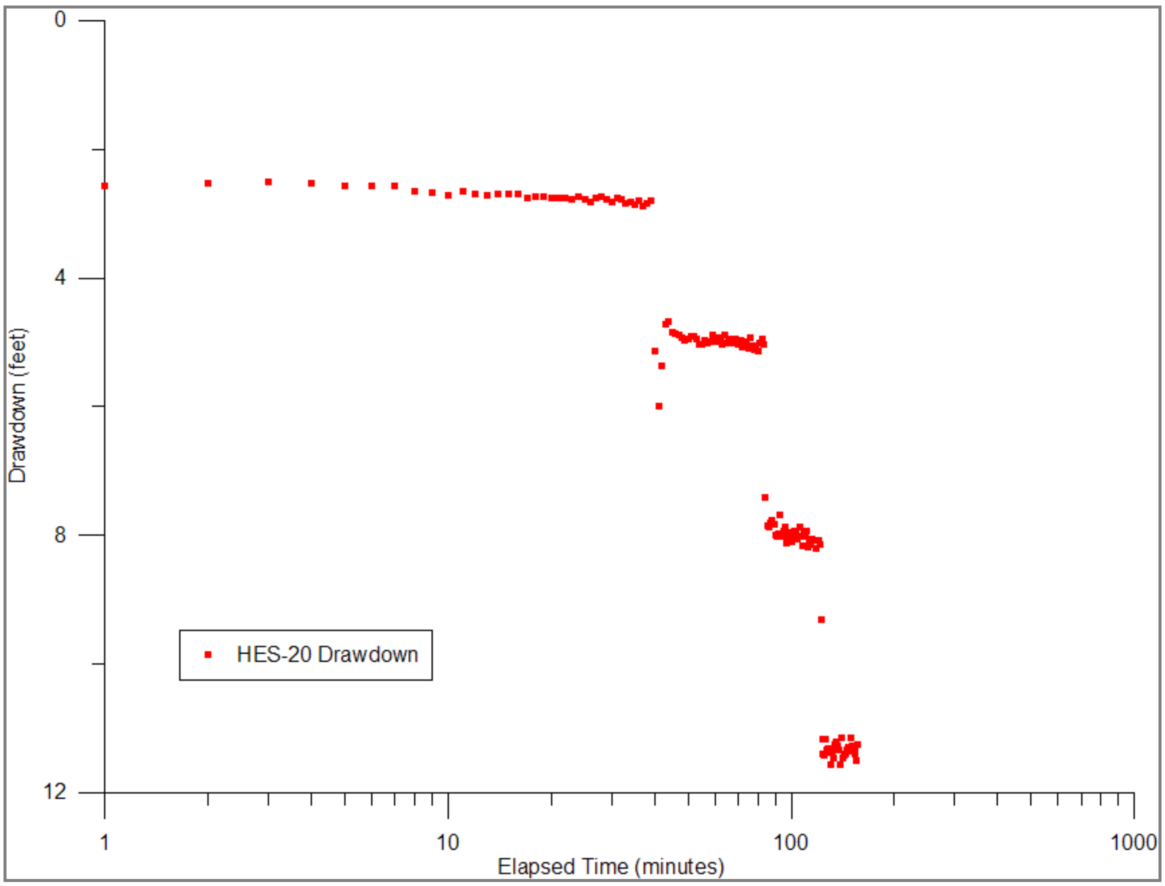

Figure 13. HES-20 step-drawdown test results.

Table 5 presents the results of the step-drawdown test data analysis. This test allowed the District to calculate the percentage head loss from laminar flow in the well and its specific capacity at different discharge rates. Calculating the head loss from laminar flow shows what percentage of head loss in the well is attributable to laminar flow. From the step-drawdown test, the SFWMD determined a pumping rate of 390 gallons per minute (gpm) was optimal for the 72-hour APT. At this pumping rate, the calculated specific capacity was approximately 41 gallons per minute per foot of drawdown (gpm/ft). Once the step-drawdown test was completed, the water level in HES-20 was allowed to recover to static conditions before starting the 72-hour APT.

Table 5. HES-20 specific capacity test results.

Pumping Rate (gpm)	Drawdown (feet)	Specific Capacity (gpm/ft)	Laminar Head-Loss (%)
146	2.81	52.03	78.2
248	5.05	49.07	67.9
351	8.13	43.16	59.9
450	11.49	39.16	53.8

Notes:
gpm – gallons per minute
gpm/ft – gallons per minute per foot
% – percent

3.4.1.3 APT Pumping Phase

The pumping (drawdown) phase of the constant rate APT commenced on April 11, 2005. The pumping well (HES-20) was pumped at 390 gpm, while water levels in the pumping well and all nearby wells were monitored. AWD operated the pump for 72 uninterrupted hours, completing the drawdown phase of the APT on April 14, 2005.

The goal of this test was to determine the hydraulic properties of the LTA and the leakance through the overlying semi-confining bed. The principal factors of aquifer performance, such as transmissivity and storage coefficients, were calculated from the drawdown and recovery data obtained from HES-15, completed in the same interval as the pumped well (HES-20). Monitoring the zones above the tested interval can determine the leakance of the semi-confining bed.

The water levels in the observation wells stabilized with approximately 1.5 feet of drawdown in HES-15 during the APT. HES-15 is located approximately 358 feet from HES-20. A 24-hour recovery period with no pumping followed the drawdown phase, and water levels were allowed to return to static conditions.

Figure 14 shows the configuration of the monitor and pumping wells used in the APT.

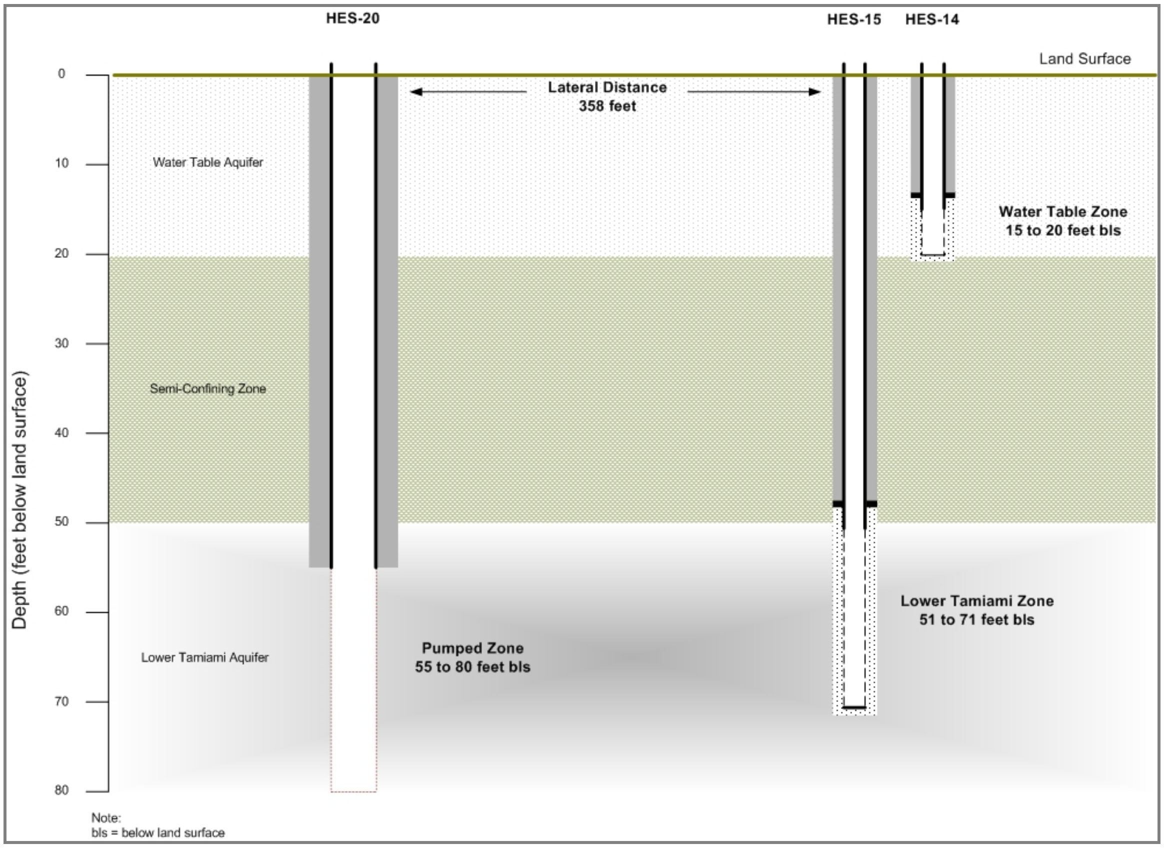

Figure 14. Site 6, Cross-section showing the well depth for the aquifer performance test.

The background data showed the LTA at this site to be a leaky-type aquifer based on the similarity in water level response between the two aquifers. A leaky (semi-confined) aquifer is one that loses or gains water (depending on the pressure gradients) through a semi-confining unit (aquitard). Various curve-matching methods were applied to determine the hydraulic properties of the aquifer and aquitard. These semi-confined, "leaky" solutions included those of Hantush and Jacob (1955), Hantush (1960), and Moench (1985). The Hantush-Jacob analytical model, which uses drawdown measured in an observation well, best represented the conditions at this site. This solution yielded a transmissivity of 140,867 gpd/ft (18,834 ft^2/day), a storativity of 1.85×10^{-4}, and an (r/B) value of 0.1. These values are consistent with those previously published in Smith and Adams (1988). The dimensionless parameter r/B characterizes the leakance across the aquitard to the pumped aquifer.

Figure 15 is a log/log plot of drawdown versus time from LTA monitor well HES-15 with the Hantush-Jacob solution. The blue line represents the 0.1 r/B type curve for this solution.

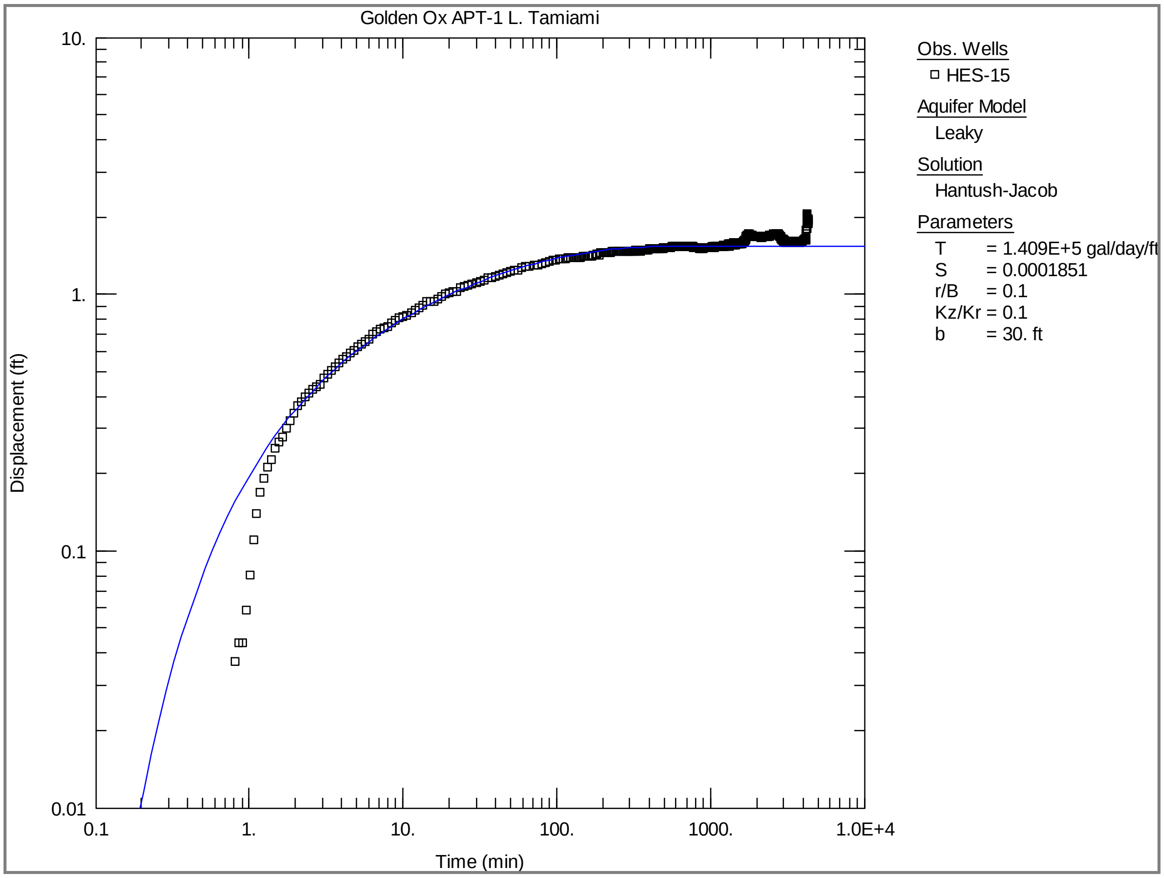

Figure 15. Site 6, Drawdown in Lower Tamiami monitor well (HES-15).

The vertical hydraulic conductivity (K') through the semi-confining layer must be determined to calculate the leakance coefficient (Equation 1).

$$B = \sqrt{\frac{Tb'}{K'}}$$ **Equation 1**

Where:

B = Leakance factor calculated from r/B = 0.1 (r is the radial distance of the observation well from the test [pumping] well).

T = Transmissivity of the tested aquifer (ft^2/day)

B' = Thickness of the semi-confining bed

K' = Vertical hydraulic conductivity of the semi-confining bed

Equation 1 is rearranged as follows (Equation 2) to calculate K':

$$K' = \frac{Tb'}{B^2}$$ **Equation 2**

The vertical hydraulic conductivity (K') calculated from the APT data was 0.0441 feet per day (ft/day) or 0.3298 gallons per day per foot squared [gpd/ft^2]. Using Equation 2, K' was calculated, and the transmissivity value was determined from the Hantush-Jacob (1955) Equation, assuming a semi-confining unit thickness of 30 feet between the two aquifers. Using K', the leakance coefficient (η) was calculated using Equation 3.

$$\eta = \frac{K'}{b'}$$ **Equation 3**

Using Equation 3 and the APT data, the leakance coefficient was calculated to be 0.0015 per day.

3.4.1.4 Water Level Responses During Tests, All Aquifers

Figure 16 shows the drawdown data in both the pumped well (HES-20) and corresponding monitor well (HES-15) in the LTA. A semi-log plot best captures the early drawdown data, which are not easily seen on a linear chart. The steep drawdown seen in the first minute of HES-20 indicates the removal of stored water in the well casing before drawdown begins in the aquifer. The maximum drawdown in HES-20 and HES-15 was approximately 10 feet and 1.5 feet, respectively.

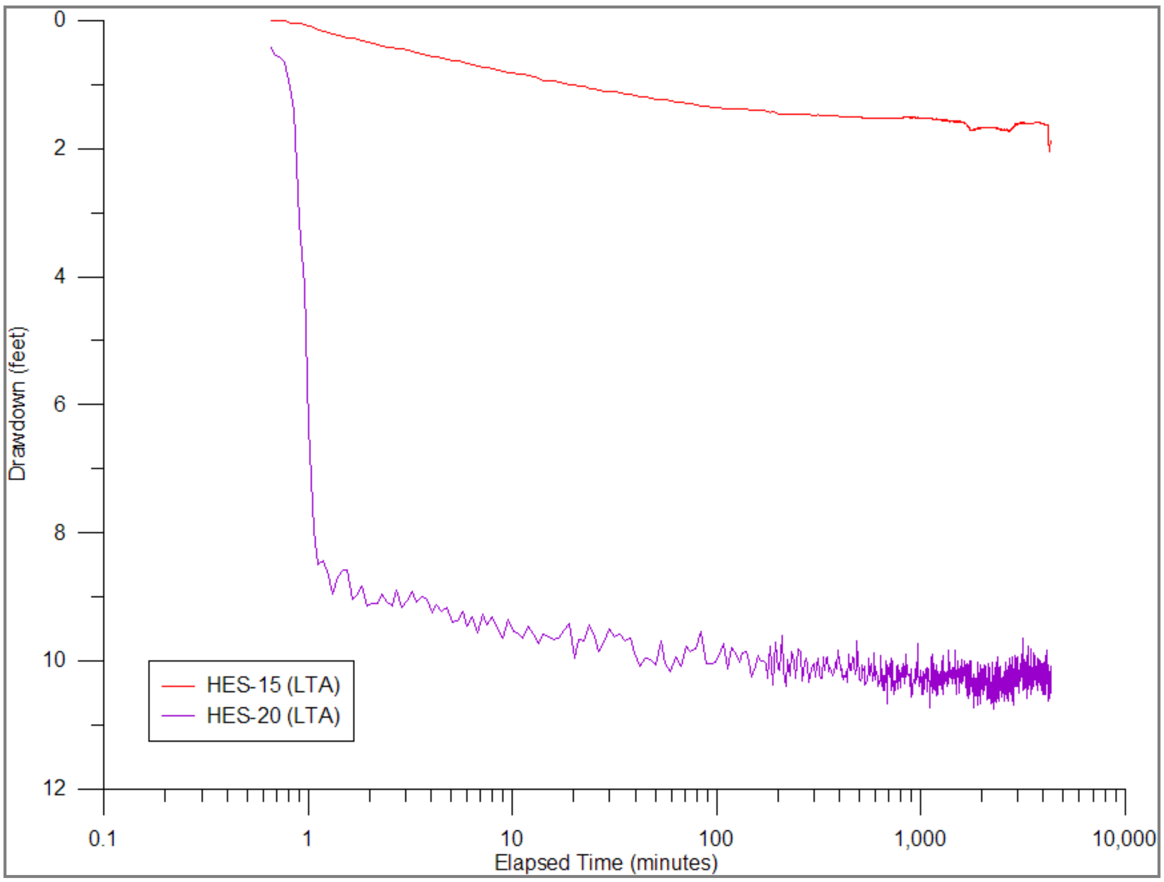

Figure 16. Site 6, Semi-log plot of LTA water levels during the drawdown phase of the APT.

Figure 17 is a linear plot of drawdown in monitor well (HES-15) during the drawdown phase of the APT. From zero to approximately 850 minutes (14 hours), the aquifer shows drawdown directly related to pumping HES-20. However, after this time the drawdown began to increase (approximately 0.2 feet) as an adjacent user began pumping. The water level in HES-15 started to rise approximately 2,750 minutes into the test, indicating the user had stopped pumping. Pumping started again for a short period toward the end of the test, as seen by the approximate 0.3 foot increase in drawdown.

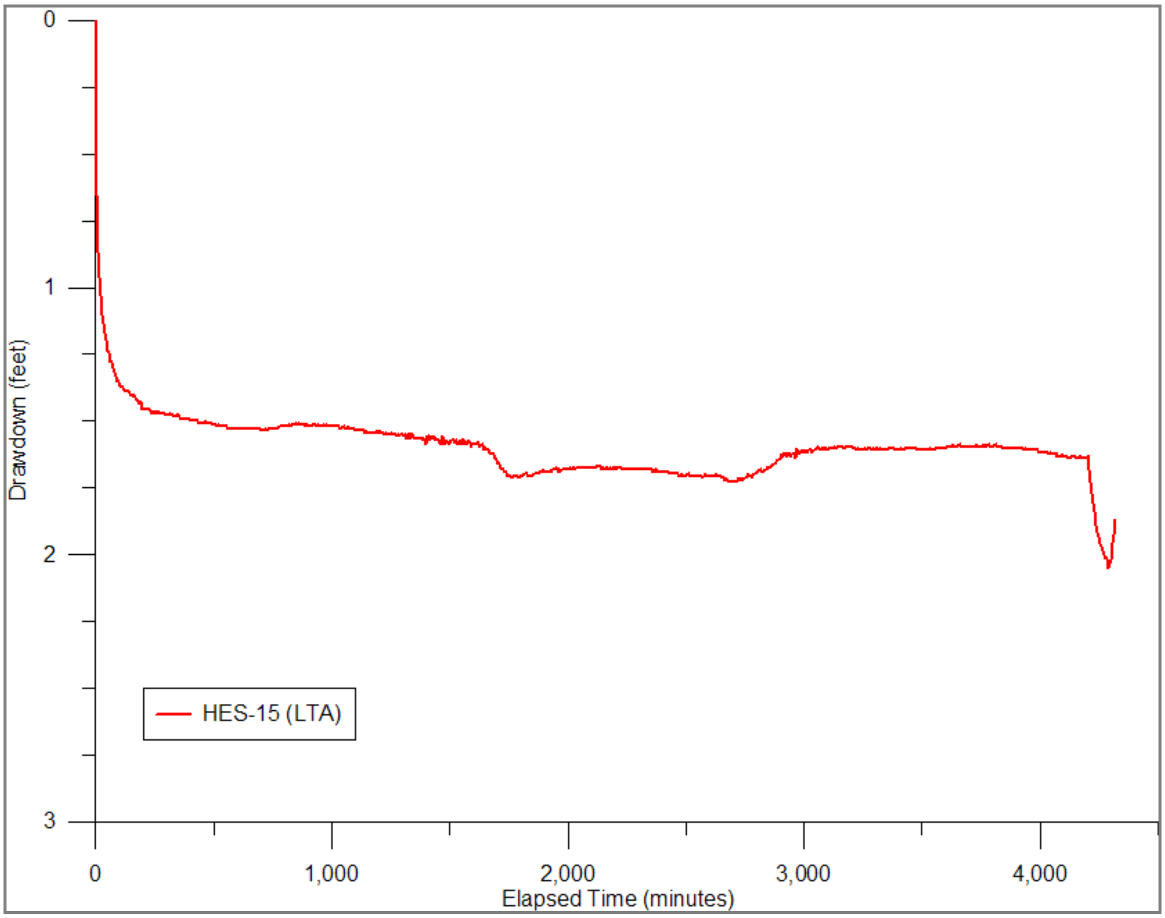

Figure 17. Site 6, Linear plot of LTA monitor well water levels during the drawdown phase of the APT.

Figure 18 is a linear plot of drawdown in the WTA monitor well (HES-14) during the drawdown phase of the APT. Similar to the plot for HES-15 (**Figure 17**) from zero to approximately 850 minutes (14 hours), the aquifer shows drawdown directly related to pumping HES-20. After this time, the additional increase in drawdown (approximately 0.2 feet) is the result of an adjacent user starting to pump. The water level in HES-14 started to rise approximately 2,800 minutes into the test, indicating the user had stopped pumping. Pumping started again for a short period toward the end of the test, as seen by the approximate 0.3 foot increase in drawdown. These same impacts in both the LTA and WTA monitor wells indicate there is good hydraulic connection between both aquifers through the semi-confining layer.

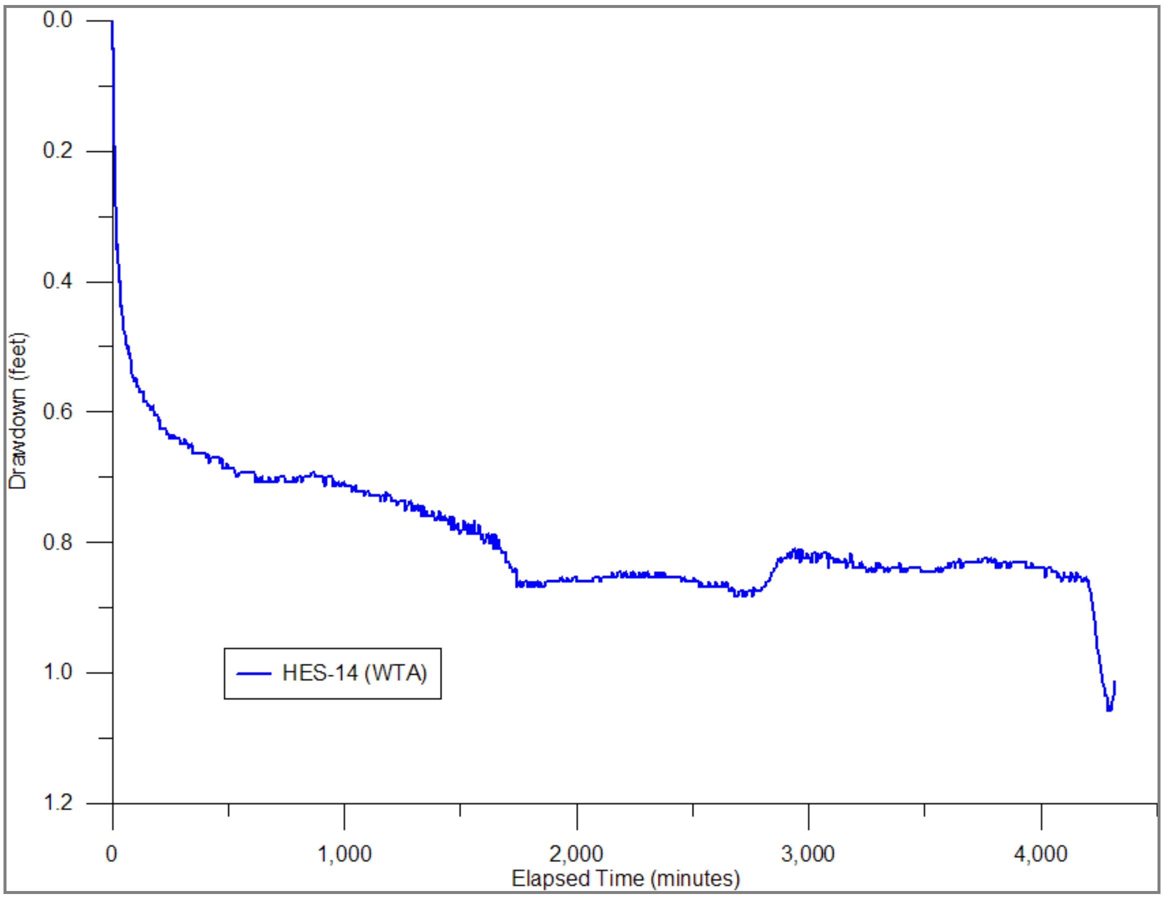

Figure 18. Site 6, Linear plot of WTA monitor well water levels during the pumping phase of the APT.

Figure 19 is a linear plot of the drawdown in wetland stilling well HES-16 during the drawdown phase of the APT. This figure shows the water level increased (drawdown decreased) during the test, even though the water levels in the WTA and LTA decreased. During the APT, water was discharged into a ditch located approximately 250 feet away from the wetland site (and HES-16), probably causing the 0.3-foot water level increase. Unfortunately, because there was no area for the HES-20 pumping well to discharge water to, the impact pumping has on the adjacent wetland from the LTA could not be evaluated at this site.

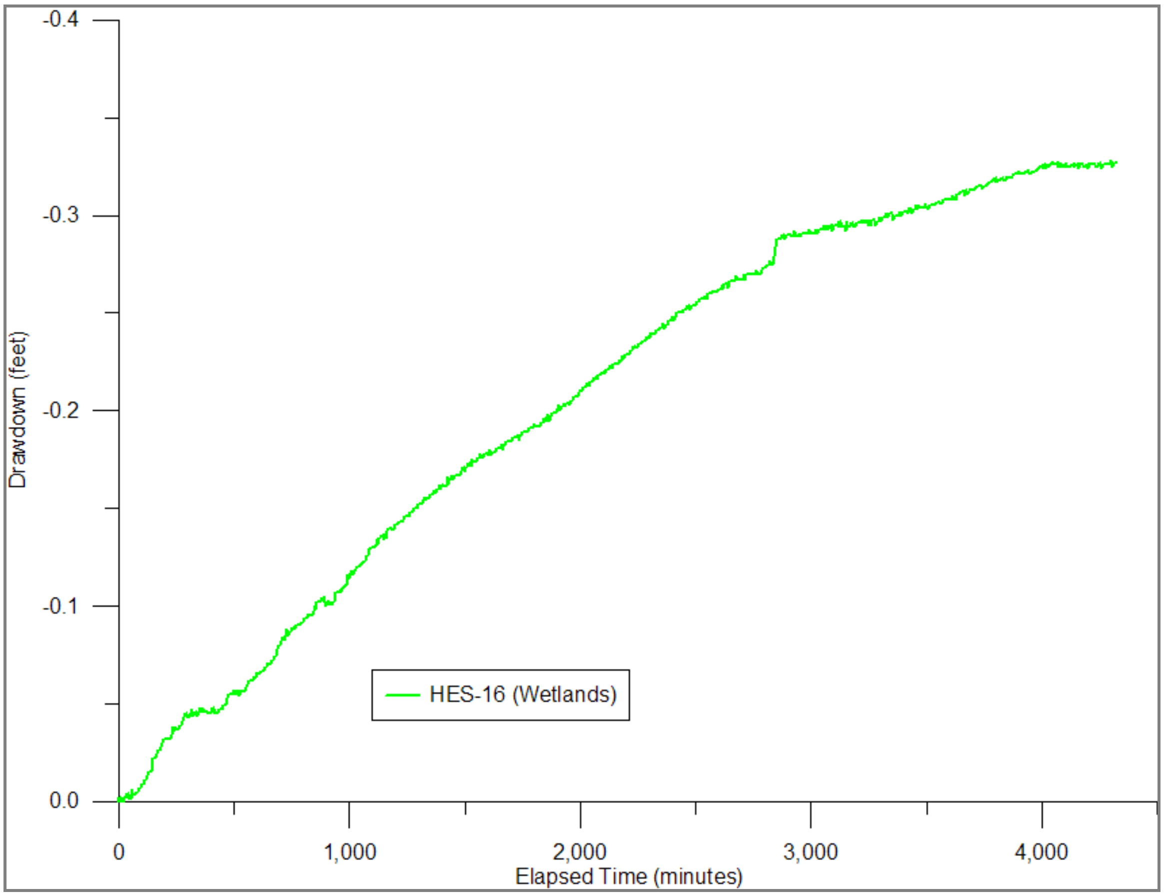

Figure 19. Site 6, Linear plot of wetland stilling well water levels during the pumping phase of the APT.

3.5.1.5 Recovery Phase

During the 24-hour recovery period following the 72-hour pumping phase of the APT, the District recorded the water levels in the pumping, monitor, and stilling wells as the water levels returned to background conditions. The data recording for the recovery phase of the APT ended April 15, 2005. **Figure 20** is a semi-log plot showing how water levels recovered (increased) in the LTA monitor well (HES-15) and the pumping well (HES-20). The steep rise in water level seen in the first few seconds of HES-20 indicates the addition of stored water in the well casing before recovery is seen in the aquifer. Approximately 10 minutes after turning off the pump in HES-20, an adjacent user began pumping. The resulting decline in water levels is apparent in both wells. Approximately 200 minutes after pumping in HES-20 stopped, the adjacent users stopped pumping, and a significant rise in the water levels is seen in both HES-15 and HES-20. Approximately 1,200 minutes into the recovery phase of the APT, an adjacent user began pumping and the water levels in both wells declined. At approximately 3,000 minutes, the adjacent user ceased pumping, and water levels in both wells rose.

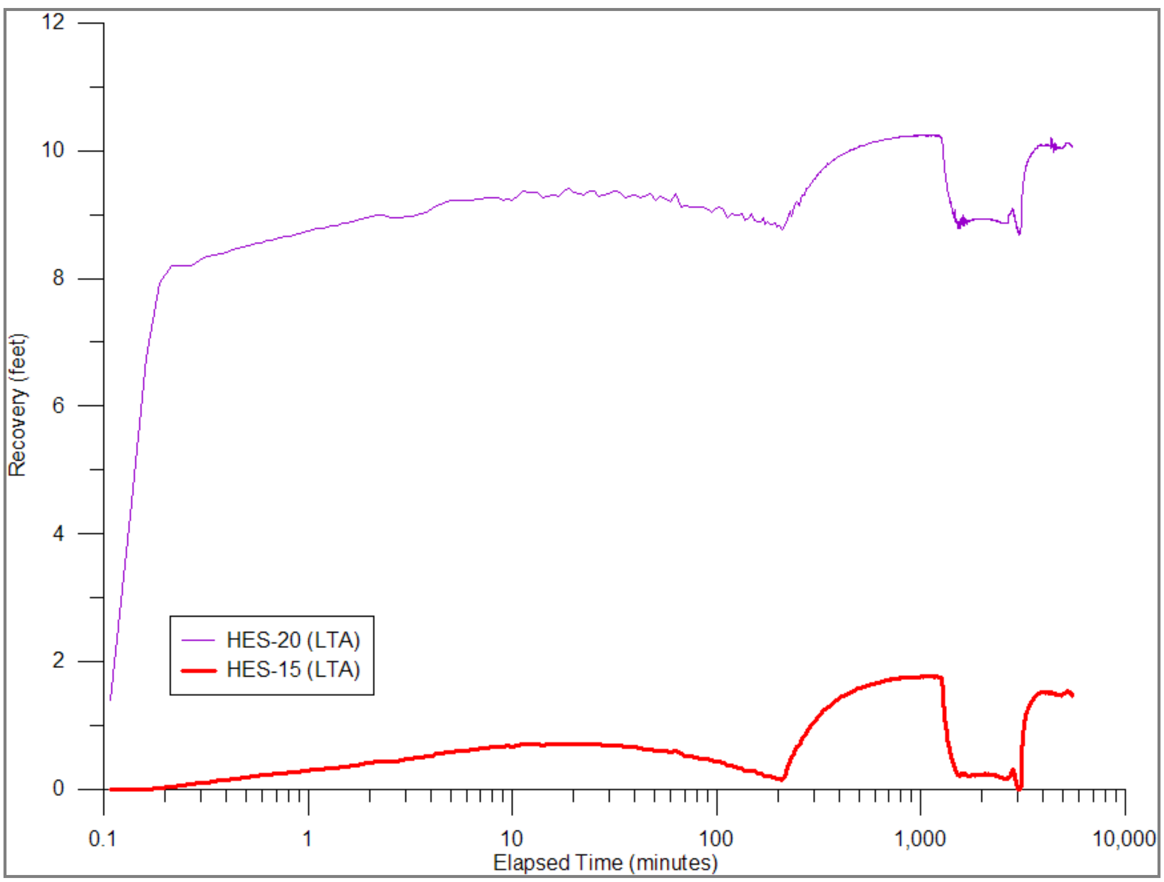

Figure 20. Site 6, Linear plot of LTA water levels in pumping well (HES-20) and monitor well (HES-15).

Figure 21 is a semi-log plot showing the water level recovering in HES-14, and the WTA monitor well after pumping in HES-20 stopped. As previously stated, the semi-log plot emphasizes the early-time data, and **Figure 21** shows an approximate two-minute lag after pumping stopped and before the water level in HES-14 started to rise. The water level fluctuations shown in **Figure 21** are due to adjacent pumping that occurred approximately 10 minutes after turning off the pump in HES-20. The resulting decline in water levels is apparent in both wells. It should be noted that the water level fluctuations appear greater in **Figure 21** than in **Figure 20** due to the differences in scale of the Y-axes of the two figures.

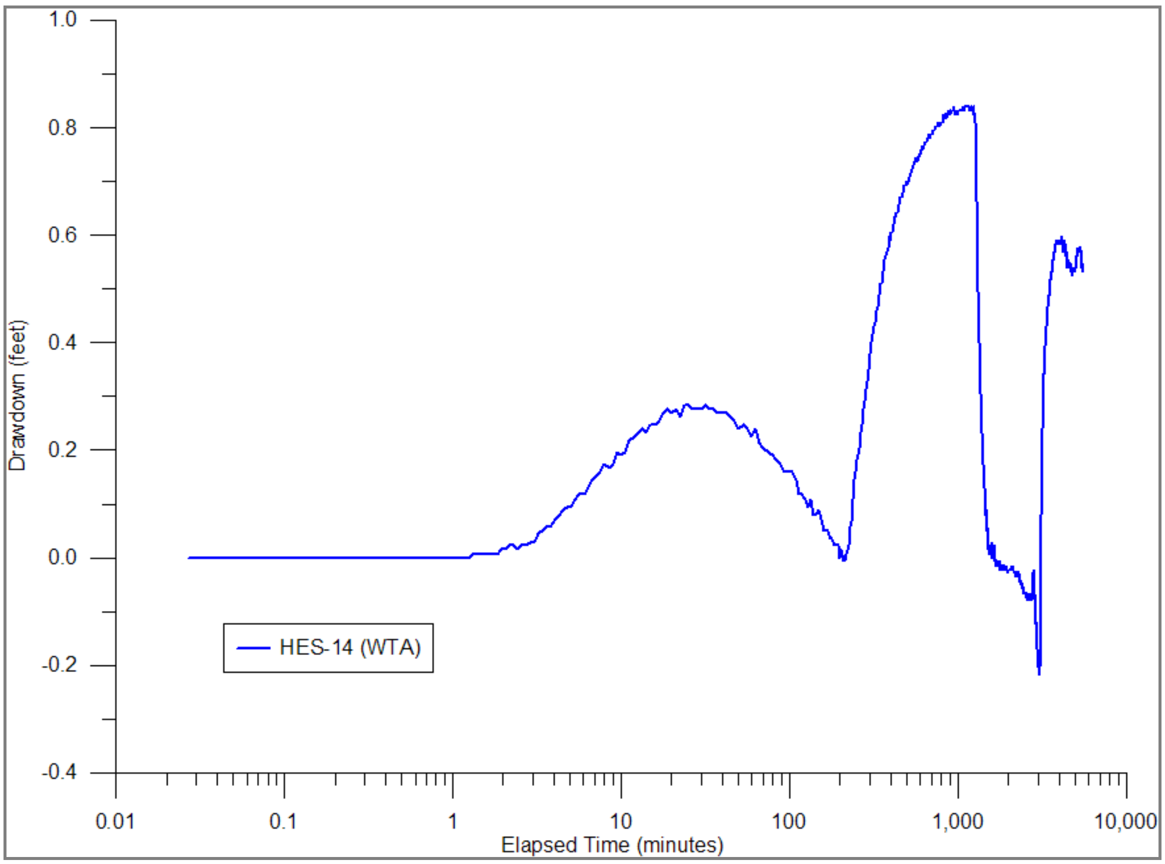

Figure 21. Site 6, Linear plot of WTA water levels in monitor well HES-14.

3.4.2 Site 4: APT 2, Southern Site

The SFWMD used three wells and a stilling well at Crooks Ranch Site 4 for the APT – one pumping well (HES-21), one LTA monitor well (HES-10), one WTA monitor well (HES-9), and one wetland stilling well (HES-11). The distance between the production well and the LTA/WTA monitor wells is approximately 312 feet to the east-northeast. The wetland stilling well is located approximately 288 feet northeast of the test production well. During the APT, an In-Situ, Inc. Hermit 3000 data logger and an In-Situ, Inc. PXD-261 pressure transducer in each well collected water level data during the drawdown and recovery phases of the test. The District programmed the data logger to record water level data on a logarithmic scale so that the instrument rapidly collected data points during the first 10 minutes of the test, when drawdown occurred quickly. After 10 minutes, the data logger collected data every minute. Before the test, the SFWMD collected background water level data in each well to determine the pumping schedule of adjacent users. Based on the high frequency of pumping by adjacent users, the SFWMD did not run a step-drawdown test in HES-21. District staff determined the frequent pumping by adjacent users would impact the step-drawdown test data. These data were collected on a linear scale every hour.

AWD installed an 8-inch diameter, Schedule 40, PVC drop pipe into HES-21. The drop pipe was attached to a centrifugal pump, and a 6-inch diameter, Schedule 40, PVC pipe carried the discharge water away from the pumping well to a ditch located 195 feet west of HES-21, and more than 400 feet away from the monitor and stilling wells. AWD installed a 4-inch orifice plate on the end of the 6-inch discharge pipe. The manometer connected near the end of the discharge line enabled District staff to determine the discharge rate during the APT. The manometer had a double-end fitting, allowing the connection of a pressure transducer and a manometer tube adjacent to a measuring stick. The SFWMD collected discharge readings using a PXD-261 pressure transducer, which were verified with manual readings on the manometer tube. A calibrated in-line flow meter verified the manometer readings.

3.4.2.1 Background Water Levels

Prior to the APT, water levels were recorded for approximately two weeks in the monitor and stilling wells at Site 4 (HES-9, HES-10, and HES-11). The purpose of the background data was to determine the timing and magnitude of pumping from LTA wells adjacent to the study area. The background water level data enabled staff to determine the pumping schedule of the adjacent users and to determine the length of the APT to minimize interference from adjacent pumpages.

As shown in **Figure 22**, water levels in the LTA monitor well rose and fell during this period in response to irrigation withdrawals from adjacent wells. During the same period, the water levels in the WTA generally declined as withdrawals from the LTA continued, indicating a very limited hydraulic connection between the two aquifers. **Section 4** of this report contains a more detailed water level analysis for this site.

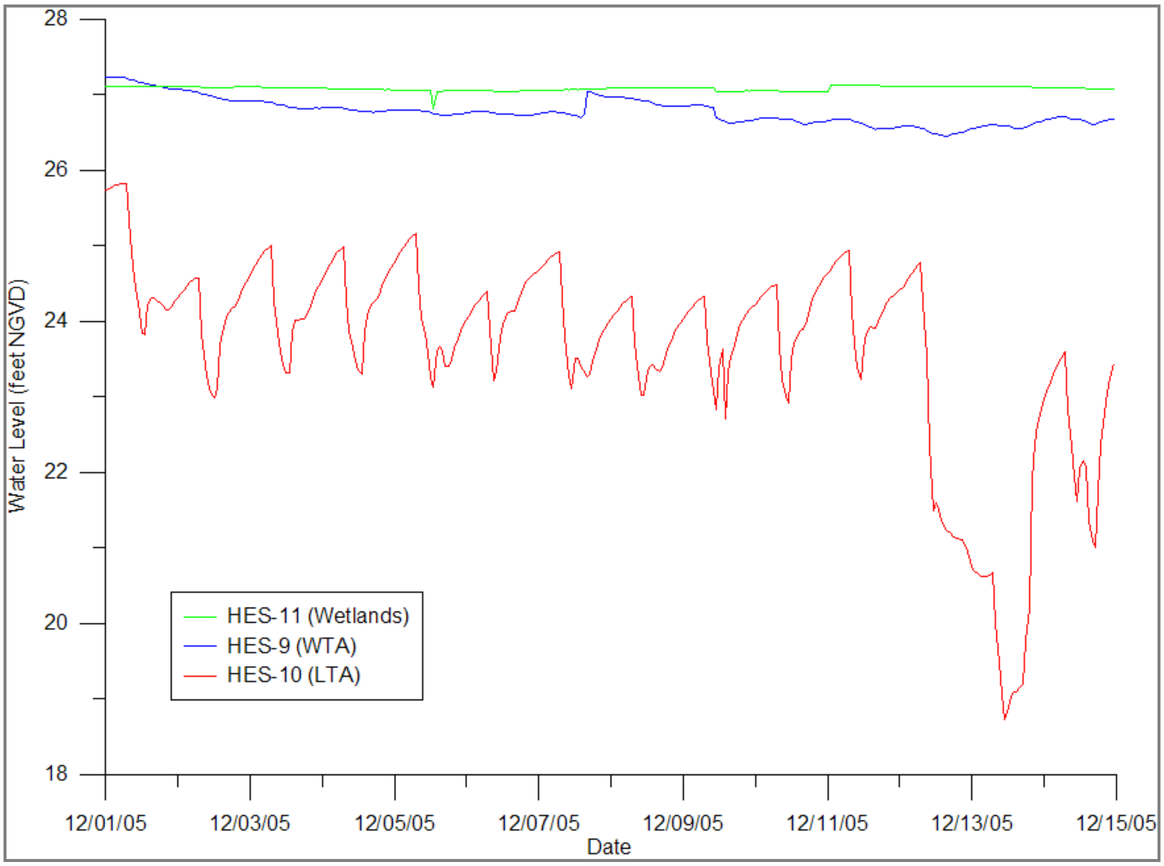

Figure 22. Site 4, Background water levels prior to the APT.

3.4.2.2 APT Pumping Phase

The pumping (drawdown) phase of the constant rate APT commenced on December 16, 2005. The pumping well (HES-21) was pumped at 503 gpm, while water levels in the pumping well and all nearby wells were monitored. AWD operated the pump for 72 uninterrupted hours, completing the drawdown phase of the APT on April 14, 2005. However, due to impacts from surrounding users, only the first six hours (360 minutes) of drawdown data were used for the analysis. As the exact number, location, time of pumping, and pumping rate of the surrounding well(s) were unknown, data from the period greater than six hours since the start of the test could not be used to provide an accurate calculation of hydraulic properties of the LTA.

The goal of this test was to determine the hydraulic properties of the LTA and the leakance through the overlying semi-confining bed. The principal factors of aquifer performance, such as transmissivity and storage coefficients, were calculated from the drawdown and recovery data obtained from HES-10, completed in the same interval as the pumped well (HES-21).

The water levels in the observation wells stabilized with approximately 1.75 feet of drawdown in HES-10 during the APT. HES-10 is located 312 feet from HES-21. A 24-hour recovery period with no pumping followed the drawdown phase, during which water levels were allowed to return to static conditions.

Figure 23 shows the configuration of the monitor and pumping wells used in the APT.

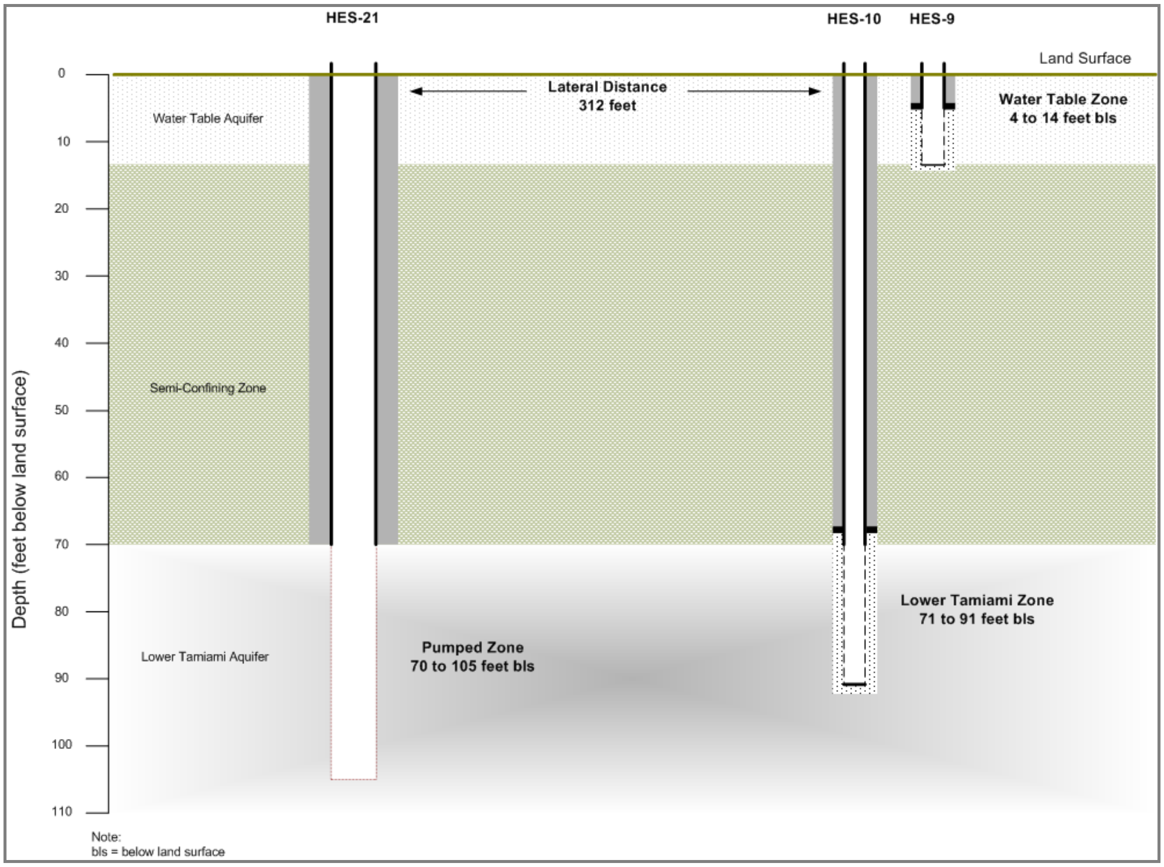

Figure 23. Site 4, Cross-section showing well depth for the aquifer performance test.

The background data showed the LTA at this site to be a leaky-type aquifer because the water levels in the WTA decline slightly in response to withdrawals in the LTA. Various curve-matching methods were applied to determine the hydraulic properties of the aquifer and aquitard. The Hantush-Jacob analytical model best represented the conditions at this site. This solution yielded a transmissivity of 162,600 gpd/ft (21,734 ft^2/day), a storativity of 2.46×10^{-4}, and an (r/B) value of 0.1. These values are consistent with those previously published in Smith and Adams (1988). The dimensionless parameter r/B characterizes the leakance across the aquitard to the pumped aquifer.

Figure 24 is a log/log plot of drawdown versus time from LTA monitor well HES-10 with the Hantush-Jacob solution. The blue line represents the 0.1 r/B type curve for this solution.

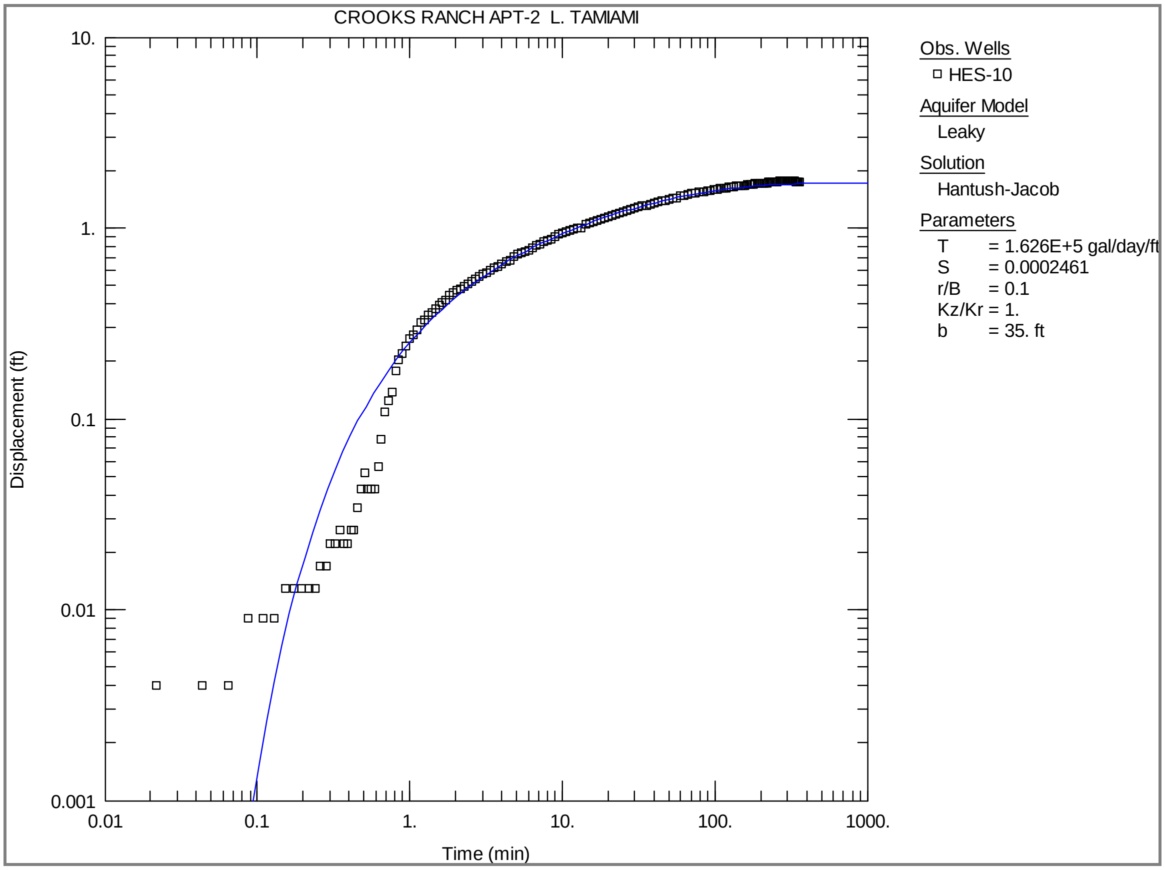

Figure 24. Site 4, Log/log plot for LTA well HES-10 during the APT.

The vertical hydraulic conductivity (K') through the semi-confining layer needs to be determined to calculate the leakance coefficient. Both K' and the leakance coefficient are determined using Equations 2 and 3 in Section 3.4.1.3. At Site 4, K' as calculated from the APT data, is 0.1520 ft/day (1.137 gpd/ft^2). A semi-confining unit thickness of 58 feet between the two aquifers was used in Equation 2. By using Equation 3, a leakance coefficient of 0.0026 per day is calculated for Site 4.

3.4.2.3 Water Level Responses during the APT, All Aquifers

Figure 25 presents the drawdown data in both the pumped well (HES-21) and corresponding monitor well (HES-10) in the LTA. The steep drawdown seen in the first minute of HES-21 indicates the removal of stored water in the well casing before drawdown begins in the aquifer. The maximum drawdown in HES-21 and HES-10 was approximately 6.5 feet and 1.7 feet, respectively.

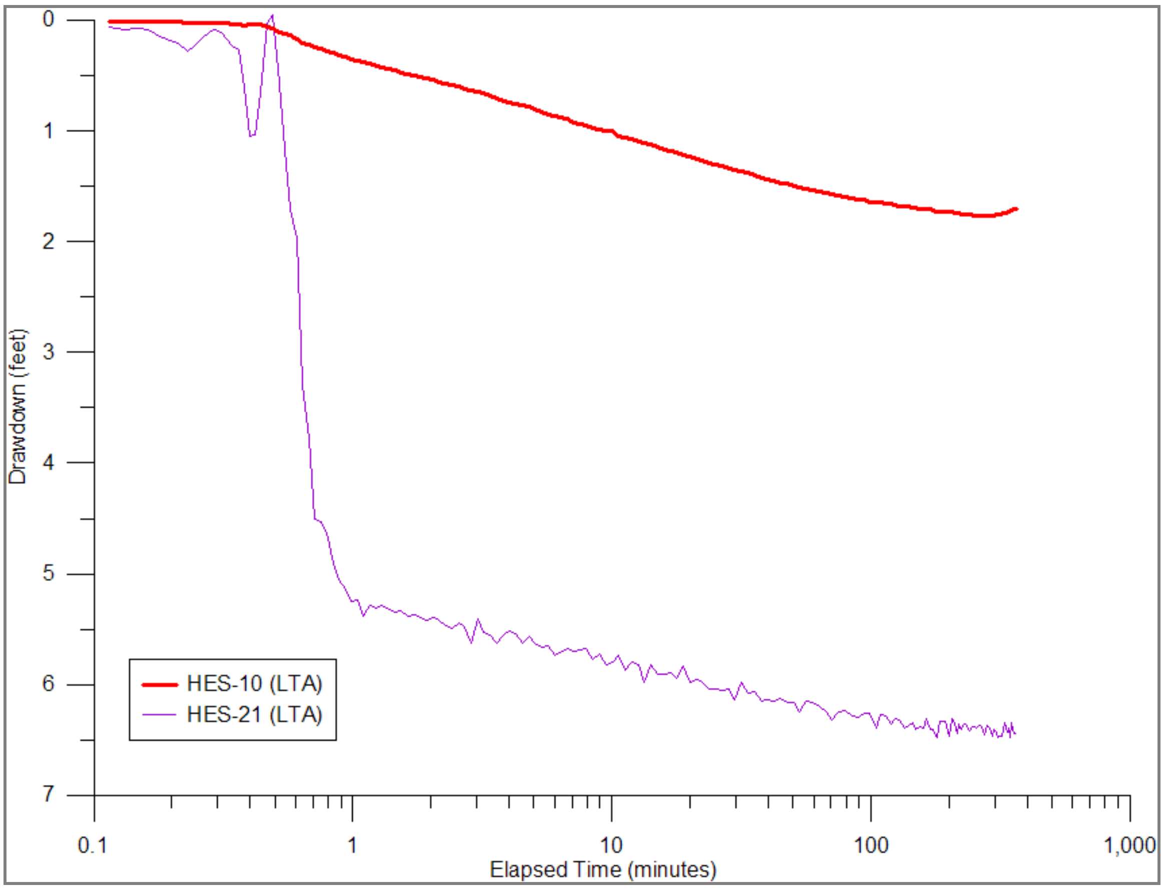

Figure 25. Site 4, Water levels in LTA pumping well (HES-21) and LTA monitor well (HES-10) during the pumping phase of the APT.

Figure 26 is a plot of water level changes during the pumping phase for the WTA well (HES-9). The maximum water level decrease in HES-9 during pumping was approximately 1.8 feet, indicating minor downward leakance.

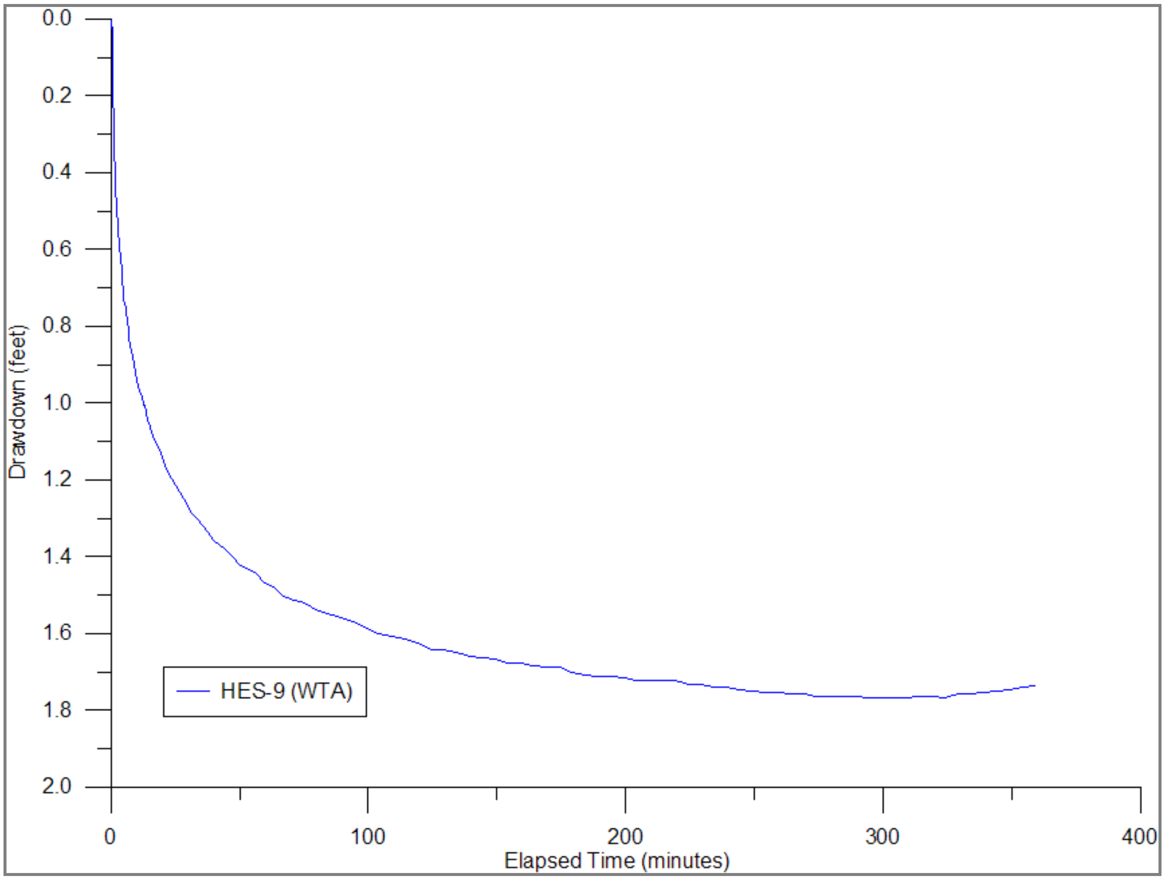

Figure 26. Site 4, Time series plot of water levels in water table well (HES-9) during the drawdown phase of the APT.

Figure 27 shows a plot of water level changes during the pumping phase for the wetland stilling well (HES-11). Water levels in the stilling well (HES-11) declined 0.07 feet during the test.

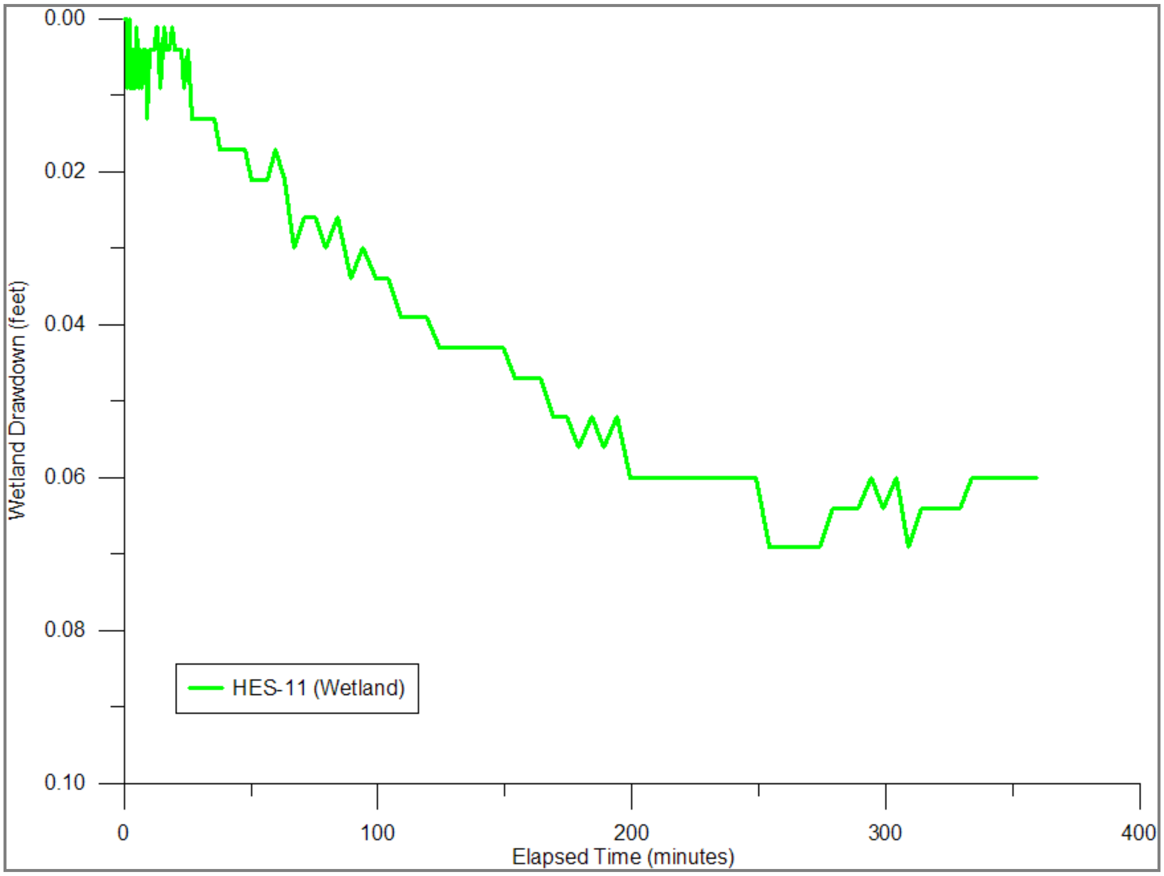

Figure 27. Site 4, Time series plot of water levels in stilling well (HES-11) during the drawdown phase of the APT.

3.4.2.4 Recovery Phase

During the 10-hour recovery period following the 72-hour pumping phase of the APT, the District recorded the water levels in the pumping, monitor, and stilling wells as the water levels returned to background conditions. The data recording for the recovery phase of the APT ended April 15, 2005. **Figure 28** is a semi-log plot showing how water levels recovered (increased) in the LTA monitor well (HES-10) and the pumping well (HES-21). The steep rise in water level seen in the first few seconds of HES-21 indicates the addition of stored water in the well casing before recovery in the aquifer. Approximately 315 minutes after turning off the pump in HES-21, an adjacent user began pumping. The resulting decline in water levels is apparent in both wells.

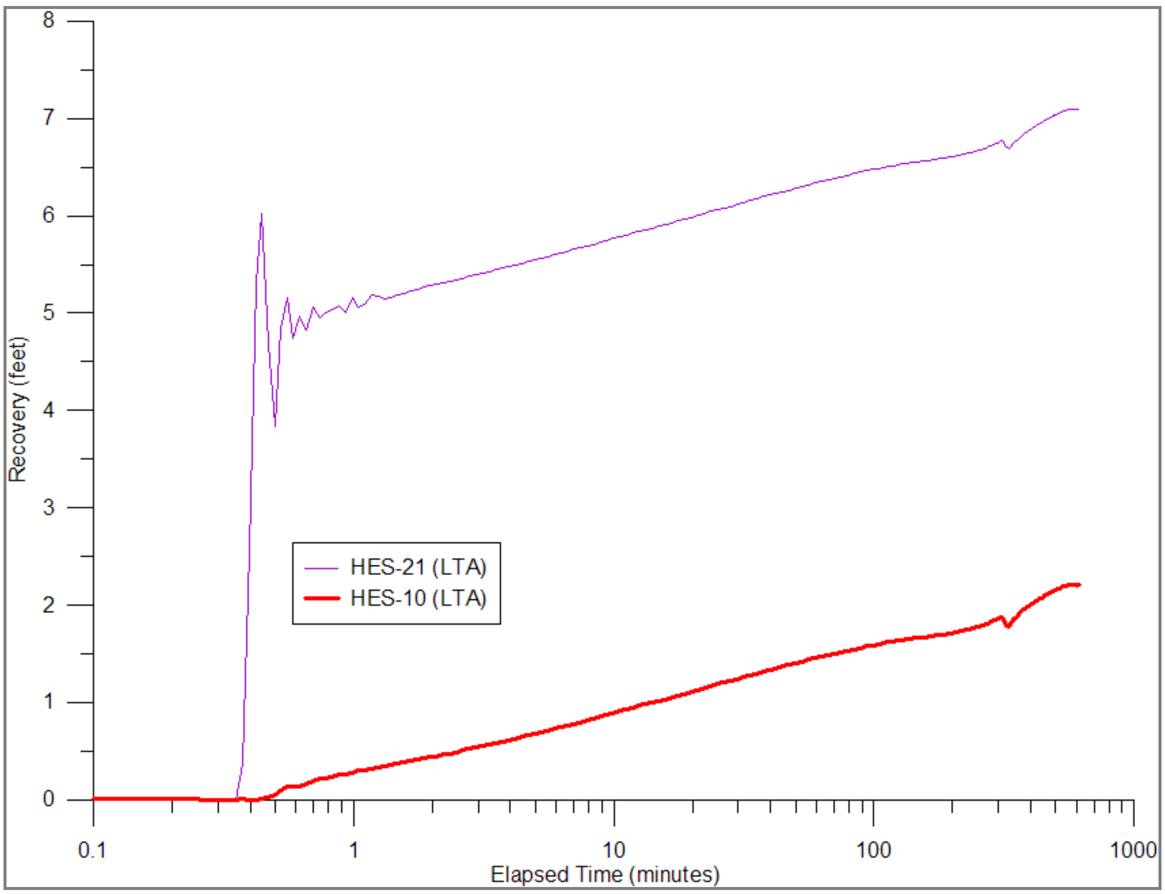

Figure 28. Site 4, Semi-log plot of water levels in the LTA pumping well (HES-21) and LTA monitor well (HES-10) during the recovery phase of the APT.

4
Groundwater Levels

4.1 WATER LEVEL AND RAINFALL DATA WITHIN THE STUDY AREA

Self-recording water level data loggers were used at the seven test sites on Crooks and Golden Ox Ranches to collect daily water level data during the period between March 2005 and November 2007. Rainfall data were collected from Site 1 from March 16, 2005 through October 26, 2007; however, data are missing for October, November, and December 2006. In addition, data from Site 5 (closest to Site 1) were used in place of missing data for January to April 2007. The rainfall data showed the distinct wet and dry seasons typical of south Florida. The rainfall data are included on the hydrographs for each site to illustrate water level changes in relation to precipitation and the time of year.

4.2 SITE WATER LEVEL DATA

4.2.1 Site 1 Water Levels

A review of the hydrographs for the study area indicates the following:

- Water levels in the wetland and the WTA correspond very closely.
- During the wet season (May through October), water levels in the LTA are approximately the same as those of the WTA and the wetland.
- Water levels decline during the dry season in all three aquifers.
- Water level declines during the dry season are most severe in the LTA aquifer, presumably due to pumping for agricultural irrigation.
- Both the wetland and the WTA water levels correspond to changes in water levels in the LTA aquifer, indicating a hydraulic connection.
- At this site, water levels in the WTA often appear to be higher than those in the wetland. This may be due to errors in the surveyed elevation of one of the wells. Due to the location of the well in a densely wooded area, the relative elevation was unable to be surveyed during the December 2008 site visit.
- The greatest amount of drawdown in the study area occurs at Sites 1 and 2.

- The greatest difference between water levels in the LTA and the WTA occurs at Sites 1 and 2.

Figure 29 is a hydrograph showing water level changes over time within the isolated wetland, the WTA, and the LTA at Site 1.

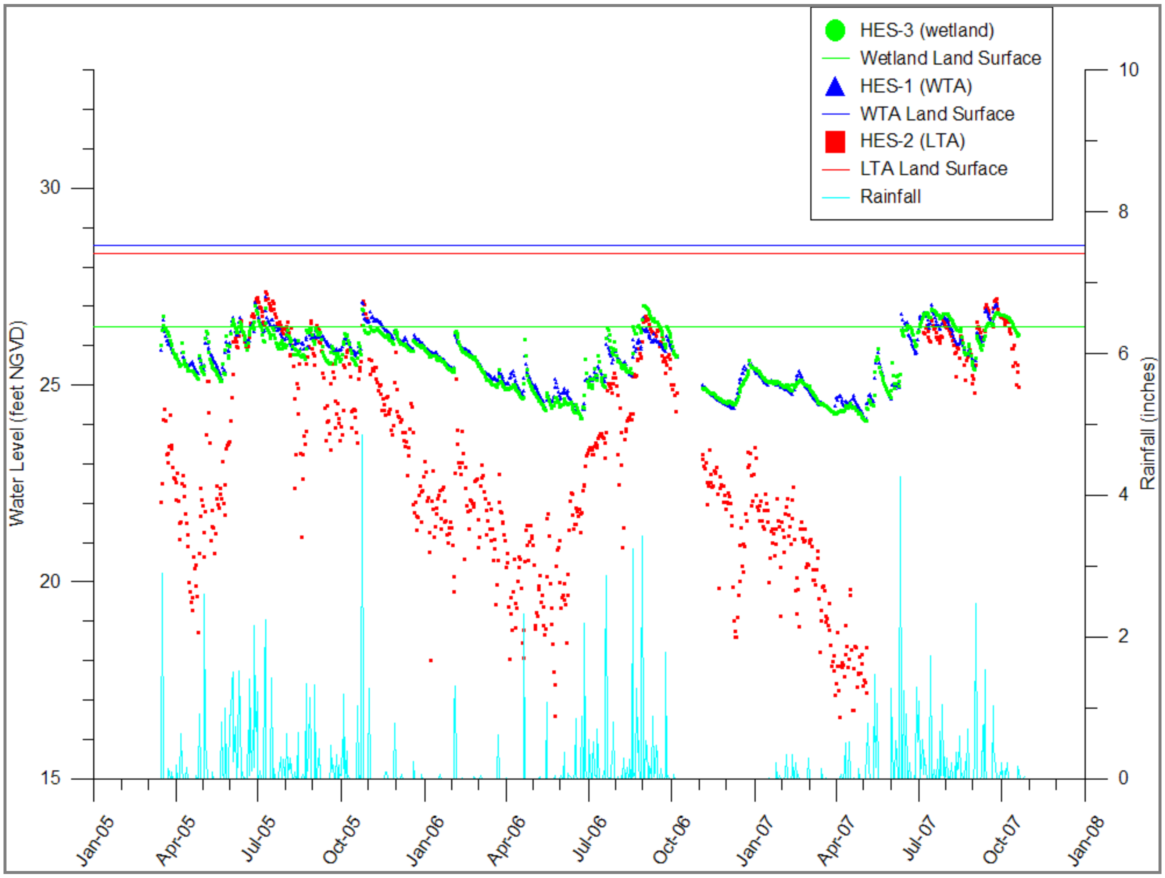

Figure 29. Site 1, Hydrograph.

Figure 30 shows a hydrograph for the wetland stilling well at Site 1, showing when the water level is above and below land surface. By counting the number of days during specific periods (e.g., wet season for the period of record), when water levels rose above the land surface, it was possible to calculate the following:

- Water levels rise above land surface approximately 22 percent of the time during the wet season.
- Water levels rise above land surface approximately 1 percent of the time during the dry season.
- Water levels rise above land surface approximately 13 percent of the time throughout the year.

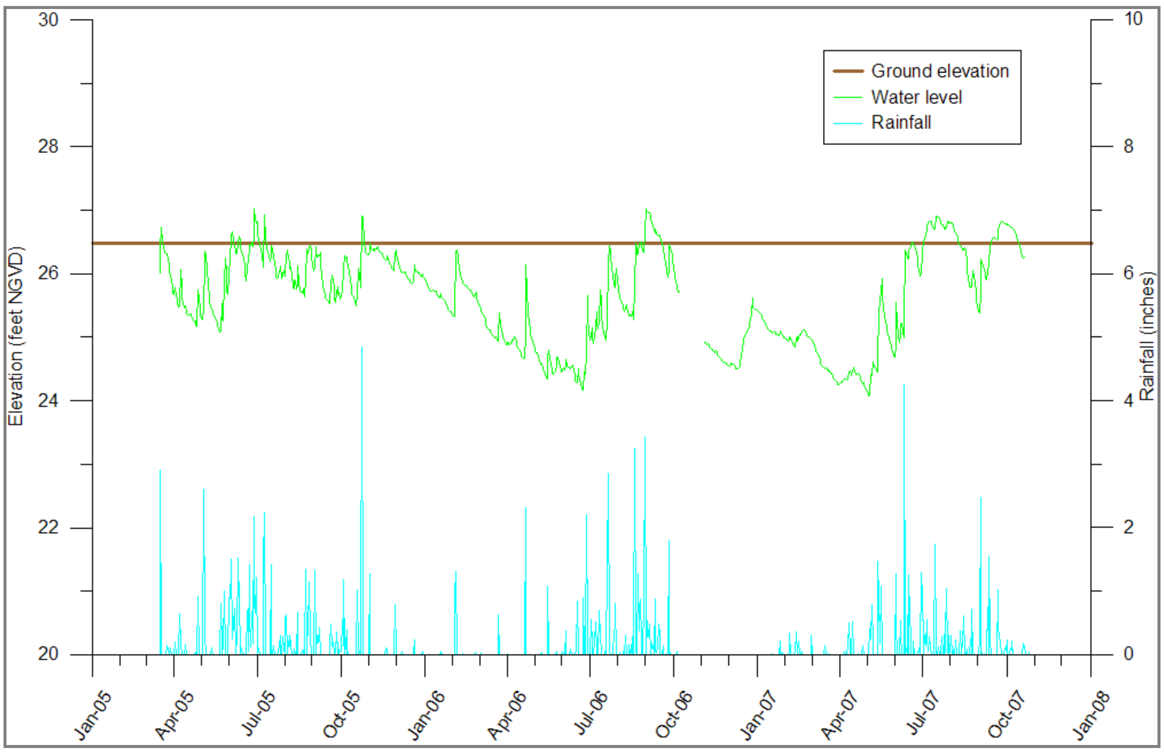

Figure 30. Site 1, Wetland hydroperiod.

4.2.2 Site 2 Water Levels

Figure 31 is a hydrograph showing water level changes over time within the isolated wetland, the WTA, and the LTA at Site 2.

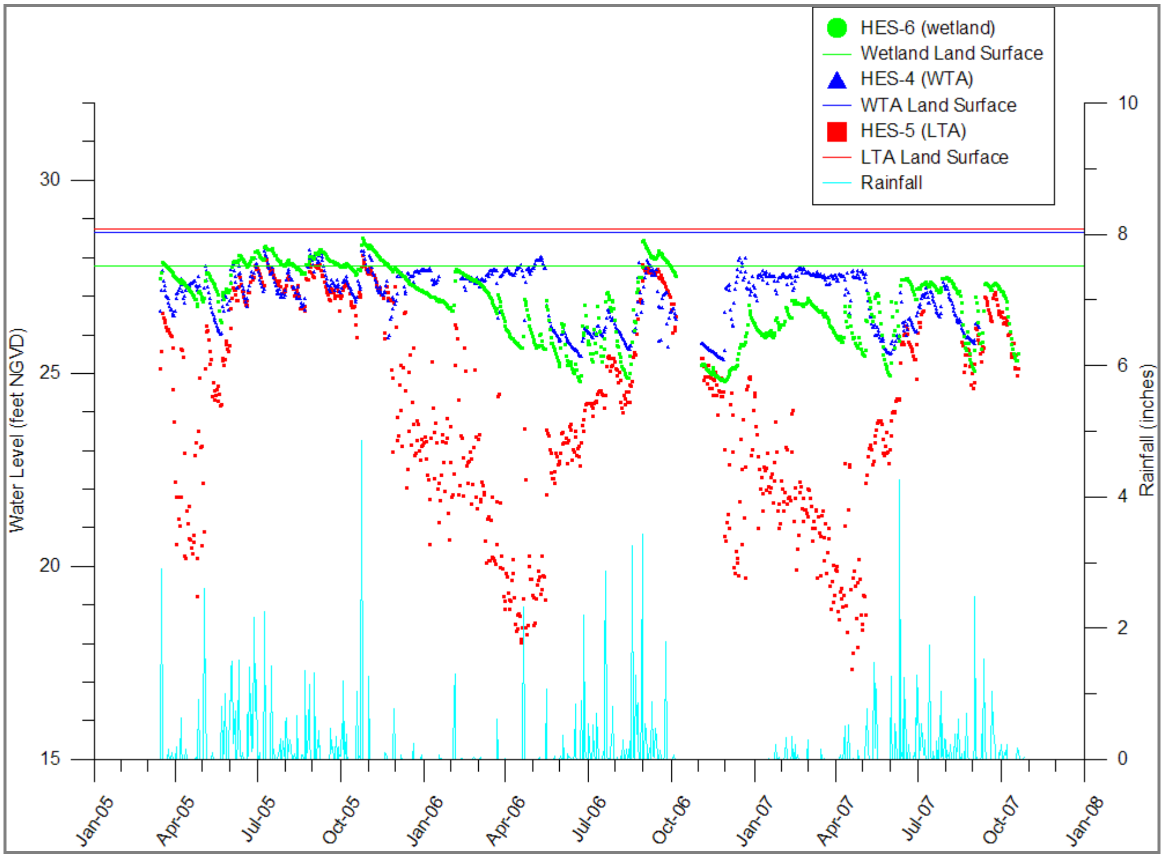

Figure 31. Site 2, Hydrograph.

A review of the hydrographs for the study area indicates the following:

- Water levels in the wetland and the WTA correspond closely.
- Water levels in the LTA during the wet season are approximately the same as those of the WTA and the wetland.
- The WTA shows some anomalous data (e.g., April through June 2006). This may be explained by wetland construction activities at the site.
- Water levels decline during the dry season of 2006 at all three monitor sites. However, this decline is less apparent in 2007.
- Water level declines during the dry season are most severe in the LTA aquifer, presumably due to pumping for agricultural irrigation.
- Both the wetland and the WTA water levels correspond to changes in water levels in the LTA aquifer, indicating a hydraulic connection.

- Water levels in the WTA often appear to be higher than those in the wetland. This may be due to an incorrect wellhead elevation for HES-6.
- The greatest amount of drawdown in the study area occurs at Sites 1 and 2.
- The greatest difference between water levels in the LTA and the WTA occurs at Sites 1 and 2.

Figure 32 presents a hydrograph for the wetland stilling well at Site 2 showing when the water level is above and below land surface.

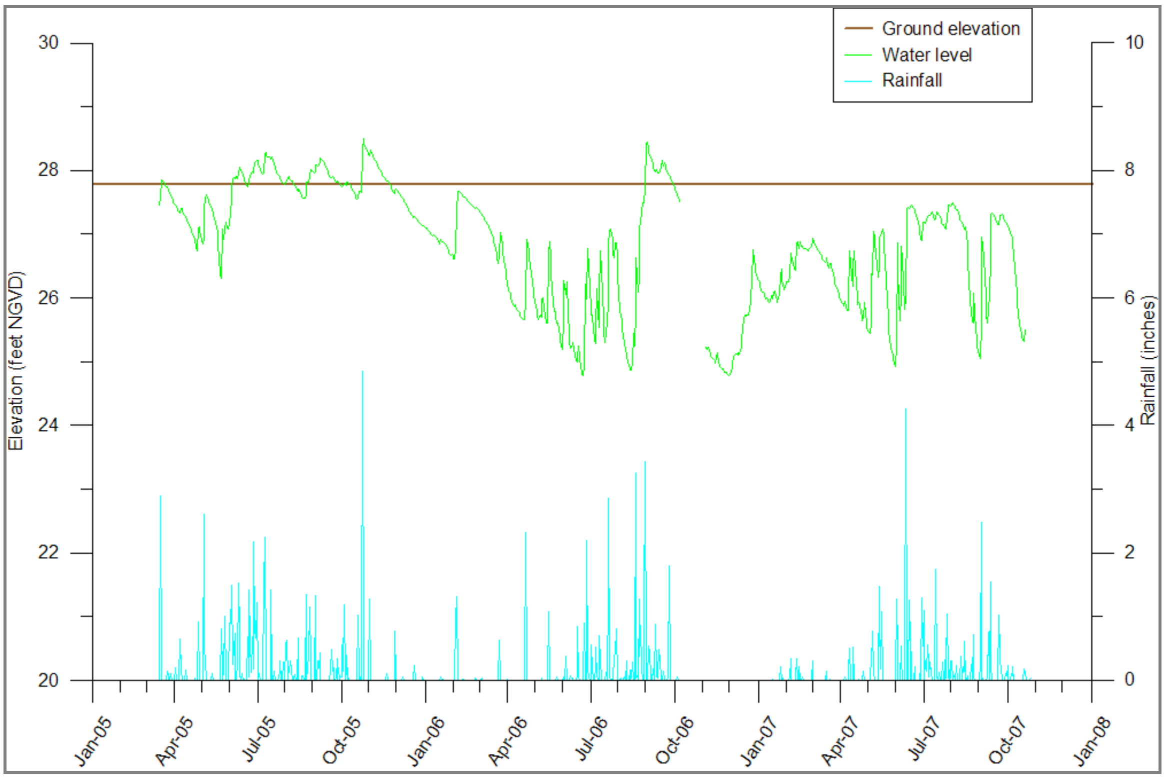

Figure 32. Site 2, Wetland hydroperiod.

By counting the number of days during specific periods (e.g., wet season for the period of record), when water levels rose above the land surface, it was possible to calculate the following:

- Water levels rise above land surface approximately 27 percent of the time during the wet season.
- Water levels rise above land surface approximately 7 percent of the time during the dry season.
- Water levels rise above land surface approximately 18 percent of the time during the period of record.

4.2.3 Site 3 Water Levels

Figure 33 is a hydrograph showing water level changes over time within the WTA and the LTA for Site 3.

A review of the hydrographs for the study area indicates the following:

- Water levels in the WTA correspond to water levels in the LTA.
- Water levels in the LTA during the wet season are approximately the same as those of the WTA, sometimes even being higher.
- Water levels decline during the dry season at both monitor sites.
- Water level declines during the dry season are most severe in the LTA aquifer, presumably due to pumping for agricultural irrigation.

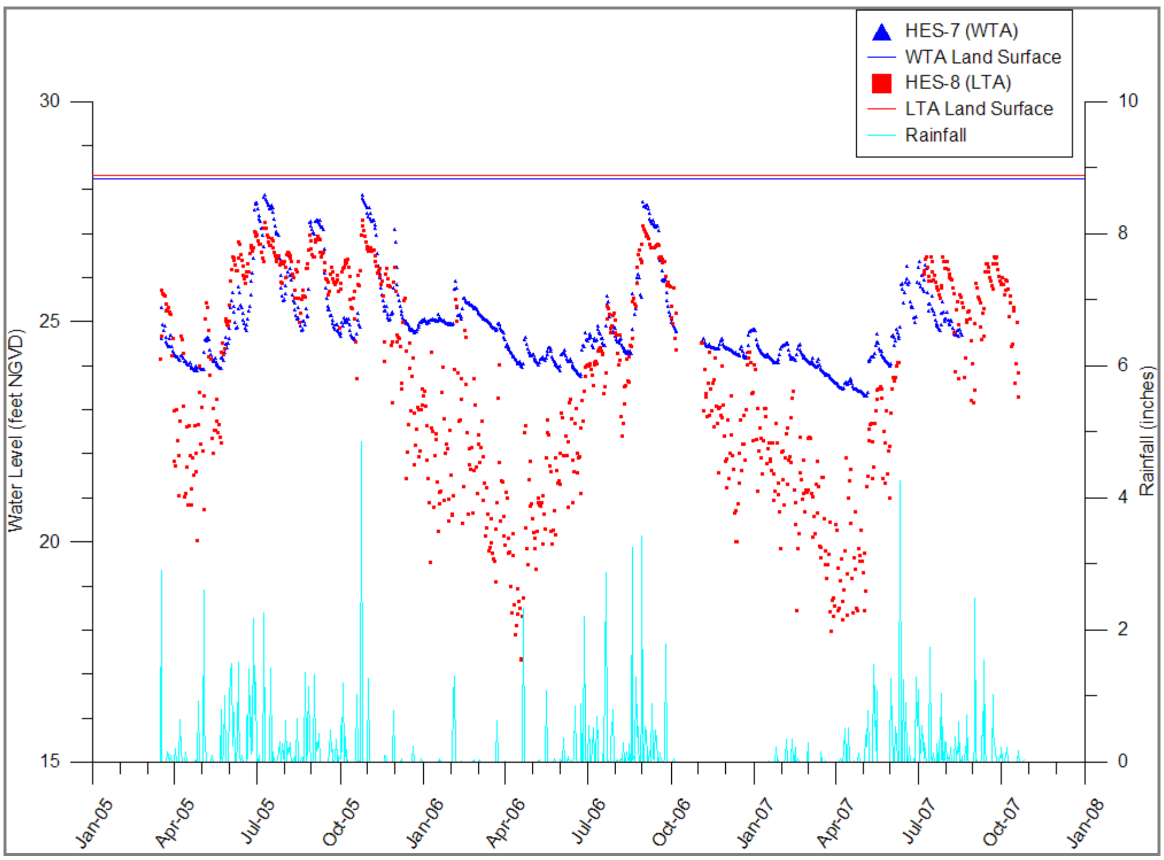

Figure 33. Site 3, Hydrograph.

4.2.4 Site 4 Water Levels

Figure 34 shows a hydrograph showing water level changes over time within the isolated wetland, the WTA, and the LTA at Site 4.

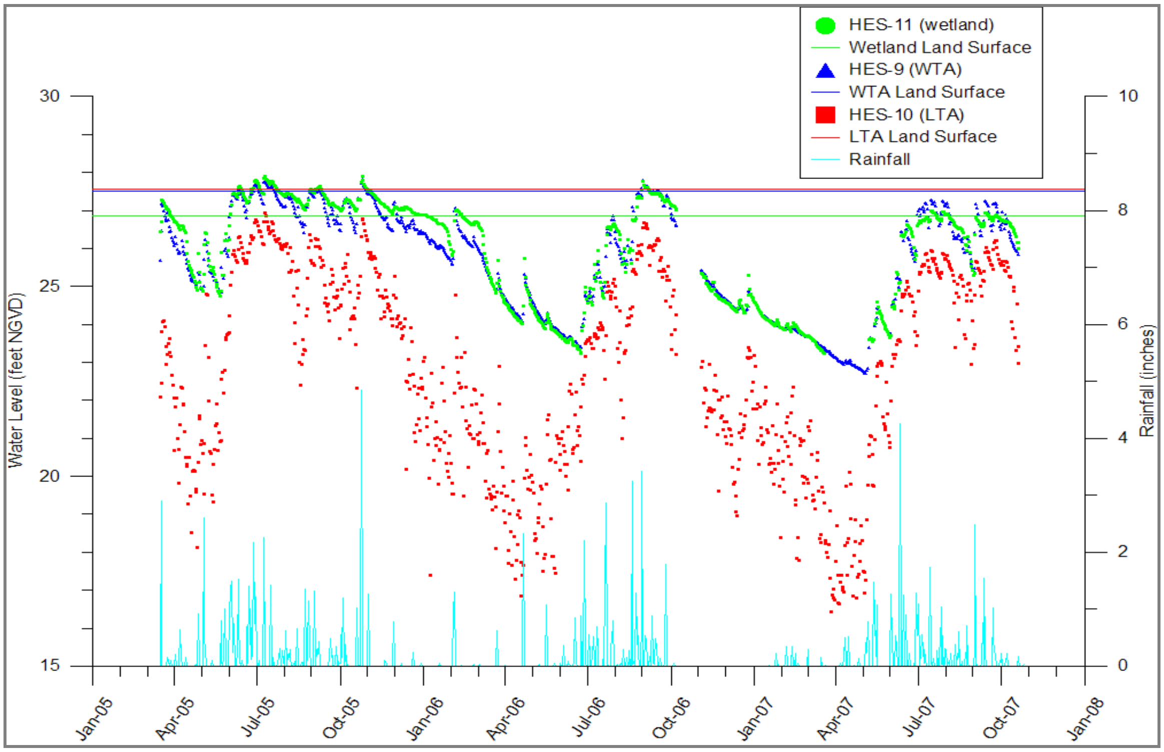

Figure 34. Site 4, Hydrograph.

A review of the hydrographs for the study area indicates the following:

- Water levels in the wetland and the WTA correspond very closely.
- Water levels in the LTA during the wet season are higher than during the dry season, but the LTA water levels are never as high as those of the WTA or wetland.
- Water levels decline during the dry season at all three monitor sites.
- Water level declines during the dry season are most severe in the LTA aquifer, presumably due to pumping for agricultural irrigation.
- Both the wetland and the WTA water levels correspond to changes in water levels in the LTA aquifer.
- Water levels in the WTA sometimes appear to be higher than those in the wetland, especially near the end of the period of record. This may be due to several factors, including: a different type of wetland habitat from the other sites; the ability of the well water level to rise above land surface because it is contained in a pipe, whereas the

surface water spreads out across the land; differences in evapotranspiration rates between the types of wetland habitat; and/or some of the sites could not be resurveyed to determine more accurate land surface elevations.

- Although Site 4 has the thickest confining layer, which would be expected to have the greatest amount of difference in water levels between the LTA and the WTA, this is not the case.

Figure 35 is a hydrograph for the wetland stilling well at Site 4 that shows when the water level is above and below land surface.

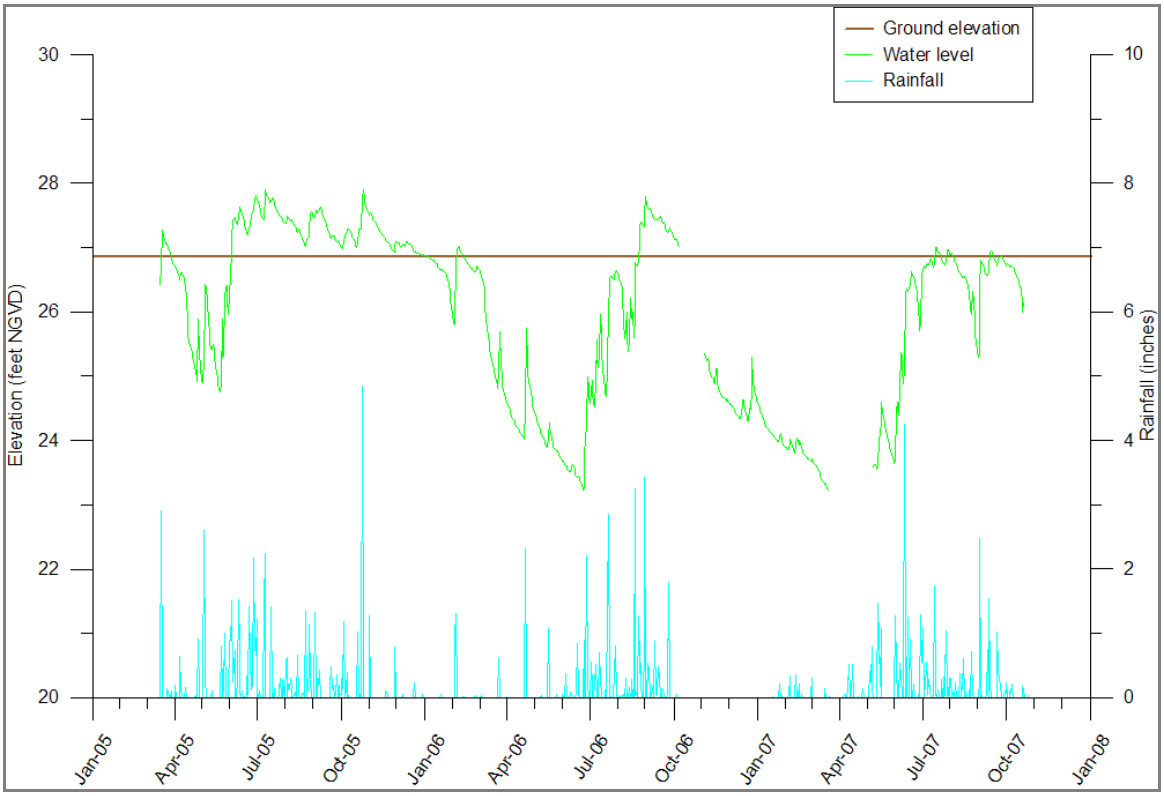

Figure 35. Site 4, Wetland hydroperiod.

By counting the number of days during specific periods (e.g., wet season for the period of record), when water levels rose above the land surface, it was possible to calculate the following:

- Water levels rise above land surface approximately 43 percent of the time during the wet season.
- Water levels rise above land surface approximately 23 percent of the time during the dry season.
- Water levels rise above land surface approximately 34 percent of the time during the period of record.

4.2.5 Site 5 Water Levels

Figure 36 presents a hydrograph that shows water level changes over time within the WTA and the LTA at Site 5.

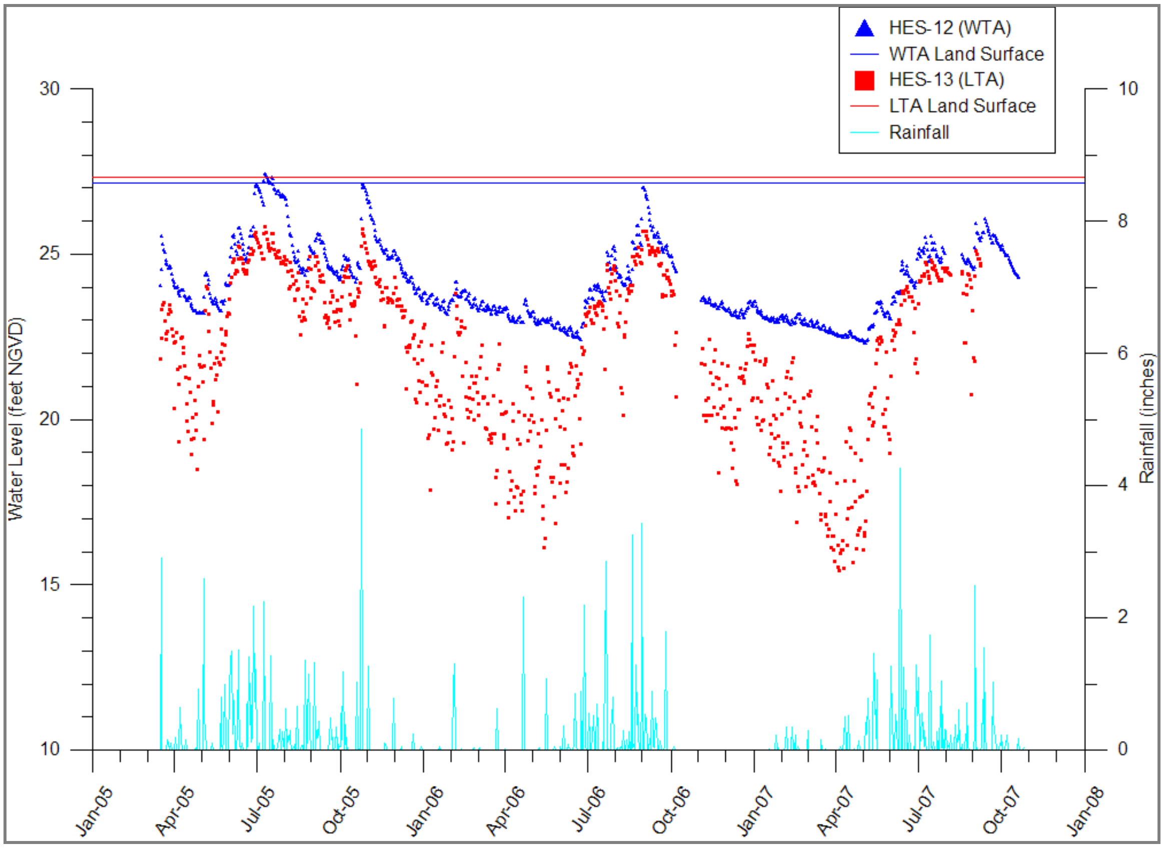

Figure 36. Site 5, Hydrograph.

A review of the hydrographs for the study area indicates the following:

- Water levels in the wetland and the WTA correspond very closely.
- Water levels in the LTA during the wet season are higher than during the dry season, but water levels in the LTA are never as high as those of the WTA.
- Water levels decline during the dry season at both monitor sites.
- Water level declines during the dry season are most severe in the LTA aquifer, presumably due to pumping for agricultural irrigation.
- Both the wetland and the WTA water levels correspond to changes in water levels in the LTA aquifer.

4.2.6 Site 6 Water Levels

Figure 37 is a hydrograph that shows water level changes over time within the isolated wetland, the WTA, and the LTA at Site 6.

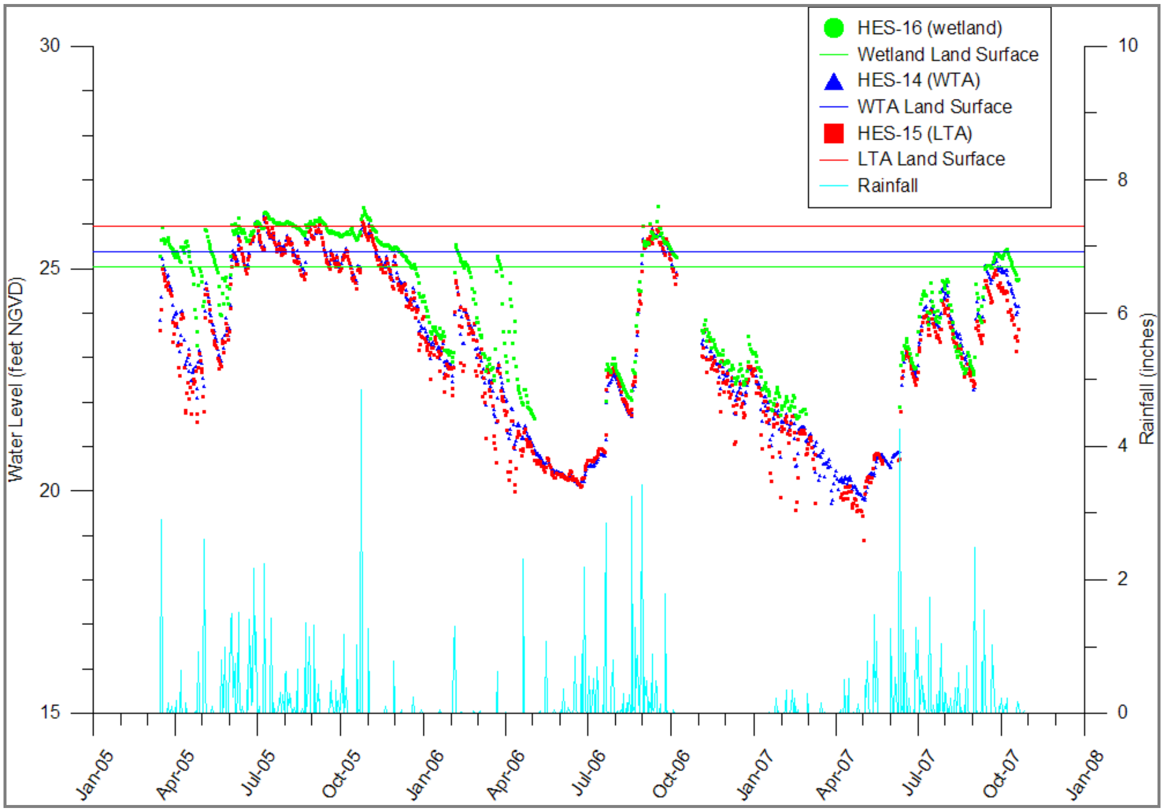

Figure 37. Site 6, Hydrograph.

A review of the hydrographs for the study area indicates the following:

- Water levels in the wetland, the WTA, and the LTA correspond very closely.
- Water levels in the LTA throughout the period of record are approximately the same as those of the WTA.
- Water levels in the wetland throughout the period of record are slightly higher than those of the WTA and the LTA.
- Water levels decline during the dry season at all three monitor sites.
- Both the wetland and the WTA water levels correspond to changes in water levels in the LTA aquifer.
- Maximum drawdown in the LTA is slightest at Sites 6 and 7.
- Water levels are more comparable here than at the other sites, especially the WTA and the LTA, even during the wet season.

- These observations may indicate a greater hydraulic connection between the aquifers as compared to the other sites.
- The greater relative hydraulic connection at Sites 6 and 7 may be due to the comparatively thin semi-confining unit, as well as the nature of the lithology at the sites (mudstone with significant amounts of shell at Site 6, and wackestone with layers of limestone at Site 7, as opposed to sticky mudstone at the other sites).

Figure 38 shows a hydrograph for the wetland stilling well at Site 6 that shows when the water level is above and below land surface.

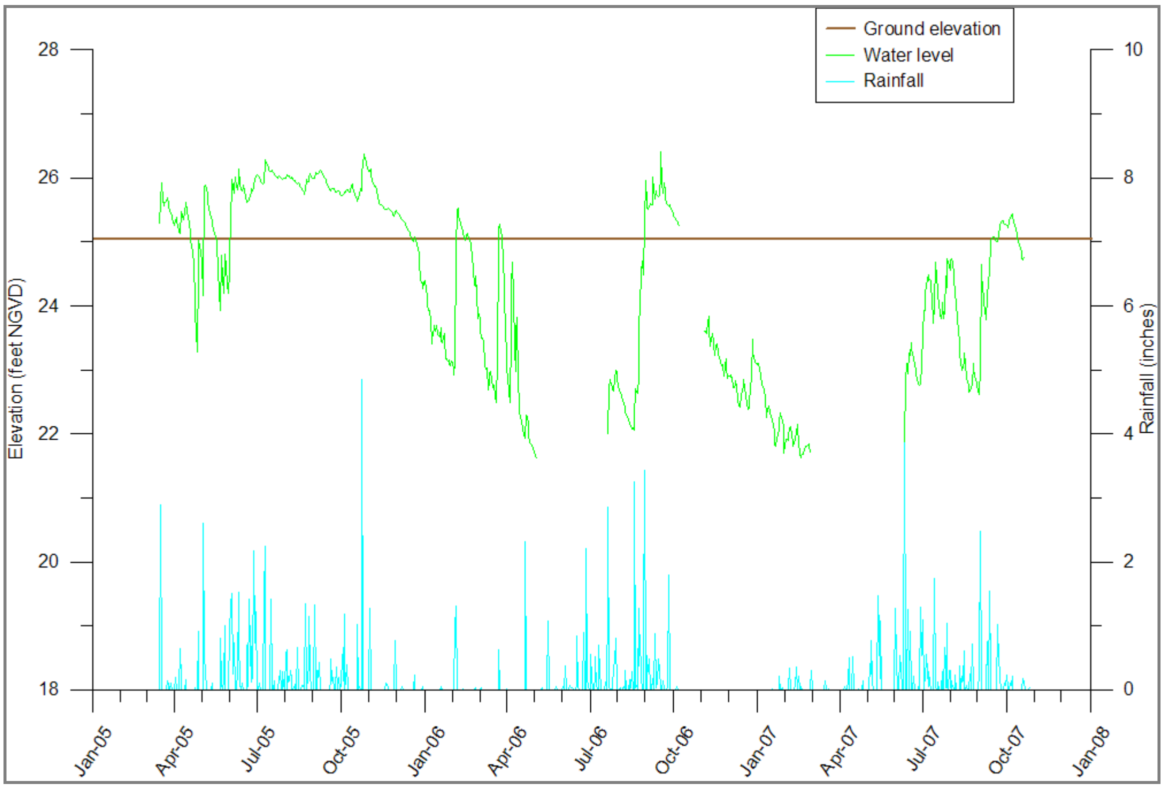

Figure 38. Site 6, Wetland hydroperiod.

By counting the number of days during specific periods (e.g., wet season for the period of record), when water levels rose above the land surface, it was possible to calculate the following:

- Water levels rise above land surface approximately 58 percent of the time during the wet season.
- Water levels rise above land surface approximately 29 percent of the time during the dry season.
- Water levels rise above land surface approximately 45 percent of the time during the period of record.

4.2.7 Site 7 Water Levels

Figure 39 presents a hydrograph that shows water level changes over time within the isolated wetland, the WTA, and the LTA at Site 7.

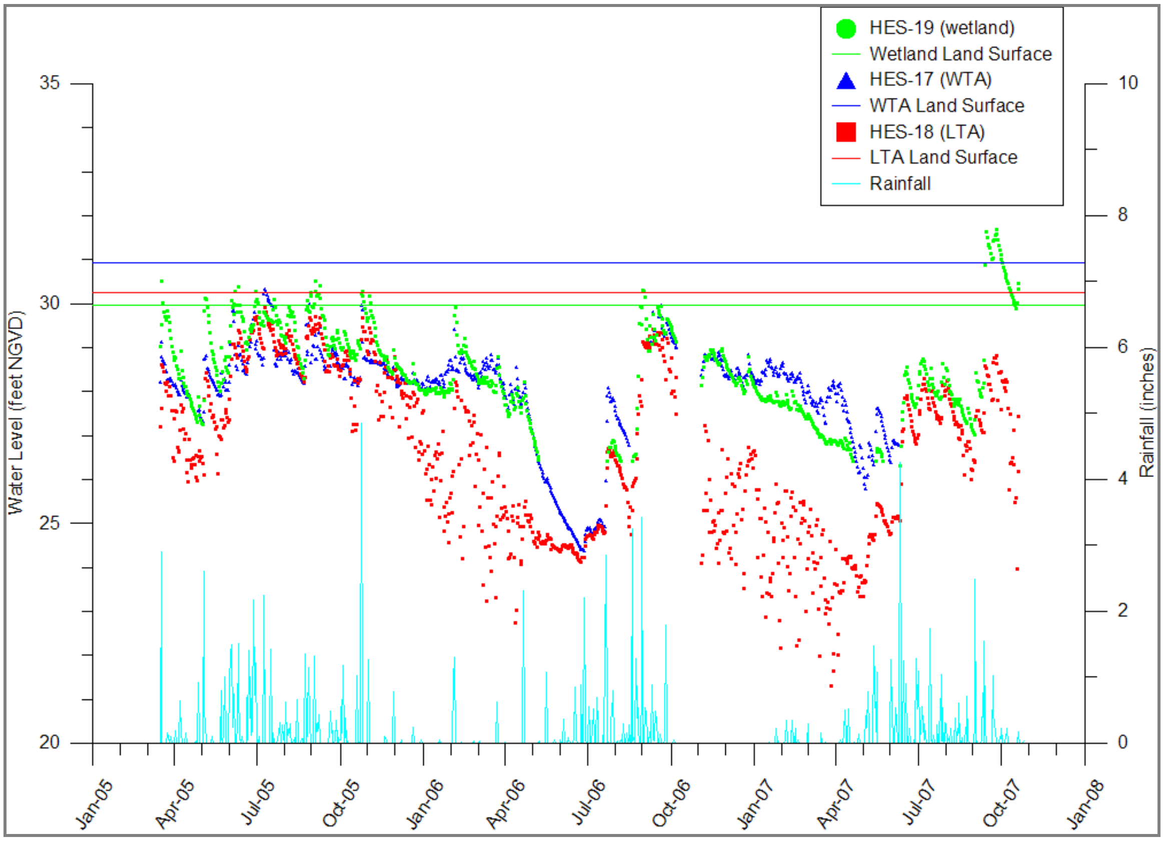

Figure 39. Site 7, Hydrograph.

A review of the hydrographs for the study area indicates the following:

- Water levels in the wetland and the WTA correspond closely.
- Water levels in the LTA during the wet season are approximately the same as those of the WTA.
- Water levels decline during the dry season at all three monitor sites.
- Water level declines during the dry season are most severe in the LTA aquifer, presumably due to pumping for agricultural irrigation.
- Both the wetland and the WTA water levels correspond to changes in water levels in the LTA aquifer.

- Water levels in the WTA often appear to be higher than those in the wetland. This may be due to several factors, including: a different type of wetland habitat from the other sites; the ability of the well water level to rise above land surface because it is contained in a pipe, whereas the surface water spreads out across the land; differences in evapotranspiration rates between the types of wetland habitat; and/or some of the sites could not be resurveyed to accurately determine land surface elevations.
- The maximum drawdown in the LTA occurs least at Sites 6 and 7.
- Water levels are more comparable here than at the other sites, especially the WTA and the LTA, even during the wet season.
- These observations may indicate a greater hydraulic connection between the aquifers as compared to the other sites.
- The greater relative hydraulic connection at Sites 6 and 7 may be due to the comparatively thin semi-confining unit, as well as the nature of the lithology at the sites (mudstone with significant amounts of shell at Site 6, and wackestone with layers of limestone at Site 7, as opposed to sticky mudstone at the other sites).

Figure 40 is a hydrograph for the wetland stilling well at Site 7 that shows when the water level is above and below land surface.

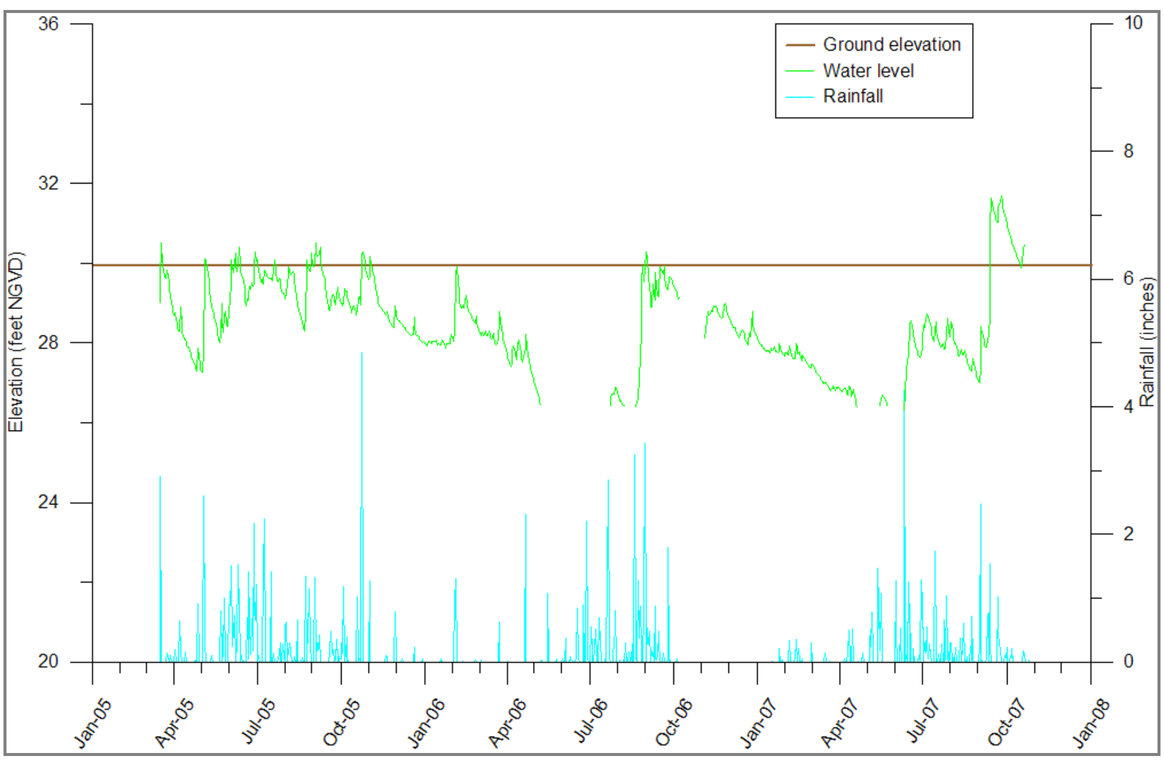

Figure 40. Site 7, Wetland hydroperiod.

By counting the number of days during specific periods (e.g., wet season for the period of record), when water levels rose above the land surface, it was possible to calculate the following:

- Water levels rise above land surface approximately 17 percent of the time during the wet season.
- Water levels rise above land surface approximately 1 percent of the time during the dry season.
- Water levels rise above land surface approximately 9 percent of the time during the period of record.

4.3 AQUIFER WATER LEVELS

4.3.1 Wetland Water Levels

Water level data from each of the five wetland stilling wells were plotted on a single hydrograph (**Figure 41**).

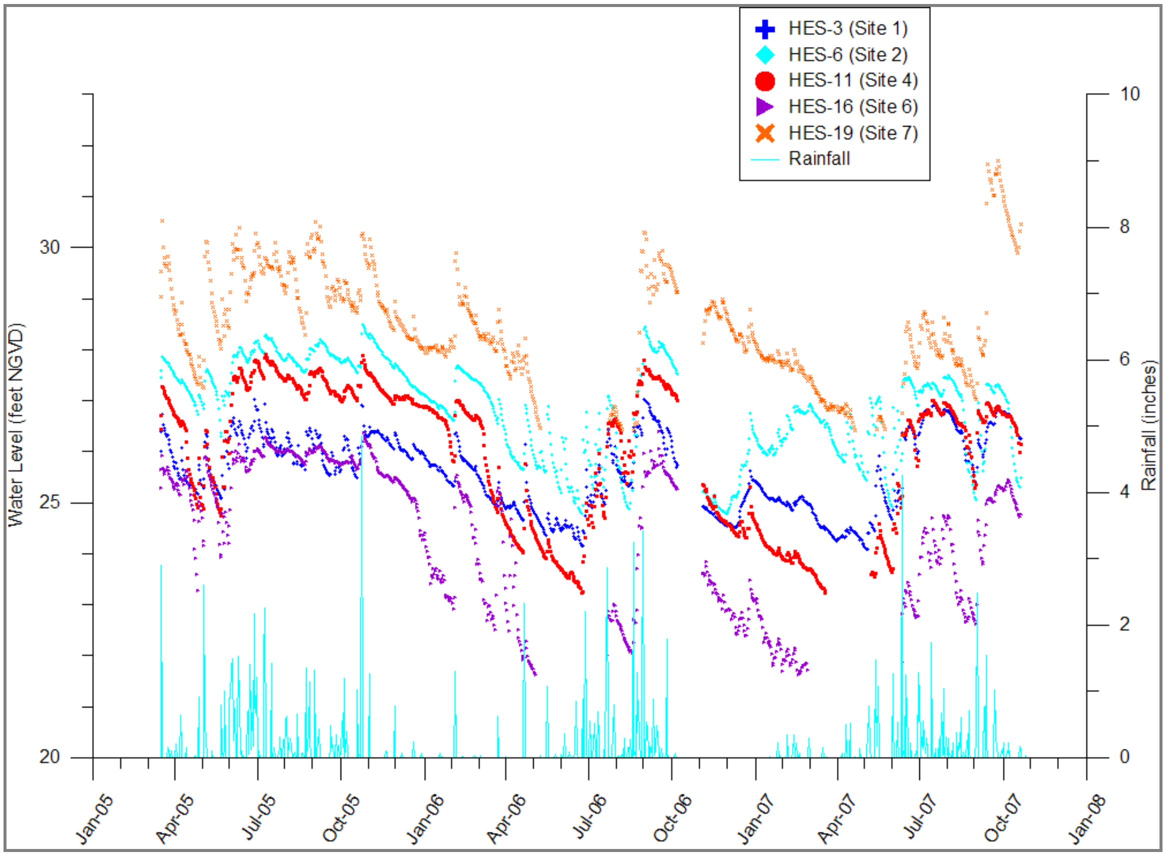

Figure 41. Wetland water levels.

A review of the hydrographs for the study area indicates the following:

- Water levels in all of the wetlands correspond closely, with differences related to changes in topographic elevations among the sites.
- Water levels are higher during the wet season, and water levels are lower in the dry season.
- The highest water levels are in the northernmost site (Site 7), where the topographic elevation is highest, and the lowest water levels are in the next northernmost site (Site 6), where the topographic elevation is lowest (See **Table 2**).
- A correlation of water levels to geographic location is not apparent.

- A correlation of water levels to proximity to regional irrigation is not apparent.

4.3.2 Water Table Aquifer Water Levels

Figure 42 is a single hydrograph that shows water level data from each of the seven WTA monitor wells.

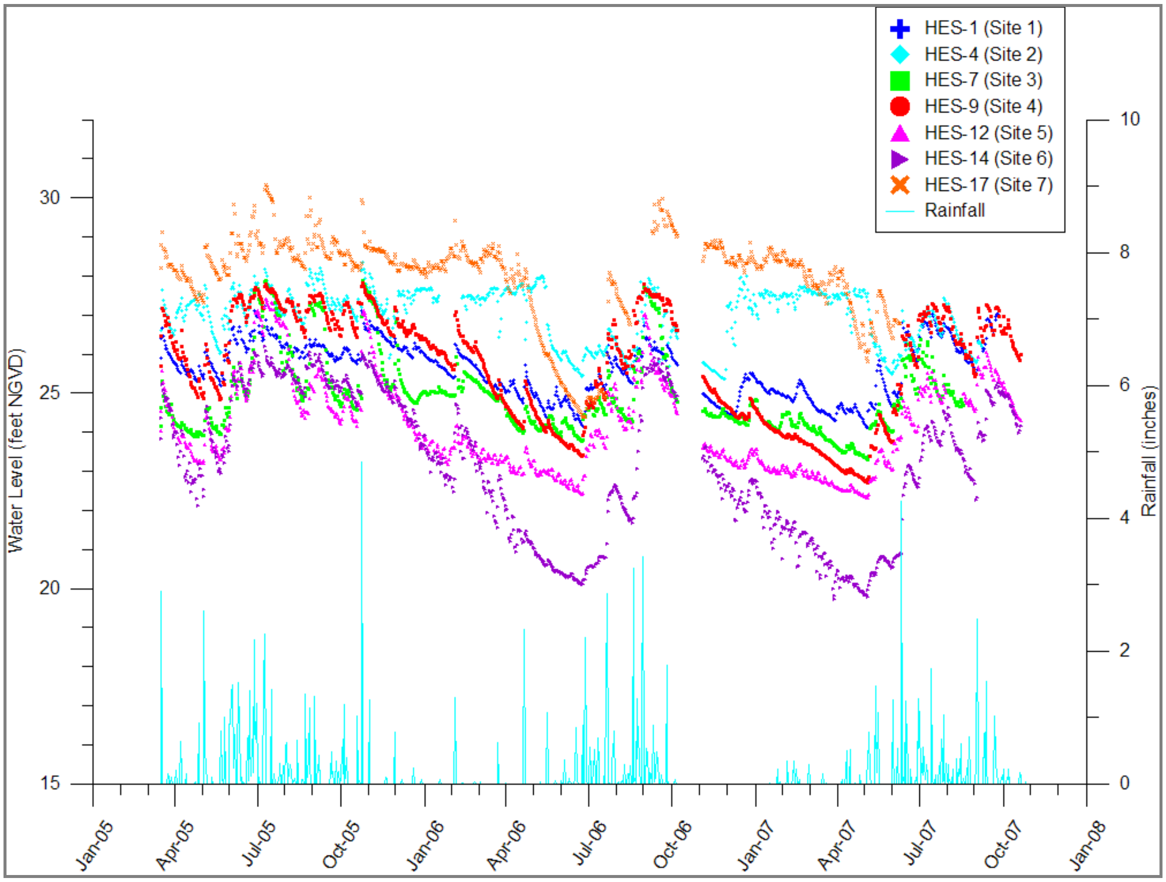

Figure 42. WTA water levels.

A review of the hydrographs for the study area indicates the following:

- Water levels in all of the WTA monitor wells correspond closely.
- Water levels are higher during the wet season and are lower during the dry season.
- The highest water levels are in the northernmost site (Site 7), where the topographic elevation is highest, and the lowest water levels are in the next northernmost site (Site 6), where the topographic elevation is lowest (See **Table 2**).
- With the exception of Site 6, it appears the highest water levels are in the north, and the lowest water levels are in the south, near the region of greatest agricultural pumpage.

4.3.3 Lower Tamiami Aquifer Water Levels

Water level data from each of the seven LTA monitor wells were plotted on a single hydrograph (**Figure 43**).

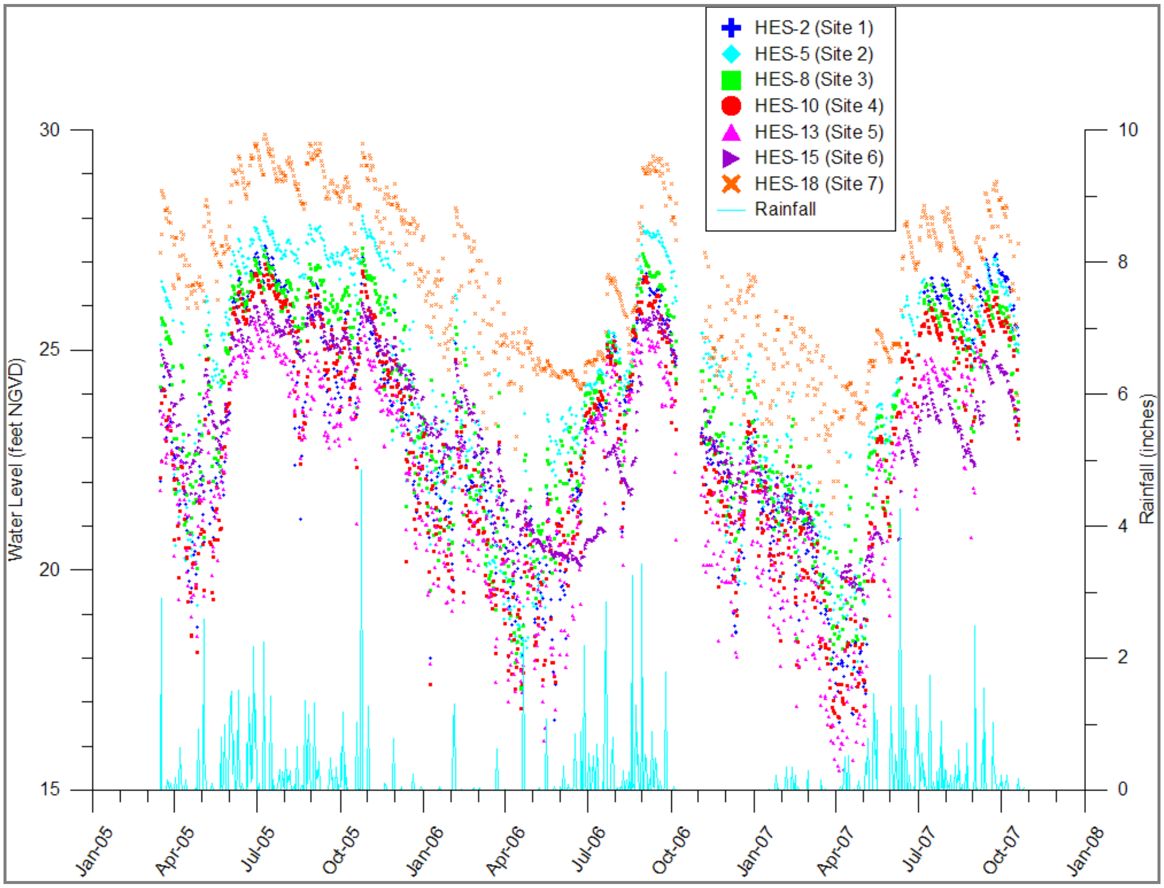

Figure 43. LTA water levels.

A review of the hydrographs for the study area indicates the following:

- Water levels in all of the LTA monitor wells correspond closely.
- Water levels are higher during the wet season and are lower during the dry season, likely due in large part to pumping effects.
- The highest water levels are in the northernmost site (Site 7), where the topographic elevation is highest. Unlike the WTA and wetland water levels, the lowest water levels in the LTA are at Site 5, the southernmost site.
- With the exception of Site 6, where water levels are lower than expected, it appears the highest water levels are in the north, and the lowest water levels are in the south, near the region of greatest agricultural pumpage.

4.4 VERTICAL HYDRAULIC GRADIENTS

Figure 44 shows the vertical hydraulic gradients calculated and plotted between the WTA and the LTA. Values greater than zero indicate a downward vertical flow from the WTA to the LTA. Values less than zero indicate upward vertical flow from the LTA to the WTA.

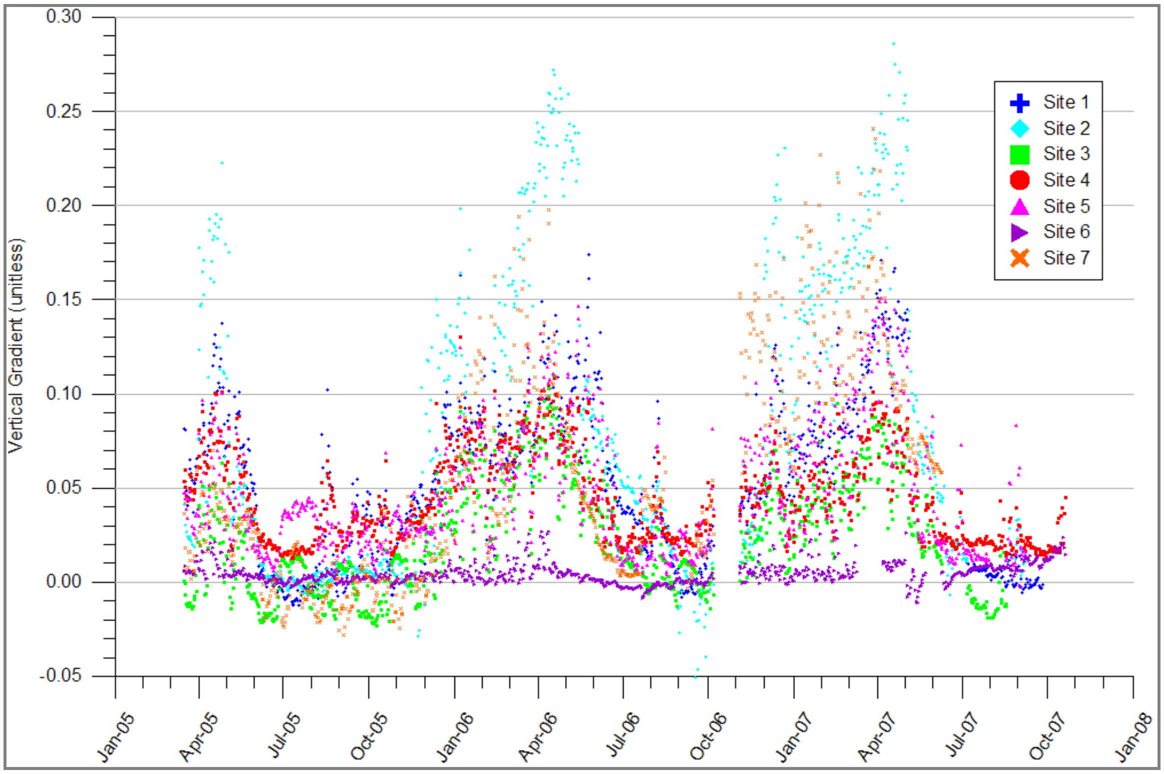

Figure 44. Vertical hydraulic gradients between the Lower Tamiami aquifer and water table aquifer.

Figure 44 indicates the farther away from zero a point occurs (either positive or negative), the steeper the hydraulic gradient between the WTA and LTA. A positive hydraulic gradient indicates a higher water level in the WTA than the LTA. A negative hydraulic gradient indicates a higher water level in the LTA than the WTA. The steepest hydraulic gradients occur at Site 2 and Site 7; though interestingly, these sites have the thinnest semi-confining unit thickness (see **Table 3**). The steepest gradients are seen in the late dry season when water use from the LTA is at its highest. The gradients flatten and return to near zero (no gradient) during the wet season. All sites, with the exception of Sites 4 and 7, periodically have a negative gradient, indicating a higher water level in the LTA than the WTA. The hydraulic gradient at Site 6 is relatively flat and close to zero. This indicates the water levels in the WTA and LTA are very close in elevation. This could be due to less confinement between the two water bearing units, indicating a greater degree of hydraulic interconnection.

5 Conclusions and Recommendations

5.1 CONCLUSIONS

The LTA is the primary source of irrigation water in the region, with approximately 565 permitted irrigation wells in the C-139 Basin. This hydrologic investigation looked at the aquifer characteristics in the LTA and the degree of interaction between the LTA, the WTA, and on-site wetlands at the Crooks Ranch and Golden Ox Ranch in Hendry County, Florida. The geologic and hydrologic data collected during this investigation indicate there is hydraulic connection between the WTA and the LTA. This connection is apparent in both the APTs and the long-term water level monitoring data. The degree of connection varies across the study area, but water use in the LTA affects water levels in the WTA at each study site.

Using the Hantush-Jacob method, aquifer parameters were calculated for the two APT sites. Site 6 yielded a transmissivity of 140,867 gpd/ft (18,834 ft^2/day), a storativity of 1.85×10^{-4}, and a leakance coefficient of 0.0015 per day. Site 4 yielded a transmissivity of 162,600 gpd/ft (21,734 ft^2/day), a storativity of 2.46×10^{-4}, and a leakance coefficient of 0.0026 per day. These values are consistent with those previously published by Smith and Adams (1988).

An evaluation of the hydraulic gradient between the WTA and the LTA shows the gradient between the two aquifers is steepest during the dry season and flattens out or reverses in the wet season. This observation is confirmed by long-term hydrographs, which show water levels in the LTA rise during the wet season, presumably because water use from the aquifer decreases. The hydraulic gradient at Site 6 remains relatively flat, and the long-term hydrograph for this site shows the water levels in the WTA and LTA correspond closely. Both of these factors indicate there is a strong hydraulic connection between the two aquifers at this site. Based on these data, it appears the steeper the hydraulic gradient between the two aquifers, the lower the degree of hydraulic connection (or the greater the degree of confinement) between the two.

At all of the study sites with stilling wells, the wetland water level data correspond closely to the water levels in the WTA. In some cases, the WTA water level is higher than that of the wetland, which may be due to several factors. It may be because the water level in the well is allowed to rise some distance above land surface, as each monitor well extends approximately 2.5 feet above land surface. The stilling well is screened above land surface, so when the wetland water level rises above the land surface, water fills in the surrounding area before it can rise in the well. As the wetland water levels respond in a similar manner to the WTA water levels, and as the data show a connection between water levels in the WTA and the LTA, there is some hydraulic connection among all three – the wetland, WTA, and LTA. Site 6 shows a high degree of hydraulic connection between the three water levels, as the level in the wetlands generally corresponds to the water level in the WTA. As previously mentioned, the water level in the WTA closely corresponds to the water level in the LTA, especially at Site 6. It is not apparent if rainfall or cessation of water use from the LTA has an impact on raising the water levels in the wetlands.

Technical and specific recommendations related to augmenting the existing monitoring program and ideas for additional data collection and analysis needs (for the next phase of investigation) are provided as follows.

5.2 RECOMMENDATIONS

Based on the findings of this hydrologic investigation, the following recommendations can be implemented to enhance the findings of this study:

- Conduct wetland assessments after reservoir construction to compare with wetland conditions before construction of the reservoir.
- Conduct wetlands assessments for all onsite wetlands, not just those planned for reservoirs. The onsite wetlands may be more vulnerable to dehydration than those enclosed by reservoirs.
- Select and monitor a wetland not impacted by groundwater withdrawals or the surface water system to determine its natural hydroperiod. In this way, the effects of groundwater withdrawals and surface water management practices can be distinguished from the existing, monitored wetlands.
- Install a rain gauge and surface water staff gauge(s) at each of the seven well locations to discern the isolated nature and effect of thunderstorms and to see how the surface water is regulated near the site.
- Conduct sieve analyses on cores (Sites 2 and 7) of the semi-confining unit to quantify vertical hydraulic conductivity between the two aquifers.
- Evaluate discharges within the study area to determine if other best management practices can be employed to retain the surface water within the wetland systems rather than discharging offsite.

- Require groundwater withdrawals be metered, both within the study area and on adjacent citrus/agricultural properties, or determine specific irrigation schedules of the various farm managers so pumpages can better reflect site irrigation practices.
- Gain information about the surface water system from as-built drawings and quantify, through time, surface water levels, and discharge volumes to natural areas or other downstream drainage systems.
- Compare pre- and post-reservoir construction hydrographs when all the reservoirs are complete.
- The APT pumping test well HES-20 at Site 4 should be properly plugged and abandoned or should be properly capped/sealed to prevent possible contamination of the aquifer.
- The APT pumping test well HES-21 at Site 6 should be located and should be properly plugged and abandoned.

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Crooks Ranch Consent Order 2004-182 CO

RECEIVED
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SOUTH FLORIDA
WATER MANAGEMENT DISTRICT

BEFORE THE GOVERNING BOARD OF THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

In re: **ORDER NO. SFWMD 2004-182-CO WU**

MICHAEL J. CROOKS

Respondent.

______________________________________/

CONSENT AGREEMENT

Pursuant to Chapter 373, Florida Statutes, and the rules promulgated thereunder, this Consent Agreement is entered into between the **SOUTH FLORIDA WATER MANAGEMENT DISTRICT** ("District") and **MICHAEL J. CROOKS** ("Respondent"), by mutual consent, without trial or adjudication of any issue of fact or law.

FINDINGS OF FACT

The District and Respondent stipulate to the following Findings of Fact:

1. The District is a public corporation of the State of Florida existing by virtue of Chapter 25270, Laws of Florida, 1949, and operating pursuant to Chapter 373, F. S. and Title 40E, F. A. C., as a multipurpose water management district with its principal office at 3301 Gun Club Road, West Palm Beach, FL 33406.

2. Respondent owns and operates an agricultural operation known as Crooks Ranch, located in Sections 11, 14, 15, 22 & 23, Township 46 South, Range 32 East, Hendry County, Florida, ("Property"). The Property is located in the C-139 Basin and it

is described on the location map attached hereto as Exhibit 1 and incorporated herein by reference. The address of the business is HC 61 Box 79, Clewiston, Florida 33440.

3. Respondent was originally permitted under Water Use Permit No. 26-00083-W for the withdrawal of irrigation water on March 12, 1977. This Permit was renewed on December 10, 1987. Within the current Permit, the Respondent is permitted to withdraw water via 10 wells from the Surficial Aquifer System to irrigate 135 acres of small vegetables within a 2,040 acre project site.

4. On May 23, 2002, Respondent applied for a Water Use Permit modification, Application # 020523-12, from the District. The application requested an increase in irrigated acreage from 135 acres to 1,597 acres of small vegetables. The application also requested to add 10 Lower Tamiami Aquifer wells to the 10 existing, permitted Surficial Aquifer wells.

5. The permit application remains incomplete and the District waived the timeframes for response to the additional information request until July 31, 2004.

6. The principle outstanding issue is whether the proposed use of water will result in harm to wetlands. The Respondent and District agree there is insufficient data available to accurately assess the impacts of the proposal to increase the total farming acreage, to increase the water use, and to construct and operate on-site reservoirs.

7. There is insufficient knowledge of the aquifer characteristics in this region as well as a lack of data regarding the hydrologic interaction between the Lower Tamiami Aquifer, Surficial Aquifer, effects of seasonality of the irrigation demands, the water table impacts associated with seepage irrigation systems, and the operation of surface

water management reservoirs on wetland hydrology. This interrelationship is currently undefined and cannot be quantified until further data is obtained.

8. The existing limited data on aquifer hydraulics suggests that the water table aquifer responds rapidly to pumpage from the Lower Tamiami aquifer in the C-139 basin suggesting there is little confinement between the two aquifers. Without offsetting factors related to irrigation methods or reservoirs, large volumes of withdrawals from the Lower Tamiami in this area could cause significant reductions in wetland hydroperiods that could be harmful.

9. Pursuant to Section 3.3.4.2, *Site Specific Considerations*, Basis Of Review For Water Use Permit Applications within the SFWMD (2003), site specific information is relevant to provide a more accurate determination of the potential for impacts to wetlands. Site specific information relevant to this determination includes local hydrology, geology, actual water use, seasonality of water use and may include such information at that detailed in Section 3.3.4.2 A – C.

10. It is recognized that certain farming activities, including seepage irrigation systems, have been documented to aid in the hydrology of wetlands systems during dry periods. Also, the crops associated with seepage irrigation systems are seasonal in nature, with little demand during the wet season and higher demand during dry season.

11. In addition, water treatment reservoirs, to be constructed by the Respondent as a component of addressing C-139 Basin water quality issues, also act to protect the hydrology of wetland systems.

12. The District has regional water resource concerns related to groundwater availability in the C-139 Basin. Agricultural water demands within Hendry County,

which comprises most of the C-139 Basin, account for 99 percent of its estimated total water supply demands. These demands were projected to grow by 50% between 1990 and_2010. ("Water Supply Needs and Sources-- 1990-2010", South Florida Water Management District July 1992.)

13. The Surficial Aquifer System (SAS), comprised of the Water Table and Lower Tamiami aquifers, within the C-139 Basin, is the primary source of fresh groundwater available to meet both existing and future water supply demands within the basin.

14. Consumptive use permit allocations from these sources in this area have been historically limited due to the variable water-bearing characteristics, susceptibility to drought stress, and potential impacts to wetlands. The lack of information regarding the potential safe yield of the Lower Tamiami Aquifer in relation to wetland and other surface waters has significantly limited the District's ability to adequately assess the availability of these groundwater resources for water supply.

15. The "Water Supply Needs and Sources-- 1990-2010", South Florida Water Management District July 1992, and Lower West Coast Regional Water Supply Plan (Recommendation 2.1) recommended that technical studies of the regional and site local characteristics of the SAS must be conducted in order to adequately assess the potential for harm to wetlands as a result of withdrawals.

16. In sum, there is little data available in the C-139 Basin regarding how agricultural pumpage from the Lower Tamiami aquifer affects the hydrology of wetland systems on a local and subregional scale. It is suspected that certain irrigation methods combined with the design of surface water management reservoirs which incorporate and preserve wetlands may effectively offset the pumpage impacts and

effectively prevent harm to wetlands. No studies have been undertaken to address the effects of that these farming practices have on protecting wetland hydrology. Without this data, groundwater resource development has been limited and may, potentially, artificially restrict the availability of groundwater for allocation.

17. In order to properly assess the impacts to wetlands, the following data will be necessary: (1) aquifer test data to determine the hydrologic interaction between pumping from the Lower Tamiami aquifer and the Water Table aquifer, (2) the effects of the proposed seepage irrigation on the hydrology of the adjacent wetlands, (3) the impacts of seasonal demands of the proposed crops on the hydroperiods of wetlands, and (4) the effects of the construction and operation of stormwater reservoirs on protecting wetlands from water use drawdowns.

18. In order to promote the regional availability of water, a study to gather this type of data would be advantageous. The District is willing to perform such a study.

ULTIMATE FACTS AND CONCLUSIONS OF LAW

19. The District alleges that, based on the information provided by the Respondent in its application, reasonable assurances have not been provided that the withdrawal of the recommended allocation from the Lower Tamiami aquifer will not harm wetlands.

20. The information existing within the C-139 Basin regarding such issues as groundwater aquifers, the interface of these aquifers with wetland features, the influence of surface water management system design features, impacts of seepage irrigation and the seasonality of demand is deficient in this region. This lack of

information may be artificially restricting development of groundwater resources throughout the C-139 basin.

21. General policies under Chapter 373, F.S., including the water use permitting statutes, require the water management districts "(2) . . . (b)to promote the conservation, replenishment, recapture, enhancement, development, and proper utilization of surface and ground water; . . . [and] (d) to promote the availability of sufficient water for all existing and future reasonable- beneficial uses and natural systems; . .." Section 373.016, F.S.

22. In addition, pursuant to Section 373.036(2), F.S., the water management districts are required to provide a district water management plan to implement its responsibilities under Chapter 373, F.S., giving due consideration to "the attainment of maximum reasonable-beneficial use of the water resources" and "the maximum economic development of the water resources consistent with other uses." Sections 373.036(2)(d)1. and 2., F.S.

23. The district water management plan includes an assessment of regional water resources needs and sources and development of technical information describing the groundwater characteristics and yields to meet water supply demands. In addition, Section 373.145, F.S., requires the water management districts to develop an nformation program designed to assess the existing hydrologic condition of groundwater sources.

24. The District has prepared a District Water Management Plan addressing the needs and sources in this region in accordance with statutory guidance.

25. Section 373.171(1), F.S., authorizes the water management districts to issue orders affecting the use of water, as conditions warrant to "obtain the most beneficial use of the water resources of the state and to protect the public, health, safety, and welfare and the interests of the water user affected, . . . "

26. Chapter 373, F.S., gives deference to water management district governing boards in defining how to maximize reasonable-beneficial uses of the States' water resources, including the balance of various missions to address harm to the water resources while developing water resources for consumptive uses. Village of Tequesta v. Jupiter Inlet Corp., 371 So. 2d 663 (Fla. 1979); Harloff v. City of Sarasota and SWFWMD, 575 So. 2d 1324 (Fla. 2d DCA 1991); Osceola County v. St. Johns River Water Management District, 486 So.2d 616, 617-618 (Fla. 5th DCA 1986), aff'd, 504 So.2d 385 (Fla. 1987).

27. The District is authorized to enter into agreements pursuant to Section 373.083, F. S.

28. The Governing Board has authorized the Executive Director, or his designee, to execute this Consent Agreement.

THEREFORE, having reached a resolution of this matter, the District and the Respondent mutually agree and it is ordered that:

ORDER

I. Consumptive Use Authorization:

A. Allocation: The District authorizes the Respondent to irrigate 687 net acres (see Exhibit 1) of small vegetables for the duration of this Consent Agreement.

The Respondent shall not exceed 256.00 MG/year, with a maximum monthly use not to exceed 61.28 MG. The District authorizes the use of wells E-3, E-5 through E-14, and proposed wells P-16, P-18, P-19, and P-20 for the withdrawal. No other wells may be utilized for this withdrawal. No increase in pumpage or irrigated acreage over the amount allotted in this Consent Agreement shall occur without written prior approval by the Director of the Water Use Regulation.

B. Pumpage Reporting: The total monthly pumpage from each well shall be reported to Kurt Leckler, Supervisor Water Use Compliance at 3301 Gun Club Road, West Palm Beach, Fl. 33406 within 15 days of the end of the month. The Respondent shall provide the District representative lithologic samples collected during drilling of one of the proposed wells at five (5) foot intervals within 30 days of the well completion.

C. Crop Maps: Prior to planting each crop, the Respondent shall submit a map of the project to the District, to the same address, which identifies the location of the crop, the number of acres, the crop type, and the specific wells to be utilized.

II. District Research Program:

A. Site Access: The Respondent grants site access, as outlined in the Right of Entry attached as Exhibit 2, to the District and its contractors for the following purposes. Within six months of the date of this Agreement, the District shall construct and begin to monitor test wells, and associated monitoring equipment. Further, the District may conduct wetland functional assessments.

B. District Compliance Inspections: The District may conduct compliance inspections to verify compliance with the provisions of the Consent Agreement or for any other District related business.

C. Aquifer Performance Test: Finally, the District may conduct an aquifer performance test on one of Respondent's Lower Tamiami Aquifer production well at a time and for a duration agreed to by both parties.

D. Scope of District Research Program: The District shall perform on-site aquifer testing, wetland water level monitoring, and calibrated groundwater modeling incorporating data collected from the site during increased water use. A goal of the District's research program is to attain sufficient information regarding groundwater availability, the interface of the aquifers with surficial features such as wetlands and surface water management systems, to enable more specific assessment of this and future consumptive use permit applications in the C-139 Basin. In this manner, the District seeks to maximize development of the groundwater resource while assuring harm to the natural system will not occur. In this specific instance, while the research work is on-going, the parties seek to_ insure that the wetlands will not be adversely impacted so as to cause harm as a result of the increase in withdrawal from the Lower Tamiami aquifer authorized herein. However, the parties recognize a potential exists for such harm. The following paragraph addresses such circumstances.

III. Respondent's Periodic Notice to the District:

A. Work Plan and Recap: The Respondent shall send a letter to the District every three months for the duration of the Consent Agreement. The letter shall outline the work that has been performed by the Respondent for the past three months and outline the work that is anticipated over the following three months. This shall include, but not be limited to, the construction of reservoirs and the acreage, crop type, irrigation method and field location of all crops planted in the previous three months and projected to be planted in the next three months, wells used and the amounts pumped from each well per month.

B. Daily rainfall measurement reporting: Further, at the time of each Work Plan Letter, the Respondent shall provide daily rain measurements to the District.

IV. Consent Agreement Termination:

This agreement shall terminate on June 1, 2006 unless extended by mutual agreement. If the District determines that Respondent's withdrawals authorized pursuant to this Consent Agreement results in harm to the natural resources, or to existing legal users, and the District determines that timely and effective mitigation is not practicable, the District may terminate this Consent Agreement. However, prior to termination of the Consent Agreement, the District shall provide the property owner a reasonable time to cure the problem and to remedy the harm. If the property owner can not timely and effectively cure the problem, the District shall consider the most reasonable timeframe and method to terminate the Consent Agreement. The District shall consider the crops that have been planted and the amount of water necessary to complete the growing season. The District shall work with the property owner and be reasonable in its solution to terminate the Consent Agreement.

V. General Provisions:

A. The Respondent shall withdraw its pending application, application No. 020523-12, within 30 days of the date of final execution of this Consent Agreement.

B. The Respondent shall comply with the conditions included in Exhibit 3 of the Consent Agreement. Failure to comply with these or other provisions of this Consent Agreement are subject to enforcement actions.

C. Execution of this Consent Agreement does not guarantee to the Respondent that the results obtained from District field investigations and/or modeling efforts will allow the continued use of water by the Respondent upon the expiration of this Consent Agreement.

D. The District does not, by entering into this Consent Agreement, agree or guarantee that Respondent's future water use permit renewal application will be approved. Further, the Consent Agreement may not be considered a permitted right to use water. Finally, the Respondent's future water use permit renewal application will be evaluated based on criteria in effect at the time the application becomes complete. However, the Respondent is permitted for a valid Water Use Permit, Permit No. 26-00083-W. Regardless of the existence of this Consent Agreement, the Respondent maintains all the rights outlined in that permit. The Respondent shall be able to continue to operate under that permit regardless of this Consent Agreement, as long as the Respondent complies with the obligations of that permit.

GENERAL PROVISIONS

29. The District hereby expressly reserves the right to petition for judicial enforcement of the terms of this Consent Agreement. In such event, the Respondent and its successors and/or assigns in interest shall not contest or deny any fact, legal conclusion, or any other matter or fact set forth in this Consent Agreement, including the Findings of Fact, Ultimate Facts and Conclusions of Law set forth herein. If the District successfully petitions or sues for enforcement of this Consent Agreement, the Respondent, its heirs, successors and/or assigns hereby agree to and shall pay all attorneys' fees, (including, but not limited to, the fair market value of in house counsel fees, as if performed by outside or private counsel, court costs and any other damages sustained by the District). In addition, the District hereby expressly reserves the right to initiate appropriate legal action to prevent or prohibit the future violation of applicable statutes or the rules promulgated there under, or to alleviate an immediate serious danger to the public health, safety or welfare.

30. The District reserves the right to curtail water use pumpage in the event of a declared water shortage pursuant to Chapter 40E-21, F.A.C.

31. Failure to comply with this Consent Agreement shall constitute a violation of Chapter 373, F. S., and enforcement proceedings may be brought in any appropriate administrative or judicial forum.

32. This Consent Agreement shall take effect after adoption by and execution on behalf of the Governing Board of the District, when the Consent Agreement is filed with and acknowledged by the Clerk of the District immediately thereafter, and shall

remain in full force and effect until its terms and conditions are completed to the satisfaction of the District. The requirements of this Consent Agreement shall bind and inure to the benefit of the successors and assigns of the Respondent, except as modified by the parties hereto. In addition, prior to any sale, transfer, conveyance or lease of the Property, the Respondent shall provide a copy of this Consent Agreement to any prospective successor in interest. Additionally, the Respondent shall provide notification to the District at least 30 days prior to any sale, transfer or conveyance of the Property.

33. Respondent hereby waives the right to request an administrative hearing on the terms of this Consent Agreement under Sections 120.569 and 120.57, F. S., and acknowledges but waives their right to appeal this Consent Agreement pursuant to Section 120.68 F. S., upon signing this Consent Agreement.

34. Entry into this Consent Agreement does not relieve the Respondent of the need to comply with all applicable federal, state or local laws, regulation or ordinances, including any District permitting requirements. Also, the Consent Agreement does not give the Respondent the authority to conduct any activities on the Property which are under District jurisdiction without first obtaining District authority.

35. In addition, nothing herein shall be construed to limit the authority of the District to undertake any action against the Respondent in response to or to recover the costs of responding to conditions at the site or to enforce the terms of this Consent Agreement and Permit No. 26-00083-W and the District hereby expressly reserves the right to initiate appropriate legal action to prevent, prohibit or abate any future violations of applicable statutes or the rules promulgated thereunder, or to alleviate an immediate

serious danger to the public health, safety or welfare or any violation not specifically addressed by this Consent Agreement.

36. Respondent is fully aware that a violation of the terms of this Consent Agreement may subject the Respondent to judicial imposition of damages, civil penalties up to Ten Thousand Dollars ($10,000.00) per offense per day, costs and criminal penalties.

37. If any event occurs which causes delay or reasonable likelihood of delay, in complying with the requirements or deadlines of this Consent Agreement, the Respondent shall have the burden of proving that the delay was or will be caused by circumstances beyond the reasonable control of the Respondent and could not have been or cannot be overcome by the Respondent's due diligence. Economic circumstances shall not be considered circumstances beyond the control of the Respondent, nor shall the failure of a contractor, subcontractor, material man, or other agent (collectively referred to as contractor) to whom responsibility for performance is delegated to meet contractually imposed deadlines be a cause beyond the control of the Respondent unless the cause of the contractor's late performance was also beyond the contractor's control. Upon occurrence of an event causing delay, or upon becoming aware of a potential for delay, the Respondent shall notify the District orally within 24 hours or by the next working day and shall, within seven days of oral notification to the District, notify the District in writing of the anticipated length and cause of the delay, the measures taken or to be taken to prevent or minimize the delay, and the timetable by which the Respondent intends to implement these measures. If the parties can agree that the delay or anticipated delay has been or will be caused by circumstance beyond

the reasonable control of the Respondent, the time for performance hereunder shall be extended for a period equal to the agreed delay resulting from such circumstances. Such agreement shall adopt all reasonable measures necessary to avoid or minimize delay. Failure of the Respondent to comply with the notice requirements of this paragraph in a timely manner shall constitute a waiver of the Respondent's right to request an extension of time for compliance with the requirements or deadlines in this Consent Agreement.

38. This Consent Agreement does not convey any property right to the Respondent, nor any rights and privileges other than those specified in the Consent Agreement. This Consent Agreement incorporates, embodies and expresses all agreements between the Respondent and the District and may not be altered except as authorized herein.

39. All notices or other submittals required under this Consent Agreement unless otherwise specified, shall be submitted to the South Florida Water Management District, Attention To: Scott Burns, Department Director, P.O. Box 24680, West Palm Beach, Florida 33416.

40. Persons who are not parties to this Consent Agreement, but whose substantial interests may be affected by this Consent Agreement, may have a right to petition this Consent Agreement. A notice of rights is attached and incorporated as Exhibit D.

41. This Consent Agreement is a final order from the District, pursuant to Section 120.52(7), F.S., and is final and effective on the date filed with the Clerk of the District unless a petition for administrative hearing is filed in accordance with Chapter

120, F.S., or any other applicable state law. Upon the timely filing of a petition, the Consent Agreement will not be effective until further order from the District.

DONE AND SO ORDERED at West Palm Beach, Palm Beach County, Florida, this 13th day of October, 2004

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
BY ITS GOVERNING BOARD

BY: ______________________
Chairman

RESPONDENT

BY: ______________________
Michael J. Crooks

ATTEST:

BY: ______________________

Legal Form Approved:

By: ______________________

40. Persons who are not parties to this Consent Agreement, but whose substantial interests may be affected by this Consent Agreement, may have a right to petition this Consent Agreement. A notice of rights is attached and incorporated as Exhibit D.

41. This Consent Agreement is a final order from the District, pursuant to Section 120.52(7), F.S., and is final and effective on the date filed with the Clerk of the District unless a petition for administrative hearing is filed in accordance with Chapter 120, F.S., or any other applicable state law Upon the timely filing of a petition, the Consent Agreement will not be effective until further order from the District.

DONE AND SO ORDERED at West Palm Beach, Palm Beach County, Florida, this 12 day of October, 2004

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
BY ITS GOVERNING BOARD

BY:____________________
Deputy Executive Director

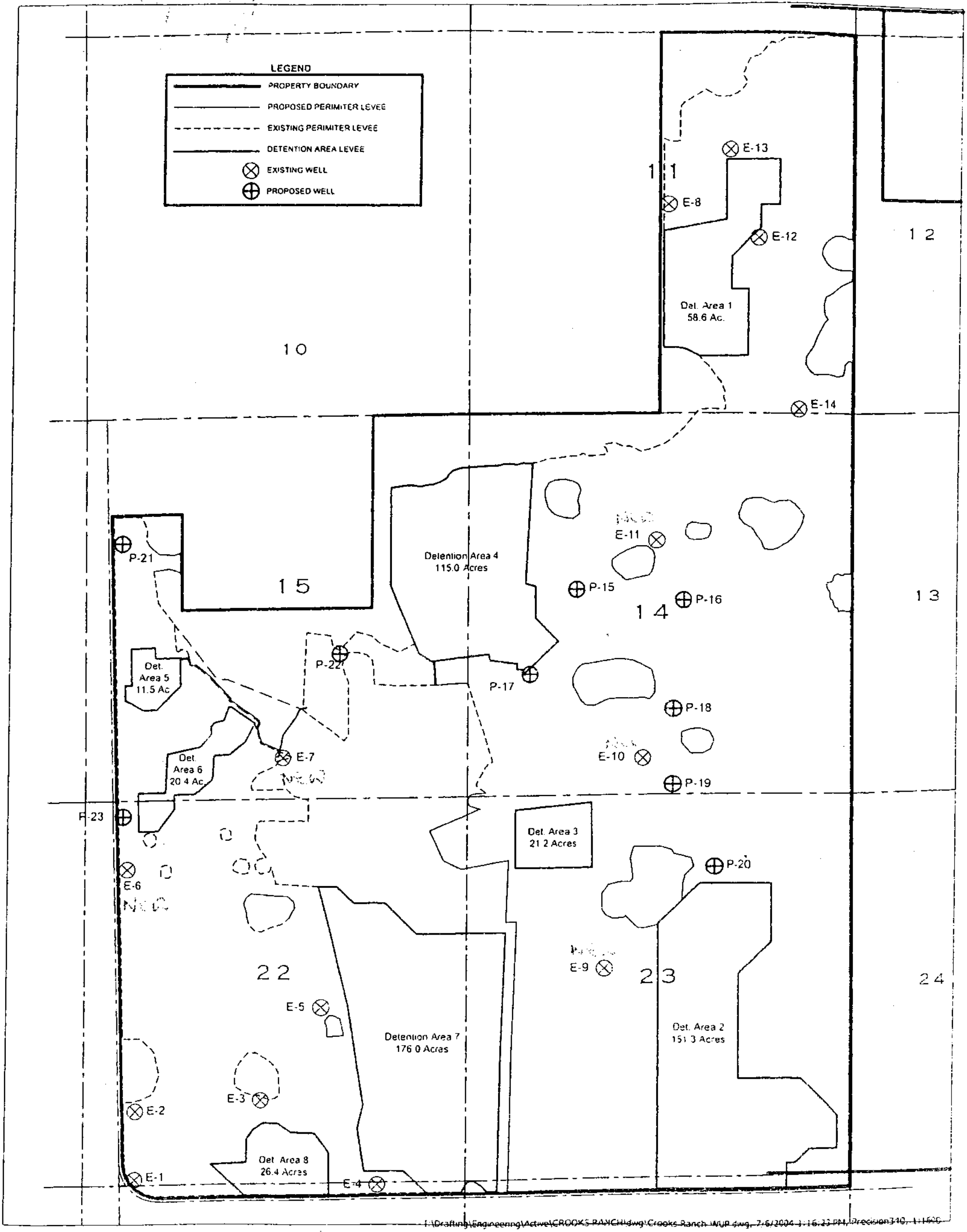
RESPONDENT

BY: Michael J. Crooks
Michael J. Crooks

ATTEST:

BY: Julia Atkins

Exhibit 1



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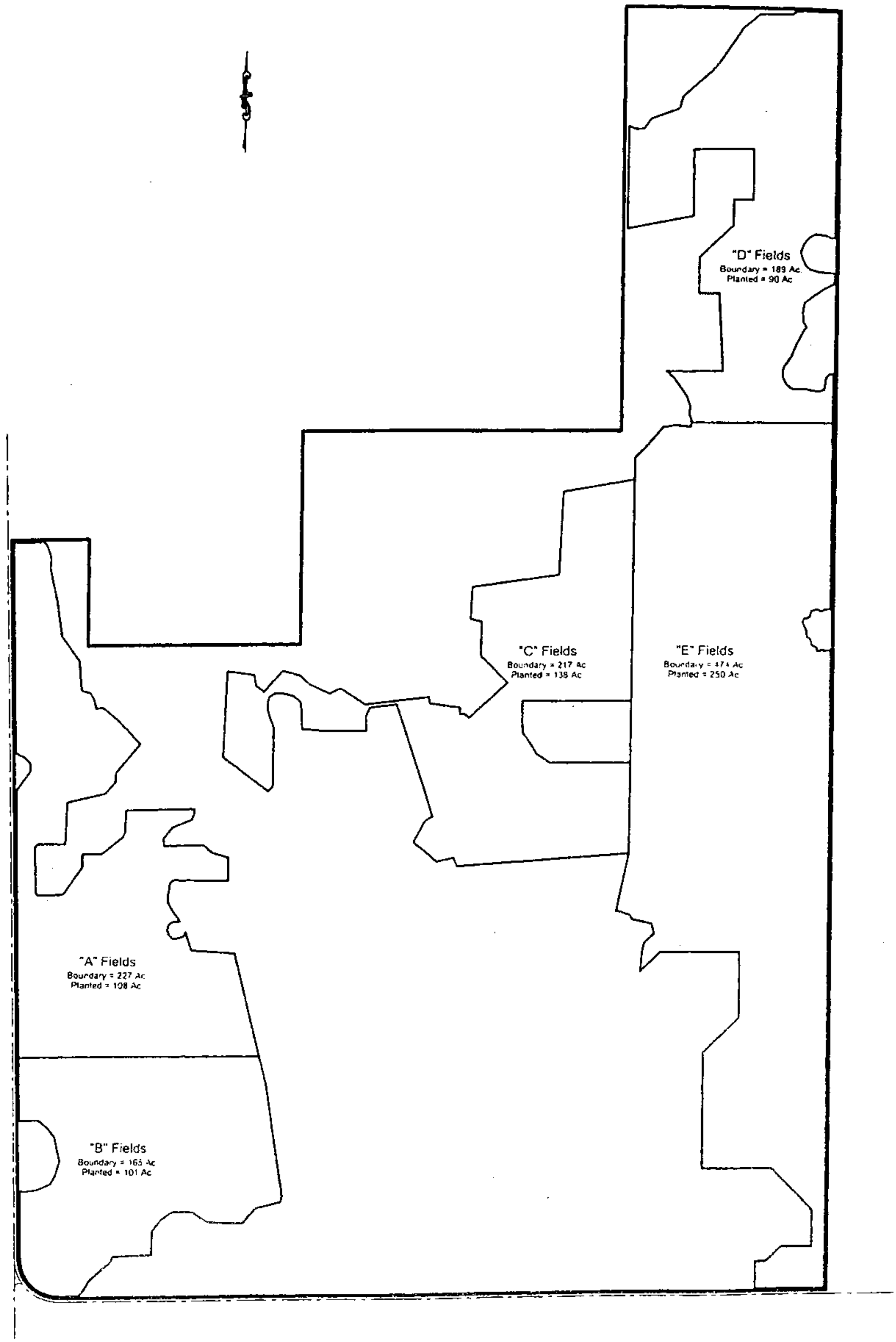

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Exhibit 2

RIGHT OF ENTRY

Project: Crooks Ranch

CROOKS RANCH , (hereinafter "Property Owner"), whose mailing address is 27210 CR 833, Clewiston, FL 33440, and SOUTH FLORIDA WATER MANAGEMENT DISTRICT, a public corporation of the State of Florida (hereinafter "District"), whose principal office is located at 3301 Gun Club Road, West Palm Beach, Florida, its agents, contractors, employees and assigns, hereby agree that District shall have the right to enter upon only that portion of that certain real property owned by Property Owner, located in Sections 11, 14, 15 22 and 23, Township 46 South, Range 32, Hendry County, (hereinafter the "Property") for the purposed described below:

Project Description

The Respondent grants site access to the District and its contractors for the following purposes. The District shall access the site in order to carry out the activities outlined in that certain Consent Agreement Order No. SFWMD 2004-182-CO WU, dated October 13, 2004. The activities shall include, but are not limited to, the construction and monitoring of test wells, and associated monitoring equipment. The District may conduct wetland functional assessments. The District may conduct compliance inspections to verify compliance with the provisions of the Consent Agreement. Finally, the District may conduct an aquifer performance test on a lower Tamiami aquifer production well.

Agreement

The Property Owner and the District hereby agree as follows:

1. The Property Owner hereby acknowledges that (i) any equipment or physical structure (i.e. water well) placed on the Property by the District shall remain the property of the District; and, (ii) upon request of the Property Owner, all such equipment shall be removed from the Property, and any wells capped or filled in, by the District on or before the termination of this Right of Entry.
2. The District agrees that, upon completion of the activities proposed in this Right of Entry, any portion of the Property which is damaged as a result of activities conducted by the District pursuant to this Right of Entry will be returned to substantially the same condition that it was in on the date hereof.
3. The Property Owner shall allow all authorized representatives of the District, their vehicles and equipment access to the Property on reasonable notice in order to implement and carry out the activities described herein, including all necessary calibration activities; the safety for which the Property Owner shall have no responsibility.
4. This Right of Entry does not convey any property rights or equipment to the Property Owner nor any rights and privileges other than those specified herein.

5. The District acknowledges its liability for torts to the extent provided and allowed under Section 768.28, Florida Statutes, and that the District is solely responsible for any damage or injury sustained by any of its representatives, subcontractors, agents and their vehicles and equipment. Nothing contained herein shall constitute a waiver of sovereign immunity beyond the limits set forth in Section 768.28, Florida Statutes.

6. The Property Owner shall not be liable under any circumstances for any damage to the District's personal property or equipment placed upon the Property in connection with this Right of Entry, or the theft thereof, unless such damage or theft is due to the willful or intentional acts or omissions of the Property Owner or the Property Owner's agents and then only to the extent such damage or theft is directly, indirectly or proximately caused by such willful or intentional acts or omissions. However, nothing contained herein shall constitute a waiver of sovereign immunity beyond the limits set forth in Section 768.28, Florida statutes, nor shall the same be construed to constitute agreement by the District to indemnify the Property Owner for the Property Owner's willful or intentional acts or omissions. The Property Owner shall not have responsibility for the security of, or restricting access to, the District's personal property or equipment for which the District assumes all risk in relation to relocating the same on Property Owner's Property.

7. The Property Owner shall indemnify, save and hold the District, its agents, assigns, and employees harmless from any and all claims or causes of action, including, without limitation, all damages, losses, liabilities, expenses, costs and attorney's fees related to such claims that may arise in connection with the work to be performed at the site, except as otherwise provided in Paragraphs 5 and 6.

8. Entry into this Right of Entry does not relieve the Property Owner's need to comply with other federal, state or local laws, regulations or ordinances, or the requirements of District issued water use permit(s).

9. This Right of Entry may be modified only upon the mutual consent of both parties, submitted in writing.

10. Prior to any sale, transfer or conveyance of the Property, the District requests notification so that alternative agreements or arrangements may be made, if necessary.

11. Either party may terminate this Right of Entry upon thirty (30) days prior written notice.

12. The initial term of this Right of Entry shall expire on June 1, 2006. All terms, conditions, covenants and provisions of this Right of Entry shall apply during such renewal term, if any.

WITNESS our hands and seals this 13th day of October, 2004.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

By:____

____
(Printed Name)

CROOKS RANCH
PROPERTY OWNER

J Michael Crooks
MICHAEL J. CROOKS

Received Time Nov.16. 7:57PM

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

By:______________________________

____
(Printed Name)

CROOKS RANCH
PROPERTY OWNER

____
MICHAEL J. CROOKS

Exhibit 3

Limiting Conditions

1) Total annual allocation is 256 MG.

Total maximum monthly allocation is 61.28 MG.

These allocations represent the amount of water required to meet the water demands as a result of rainfall deficit during a drought with the probability of recurring one year in ten. The Respondent shall not exceed these allocations in hydrologic conditions less than a 1 in 10 year drought event. If the rainfall deficit is more severe than that expected to recur once every ten years, the withdrawals shall not exceed that amount necessary to continue to meet the reasonable-beneficial demands under such conditions, provided no harm to the water resources occur and:

The withdrawal is otherwise consistent with applicable declared Water Shortage Orders in effect pursuant to Chapter 40E-21, F.A.C.

2) Respondent shall mitigate interference with existing legal uses that was caused in whole or in part by the Respondent's withdrawals, consistent with the approved mitigation plan. As necessary to offset the interference, mitigation will include pumpage reduction, replacement of the impacted individual's equipment, relocation of wells, change in withdrawal source, or other means.

Interference to an existing legal use is defined as an impact that occurs under hydrologic conditions equal to or less severe than a 1 in 10 year drought event that results in the:

1. Inability to withdraw water consistent with provisions of the permit, such as when remedial structural or operational actions not materially authorized by existing permits must be taken to address the interference; or

2. Change in the quality of water pursuant to primary State Drinking Water Standards to the extent that the water can no longer be used for its authorized purpose, or such change is imminent.

3) Respondent shall mitigate harm to existing off-site land uses caused by the Respondent's withdrawals. When harm occurs, or is imminent, the District will require the Respondent to modify withdrawal rates or mitigate the harm. Harm includes:

1. Significant reduction in water levels on the property to the extent that the designed function of the water body and related surface water management improvements are damaged, not including aesthetic values. The designed function of a water body is identified in the original permit or other governmental authorization issued for the construction of the water body. In cases where a permit was not required, the designed function shall be determined based on the purpose for the original construction of the water body (e.g. fill for construction, mining, drainage canal, etc.)

2. Damage to agriculture, including damage resulting from reduction in soil moisture resulting from consumptive use; or

3. Land collapse or subsidence caused by reduction in water levels associated with consumptive use.

4) Respondent shall mitigate harm to the natural resources caused by the respondent's withdrawals, as determined through reference to the Consent Agreement. When harm occurs, or is imminent, the District will require the Respondent to modify withdrawal rates or mitigate the harm. Harm includes:

(1) Reduction in ground or surface water levels that result in harmful lateral movement of the fresh water/salt water interface,

(2) Reduction in water levels that harm the hydroperiod of wetlands,

(3) Significant reduction in water levels or hydroperiod in a naturally occurring water body such as a lake or pond,

(4) Harmful movement of contaminants in violation of state water quality standards,

(5) Harm to the natural system including damage to habitat for rare and endangered species.

5) Prior to the use of any water withdrawal facility authorized under this Consent Agreement, unless otherwise specified, the Respondent shall equip each facility with a District-approved operating water use accounting system and submit a report of calibration to the District, pursuant to Section 4.1, Basis of Review for Water Use Permit Applications.

In addition, the Respondent shall submit a report of recalibration for the water use accounting system for each water withdrawal facility (existing and proposed) authorized under this Consent Agreement every five years from each previous calibration, continuing at five-year increments.

6) Monthly withdrawals for each withdrawal facility shall be submitted to the District quarterly. The water accounting method and means of calibration shall be stated on each report.

7) If a proposed well location is different from a location specified in the Consent Agreement, the Respondent shall submit to the District an evaluation of the impact of pumpage from the proposed well location on adjacent existing legal uses, pollution sources, environmental features, the saline water interface, and water bodies one month prior to all new well construction.

8) Respondent shall secure a well construction permit prior to construction, repair, or abandonment of all wells, as described in Chapters 40E-3 and 40E-30, Florida Administrative Code.

9) The Respondent shall submit to the District an updated Well Description Table (Table A) within one month of completion of the proposed wells identifying the actual total and cased depths, pump manufacturer and model numbers, pump types, intake depths and type of meters.

10) In the event of a declared water shortage, water withdrawal reductions will be ordered by the District in accordance with the Water Shortage Plan, Chapter 40E-21, F.A.C. The Respondent is advised that during a water shortage, pumpage reports shall be submitted as required by Chapter 40-21, F.A.C.

11) Monthly withdrawals for each withdrawal facility shall be submitted to the District quarterly. The water accounting method and means of calibration shall be stated on each report.

B

Golden Ox Ranch Consent Order 2005-003 CO WU

1-12-2005

BEFORE THE GOVERNING BOARD OF THE
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

In re: ORDER NO. SFWMD 2005-003 CO WU

JAMES D. HULL and PAULINE TOWNSEND
Respondents.

______________________________/

CONSENT AGREEMENT

Pursuant to Chapter 373, Florida Statutes, and the rules promulgated thereunder, this Consent Agreement is entered into between the **SOUTH FLORIDA WATER MANAGEMENT DISTRICT** ("District") and **JAMES D. HULL and PAULINE TOWNSEND** ("Respondents"), by mutual consent, without trial or adjudication of any issue of fact or law.

FINDINGS OF FACT

The District and Respondent stipulate to the following Findings of Fact:

1. The District is a public corporation of the State of Florida existing by virtue of Chapter 25270, Laws of Florida, 1949, and operating pursuant to Chapter 373, F. S. and Title 40E, F. A. C., as a multipurpose water management district with its principal office at 3301 Gun Club Road, West Palm Beach, FL 33406.

2. Respondents owns and operates an agricultural operation known as Devils Garden Golden Ox, located in Section 3 and 10, Township 46 South, Range 32 East, Hendry County, Florida, ("Property"). The Property is located in the C-139 Basin and it is described on the location map attached hereto as Exhibit 1 and incorporated herein

by reference. The address of the business is 5300 Lee Boulevard, Lehigh Acres, Florida 33971.

Enforcement History

3. It is the District's position that District staff conducted numerous inspections of the Property between September 23, 2002 and April 28, 2003. During several of these inspections, District staff documented unauthorized "works" on the Property, such as dike construction, ditch excavation, surface water pumping, unpermitted discharge and water use. These works were impeding historic surface water flows and creating adverse impacts to adjacent properties.

4. A Notice of Violation was issued on September 27, 2003 and amended on October 24, 2002 to the Respondent. The District cost code for the enforcement is 2160.

5. An In Aid of Settlement Letter was issued on March 24, 2003.

6. Respondent has applied for an Environmental Resource Permit from the District, application #000731-4, on July 31, 2000. The application would allow the construction and operation of a surface water management system for an agricultural operation on 1284.06 acres in Hendry County on the subject property.

Water Use History

7. Respondents have an existing farm that has no existing water use permit. The Respondents have 14 existing wells constructed in the Surficial Aquifer System (lower Tamiami aquifer) to irrigate 474.2 acres of small vegetables within a 1,284 acre project site.

8. On February 8, 1999, Respondents applied for a Water Use Permit, Application # 990208-9, from the District.

9. Due to lack of information, and uncertainty of the available information, the applicant has not been able to satisfy the criteria of Chapter 373, F.S, or Chapter 40E-2, F.A.C. The applicant has not received a water use permit from the District. Instead, the application, # 990208-9, is currently incomplete.

LACK OF HYDROLOGIC DATA IN C-139 BASIN

10. The principle outstanding issue is whether the proposed use of water will result in harm to wetlands pursuant to Rule 40E-2.301, F.A.C. Pursuant to Section 3.3.4.2, *Site Specific Considerations*, Basis Of Review For Water Use Permit Applications within the SFWMD (2003), site specific information is relevant to provide a more accurate determination of the potential for impacts to wetlands. Site specific information relevant to this determination includes local hydrology, geology, actual water use, seasonality of water use and may include such information at that detailed in Section 3.3.4.2 A – C. The Respondents and District agree there is insufficient data available to accurately assess the impacts of the proposal to increase the total farming acreage, to increase the water use, and to construct and operate on-site reservoirs.

11. However, there is insufficient knowledge of the aquifer characteristics in this region, as well as a lack of data regarding the hydrologic interaction between the Lower Tamiami Aquifer, Surficial Aquifer, effects of seasonality of the irrigation demands, the water table impacts associated with seepage irrigation systems, and the operation of surface water management reservoirs on wetland hydrology. This interrelationship is currently undefined and cannot be quantified until further data is obtained.

12. The existing limited data on aquifer hydraulics suggests that the water table aquifer responds rapidly to pumpage from the Lower Tamiami aquifer in the C-139 basin suggesting there is little confinement between the two aquifers. Without offsetting factors related to irrigation methods or reservoirs, large volumes of withdrawals from the Lower Tamiami in this area could cause significant reductions in wetland hydroperiods that could be harmful.

13. It is recognized that certain farming activities, including seepage irrigation systems, have been documented to aid in the hydrology of wetlands systems during dry periods. Also, the crops associated with seepage irrigation systems are seasonal in nature, with little demand during the wet season and higher demand during dry season.

14. In addition, water treatment reservoirs, to be constructed by the Respondents as a component of addressing C-139 Basin water quality issues, also act to protect the hydrology of wetland systems.

15. The District has regional water resource concerns related to groundwater availability in the C-139 Basin. Agricultural water demands within Hendry County, which comprises most of the C-139 Basin, account for 99 percent of its estimated total water supply demands. These demands were projected to grow by 50% between 1990 and 2010. ("Water Supply Needs and Sources-- 1990-2010", South Florida Water Management District July 1992.)

16. The Surficial Aquifer System (SAS), comprised of the Water Table and Lower Tamiami aquifers, within the C-139 Basin, is the primary source of fresh groundwater available to meet both existing and future water supply demands within the basin.

17. Consumptive use permit allocations from these sources in this area have been historically limited due to the variable water-bearing characteristics, susceptibility to drought stress, and potential impacts to wetlands. The lack of information regarding the potential safe yield of the Lower Tamiami Aquifer in relation to wetland and other surface waters has significantly limited the District's ability to adequately assess the availability of these groundwater resources for water supply.

18. The "Water Supply Needs and Sources-- 1990-2010", South Florida Water Management District July 1992, and Lower West Coast Regional Water Supply Plan (Recommendation 2.1) recommended that technical studies of the regional and site local characteristics of the SAS must be conducted in order to adequately assess the potential for harm to wetlands as a result of withdrawals.

19. In sum, there is little data available in the C-139 Basin regarding how agricultural pumpage from the Lower Tamiami aquifer affects the hydrology of wetland systems on a local and subregional scale. It is suspected that certain irrigation methods combined with the design of surface water management reservoirs which incorporate and preserve wetlands may effectively offset the pumpage impacts and effectively prevent harm to wetlands. No studies have been undertaken to address the effects of that these farming practices have on protecting wetland hydrology. Without this data, groundwater resource development has been limited and may, potentially, artificially restrict the availability of groundwater for allocation.

20. In order to properly assess the impacts to wetlands, the following data will be necessary: (1) aquifer test data to determine the hydrologic interaction between pumping from the Lower Tamiami aquifer and the Water Table aquifer, (2) the effects of

the proposed seepage irrigation on the hydrology of the adjacent wetlands, (3) the impacts of seasonal demands of the proposed crops on the hydroperiods of wetlands, and (4) the effects of the construction and operation of stormwater reservoirs on protecting wetlands from water use drawdowns.

21. In order to promote the regional availability of water, a study to gather this type of data would be advantageous. The District is willing to perform such a study. The District's policy, pursuant to Chapter 373.016, F.S., is to promote the conservation, replenishment, recapture, enhancement, development, and proper utilization of surface and ground water.

22. The District is able to study wetland impacts and impacts to the aquifer while temporarily authorizing withdrawals by the Respondents with conditions to ensure any impacts will be mitigated. This information can be used by the District, and applicants, for future water use permit applications.

ULTIMATE FACTS AND CONCLUSIONS OF LAW

23. The District alleges that the Respondent violated the District's rules by performing activities on the Property without prior issuance of an environmental resource permit pursuant to Chapter 373, F.S., and Chapters 40E-4 and 40E-40, F.A.C., which prohibit the construction and operation of any works without first satisfying the criteria of the District through the permitting process.

24. Pursuant to Sections 373.413, and/or 373.414, F.S., and the implementing regulations found in Titles 40E and/or 62, F.A.C., the District is authorized to require permits for construction, alteration, and/or operation of surface water

management systems, including activities which impact wetlands. In the issuance of construction permits, the District is authorized to impose reasonable conditions necessary to assure the activities will not be harmful to the water resources of the District. As to issuance of operation permits, the District is authorized by Section 373.416, F.S., to impose reasonable conditions necessary to assure that the operation or maintenance of any surface water management system will not be inconsistent with the overall objectives of the District.

25. The District may enforce its permits and orders pursuant to Chapters 373 and 120, F.S., by maintenance of appropriate actions and may recover a civil penalty for each offense in an amount not to exceed Ten Thousand Dollars ($10,000) per offense, with each date during which such violation occurs constituting a separate offense. The District may further recover investigative costs, court costs and reasonable attorney's fees.

26. The District alleges that, based on the information provided by the Respondents in their water use application, reasonable assurances have not been provided that the withdrawal of the requested allocation from the Lower Tamiami aquifer will not harm wetlands.

27. The information existing within the C-139 Basin regarding such issues as groundwater aquifers, the interface of these aquifers with wetland features, the influence of surface water management system design features, impacts of seepage irrigation and the seasonality of demand is deficient in this region. This lack of information may be artificially restricting development of groundwater resources throughout the C-139 basin.

28. General policies under Chapter 373, F.S., including the water use permitting statutes, require the water management districts "(2) . . . (b)to promote the conservation, replenishment, recapture, enhancement, development, and proper utilization of surface and ground water; . . . [and] (d) to promote the availability of sufficient water for all existing and future reasonable- beneficial uses and natural systems; . ..." Section 373.016, F.S.

29. In addition, pursuant to Section 373.036(2), F.S., the water management districts are required to provide a district water management plan to implement its responsibilities under Chapter 373, F.S., giving due consideration to "the attainment of maximum reasonable-beneficial use of the water resources" and "the maximum economic development of the water resources consistent with other uses." Sections 373.036(2)(d)1. and 2., F.S.

30. The District water management plan includes an assessment of regional water resources needs and sources and development of technical information describing the groundwater characteristics and yields to meet water supply demands. In addition, Section 373.145, F.S., requires the water management districts to develop an nformation program designed to assess the existing hydrologic condition of groundwater sources.

31. The District has prepared a District Water Management Plan addressing the needs and sources in this region in accordance with statutory guidance.

32. Section 373.171(1), F.S., authorizes the water management districts to issue orders affecting the use of water, as conditions warrant to "obtain the most

beneficial use of the water resources of the state and to protect the public, health, safety, and welfare and the interests of the water user affected, . . ."

33. Chapter 373, F.S., gives deference to water management district governing boards in defining how to maximize reasonable-beneficial uses of the States' water resources, including the balance of various missions to address harm to the water resources while developing water resources for consumptive uses. Village of Tequesta v. Jupiter Inlet Corp., 371 So. 2d 663 (Fla. 1979); Harloff v. City of Sarasota and SWFWMD, 575 So. 2d 1324 (Fla. 2d DCA 1991); Osceola County v. St. Johns River Water Management District, 486 So.2d 616, 617-618 (Fla. 5th DCA 1986), aff'd, 504 So.2d 385 (Fla. 1987). The District can temporarily authorize water use to enable the study of possible wetland impacts and aquifer impacts of the withdrawals in order to gain knowledge for future consumptive use permits.

34. The District is authorized to enter into agreements pursuant to Section 373.083, F. S.

35. The Governing Board has authorized the Executive Director, or his designee, to execute this Consent Agreement.

THEREFORE, having reached a resolution of this matter, the District and the Respondents mutually agree and it is ordered that:

ORDER

I. Penalties

A. Respondent shall, within 60 days of the effective date of this Consent Agreement, pay the District's reasonable investigative costs in the amount of Two

Thousand Dollars ($2,000). The amount shall be paid by cashier's check or money order and tendered to the District via US Mail or and delivery at the following address: South Florida Water Management District, 3301 Gun Club Road, Post Office Box 24680, West Palm Beach, Florida 33416-4680, Attn: Anita Bain, Regulation Division. Respondent agrees that these amounts are reasonable and shall not contest them in any subsequent action regarding this Consent Agreement.

B. This Consent Agreement shall not constitute an admission of liability on the Respondent's behalf.

II. Consumptive Use Authorization:

A. Allocation: The District authorizes the Respondents to irrigate 201.48 net acres (see Exhibit 1) of small vegetables for the duration of this Consent Agreement. The Respondents shall not exceed 132.48 MG/year, with a maximum monthly use not to exceed 37.25 MG. The District authorizes the use of wells W21 through W23, W31, W51 through W53 for the withdrawal. No other wells may be utilized for this withdrawal. No increase in pumpage or irrigated acreage over the amount allotted in this Consent Agreement shall occur without approval from the Governing Board.

B. Pumpage Reporting: The total monthly pumpage from each well shall be reported to Kurt Leckler, Supervisor Water Use Compliance at 3301 Gun Club Road, West Palm Beach, Fl. 33406 within 15 days of the end of the month. The Respondents shall provide the District representative lithologic samples collected during drilling of one of the proposed wells at five (5) foot intervals within 30 days of the well completion.

C. **Crop Maps:** Prior to planting each crop, the Respondents shall submit a map of the project to the District, to the same address, which identifies the location of the crop, the number of acres, the crop type, and the specific wells to be utilized.

D. **Resources:** The Respondents will be required to mitigate for any harm to wetlands which occurs as a result of the pumping in this Consent Agreement.

II. District Research Program:

A. **Site Access:** The Respondents grant site access, as outlined in the Right of Entry attached as Exhibit 2, to the District and its contractors for the following purposes. Within six months of the date of this Agreement, the District shall construct and begin to monitor test wells, and associated monitoring equipment. Further, the District may conduct wetland functional assessments.

B. **District Compliance Inspections:** The District may conduct compliance inspections to verify compliance with the provisions of the Consent Agreement or for any other District related business.

C. **Aquifer Performance Test:** Finally, the District may conduct an aquifer performance test on one of Respondents' Lower Tamiami Aquifer production well at a time and for a duration agreed to by both parties.

D. **Scope of District Research Program:** The District shall perform on-site aquifer testing, wetland water level monitoring, and calibrated groundwater modeling incorporating data collected from the site during increased water use. A goal of the District's research program is to attain sufficient information regarding groundwater availability, the interface of the aquifers with surficial features such as wetlands and surface water management systems, to enable more specific assessment of this and future consumptive use permit applications in the C-139 Basin.

III. Respondent's Periodic Notice to the District:

A. Work Plan and Recap: The Respondent's shall send a letter to the District every three months for the duration of the Consent Agreement. The letter shall outline the work that has been performed by the Respondent for the past three months and outline the work that is anticipated over the following three months. This shall include, but not be limited to, the construction of reservoirs and the acreage, crop type, irrigation method and field location of all crops planted in the previous three months and projected to be planted in the next three months, wells used and the amounts pumped from each well per month.

B. Daily rainfall measurement reporting: Further, at the time of each Work Plan Letter, the Respondent's shall provide daily rain measurements to the District.

IV. Consent Agreement Termination:

This agreement shall terminate on June 1, 2006 unless extended by mutual agreement. If the District determines that Respondents' withdrawals authorized pursuant to this Consent Agreement results in harm to the natural resources, or to existing legal users, and the District determines that timely and effective mitigation is not practicable, the District may terminate this Consent Agreement. However, prior to termination of the Consent Agreement, the District shall provide the property owner a reasonable time to cure the problem and to remedy the harm. If the property owner can not timely and effectively cure the problem, the District shall consider the most reasonable timeframe and method to terminate the Consent Agreement. The District shall consider the crops that have been planted and the amount of water necessary to complete the growing season. The District shall work with the property owner and be reasonable in its solution to terminate the Consent Agreement.

V. General Provisions:

A. The Respondents shall withdraw its pending application, application No. 990208-9, within 30 days of the date of final execution of this Consent Agreement.

B. The Respondents shall comply with the conditions included in Exhibit 3 of the Consent Agreement. Failure to comply with these or other provisions of this Consent Agreement are subject to enforcement actions.

C. Execution of this Consent Agreement does not guarantee to the Respondents that the results obtained from District field investigations and/or modeling efforts will allow the continued use of water by the Respondents upon the expiration of this Consent Agreement.

D. The District does not, by entering into this Consent Agreement, agree or guarantee that Respondents' future water use permit application will be approved. Further, the Consent Agreement may not be considered a permitted right to use water. Finally, the Respondent's future water use permit application will be evaluated based on criteria in effect at the time the application becomes complete.

<u>GENERAL PROVISIONS</u>

36. The District hereby expressly reserves the right to petition for judicial enforcement of the terms of this Consent Agreement. In such event, the Respondents and their successors and/or assigns in interest shall not contest or deny any fact, legal conclusion, or any other matter or fact set forth in this Consent Agreement, including the Findings of Fact, Ultimate Facts and Conclusions of Law set forth herein. If the District successfully petitions or sues for enforcement of this Consent Agreement, the Respondent, its heirs, successors and/or assigns hereby agree to and shall pay all attorneys' fees, (including, but not limited to, the fair market value of in house counsel fees, as if performed by outside or private counsel, court costs and any other damages sustained by the District). In addition, the District hereby expressly reserves the right to initiate appropriate legal action to prevent or prohibit the future violation of applicable statutes or the rules promulgated there under, or to alleviate an immediate serious danger to the public health, safety or welfare.

37. The District reserves the right to curtail water use pumpage in the event of a declared water shortage pursuant to Chapter 40E-21, F.A.C.

38. Failure to comply with this Consent Agreement shall constitute a violation of Chapter 373, F. S., and enforcement proceedings may be brought in any appropriate administrative or judicial forum.

39. This Consent Agreement shall take effect after adoption by and execution on behalf of the Governing Board of the District, when the Consent Agreement is filed with and acknowledged by the Clerk of the District immediately thereafter, and shall remain in full force and effect until its terms and conditions are completed to the satisfaction of the District. The requirements of this Consent Agreement shall bind and

inure to the benefit of the successors and assigns of the Respondent, except as modified by the parties hereto. In addition, prior to any sale, transfer, conveyance or lease of the Property, the Respondent shall provide a copy of this Consent Agreement to any prospective successor in interest. Additionally, the Respondent shall provide notification to the District at least 30 days prior to any sale, transfer or conveyance of the Property.

40. Respondents hereby waives the right to request an administrative hearing on the terms of this Consent Agreement under Sections 120.569 and 120.57, F. S., and acknowledges but waives their right to appeal this Consent Agreement pursuant to Section 120.68 F. S., upon signing this Consent Agreement.

41. Entry into this Consent Agreement does not relieve the Respondents of the need to comply with all applicable federal, state or local laws, regulation or ordinances, including any District permitting requirements. Also, the Consent Agreement does not give the Respondents the authority to conduct any activities on the Property which are under District jurisdiction without first obtaining District authority.

42. In addition, nothing herein shall be construed to limit the authority of the District to undertake any action against the Respondents in response to or to recover the costs of responding to conditions at the site or to enforce the terms of this Consent Agreement and the District hereby expressly reserves the right to initiate appropriate legal action to prevent, prohibit or abate any future violations of applicable statutes or the rules promulgated thereunder, or to alleviate an immediate serious danger to the public health, safety or welfare or any violation not specifically addressed by this Consent Agreement.

43. Respondents are fully aware that a violation of the terms of this Consent Agreement may subject the Respondent to judicial imposition of damages, civil penalties up to Ten Thousand Dollars ($10,000.00) per offense per day, costs and criminal penalties.

44. If any event occurs which causes delay or reasonable likelihood of delay, in complying with the requirements or deadlines of this Consent Agreement, the Respondents shall have the burden of proving that the delay was or will be caused by circumstances beyond the reasonable control of the Respondents and could not have been or cannot be overcome by the Respondents' due diligence. Economic circumstances shall not be considered circumstances beyond the control of the Respondents, nor shall the failure of a contractor, subcontractor, material man, or other agent (collectively referred to as contractor) to whom responsibility for performance is delegated to meet contractually imposed deadlines be a cause beyond the control of the Respondents unless the cause of the contractor's late performance was also beyond the contractor's control. Upon occurrence of an event causing delay, or upon becoming aware of a potential for delay, the Respondents shall notify the District orally within 24 hours or by the next working day and shall, within seven days of oral notification to the District, notify the District in writing of the anticipated length and cause of the delay, the measures taken or to be taken to prevent or minimize the delay, and the timetable by which the Respondents intends to implement these measures. If the parties can agree that the delay or anticipated delay has been or will be caused by circumstance beyond the reasonable control of the Respondents, the time for performance hereunder shall be extended for a period equal to the agreed delay

resulting from such circumstances. Such agreement shall adopt all reasonable measures necessary to avoid or minimize delay. Failure of the Respondent's to comply with the notice requirements of this paragraph in a timely manner shall constitute a waiver of the Respondent's right to request an extension of time for compliance with the requirements or deadlines in this Consent Agreement.

45. This Consent Agreement does not convey any property right to the Respondent, nor any rights and privileges other than those specified in the Consent Agreement. This Consent Agreement incorporates, embodies and expresses all agreements between the Respondents and the District and may not be altered except as authorized herein.

46. All notices or other submittals required under this Consent Agreement unless otherwise specified, shall be submitted to the South Florida Water Management District, Attention To: Scott Burns, Department Director, P.O. Box 24680, West Palm Beach, Florida 33416.

47. Persons who are not parties to this Consent Agreement, but whose substantial interests may be affected by this Consent Agreement, may have a right to petition this Consent Agreement. A notice of rights is attached and incorporated as Exhibit D.

48. This Consent Agreement is a final order from the District, pursuant to Section 120.52(7), F.S., and is final and effective on the date filed with the Clerk of the District unless a petition for administrative hearing is filed in accordance with Chapter 120, F.S., or any other applicable state law. Upon the timely filing of a petition, the Consent Agreement will not be effective until further order from the District.

120, F.S., or any other applicable state law. Upon the timely filing of a petition, the Consent Agreement will not be effective until further order from the District.

DONE AND SO ORDERED at West Palm Beach, Palm Beach County, Florida, this 12 day of January, 2005

SOUTH FLORIDA WATER MANAGEMENT DISTRICT
BY ITS GOVERNING BOARD

BY: ______________________
Chairman

RESPONDENTS

BY: ______________________
JAMES D. HULL

BY: ______________________
PAULINE TOWNSEND

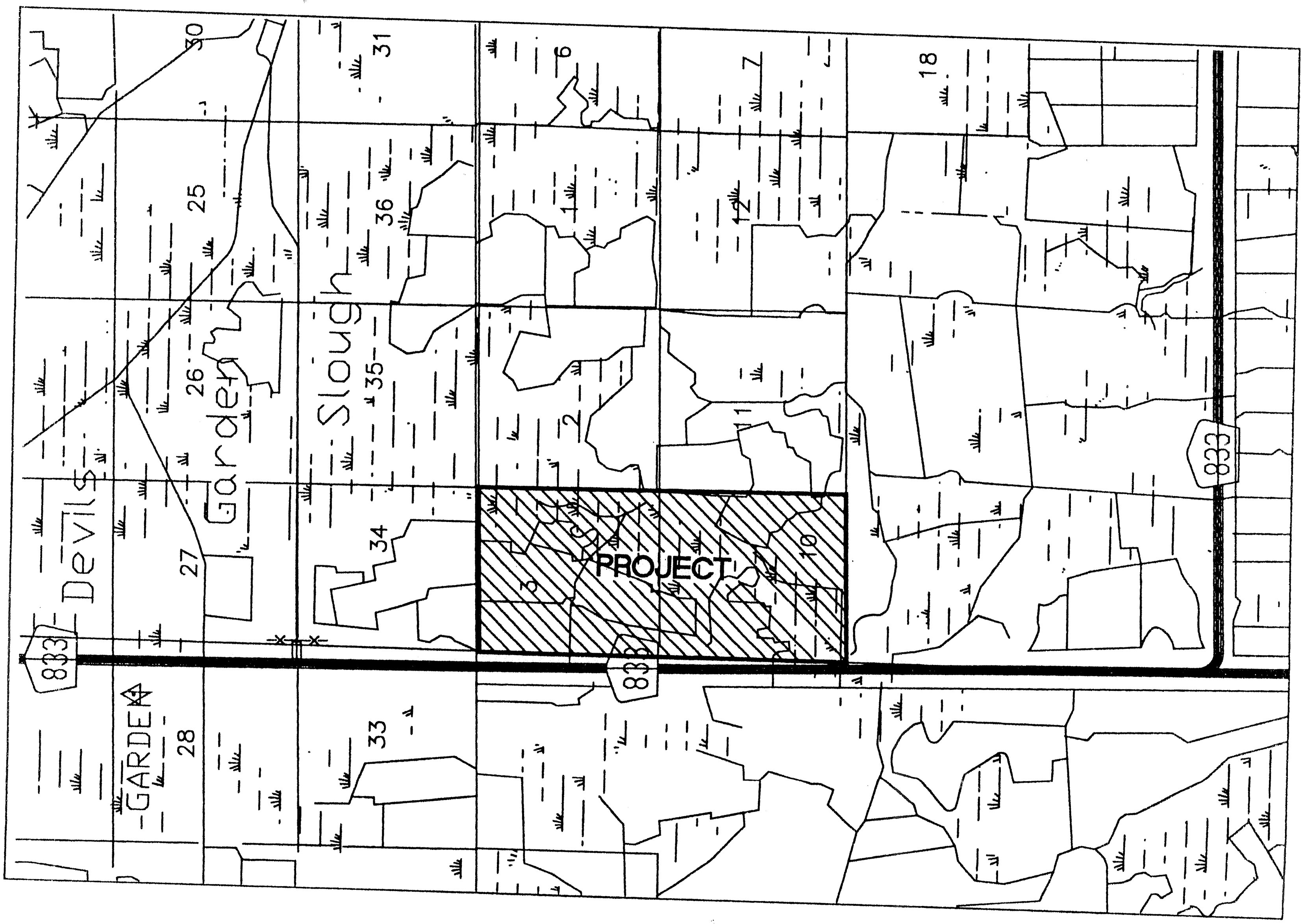
ATTEST:

BY: ______________________

Legal Form Approved:

By: ______________________

A PARCEL OF LAND LYING IN SECTIONS 3 AND 10, TOWNSHIP 46 SOUTH, RANGE 32 EAST IN HENDRY COUNTY, FLORIDA



LOCATIOl . MAP

RIGHT OF ENTRY

Project: Golden Ox

JAMES HULL and PAULINE TOWNSEND, (hereinafter "Property Owners"), whose mailing address is 5300 Lee Boulevard, Lehigh Acres, FL 33871 and SOUTH FLORIDA WATER MANAGEMENT DISTRICT, a public corporation of the State of Florida (hereinafter "District"), whose principal office is located at 3301 Gun Club Road, West Palm Beach, Florida, its agents, contractors, employees and assigns, hereby agree that District shall have the right to enter upon only that portion of that certain real property owned by Property Owners, located in Sections 3 and 10, Township 46 South, Range 32, Hendry County, (hereinafter the "Property") for the purposed described below:

Project Description

The Property Owners grant site access to the District and its contractors for the following purposes. The District shall access the site in order to carry out the activities outlined in that certain Consent Agreement Order No. SFWMD 2005 - 003 CO WU WU, dated January 12, 2004. The activities shall include, but are not limited to, the construction and monitoring of test wells, and associated monitoring equipment. The District may conduct wetland functional assessments. The District may conduct compliance inspections to verify compliance with the provisions of the Consent Agreement. Finally, the District may conduct an aquifer performance test on a lower Tamiami aquifer production well.

Agreement

The Property Owners and the District hereby agree as follows:

1. The Property Owners hereby acknowledges that (i) any equipment or physical structure (i.e. water well) placed on the Property by the District shall remain the property of the District; and, (ii) upon request of the Property Owners, all such equipment shall be removed from the Property, and any wells capped or filled in, by the District on or before the termination of this Right of Entry.
2. The District agrees that, upon completion of the activities proposed in this Right of Entry, any portion of the Property which is damaged as a result of activities conducted by the District pursuant to this Right of Entry will be returned to substantially the same condition that it was in on the date hereof.
3. The Property Owners shall allow all authorized representatives of the District, their vehicles and equipment access to the Property on reasonable notice in order to implement and carry out the activities described herein, including all necessary calibration activities; the safety for which the Property Owner shall have no responsibility.
4. This Right of Entry does not convey any property rights or equipment to the Property Owners nor any rights and privileges other than those specified herein.

Exhibit 2

5. The District acknowledges its liability for torts to the extent provided and allowed under Section 768.28, Florida Statutes, and that the District is solely responsible for any damage or injury sustained by any of its representatives, subcontractors, agents and their vehicles and equipment. Nothing contained herein shall constitute a waiver of sovereign immunity beyond the limits set forth in Section 768.28, Florida Statutes.

6. The Property Owners shall not be liable under any circumstances for any damage to the District's personal property or equipment placed upon the Property in connection with this Right of Entry, or the theft thereof, unless such damage or theft is due to the willful or intentional acts or omissions of the Property Owners or the Property Owner's agents and then only to the extent such damage or theft is directly, indirectly or proximately caused by such willful or intentional acts or omissions. However, nothing contained herein shall constitute a waiver of sovereign immunity beyond the limits set forth in Section 768.28, Florida statutes, nor shall the same be construed to constitute agreement by the District to indemnify the Property Owners for the Property Owners' willful or intentional acts or omissions. The Property Owners shall not have responsibility for the security of, or restricting access to, the District's personal property or equipment for which the District assumes all risk in relation to relocating the same on Property Owners' Property.

7. The Property Owners shall indemnify, save and hold the District, its agents, assigns, and employees harmless from any and all claims or causes of action, including, without limitation, all damages, losses, liabilities, expenses, costs and attorney's fees related to such claims that may arise in connection with the work to be performed at the site, except as otherwise provided in Paragraphs 5 and 6.

8. Entry into this Right of Entry does not relieve the Property Owners' need to comply with other federal, state or local laws, regulations or ordinances, or the requirements of District issued water use permit(s).

9. This Right of Entry may be modified only upon the mutual consent of both parties, submitted in writing.

10. Prior to any sale, transfer or conveyance of the Property, the District requests notification so that alternative agreements or arrangements may be made, if necessary.

11. Either party may terminate this Right of Entry upon thirty (30) days prior written notice.

12. The initial term of this Right of Entry shall expire on June 1, 2006. All terms, conditions, covenants and provisions of this Right of Entry shall apply during such renewal term, if any.

WITNESS our hands and seals this 12 day of January, 2005.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

By:____

CHAIRMAN

PROPERTY OWNER

____

JAMES HULL

PROPERTY OWNER

____

PAULINE TOWNSEND

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

By:______________________________

____
(Printed Name)

PROPERTY OWNER

James S Hull
____
JAMES HULL

PROPERTY OWNER

Pauline Townsend
____
PAULINE TOWNSEND

Limiting Conditions

1) Total annual allocation is 132.48 MG.

Total maximum monthly allocation is 37.25 MG.

These allocations represent the amount of water required to meet the water demands as a result of rainfall deficit during a drought with the probability of recurring one year in ten. The Respondent shall not exceed these allocations in hydrologic conditions less than a 1 in 10 year drought event. If the rainfall deficit is more severe than that expected to recur once every ten years, the withdrawals shall not exceed that amount necessary to continue to meet the reasonable-beneficial demands under such conditions, provided no harm to the water resources occur and:

The withdrawal is otherwise consistent with applicable declared Water Shortage Orders in effect pursuant to Chapter 40E-21, F.A.C.

2) Respondent shall mitigate interference with existing legal uses that was caused in whole or in part by the Respondent's withdrawals, consistent with the approved mitigation plan. As necessary to offset the interference, mitigation will include pumpage reduction, replacement of the impacted individual's equipment, relocation of wells, change in withdrawal source, or other means.

Interference to an existing legal use is defined as an impact that occurs under hydrologic conditions equal to or less severe than a 1 in 10 year drought event that results in the:

1. Inability to withdraw water consistent with provisions of the permit, such as when remedial structural or operational actions not materially authorized by existing permits must be taken to address the interference; or

2. Change in the quality of water pursuant to primary State Drinking Water Standards to the extent that the water can no longer be used for its authorized purpose, or such change is imminent.

3) Respondent shall mitigate harm to existing off-site land uses caused by the Respondent's withdrawals. When harm occurs, or is imminent, the District will require the Respondent to modify withdrawal rates or mitigate the harm. Harm includes:

1. Significant reduction in water levels on the property to the extent that the designed function of the water body and related surface water management improvements are damaged, not including aesthetic values. The designed function of a water body is identified in the original permit or other governmental authorization issued for the construction of the water body. In cases where a permit was not required, the designed function shall be determined based on the purpose for the original construction of the water body (e.g. fill for construction, mining, drainage canal, etc.)

2. Damage to agriculture, including damage resulting from reduction in soil moisture resulting from consumptive use; or

3. Land collapse or subsidence caused by reduction in water levels associated with consumptive use.

Exhibit 3

4) Respondents shall mitigate harm to the natural resources cause by the Respondent's withdrawals, as determined through reference to the Consent Agreement. When harm occurs, or harm is imminent, the District will require the Respondents to modify withdrawal rates or mitigate the harm. Harm includes:

(1) Reduction in ground or surface water levels that result in harmful lateral movement of the fresh water/saltwater interface,

(2) Reduction in water levels that harm the hydroperiods of wetlands,

(3) Significant reduction in water levels or hydroperiod in a naturally occurring water body such as a lake or a pond,

(4) Harmful movement of contaminants in violation of state water quality standards,

(5) Harm to the natural system including damage to habitat for rare and endangered species.

5) Prior to the use of any water withdrawal facility authorized under this Consent Agreement, unless otherwise specified, the Respondent shall equip each facility with a District-approved operating water use accounting system and submit a report of calibration to the District, pursuant to Section 4.1, Basis of Review for Water Use Permit Applications.

In addition, the Respondent shall submit a report of recalibration for the water use accounting system for each water withdrawal facility (existing and proposed) authorized under this Consent Agreement every five years from each previous calibration, continuing at five-year increments.

6) Monthly withdrawals for each withdrawal facility shall be submitted to the District quarterly. The water accounting method and means of calibration shall be stated on each report.

7) If a proposed well location is different from a location specified in the Consent Agreement, the Respondent shall submit to the District an evaluation of the impact of pumpage from the proposed well location on adjacent existing legal uses, pollution sources, environmental features, the saline water interface, and water bodies one month prior to all new well construction.

8) Respondent shall secure a well construction permit prior to construction, repair, or abandonment of all wells, as described in Chapters 40E-3 and 40E-30, Florida Administrative Code.

9) The Respondent shall submit to the District an updated Well Description Table (Table A) within one month of completion of the proposed wells indentifying the actual total and cased depths, pump manufacturer and model numbers, pump types, intake depths and type of meters.

10) In the event of a declared water shortage, water withdrawal reductions will be ordered by the District in accordance with the Water Shortage Plan, Chapter 40E-21, F.A.C. The Respondent is advised that during a water shortage, pumpage reports shall be submitted as required by Chapter 40-21, F.A.C.

11) Monthly withdrawals for each withdrawal facility shall be submitted to the District quarterly. The water accounting method and means of calibration shall be stated on each report.

C
Aquae Sulis Report

Crooks Ranch

Water Level Data Collection
and
Statistical Analysis

AQUAE SULIS, INC.

ASI

April 2006

CONTENTS

Figures

Appendices

Introduction

Background

Aquae Sulis Inc. (ASI) was contracted by the South Florida Water Management District (District) to deploy 19 self-recording water level data logger at seven test sites at Crook and Golden Ox ranches located in southeast Hendry County. Five sites included a wetland stilling well, water table aquifer (WTA) monitor well and lower Tamiami aquifer (LTA) monitor well. At two sites, only a WTA monitor well and LTA monitor well were constructed. In addition to monitoring ground water levels, one rain gauge was deployed near Site 1 to measure and record rainfall to determine its effect on wetland and ground water levels. A location map showing the seven monitoring sites at Crook and Golden Ox ranches is provided in **Figure 1.**

ASI provided instrument maintenance, retrieved water level data from the self-recording probes and rain gauge, and documented site conditions (e.g., flooding conditions) and construction activities (e.g., onsite reservoir or canals). The retrieved data was checked, processed, and transmitted to the District on a monthly basis.

Project Objective

The objective of this monitoring program was to ensure that continuous, independent and accurate water level and rainfall data are recorded and available for detail analysis. This report was formatted and written to be part of a larger document prepared by the SFWMD that will incorporate the hydro geologic, surface water hydrology and ecological data collected at the Crook and Golden Ox ranches.

Water Level Data Collection

Equipment

For this project, In-situ miniTrolls were selected based on their accuracy, stability, and long-term reliability.

The miniTroll Monitoring Data Loggers feature:

- Automatic Barometric Compensation
- Automatic Temperature Compensation
- Fluid Density Correction
- Gravitational Acceleration Correction
- Liquid Density Correction
- NIST-Traceable Calibration

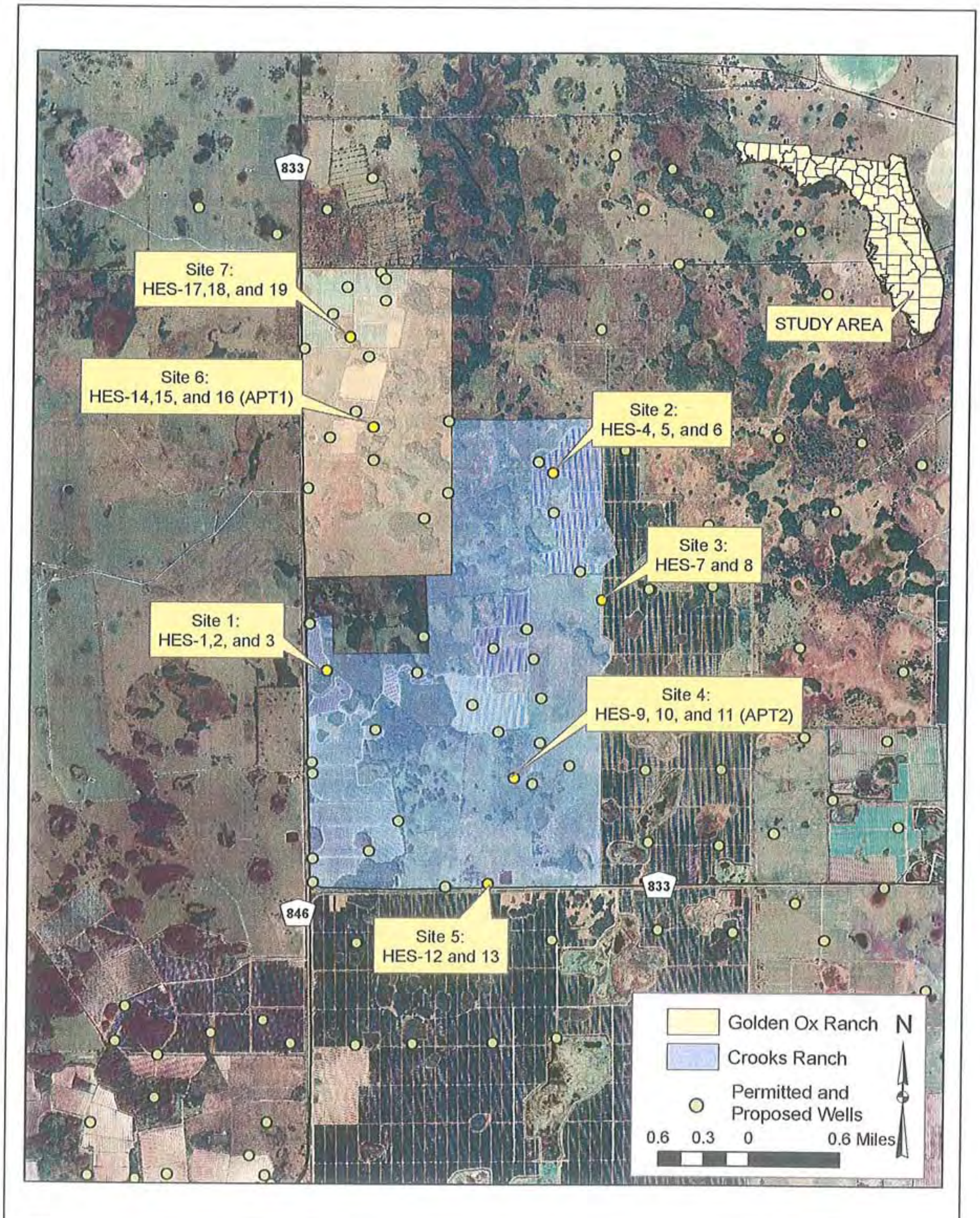


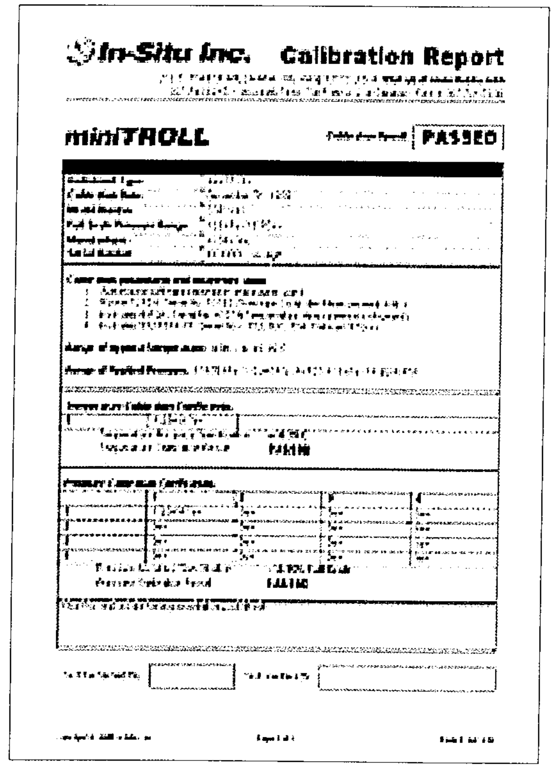
Figure 1. Location Map of Monitoring Sites at Crook and Golden Ox Ranches.

Calibration

MiniTrolls are calibrated using NIST-Traceable standards and compensated for temperature across the entire range.

A sample calibration report has been included as reference to those found in **Appendix A** for the nineteen miniTrolls used in this monitoring program

The calibration reports verify that each of these units either meet or exceed In-Situ's rigid accuracy standards.


In-Situ Inc. Calibration Report

miniTROLL

PASSED

Methodology

On a monthly basis, each of the nineteen miniTrolls and rain gauge are inspected for damage then the data are retrieved from the data loggers. During the data download, internal parameters of data loggers are checked. This includes its programming status, available free memory and current power level. Once the data has been full retrieved, it is viewed and graphed using Win-Situ-4.0 software to verify the correct number of data records and that the water level data trends are consistent.

Another important activity during each monthly site visit is to document site conditions. This is done via field notes and by digital photographs that are taken at each well site. This provides a chronology of site conditions and identifies when new construction activities (pre and post reservoir, if any) take place that may affect recorded water levels. In addition, this information helps to relate observed changes in water levels trends with either natural (wet vs. dry season) or farming (growing vs. non growing season) activities.

Data Compilation

The In-Situ binary (bin) files are extracted from the individual miniTrolls using an In-situ Rugged Reader. The binary files are then transferred from the Rugged Reader to a PC using Microsoft® ActiveSync-4.1 software. The water level data in binary format are exported via Win-Situ software to an Excel spreadsheet format for graphical display and data manipulation. Within the exported Excel spreadsheet, the water level data are corrected to the North American Vertical Datum of 1988 (NAVD, 88). First, the pressure exerted by the water column that resides above the miniTroll, measured in pound per square inch (psi) is converted to feet of equivalent freshwater head. This is done by multiplying the measured transducer pressure by a conversion factor of 2.31 (assuming the total dissolve solid concentration does not exceed 1,000 milligram per liter (mg/L) using equation no 1:

$$FWH = MTP * 2.31 \qquad (1)$$

Where:
FWH = Freshwater Head in feet
MTP = Measured Transducer Pressure in pounds per square inch
2.31 = Conversion Factor (dimensionless).

Second, the miniTroll's setting depth elevation must be determined. The setting depth elevation reference to NAVD, 88 is determined using the surveyed well pad elevation, the length of well casing above the well pad, and the length of cable attached to the miniTroll using equation no. 2:

$$TSD = SWPE + WC - CL \qquad (2)$$

Where:
TSD = Transducer Setting Depth (feet – NAVD, 88)
SWPE = Surveyed Well Pad Elevation (feet – NAVD, 88)
WC = Well Casing above well pad (feet)
CL = Cable Length (feet)

Once these two parameters are determined, the freshwater head (FWH) is added to the transducer setting depth (TSD) to yield water levels corrected to NAVD, 1988 (mean sea level). The surveyed elevation data and various measured physical attributes (i.e., cable length) are provided in **Appendix B.**

The corrected water levels for each of the monitor/stilling wells at individual sites are presented graphically via a type of time series graph referred to as a hydrograph. The hydrographs were used to compare water-level changes over time at each site between the wetland, water table aquifer and lower Tamiami aquifer in response to natural (rainfall) and artificial (ground water pumpage) factors.

Statistical Analysis

Basic Summary Statistics

Basic Summary Statistics were computed using hourly water level readings for each of the wetland stilling wells and ground water monitor wells collected for a little over a 1-year period (381 days). The parameters determined include:

- Minimum recorded value – lowest recorded water level for the period of record (POR)
- Maximum recorded value – highest recorded water level for the POR
- Range – the absolute value between the minimum and maximum recorded values measured during the POR– this value is useful to determine magnitude of water level change over the period of record
- Mean – average value – all hourly value were summed and divided by the total number of recorded values (number of hourly values = 9,142).
- Median – The median or 50 percentile is the middle of a distribution where half the values are above the median and half are below. The median value is less sensitive to extreme value than the arithmetic mean.
- Standard Deviation - tells how widely the values in a data set are spread apart. A large standard deviation tells you that the data are fairly diverse, while a small standard deviation tells you the data are pretty tightly bunched together.

Correlation Coefficients

The first step to determine the relationship between variables is to construct X-Y scatter plots to visually inspect the data for outliers and to see if the relationship between the two measured variables is linear. In addition, this type of plot helps to determine visually whether there is a strong or weak correlation between two variables, and whether the correlation is positive or negative (based on the direction of the best fit line). However, there is a mathematical way of quantifying the linear relationship between variables by calculating the correlation coefficient. This is also known as Pearson's Correlation Coefficient, represented by the letter **R**. It is a single number, which ranges from -1 (strong negative correlation) to +1 (strong positive correlation). The correlation coefficient indicates whether there is a relationship between the two variables, and whether the relationship is a positive or a negative number. Correlation coefficients that are close to -1 or +1 indicate a strong correlation. Values close to 0 indicate a weak correlation, with the value of zero indicating no correlation at all.

Initially, hourly data were used to determine the degree of linear relationship between the various water level data sets but a large degree of scatter ("statistical noise") was noted. In an effort to reduce the "noise" various time averaging filters were applied. This included calculating the mean values for 4, 12 and 24 hour time steps. X-Y scatter plots were constructed using the three time average water level data from two sites (no.3 and no.4) and the coefficient of determination ($\mathbf{R}^2$ see below explanation) determined. The daily mean (24-hour time average) produced the highest coefficients of determination. Therefore, the daily mean water levels were computed for each of the 19 water level data sets over the POR and used to calculated the correlation coefficients used in this analysis.

Occasionally, the coefficient of determination is used synonymously with the correlation coefficient. However, the coefficient of determination written as $\mathbf{R^2}$ indicates the proportion of the variation between the data points as accounted for by the best fit line through the points. It indicates how close the points are to the best fit line and is found by squaring the correlation coefficient.

Although a correlation between two variables doesn't mean that one of them causes the other, it can suggest a way of finding out what the true cause might be. There may be some underlying variable that is causing both of them but not identified during the development of a monitoring program.

The District also provided monthly total pumpage data to ASI from Crook and Golden Ox Ranches for data processing and analysis. The transformed monthly total pumpage into hourly rates produced poor correlations to water levels changes in the water table and lower Tamiami aquifers. This is due to distributing the ground water withdrawals evenly over a 24-hour daily period using the monthly reported total value. To properly compare ground water withdrawals (pumpage) with hourly ground water level data, it would be necessary to determine site specific irrigation schedules so that realistic hourly based pumpage data can be created. Due to the lack of accurate pumpage data and the fact that the initial statistical analyzes produced poor results, it was not used as a statistical indicator. Even though it was not used statistically, ground water withdrawals from the lower Tamiami aquifer are apparent on the individual site hydrographs. The processed pumpage data is provided on the accompanying CD.

The next section will provide a summary of the data collected at each of the seven monitoring sites followed by a section discussing the relationship of water level data from each monitored water source such as wetlands, the water table aquifer and lower Tamiami aquifer.

Site Specific Data Summary & Observations

Site No. 1 - Data Summary

The first monitoring site is on the western portion of Crook's Ranch located 0.1 mile north of the main entrance to Farm Op #5 off of County Road (CR) 833. The water table (HES-1) and lower Tamiami aquifer (HES-2) monitor wells were constructed about 15 feet from an onsite irrigation/drainage ditch, which is maintained at a certain control elevation over the entire monitoring period. The surrounding land is used for small vegetable farming, primarily specialty peppers. A stilling well identified as HES-3 was constructed within the proximal isolated wetland, which is located about 250 feet south of the two surficial aquifer monitor wells. Monthly photographs of the site are provided in the accompanying CD.

Figure 2 is a hydrograph showing water level change over time within the isolated wetland, water table aquifer and lower Tamiami aquifer plus rainfall for Site No. 1. The wetland surface elevation at this site is also provided for reference.

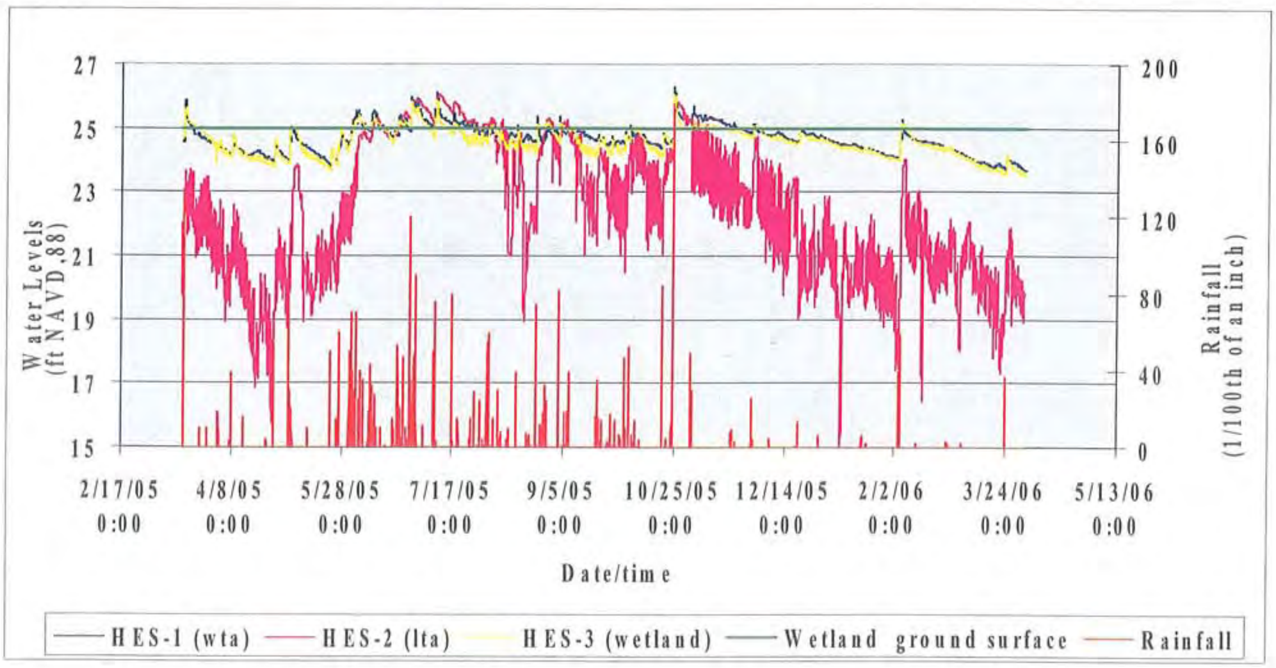


Figure 2 Time series plot (hydrograph) of water levels and rainfall – Site No.1

Table 1 contains the summary statistics for the individual monitor/stilling well located at this site.

Monitored Source	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (Feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
WTA	HES-1	23.69'	26.32'	2.63	24.67'	24.67'	0.44
LTA	HES-2	14.80'	26.07'	11.28	22.44'	22.39'	2.16
Wetland	HES-3	23.46'	26.06'	2.60	24.56'	24.58'	0.44
Period of Record 3/16/05 to 4/01/06							

Table 1 Basic summary statistics of water level data – Site No.1

Table 2 contains the calculated linear correlation coefficient between the LTA, WTA, and wetland daily mean water levels at this site.

Relationship	Period of Record 3/16/05 - 4/1/06	Non Growing Season 6/1/05 - 8/9/05	Growing Season 11/1/05 - 4/1/06
Lower Tamiami vs. Wetlands	0.7851	0.3979	0.7834
Lower Tamiami vs. Water Table	0.8056	0.5505	0.8012
Water Table vs. Wetland	0.9823	0.8455	0.9816

Table 2 Linear correlation coefficients of water levels between groups – Site No.1

The individual linear correlation coefficient plots of water levels and rainfall are provided in **Appendix C & D,** respectively.

Table 3 contains the linear correlation coefficients of rainfall versus hourly water level changes in the wetland, WTA and LTA (Period of Record - 3/16/05 to 4/1/06).

Group	Correlation Coefficient
Wetland vs. rainfall	0.6473
Water Table aquifer vs. rainfall	0.8106
Lower Tamiami aquifer vs. rainfall	0.0458
Distance from Rain Gauge = 0.15 mile	

Table 3 Correlation coefficients of rainfall vs. hourly water level changes – Site No. 1

A review of the hydrograph (Figure 2), the summary statistics (Table 1), and linear correlation coefficients (Table 2 & 3) indicate the following:

- Ground surface elevation at the monitor well location average 26.74 feet NAVD, 88 whereas the wetland surface was measured at 24.99 feet NAVD, 88. The wetland is located in a slight topographic low, with ground surface elevation 0.75 feet lower than those at the monitor well location.
- Water levels in all three monitor wells fluctuate over time with the largest fluctuation of 11.28 feet occurring in HES-2, which monitors the lower Tamiami aquifer – the main source of water for crop irrigation.
- During the first part of the wet season (6/1/05 to 8/9/05) water levels in the lower Tamiami aquifer are greater (higher) than those in the wetland and water table aquifer. This indicates that the lower Tamiami aquifer is semi-confined and has an upward ground water gradient during the wet season.
- Water levels within the isolated wetlands drop below land surface during much of the dry/growing season.
- Water levels in the isolated wetland stilling well are slightly lower than those in the water table aquifer monitor well. The higher water levels in the water table aquifer monitor well may be accounted for by its close proximity (12 feet) to a moderate size surface water canal.
- The range of water level change within the isolated wetland is 2.63 feet observed over the period of record.

- The majority of rainfall occurs during the normal wet season from June through October causing water levels to increase in the wetland and water table aquifer from direct recharge. The highest hourly rainfall total of 1.80 inches occurred during Hurricane Wilma on 10/24/05.
- The hydrograph shows that during the growing season, water levels in the lower Tamiami aquifer rise in response to significant rainfall events. However, this is not a response to direct recharge but an effect of reduced ground water pumpage for irrigation purposes. Even though it correlates well with significant rainfall events, the calculated correlation coefficient over the period of record was 0.0458, which indicates no long-term relationship between rainfall and **hourly** water level change in the lower Tamiami aquifer.
- The calculated correlation values indicate a moderate to strong correlation between the wetland, water table aquifer, and lower Tamiami aquifer over the period of record.
- During the non-growing (wet) season the correlation between the LTA vs. wetland ($R = 0.3979$) and the LTA vs. WTA ($R = 0.5505$) are less than those determined from the period of record. By including water levels acquired from two growing seasons, the strength of correlation increases, suggesting that <u>under stressed conditions</u> the monitor intervals behave more closely to one another.
- During the wet season there is a strong positive linear correlation between the WTA and wetlands ($R = 0.8455$) but during the growing season R increases to 0.9816.
- During the growing (dry) season the correlation between the LTA vs. wetland ($R = 0.7834$) the LTA vs. WTA ($R = 0.8012$), and WTA vs. wetland ($R = 0.9816$) all increase compared to those determined from the non-growing season. Again, indicating that under stressed conditions (ground water pumpage and lack of rainfall) the monitored intervals behave more closely to one another.
- The mean & median values (Table 1) for the wetland, WTA, and LTA suggest that the WTA recharges the underlying LTA over the majority of the POR, and more substantially during the growing season (see Figure 5).

<u>Site No. 2 – Data Summary</u>

This monitoring site is located within the northeastern portion of Crook's Ranch surrounded by small vegetable fields. At this site, a surface water reservoir/canal system was constructed during the latter part of November, 2005, prior to start of the 2005-2006 growing season. A 10 foot levee was constructed along the perimeter of the wetland with surface water canals constructed along the interior and exterior portion of the levee. From field observations and water level data, ground water is pumped from the lower Tamiami aquifer into the perimeter surface water canals, which recharges the water table aquifer. To date, the interior canal surface water levels are maintained slightly below ground surface and are not used to inundate the wetlands. The monthly site photographs found in the accompanying CD shows conditions prior to and after the reservoir/canals were constructed.

Figure 3 is a hydrograph showing water level change over time within the isolated wetland, water table aquifer and lower Tamiami aquifer plus rainfall at Site No. 2. The land wetland surface elevation at this site is also provided for reference.

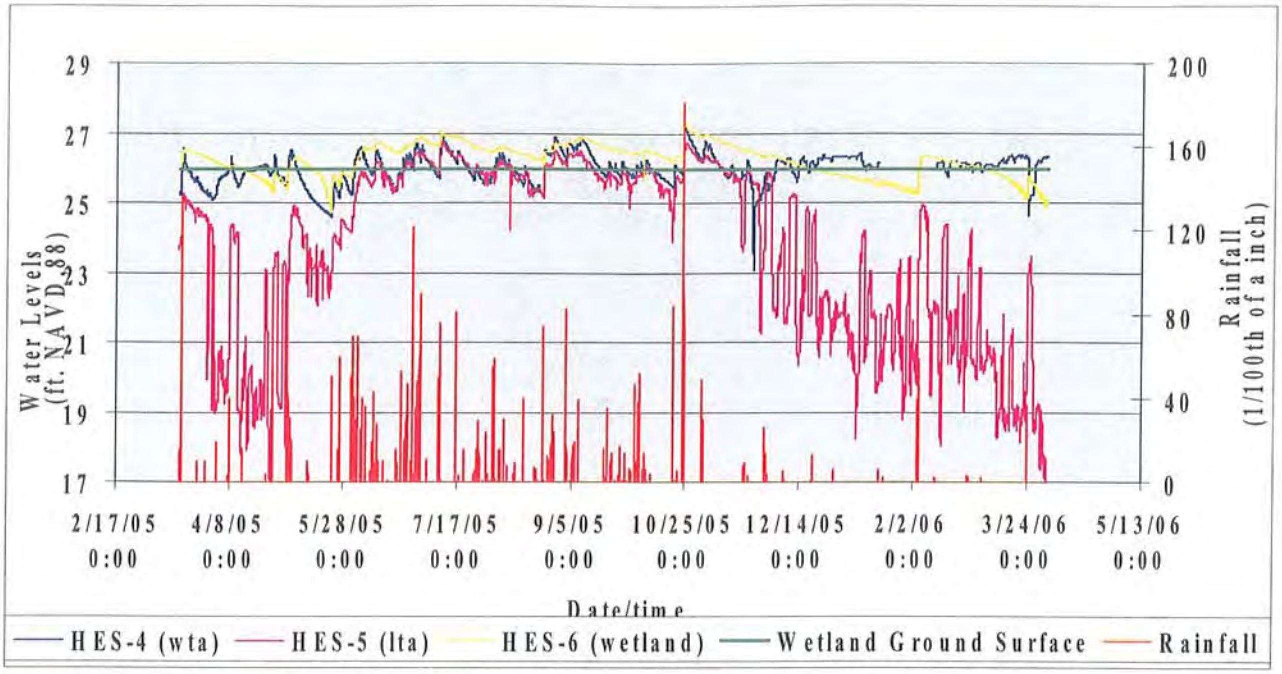


Figure 3 Time series plot of water levels and rainfall – Site No.2

Table 4 contains the summary statistics for individual monitor/stilling wells located at this site

Monitored Source	Station ID	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
WTA	**HES-4**	**23.08'**	**27.16'**	**4.08**	**25.98'**	**26.02'**	**0.43**
LTA	**HES-5**	**17.04'**	**26.76'**	**9.72**	**23.78'**	**24.83'**	**2.53**
Wetland	**HES-6**	**24.72'**	**27.34'**	**2.62**	**26.21'**	**26.29'**	**0.46**
Period of Record 3/16/05 to 4/01/06							

Table 4 Basic summary statistics of water level data – Site No.2

Table 5 contains the calculated linear correlation coefficient between the LTA, WTA, and wetland daily mean water levels at this site.

Relationship	Period of Record 3/16/05 - 4/1/06	Non Growing Season 6/1/05 - 11/1/05	Growing Season Pre-Reservoir 3/16/05 - 5/31/05	Growing Season Post Reservoir 12/1/05 - 4/1/06
Lower Tamiami vs. Wetlands	0.8380	0.8713	0.4573	0.6030
Lower Tamiami vs. Water Table	0.0557	0.8284	0.2283	-0.4649
Water Table vs. Wetland	0.2956	0.7649	0.2740	-0.2455

Table 5 Correlation coefficients water levels between the groups – Site No. 2

The individual linear correlation coefficient plots of water levels and rainfall data are provided in **Appendix C & D,** respectively.

Table 6 contains the linear correlation coefficients of rainfall versus hourly water level changes in the wetland, WTA and LTA (Period of Record – 3/16/05 to 4/1/06)

Group	Correlation Coefficient
Wetland vs. rainfall	0.3511
Water Table aquifer vs. rainfall	0.5777
Lower Tamiami aquifer vs. rainfall	0.1166
Distance from Rain Gauge = 2 miles	

Table 6 Correlation coefficients of rainfall vs. hourly water level changes – Site No. 2

A review of the hydrograph (Figure 3), the summary statistics (Table 4), and linear correlation coefficients (Table 5 & 6) suggests the following:

- Ground surface elevation at the monitor well location average 27.10 feet NAVD, 88 whereas the wetland surface was measured at 25.95 feet NAVD, 88. The wetland is located in a slight topographic low, with the ground levels approximately 1.15 feet lower than those at the monitor well location.
- The majority of rainfall occurs during the normal wet season from June through October causing water levels to increase in the wetland and water table from direct recharge. The highest rainfall event of 1.80 inches occurred on 10/24/05 during Hurricane Wilma.
- Water levels in all three monitor/stilling wells fluctuate over time with the largest fluctuation of 9.72 feet occurring in HES-5, which monitors the lower Tamiami aquifer – the main source of water for crop irrigation. The standard deviation of 2.53 feet also indicates consistently large fluctuations in water levels occur within the LTA.
- The maximum range of water level change observed over the period of record within the isolated wetland is 2.63 feet. A standard deviation of 0.46 feet indicates some variability in water level in the wetlands occur but are not as significant as those in the lower Tamiami aquifer.
- During the non-growing (wet) season (6/1/05 to 10/1/05) water levels in the lower Tamiami aquifer are equal to or less than those in the wetland and water table aquifer indicating that recharge to the LTA occurs from the overlying WTA.
- The hydrograph and correlation coefficients indicate a moderate to strong positive correlation between the wetland, water table aquifer, and lower Tamiami aquifer water levels during the non-growing (wet) season suggesting they are interrelated under non-farming conditions.
- During the first monitored growing season (3/16 /05 to 6/1/05), water levels within the isolated wetlands drop below land surface intermittently and are slightly lower than water levels in the WTA. Water levels in the WTA remain higher than the wetland during certain times because onsite irrigation adds water to the WTA and this helps to maintain them at a regulated elevation.
- Correlation coefficients were calculated for a growing season prior to and after the reservoir was constructed. These pre and post reservoir coefficients indicate a change in the relationship between the water level groups. Pre reservoir, there was a weak positive linear correlation between the groups. However, after the reservoir was constructed, the weak positive linear correlation between the LTA vs. WTA and the WTA vs. wetland changed to a weak negative correlation. This indicates that after reservoir construction, as water levels

decrease in the LTA, they increase in the WTA (e.g., negative correlation), and as water levels increase in the WTA, they decrease in the wetlands.

- The negative correlation between the WTA and wetland may be due to the WTA monitor well being in close proximity (16 feet) to the exterior perimeter canal of the reservoir. In addition, small internal irrigation ditch and flood irrigation within the adjacent vegetable fields help to distribute the pumped water within the WTA, maintaining water levels artificially high during the growing season. However, in the wetland, water is only being provided along its perimeter causing water levels in the interior part of the wetland to decline during the dry/growing season.
- The poor correlation among the various water level groups and hourly rainfall may be due the surface water management system.

Site No. 3 – Data Summary

This monitoring site is located within the eastern portion of Crook's Ranch in unimproved pasture with no wetlands in close proximity. Small vegetable fields are about a quarter mile to the north of this monitor site but a fairly large citrus grove is present to the west. A moderate size surface canal is also located about 20 feet to the west of the monitor wells and is occupied with water during the majority of the year. A combination of higher land surface elevations and close proximity to a surface drainage water canal keeps this site dry during the year.

Figure 4 is a hydrograph showing water level change over time within the water table and lower Tamiami aquifers plus rainfall for Site No. 3. The land surface elevation at this site is also provided for reference.

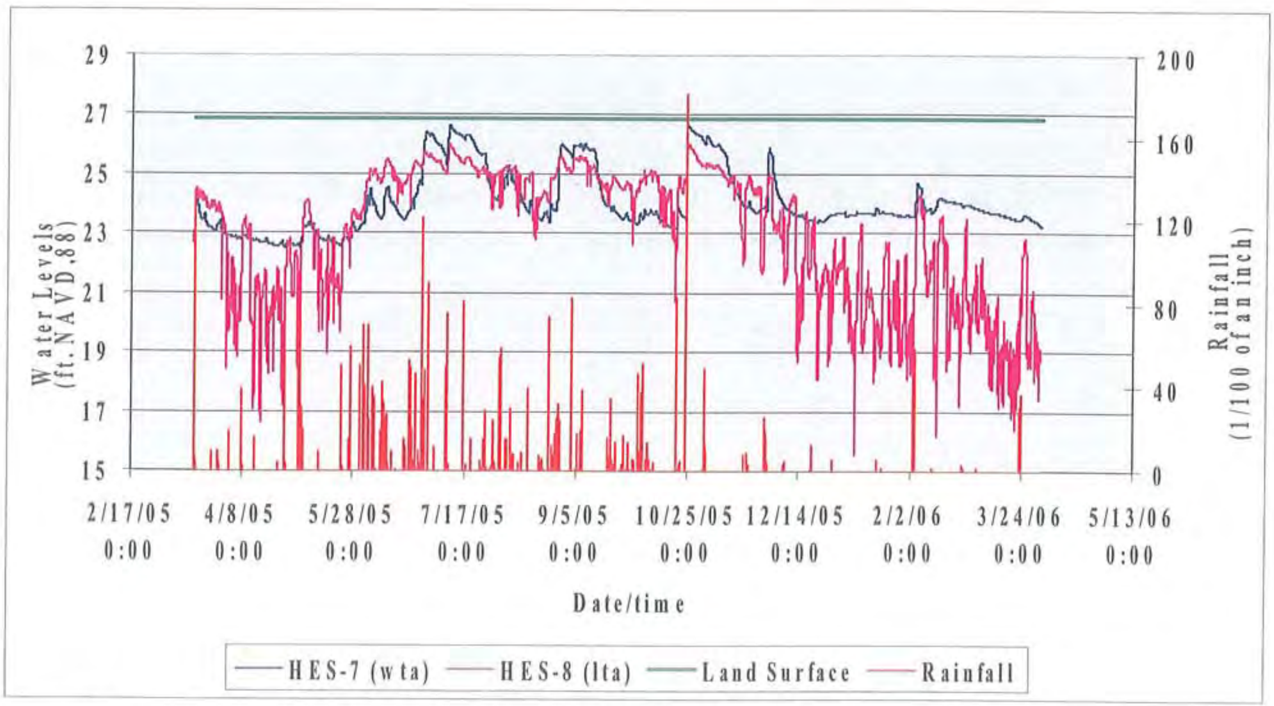


Figure 4 Time series plot of water levels and rainfall – Site No.3

Table 7 contains the summary statistics for individual monitor/stilling wells located at this site

Monitored Source	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
WTA	**HES-7**	**22.52'**	**26.63'**	**4.11**	**24.02'**	**23.70'**	**1.03**
LTA	**HES-8**	**15.59'**	**26.01'**	**10.42**	**23.04'**	**23.81'**	**2.22**
Period of Record 3/16/05 to 4/01/06							

Table 7 Basic summary statistics of water level data – Site No.3

Table 8 contains the calculated linear correlation coefficient between the LTA and WTA <u>daily mean</u> water levels at this site

Relationship	Period of Record 3/16/05 - 4/1/06	Non Growing Season 6/1/05 - 12/1/06	Growing Season 12/1/05 - 4/1/06
Lower Tamiami vs. Water Table	0.5988	0.6942	0.4664

Table 8 Correlation Coefficients of water levels between the LTA & WTA – Site No. 3

The individual linear correlation coefficient plots of water levels and rainfall are provided in **Appendix C& D,** respectively

Table 9 contains the linear correlation coefficients of rainfall versus hourly water level changes in the WTA and LTA (Period of Record – 3/16/05 to 4/1/06).

Group	Correlation Coefficient
Water Table aquifer vs. rainfall	0.6246
Lower Tamiami aquifer vs. rainfall	0.0933
Distance from Rain Gauge = 1.8 miles	

Table 9 Correlation coefficients of rainfall vs. hourly water level changes – Site No. 3

A review of the hydrograph (Figure 4), the summary statistics (Table 7), and linear correlation coefficients (Table 8 & 9) suggests the following:

- The linear correlation coefficient between rainfall and water levels in the WTA and LTA at this site are 0.6246 and 0.0930, respectively.
- The R value of 0.6246 between rainfall and WTA hourly water level change indicate a moderate positive correlation. The slightly lower R-value of 0.6246 than expected as compared to a value of +1 may be a function of distance from the rain gauge (the rain gauge is located 1.8 miles to the west) and time lag for the water to move through the vadose zone into the saturated zone (ground water) may be greater than the 1-hour sample frequency of the water level probes.

- The R value of 0.0930 indicates there is no linear correlation between rainfall and LTA hourly water level changes. This too is excepted since the top of LTA is at 80 feet below land surface and is semi-confined in nature.
- Water levels in the two monitor wells fluctuate over time with the largest fluctuation of 10.72 feet occurring in HES-8, which monitors the lower Tamiami aquifer – the main source of water for crop/citrus irrigation. A standard deviation of 2.22 feet indicates a high degree of variability of water levels within the LTA. This variability is also observed in the above hydrograph and the X-Y scatter plot found in **Appendix C.**
- During several periods of the non growing (wet) season (6/1/05 to 10/1/05) water levels in the lower Tamiami aquifer are greater (higher) than those in the water table aquifer. This indicates that the lower Tamiami aquifer is semi-confined and provides recharge to the WTA during the wet season.
- During the non-growing season there is a moderate positive linear correlation of (R = 0.6842) between LTA and WTA water levels. This suggests that under non stressed or unregulated conditions these water level groups are interrelated.
- During the growing season there is a weaker positive correlation between the LTA and WTA (R = 0.4664). During this time, water levels fluctuate in the LTA in response to ground water withdrawals whereas the management of the moderately sized surface water canal slightly to the north helps to maintain consistent water levels in the WTA as compared to those in the LTA.

Site No. 4 – Data Summary

The 4th monitoring site is located in the southeastern part of Crook's Ranch in improved pasture land with associated wetlands. During a large portion of the year, this site is inundated by water and occurs inside and outside the wetland based on direct observations and noted in the below hydrograph. There are no surface water canals proximal to the monitor site but the area to the north and east may be part of a larger freshwater slough that drains water to the south.

Figure 5 is a hydrograph showing water level change over time within the wetland, water table aquifer and lower Tamiami aquifer plus rainfall for Site No. 4.

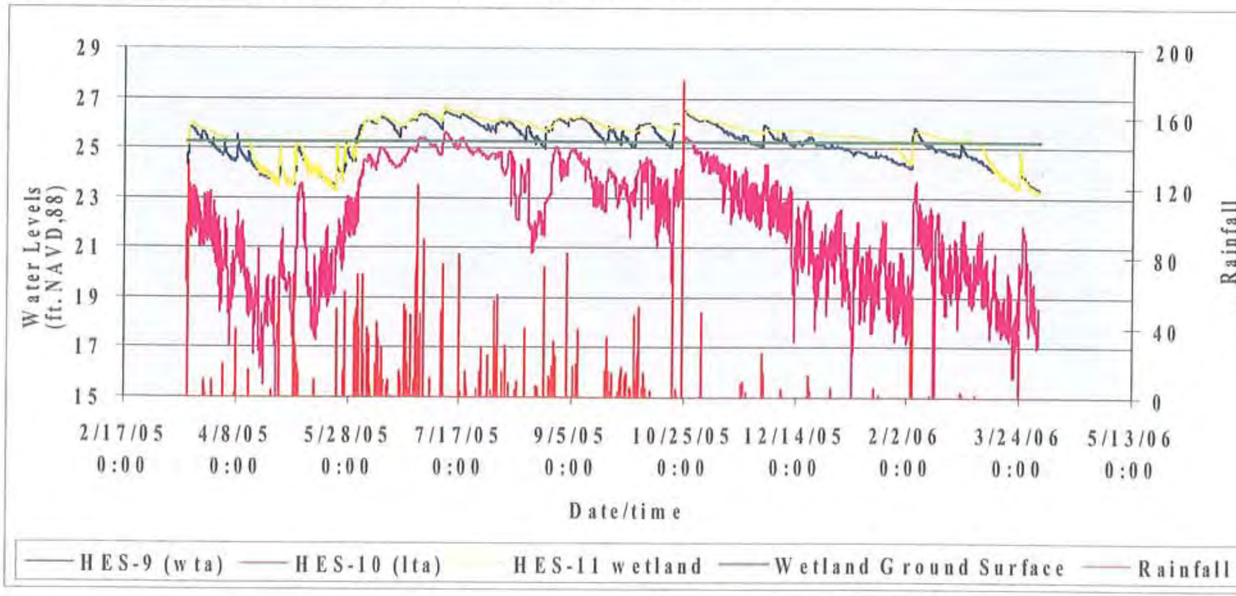


Figure 5 Time series plot (hydrograph) of water levels and rainfall – Site No.4

Table 10 contains the summary statistics for the individual monitor/stilling wells located at this site

Monitored Source	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
WTA	**HES-9**	**23.32'**	**26.56'**	**3.25**	**25.19'**	**25.29'**	**0.80**
LTA	**HES-10**	**12.79'**	**25.62'**	**12.84**	**22.05'**	**22.42'**	**2.39**
Wetland	**HES-11**	**23.16'**	**26.63'**	**3.47**	**25.45'**	**25.69'**	**0.80**
Period of Record 3/16/05 to 4/01/06							

Table 10 Basic summary statistics of water level data – Site No.4

Table 11 contains the calculated linear correlation coefficient between the WTA, LTA, and wetland daily mean water levels at this site

Relationship	Period of Record 3/16/05 - 4/1/06	Non Growing Season 6/1/05 - 8/9/05	Growing Season 11/1/05 - 4/1/06
Lower Tamiami vs. Wetlands	0.8249	0.8914	0.7320
Lower Tamiami vs. Water Table	0.9067	0.7779	0.8499
Water Table vs. Wetland	0.9609	0.8724	0.9453

Table 11 Correlation coefficients of water levels between the groups – Site No. 4

The individual linear correlation coefficient plots of water levels and rainfall for Site No. 4 are provided in **Appendix C & D,** respectively.

Table 12 contains the linear correlation coefficients of rainfall versus hourly water level changes in the wetland, WTA and LTA (Period of Record – 3/16/05 to 4/1/06).

Group	Correlation Coefficient
Wetland vs. rainfall	0.3673
Water Table aquifer vs. rainfall	0.5092
Lower Tamiami aquifer vs. rainfall	0.0529
Distance from Rain Gauge = 1.3 miles	

Table 12 Correlation coefficients of rainfall vs. hourly water level changes – Site No.4

A review of the hydrograph (Figure 5), the summary statistics (Table 10), and linear correlation coefficients (Table 11 & 12) suggests the following:

- Ground surface elevation at the monitor well location is approx. 25.95 feet NAVD, 88 whereas the wetland surface was measured at 25.25 feet NAVD. The wetland is located in a slight topographic low, with the ground levels approximately 0.7 feet lower than those at the monitor well location.

- The majority of rainfall occurs during the normal wet season from June through October causing water levels to increase in the wetland and the water table from direct recharge. The highest rainfall event of 1.80 inches occurred during Hurricane Wilma.
- The linear correlation coefficient between rainfall and water levels in the WTA, LTA and Wetland at this site are 0.5092, 0.0529 and 0.3673, respectively.
- An R-value of 0.5092 between rainfall and WTA hourly water level change indicate a moderate positive correlation. The slightly lower R-value of 0.5092 as compared to a value of +1 may be a function of distance from the rain gauge (the rain gauge is located 1.3 miles to the north), time lag for the water to move through the vadose zone (a function of the vertical permeability of the surface sediments) in the ground water system and the isolated nature of rainfall.
- An R-value of 0.3673 between rainfall and wetland hourly changes in water level indicate a weaker then expected positive correlation. This may be due to distance from the rain gauge, the configuration and connection of the wetland to the adjoining slough, the isolated nature of rainfall, and how the surface water is managed around this site.
- Water levels in all the monitor/stilling wells fluctuate over time with the largest fluctuation of 12.84 feet occurring in HES-10, which monitors the lower Tamiami aquifer – the main source of water for crop/citrus irrigation located to south and west. The high standard deviation of 2.39 feet indicates a high degree of variability of water levels within the LTA as shown by the fluctuating nature of the LTA hydrograph.
- The calculated correlation values indicate a strong positive linear correlation between the wetland, water table aquifer and lower Tamiami aquifer over the period of record, especially, between the WTA and wetland (R = 0.9609)
- The maximum range of water level change observed over the period of record within the isolated wetland is 3.47 feet. A standard deviation of 0.80 feet indicates some variability in water levels as compared to its median value.
- During the growing (dry) season changes in water levels in the LTA affect the WTA water levels slightly more and have less affect on the wetland water levels as compared to the non-growing season. This may be a result of a downward gradient and subsequent leakance across the semi-confining unit caused by ground water withdrawal from the LTA during the growing season.
- The leakance value of 1.1 x 10^{2} gpd/ft^2 was determined by SFWMD from an aquifer performance test conducted at this site. Based on calculated correlation coefficients between the WTA and LTA, it appears that the semi-confining unit impedes the vertical flow between the WTA and LTA under non-stressed conditions (R = 0.77). However, during the growing season, additional water moves through the semi-confining due to a higher induced vertical gradient caused by ground water withdrawals for the underlying LTA resulting in a higher linear correlation (R = 0.85) between the LTA and WTA.
- Water levels within the isolated wetlands drop below land surface intermittently during the latter part of the growing season and become equal to ground water levels in the WTA.

Site No. 5 – Data Summary

This site is located along the southern boundary of Crook's Ranch in improved pasture land just north of CR 833. The ground surface at this site is relatively free of standing water over the majority of the year. Ground water levels however exceed land surface of 25.65 feet NAVD, 88 during a small part of the wet season causing minor flooding conditions. There is a large surface water canal system associated with the Southern Gardens Citrus operations located about 200 feet south of the monitoring site that directly affect surface and water table aquifer water levels.

Figure 6 is a hydrograph showing water level change over time within the water table and lower Tamiami aquifers plus rainfall for Site No. 5. The land surface elevation is also provided for reference.

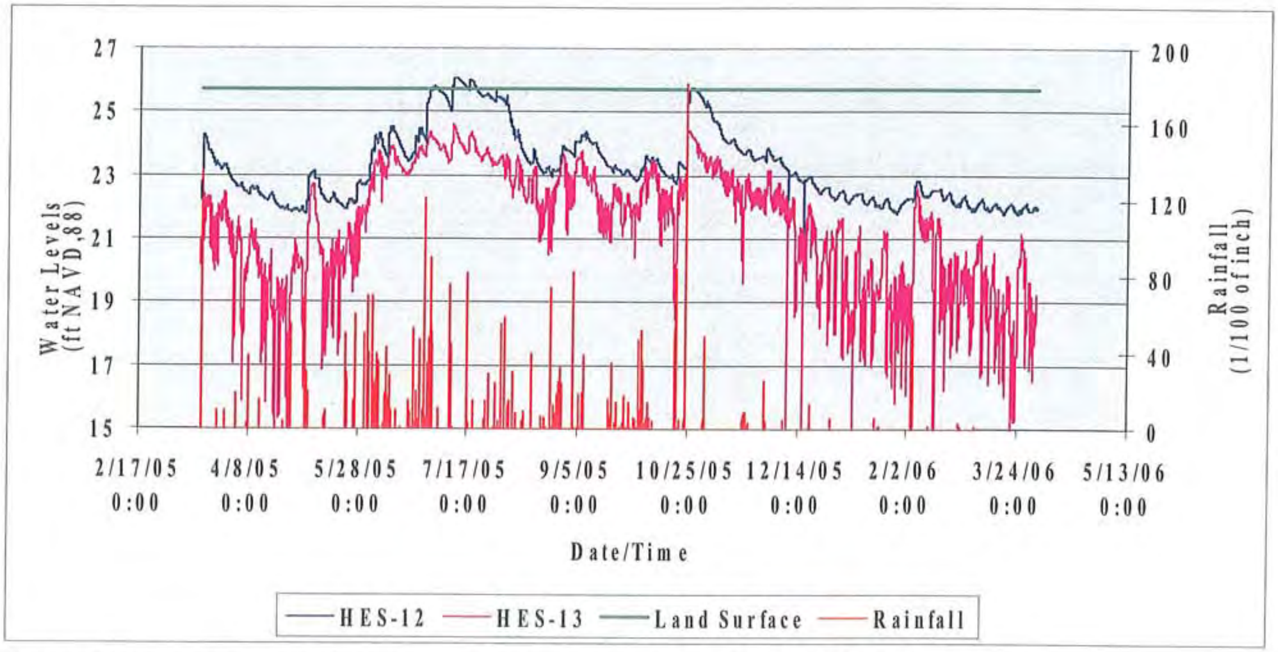


Figure 6 Time series plot (hydrograph) of water levels and rainfall – Site No. 5

Table 13 contains the summary statistics for the individual monitor/stilling wells located at this site

Monitored Source	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
WTA	**HES-12**	**21.80'**	**26.07'**	**4.28**	**23.26'**	**23.08'**	**1.14**
LTA	**HES-13**	**12.66'**	**24.60'**	**11.94**	**21.42'**	**21.83'**	**1.96**
Period of Record 3/16/05 to 4/01/06							

Table 13 Basic summary statistics of water level data – Site No.5

Table 14 contains the calculated linear correlation coefficients between the WTA and LTA daily mean water levels at this site.

Relationship	Period of Record 3/16/05 - 4/1/06	Non Growing Season 6/1/05 - 12/1/05	Growing Season 12/1/05 - 4/1/06
Lower Tamiami vs. Water Table	0.8606	0.8257	0.7459

Table 14 Correlation coefficients of water levels between the LTA & WTA – Site No.5

The individual linear correlation coefficient plots of water levels and rainfall are provided in **Appendix C & D,** respectively.

Table 15 contains the linear correlation coefficients of rainfall versus hourly water level changes in the WTA and LTA (Period of Record – 3/16/05 to 4/1/06).

Group	Correlation Coefficient
Water Table aquifer vs. rainfall	0.6746
Lower Tamiami aquifer vs. rainfall	0.0714
Distance from Rain Gauge = 1.7 miles	

Table 15 Correlation coefficients of rainfall vs. hourly water level changes – Site No. 5

A review of the hydrograph (Figure 6), the summary statistics (Table 13), and linear correlation coefficients (Tables 14 & 15) suggests the following:

- The R-value of 0.6746 between rainfall and WTA hourly water level change indicate a moderate positive correlation, which suggest water levels in the WTA rise in response to rainfall. The R-value of 0.0714 suggests no linear correlation between rainfall and LTA water levels, as expected, since this is a semi-confined aquifer.
- Water levels in the two monitor wells fluctuate over time with the largest fluctuation of 11.94 feet occurring in HES-13, which monitors the lower Tamiami aquifer – the main source of water for citrus irrigation to the south. A standard deviation of 1.96 feet indicates a high degree of variability of water levels within the LTA due to ground water withdrawals over the POR. The water level variability is noted in the above hydrograph and the linear correlation plots provided in **Appendix C.**
- The calculated correlation values indicate a strong positive linear correlation between the water table aquifer and lower Tamiami aquifer over the period of record and suggest that the WTA and LTA are hydraulically connected.
- During the growing (dry) season the correlation coefficient between the LTA and WTA decrease as compared to the non-growing season. This suggests that during the growing season changes in ground water levels in the LTA affect the WTA water levels slightly less than during the non-growing season. This may be due to the surface water management scheme of the proximal canal system of the adjacent citrus operations that regulate ground water levels within a certain elevation during the growing (dry) season. The site hydrograph indicates that water levels in the WTA do not fall below 22 feet NAVD, 88, even during periods of intense ground water withdrawals from the underlying LTA.
- Water levels in the WTA are consistently higher (median = 23.08 ft. NAVD, 88) than those in the LTA (median = 21.83 feet NAVD, 88). The downward gradient indicates that the WTA provides recharge to the LTA. This recharge pattern may be an artifact of the surface water management program utilized by Citrus operations to the south that maintains water levels in the WTA artificially high.

Site No. 6 – Data Summary

The site is located at the southern part of Golden Ox Ranch in improved pasture land with associated marsh/wetlands. During a large portion of the year, standing water is present based on direct observations and noted in the below site hydrograph. There are no surface water canals proximal to the monitor/stilling wells site but the area to the north and east appears to act as a slough moving water to the south similar to those found at Site No. 4 at Crook's Ranch.

Figure 7 is a hydrograph showing water level change over time within the water table aquifer lower Tamiami aquifer and wetland plus rainfall for Site No. 6.

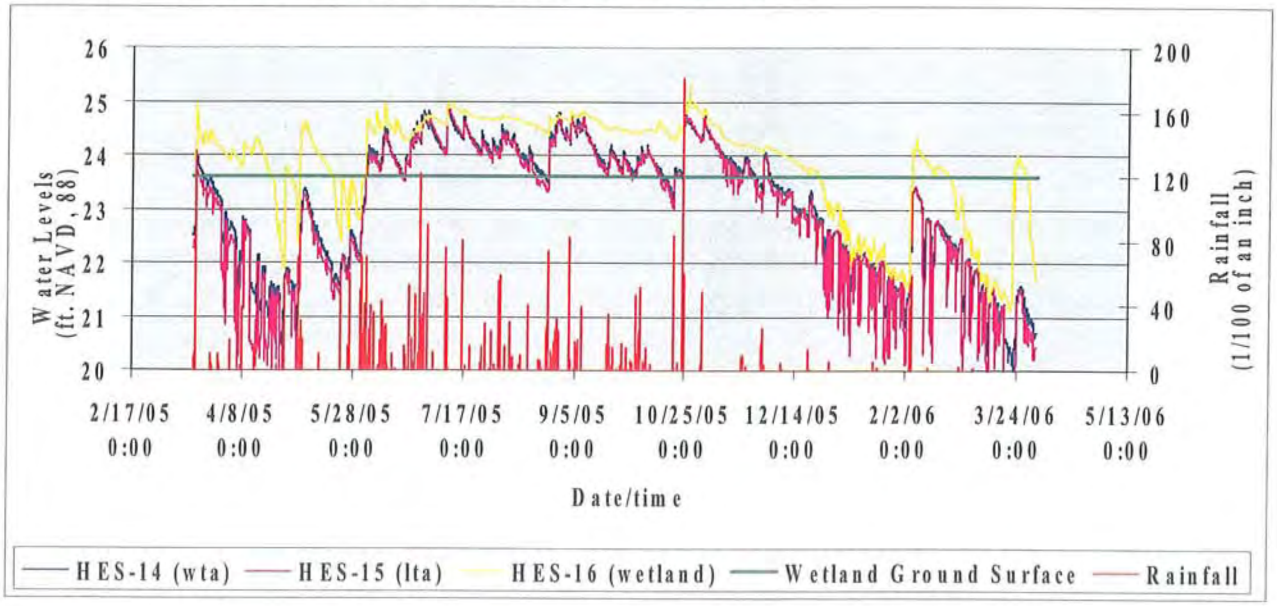


Figure 7 Time series plot (hydrograph) of water levels and rainfall – Site No.6.

Table 16 contains the summary statistics for the individual monitor/stilling wells located at this site

Monitored Source	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
WTA	HES-14	19.93'	24.92'	4.99	23.09'	23.42'	1.15
LTA	HES-15	18.68'	24.87'	6.19	22.95'	23.30'	1.29
Wetland	HES-16	21.12'	25.30'	4.18	23.85'	24.18'	0.95
Period of Record 3/16/05 to 4/01/06							

Table 16 Basic summary statistics of water level data – Site No.6

Table 17 contains the calculated linear correlation coefficients between the WTA, LTA and wetland daily mean water levels at this site.

Relationship	Period of Record 3/16/05 - 4/1/06	Non Growing Season 6/1/05 - 12/1/05	Growing Season 12/1/05 - 4/1/06
Lower Tamiami vs. Wetlands	0.8379	0.8102	0.7278
Lower Tamiami vs. Water Table	0.9945	0.9917	0.9862
Water Table vs. Wetland	0.8659	0.8199	0.7778

Table 17 Correlation coefficients of water levels between the groups – Site No.6

The individual linear correlation coefficient plots of water levels and rainfall data for Site No. 6 are provided in **Appendix C & D,** respectively.

Table 18 contains the linear correlation coefficients of rainfall versus hourly water level changes in the wetland, WTA and LTA (Period of Record – 3/16/05 to 4/1/06).

Group	Correlation Coefficient
Wetland vs. rainfall	0.3779
Water Table aquifer vs. rainfall	0.3624
Lower Tamiami aquifer vs. rainfall	0.1269
Distance from Rain Gauge = 1.8 miles	

Table 18 Correlation coefficients of rainfall vs. hourly water level changes - Site No. 6

A review of the hydrograph (Figure 7), the summary statistics (Table 16), and linear correlation coefficients (Table 17 & 18) suggests the following:

- The wetland is located in a topographic low, with ground surface approximately 1 foot lower than those at the monitor well location.
- Water levels in all the onsite monitor/stilling wells fluctuate over time with the largest fluctuation of 6.91 feet occurring in HES-15, which monitors the lower Tamiami aquifer – the main source of water for small vegetable irrigation. A standard deviation of 1.26 feet indicates a moderate degree of variability of water levels within the LTA, the lowest of all the 7 LTA monitor wells.
- The linear correlation coefficient between rainfall and water levels in the WTA, LTA, and wetland at this site are 0.3624, 0.1269 and 0.3779, respectively. Possibly due the surface water management practices.
- The weak linear correlation between rainfall and hourly water level change associated with the WTA and monitored wetland may be a function of the surface water drainage pattern controlled by topography or artificial surface water controls (canal and surface water pumps) that mute or delays the pulse effect of rainfall.
- The large increases in wetland water levels after significant rainfall events, a large range in water levels, and higher water levels then the WTA indicate that this area may be used to store excessive storm water during the growing season
- An R-value of 0.1269 suggests no linear correlation between rainfall and LTA water levels, as expected, since this is a semi-confined aquifer.

- The median water level value (as listed in Table 16) for the WTA, LTA, and wetland are within a narrow range of one another, which indicates the WTA, LTA and wetland are hydraulically connected.
- The leakance value of 7.8 x 10^{-3} gpd/ft^2 was determined by SFWMD from an aquifer performance test conducted at this site. Based on calculated correlation coefficients between the WTA and LTA, it appears that the semi-confining unit does not impede vertical flow between the WTA and LTA under stress or non-stressed conditions with R values of 0.9862 and 0.9917, respectively.
- The calculated correlation values (as listed in Table 17) indicate a strong positive linear correlation between the wetland, water table aquifer, and lower Tamiami aquifer over the period of record. These values also suggest that the wetland, WTA and LTA are hydraulically connected.
- There is only a slight difference in correlation coefficient for the wetland, WTA and LTA during growing and non-growing seasons indicating hydraulic connection between the groups

Site No. 7 –Data Summary

The 7th monitoring site is located along the northern section of Golden Ox Ranch adjacent to large tracts of small vegetable fields, which surrounds the monitored Wetland. The ground surface at this location is relatively free of standing water over the majority of the year. At this site, a perimeter canal around the wetland was constructed during the latter part of September, 2005. The dredge material from the canal was used to raise the ground surface along the outside perimeter of the wetland. This design allows the water levels in the perimeter canal to be held slightly higher than the natural grade of the wetland, if necessary.

Figure 8 is a hydrograph showing water level change over time within the water table aquifer lower Tamiami aquifer and Wetland plus rainfall and wetland ground surface for Site No. 7

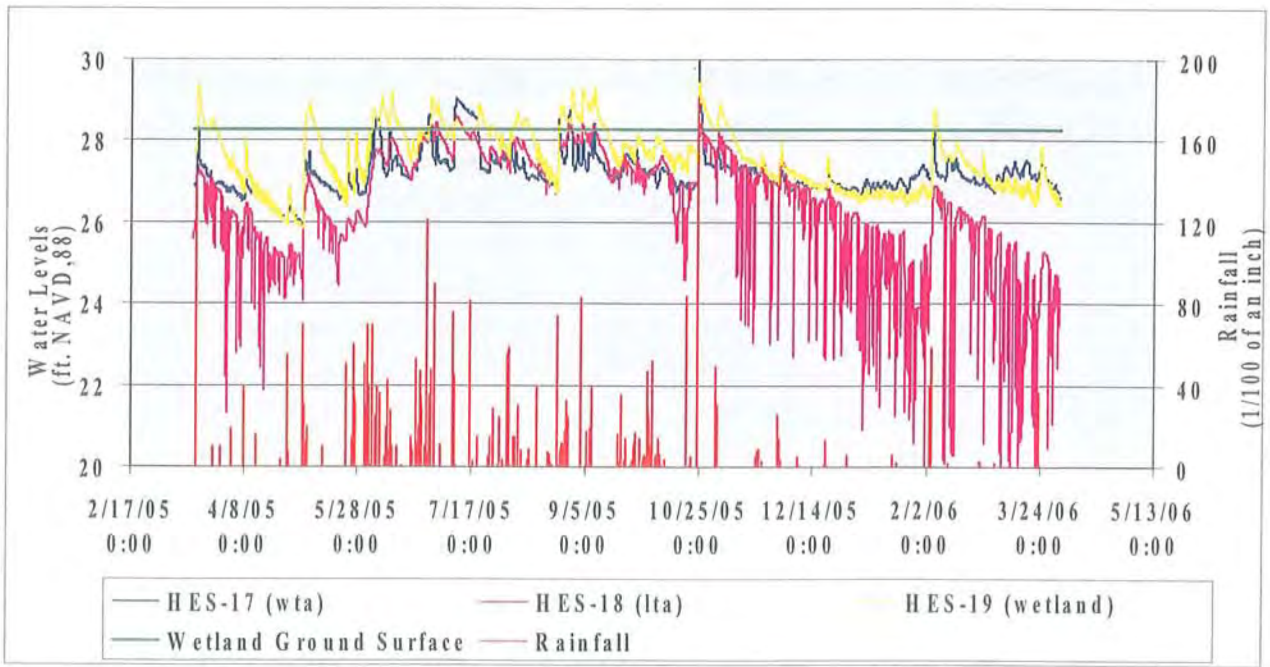


Figure 8 Time series plot (hydrograph) of water levels and rainfall – Site No.7

Table 19 contains the summary statistics for the individual monitor/stilling wells located at this site

Monitored Source	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
WTA	**HES-17**	**25.92'**	**30.01'**	**4.08**	**27.20'**	**27.14'**	**0.51**
LTA	**HES-18**	**18.65'**	**28.63'**	**9.98**	**26.40'**	**26.80'**	**1.53**
Wetland	**HES-19**	**25.86'**	**29.44'**	**3.58**	**27.57'**	**27.54'**	**0.76**
Period of Record 3/16/05 to 4/01/06							

Table 19 Basic Summary Statistics of Water Level Data – Site No.7

Table 20 lists the calculated linear correlation coefficients between the WTA, LTA and wetland daily mean water levels at this site.

Relationship	Period of Record 3/16/05 - 4/1/06	Non Growing Season 6/1/05 - 11/1/05	Growing Season Pre-Reservoir 3/16/05 - 6/1/05	Growing Season Post Reservoir 11/1/05 - 4/1/06
Lower Tamiami vs. Wetlands	0.7987	0.7844	0.9034	0.6306
Lower Tamiami vs. Water Table	0.5615	0.7175	0.8660	0.1157
Water Table vs. Wetland	0.7256	0.5462	0.9514	0.6529

Table 20 Correlation coefficients of water levels between the groups – Site No.7

The individual linear correlation coefficient plots of water level and rainfall are provided in **Appendix C & D,** respectively

Table 21 contains the linear correlation coefficients of rainfall versus hourly water level changes in the Wetland, WTA and LTA (Period of Record – 3/16/05 to 4/1/06).

Group	Correlation Coefficient
Wetland vs. rainfall	0.3817
Water Table aquifer vs. rainfall	0.6212
Lower Tamiami aquifer vs. rainfall	0.0316
Distance from Rain Gauge = 2.3 miles	

Table 21 Correlation coefficients of rainfall vs. hourly water level changes – Site No.7

A review of the hydrograph (Figure 8), the summary statistics (Table 19), and linear correlation coefficients (Table 20 & 21) suggests the following:

- The wetland is located in a topographic low where ground levels are approximately 1 foot lower than those at the monitor well location.
- Water levels in the all the onsite monitor/stilling wells fluctuate over time with the largest fluctuation of 9.81 feet occurring in HES-18, which monitors the lower Tamiami aquifer – the main source of water for crop irrigation. A standard deviation of 1.53 feet indicates a moderate degree of variability of water levels within the LTA, which is also noted in the above hydrograph.
- The linear correlation coefficient between rainfall and water levels in the WTA, LTA and Wetland at this site are 0.6212, 0.0316 and 0.3819, respectively.
- There is a moderate positive linear correlation between rainfall and hourly water level change associated with the WTA. However, there is a weaker correlation (R = 0.3839) between rainfall and hourly water level change associated with the monitored wetland. This weak correlation may be a function of the lateral distance from the rain gauge, (located 2.3 miles south) and the isolated nature of the rainfall in south Florida. It may also be due to the fact the dense wetland canopy at site may intercept a large portion of the rainfall. Another reason may be that the larger surface water system (canals, ditches and surface water pumps) may bring excessive storm water runoff from outside the immediate area causing water to be distributed over the land surface causing water levels to rise in the WTA but not have the same affect on the isolated wetland.
- An R value of 0.0316 suggests little correlation between rainfall and LTA water level change, as expected, since this is a semi-confined aquifer and will respond slowly to direct recharge.
- During the non-growing (wet) season water levels in the LTA and wetland are greater than those in the WTA. During the wet season, the WTA is recharged by the overlying wetland and underlying LTA.
- During several periods of the wet season (6/1/05 to 10/1/05) water levels in the lower Tamiami aquifer are greater (higher) than those in the water table aquifer. This indicates that the lower Tamiami aquifer is semi-confined and provides recharge to the WTA during the wet season.
- During the non-growing (wet) season there is a moderate positive linear correlation (R = 0.7175) between LTA and WTA water levels During the growing (dry) season, wetland water levels fall below its natural grade and only rise above grade after a significant rainfall event.
- During the growing (dry) season from 3/16-05 to 6/1/05, prior to the construction of the wetland perimeter canal, water levels in the wetland were more variable and had a stronger correlation (R= 0.9034) with water levels of the pumped LTA.
- During the growing (dry) season from 11/1/05 to 4/1/06, after the construction of the wetland perimeter canal, water levels in the wetland were less variable and had a lower correlation (R = 0.6306) with water levels of the pumped LTA. However, wetland water levels were below natural grade for a longer period of time. The perimeter canal causes water levels in the wetland to be more consistent with those of the WTA.

Water Source Specific Data Summary & Observations

Wetland – Data Summary

Generally speaking, a wetland is an area that is neither dry land nor open water. All wetlands are formed and sustained by the influence of water on land. However, the depth and duration of water in different types of wetlands can be extremely variable. In some wetlands the water is at ground level, where the saturated soils stay wet most of the time while other wetlands are inundated, with normal water levels above ground. The method of determining the limits of a wetland is found in Section 62-340.300 of the Florida Administrative Code.

For direct comparison purposes all the wetland water level data combined with rainfall from each of the five wetland sites were plotted on a single hydrograph as shown in **Figure 9**. This was done to observe/compare water level fluctuations over time and space and compare the influence of rainfall on wetland water levels.

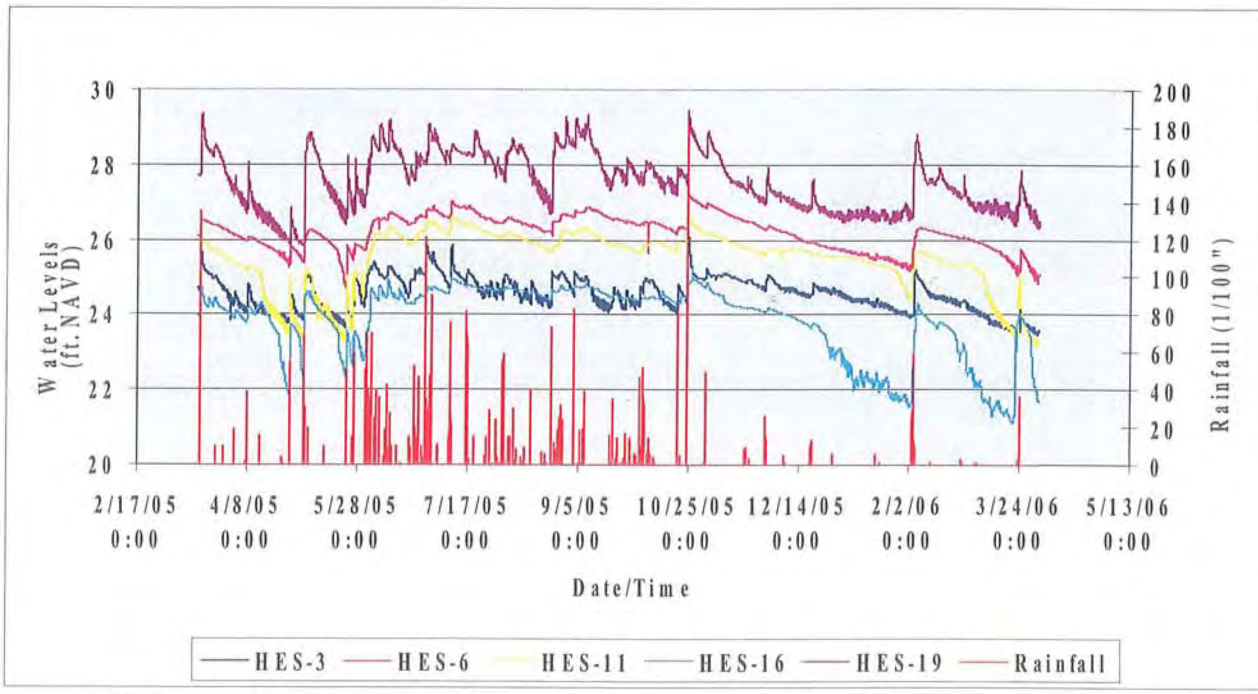


Figure 9 Hydrograph of wetland stilling well water levels plus rainfall.

The hourly water level change was calculated by each hourly water level reading from the previous reading. The net difference (-/+) in feet were plotted for each wetland combined with hourly rainfall data versus time. **Figure 10** is a time series plot of hourly water level change in wetlands.

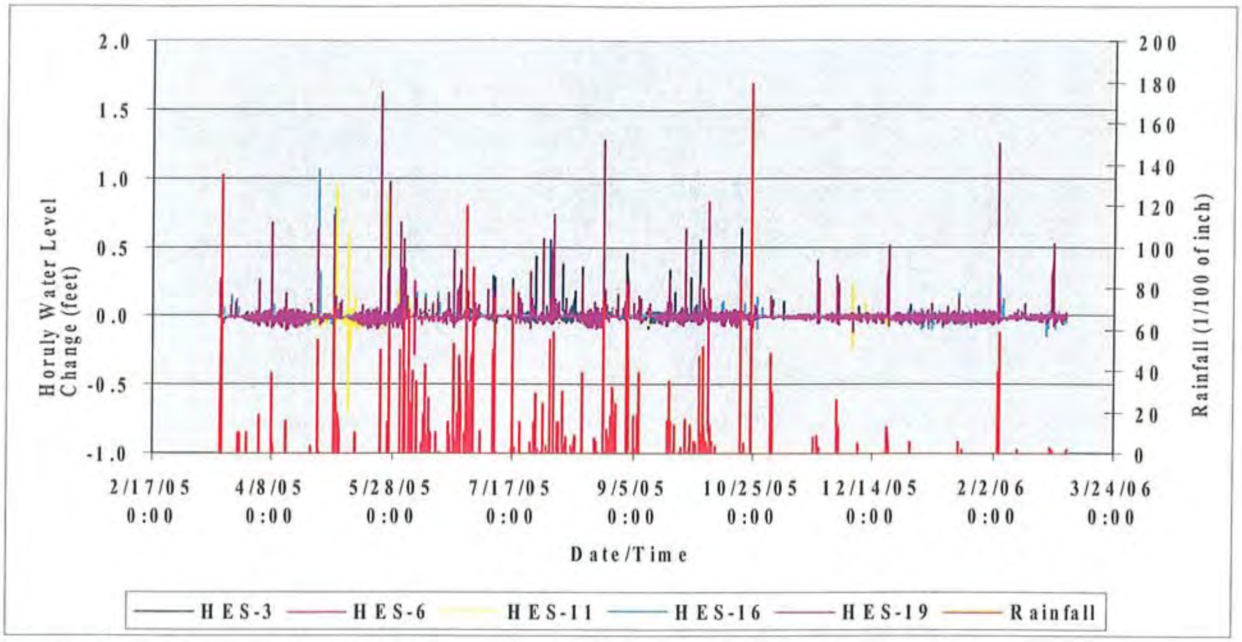


Figure 10 Time series plot of hourly water level change in individual wetlands

Table 22 contains the summary statistics for the stilling wells located at the five individual wetland monitoring sites.

Site Id	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
1	HES-3	23.46'	26.06'	2.60	24.56'	24.58'	0.44
2	HES-6	24.72'	27.34'	2.62	26.21'	26.29'	0.46
4	HES-11	23.16'	26.63'	3.47	25.45'	25.69'	0.80
6	HES-16	21.12'	25.30'	4.18	23.85'	24.18'	0.95
7	HES-19	25.86'	29.44'	3.58	27.57'	27.54'	0.76
Period of Record 3/16/05 to 4/01/06							

Table 22 Basic summary statistics of wetland water level data.

A review of the hydrograph (Figure 9), the time-series plot of hourly water level changes (Figure 10) and water level summary statistics (Table 22), suggests the following:

- The hydrograph for the stilling well identified as HES-19 located at site 7 shows the most erratic trend in hourly water levels over the POR. Water levels also rise dramatically with significant rainfall events but are also affected by other factors. The high magnitude of hourly water level change is illustrated in Figure 10 whereby the purple line that depicts HES-19 over prints the hourly water level change measured from the other wetland stilling wells.
- Visually, the hydrographs for HES-3 located at Site No.1 and HES-6 located at Site No. 2 are similar in trend and magnitude of change. The standard deviation of 0.44 and 0.46 for HES-3 and HES-6, respectively also indicate a similar degree of variability. These stilling wells are located on Crook's Ranch both in close proximity to vegetable fields where

irrigation canals and flood irrigation is used keep to surface/ground water within a narrow range as reflected by lower range and standard deviation.

- The stilling well identified as HES-19 located in the northern most portion of the study area has the highest median water level of 27.57 feet (NAVD, 88). The lowest median water level (24.18 ft. NAVD, 88) of all the five wetland sites is recorded by HES-16, located at Site No.6, which is located about ¾ to 1 mile south of Site No.7.
- At Site No. 7, the construction of the wetland perimeter canal help to reduce the effects of ground water withdrawals from the LTA on the wetland during the growing season from 11/05 to 4/06. The perimeter canal has also helped to maintain more consistent water levels and do not allow them to fall below 26.8 feet NAVD, 88 (Figure 9) as compared to the previous growing season.
- During the growing (dry) season, water levels in HES-16, located at Site No. 6 as shown in Figure 9 are more erratic and drop lower than any of the other four wetland sites. Also, water levels from HES-16, has the highest range of 4.18 feet and greatest variability based on a standard deviation of 0.95 feet.
- During the growing season water levels in wetland at Site No. 6, appears to be most negatively impacted as compared to the other 5 wetland sites by declining water levels in the LTA due to ground water withdrawals.

Water Table Aquifer – Data Summary

The water table aquifer consists primarily of Holocene and Pleistocene aged unconsolidated quartz sands, terrigenous mudstones, shell beds, and quartz sandstone. This aquifer extends from land surface to the top of semi-confining beds that are part of the Tamiami Formation and is unconfined in nature meaning under atmospheric conditions.

For direct comparison purposes all the water table aquifer water level data combined with rainfall from each of the seven sites were plotted on a single hydrograph as shown in **Figure 11**.

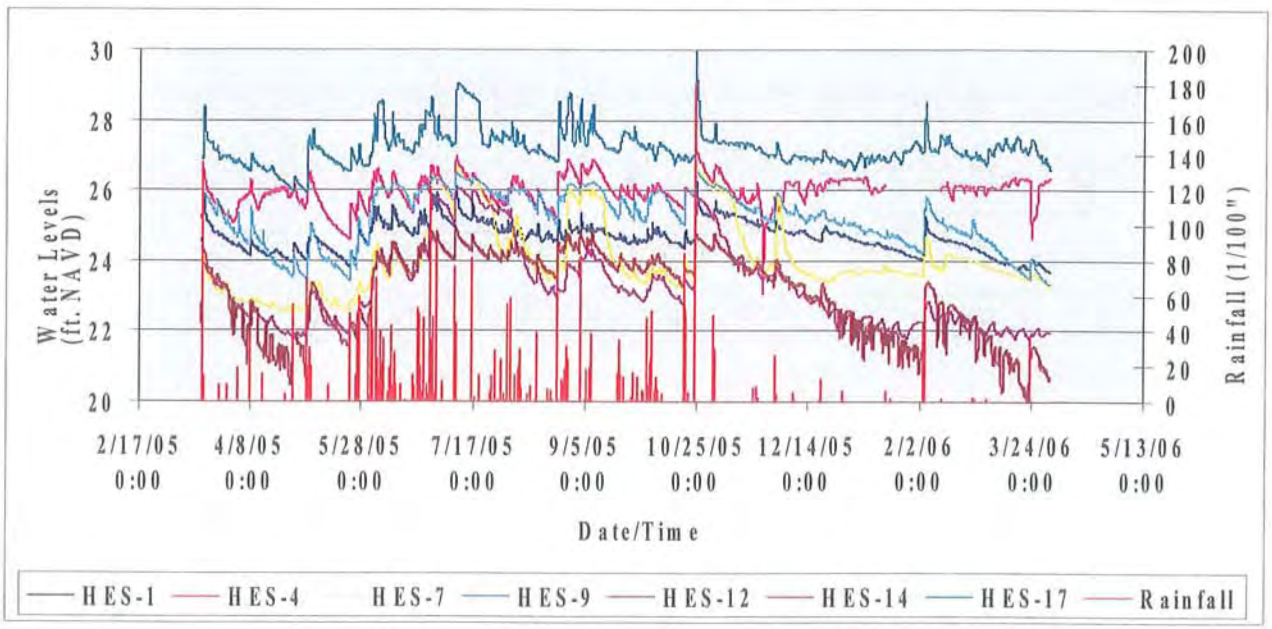


Figure 11 Time series plot of Water Table aquifer water levels and rainfall.

The hourly water level change was calculated by each hourly water level reading from the previous reading. The net difference (-/+) in feet were plotted for each wetland combined with hourly rainfall data versus time. **Figure 12** is a time series plot of hourly water level change in response to rainfall and/or ground water withdrawals.

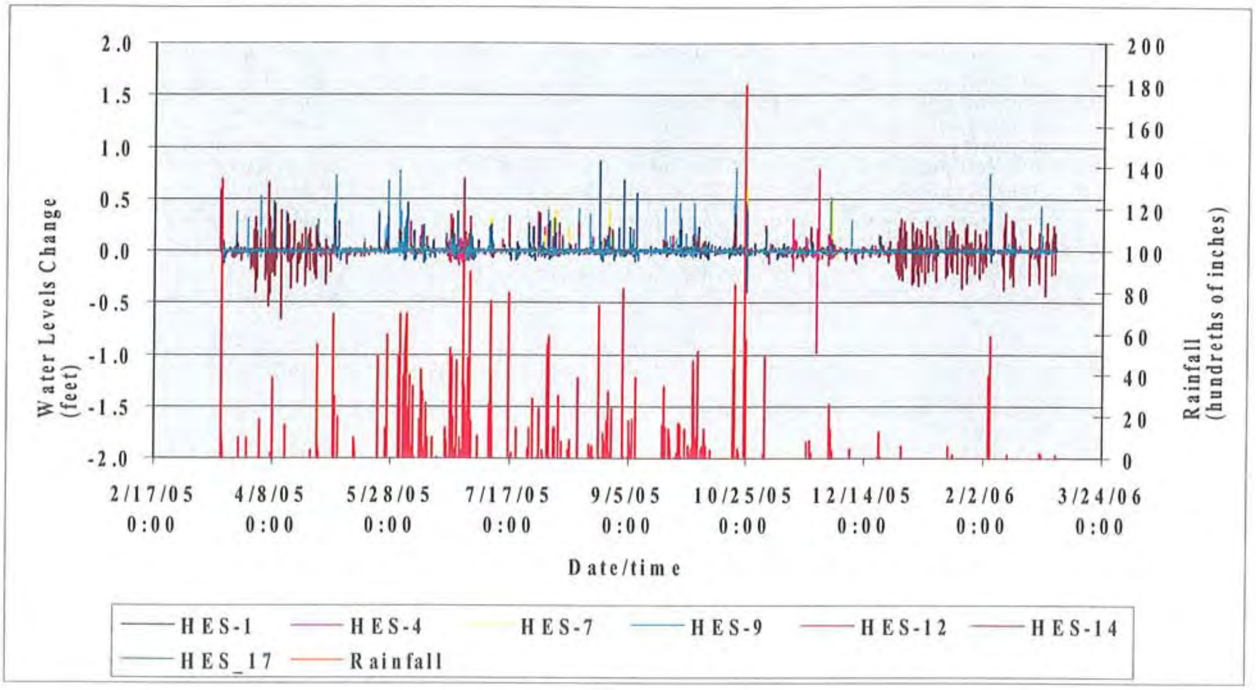


Figure 12 Time series plot of hourly water level changes in the WTA and rainfall

Table 23 contains the summary statistics for water table aquifer monitor wells located at the seven individual monitoring sites.

Site Id	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
1	HES-1	23.69	26.32	2.63	24.67	24.67	0.44
2	HES-4	23.08	27.16	4.08	25.98	26.02	0.43
3	HES-7	22.52	26.63	4.11	24.02	23.70	1.03
4	HES-9	23.32	26.56	3.25	25.19	25.29	0.80
5	HES-12	21.80	26.07	4.28	23.26	23.08	1.14
6	HES-14	19.93	24.92	4.99	23.09	23.42	1.15
7	HES-17	25.92	30.01	4.08	27.20	27.14	0.51
Period of Record 3/16/05 to 4/01/06							

Table 23 Basic summary statistics of the WTA water level data

A review of the hydrograph (Figure 11), the time-series plot of hourly water level changes (Figure 12) and water level summary statistics (Table 23), suggests the following:

- Regionally, ground water flow in the WTA is to the south-southeast. Based on the median and mean values from each site, the general ground water flow direction underlying Golden Ox and Crook's Ranch is towards the south but is locally variable due to site specific surface water management practices.
- The hydrograph for the monitor wells HES-1 and HES-4 located Site No. 1 and 2, respectively are very similar in trend and the degree of hourly water level changes recorded over the POR. This observation is also supported by similar calculated range and standard deviation values. (see Table 23)
- The hydrograph for the monitor wells HES-12 and HES-14 located at Site No. 5 and 6 are very similar in trend and degree of change of hourly water levels recorded over the POR. This observation is also supported by similar range and standard deviation values. (see Table 23)
- During the growing season, the high magnitude hourly water level changes are illustrated in Figure 12 where the brown line representing HES-14 over prints the changes recorded by the other 6 water table aquifer monitor wells. This suggests that the WTA is effected by ground water withdrawals from the LTA.
- During the non-growing (wet) season, higher magnitude hourly water level changes are noted by HES-9, possibly in response to citrus irrigation to the west and south.

Lower Tamiami Aquifer – Data Summary

The lower Tamiami aquifer is composed primarily of late Pliocene-aged sediments consisting of moderately to well-consolidated shell beds and sandy limestone to quartz sandstone of the Tamiami Formation. This aquifer is generally semi-confined and extends from below the overlying semi-confining unit to a depth of 120 feet below land surface.

For direct comparison purposes all the lower Tamiami aquifer water level data from each of the seven monitor sites combined with rainfall were plotted on a single hydrograph – **Figure 13**

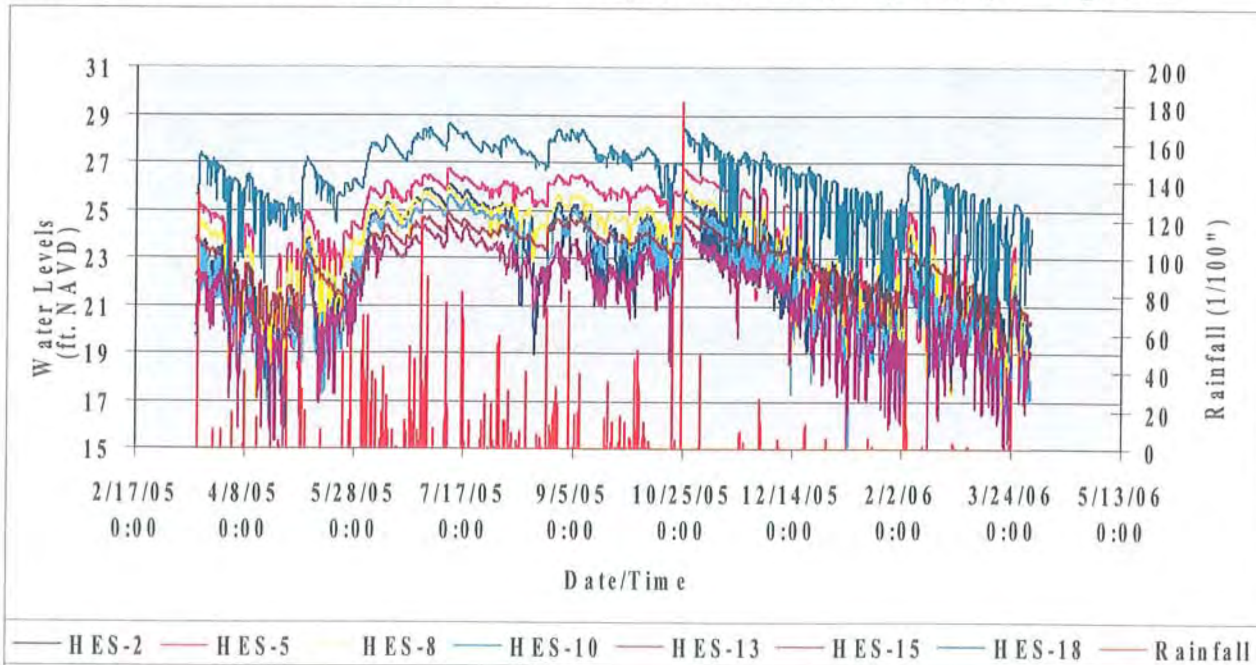


Figure 13 Time series plot of LTA water levels and rainfall.

The hourly water level changes were calculated by subtracting each hourly water level reading from the previous reading. The net difference (-/+) in feet were plotted for each lower Tamiami aquifer monitor well combined with hourly rainfall data versus time. **Figure 14** is a time series plot of hourly water level change and rainfall

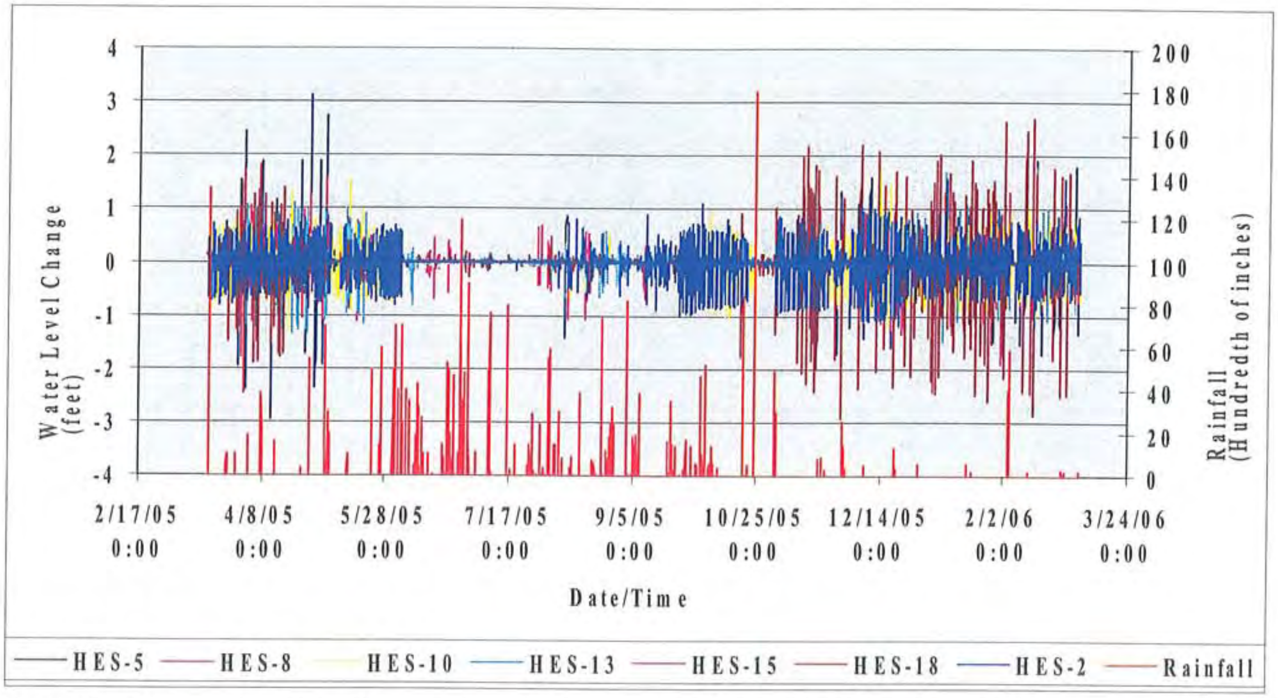


Figure 14 Time series plot of hourly water level changes in the LTA and rainfall

Table 24 contains the summary statistics for the lower Tamiami aquifer monitor wells located at the seven individual monitoring sites.

Site Id	Station Id	Minimum Value (NAVD,88)	Maximum Value (NAVD,88)	Range (feet)	Mean Value (NAVD,88)	Median Value (NAVD,88)	Standard Deviation (feet)
1	HES-2	14.80	26.07	11.28	22.44	22.39	2.16
2	HES-5	17.04	26.76	9.72	23.78	24.83	2.53
3	HES-8	15.59	26.01	10.42	23.04	23.81	2.22
4	HES-10	12.79	25.62	12.84	22.05	22.42	2.39
5	HES-13	12.66	24.60	11.94	21.42	21.83	1.96
6	HES-15	18.68	24.87	6.19	22.95	23.30	1.29
7	HES-18	18.65	28.63	9.98	26.40	26.80	1.53
Period of Record 3/16/05 to 4/01/06							

Table 24 Basic summary statistics of the LTA water level data

A review of the hydrograph (Figure 13), the time-series plot of hourly water level changes (Figure 14), and water level summary statistics (Table 24), suggests the following:

- Regionally, ground water flow in the LTA is to the south-southeast. Based on the median and mean values from each site, the general ground water flow direction underlying Golden Ox and Crook's Ranch is towards the south but is locally variable due to site specific irrigation and surface water management practices.
- The calculated difference in mean values between the WTA and LTA indicate that over the POR the vertical gradients at all 7 sites are negative indicating that the WTA recharges the LTA. The vertical gradients range from -0.14 feet to -3.14 feet.
- Figure 13 indicates that the majority of ground water withdrawals from the LTA occur from November through the end of May with minor withdrawals at several locations (HES-2, 10 and 13) occurring between August to mid-October.
- The greatest and most frequent changes in water levels in the LTA during the dry season occur around Site No.2 (HES-5) – refer to Figure 14. HES-5 also has the highest variability in water levels over the POR with a calculated standard deviation of 2.53
- During the growing season, the greatest hourly changes (magnitude) in water levels occur at Site No. 7 as shown by HES-18 in Figure 14.
- The largest range of water levels occurs in HES-10 (12.84 feet) followed by HES- 13 (11.94 feet) both located in the southern portion of the study area.
- All LTA monitor wells record declining water levels during the growing season but appear to recover during the wet season with no discernable long-term water level tend observed over the POR.
- The submitted monthly pumpage reports by the water use permittees does not accurately reflect the draw downs recorded by the LTA monitor wells. Better control of ground water withdrawals are needed.

Summary & Recommendations

A summary of general observations from the analysis of the water level, rainfall and pumpage data from the Crook and Ox Ranches in Hendry County is provided below:

- Generally, good correlation exists between wetland and the water table aquifer water levels in response to rainfall but correlation coefficients become lower as distance increases from the single rainfall station used in the analysis and the management of the surface water system. **Recommendation** – Install a rain gauge and surface water staff gauge(s) at each of the seven locations to discern the isolated nature and effect of thunderstorms especially during the wet season and the how the surface water is regulated proximal to the site.
- Based on hourly water level and rainfall data, there appears to be a time lag of 1 to 2 hours in water level changes in the water table in the response to a recharge event. This time lag produces a lower than expected correlation coefficient. **Recommendation** – All correlation analysis should be performed using daily mean values so that the time lag effects are diminished.
- There are variable degree of correlations between the wetland and water table and lower Tamiami aquifers water levels at each of the 5 wetland site locations – primarily due to localized change in surface and subsurface hydrology. **Recommendation** – Integrate the hydrograph analyses into the hydrogeologic data and surface water management scheme to determine site specific cause and affect relationships.
- The reported monthly pumpage data transformed into hourly rates produced poor correlation to water level changes. This is due in fact to distributing the pumpages evenly over a 24-hour daily period using the monthly reported value. **Recommendation** – Determine specific irrigation schedules from the various farm managers so that the pumpages can better reflect site irrigation practices or require that the ground water withdrawals be timed and metered.
- The surface water management scheme that affect water levels in the wetland and water table aquifer at Crook and Golden Ox ranches but are not quantified. **Recommendation -** Gain information on the surface water system from as-built drawings and quantify surface water levels and discharge volumes to natural areas (wetland marshes or slough) or other downstream drainage systems.
- The natural hydro-periods for the monitored wetlands, especially during the dry season can not be determined because irrigation and surface water management practices maintain water levels for optimal irrigation and flood control benefits. **Recommendation** - Select and monitor a wetland that is not impacted by ground water withdrawals or the surface water system to determine its natural hydro period. In this way, the effects of ground water withdrawals and surface water management practices can be discerned on the existing monitored wetlands.
- There were small water level changes in the various monitor intervals under non-stressed conditions that appear to be related to barometric pressure effects. **Recommendation** – Retrieve barometric pressure data from local weather stations to determine barometric efficiencies.

Appendix A

In-Situ Mini-Troll's Calibration Sheets

Crooks Ranch Monitoring Project
Equipment Deployed

Sample Time	1 per hour

Number	Well Number	Site Location	Well Name	15 psi Mini Troll	Vented Cable
1	HES-1	Site 1 West	Water Table	19216	89688
2	HES-2	Site 1 West	Tamiami	19254	89689
3	HES-3	Site 1 West	Stilling Well	19313	89690
4	HES-4	Site 2 North	Water Table	19322	89691
5	HES-5	Site 2 North	Tamiami	19325	89692
6	HES-6	Site 2 North	Stilling Well	19327	89693
7	HES-7	Site 3 East	Water Table	19338	89694
8	HES-8	Site 3 East	Tamiami	19343	89695
9	HES-9	Site 4 South	Water Table	19344	89696
10	HES-10	Site 4 South	Tamiami	19355	89751
11	HES-11	Site 4 South	Stilling Well	19377	89752
12	HES-12	Site 5 South	Water Table	19382	89753
13	HES-13	Site 5 South	Tamiami	19388	89754
14	HES-14	Ox Site 6	Water Table	19393	89755
15	HES-15	Ox Site 6	Tamiami	19422	89756
16	HES-16	Ox Site 6	Stilling Well	19424	89757
17	HES-17	Ox Site 7	Water Table	19487	89758
18	HES-18	Ox Site 7	Tamiami	19499	89759
19	HES-19	Ox Site 7	Stilling Well	19503	89760
20	HES-20	Ox Production Well			

In-Situ Inc.
Helping monitor the earth's resources

Mini-Troll Submersible Cable Quality Inspection Report

Date Inspected 2-10-05

Area of Inspection		Pass	Fail	Inspected By	Failure Corrected (Date / By)	Verified By
Master Schedule Order Number	329435	✓	☐			
Cable Length Verified	20 ft. / 6.1 m.	✓	☐			
Cable Type Verified	POLY / FEP / Poly Non-Vented	✓	☐			
Vent Tube is Open and Clear		✓	☐			
Reel Configuration Verified	NR / Plastic / PL / SS / LS / WOOD	✓	☐			
Std / Water Barrier / NA	DOCUMENT	✓	☐			
Artesian, NPT to NPT / NPT to PVC / NA	DOCUMENT	✓	☐			
Backshell and Bulgin connectors are Free of Defects		✓	☐			
Continuity Check Done on all Backshell to Bulgin Connector		✓	☐			
Dust Cap installed on Backshell		✓	☐			
Dust Cap installed on Bulgin Connector:	Vented / Non-vented	✓	☐			
Cable Jacket Inspected for Defects		✓	☐			
Labels correct and installed on cable		✓	☐			
Revision #070204		✓	☐			
Inspection Documentation Correct and Included with Completed Job		✓	☐			

SERIAL NUMBER(s):

89688 89694
89689 89695
89690 89696
89691
89692
89693

I certify that this unit has been inspected and meets all of the required Quality Inspection Points as prescribed by this document. Any and all failures have been isolated and corrected (as indicated above). This unit is acceptable for release to the Shipping Department for shipment..

Carrie McKennan
Production Technician

In-Situ Inc.
Helping monitor the earth's resources

Mini-Troll Submersible Cable Quality Inspection Report

Date Inspected 2-16-05

Area of Inspection	Pass	Fail	Inspected By	Failure Corrected (Date / By)	Verified By
Master Schedule Order Number 329437	✓	☐			
Cable Length Verified 20 ft. / 6.1 m.	✓	☐			
Cable Type Verified POLY / FEP / Poly Non-Vented	✓	☐			
Vent Tube is Open and Clear	✓	☐			
Reel Configuration Verified NR / Plastic / PL / SS / LS / WOOD	✓	☐			
Std / Water Barrier / NA DOCUMENT	✓	☐			
Artesian, NPT to NPT / NPT to PVC / NA DOCUMENT	✓	☐			
Backshell and Bulgin connectors are Free of Defects	✓	☐			
Continuity Check Done on all Backshell to Bulgin Connector	✓	☐			
Dust Cap installed on Backshell	✓	☐			
Dust Cap installed on Bulgin Connector: Vented / Non-vented	✓	☐			
Cable Jacket Inspected for Defects	✓	☐			
Labels correct and installed on cable	✓	☐			
Revision #070204	✓	☐			
Inspection Documentation Correct and Included with Completed Job	✓	☐			

SERIAL NUMBER(s):

89751 89756
89752 89757
89753 89758
89754 89759
89755 89760

I certify that this unit has been inspected and meets all of the required Quality Inspection Points as prescribed by this document. Any and all failures have been isolated and corrected (as indicated above). This unit is acceptable for release to the Shipping Department for shipment..

Carrie McKennan
Production Technician

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19216 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 27.08	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/8/05 4:20:48 PM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.14VDC	☑	☐	☐	BN
Wake Current: 18.28 mA	☑	☐	☑	BN
Sleep Current: .16mA	☑	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

[signature]

Bruce Nordell

In-Situ Inc.

Calibration Report

Report Number:20050208162019216

221 East Lincoln Avenue, Fort Collins, Colorado 80524 USA. Visit us at www.in-situ.com
1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-08
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19216

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 41014
2. Instrulab model 832 s/n 12070(RTD-03)
3. Ruska model 7215xi s/n 53144
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.18 C to 49.76 C
Range of Applied Pressure: 0.0000 kPa (0.0000 PSI) to 103.4246 kPa (15.0005 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.26 C	35.27 C	0.0002 PSI	0.0000 PSI
		4.9503 PSI	4.9500 PSI
		10.0500 PSI	10.0493 PSI
		15.0000 PSI	14.9975 PSI
		10.0501 PSI	10.0493 PSI
		4.9499 PSI	4.9504 PSI
		0.0002 PSI	0.0010 PSI

Test Performed By: JB
Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19254 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	✓	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	✓	☐	☐	jm
Temperature coefficients verified	✓	☐	☐	jm
Temperature Reading @ open air temp: 25.05	✓	☐	☐	jm
Pressure coefficients verified	✓	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): -0.00	✓	☐	☐	jm
Calibration pressure range: 15G	✓	☐	☐	jm
Calibration date: 2/10/05 6:34:42 AM	✓	☐	☐	jm
Firmware version: 3.09	✓	☐	☐	jm
Power Source: Internal	✓	☐	☐	jm
Battery Type: Lithium	✓	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.17VDC	✓	☐	☐	jm
Wake Current: 17.15	~~☐~~	☐	✓	jm
Sleep Current: .13	~~☐~~	☐	✓	jm
Dust Cap Type: Standard	✓	☐	☐	jm
Job Number: 329436				

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Judi Mathews

In-Situ Inc.

Calibration Report

Report Number: 20050210063419254

221 East Lincoln Avenue, Fort Collins, Colorado 80524 USA. Visit us at www.in-situ.com
1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-10
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19254

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.14 C to 49.78 C
Range of Applied Pressure: 0.0001 kPa (0.0000 PSI) to 103.4236 kPa (15.0003 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.29 C	0.0001 PSI	0.0016 PSI
		4.9502 PSI	4.9502 PSI
		10.0503 PSI	10.0490 PSI
		14.9998 PSI	14.9991 PSI
		10.0500 PSI	10.0505 PSI
		4.9499 PSI	4.9506 PSI
		0.0001 PSI	0.0026 PSI

Test Performed By: JM

Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19313 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 27.76	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/1/05 4:42:02 PM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.15VDC	☑	☐	☐	BN
Wake Current: 19.73mA	☑	☐	☑	BN
Sleep Current: .19mA	☑	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

Bruce Nordell

Bruce Nordell

In-Situ Inc.

Calibration Report

Report Number:20050201164219313

221 East Lincoln Avenue, Fort Collins, Colorado 80524 USA. Visit us at www.in-situ.com
1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-01
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19313

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.14 C to 49.78 C
Range of Applied Pressure: -0.0004 kPa (-0.0001 PSI) to 103.4243 kPa (15.0004 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.29 C	-0.0000 PSI	0.0002 PSI
		4.9497 PSI	4.9488 PSI
		10.0505 PSI	10.0477 PSI
		15.0000 PSI	14.9959 PSI
		10.0498 PSI	10.0487 PSI
		4.9499 PSI	4.9512 PSI
		-0.0000 PSI	0.0007 PSI

Test Performed By: JM
Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19322 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 25.73	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): 0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/10/05 6:34:42 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.16VDC	☑	☐	☐	jm
Wake Current: 19.69	~~☐~~	☐	☑	jm
Sleep Current: .27	☐	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329436				

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Judi Mathews

Generated by QAMiniTroll version 1, 0, 8, 0

In-Situ Inc.

Calibration Report

Report Number:20050210063419322

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-10
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19322

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.14 C to 49.78 C
Range of Applied Pressure: 0.0001 kPa (0.0000 PSI) to 103.4236 kPa (15.0003 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.30 C	0.0001 PSI	0.0005 PSI
		4.9502 PSI	4.9484 PSI
		10.0503 PSI	10.0478 PSI
		14.9998 PSI	14.9966 PSI
		10.0500 PSI	10.0491 PSI
		4.9499 PSI	4.9510 PSI
		0.0001 PSI	0.0009 PSI

Test Performed By: JM Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19325 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 25.38	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/10/05 6:34:42 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.17VDC	☑	☐	☐	jm
Wake Current: 16.68	~~☐~~	☐	☑	jm
Sleep Current: .12	~~☐~~	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329436				

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Judi Mathews

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In-Situ Inc.

Calibration Report

Report Number:20050210063419325

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-10
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19325

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.14 C to 49.78 C
Range of Applied Pressure: 0.0001 kPa (0.0000 PSI) to 103.4243 kPa (15.0004 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.31 C	0.0001 PSI	0.0005 PSI
		4.9502 PSI	4.9496 PSI
		10.0503 PSI	10.0493 PSI
		14.9998 PSI	14.9985 PSI
		10.0500 PSI	10.0497 PSI
		4.9499 PSI	4.9505 PSI
		0.0001 PSI	0.0015 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19327 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 25.10	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/10/05 6:34:42 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.20VDC	☑	☐	☐	jm
Wake Current: 17.51	☐	☐	☑	jm
Sleep Current: .12	☐	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329436				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

Judi

Judi Mathews

In-Situ Inc.

Calibration Report

Report Number:20050210063419327

221 East Lincoln Avenue, Fort Collins, Colorado 80524 USA. Visit us at www.in-situ.com
1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-10
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19327

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.14 C to 49.78 C
Range of Applied Pressure: 0.0001 kPa (0.0000 PSI) to 103.4243 kPa (15.0004 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.32 C	0.0001 PSI	0.0011 PSI
		4.9502 PSI	4.9512 PSI
		10.0503 PSI	10.0491 PSI
		14.9998 PSI	14.9976 PSI
		10.0500 PSI	10.0491 PSI
		4.9499 PSI	4.9502 PSI
		0.0001 PSI	0.0016 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19338 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 25.21	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/9/05 6:46:07 AM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.20VDC	☑	☐	☐	BN
Wake Current: 19.01 mA	☑	☐	☑	BN
Sleep Current: .16 mA	☑	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

Bruce Nordell

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In-Situ Inc.

Calibration Report

Report Number: 20050209064619338

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-09
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19338

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0004 kPa (-0.0001 PSI) to 103.4246 kPa (15.0005 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.30 C	0.0000 PSI	0.0003 PSI
		4.9503 PSI	4.9490 PSI
		10.0500 PSI	10.0481 PSI
		14.9998 PSI	14.9973 PSI
		10.0499 PSI	10.0485 PSI
		4.9499 PSI	4.9511 PSI
		0.0001 PSI	0.0007 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19343 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 25.40	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): 0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/9/05 6:46:07 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.19VDC	☑	☐	☐	jm
Wake Current: 19.08	~~☐~~	☐	☑	jm
Sleep Current: .14	~~☐~~	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329436				

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Judi
Judi Mathews

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In-Situ Inc.

Calibration Report

Report Number:20050209064619343

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-09
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19343

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0004 kPa (-0.0001 PSI) to 103.4245 kPa (15.0005 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.30 C	0.0000 PSI	0.0001 PSI
		4.9503 PSI	4.9490 PSI
		10.0500 PSI	10.0491 PSI
		14.9998 PSI	14.9980 PSI
		10.0499 PSI	10.0491 PSI
		4.9499 PSI	4.9505 PSI
		0.0001 PSI	0.0006 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19344 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 26.78	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): 0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/10/05 6:34:42 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.19VDC	☑	☐	☐	jm
Wake Current: 18.07	~~☐~~	☐	☑	jm
Sleep Current: .05	~~☐~~	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329436				

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Judi

Judi Mathews

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In-Situ Inc.

Calibration Report

Report Number:20050210063419344

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miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-10
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19344

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.14 C to 49.78 C
Range of Applied Pressure: 0.0001 kPa (0.0000 PSI) to 103.4243 kPa (15.0004 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	**Over entire temperature range**
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	**Temperature Reported**	**Pressure Applied**	**Pressure Reported**
35.30 C	**35.31 C**	**0.0001 PSI**	**0.0016 PSI**
		4.9502 PSI	**4.9498 PSI**
		10.0503 PSI	**10.0494 PSI**
		14.9998 PSI	**14.9979 PSI**
		10.0500 PSI	**10.0498 PSI**
		4.9499 PSI	**4.9517 PSI**
		0.0001 PSI	**0.0026 PSI**

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19355 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 26.01	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/9/05 6:46:07 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.19VDC	☑	☐	☐	jm
Wake Current: 16.14	~~☐~~	☐	☑	jm
Sleep Current: .08	~~☐~~	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329536				

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Judi

Judi Mathews

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In-Situ Inc.

Calibration Report

Report Number:20050209064619355

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-09
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19355

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0004 kPa (-0.0001 PSI) to 103.4245 kPa (15.0005 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.29 C	0.0000 PSI	-0.0002 PSI
		4.9503 PSI	4.9485 PSI
		10.0500 PSI	10.0468 PSI
		14.9998 PSI	14.9976 PSI
		10.0499 PSI	10.0477 PSI
		4.9499 PSI	4.9494 PSI
		0.0001 PSI	0.0007 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19377 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 26.07	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/8/05 6:45:32 AM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.12VDC	☑	☐	☐	BN
Wake Current: 16.08 mA	☑	☐	☑	BN
Sleep Current: .19 mA	☑	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

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Bruce Nordell

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In-Situ Inc.

Calibration Report

Report Number:20050208064519377

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miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-08
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19377

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0003 kPa (-0.0000 PSI) to 103.4255 kPa (15.0006 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.27 C	-0.0000 PSI	-0.0003 PSI
		4.9500 PSI	4.9482 PSI
		10.0500 PSI	10.0471 PSI
		14.9998 PSI	14.9982 PSI
		10.0500 PSI	10.0475 PSI
		4.9502 PSI	4.9496 PSI
		-0.0000 PSI	0.0002 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19382 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 25.84	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/9/05 6:46:07 AM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.23VDC	☑	☐	☐	BN
Wake Current: 17.69 mA	☑ (struck out)	☐	☑	BN
Sleep Current: .17 mA	☑ (struck out)	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

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[signature]

Bruce Nordell

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In-Situ Inc.

Calibration Report

Report Number: 20050209064619382

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miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-09
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19382

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0004 kPa (-0.0001 PSI) to 103.4246 kPa (15.0005 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	PASSED	PASSED

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.29 C	0.0000 PSI	0.0005 PSI
		4.9503 PSI	4.9491 PSI
		10.0500 PSI	10.0500 PSI
		14.9998 PSI	14.9977 PSI
		10.0499 PSI	10.0490 PSI
		4.9499 PSI	4.9501 PSI
		0.0001 PSI	0.0016 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19388 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 26.37	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/9/05 6:46:07 AM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.12VDC	☑	☐	☐	BN
Wake Current: 19.75 mA	☑	☐	☑	BN
Sleep Current: .19 mA	☑	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

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Bruce Nordell

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In-Situ Inc.

Calibration Report

Report Number: 20050209064619388

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miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-09
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19388

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0004 kPa (-0.0001 PSI) to 103.4246 kPa (15.0005 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.28 C	0.0000 PSI	-0.0006 PSI
		4.9503 PSI	4.9482 PSI
		10.0500 PSI	10.0469 PSI
		14.9998 PSI	14.9963 PSI
		10.0499 PSI	10.0482 PSI
		4.9499 PSI	4.9500 PSI
		0.0001 PSI	0.0003 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19393 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 26.56	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): 0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/9/05 6:46:07 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.16VDC	☑	☐	☐	jm
Wake Current: 19.59	~~☐~~	☐	☑	jm
Sleep Current: .08	~~☐~~	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329436				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

Judi

Judi Mathews

Generated by QAMiniTroll version 1, 0, 8, 0

In-Situ Inc.

Calibration Report

Report Number:20050209064619393

221 East Lincoln Avenue, Fort Collins, Colorado 80524 USA. Visit us at www.in-situ.com
1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-09
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19393

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0004 kPa (-0.0001 PSI) to 103.4245 kPa (15.0005 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.29 C	0.0000 PSI	0.0004 PSI
		4.9503 PSI	4.9503 PSI
		10.0500 PSI	10.0473 PSI
		14.9998 PSI	14.9963 PSI
		10.0499 PSI	10.0490 PSI
		4.9499 PSI	4.9508 PSI
		0.0001 PSI	0.0012 PSI

Test Performed By: JM
Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19422 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 26.87	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): 0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/8/05 6:45:32 AM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.24VDC	☑	☐	☐	BN
Wake Current: 17.21 mA	☑	☐	☑	BN
Sleep Current: .05 mA	☑	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

[signature]

Bruce Nordell

In-Situ Inc.

Calibration Report

Report Number:20050208064519422

221 East Lincoln Avenue, Fort Collins, Colorado 80524 USA. Visit us at www.in-situ.com
1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-08
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19422

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0002 kPa (-0.0000 PSI) to 103.4211 kPa (15.0000 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.32 C	-0.0000 PSI	0.0002 PSI
		4.9504 PSI	4.9490 PSI
		10.0500 PSI	10.0467 PSI
		15.0006 PSI	14.9964 PSI
		10.0501 PSI	10.0485 PSI
		4.9498 PSI	4.9514 PSI
		-0.0000 PSI	0.0020 PSI

Test Performed By: JM Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19424 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 25.69	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): 0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/10/05 6:34:42 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.16VDC	☑	☐	☐	jm
Wake Current: 17.72	~~☐~~	☐	☑	jm
Sleep Current: .15	~~☐~~	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329436				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

Judi

Judi Mathews

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In-Situ Inc.

Calibration Report

Report Number:20050210063419424

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-10
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19424

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.14 C to 49.78 C
Range of Applied Pressure: 0.0001 kPa (0.0000 PSI) to 103.4236 kPa (15.0003 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.32 C	0.0001 PSI	0.0021 PSI
		4.9502 PSI	4.9507 PSI
		10.0503 PSI	10.0502 PSI
		14.9998 PSI	15.0004 PSI
		10.0500 PSI	10.0521 PSI
		4.9499 PSI	4.9521 PSI
		0.0001 PSI	0.0031 PSI

Test Performed By: JM
Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19487 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 26.05	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/8/05 6:45:32 AM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.21VDC	☑	☐	☐	BN
Wake Current: 12.15 mA	☑	☐	☑	BN
Sleep Current: .15 mA	☑	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

Bruce Nordell

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In-Situ Inc.

Calibration Report

Report Number:20050208064519487

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-08
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19487

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0003 kPa (-0.0000 PSI) to 103.4255 kPa (15.0006 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.32 C	-0.0000 PSI	-0.0005 PSI
		4.9500 PSI	4.9487 PSI
		10.0500 PSI	10.0483 PSI
		14.9998 PSI	14.9969 PSI
		10.0500 PSI	10.0496 PSI
		4.9502 PSI	4.9505 PSI
		-0.0000 PSI	0.0004 PSI

Test Performed By: JM Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19499 Model Standard P Date Inspected 2/14/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	jm
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	jm
Temperature coefficients verified	☑	☐	☐	jm
Temperature Reading @ open air temp: 25.56	☑	☐	☐	jm
Pressure coefficients verified	☑	☐	☐	jm
Pressure Reading @ 0.00 (no pressure applied): -0.00	☑	☐	☐	jm
Calibration pressure range: 15G	☑	☐	☐	jm
Calibration date: 2/9/05 6:46:07 AM	☑	☐	☐	jm
Firmware version: 3.09	☑	☐	☐	jm
Power Source: Internal	☑	☐	☐	jm
Battery Type: Lithium	☑	☐	☐	jm
Battery Capacity: 100%remaining @ : 3.16VDC	☑	☐	☐	jm
Wake Current: 17.71	~~☐~~	☐	☑	jm
Sleep Current: .14	~~☐~~	☐	☑	jm
Dust Cap Type: Standard	☑	☐	☐	jm
Job Number: 329536				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

Judi Mathews

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In-Situ Inc.

Calibration Report

Report Number:20050209064619499

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-09
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19499

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0004 kPa (-0.0001 PSI) to 103.4245 kPa (15.0005 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.31 C	0.0000 PSI	0.0003 PSI
		4.9503 PSI	4.9487 PSI
		10.0500 PSI	10.0481 PSI
		14.9998 PSI	14.9980 PSI
		10.0499 PSI	10.0481 PSI
		4.9499 PSI	4.9500 PSI
		0.0001 PSI	0.0012 PSI

Test Performed By: JM   Test Verified By:

In-Situ Inc.

Quality Inspection Report
SSP-100 miniTroll

Unit Serial Number 19503 Model Standard P Date Inspected 2/10/05

Area of Inspection	Pass	Fail	N/A	Inspected By
Calibration Results:	☑	☐	☐	BN
Communication (Communication Port opens / Unit Responds)	☑	☐	☐	BN
Temperature coefficients verified	☑	☐	☐	BN
Temperature Reading @ open air temp: 26.60	☑	☐	☐	BN
Pressure coefficients verified	☑	☐	☐	BN
Pressure Reading @ 0.00 (no pressure applied): 0.00	☑	☐	☐	BN
Calibration pressure range: 15G	☑	☐	☐	BN
Calibration date: 2/8/05 6:45:32 AM	☑	☐	☐	BN
Firmware version: 3.09	☑	☐	☐	BN
Power Source: Internal	☑	☐	☐	BN
Battery Type: Lithium	☑	☐	☐	BN
Battery Capacity: 100%remaining @ : 3.23VDC	☑	☐	☐	BN
Wake Current: 16.73 mA	☑	☐	☑	BN
Sleep Current: .17 mA	☑	☐	☑	BN
Dust Cap Type: Standard	☑	☐	☐	BN
Job Number: 329434				

Thank you for purchasing quality In-Situ products. I have personally certified that this product has been inspected and meets all of the required Quality Inspection Points as prescribed by this document.

Bruce Nordell

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In-Situ Inc.

Calibration Report

Report Number:20050208064519503

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1-970-498-1500, 1-800-446-7488 (Toll Free USA & Canada), FAX: 1-970-498-1598

miniTROLL

Calibration Result: **PASSED**

Instrument Type:	miniTROLL
Calibration Date:	2005-02-08
Model Number:	SSP-100
Full Scale Pressure Range:	103.4214 kPa (15 PSI) Gauge
Manufacturer:	In-Situ, Inc.
Serial Number:	19503

Calibration Procedures and Equipment Used: Standards used in this calibration are traceable to the National Institute of Standards and Technology.

1. Instrulab model 4312A-15 s/n 30117
2. Instrulab model 832 s/n 12086 (RTD-06)
3. Ruska model 7215xi s/n 55556
4. Automated software calibration procedures used.

Range of Applied Temperature: -5.13 C to 49.78 C
Range of Applied Pressure: -0.0003 kPa (-0.0000 PSI) to 103.4255 kPa (15.0006 PSI)

Temperature Calibration:

Temperature Accuracy Specification: +/- 0.25 C
Temperature Calibration Results: **PASSED**

Pressure Calibration: Range For 15psig: 10.5m, 34.60ft.

	At 15.0 C	Over entire temperature range
Pressure Accuracy Specification:	+/- 0.100 %FS	+/- 0.200 %FS
Pressure Calibration Result:	**PASSED**	**PASSED**

Post-Calibration Check:

Temperature Applied	Temperature Reported	Pressure Applied	Pressure Reported
35.30 C	35.33 C	-0.0000 PSI	-0.0003 PSI
		4.9500 PSI	4.9481 PSI
		10.0500 PSI	10.0474 PSI
		14.9998 PSI	14.9960 PSI
		10.0500 PSI	10.0474 PSI
		4.9502 PSI	4.9485 PSI
		-0.0000 PSI	0.0002 PSI

Test Performed By: JM Test Verified By:

Appendix B

Monitor/Stilling Well Surveyed Elevations
&
Physical Attributes

Crooks Ranch Monitoring Project Equipment Deployed			Top of Wellhead to Transducer Distance (feet)	Survey Disc to Top of Wellhead Distance (feet)	Survey Pad Elevation NAVD 88 Elevation (feet)	Transducer Elevation (ft) NAVD 88 Elevation (feet)	Land Surface Elevation (ft) NAVD 88 Elevation (feet)
Site No.	Well Identifier	Monitor Zone					
1	HES-1	Water Table	-13.33	2.35	27.56	16.58	26.89
1	HES-2	Tamiami	-20.27	2.41	27.25	9.39	26.58
1	HES-3	Stilling Well	-7.40		28.99	21.59	24.99
2	HES-4	Water Table	-13.33	2.48	27.72	16.87	27.05
2	HES-5	Tamiami	-20.17	2.57	27.80	10.20	27.13
2	HES-6	Stilling Well	-7.16		29.95	22.79	25.95
3	HES-7	Water Table	-13.33	2.60	27.52	16.79	26.85
3	HES-8	Tamiami	-20.30	2.54	27.60	9.84	26.93
4	HES-9	Water Table	-13.30	2.50	26.62	15.82	25.95
4	HES-10	Tamiami	-20.34	2.50	26.66	8.82	25.99
4	HES-11	Stilling Well	-7.18		29.25	22.07	25.25
5	HES-12	Water Table	-13.16	2.70	26.27	15.81	25.60
5	HES-13	Tamiami	-20.48	2.60	26.39	8.51	25.72
6	HES-14	Water Table	-13.18	2.56	24.47	13.85	23.80
6	HES-15	Tamiami	-20.40	2.63	24.51	6.74	23.84
6	HES-16	Stilling Well	-7.16		27.54	20.38	23.61
7	HES-17	Water Table	-11.27	2.54	30.02	21.29	29.35
7	HES-18	Tamiami	-20.42	2.67	29.29	11.54	28.62
7	HES-19	Stilling Well	-7.20		32.28	25.08	28.28

CROOKS RANCH WELL ELEVATIONS

6-29-05

HURTZ
SEPULVEDA
WHITE

STA	+	HI	−	EL	BM	
	4.08					
BM-4	3.51 (3.507)	31.643			28.136	FB 520 PAGE 3 NOTE: AERIAL SHOWS
	2.93					26.51 FOR BM-4
			5.07			
CROOKS REF			4.93 (4.933)	26.709		SET 1/2" I.R. W/ CAP N. OF RD, NE OF BM-4
			4.80			
Ā- REF STA @ CROOKS REF						
ANT HT = 1.217 M						
JOB NAME: CROOKS WELLS						
	5.27					
(LTA) HES-2	4.66 (4.660)	31.906			27.246	BRASS DISC. 0.537 Δ HT FROM CROOKS REF
	4.05					
	5.26		6.21			
TP-1	5.04 (5.037)	31.706	5.87 (5.867)	26.040		HUB
	4.81		5.52			
			2.16			
wetland HES-3			2.08 (2.083)	28.993		TOP OF PVC WELL CASING
			2.01			
WTA HES 1				27.563		BRASS DISC ΔHT 0.754
WETA HES 4				27.715		" ΔHT 1.006
CTN HES 5				27.801		" ΔHT 1.092
wetland HES 6				29.949		TOP OF PVC WELL CASING ΔHT 3.240

10/13/2005 07:14 8132810881 BLACK & VEATCH PAGE 02

CROOKS RANCH – WELL ELEVATIONS

STA	+	HI	–	EL	BM
HES-7				27.522	
HES-8				27.604	
HES-12	5.80 / 5.57 / 5.34 (5.570)	31.841		26.271	
HES-13			5.64 / 5.45 / 5.25 (5.447)	26.394	
SITE 4	8 IN.			27.916	
HES 10				26.664 ✓	
HES-9	4.66 / 4.21 / 3.76 (4.210)	30.827		26.617 ✓	
HES-11 SITE 4	4 IN.		2.06 / 1.58 / 1.10 (1.580)	29.247	

GOLDEN OX RANCH

STA	+	HI	–	EL	BM
Site #7 TBM.	5.21 / 5.05 / 4.89 (5.050)	33.764			28.714
HES-18			4.85 / 4.47 / 4.09 (4.470)	29.294	

20

6-30-05

ANT HT = 1.205 M — KURT SEPULVEDA WHITE

BRASS DISC	Δ HT	0.813
"	"	0.895
"	"	– 0.439
"		
TOP CASING	Δ HT	1.107
BRASS DISC	"	– 0.045
BRASS DISC	"	– 0.092
TOP CASING		

ANT HT = 1.283 M.

HUB	Δ HT	2.005
BRASS DISC.		

CROOKS RANCH & GOLDEN OX RANCH

WELL ELEVATIONS

STA	+	HI	−	EL	BM
		33.764			
			4.12		
HES-17			3.74 (3.740 M)	30.024	
			3.36		
	7.98				
TBM	7.64 (7.640)	36.354			28.714
	7.30				
			4.56		
HES-19			4.07 (4.070)	32.284 ✓	
			3.58		
SITE 6	N			29.797	
HES-15				27.312	
HES-14				27.219	

6-30-05 21

BRASS DISC

HUB 1

WELL CASING	ΔHT	3.088
	"	0.603
	"	0.510

CROOKS RANCH & GOLDEN OX RANCH

WELL ELEVATIONS

7-1-05

22

RUKER
WHITE

STA	+	HI	−	EL	BM
	4.58				
T.B.M.	4.47 (4.470)	31.869			27.399
	4.36				
			3.66		
SITE 6	8"		3.33 (3.330)	28.539	
			3.00		

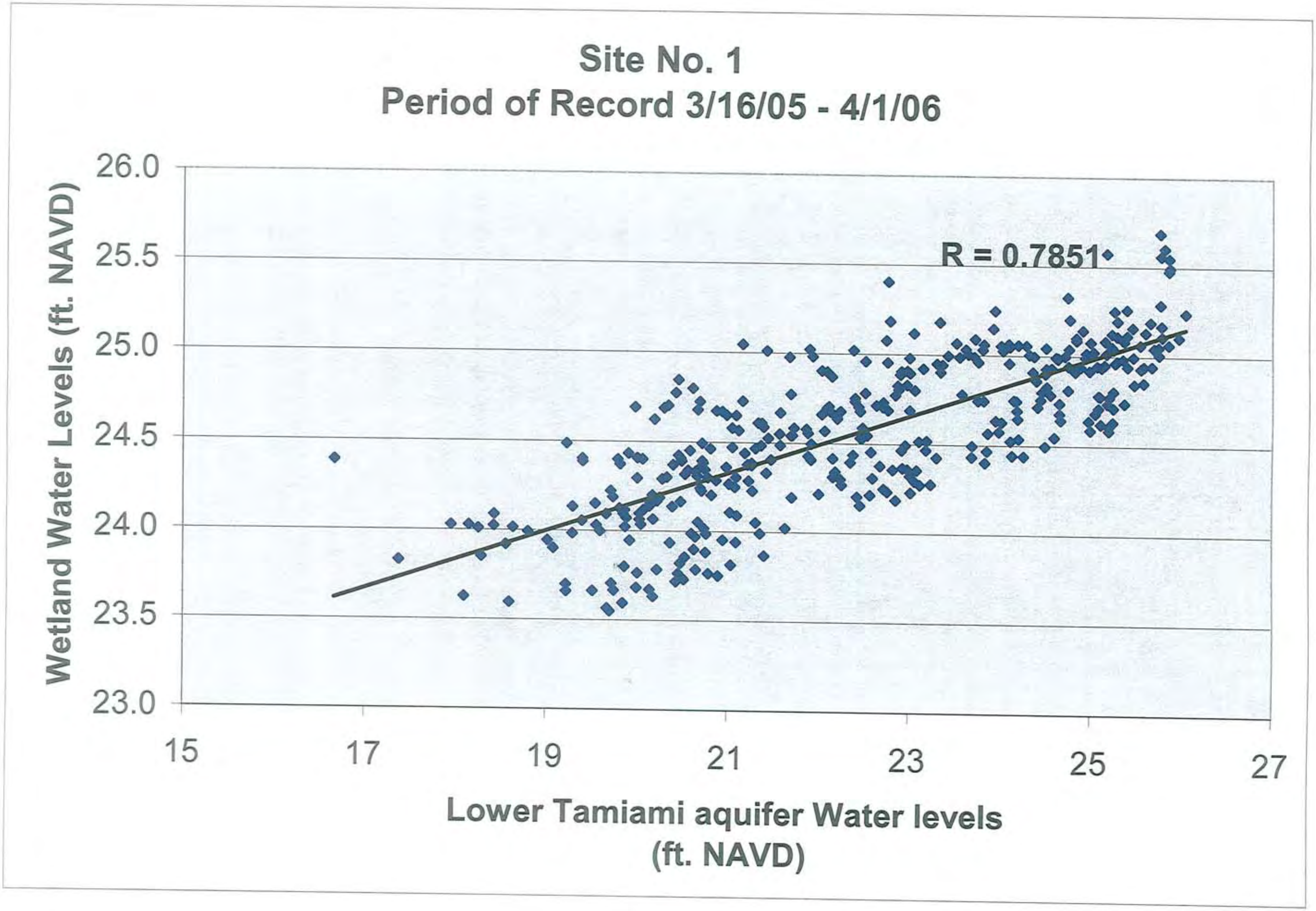
HUB 2 ΔHT - 0.690

- This is the Production well

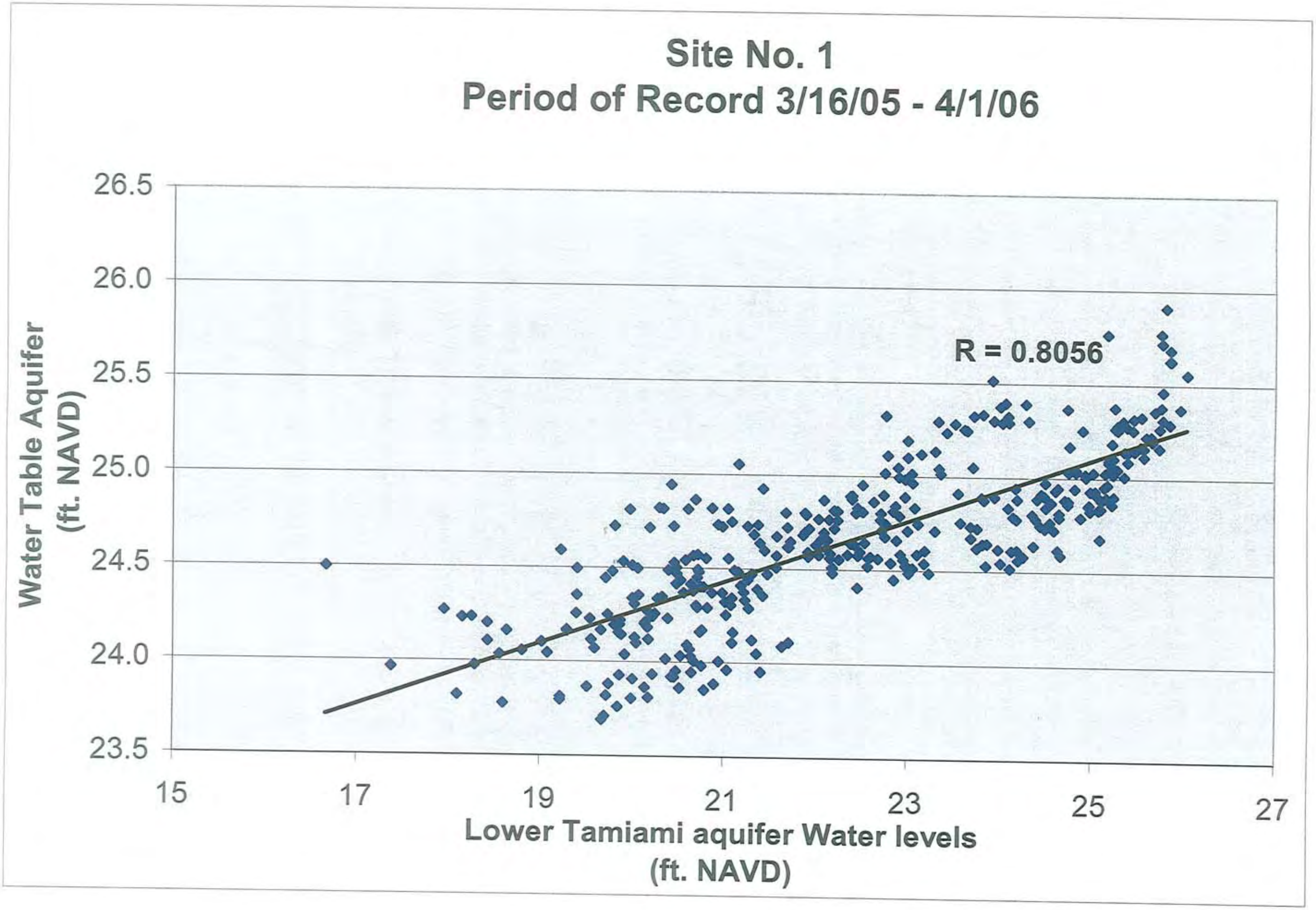
no Elevation for HES-16 wetland site

Appendix C

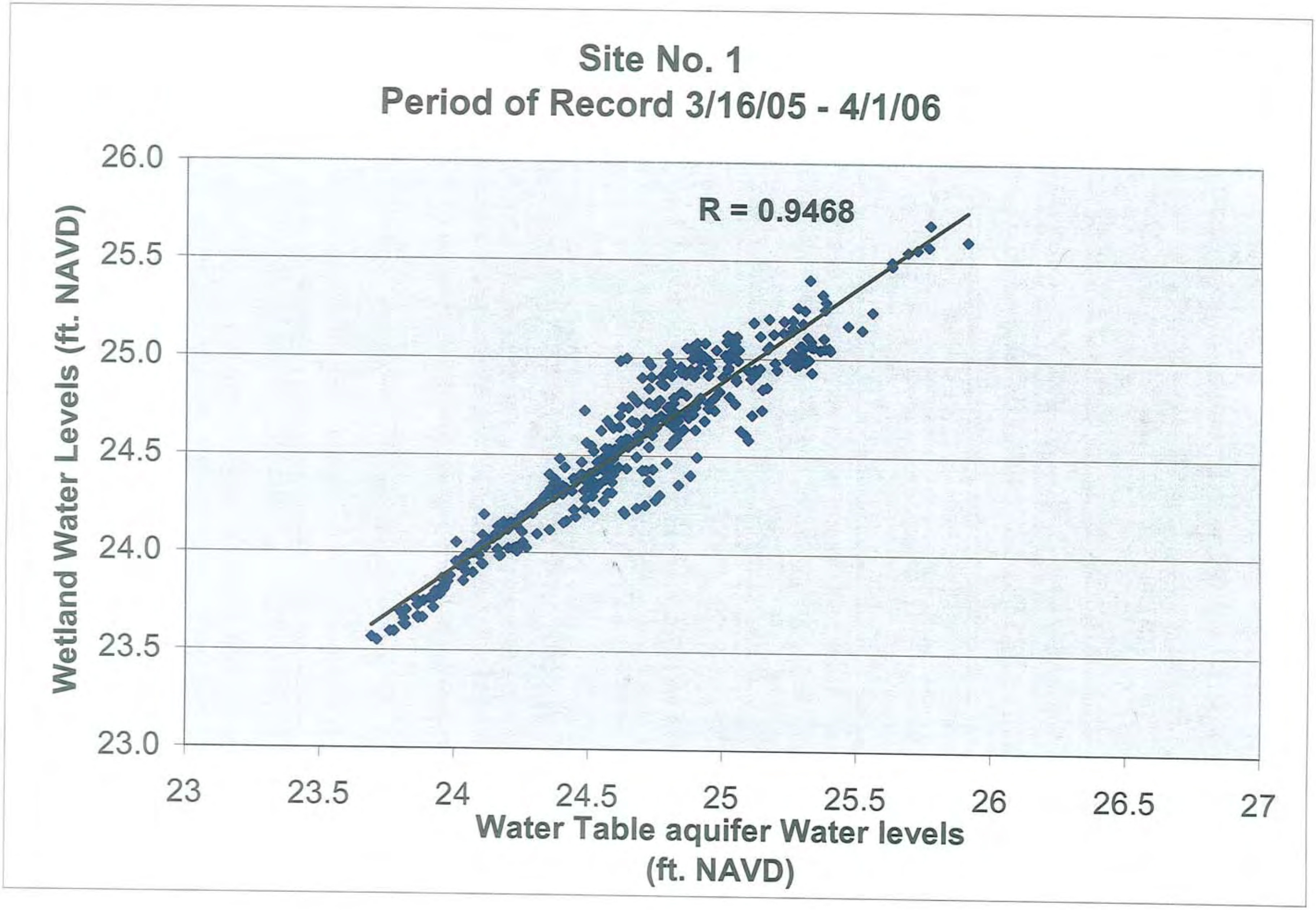
Water Level Correlation Plots

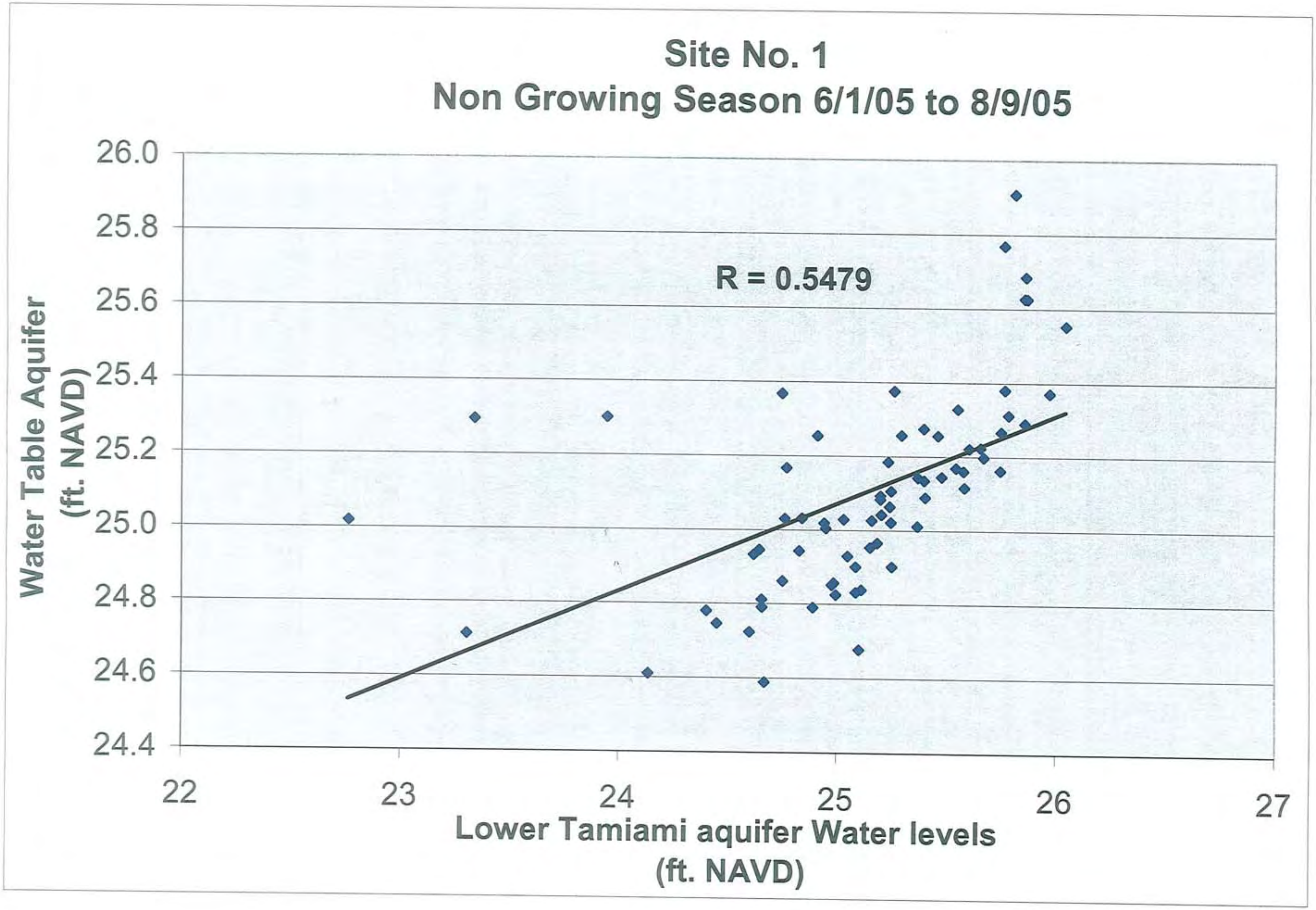


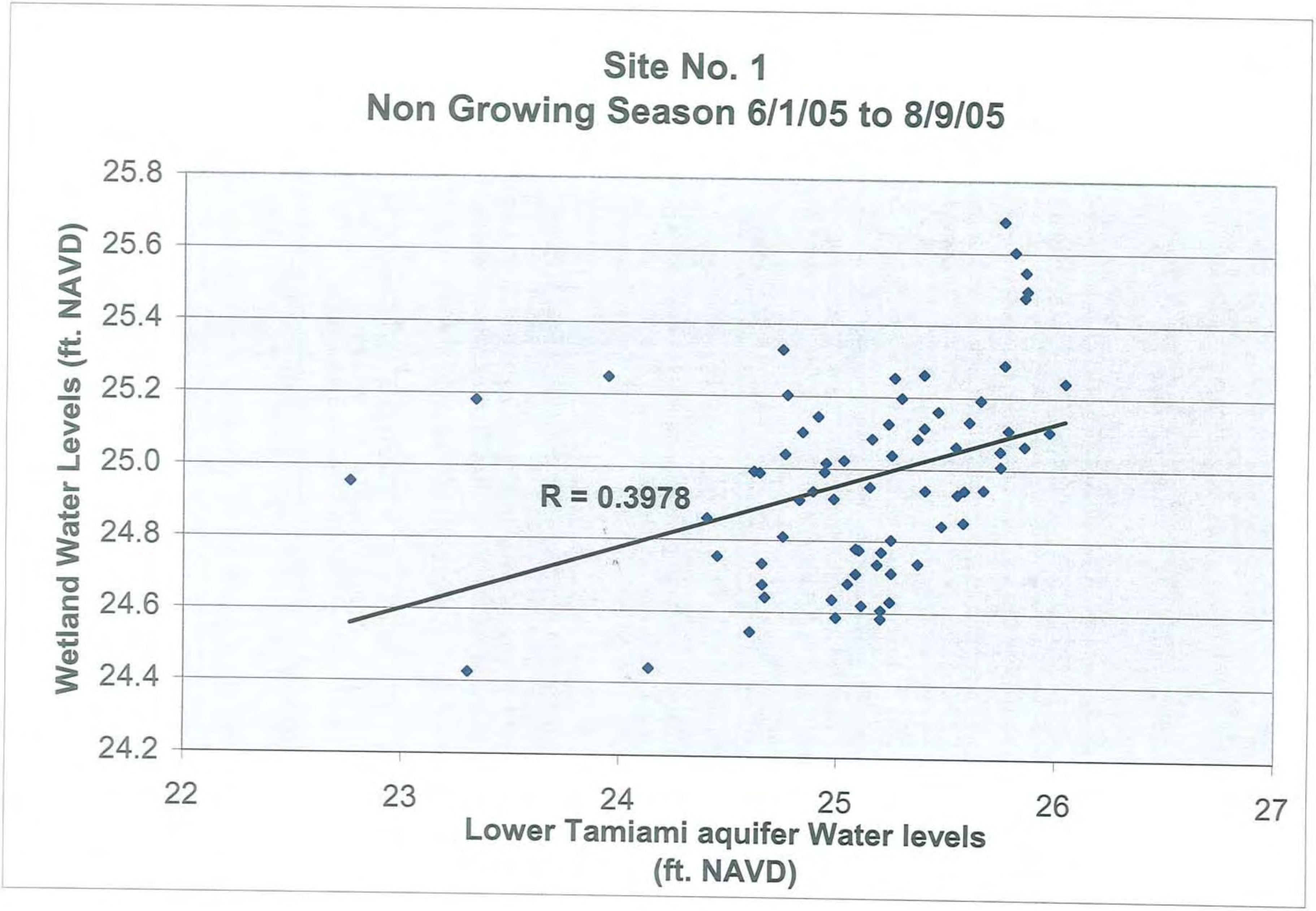
Site No. 1
Period of Record 3/16/05 - 4/1/06
Wetland Water Levels (ft. NAVD)
26.0
25.5
25.0
24.5
24.0
23.5
23.0
R = 0.7851
15
17
19
21
23
25
27
Lower Tamiami aquifer Water levels
(ft. NAVD)



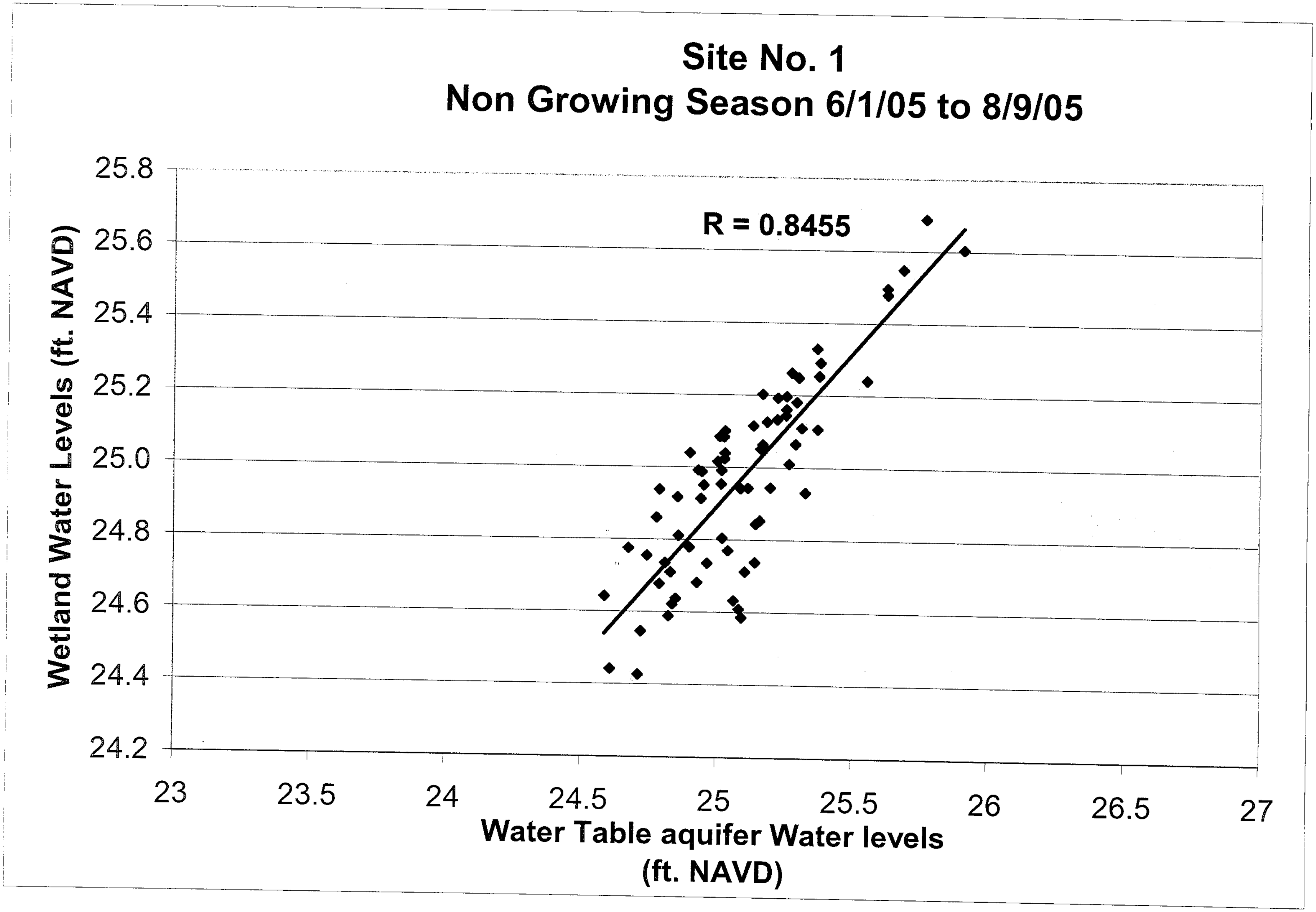
Site No. 1
Period of Record 3/16/05 - 4/1/06
R = 0.8056
Water Table Aquifer (ft. NAVD)
26.5
26.0
25.5
25.0
24.5
24.0
23.5
15
17
19
21
23
25
27
Lower Tamiami aquifer Water levels (ft. NAVD)

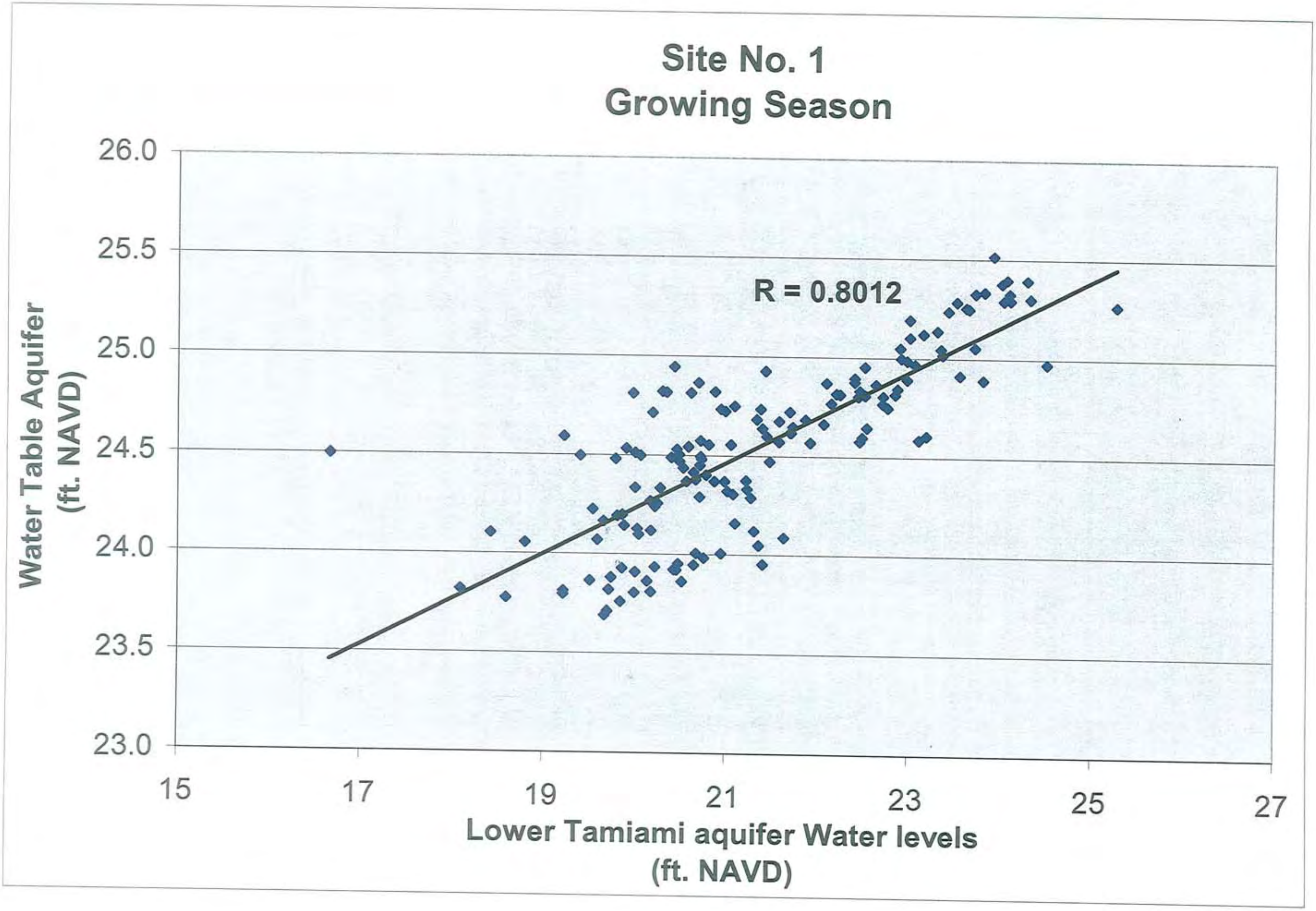

Site No. 1
Period of Record 3/16/05 - 4/1/06
R = 0.9468
Wetland Water Levels (ft. NAVD)
26.0
25.5
25.0
24.5
24.0
23.5
23.0
23
23.5
24
24.5
25
25.5
26
26.5
27
Water Table aquifer Water levels
(ft. NAVD)


Site No. 1
Non Growing Season 6/1/05 to 8/9/05
R = 0.5479
Water Table Aquifer
(ft. NAVD)
26.0
25.8
25.6
25.4
25.2
25.0
24.8
24.6
24.4
22
23
24
25
26
27
Lower Tamiami aquifer Water levels
(ft. NAVD)

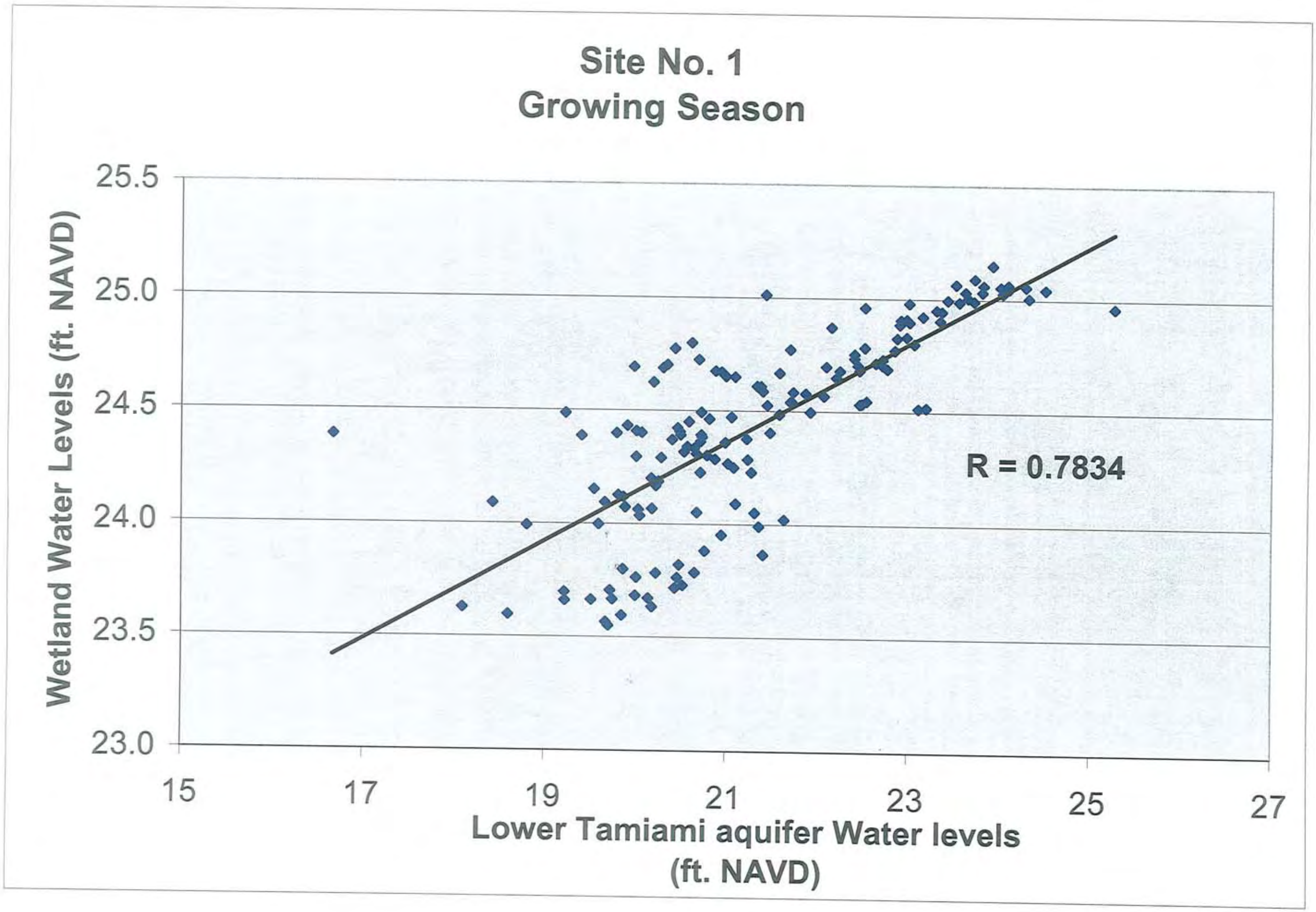


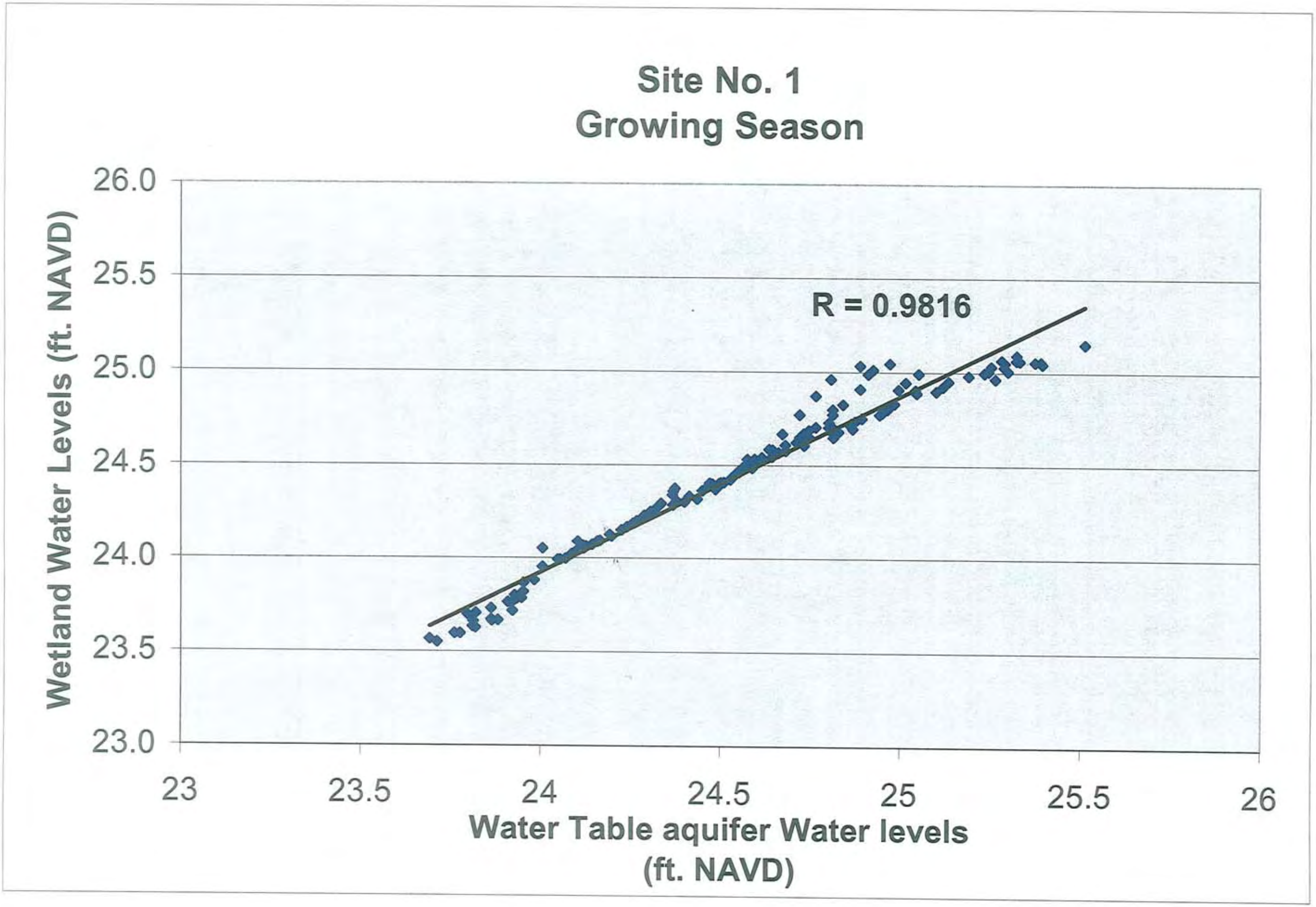
Site No. 1
Non Growing Season 6/1/05 to 8/9/05
R = 0.3978
Wetland Water Levels (ft. NAVD)
25.8
25.6
25.4
25.2
25.0
24.8
24.6
24.4
24.2
22
23
24
25
26
27
Lower Tamiami aquifer Water levels (ft. NAVD)

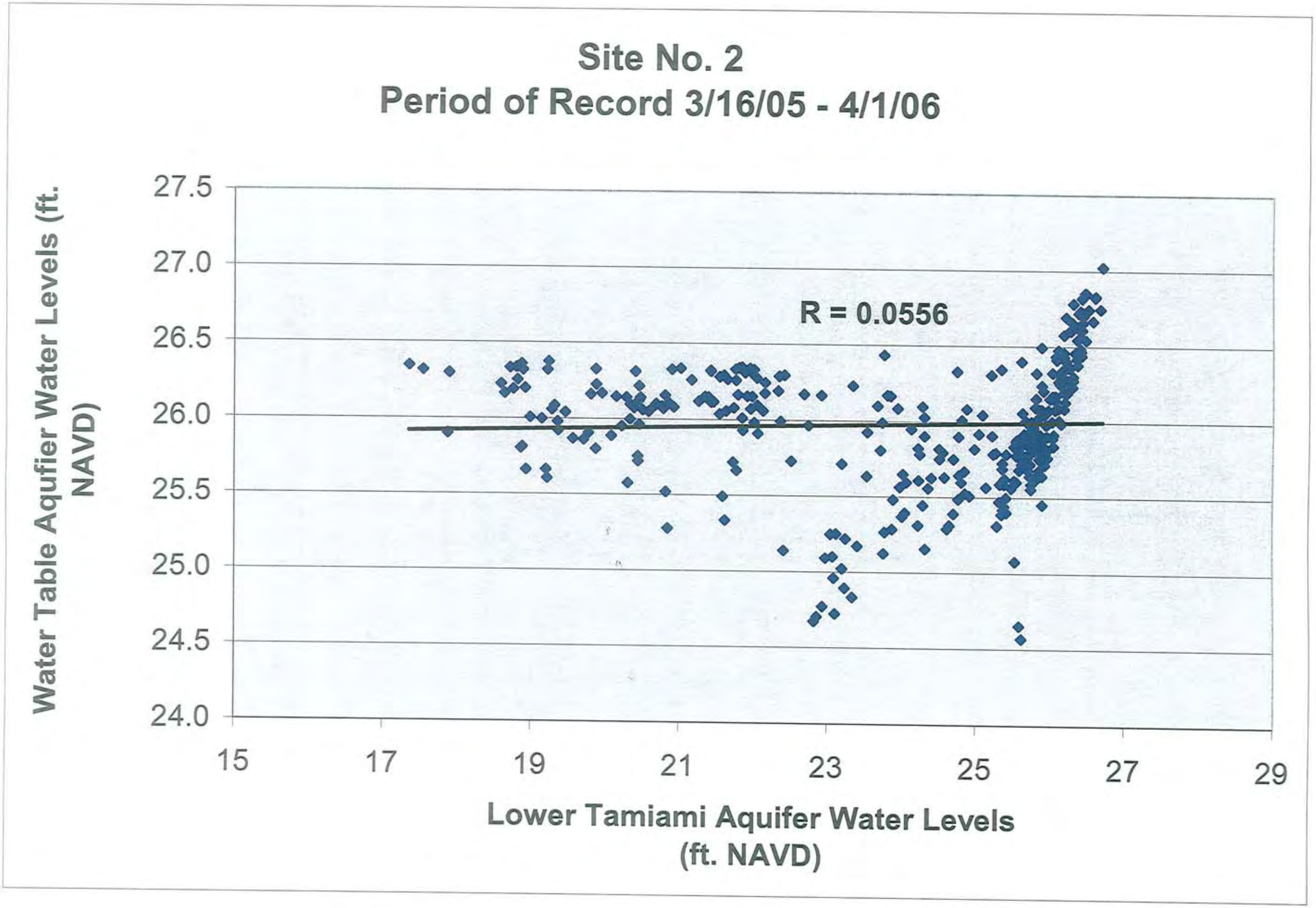

Site No. 1
Non Growing Season 6/1/05 to 8/9/05
R = 0.8455
Wetland Water Levels (ft. NAVD)
25.8
25.6
25.4
25.2
25.0
24.8
24.6
24.4
24.2
23
23.5
24
24.5
25
25.5
26
26.5
27
Water Table aquifer Water levels
(ft. NAVD)



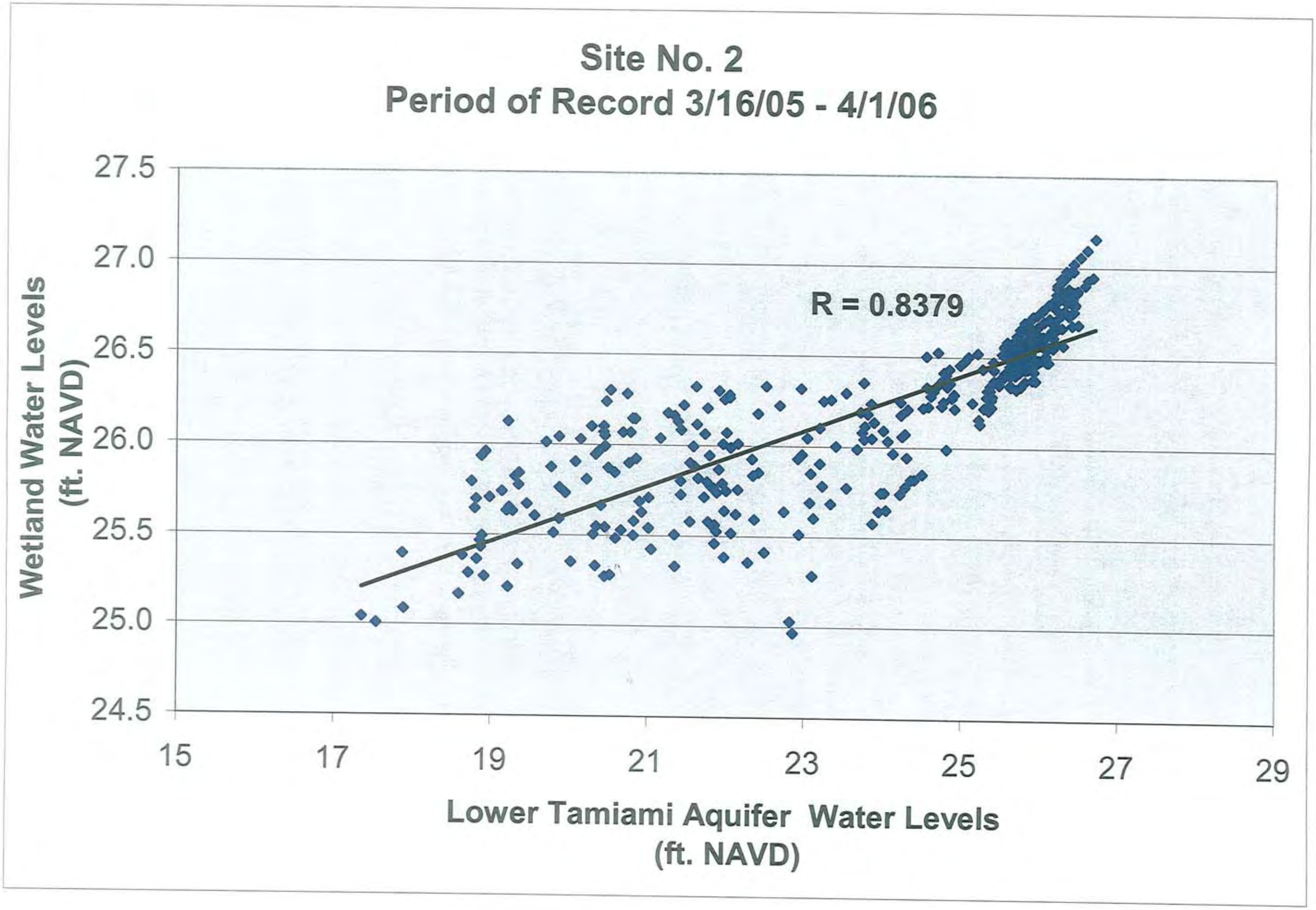
Site No. 1
Growing Season
R = 0.8012
Water Table Aquifer (ft. NAVD)
Lower Tamiami aquifer Water levels (ft. NAVD)
26.0
25.5
25.0
24.5
24.0
23.5
23.0
15
17
19
21
23
25
27


Site No. 1
Growing Season
Wetland Water Levels (ft. NAVD)
25.5
25.0
24.5
24.0
23.5
23.0
15
17
19
21
23
25
27
Lower Tamiami aquifer Water levels (ft. NAVD)
R = 0.7834

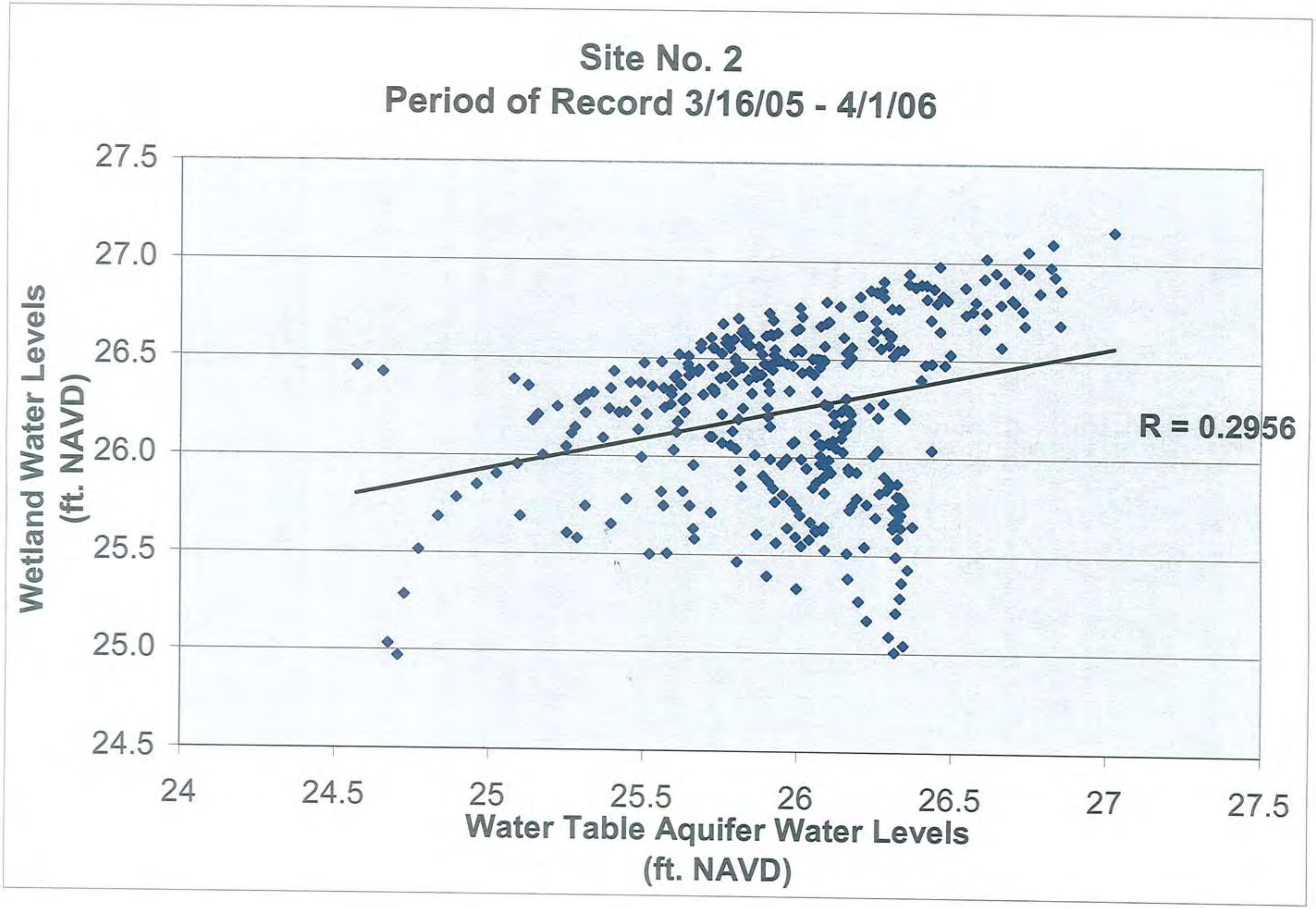

Site No. 1
Growing Season
26.0
25.5
25.0
24.5
24.0
23.5
23.0
Wetland Water Levels (ft. NAVD)
R = 0.9816
23
23.5
24
24.5
25
25.5
26
Water Table aquifer Water levels
(ft. NAVD)



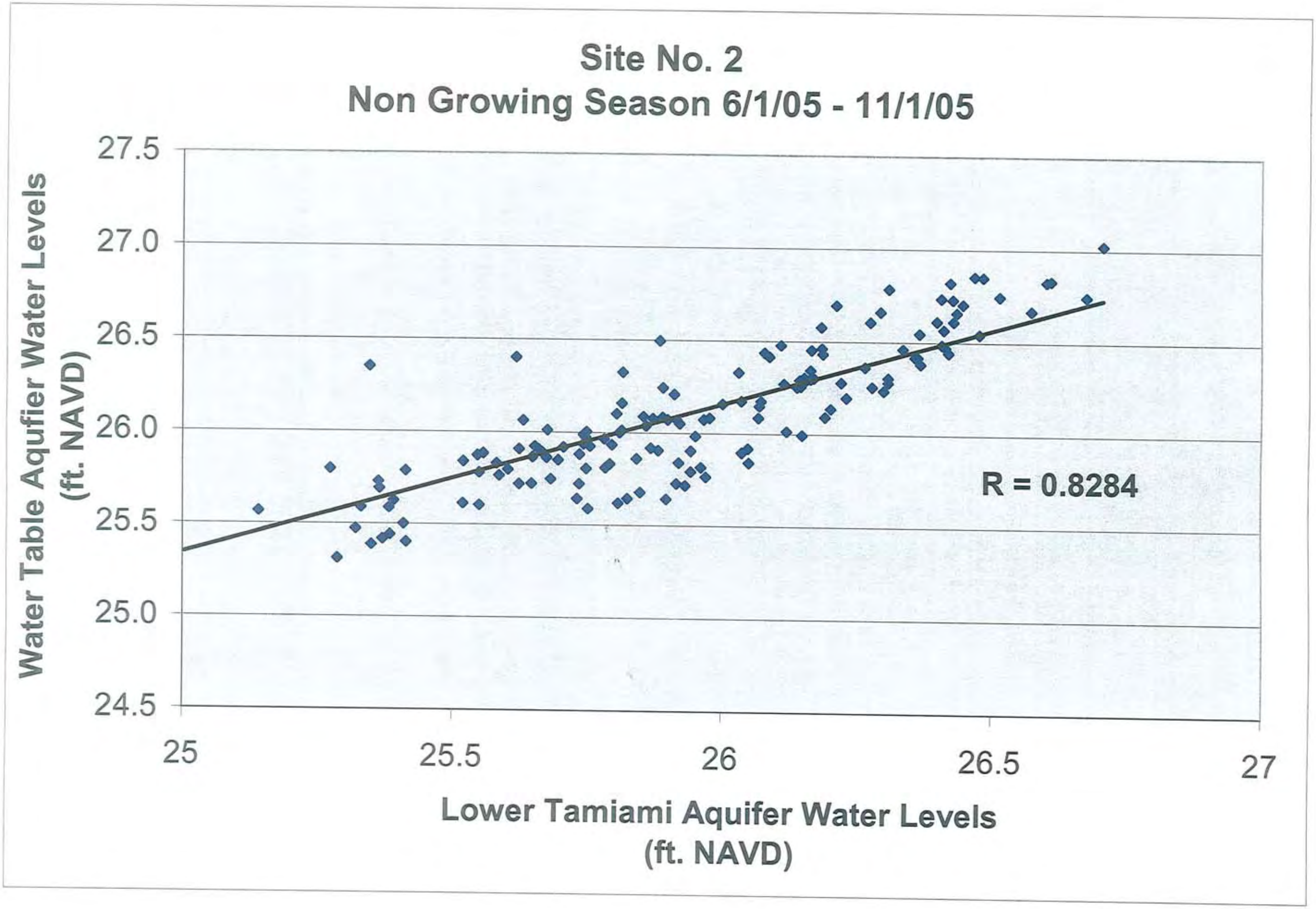
Site No. 2
Period of Record 3/16/05 - 4/1/06
Water Table Aquifer Water Levels (ft. NAVD)
27.5
27.0
26.5
26.0
25.5
25.0
24.5
24.0
R = 0.0556
15
17
19
21
23
25
27
29
Lower Tamiami Aquifer Water Levels (ft. NAVD)

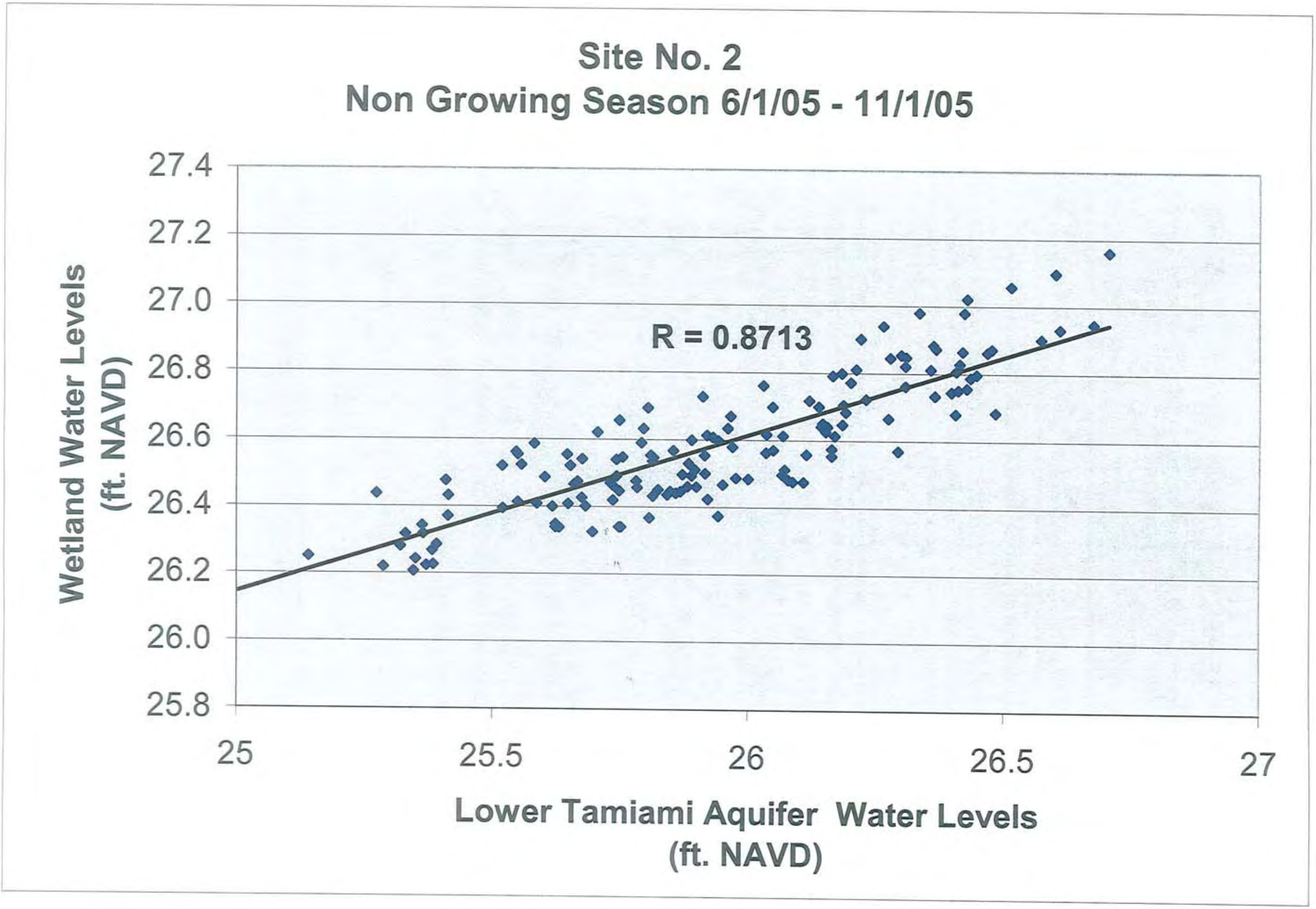


Site No. 2
Period of Record 3/16/05 - 4/1/06
R = 0.8379
Wetland Water Levels (ft. NAVD)
27.5
27.0
26.5
26.0
25.5
25.0
24.5
15
17
19
21
23
25
27
29
Lower Tamiami Aquifer Water Levels (ft. NAVD)

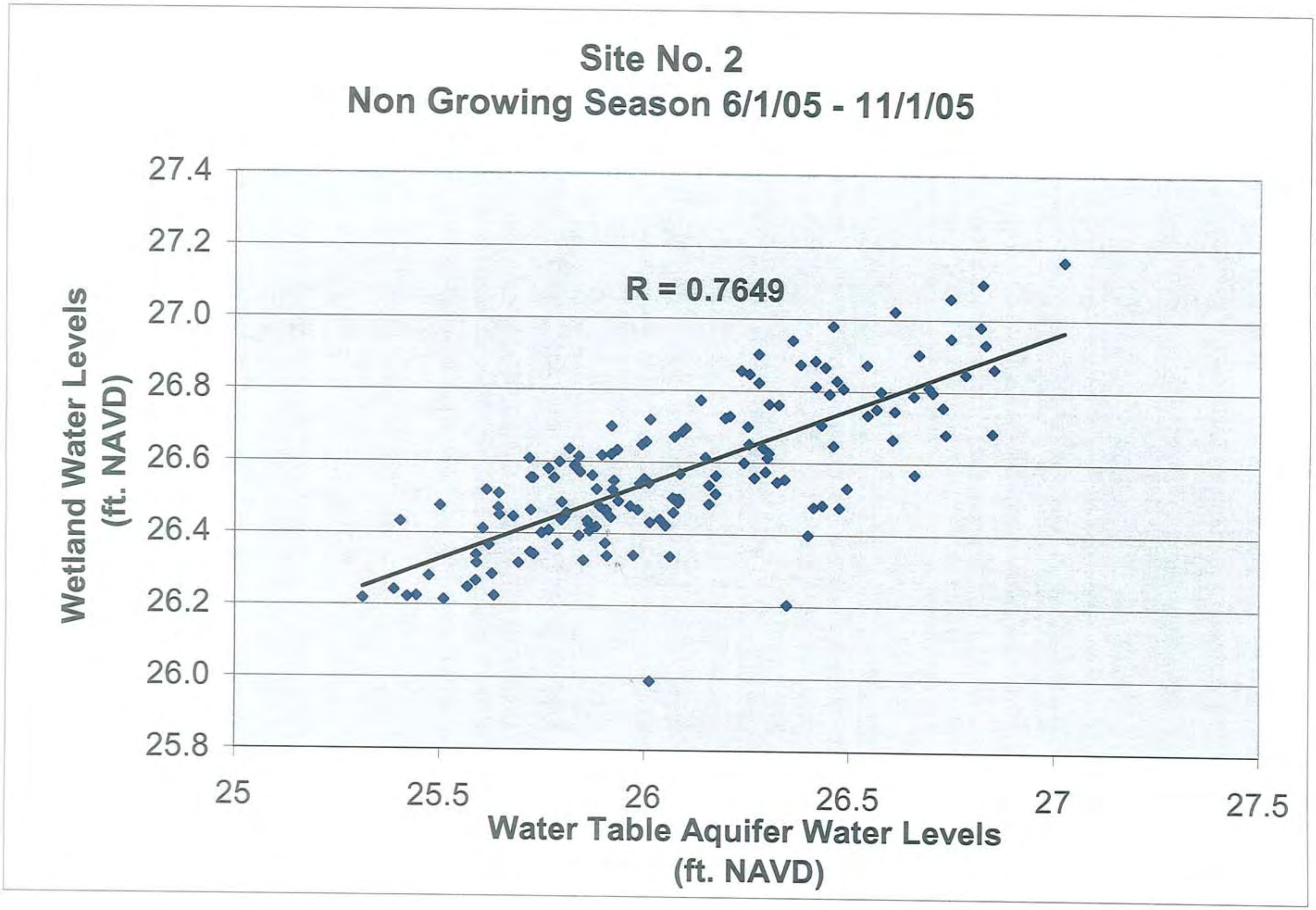


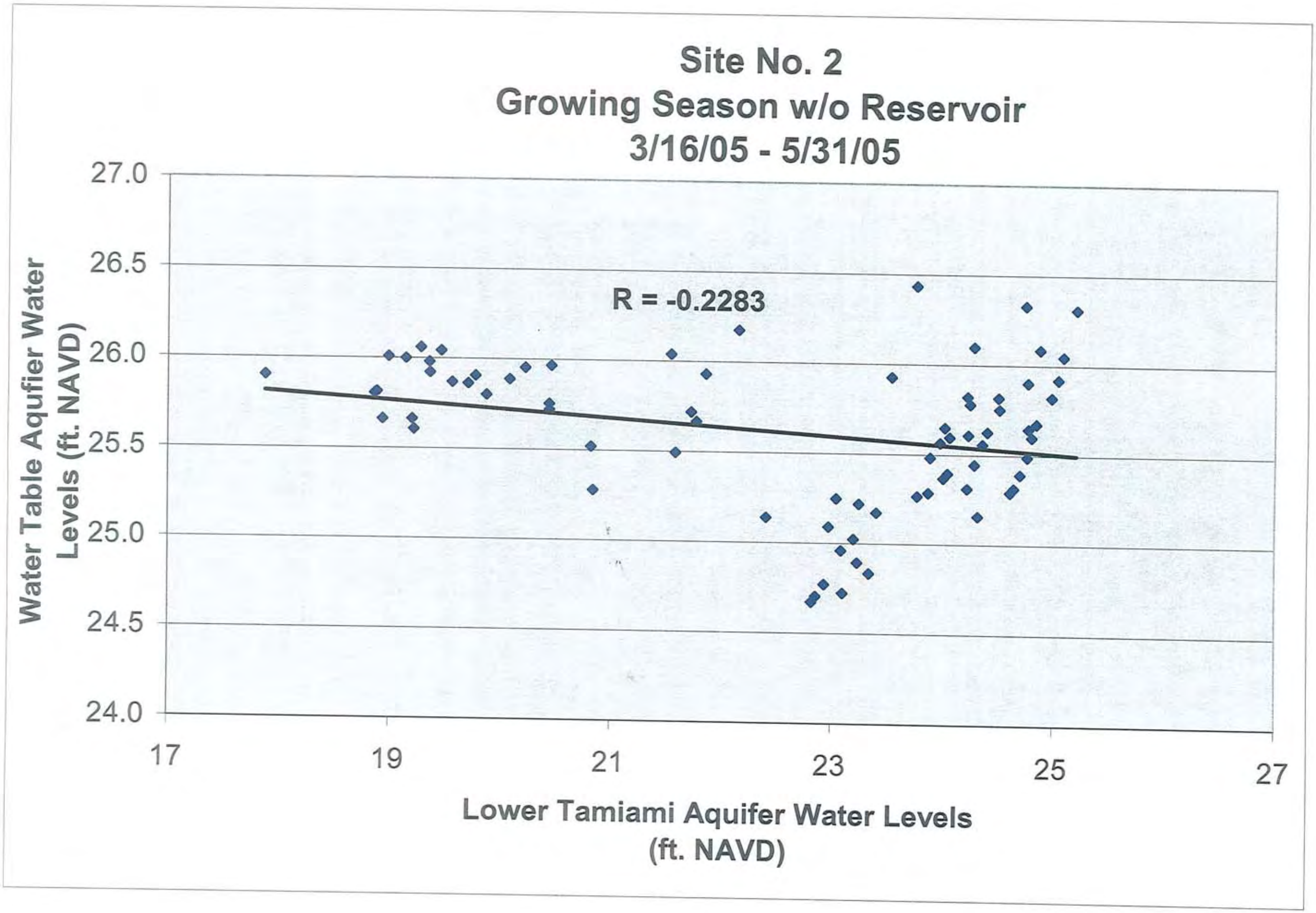
Site No. 2
Period of Record 3/16/05 - 4/1/06
27.5
27.0
26.5
26.0
25.5
25.0
24.5
Wetland Water Levels
(ft. NAVD)
R = 0.2956
24
24.5
25
25.5
26
26.5
27
27.5
Water Table Aquifer Water Levels
(ft. NAVD)

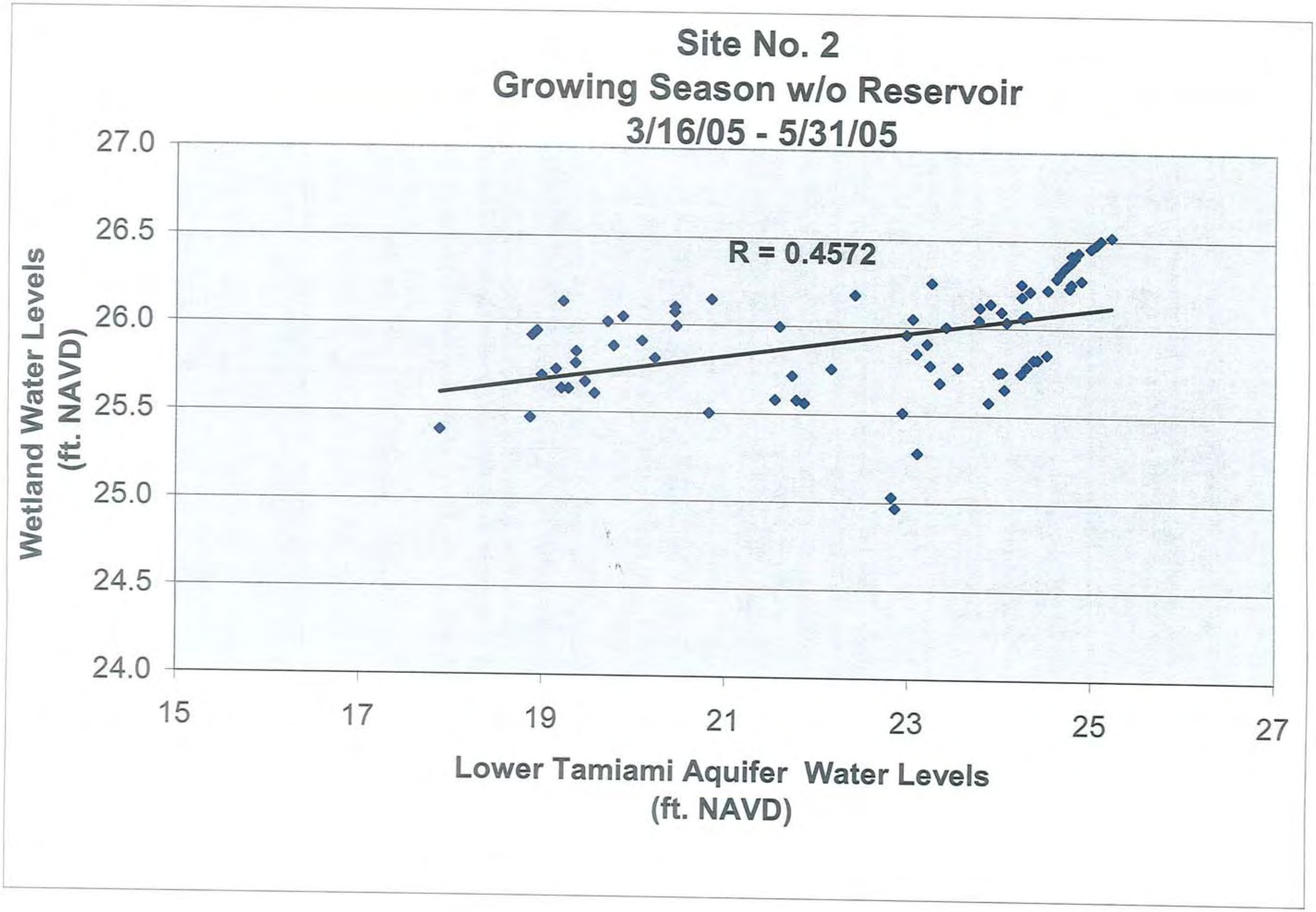

Site No. 2
Non Growing Season 6/1/05 - 11/1/05
Water Table Aquifer Water Levels (ft. NAVD)
27.5
27.0
26.5
26.0
25.5
25.0
24.5
25
25.5
26
26.5
27
R = 0.8284
Lower Tamiami Aquifer Water Levels (ft. NAVD)



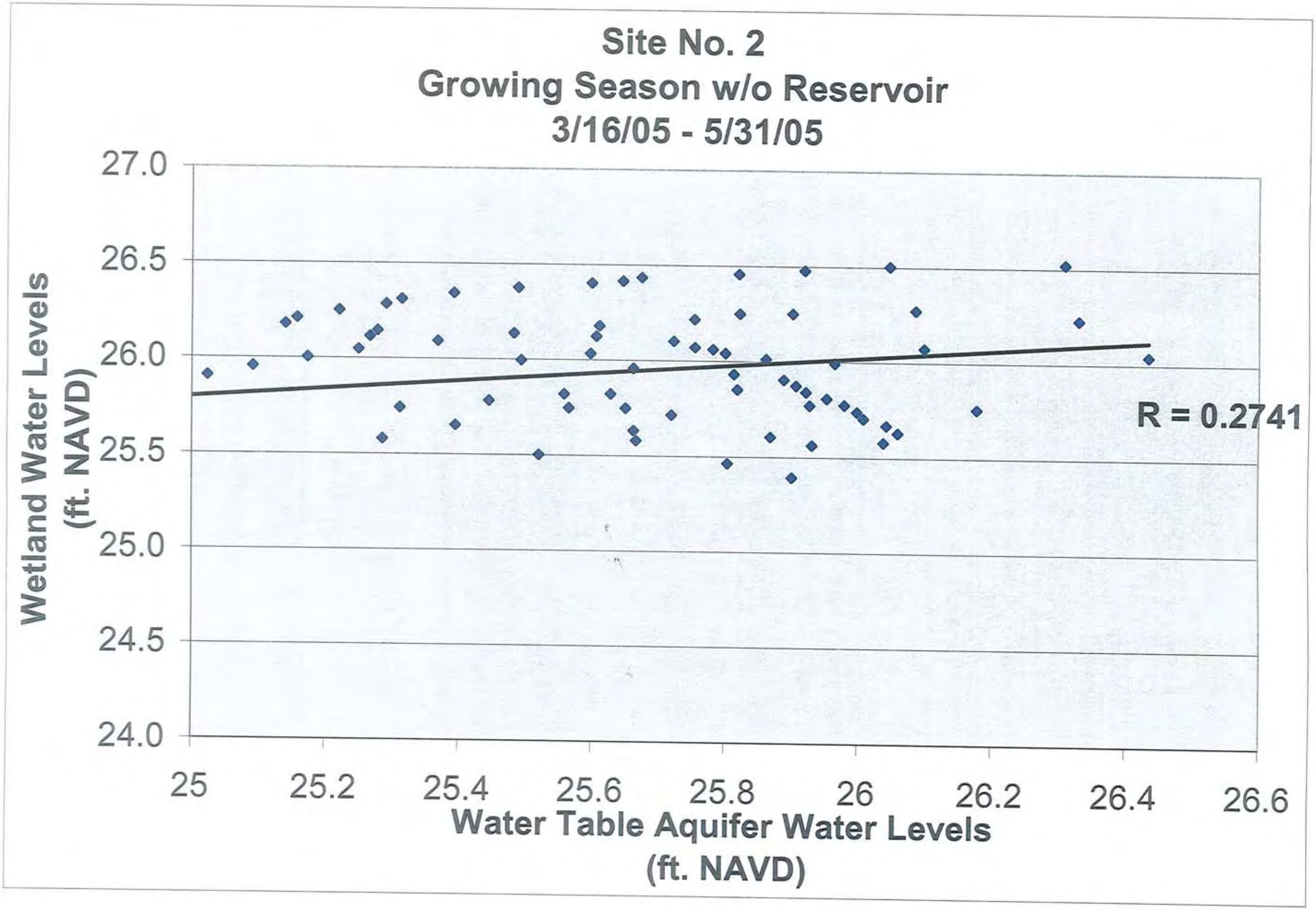
Site No. 2
Non Growing Season 6/1/05 - 11/1/05
27.4
27.2
27.0
26.8
26.6
26.4
26.2
26.0
25.8
Wetland Water Levels (ft. NAVD)
R = 0.8713
25
25.5
26
26.5
27
Lower Tamiami Aquifer Water Levels (ft. NAVD)

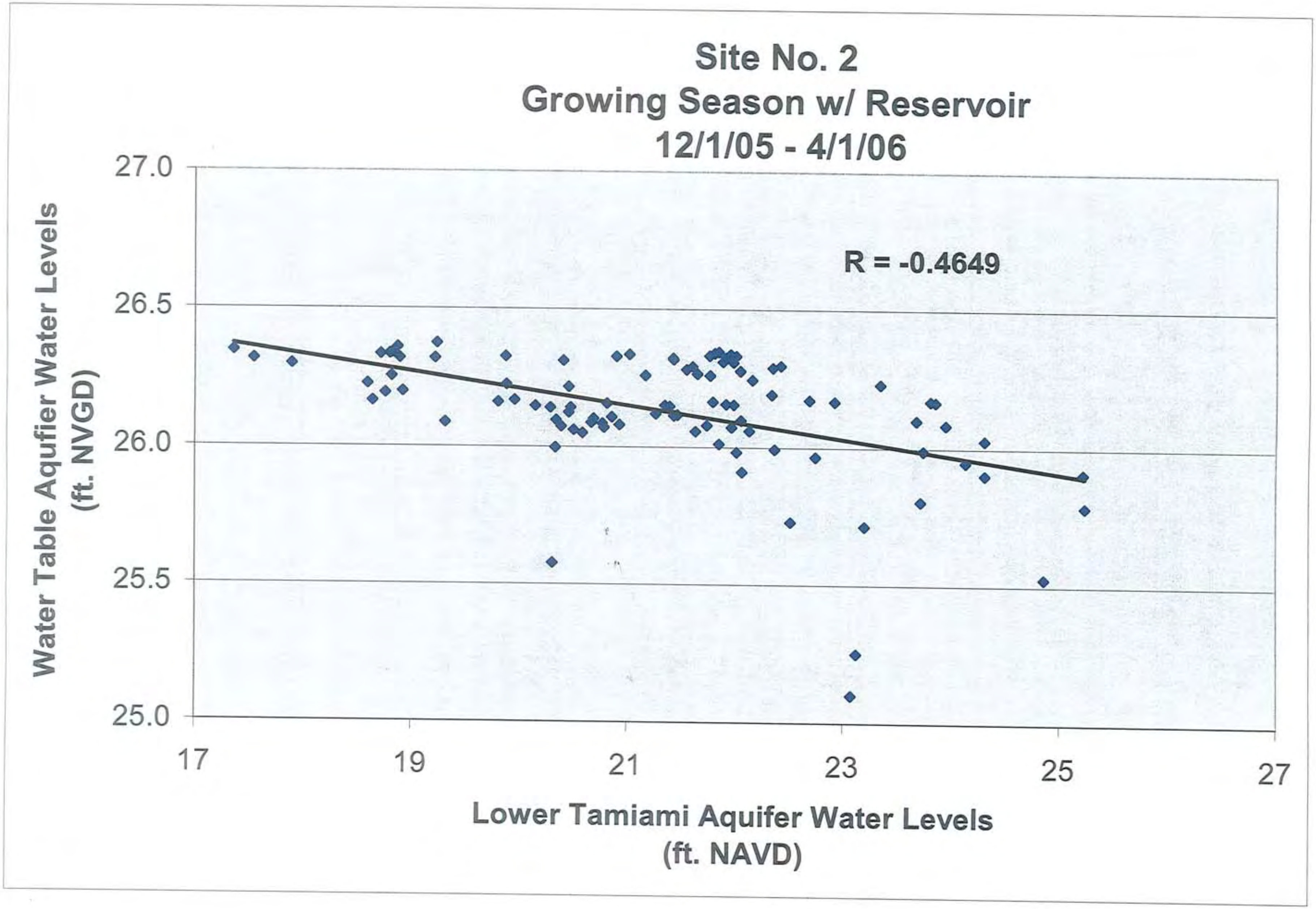

Site No. 2
Non Growing Season 6/1/05 - 11/1/05
R = 0.7649
Wetland Water Levels
(ft. NAVD)
27.4
27.2
27.0
26.8
26.6
26.4
26.2
26.0
25.8
25
25.5
26
26.5
27
27.5
Water Table Aquifer Water Levels
(ft. NAVD)

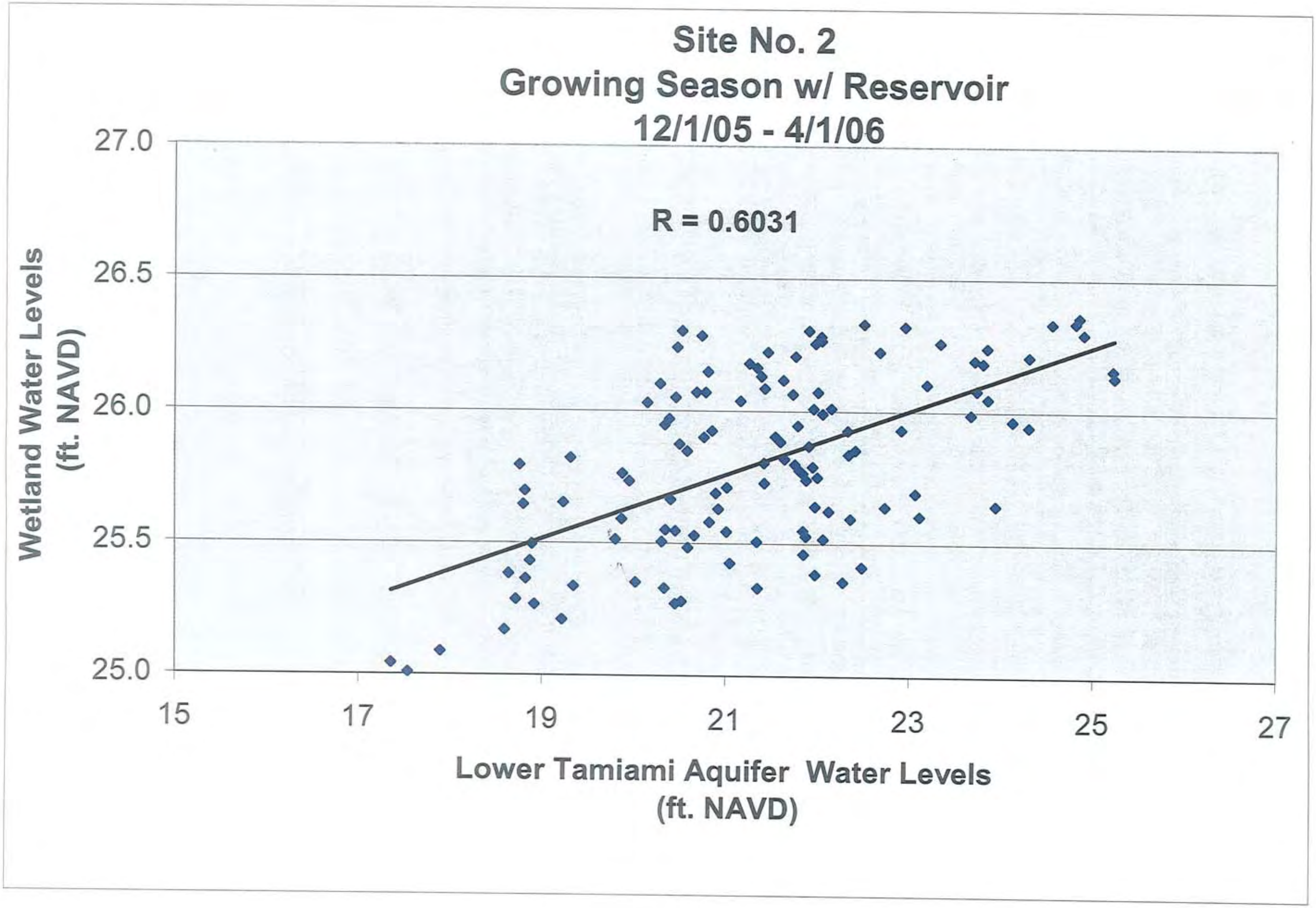

Site No. 2
Growing Season w/o Reservoir
3/16/05 - 5/31/05
R = -0.2283
Water Table Aquifier Water Levels (ft. NAVD)
Lower Tamiami Aquifer Water Levels (ft. NAVD)
27.0
26.5
26.0
25.5
25.0
24.5
24.0
17
19
21
23
25
27



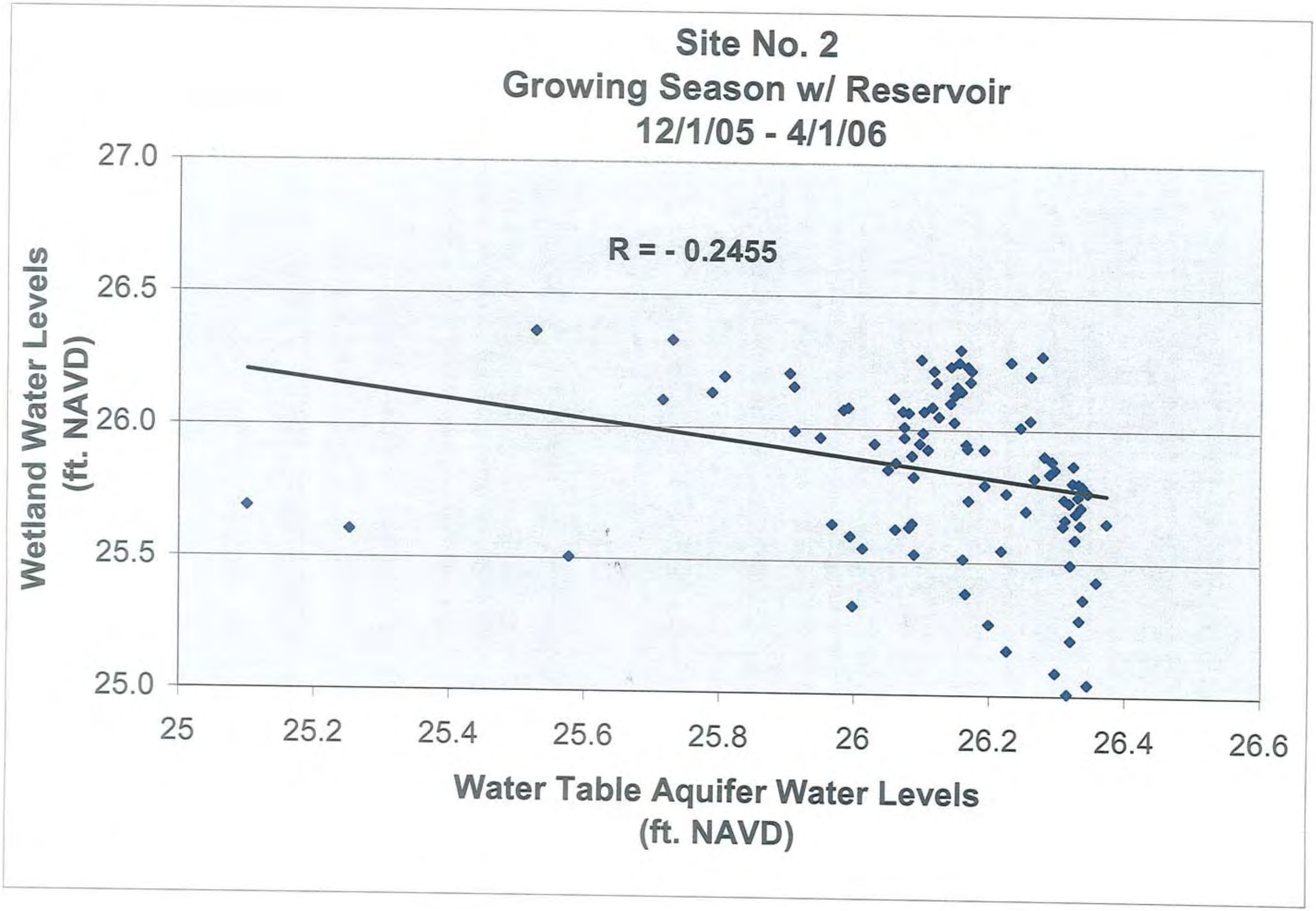
Site No. 2
Growing Season w/o Reservoir
3/16/05 - 5/31/05
R = 0.4572
Wetland Water Levels
(ft. NAVD)
Lower Tamiami Aquifer Water Levels
(ft. NAVD)
27.0
26.5
26.0
25.5
25.0
24.5
24.0
15
17
19
21
23
25
27


Site No. 2
Growing Season w/o Reservoir
3/16/05 - 5/31/05
Wetland Water Levels
(ft. NAVD)
27.0
26.5
26.0
25.5
25.0
24.5
24.0
R = 0.2741
25
25.2
25.4
25.6
25.8
26
26.2
26.4
26.6
Water Table Aquifer Water Levels
(ft. NAVD)

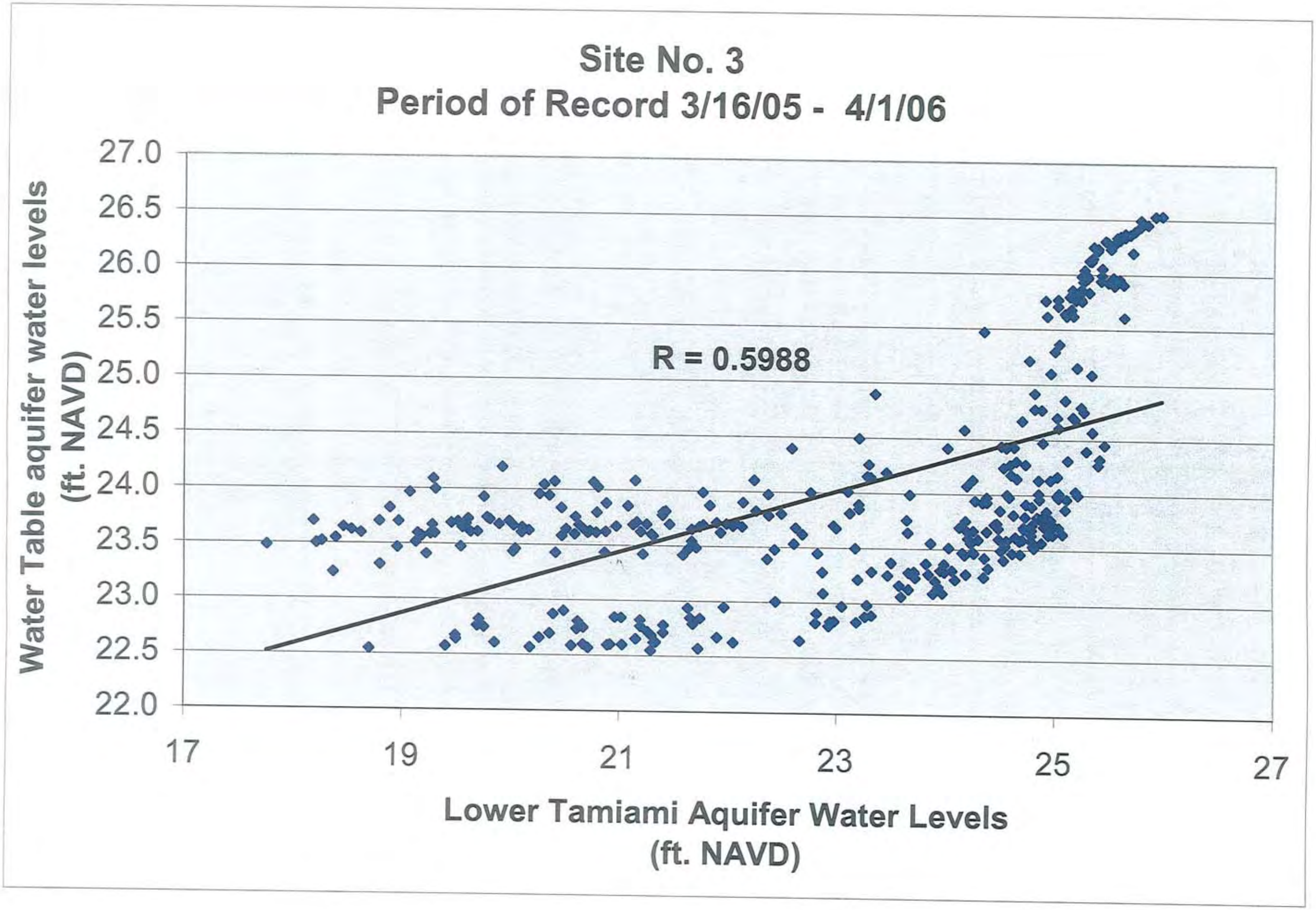

Site No. 2
Growing Season w/ Reservoir
12/1/05 - 4/1/06
R = -0.4649
27.0
26.5
26.0
25.5
25.0
17
19
21
23
25
27
Water Table Aqufier Water Levels
(ft. NVGD)
Lower Tamiami Aquifer Water Levels
(ft. NAVD)



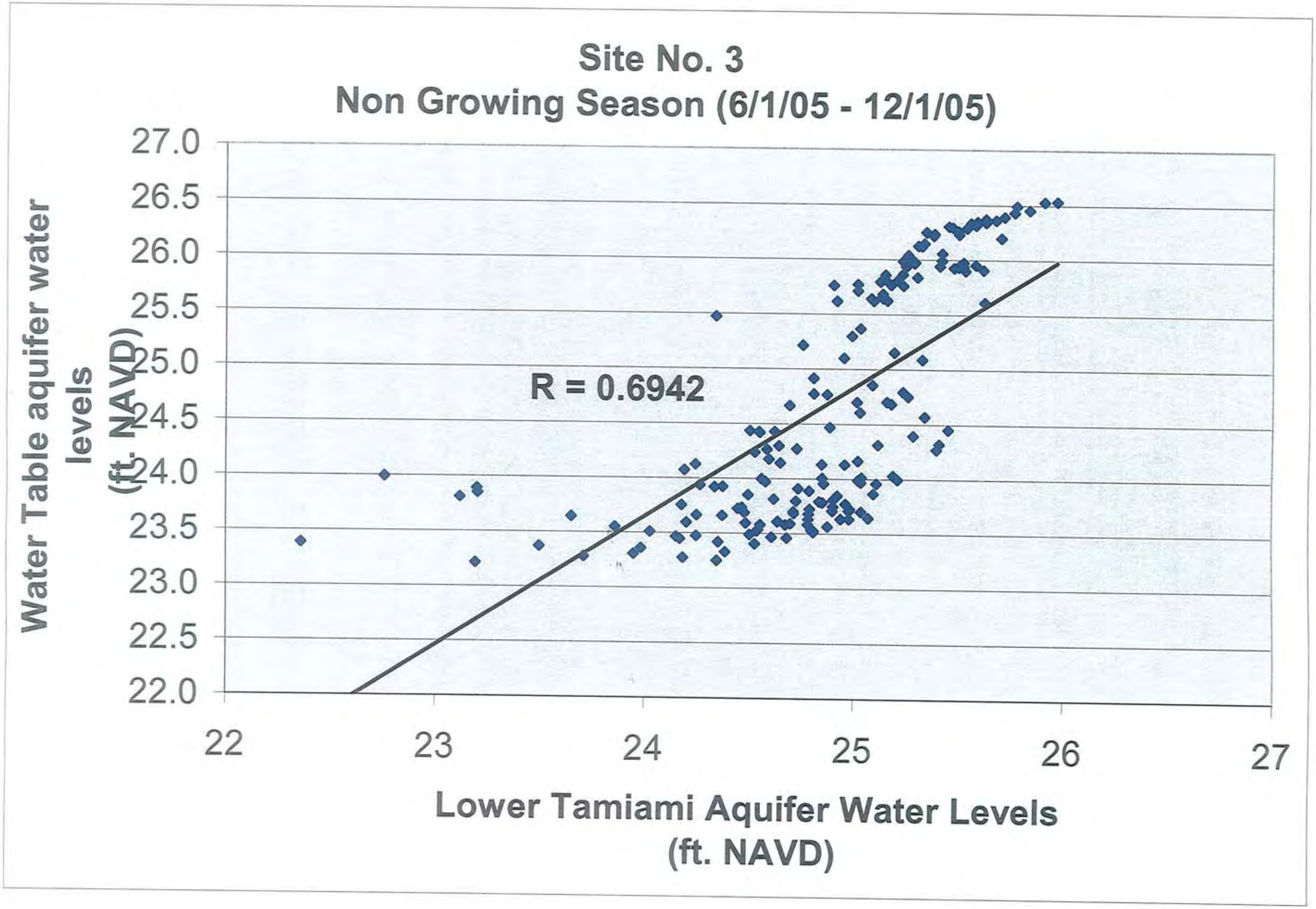
Site No. 2
Growing Season w/ Reservoir
12/1/05 - 4/1/06
R = 0.6031
27.0
26.5
26.0
25.5
25.0
Wetland Water Levels
(ft. NAVD)
15
17
19
21
23
25
27
Lower Tamiami Aquifer Water Levels
(ft. NAVD)



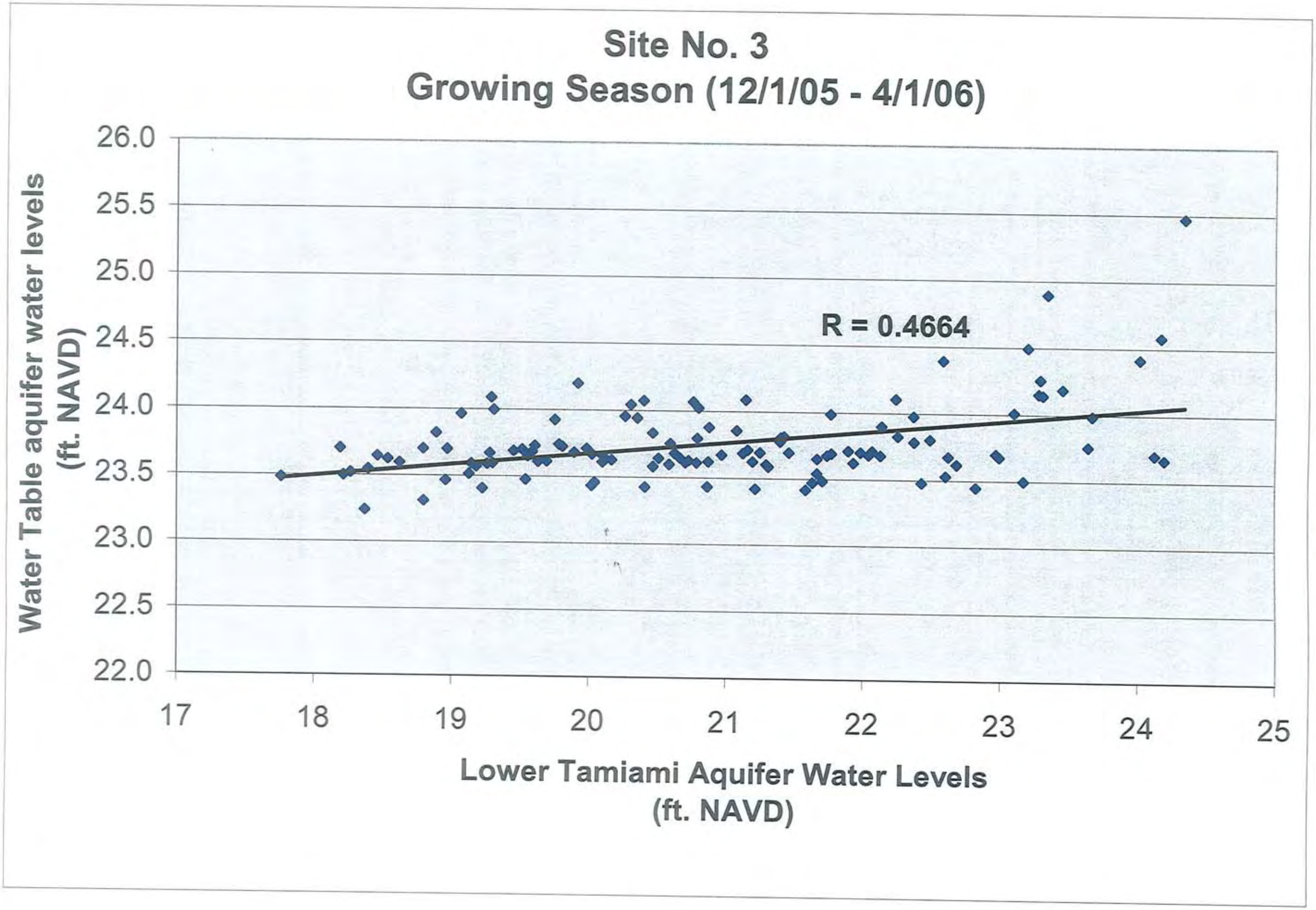
Site No. 2
Growing Season w/ Reservoir
12/1/05 - 4/1/06
R = - 0.2455
Wetland Water Levels
(ft. NAVD)
27.0
26.5
26.0
25.5
25.0
25
25.2
25.4
25.6
25.8
26
26.2
26.4
26.6
Water Table Aquifer Water Levels
(ft. NAVD)



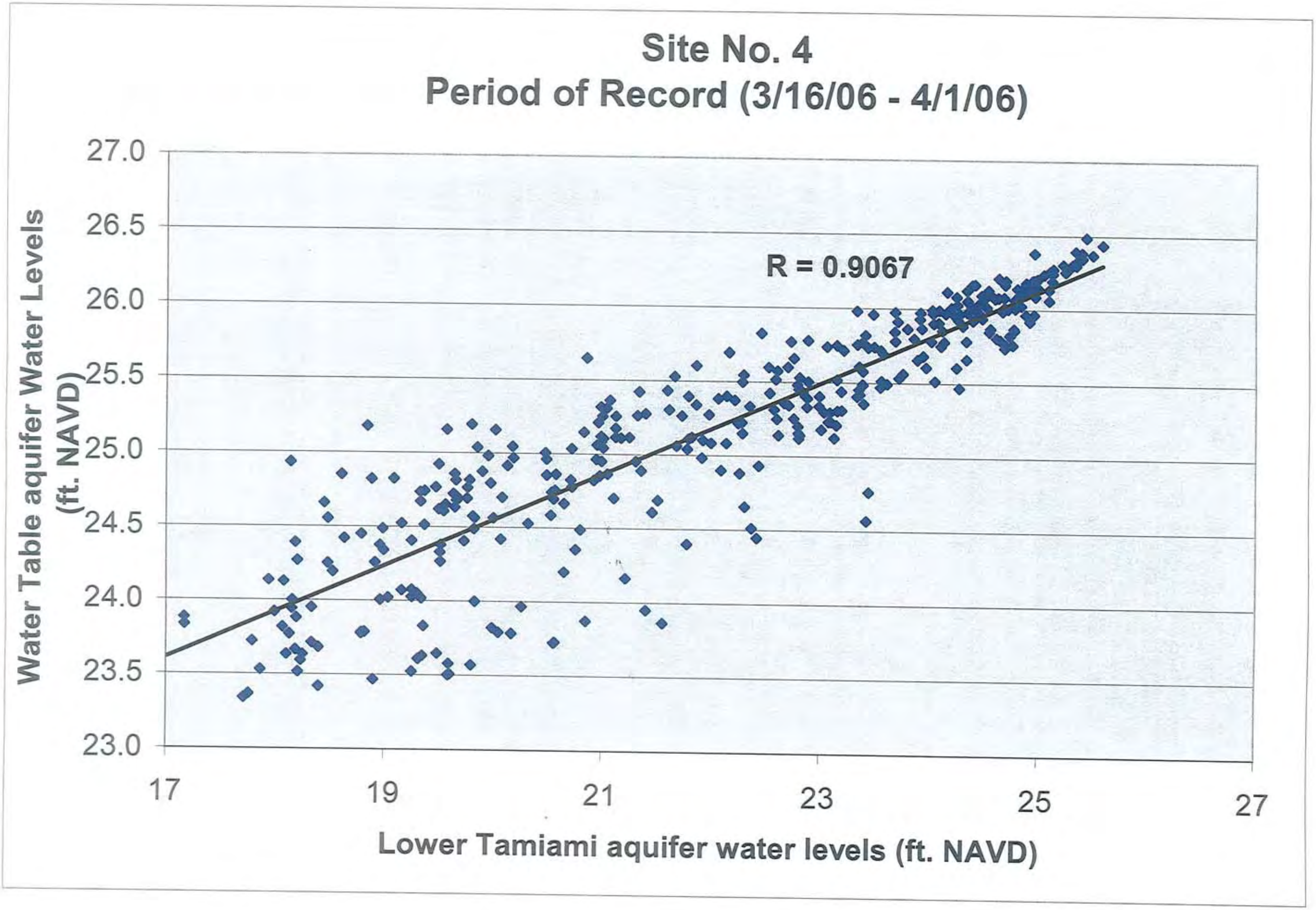
Site No. 3
Period of Record 3/16/05 - 4/1/06
Water Table aquifer water levels
(ft. NAVD)
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
R = 0.5988
17
19
21
23
25
27
Lower Tamiami Aquifer Water Levels
(ft. NAVD)



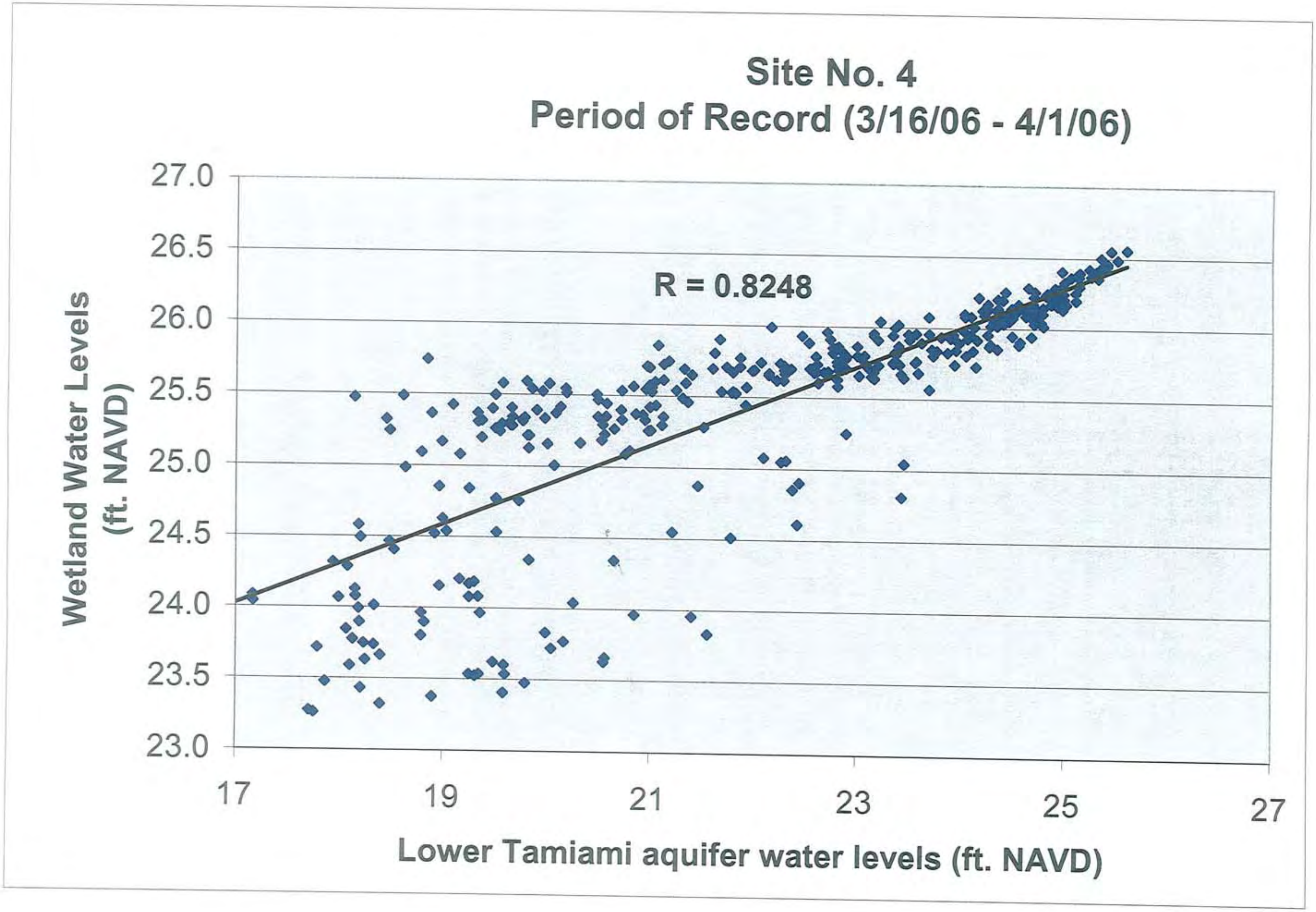
Site No. 3
Non Growing Season (6/1/05 - 12/1/05)
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
R = 0.6942
22
23
24
25
26
27
Water Table aquifer water levels (ft. NAVD)
Lower Tamiami Aquifer Water Levels (ft. NAVD)

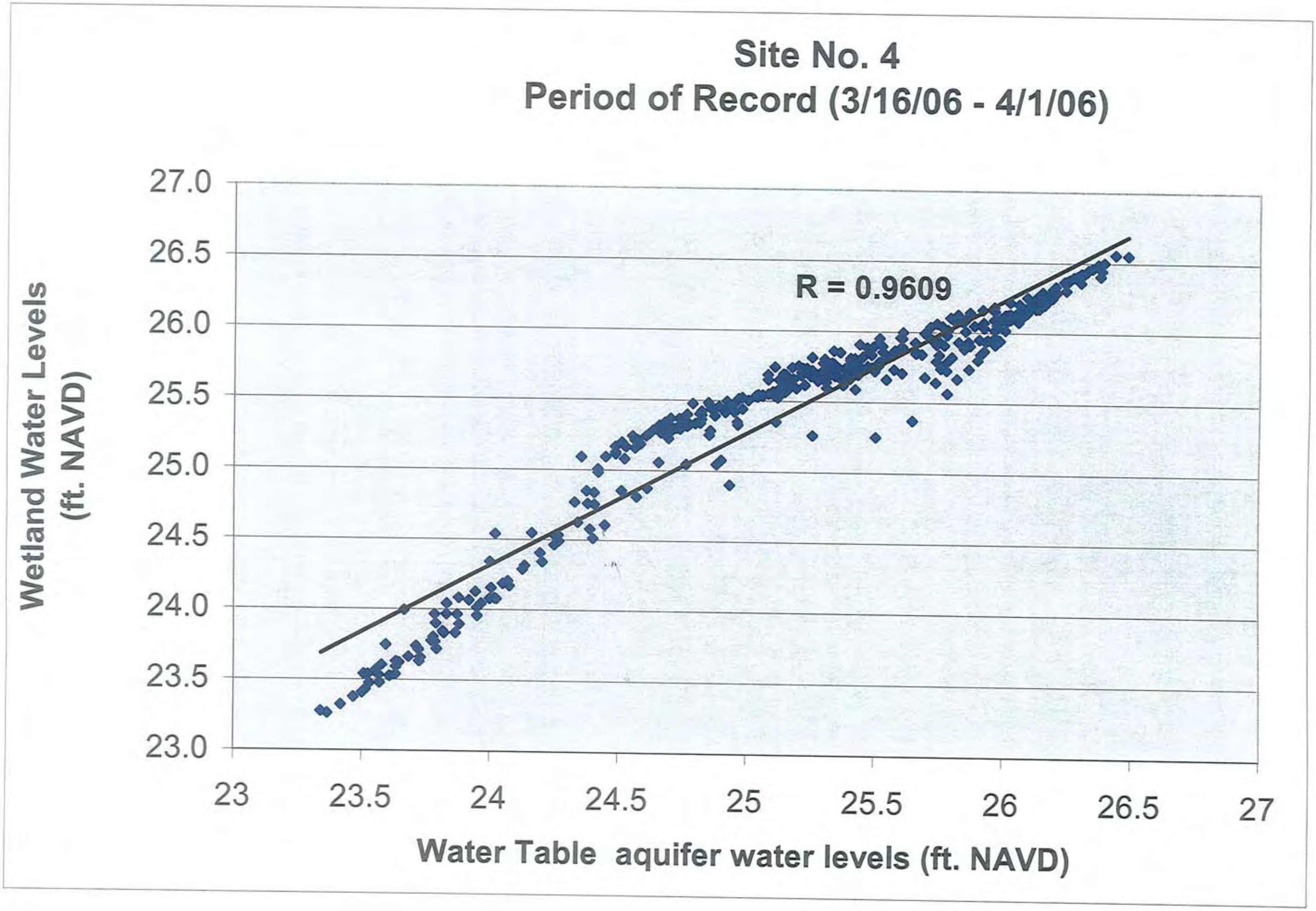


Site No. 3
Growing Season (12/1/05 - 4/1/06)
R = 0.4664
Water Table aquifer water levels (ft. NAVD)
26.0
25.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
17
18
19
20
21
22
23
24
25
Lower Tamiami Aquifer Water Levels (ft. NAVD)

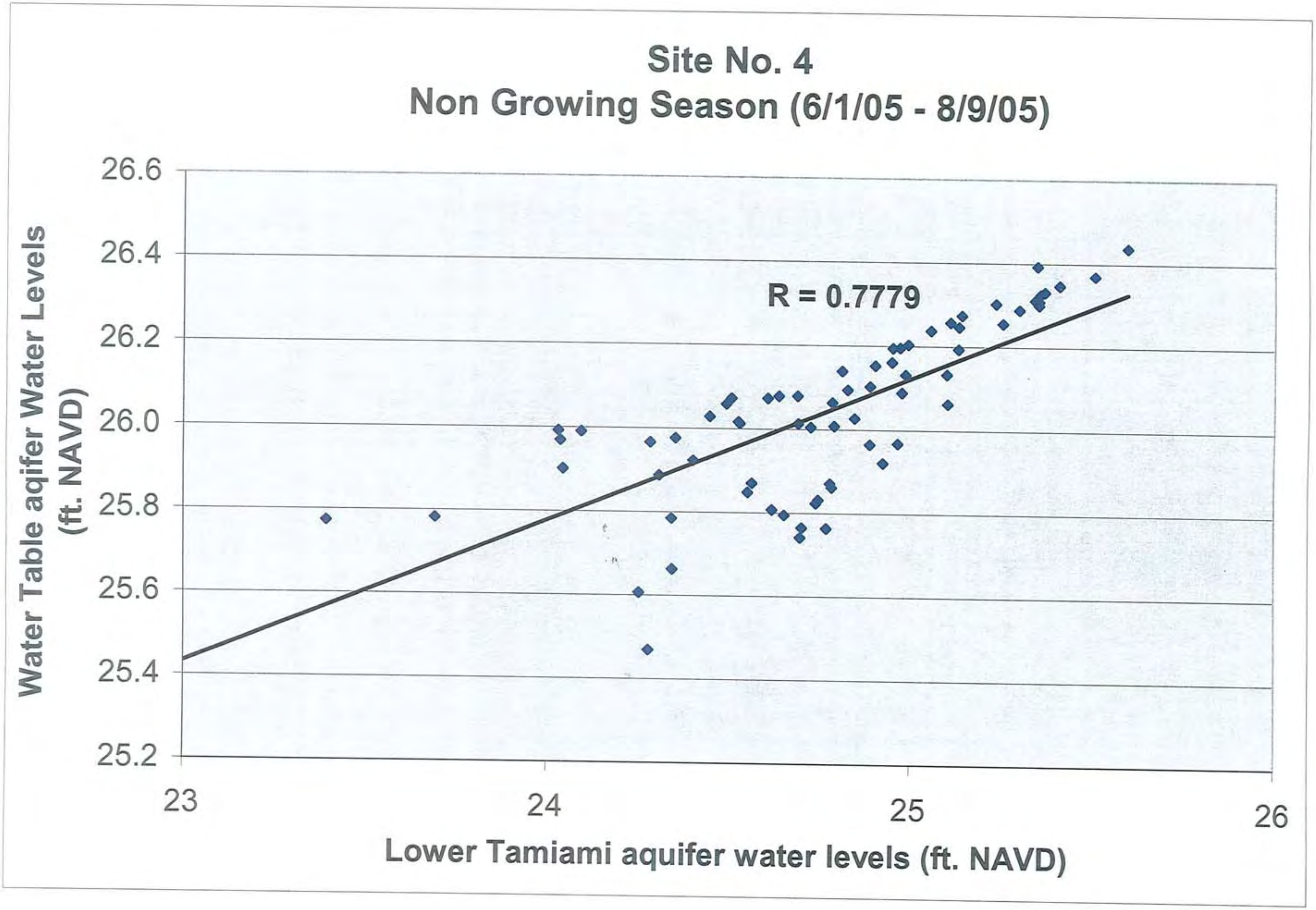


Site No. 4
Period of Record (3/16/06 - 4/1/06)
R = 0.9067
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
Water Table aquifer Water Levels (ft. NAVD)
17
19
21
23
25
27
Lower Tamiami aquifer water levels (ft. NAVD)

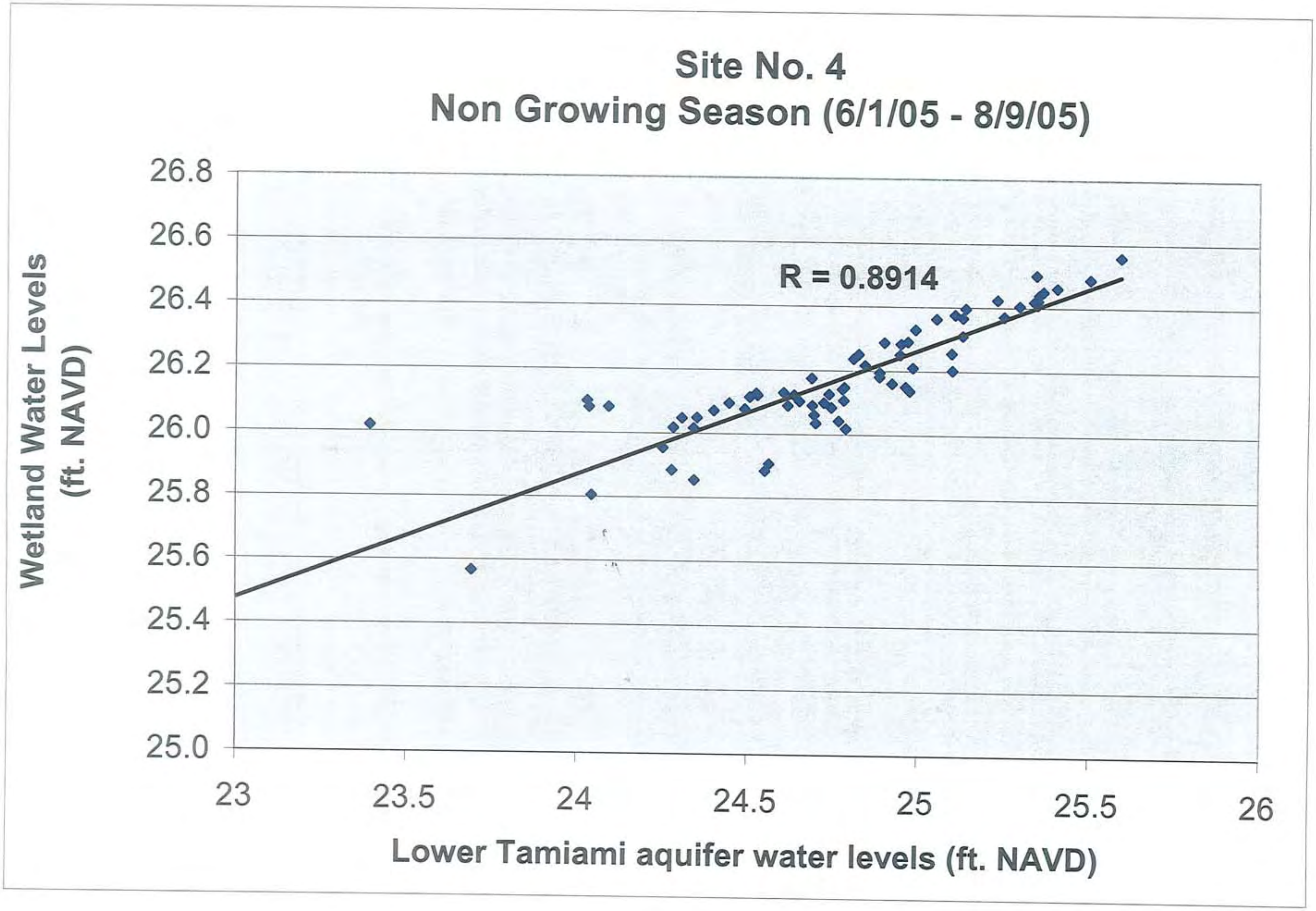

Site No. 4
Period of Record (3/16/06 - 4/1/06)
R = 0.8248
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
Wetland Water Levels (ft. NAVD)
17
19
21
23
25
27
Lower Tamiami aquifer water levels (ft. NAVD)



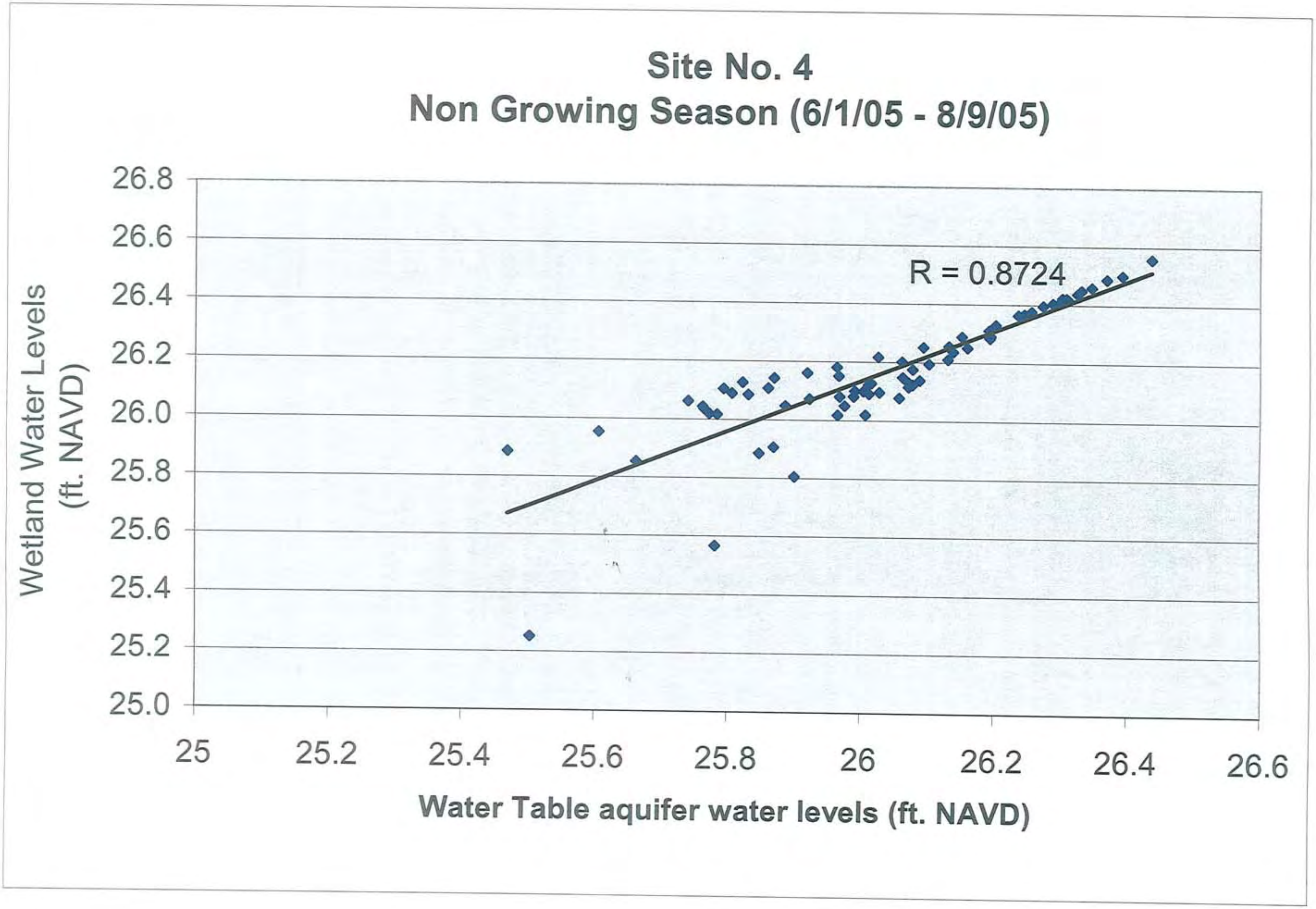
Site No. 4
Period of Record (3/16/06 - 4/1/06)
R = 0.9609
Wetland Water Levels (ft. NAVD)
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
23
23.5
24
24.5
25
25.5
26
26.5
27
Water Table aquifer water levels (ft. NAVD)



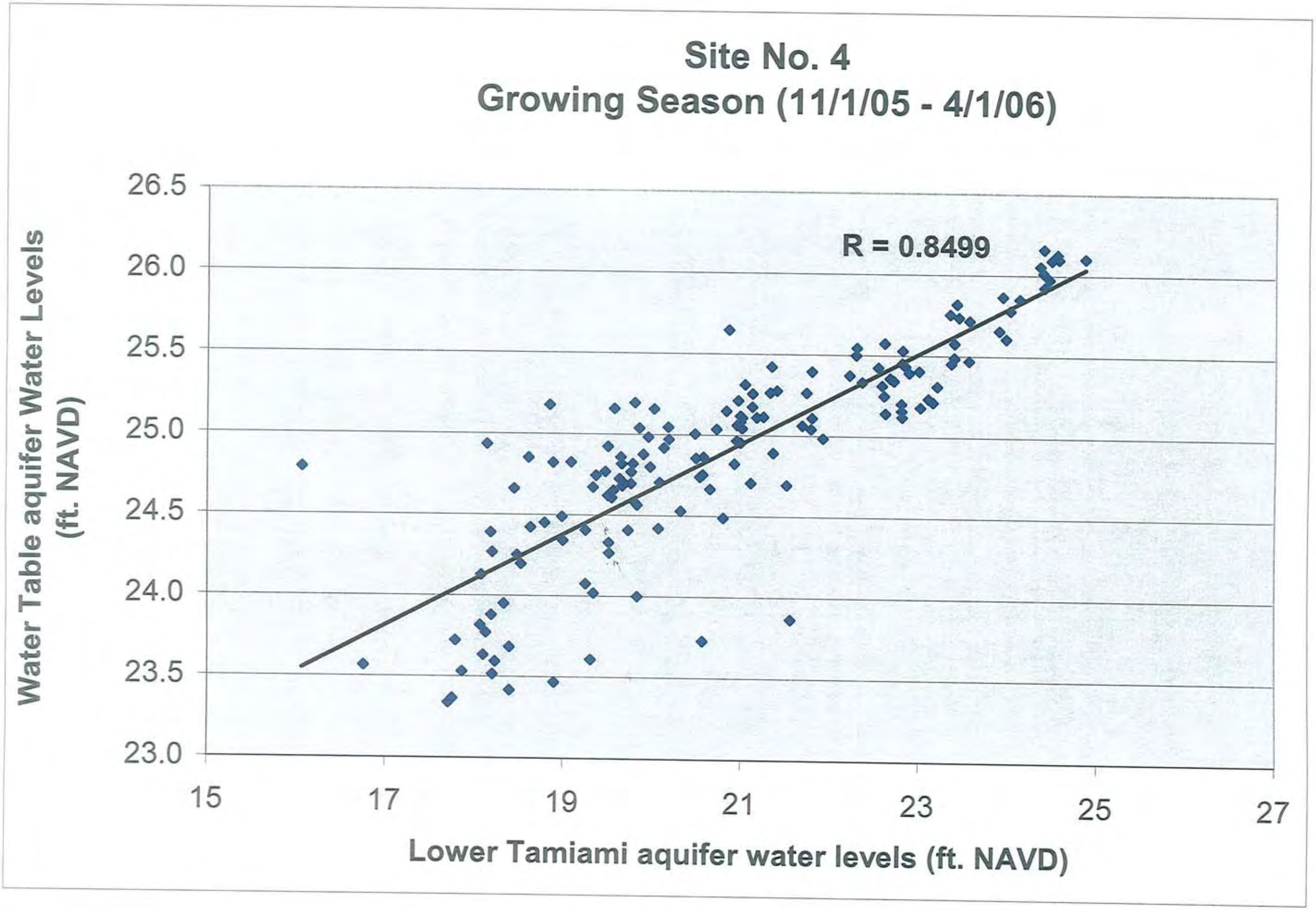
Site No. 4
Non Growing Season (6/1/05 - 8/9/05)
R = 0.7779
Water Table aqifer Water Levels
(ft. NAVD)
26.6
26.4
26.2
26.0
25.8
25.6
25.4
25.2
23
24
25
26
Lower Tamiami aquifer water levels (ft. NAVD)

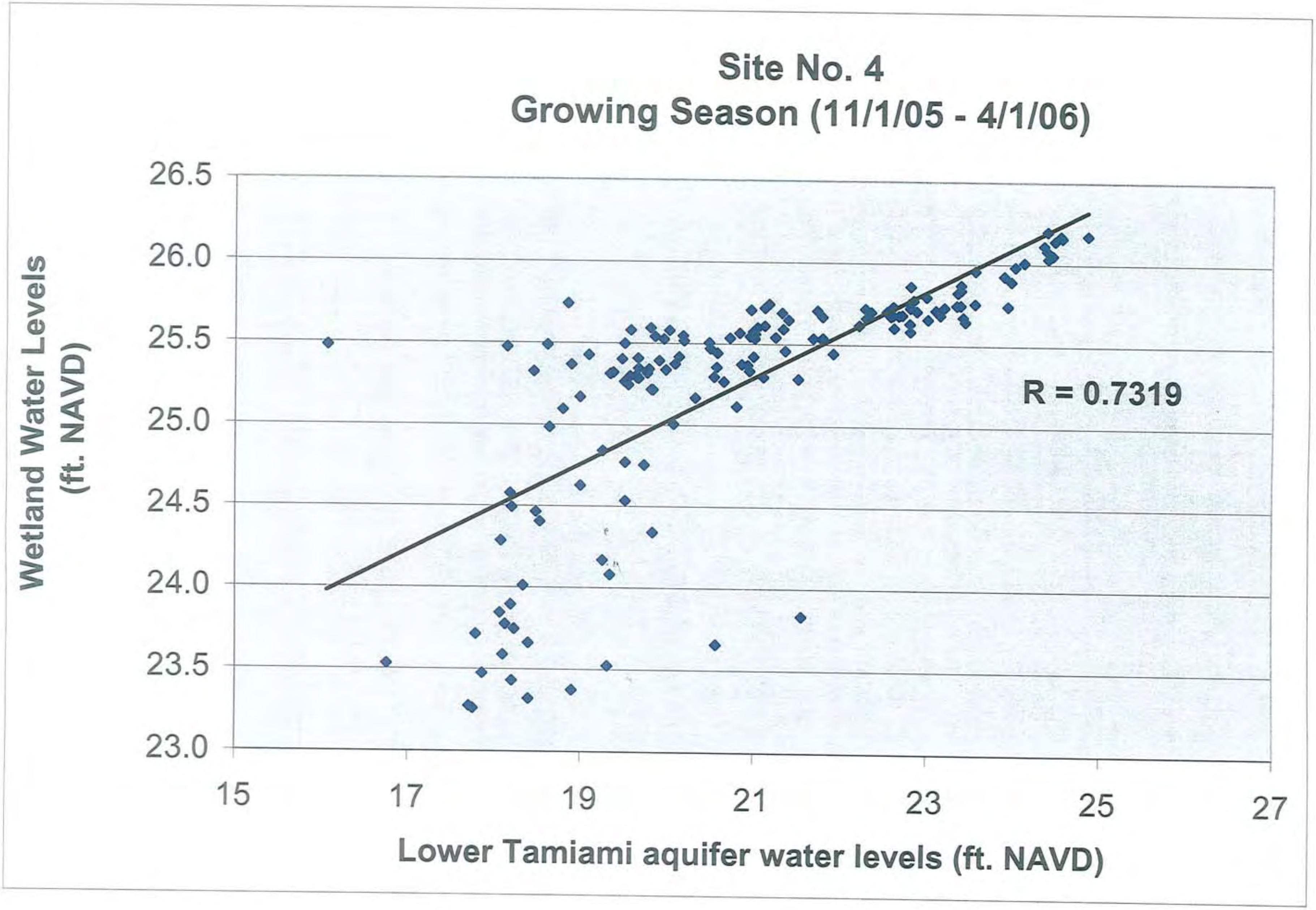


Site No. 4
Non Growing Season (6/1/05 - 8/9/05)
R = 0.8914
Wetland Water Levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)
26.8
26.6
26.4
26.2
26.0
25.8
25.6
25.4
25.2
25.0
23
23.5
24
24.5
25
25.5
26

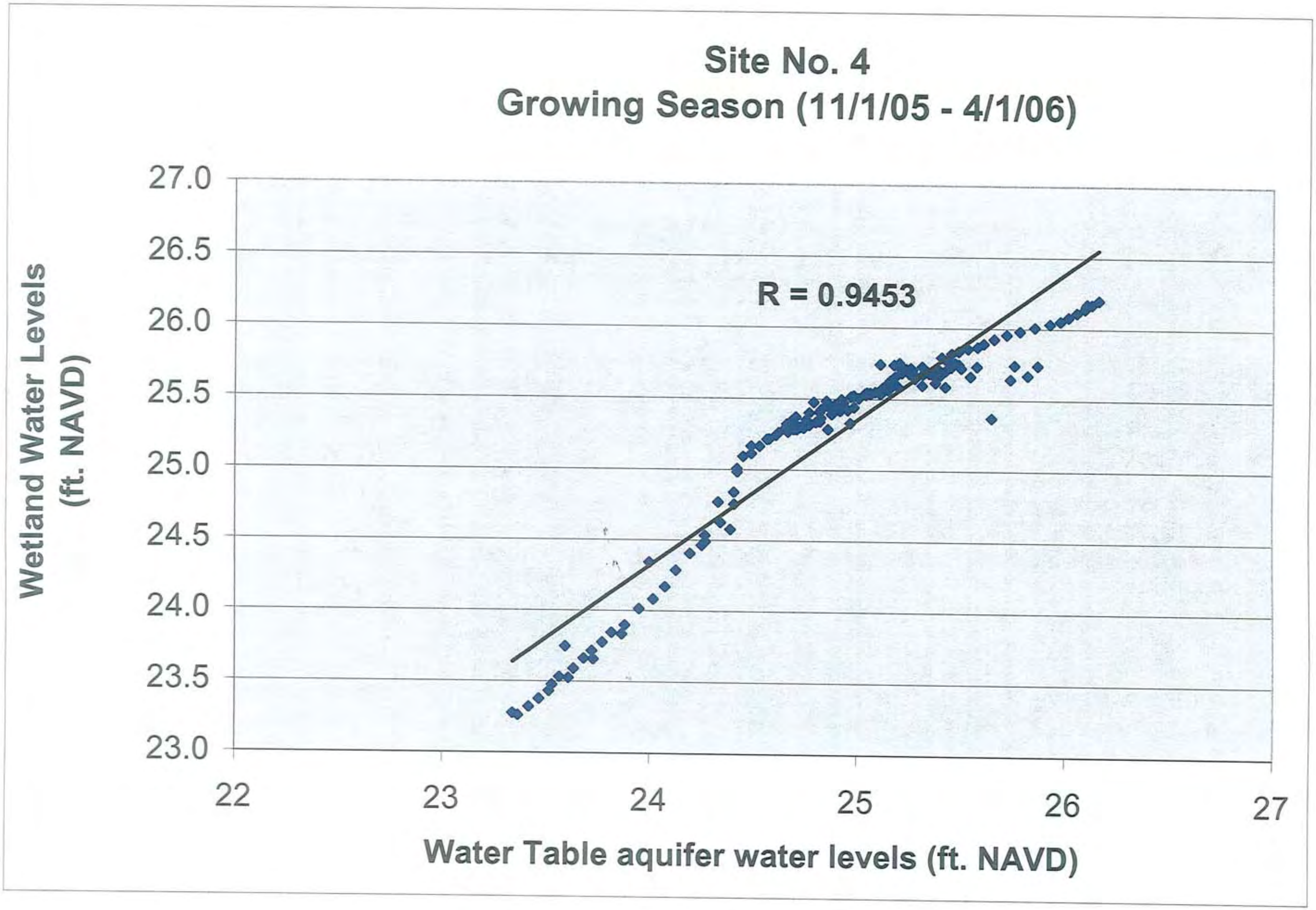


Site No. 4
Non Growing Season (6/1/05 - 8/9/05)
Wetland Water Levels (ft. NAVD)
26.8
26.6
26.4
26.2
26.0
25.8
25.6
25.4
25.2
25.0
R = 0.8724
25
25.2
25.4
25.6
25.8
26
26.2
26.4
26.6
Water Table aquifer water levels (ft. NAVD)

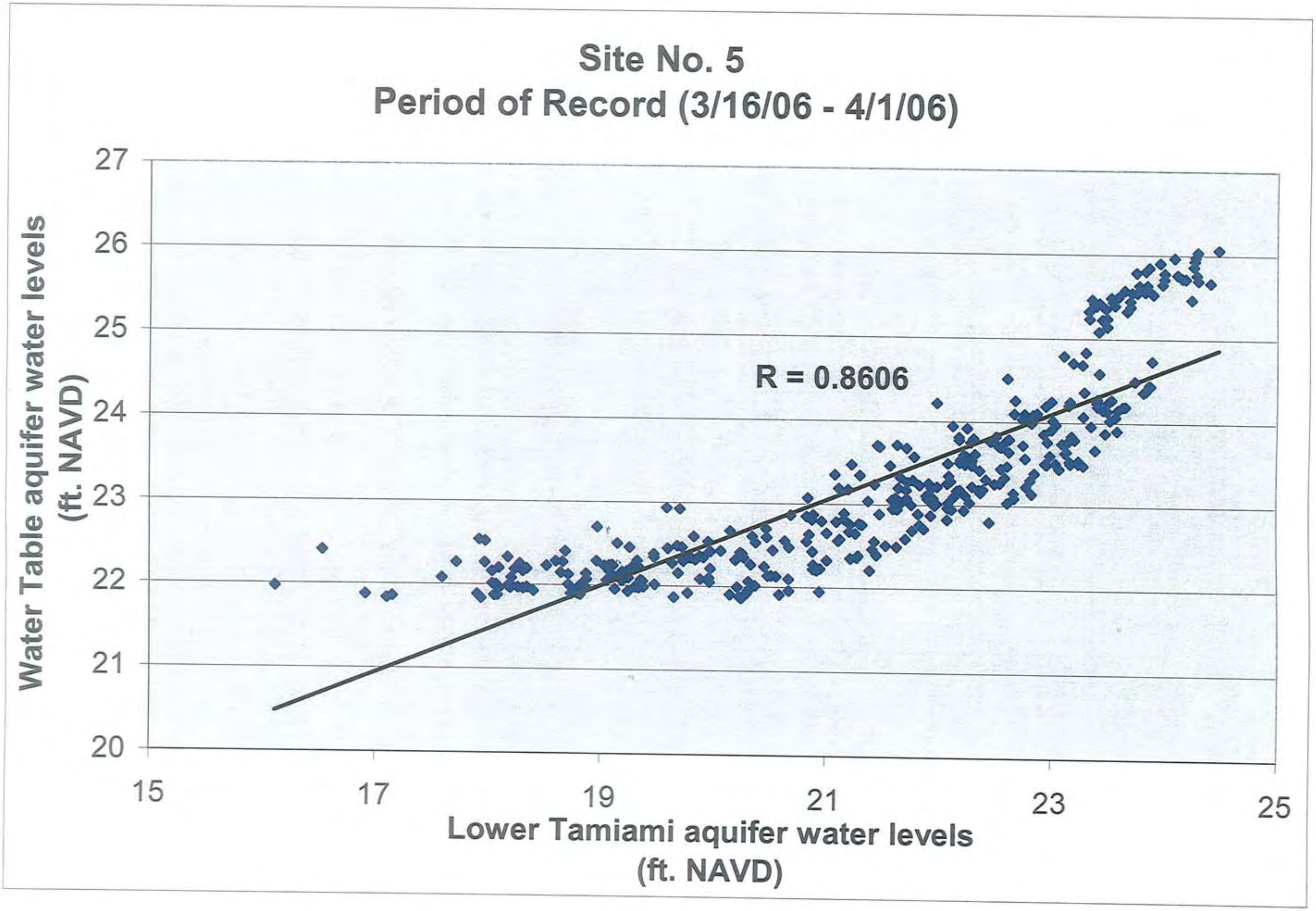

Site No. 4
Growing Season (11/1/05 - 4/1/06)
R = 0.8499
Water Table aquifer Water Levels (ft. NAVD)
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
15
17
19
21
23
25
27
Lower Tamiami aquifer water levels (ft. NAVD)

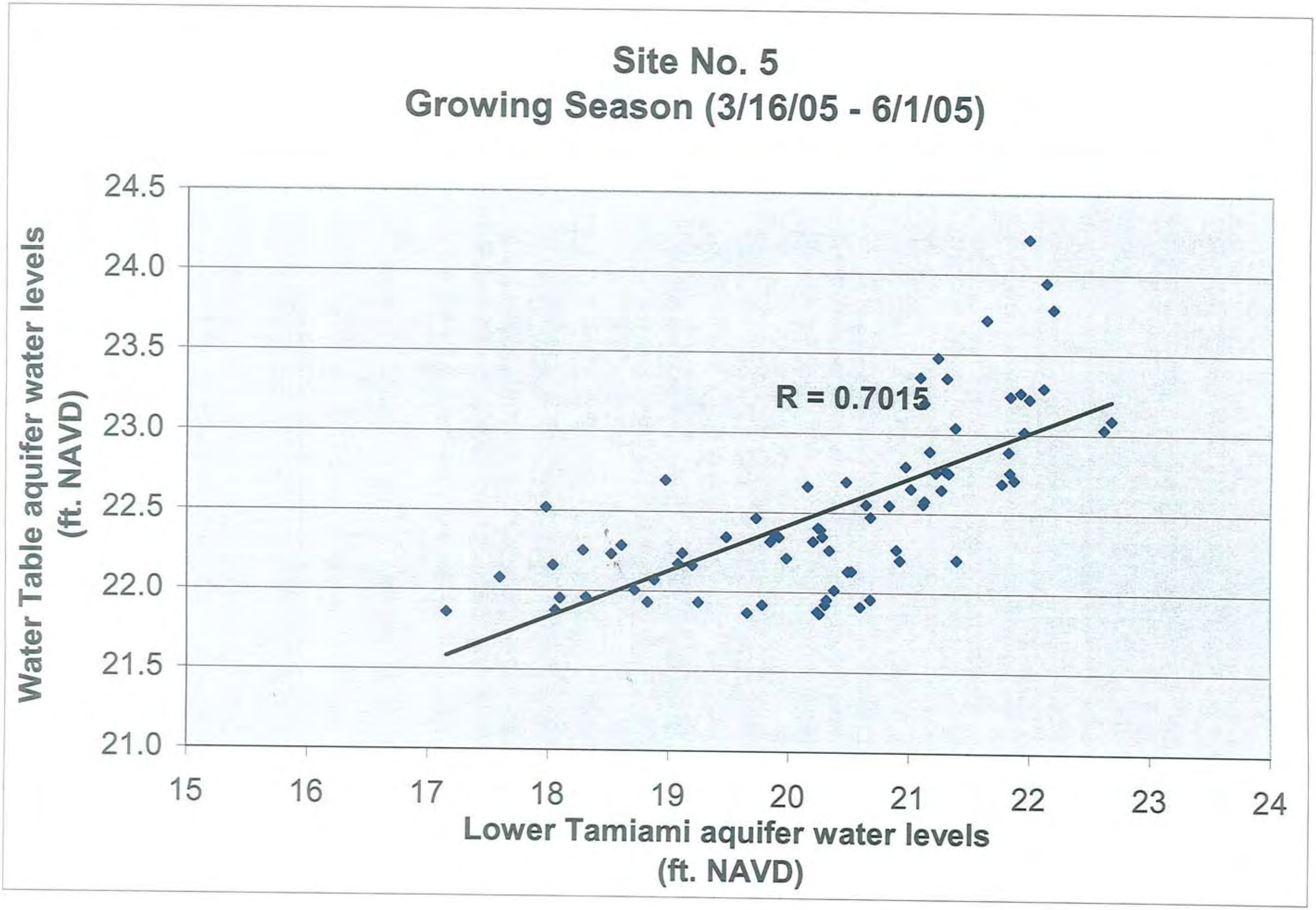


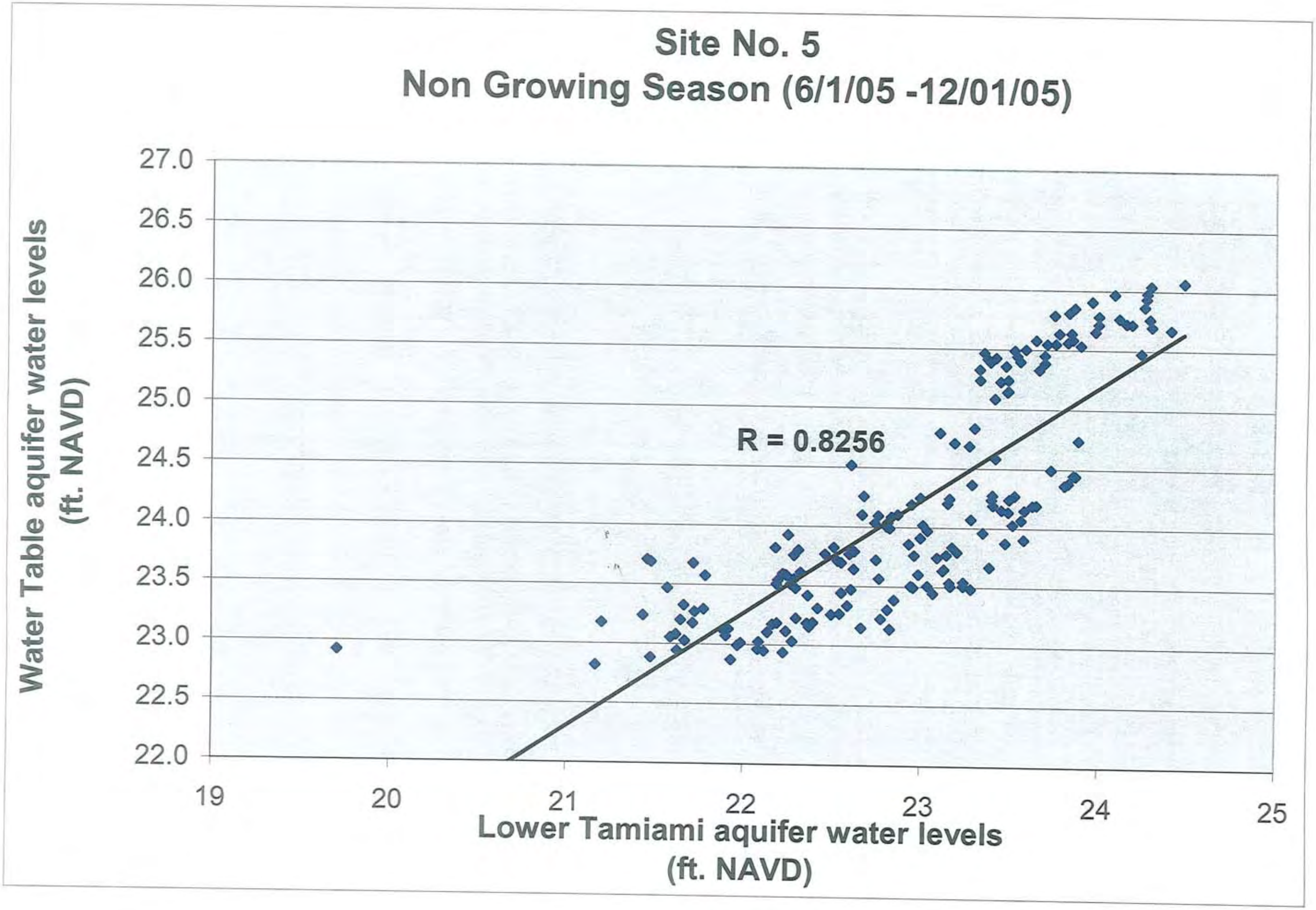
Site No. 4
Growing Season (11/1/05 - 4/1/06)
Wetland Water Levels (ft. NAVD)
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
15
17
19
21
23
25
27
R = 0.7319
Lower Tamiami aquifer water levels (ft. NAVD)

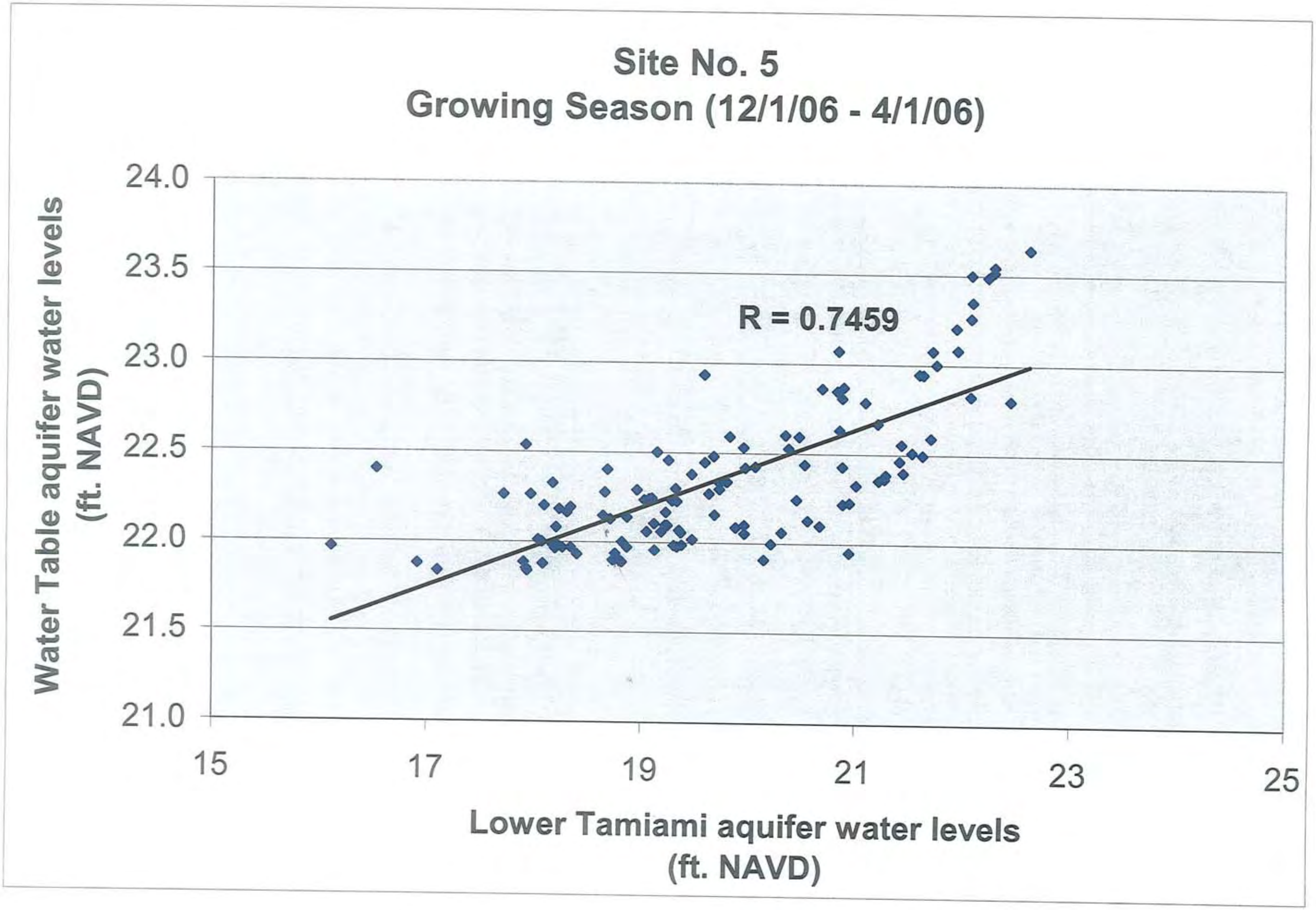


Site No. 4
Growing Season (11/1/05 - 4/1/06)
R = 0.9453
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
Wetland Water Levels
(ft. NAVD)
22
23
24
25
26
27
Water Table aquifer water levels (ft. NAVD)

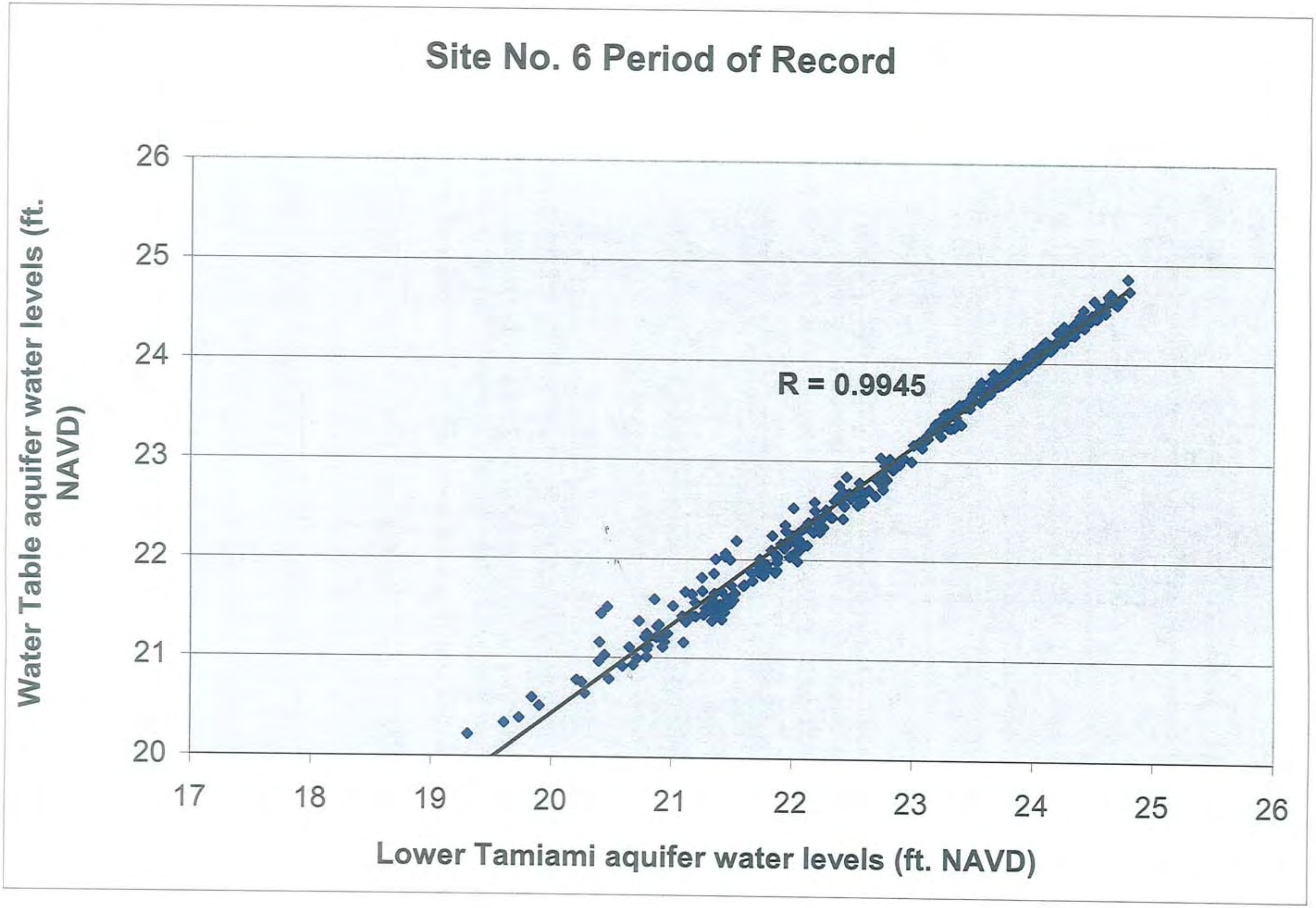

Site No. 5
Period of Record (3/16/06 - 4/1/06)
Water Table aquifer water levels
(ft. NAVD)
Lower Tamiami aquifer water levels
(ft. NAVD)
R = 0.8606
27
26
25
24
23
22
21
20
15
17
19
21
23
25


Site No. 5
Growing Season (3/16/05 - 6/1/05)
Water Table aquifer water levels
(ft. NAVD)
24.5
24.0
23.5
23.0
22.5
22.0
21.5
21.0
R = 0.7015
15
16
17
18
19
20
21
22
23
24
Lower Tamiami aquifer water levels
(ft. NAVD)

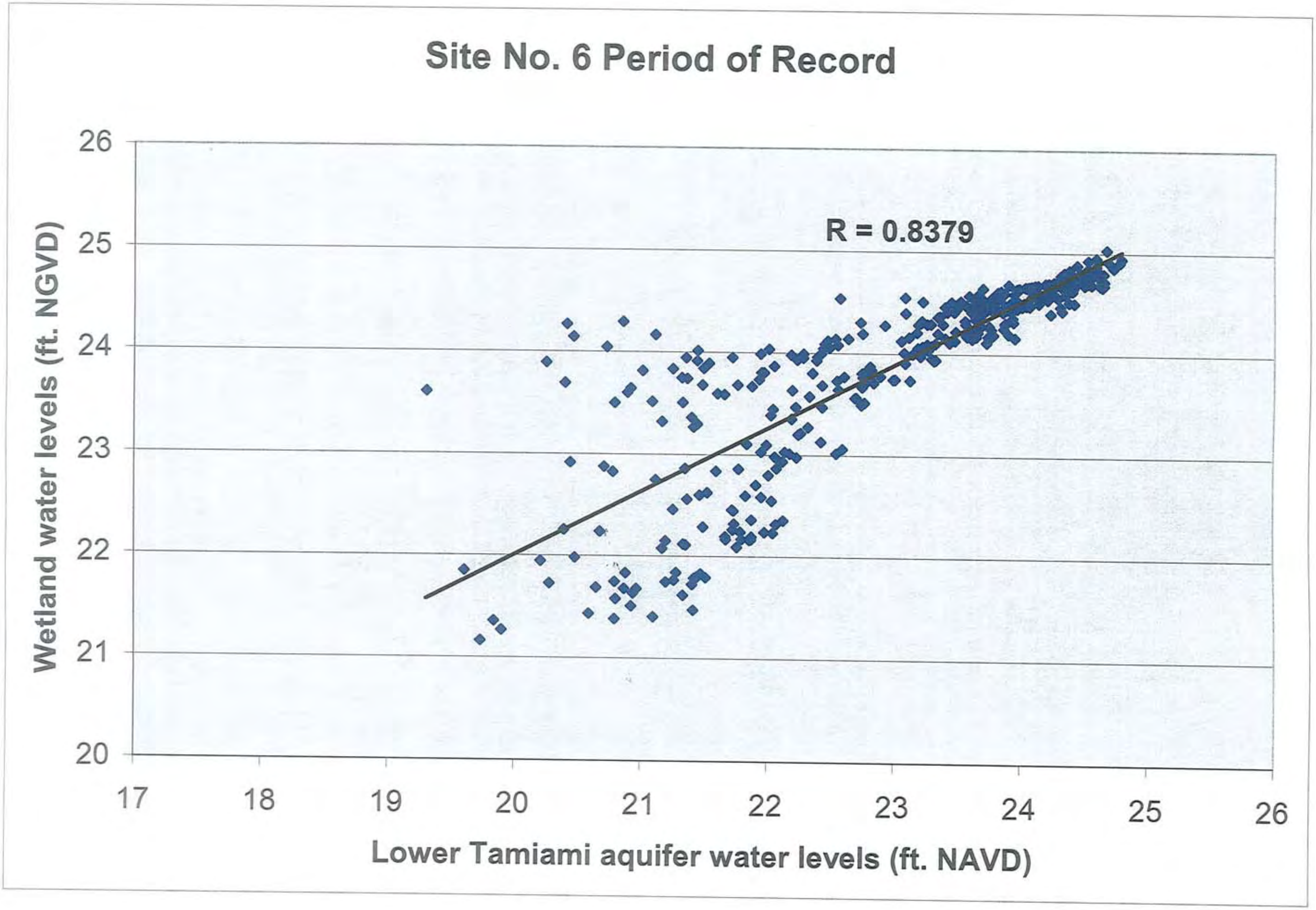

Site No. 5
Non Growing Season (6/1/05 -12/01/05)
Water Table aquifer water levels (ft. NAVD)
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
R = 0.8256
19
20
21
22
23
24
25
Lower Tamiami aquifer water levels (ft. NAVD)

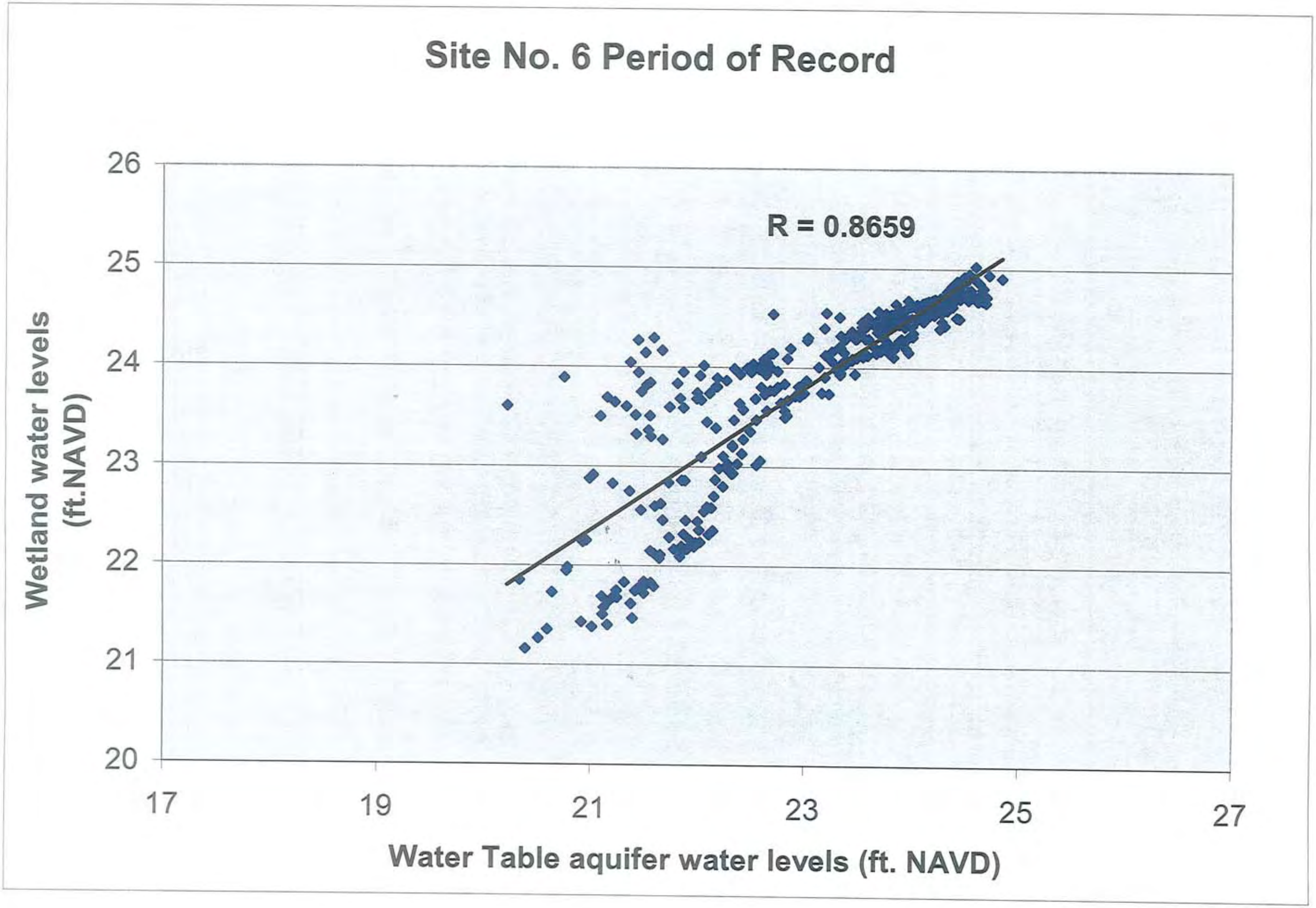


Site No. 5
Growing Season (12/1/06 - 4/1/06)
R = 0.7459
Water Table aquifer water levels (ft. NAVD)
24.0
23.5
23.0
22.5
22.0
21.5
21.0
15
17
19
21
23
25
Lower Tamiami aquifer water levels (ft. NAVD)

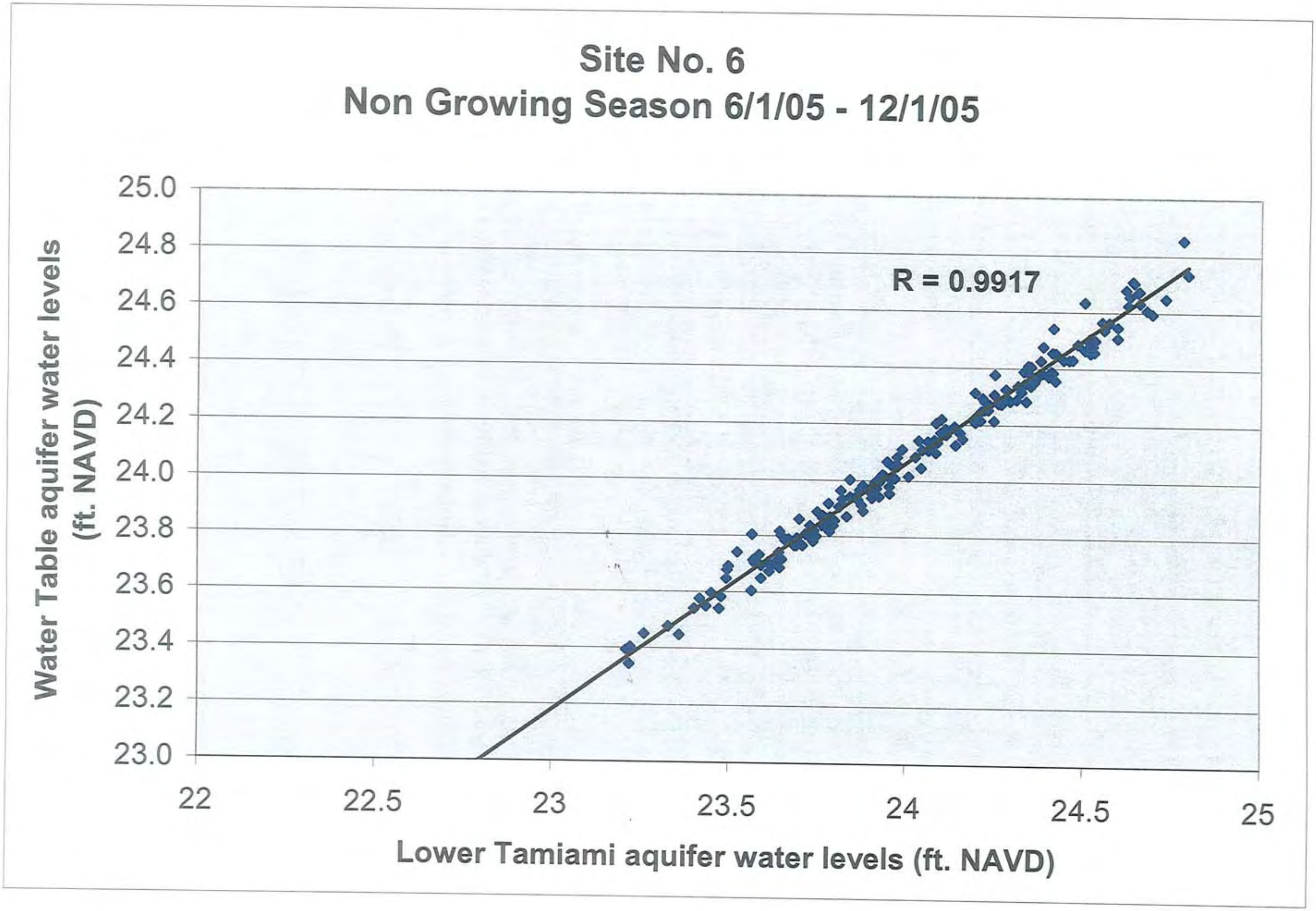


Site No. 6 Period of Record
Water Table aquifer water levels (ft. NAVD)
26
25
24
23
22
21
20
R = 0.9945
17
18
19
20
21
22
23
24
25
26
Lower Tamiami aquifer water levels (ft. NAVD)

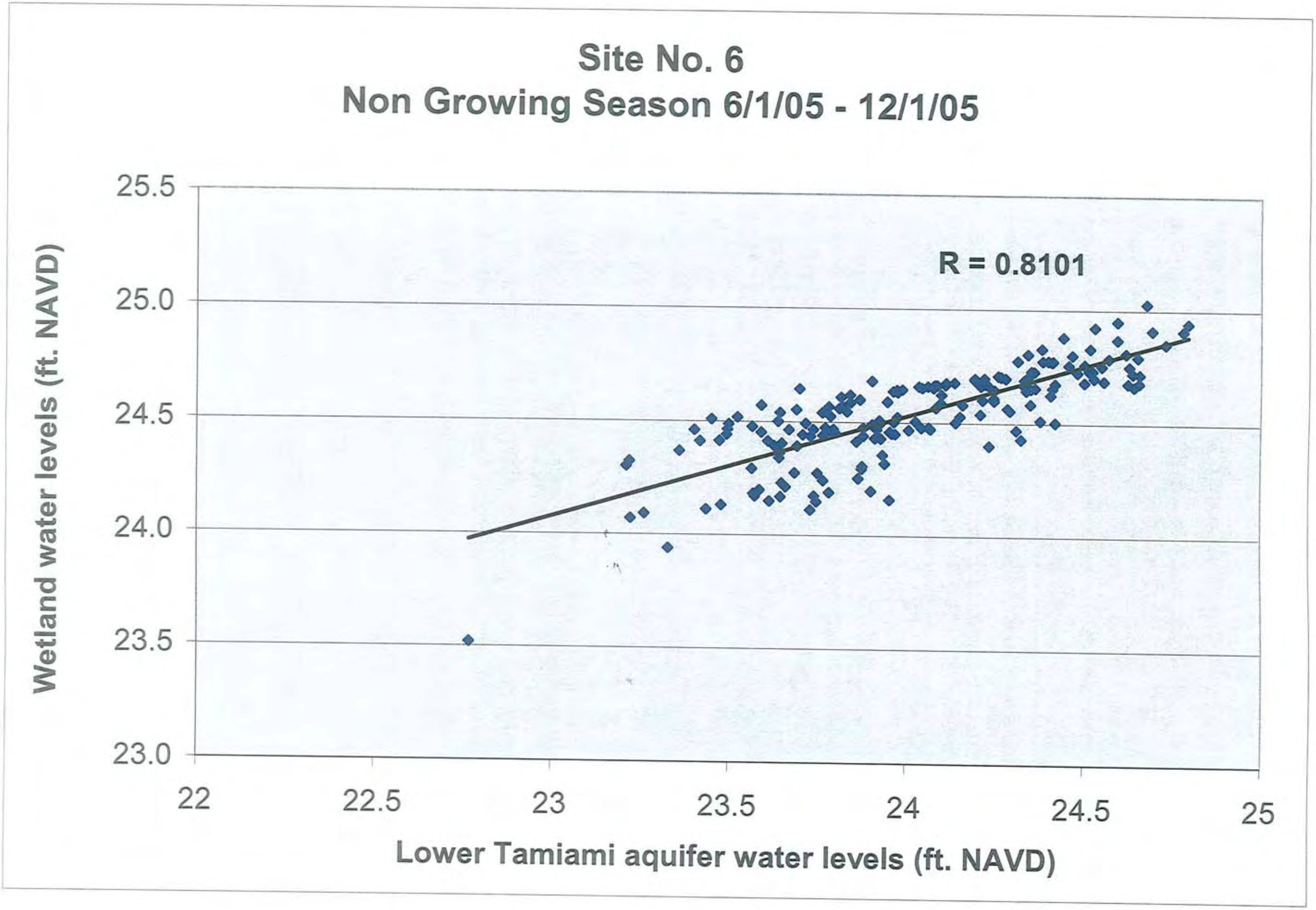

Site No. 6 Period of Record
R = 0.8379
Wetland water levels (ft. NGVD)
Lower Tamiami aquifer water levels (ft. NAVD)
26
25
24
23
22
21
20
17
18
19
20
21
22
23
24
25
26

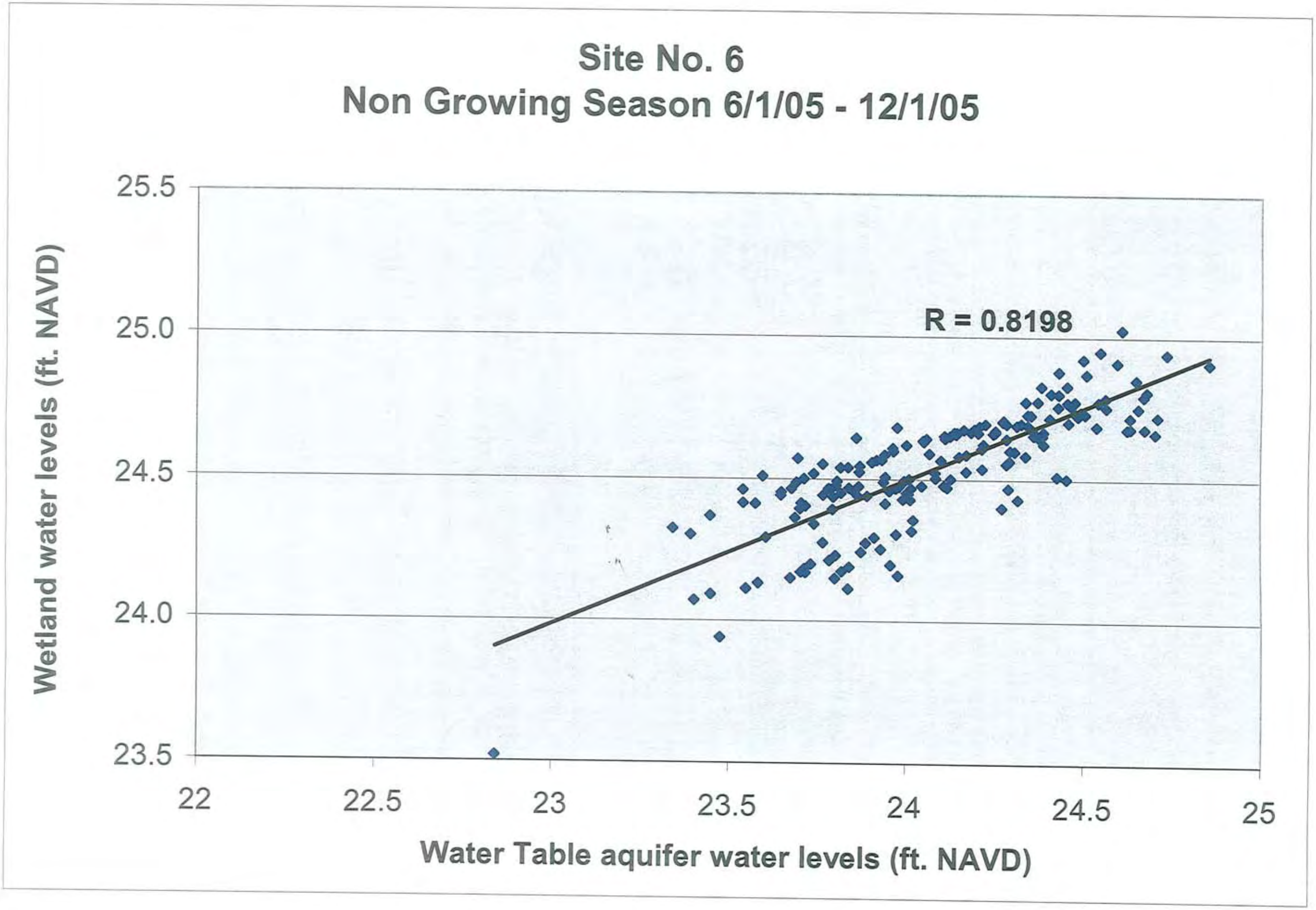


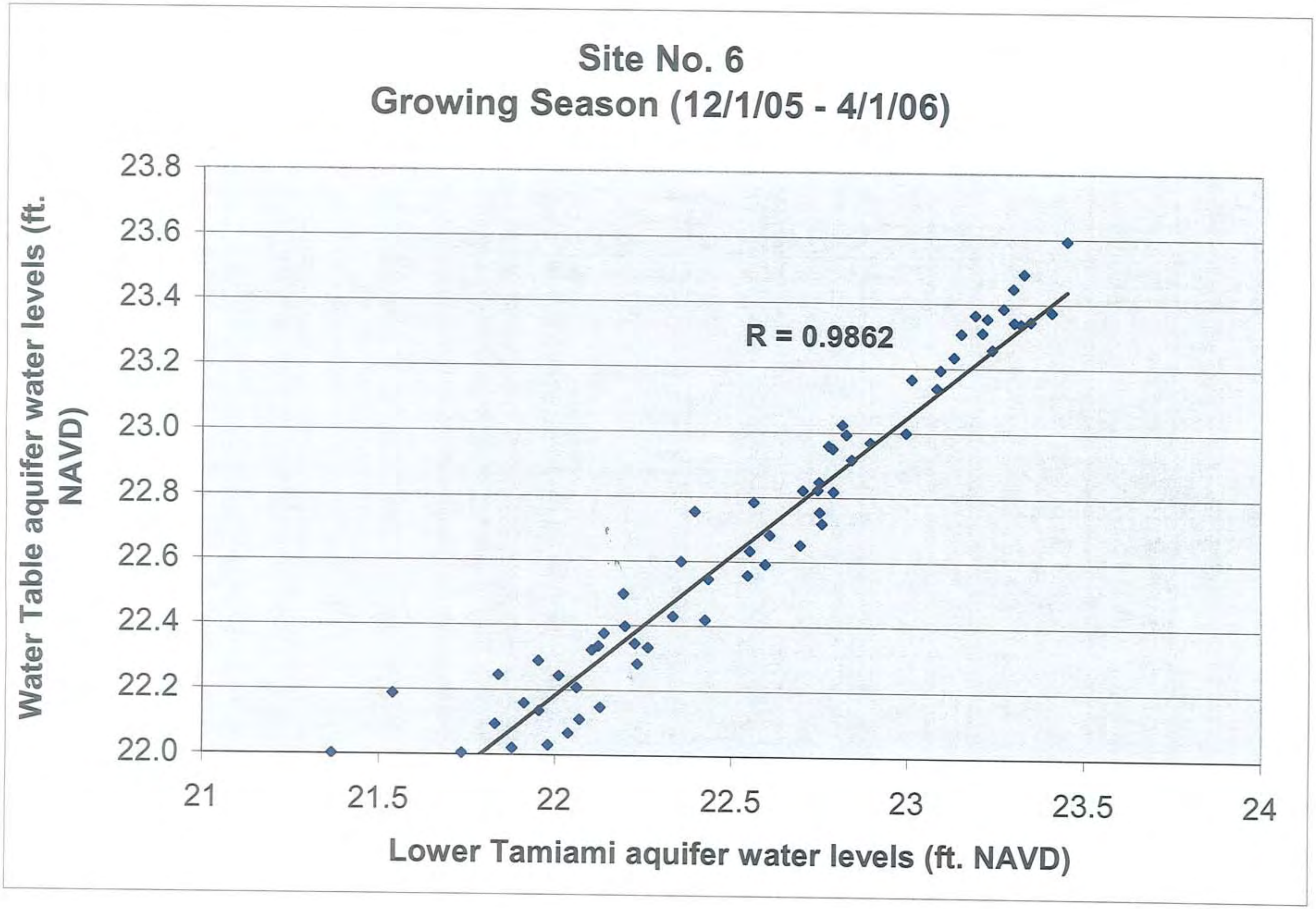
Site No. 6 Period of Record
R = 0.8659
Wetland water levels (ft.NAVD)
26
25
24
23
22
21
20
17
19
21
23
25
27
Water Table aquifer water levels (ft. NAVD)

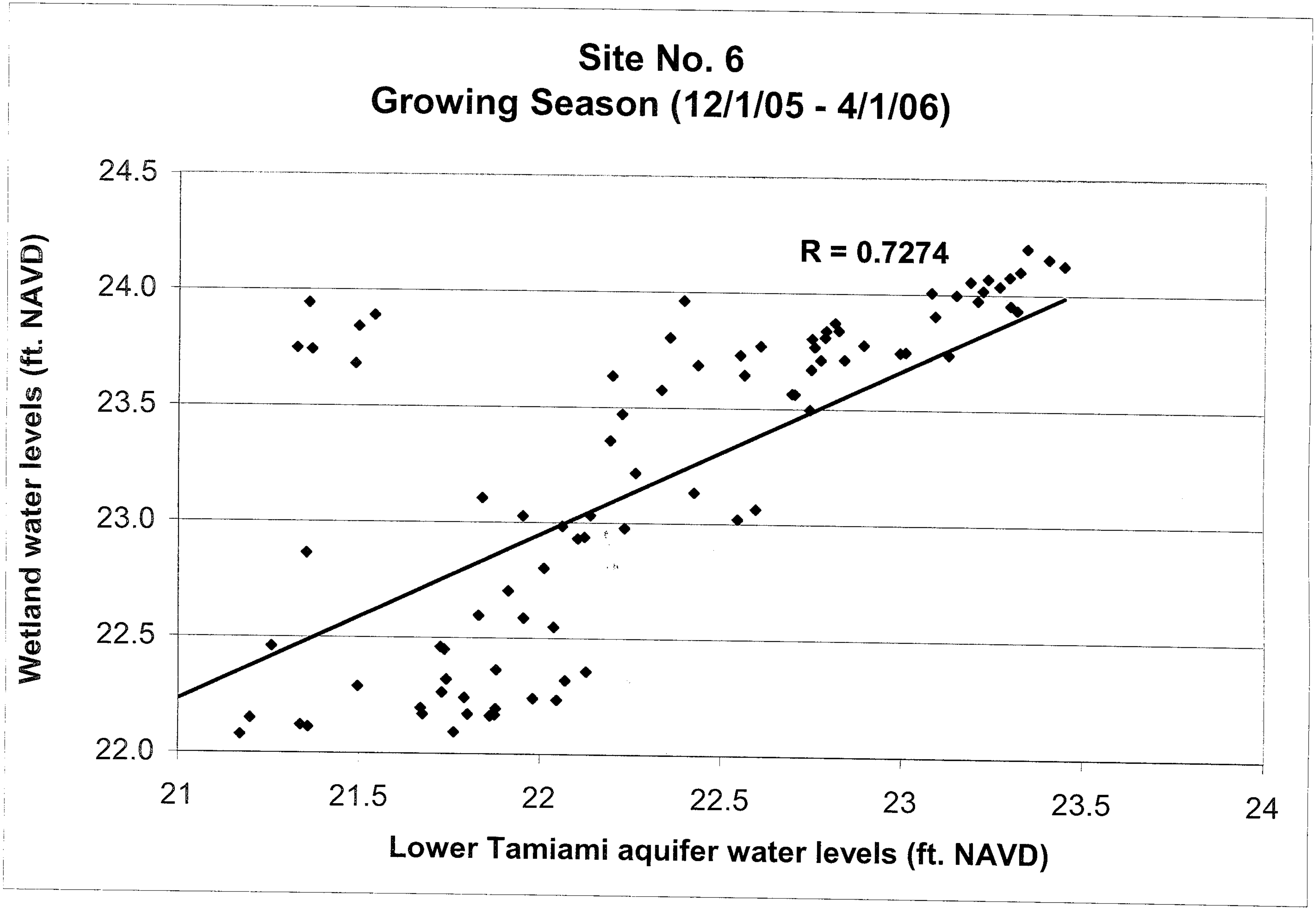


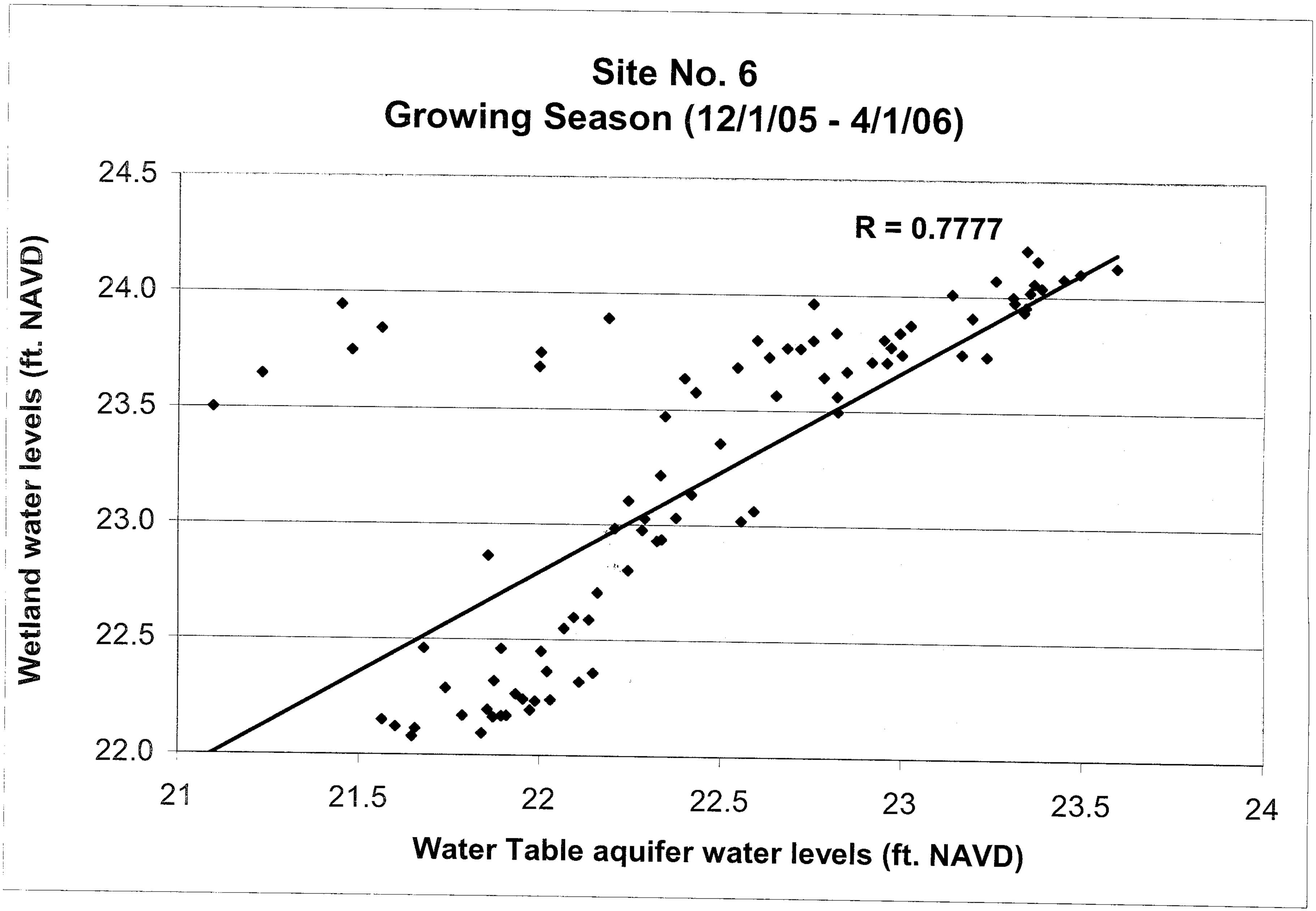
Site No. 6
Non Growing Season 6/1/05 - 12/1/05
R = 0.9917
Water Table aquifer water levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)
25.0
24.8
24.6
24.4
24.2
24.0
23.8
23.6
23.4
23.2
23.0
22
22.5
23
23.5
24
24.5
25


Site No. 6
Non Growing Season 6/1/05 - 12/1/05
R = 0.8101
Wetland water levels (ft. NAVD)
25.5
25.0
24.5
24.0
23.5
23.0
22
22.5
23
23.5
24
24.5
25
Lower Tamiami aquifer water levels (ft. NAVD)

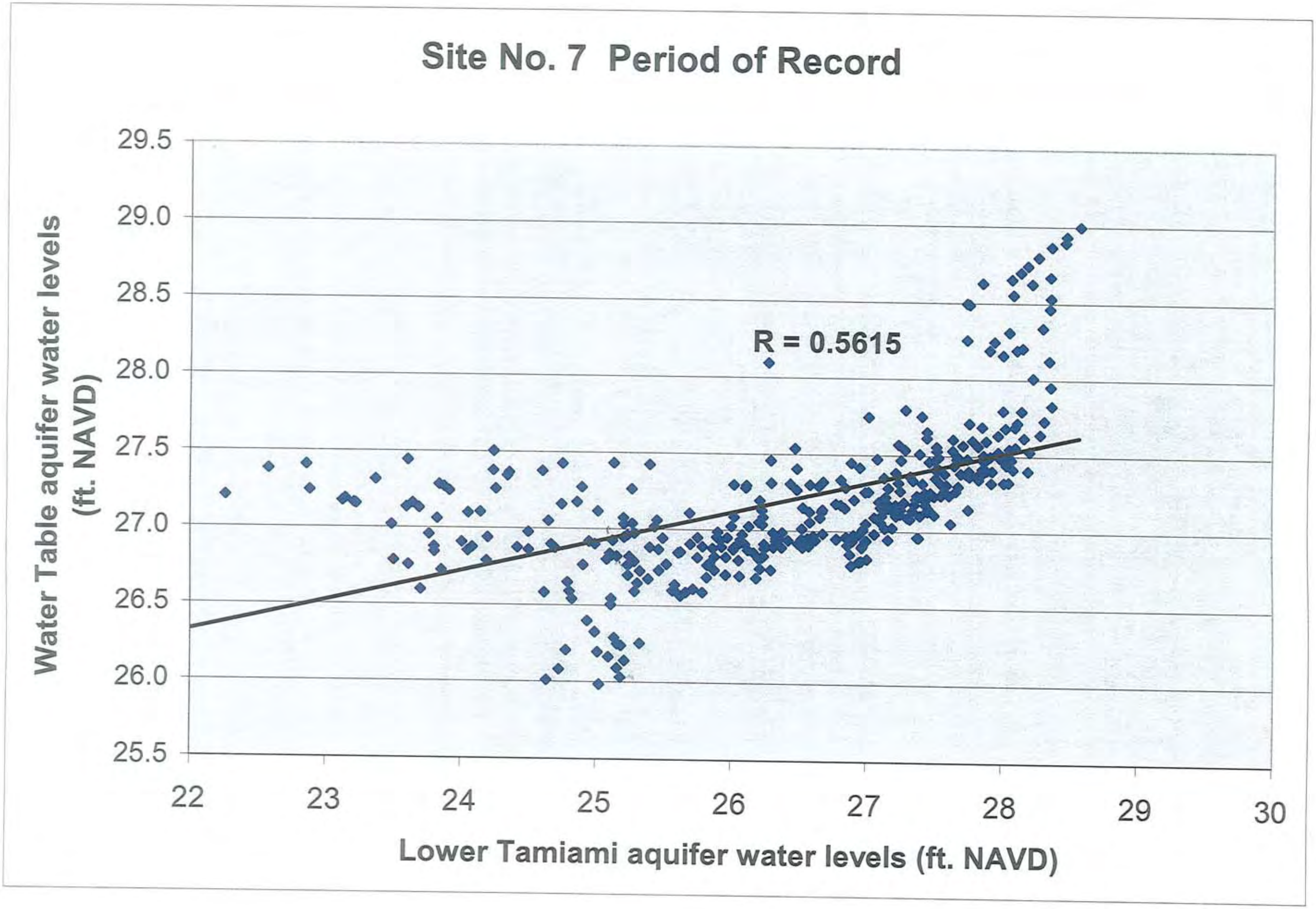

Site No. 6
Non Growing Season 6/1/05 - 12/1/05
R = 0.8198
Wetland water levels (ft. NAVD)
25.5
25.0
24.5
24.0
23.5
22
22.5
23
23.5
24
24.5
25
Water Table aquifer water levels (ft. NAVD)

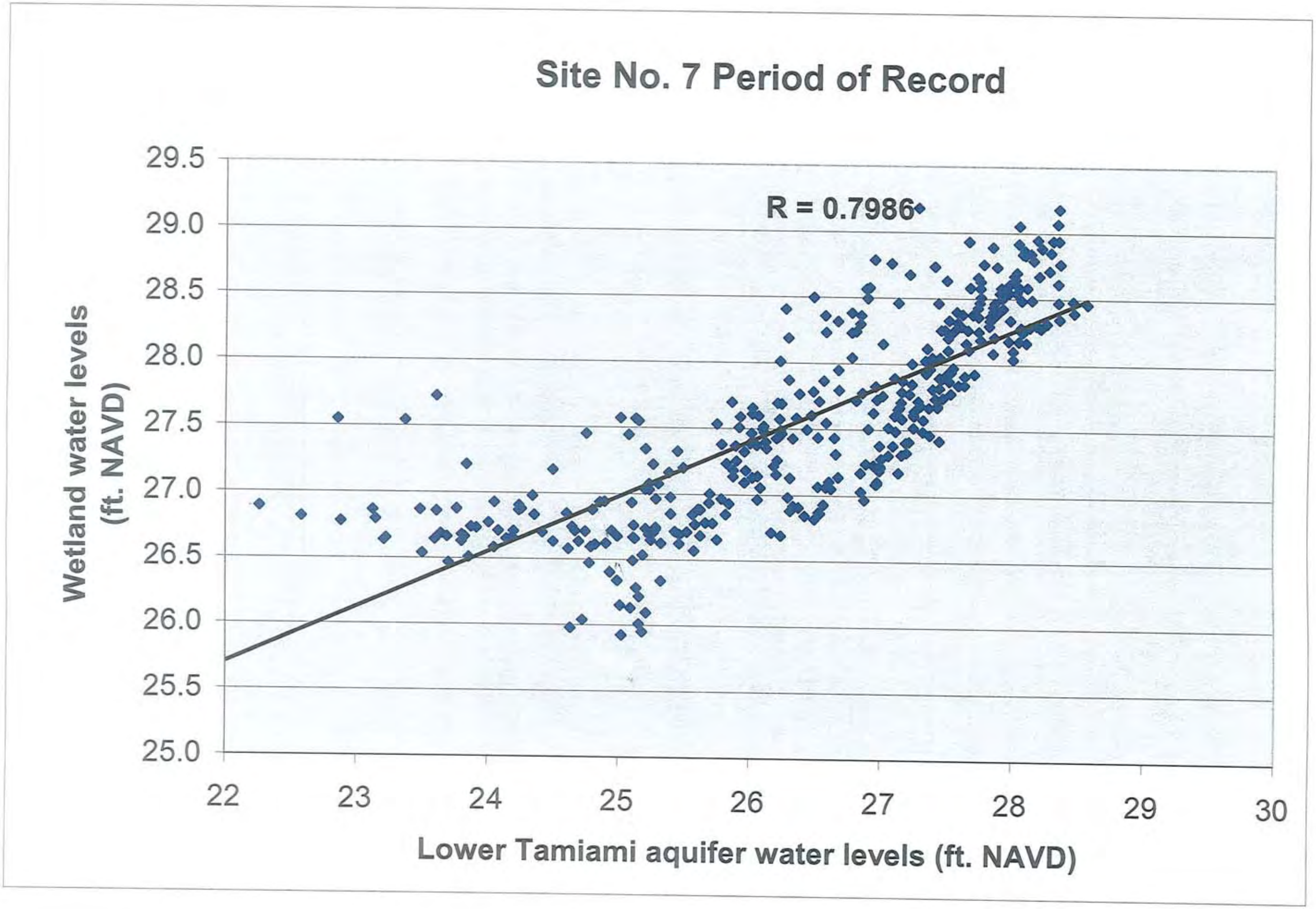

Site No. 6
Growing Season (12/1/05 - 4/1/06)
R = 0.9862
Water Table aquifer water levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)
23.8
23.6
23.4
23.2
23.0
22.8
22.6
22.4
22.2
22.0
21
21.5
22
22.5
23
23.5
24

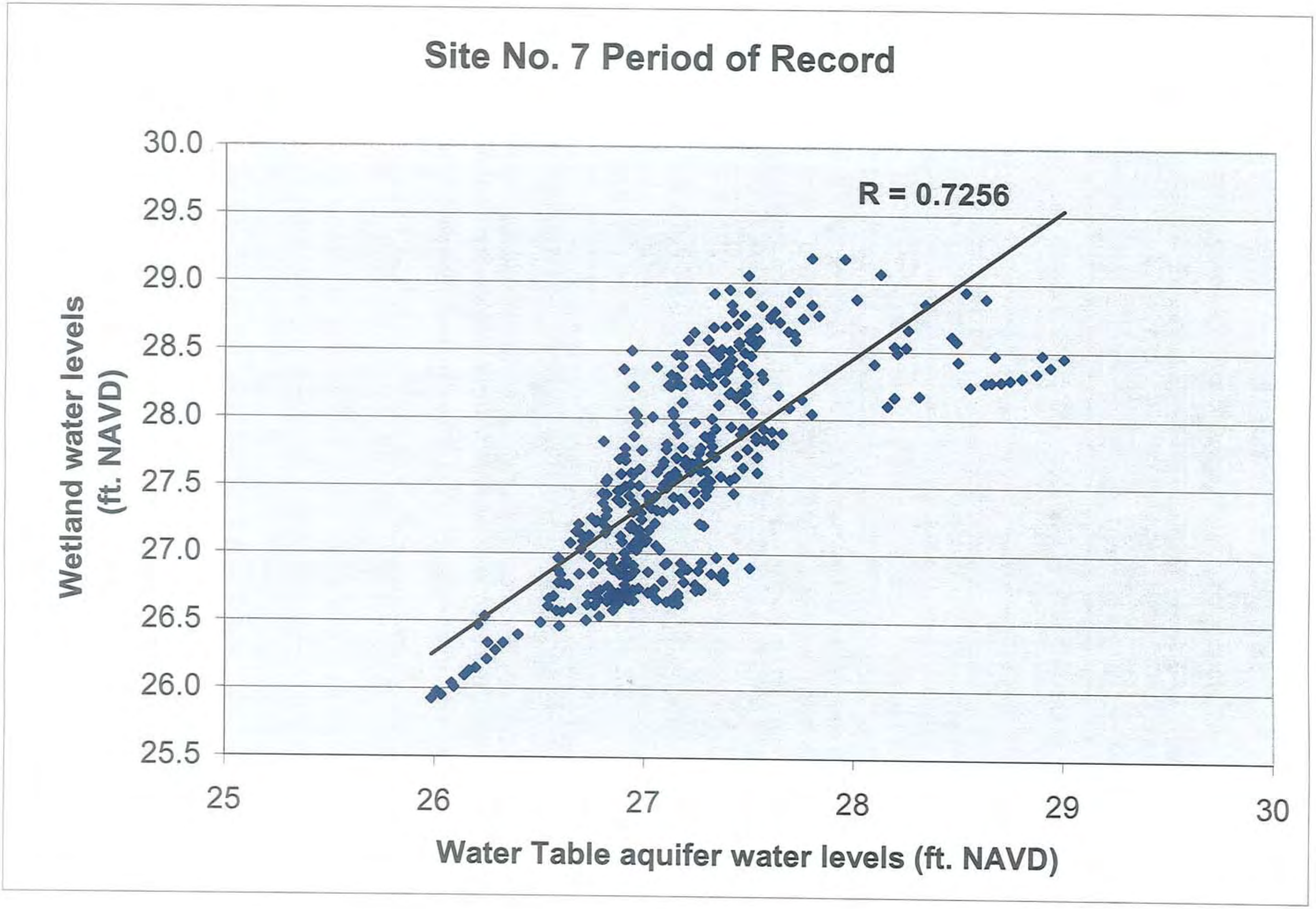

Site No. 6
Growing Season (12/1/05 - 4/1/06)
R = 0.7274
Wetland water levels (ft. NAVD)
24.5
24.0
23.5
23.0
22.5
22.0
21
21.5
22
22.5
23
23.5
24
Lower Tamiami aquifer water levels (ft. NAVD)

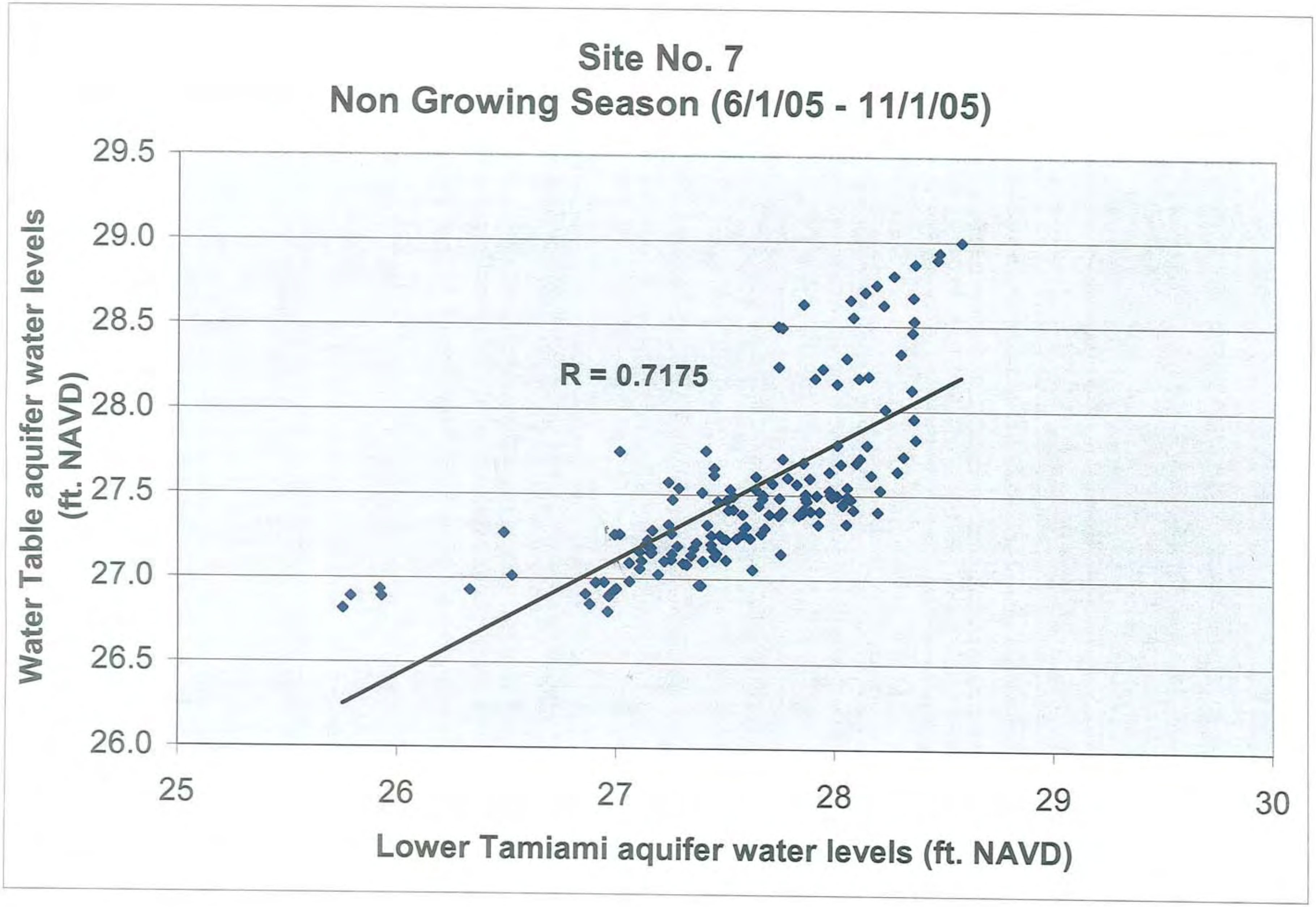


Site No. 6
Growing Season (12/1/05 - 4/1/06)
R = 0.7777
24.5
24.0
23.5
23.0
22.5
22.0
21
21.5
22
22.5
23
23.5
24
Wetland water levels (ft. NAVD)
Water Table aquifer water levels (ft. NAVD)

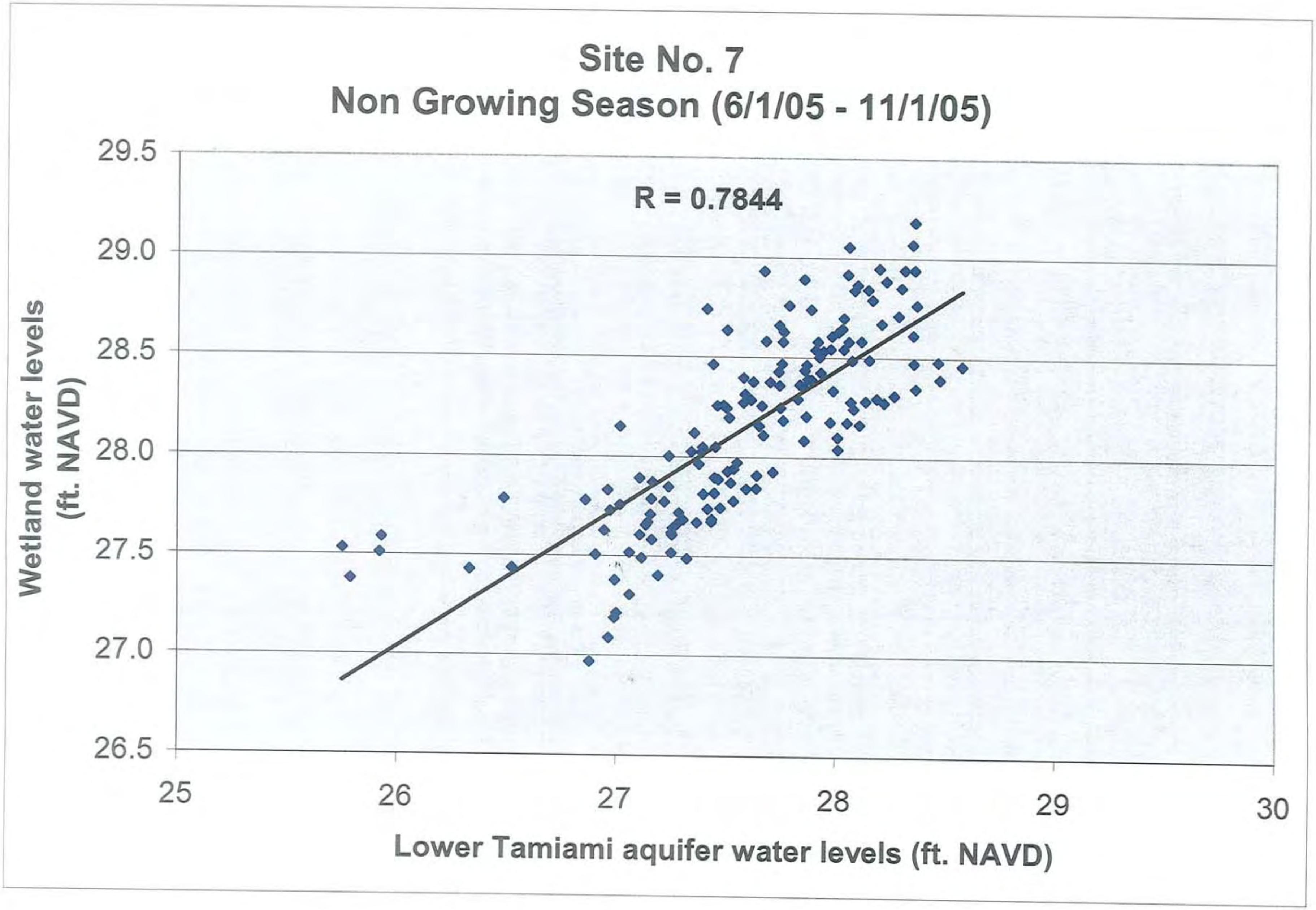

Site No. 7 Period of Record
R = 0.5615
Water Table aquifer water levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)
29.5
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25.5
22
23
24
25
26
27
28
29
30


Site No. 7 Period of Record
R = 0.7986
Wetland water levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)
29.5
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25.5
25.0
22
23
24
25
26
27
28
29
30

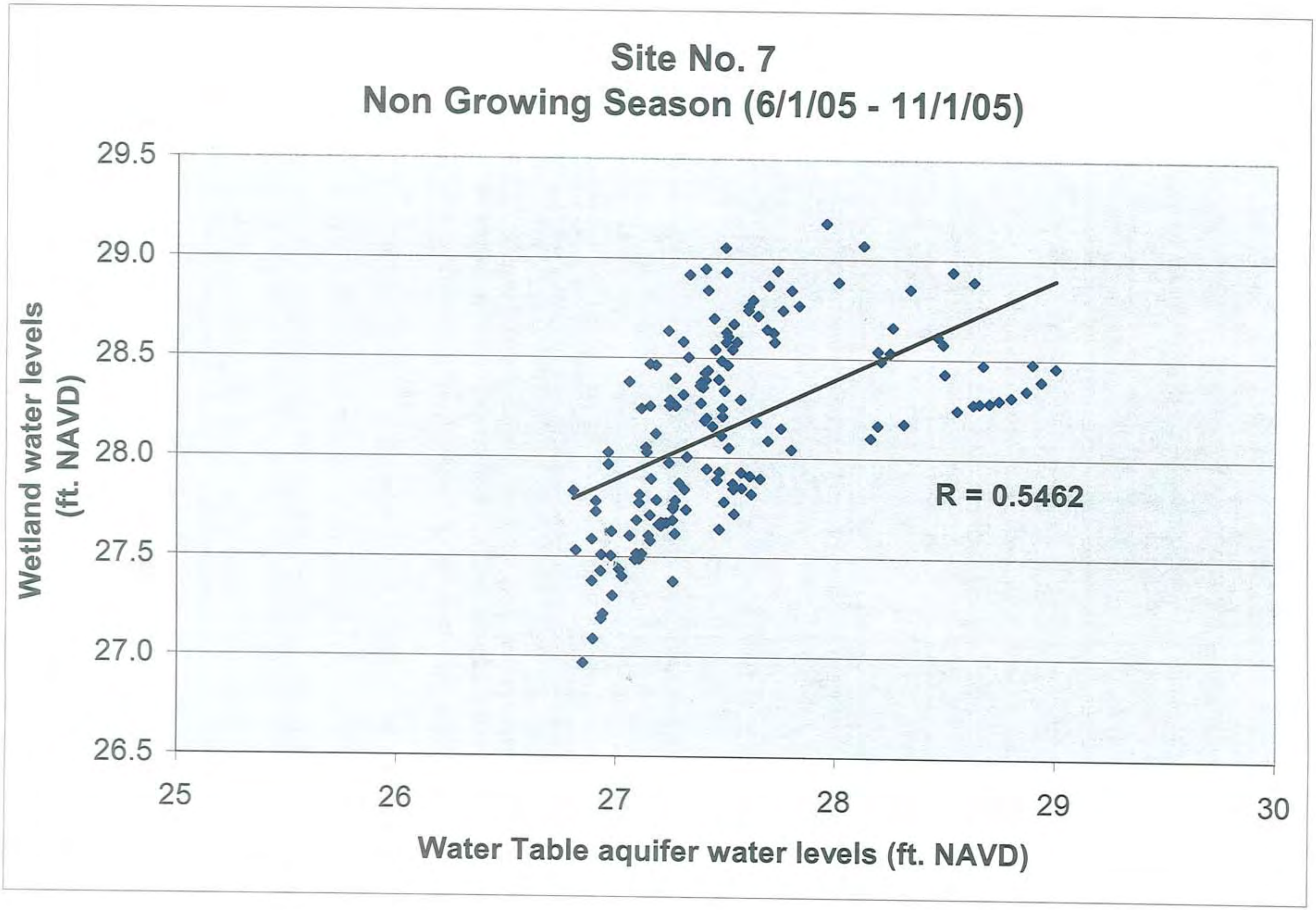

Site No. 7 Period of Record
R = 0.7256
Wetland water levels (ft. NAVD)
30.0
29.5
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25.5
25
26
27
28
29
30
Water Table aquifer water levels (ft. NAVD)



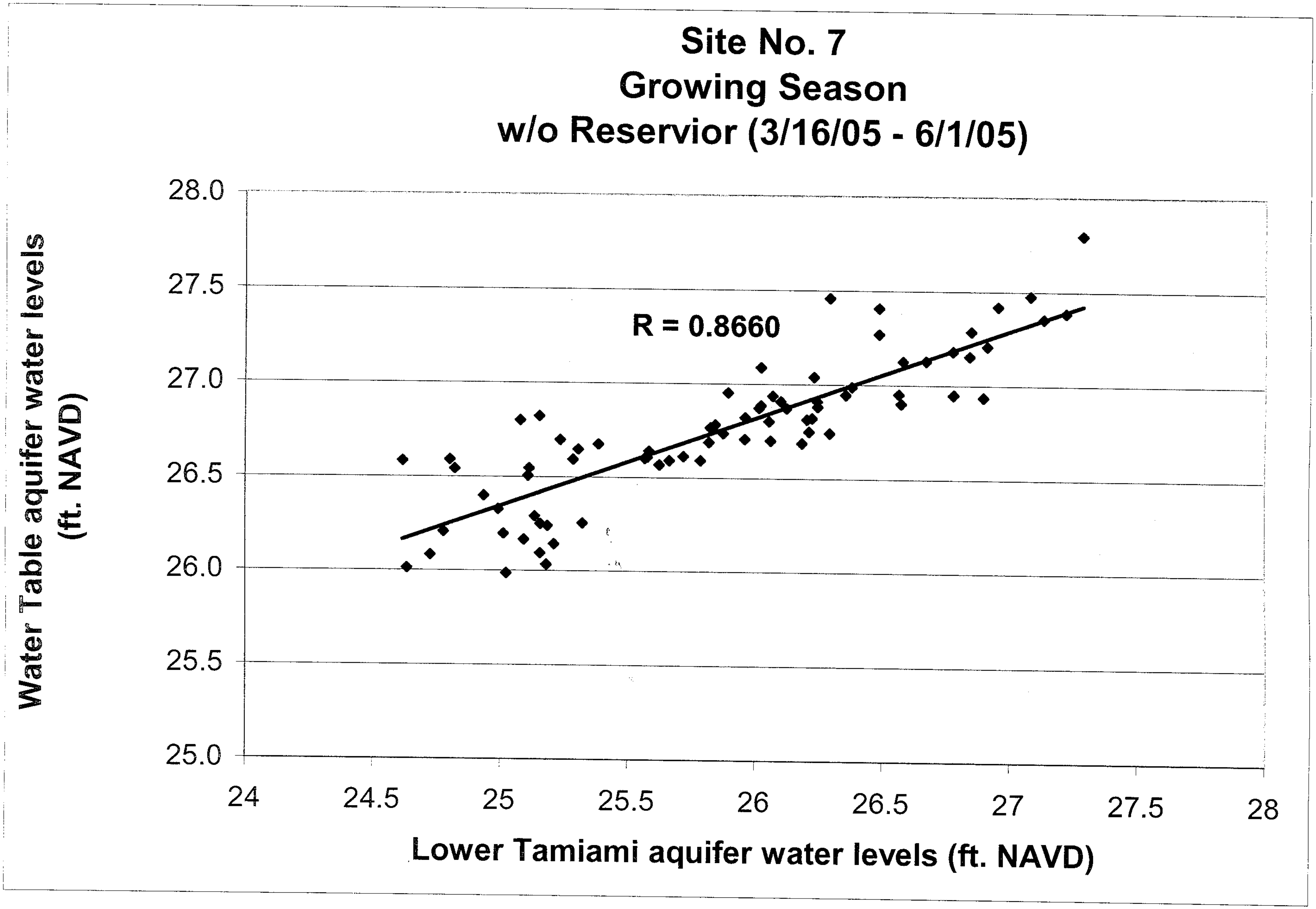
Site No. 7
Non Growing Season (6/1/05 - 11/1/05)
R = 0.7175
Water Table aquifer water levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)
29.5
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25
26
27
28
29
30



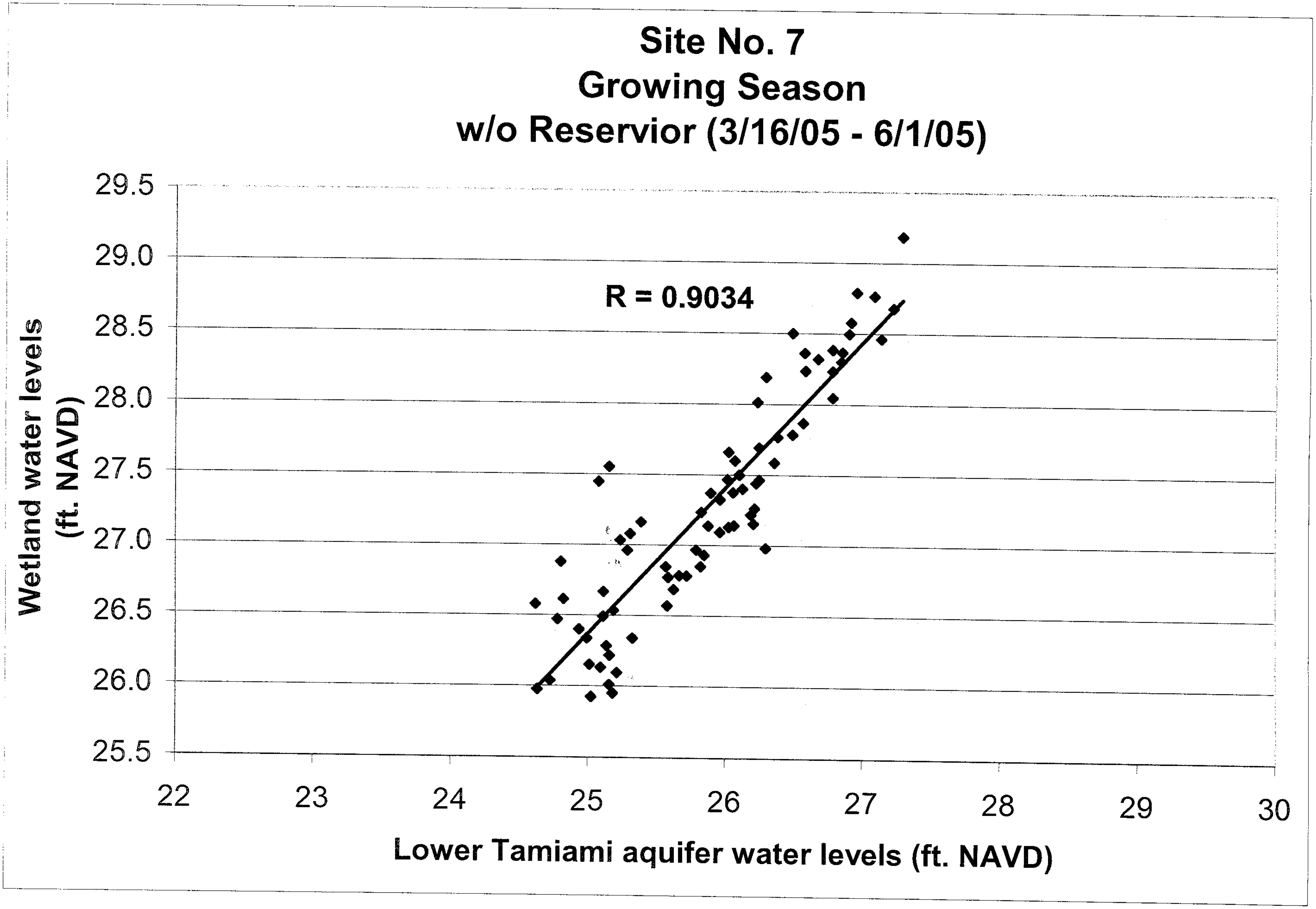
Site No. 7
Non Growing Season (6/1/05 - 11/1/05)
R = 0.7844
Wetland water levels (ft. NAVD)
29.5
29.0
28.5
28.0
27.5
27.0
26.5
25
26
27
28
29
30
Lower Tamiami aquifer water levels (ft. NAVD)



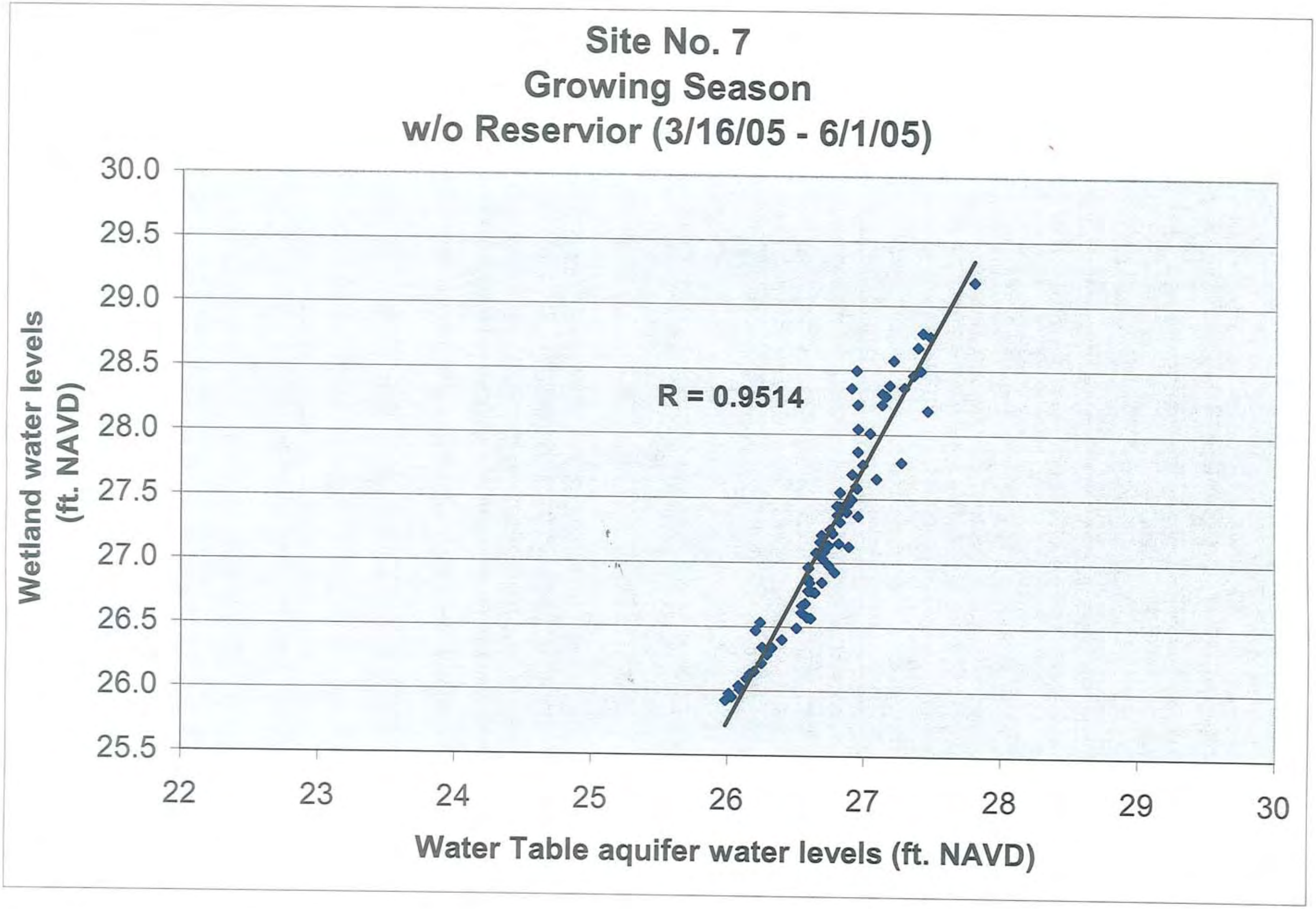
Site No. 7
Non Growing Season (6/1/05 - 11/1/05)
29.5
29.0
28.5
28.0
27.5
27.0
26.5
25
26
27
28
29
30
Wetland water levels
(ft. NAVD)
Water Table aquifer water levels (ft. NAVD)
R = 0.5462



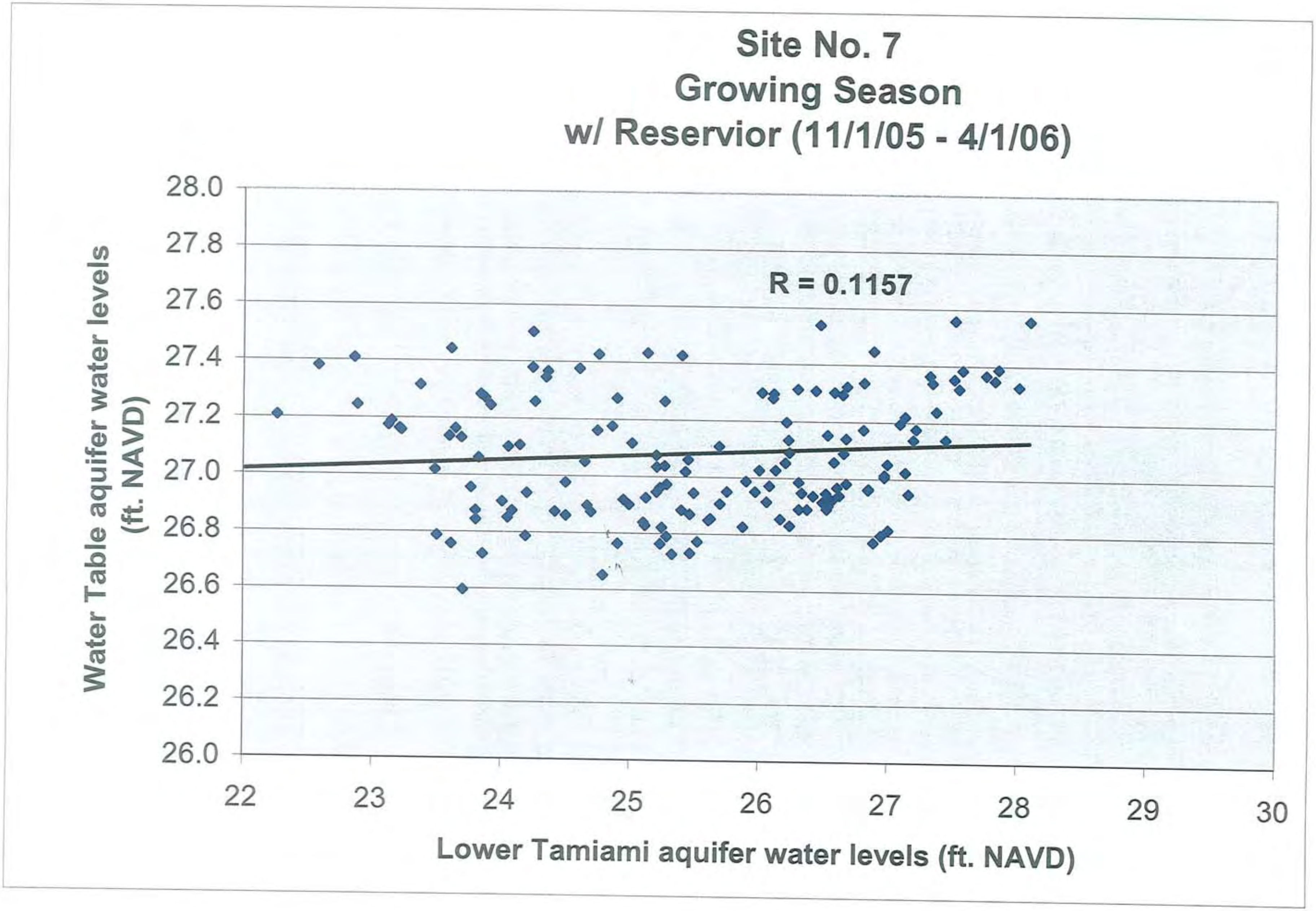
Site No. 7
Growing Season
w/o Reservior (3/16/05 - 6/1/05)
R = 0.8660
28.0
27.5
27.0
26.5
26.0
25.5
25.0
24
24.5
25
25.5
26
26.5
27
27.5
28
Water Table aquifer water levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)



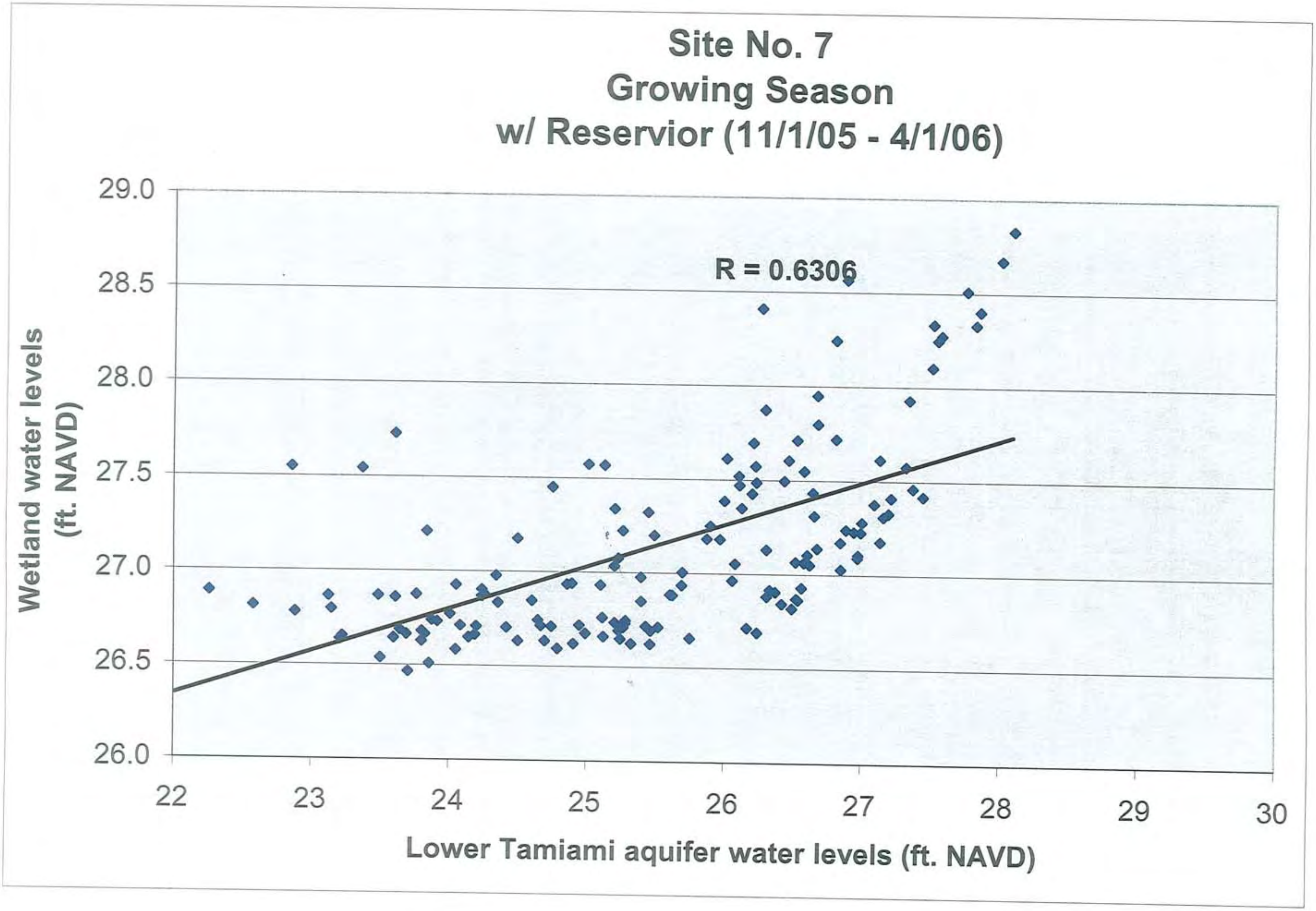
Site No. 7
Growing Season
w/o Reservior (3/16/05 - 6/1/05)
R = 0.9034
Wetland water levels (ft. NAVD)
29.5
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25.5
22
23
24
25
26
27
28
29
30
Lower Tamiami aquifer water levels (ft. NAVD)

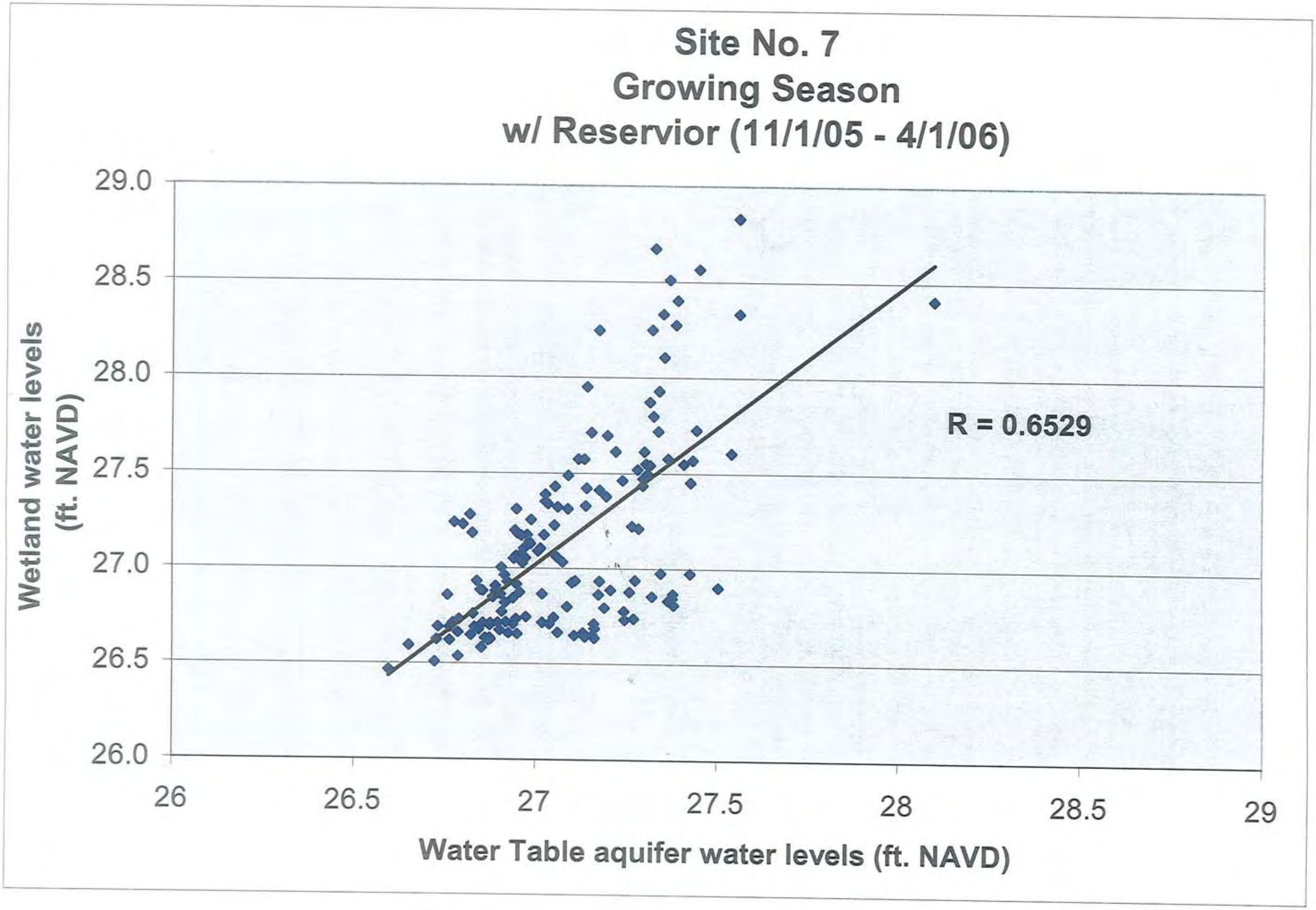


Site No. 7
Growing Season
w/o Reservior (3/16/05 - 6/1/05)
R = 0.9514
30.0
29.5
29.0
28.5
28.0
27.5
27.0
26.5
26.0
25.5
Wetland water levels (ft. NAVD)
22
23
24
25
26
27
28
29
30
Water Table aquifer water levels (ft. NAVD)



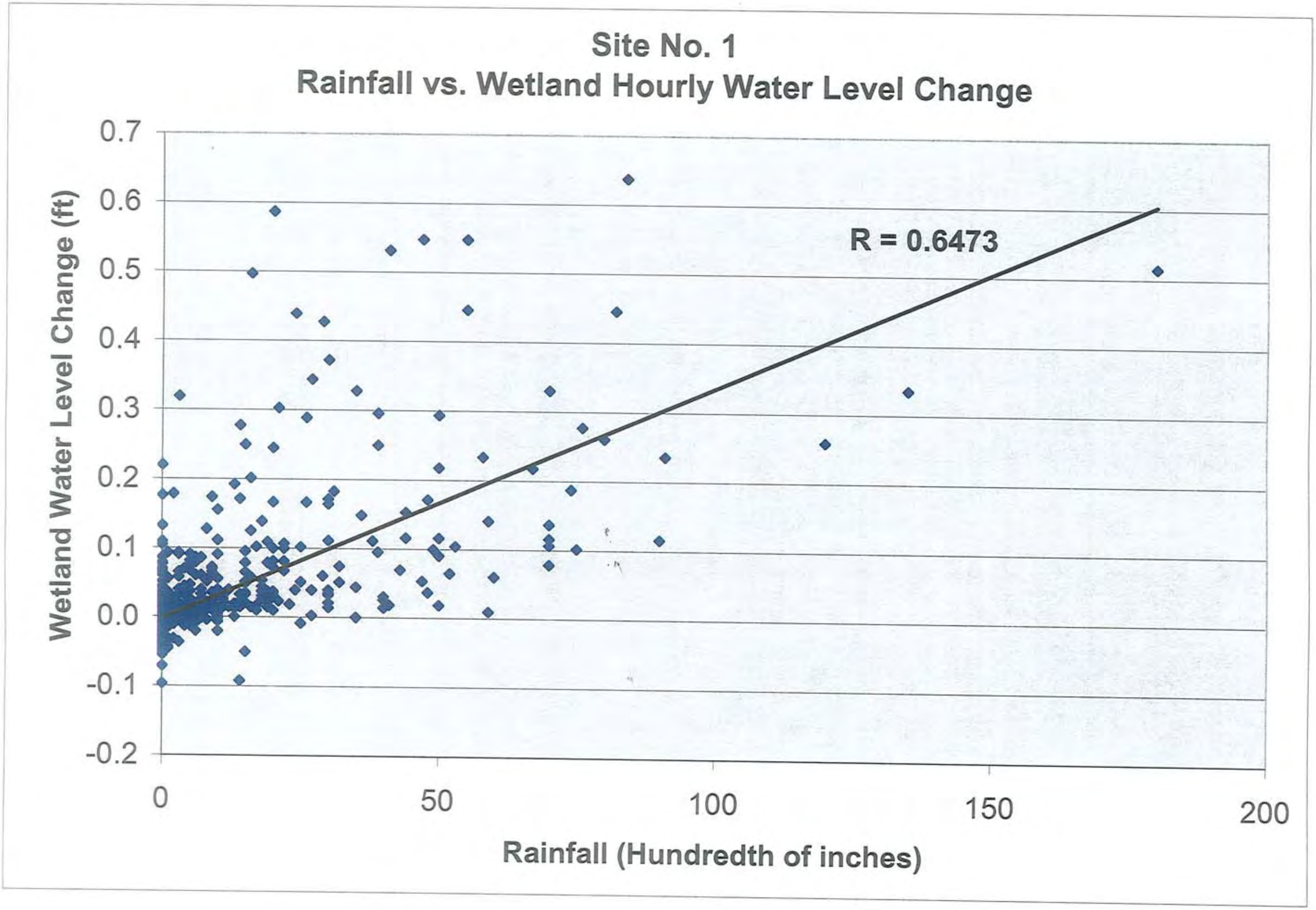
Site No. 7
Growing Season
w/ Reservior (11/1/05 - 4/1/06)
R = 0.1157
Water Table aquifer water levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)
28.0
27.8
27.6
27.4
27.2
27.0
26.8
26.6
26.4
26.2
26.0
22
23
24
25
26
27
28
29
30


Site No. 7
Growing Season
w/ Reservior (11/1/05 - 4/1/06)
R = 0.6306
Wetland water levels (ft. NAVD)
Lower Tamiami aquifer water levels (ft. NAVD)
29.0
28.5
28.0
27.5
27.0
26.5
26.0
22
23
24
25
26
27
28
29
30

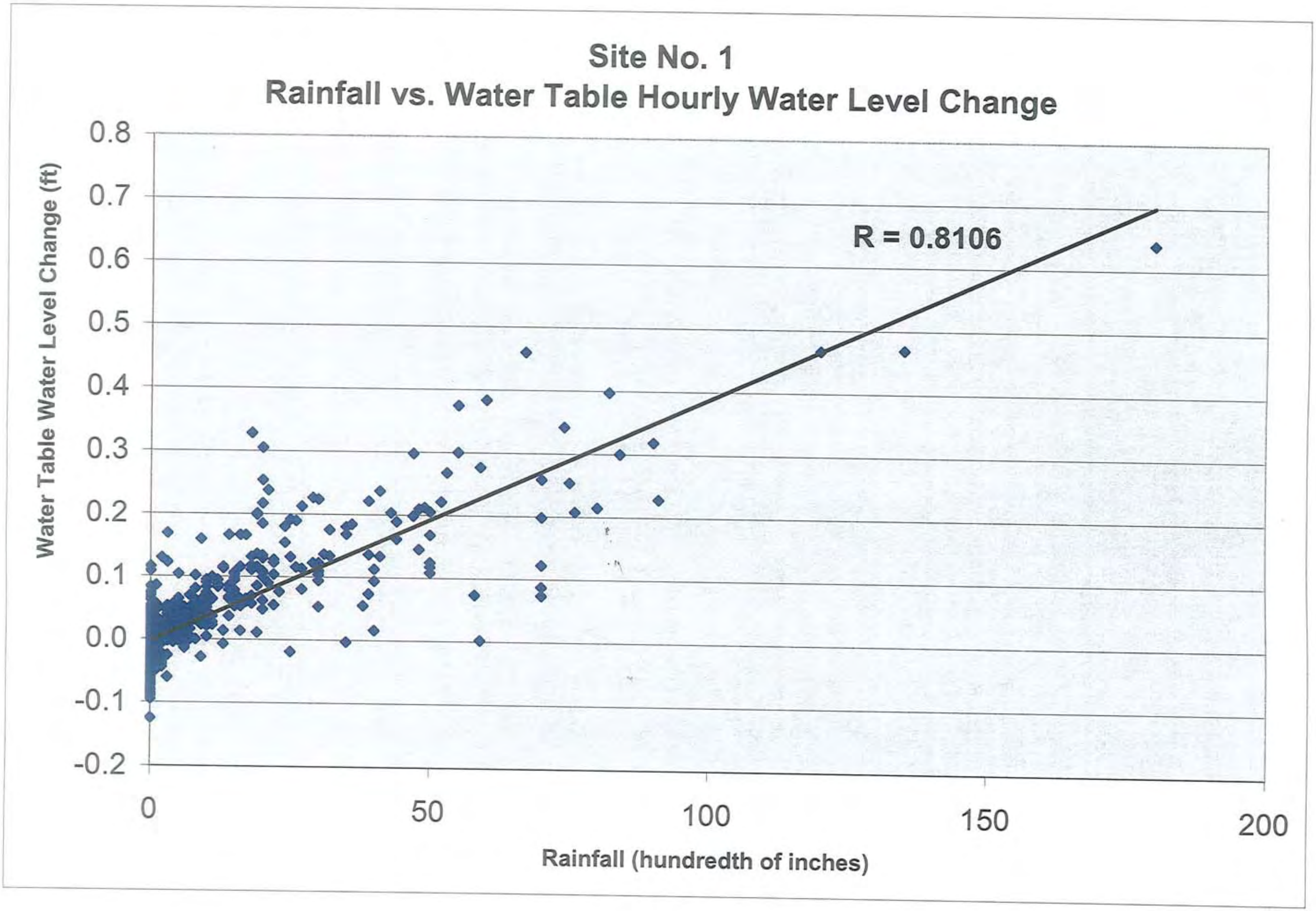

Site No. 7
Growing Season
w/ Reservior (11/1/05 - 4/1/06)
29.0
28.5
28.0
27.5
27.0
26.5
26.0
Wetland water levels (ft. NAVD)
R = 0.6529
26
26.5
27
27.5
28
28.5
29
Water Table aquifer water levels (ft. NAVD)

Appendix D

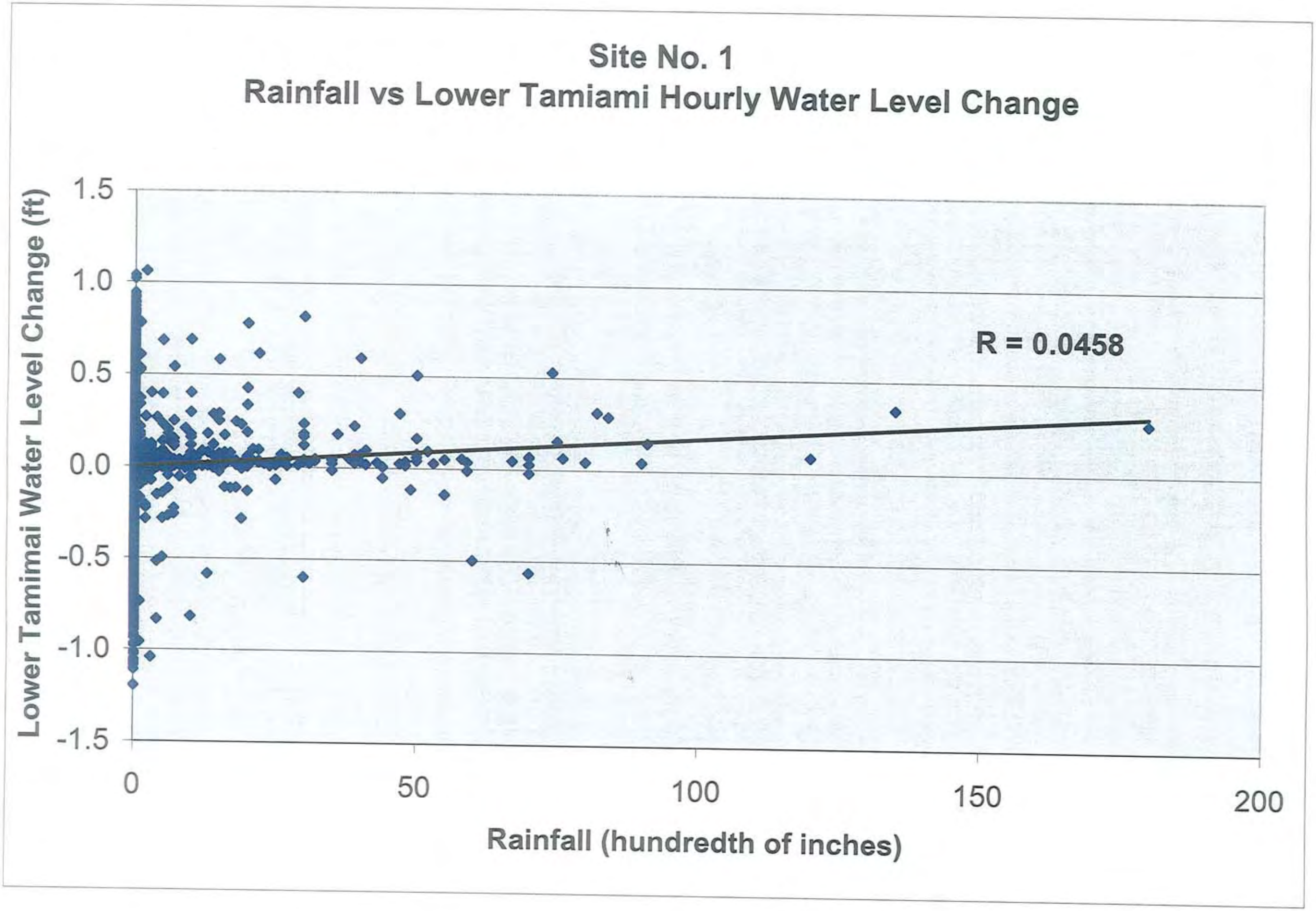
Rainfall Correlation Plots



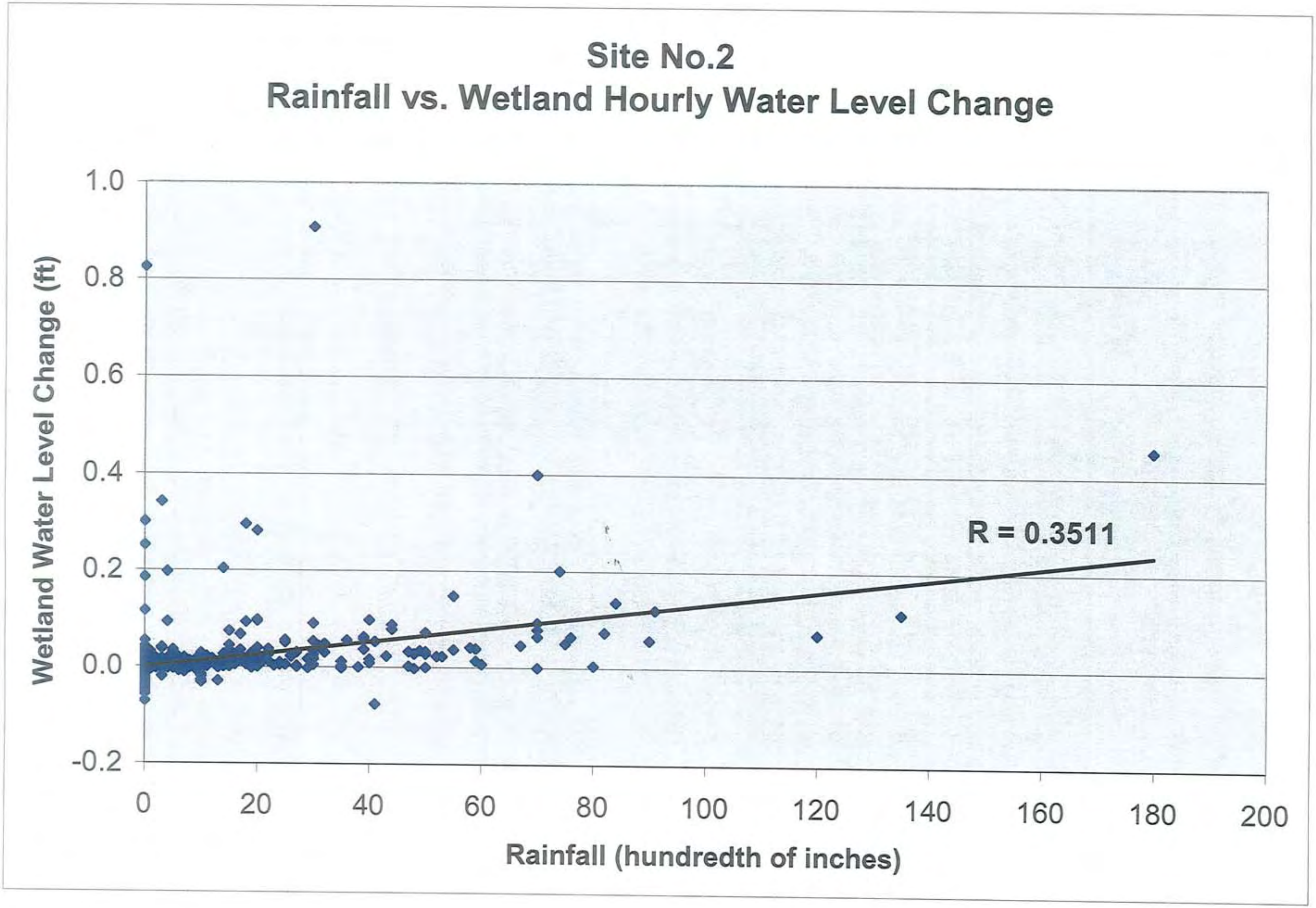
Site No. 1
Rainfall vs. Wetland Hourly Water Level Change
R = 0.6473
Wetland Water Level Change (ft)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
0
50
100
150
200
Rainfall (Hundredth of inches)

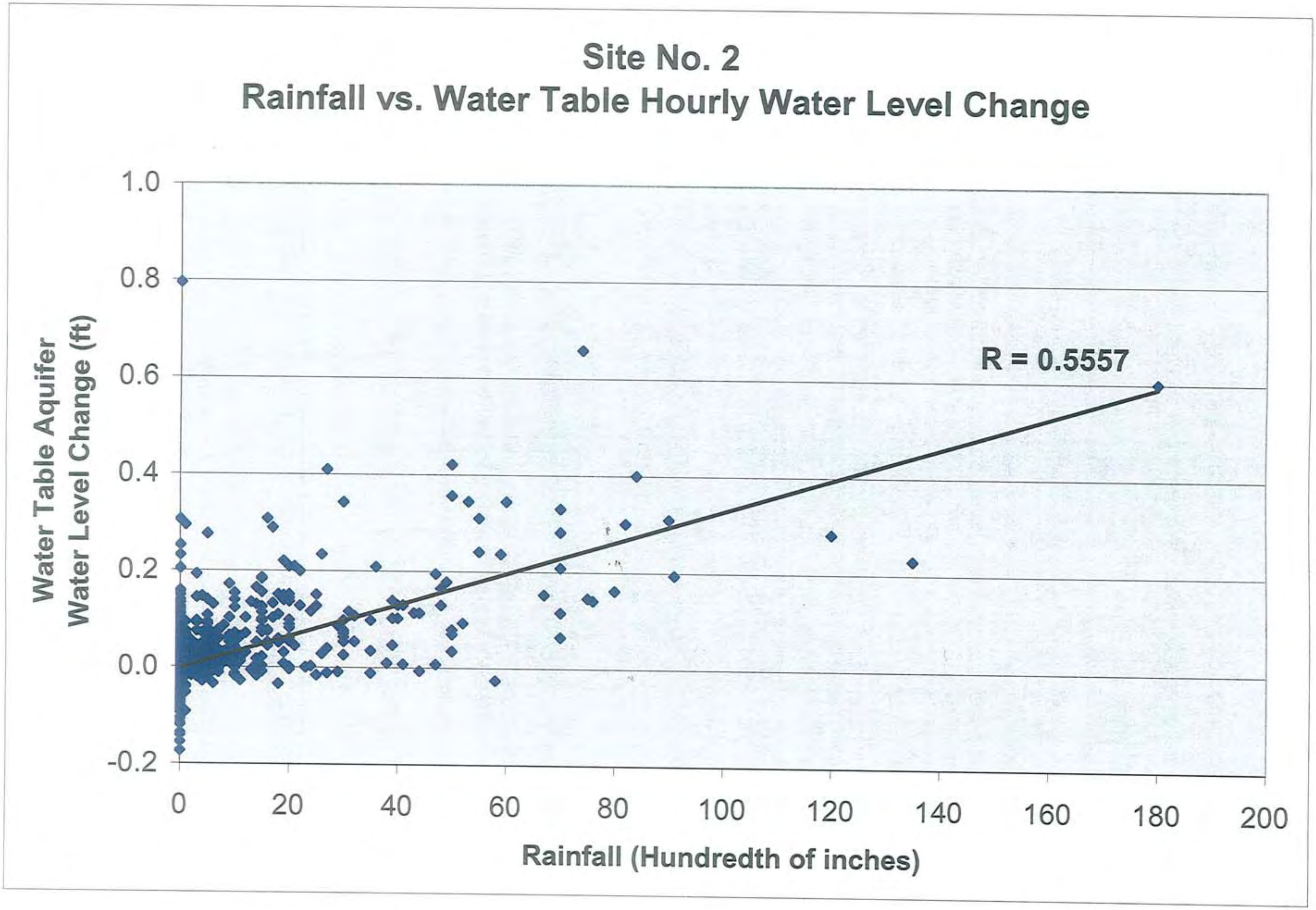


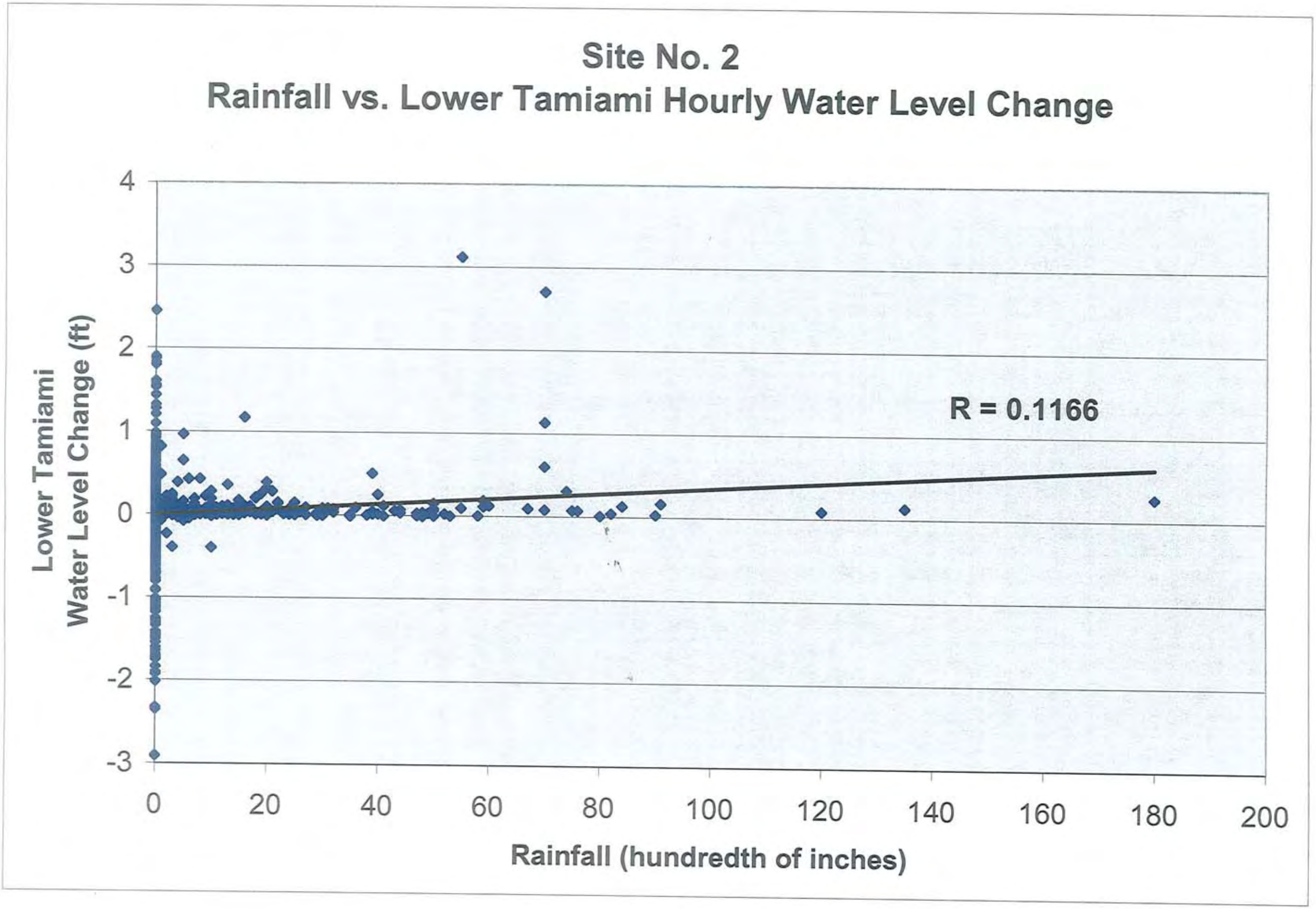
Site No. 1
Rainfall vs. Water Table Hourly Water Level Change
R = 0.8106
Water Table Water Level Change (ft)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
0
50
100
150
200
Rainfall (hundredth of inches)

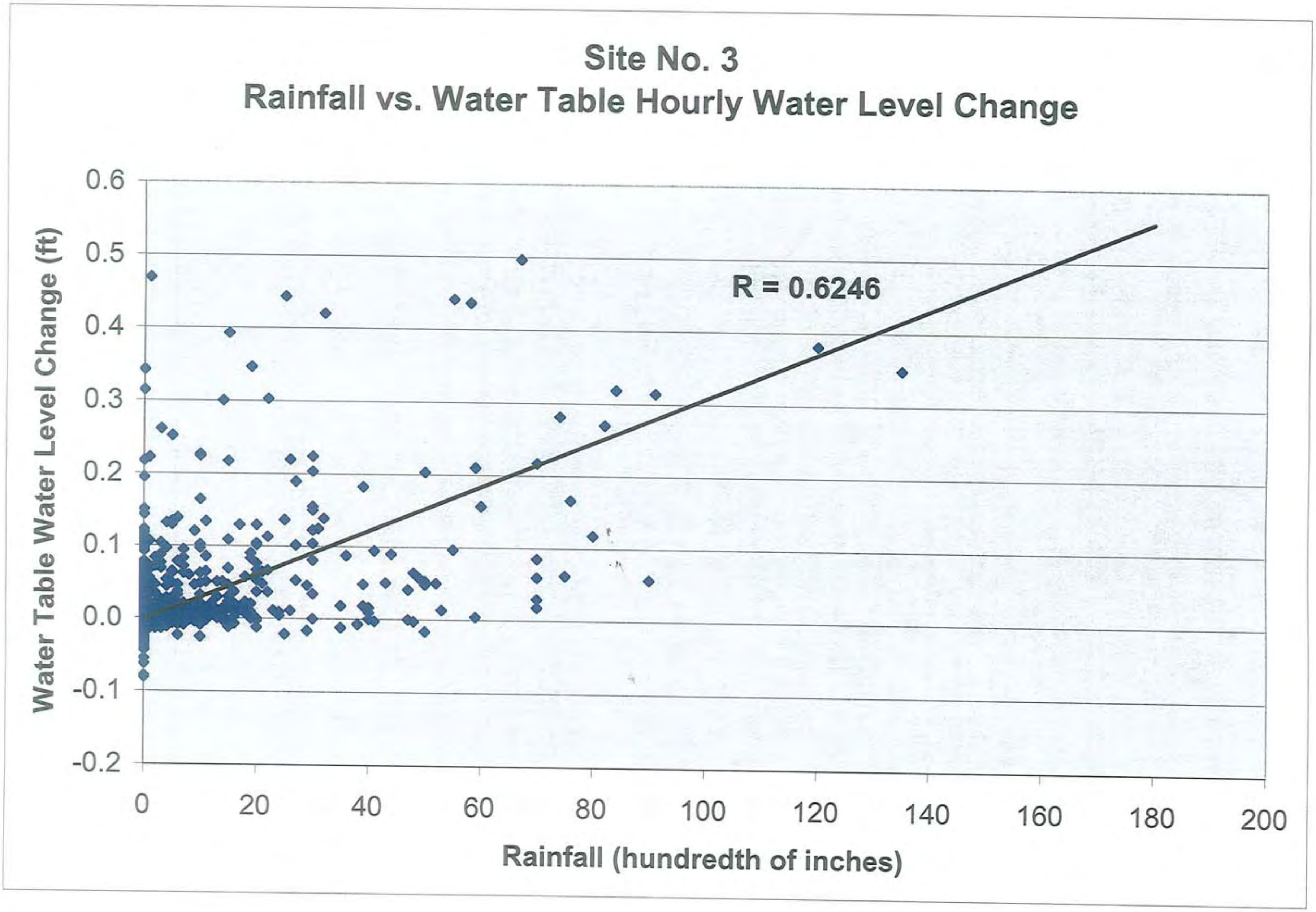


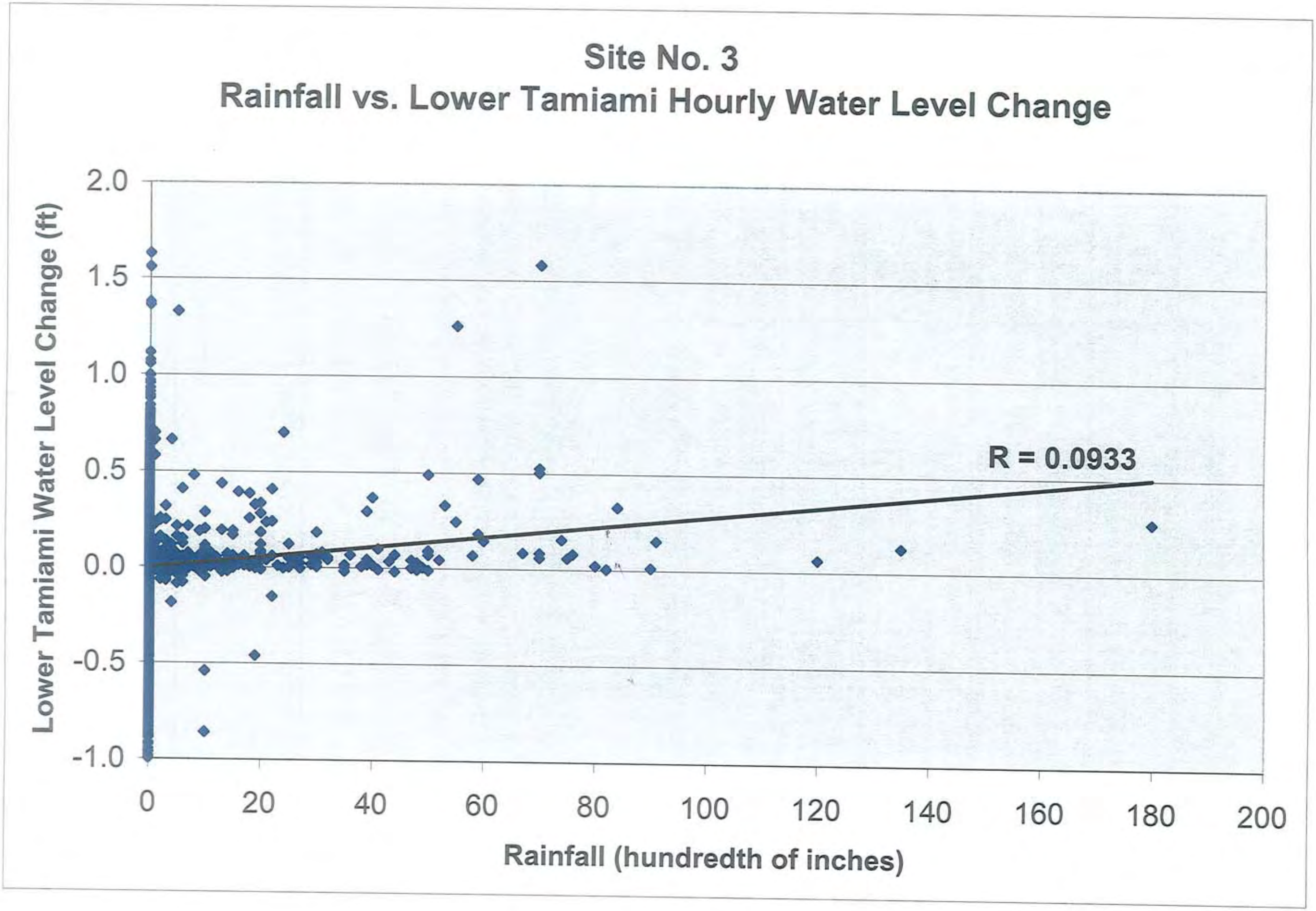
Site No. 1
Rainfall vs Lower Tamiami Hourly Water Level Change
R = 0.0458
Lower Tamimai Water Level Change (ft)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
50
100
150
200
Rainfall (hundredth of inches)


Site No.2
Rainfall vs. Wetland Hourly Water Level Change
Wetland Water Level Change (ft)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
R = 0.3511
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)

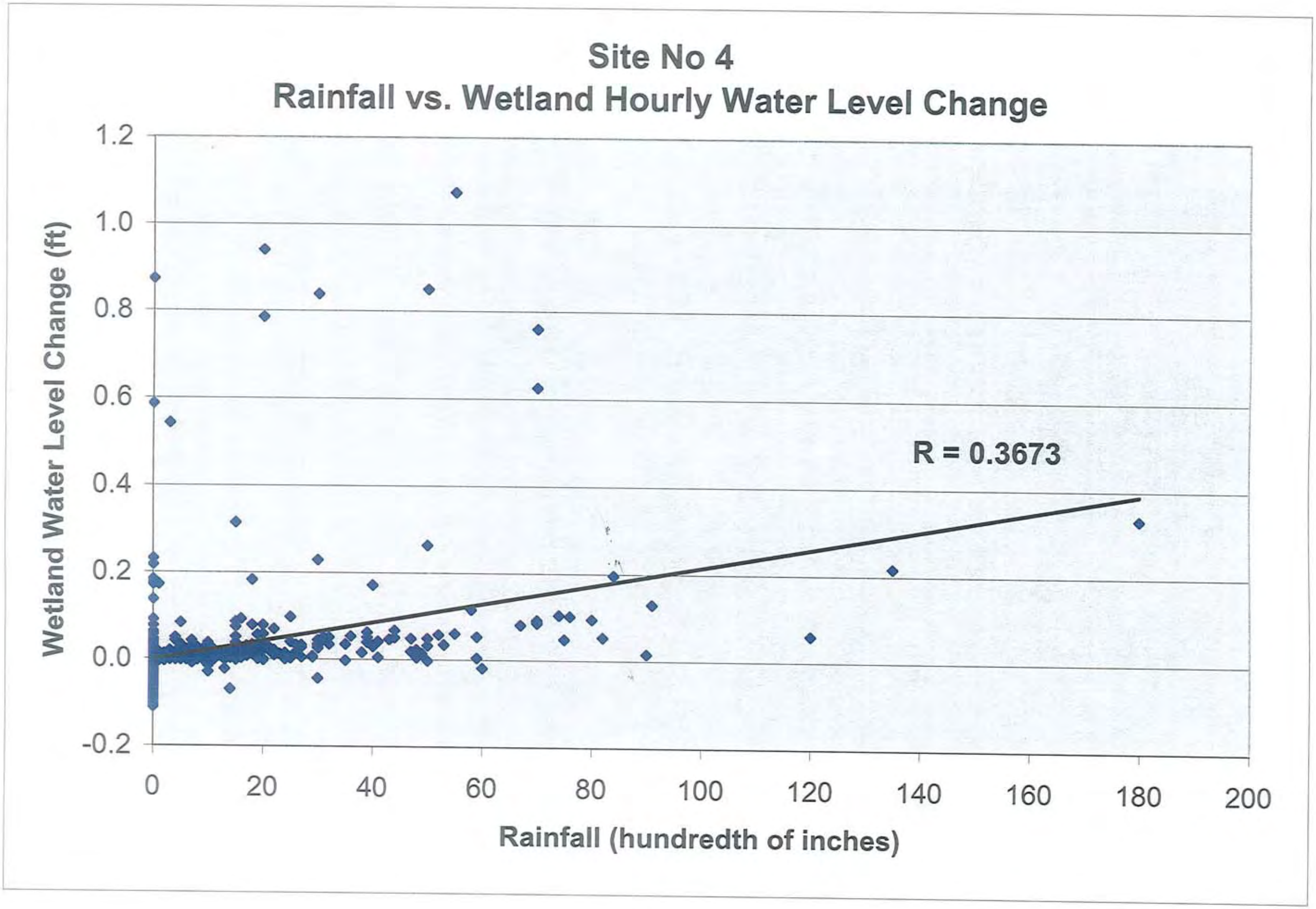

Site No. 2
Rainfall vs. Water Table Hourly Water Level Change
Water Table Aquifer
Water Level Change (ft)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
R = 0.5557
0
20
40
60
80
100
120
140
160
180
200
Rainfall (Hundredth of inches)


Site No. 2
Rainfall vs. Lower Tamiami Hourly Water Level Change
Lower Tamiami
Water Level Change (ft)
R = 0.1166
4
3
2
1
0
-1
-2
-3
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)

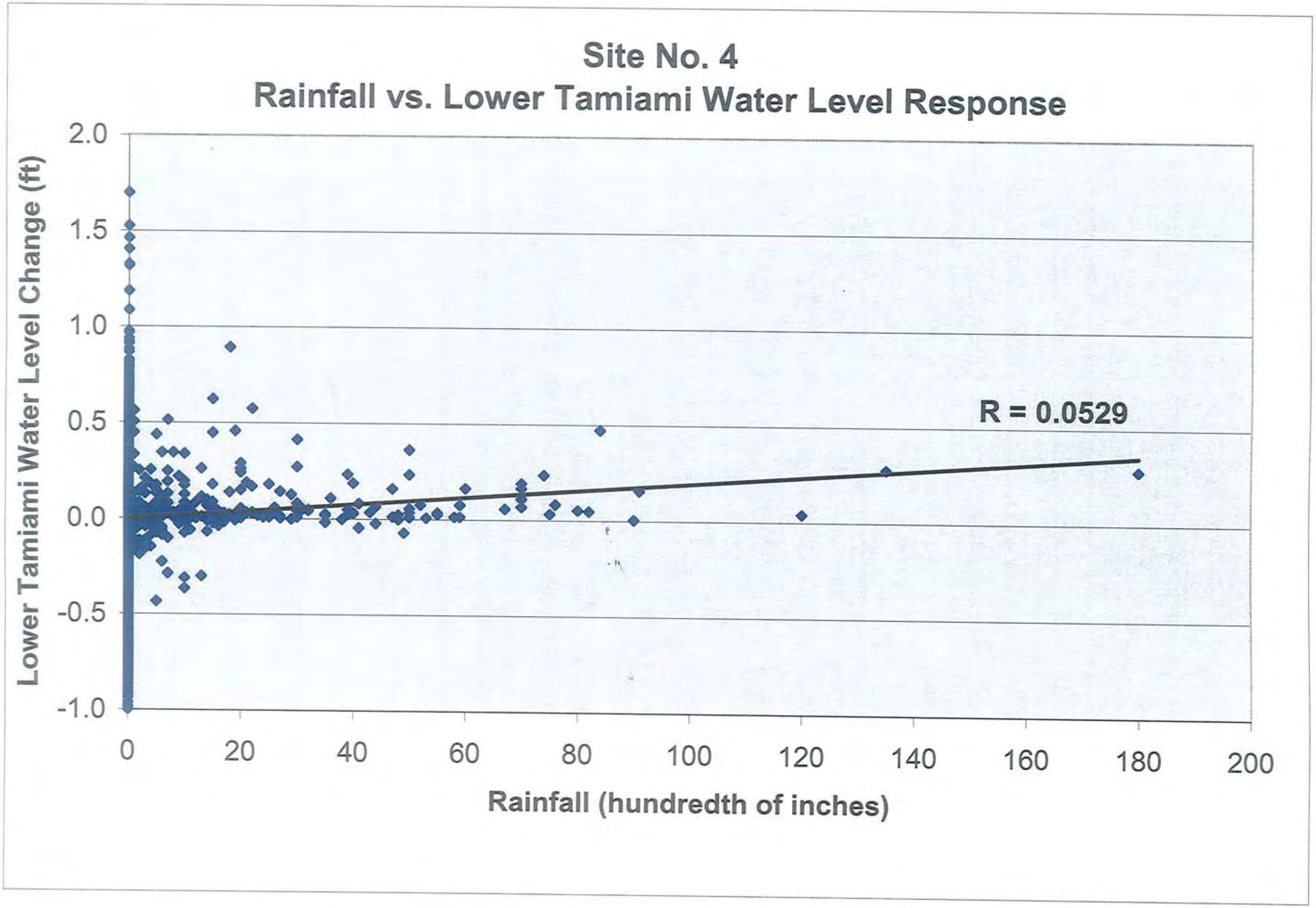

Site No. 3
Rainfall vs. Water Table Hourly Water Level Change
R = 0.6246
Water Table Water Level Change (ft)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)

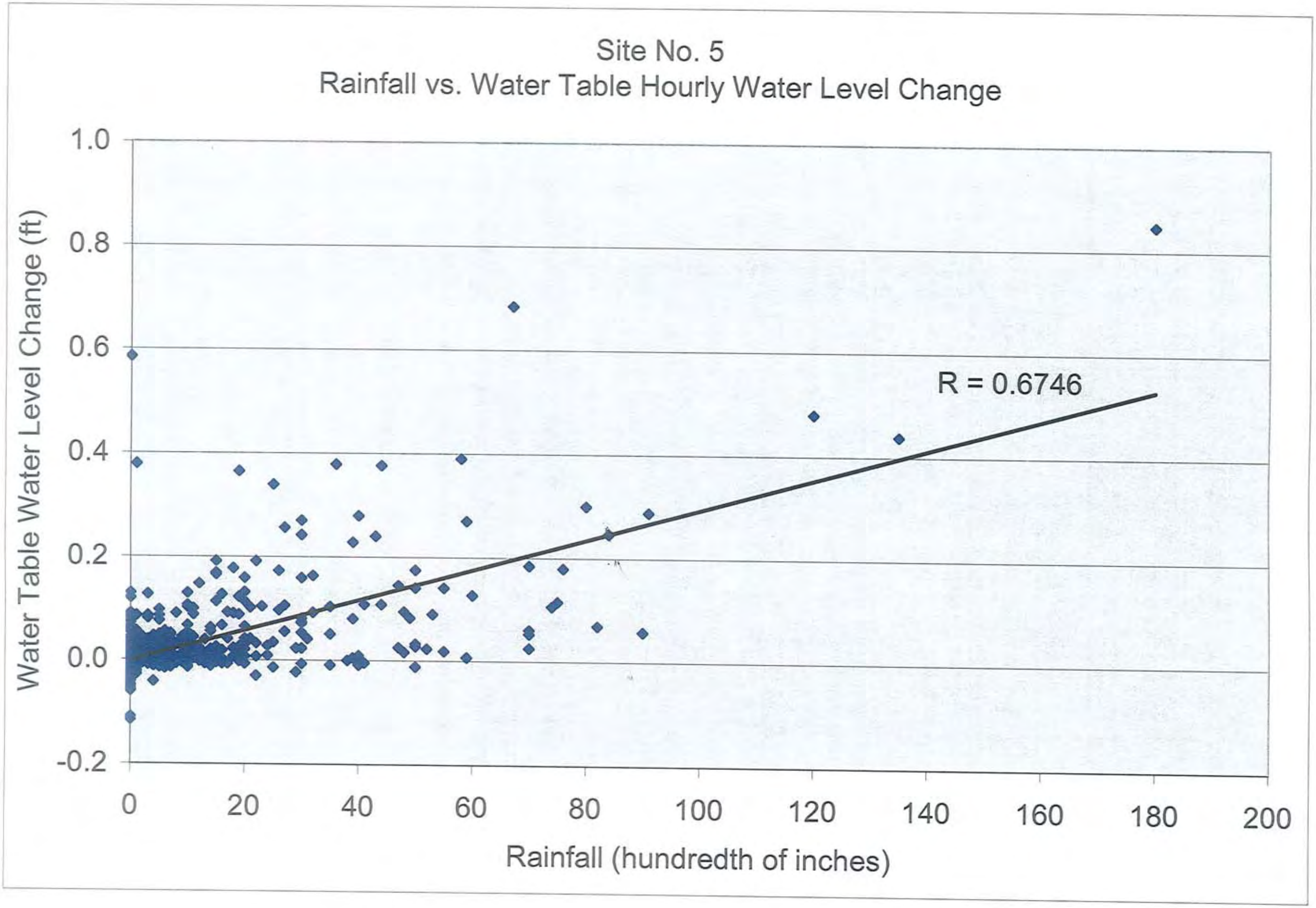


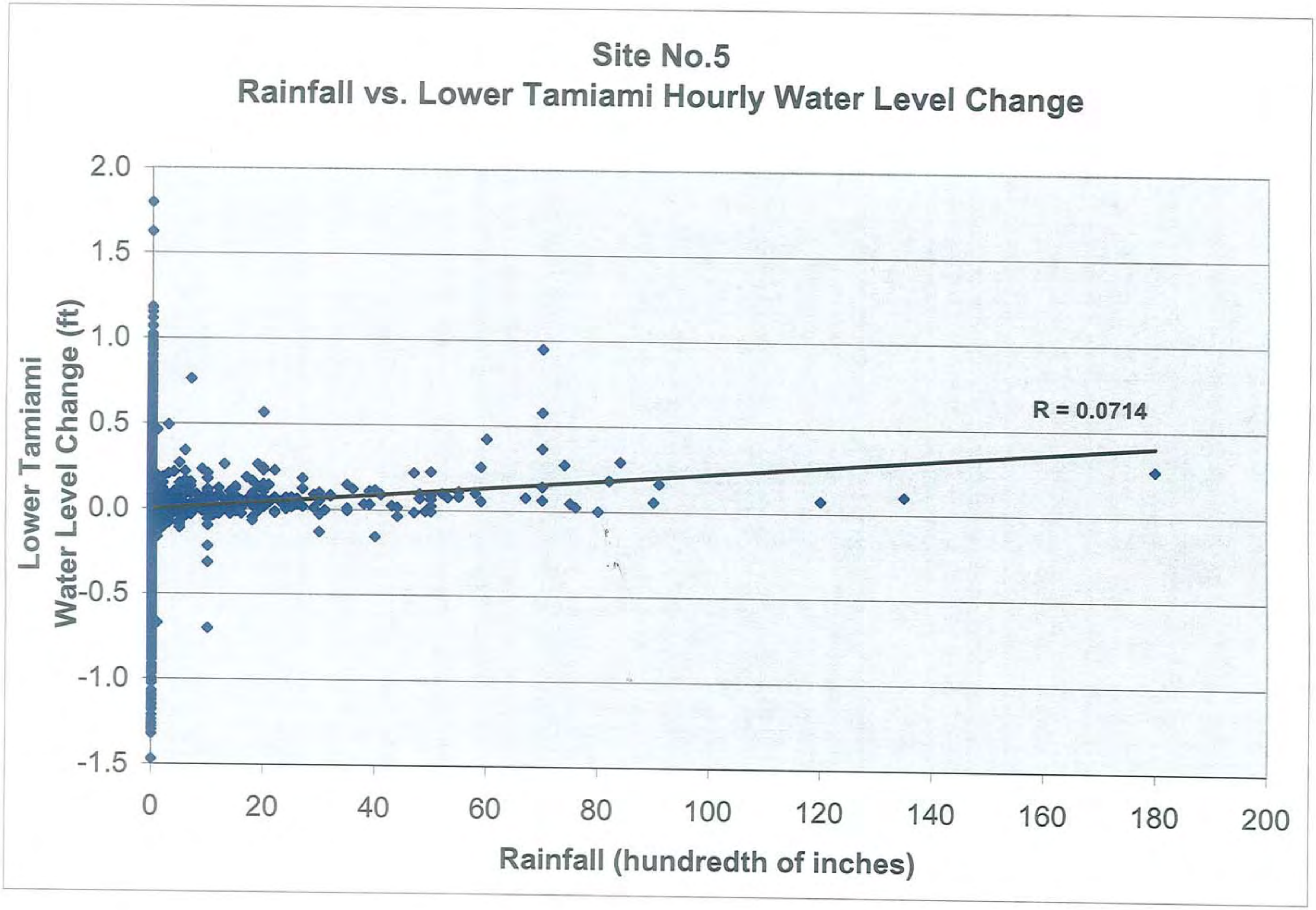
Site No. 3
Rainfall vs. Lower Tamiami Hourly Water Level Change
R = 0.0933
Lower Tamiami Water Level Change (ft)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)



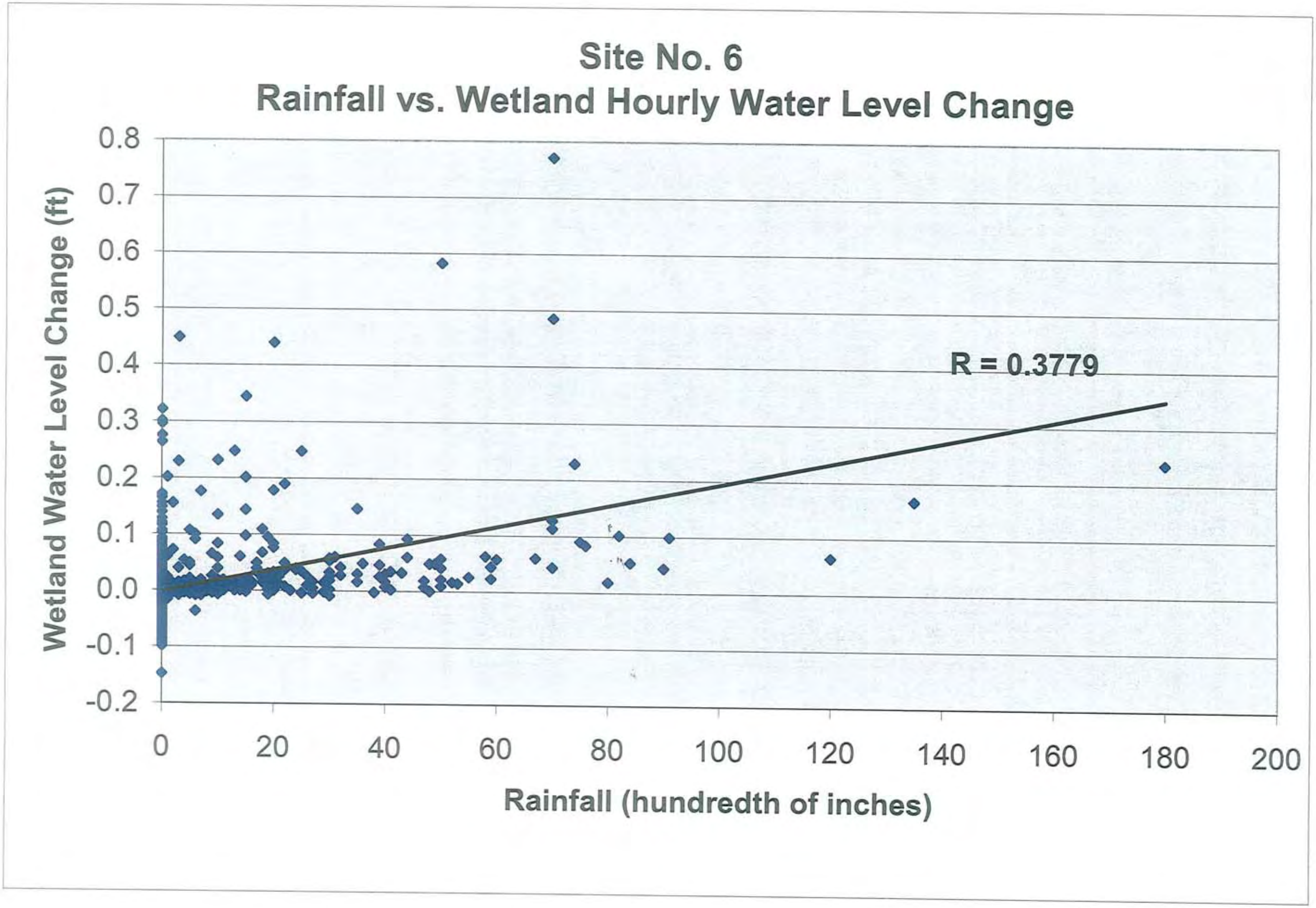
Site No 4
Rainfall vs. Wetland Hourly Water Level Change
Wetland Water Level Change (ft)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
R = 0.3673
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)


Site No. 4
Rainfall vs. Lower Tamiami Water Level Response
Lower Tamiami Water Level Change (ft)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
R = 0.0529
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)

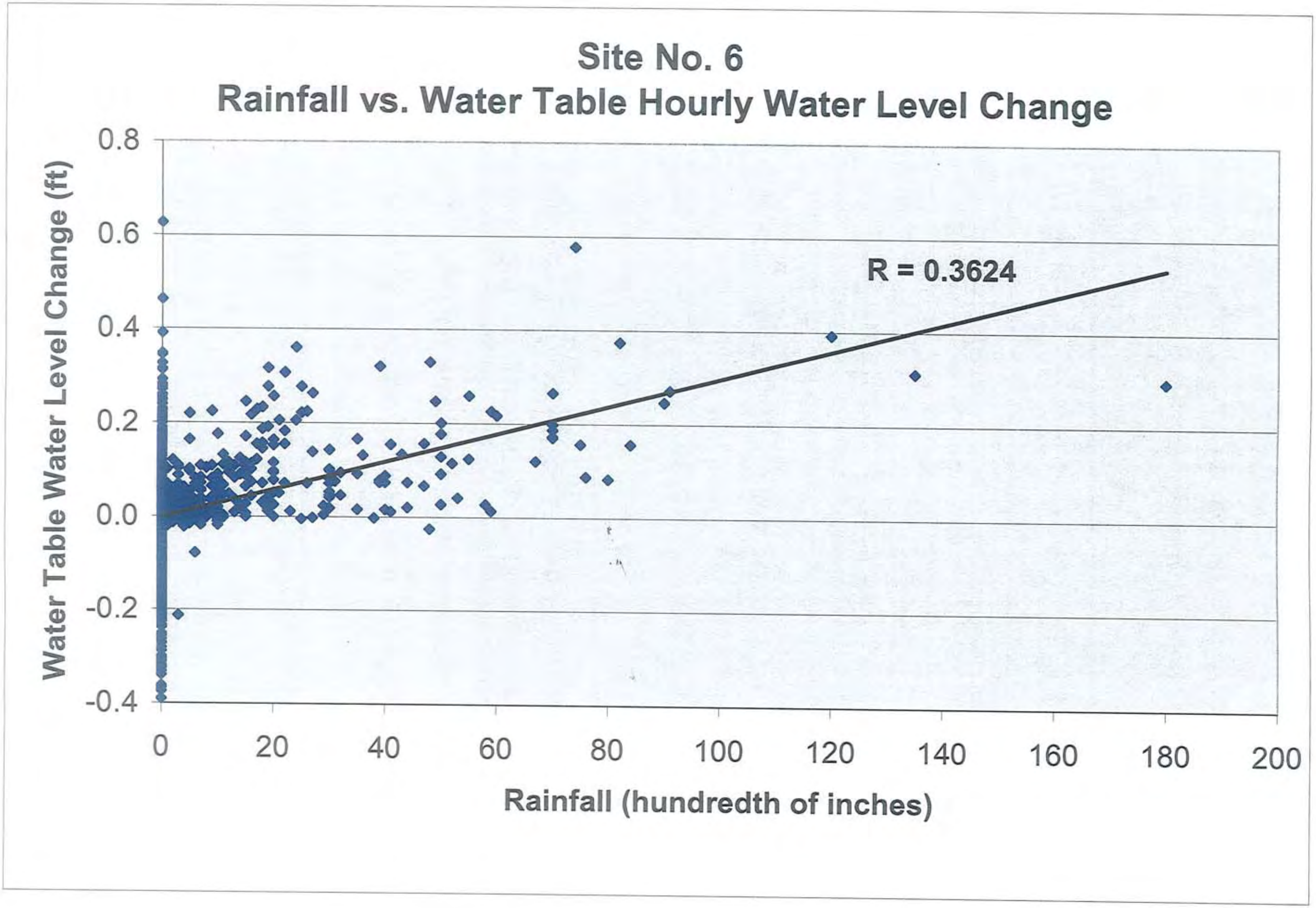

Site No. 5
Rainfall vs. Water Table Hourly Water Level Change
R = 0.6746
Water Table Water Level Change (ft)
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)

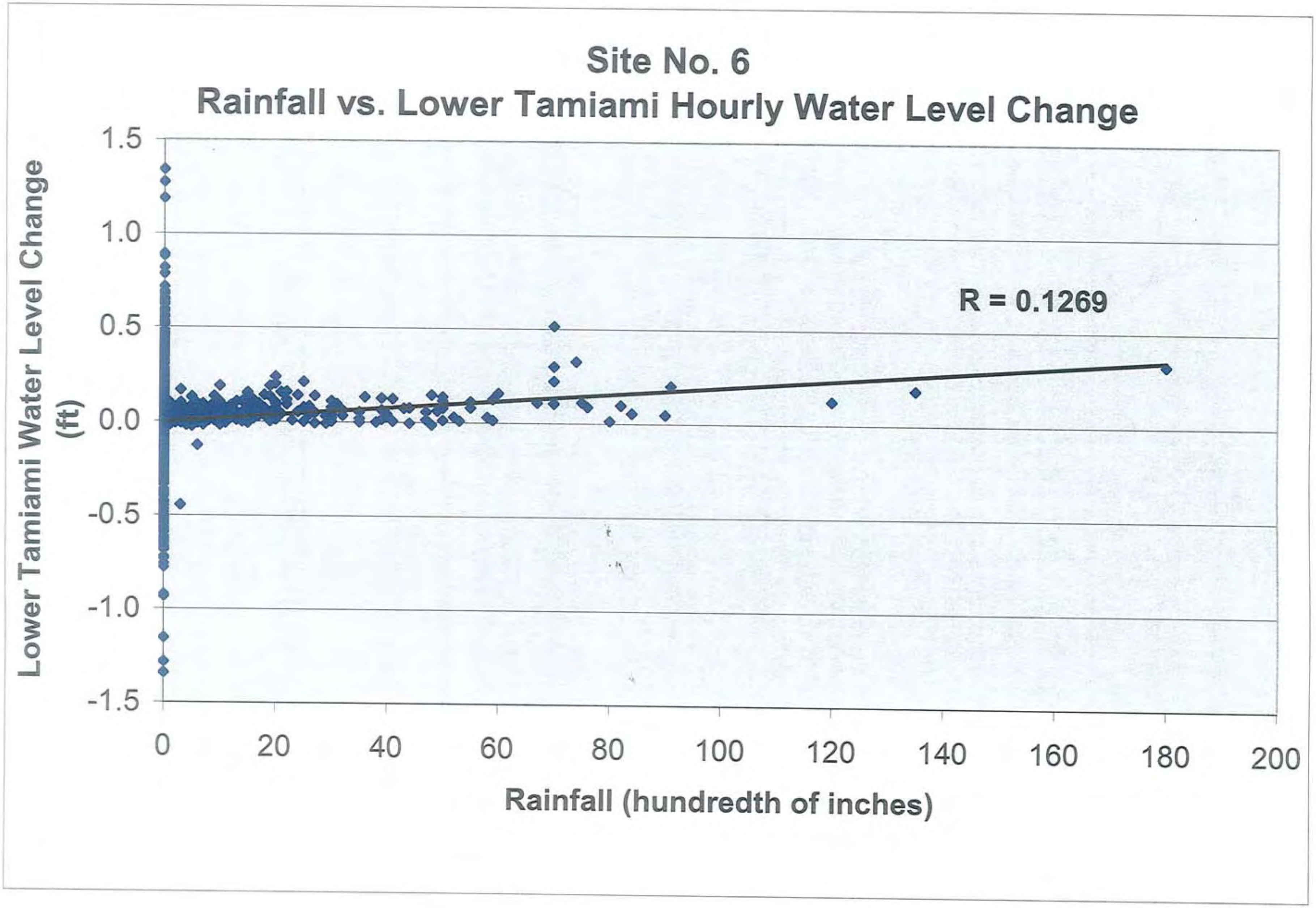


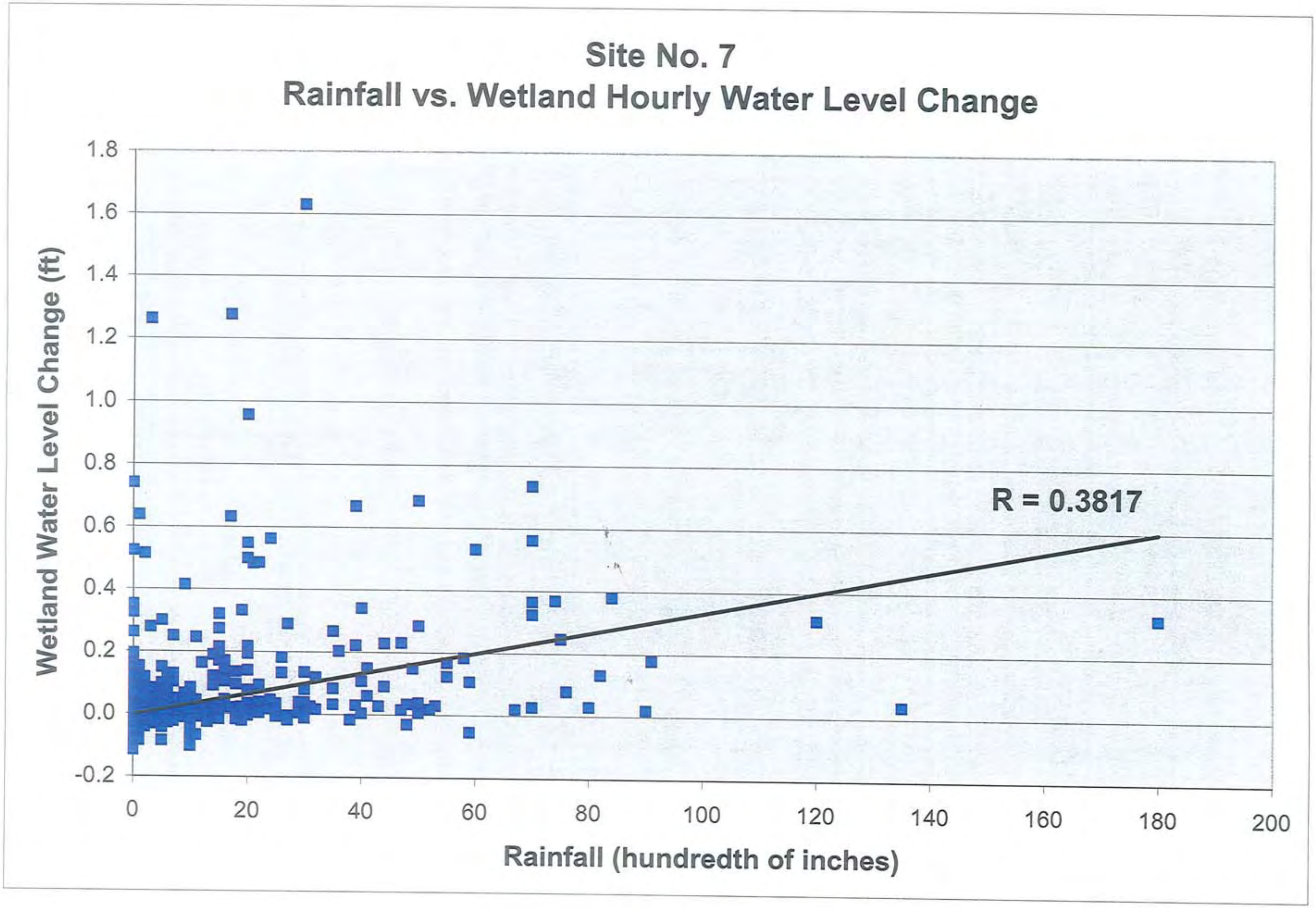
Site No.5
Rainfall vs. Lower Tamiami Hourly Water Level Change
Lower Tamiami Water Level Change (ft)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
R = 0.0714
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)

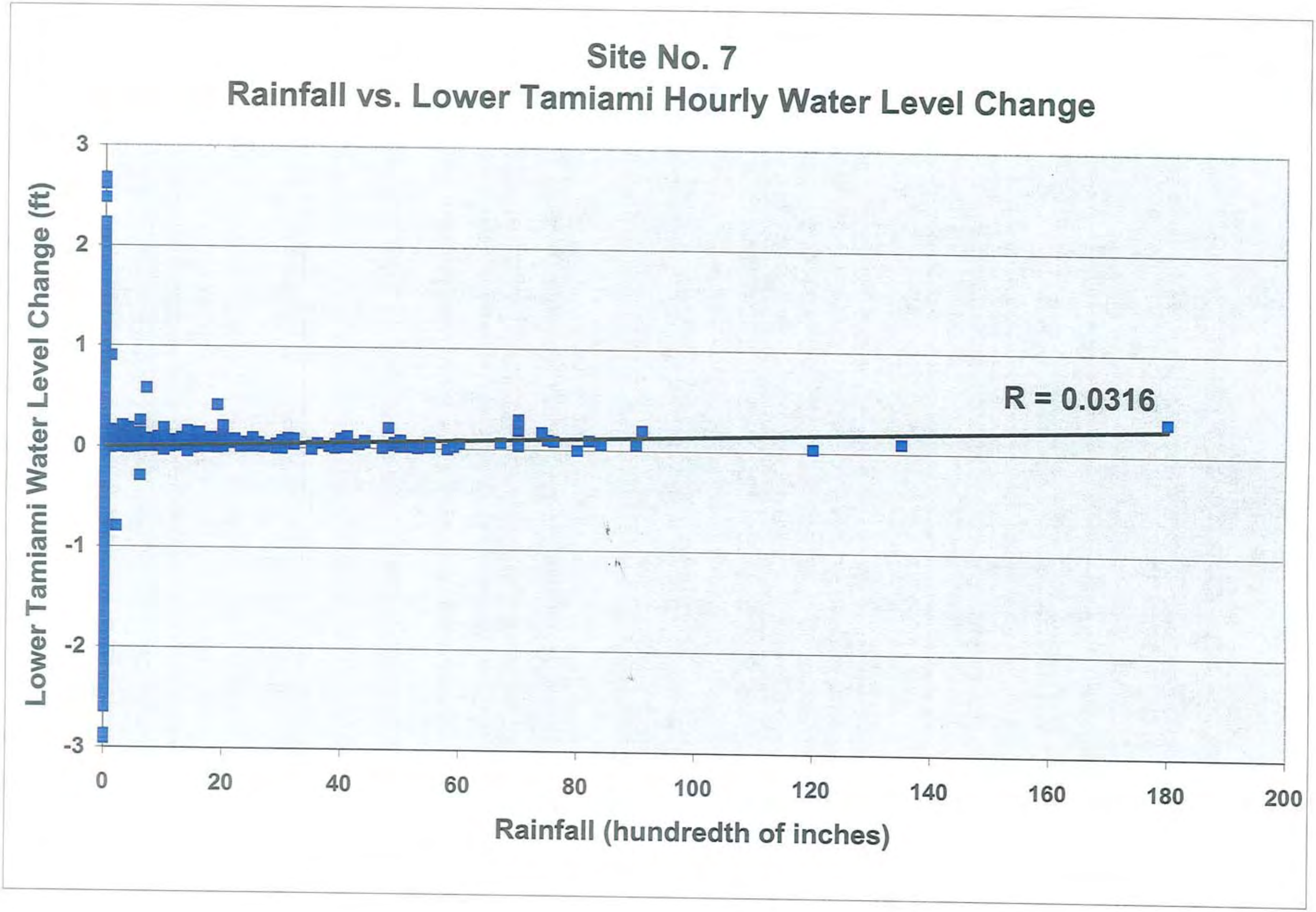


Site No. 6
Rainfall vs. Wetland Hourly Water Level Change
R = 0.3779
Wetland Water Level Change (ft)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)

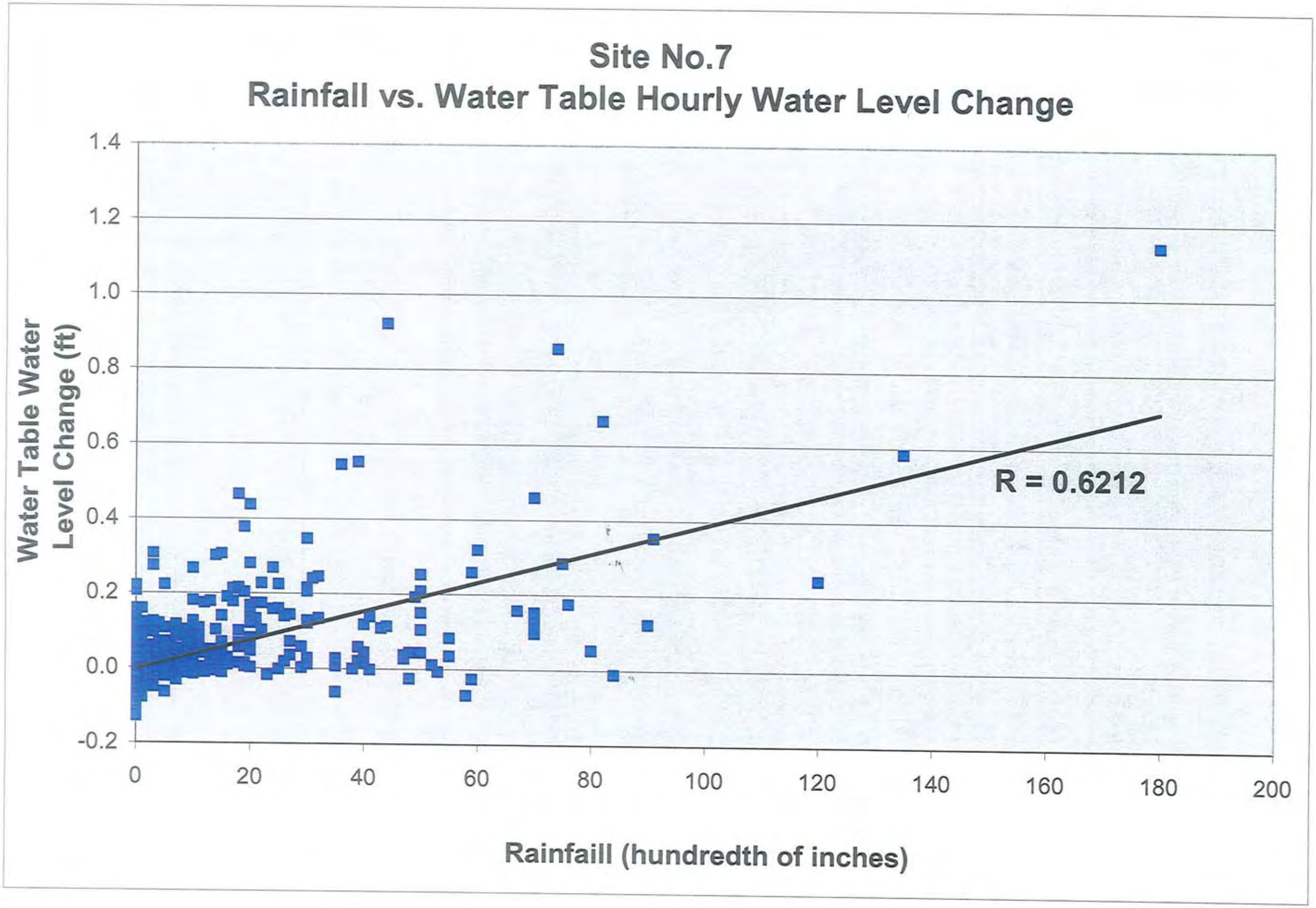

Site No. 6
Rainfall vs. Water Table Hourly Water Level Change
Water Table Water Level Change (ft)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
R = 0.3624
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)


Site No. 6
Rainfall vs. Lower Tamiami Hourly Water Level Change
Lower Tamiami Water Level Change (ft)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
R = 0.1269
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)


Site No. 7
Rainfall vs. Wetland Hourly Water Level Change
Wetland Water Level Change (ft)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
R = 0.3817
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)



Site No. 7
Rainfall vs. Lower Tamiami Hourly Water Level Change
Lower Tamiami Water Level Change (ft)
3
2
1
0
-1
-2
-3
R = 0.0316
0
20
40
60
80
100
120
140
160
180
200
Rainfall (hundredth of inches)



Site No.7
Rainfall vs. Water Table Hourly Water Level Change
Water Table Water Level Change (ft)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
0
20
40
60
80
100
120
140
160
180
200
R = 0.6212
Rainfaill (hundredth of inches)

D

Adamski Geological Consulting Report

Crooks Ranch/Golden Ox, LWDD E-1 and E-2, and Loxahatchee Mitigation Bank Project Data Processing

(Purchase Order No. 4500022767)

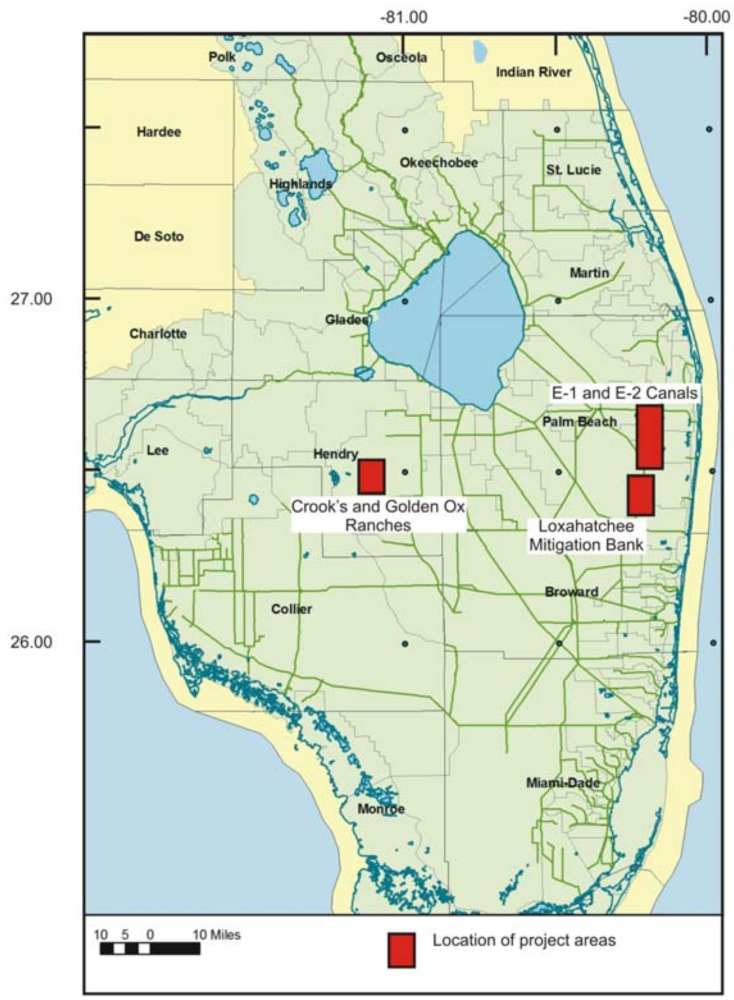


Figure 1 Location of the 37 target wells

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August 2008
Volume 1 of 2

EXECUTIVE SUMMARY

The South Florida Water Management District (SFWMD) is responsible for the stewardship of the region's water resources. As part of the agency's mission, its personnel have conducted a number of localized projects designed to meet specific objectives. Much of the resulting groundwater, surface water, and meteorological data from these individual projects reside in hardcopy format or in electronic files on personal computers. One of the goals of SFWMD is to enter these data into the corporate database, DBHYDRO, so that the data are accessible to other SFWMD users, contractors, water managers, and the general public.

Adamski Geological Consulting, LLC, (AGC) was selected to review and revise the site information and time-series data from three projects conducted by SFWMD for eventual uploading into DBHYDRO. The three projects and their associated stations are as follows:

- **Crook's and Golden Ox Ranches**—a total of fourteen groundwater wells and five stilling wells were installed at seven sites on two ranches located in Hendry County. Groundwater level data and wetland stage data were collected from the stations from March 2005 through October 2007 as part of a hydrogeological assessment of the area. Time-series data were collected in 1-hour increments. Rainfall data were collected at 1-hour increments at four of the sites from January through October 2007. Aquifer performance tests were conducted at two monitor wells installed at the ranches.
- **LWDD E-1 and E-2**—a total of seven stilling wells were installed at six locations on the E-1 and E-2 Canals in Palm Beach County. Stage data were collected from the E-1 Canal stations from May 2005 through May 2008, whereas stage data were collected from the E-2 stations from October 2006 through May 2008. Time-series data were collected in 15-minute increments.
- **Loxahatchee Mitigation Bank**—five stilling wells and two groundwater wells were installed as part of the Loxahatchee Mitigation Bank. The period of data collection varied between the sites. The data set from one well (FPL) extends from October 2002 – March 2008, whereas data were collected from stilling well SWL3 only from March – December 2005. The collection was sporadic with large gaps in most of the time-series data. The temporal resolution of the data varied from 15-minute to 1-hour increments.

Staff at AGC performed the following tasks and data analysis as part of this project.

- Meta data (site information) and time-series data from all 37 sites were obtained from SFWMD and its contractors. Site information, which included latitude-longitude coordinates, reference and land-surface elevation, photographs, field books, and lithologic descriptions, were mostly available in

electronic files. Time-series data included the raw (breakpoint) data available in numerous electronic spreadsheet and ASCII files.

- The reference elevations, land-surface elevations, and time-series data from the Crook's and Golden Ox Ranches project were converted from North American Vertical Datum of 1988 (NAVD88) to the National Geodetic Vertical Datum of 1929 (NGVD29).
- The site information was entered into registration worksheets for each station for uploading into DBHYDRO. One registration worksheet was completed for sites with two or more stations, such as site HESDS1 which included two wells, one stilling well and one rain station.
- Construction and lithologic data, when available, were entered into the Hydrogeologic Data Loader for uploading into DBHYDRO. Information about the two aquifer performance tests also were entered into the Hydrogeologic Data Loader.
- Information from each site, including the registration worksheets, was compiled into folders for uploading into the SFWMD SIM Maintenance database.
- The breakpoint data from each station were compiled into single files, and reviewed for accuracy and completeness. A final set breakpoint data from each station were compiled into one or more comma-delimited files for uploading into DBHYDRO.
- Daily values (means for water levels and sums for rainfall) were calculated from the breakpoint data. Daily-value data were compiled into comma-delimited files for uploading into DBHYDRO.
- Daily-values data from each station were thoroughly reviewed according to SFWMD quality assurance protocols. Summary statistics, box plots, and hydrographs were generated to assess the data from each station for periods of missing values (gaps) and anomalies that could indicate erroneous data.
- A final set of preferred data were generated in comma-delimited files for each station for uploading into DBHYDRO.

In general, the site information for the stations appeared to be accurate, but the quantity of available data varied between the three projects. Location coordinates, reference and land-surface elevations, construction information, photographs, and lithologic information were readily available for the 19 wells and stilling wells at Crook's and Golden Ox Ranches. The stations on the E-1 and E-2 Canals also had accurate information on location, reference and land-surface elevations, and photographs, but construction information generally was unavailable. Well depth and lithology was not available for the two wells installed as part of the Loxahatchee Mitigation Bank, and reference elevations for were not available for two of the stilling wells (Double72s and Double84s).

The time-series data (water-level and rainfall data) from the 37 stations generally appeared to be valid data that accurately represents hydrologic conditions at the sites. However, 27 of the 33 wells and stilling wells had periods of missing data. The gaps in original time-series data ranged in length from 1 day to 183 days. No attempt was made to estimate values for the missing data.

A total of seven sites had anomalous data that were inconsistent with nearby stations, and determined to be erroneous. Three stations (HES-11, HES-16, and HES-19) had periods of anomalous data that probably resulted from the water level declining below the instrument in these stilling wells. The anomalous data from these stations were deleted and the missing values coded as M. Correction factors were applied to portions of the time-series data from two stations (E2LWN_H and US441). Finally, the time-series data from Double72s had two periods of anomalous data that were subsequently deleted. Deletion of erroneous data resulted in a higher number of missing values for each of these stations.

Overall, the site information and time-series data from these stations have been thoroughly reviewed, and generally appear to be accurate. Anomalous or suspicious data were confirmed with similar data from nearby stations, corrected, or deleted before the preferred set of time-series data were compiled. The time-series and site information data have been compiled and are ready for uploading into DBHYDRO and associated SFWMD databases.

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1 INTRODUCTION

1.1 Objectives

The objective of this contract (P.O. no. 4500022767) is to obtain professional consulting services for processing site information (Meta data) and providing quality assurance and quality control of ground-water data. The objective of the project is to review and revise Meta data and time-series data (water levels) for 37 stations, stilling wells, and rain stations monitored by the South Florida Water Management District (SFWMD). This report contains the summary of the review and revisions of the 37 stations. SFWMD staff collected and used the data from these stations for scientific, modeling, and regulatory purposes. The data currently are stored on individual computers in SFWMD. The purpose of this project is to enter the Meta and time-series data into templates for uploading into the SFWMD corporate database, DBHYDRO, and have the data available for use by the general public, consulting firms, and other government agencies. Hence, the quality of these data is crucial to the mission of SFWMD.

SFWMD procured the services of Adamski Geological Consulting, LLC (AGC) to conduct task orders as outlined in the statement of work dated March 26, 2008. The duration of the project is from March through August 28, 2008.

1.2 Scope of Work

The overall scope of work for the project is to conduct quality assurance/quality control assessment of site information (Meta data) and time-series data for 37 stations. The work is to be conducted off-site by staff at AGC. The project was conducted in two phases as follows:

Phase 1. Compilation of existing data

- All available Meta and time-series data for the stations were obtained from SFWMD.
- The vertical datum for wells from Crook's and Golden Ox Ranches was converted from the North American Vertical Datum of 1988 (NAVD 88) to the National Geodetic Vertical Datum of 1929 (NGVD 29) using the U.S. Army Corps of Engineers Corpscon6 software.
- New station registration forms were generated for all stations for uploading of site location and elevation information into DBHYDRO. Electronic files containing photographs, survey notes, and other information were arranged in folders for storage in the SFWMD database.
- The Hydrogeologic data loader was completed for all monitoring and stilling wells for uploading of construction and geologic information into DBHYDRO.

Phase 2. Analysis of data and report activities

- Continual time-series (breakpoint) data for each station were compiled. Breakpoint data were collected at 15-minute or 1-hour increments, depending upon the station.
- Daily value (averages) data were calculated from the breakpoint data
- Daily value data were extensively reviewed for quality control; summary statistics and hydrographs were generated for daily value data from each station.
- Breakpoint and daily-value data were exported into ASCII files for uploading into DBHYDRO.
- All files were downloaded onto a DVD and submitted with this report.

The purpose of this report is to summarize work conducted by AGC on the project through August 2008. During this period, Meta and time-series data from 37 stations were reviewed and revised for quality assurance and quality control. The revised data are submitted with this report for approval and uploading into DBHYDRO.

1.3 Data Sources

The Meta and time-series data for all 37 stations were collected by SFWMD and its contractors, and will be uploaded into the DBHYDRO database (Table 1). The data were collected as part of three separate projects. The first project was the Crook's and Golden Ox Ranches, which reviewed the effects of groundwater withdrawals on wetlands located on two ranches in Hendry County. The second project consisted of monitoring water levels (stage) on the E-1 and E-2 Canals in the Lake Worth Drainage District. The third project consisted of monitoring water levels as part of the Loxahatchee Mitigation Bank.

Number	*Station name*	*Station type*	*Project*	*Reference elevation*
1	HES-1	Well	Crook's/Golden Ox	31.245
2	HES-2	Well	Crook's/Golden Ox	30.995
3	HES-3	Stilling well	Crook's/Golden Ox	30.325
4	HESDS1_R	Rain station	Crook's/Golden Ox	
5	HES-4	Well	Crook's/Golden Ox	31.469
6	HES-5	Well	Crook's/Golden Ox	31.619
7	HES-6	Stilling well	Crook's/Golden Ox	31.289
8	HES-7	Well	Crook's/Golden Ox	31.422
9	HES-8	Well	Crook's/Golden Ox	31.422
10	HESDS3_R	Rain station	Crook's/Golden Ox	
11	HES-9	Well	Crook's/Golden Ox	30.452
12	HES-10	Well	Crook's/Golden Ox	30.482
13	HES-11	Stilling well	Crook's/Golden Ox	30.592
14	HES-12	Well	Crook's/Golden Ox	30.315
15	HES-13	Well	Crook's/Golden Ox	30.325
16	HESDS5_R	Rain station	Crook's/Golden Ox	
17	HES-14	Well	Crook's/Golden Ox	28.355
18	HES-15	Well	Crook's/Golden Ox	28.475
19	HES-16	Stilling well	Crook's/Golden Ox	29.875
20	HES-17	Well	Crook's/Golden Ox	33.932
21	HES-18	Well	Crook's/Golden Ox	33.352
22	HES-19	Stilling well	Crook's/Golden Ox	33.612
23	HESDS7_R	Rain station	Crook's/Golden Ox	
24	E1BOYNTON	Stilling well	LWDD E1 and E2	20.126
25	E1LW	Stilling well	LWDD E1 and E2	21.177
26	E1PIONEER	Stilling well	LWDD E1 and E2	21.935
27	E1E2LYONS	Stilling well	LWDD E1 and E2	18.54
28	E2BENOIST	Stilling well	LWDD E1 and E2	23.16
29	E2LWN_H	Stilling well	LWDD E1 and E2	18.45
30	E2LWS_T	Stilling well	LWDD E1 and E2	18.47
31	DOUBLE72	Stilling well	Loxahatchee	

32	DOUBLE84s	Stilling well	Loxahatchee	
33	FPL	Well	Loxahatchee	19.42
34	G94A	Stilling well	Loxahatchee	16.92
35	MUDFLATS	Well	Loxahatchee	18.71
36	SWL3	Stilling well	Loxahatchee	15.55
37	US441	Stilling well	Loxahatchee	19.35

Table 1 Site information for target stations reviewed through August 2008. [WMD, South Florida Water Management District]

The site information and time-series data from most of the target stations were obtained from electronic files stored on CDs or on the SFWMD ftp server. The time-series data from the seven target stations for the Loxahatchee Mitigation Bank were obtained from the contractor, Tetra Tech, EC, Inc. The time-series data from nearby wells, stilling wells, and rain gages also were downloaded from DBHYDRO to assist in the quality assurance analysis of the time-series data. A discussion of the results in provided in the following Results and Discussion section.

2 METHODS

2.1 Data Acquisition

Meta data and time-series data for the 37 stations and rain gages were obtained from SFWMD by downloading the files from the agency's ftp site.

2.2 Procedures for Compiling Existing Information

Accurate site information and time-series data are important in maintaining the integrity of the SFWMD database. The site information and time-series data were reviewed and compiled as follows:

1. AGC staff became familiar with and knowledgeable about the target stations by reviewing photographs, survey reports, and field notes. AGC also consulted the statement of work and final report (Lukasiewicz and other, in press) to obtain additional information on the Crook's Ranch and Golden Ox Ranch project.
2. In order to obtain the most accurate information on station location, construction, and site geology, AGC spoke with numerous individuals involved in the projects. These individuals included Cindy Bevier, PG, and Simon Sunderland (SFWMD), Ed Rectenwald, PG (MWH Americas, Inc.), Scott Jones, PE (Johnson-Prewitt & Associates, Inc.), Paul Petrey (Applied Drilling Engineering, Inc.), Patrick Zuloaga and Maura Saks, PE (Tetra Tech EC, Inc.) and staff at Advanced Well Drilling (Appendix B).
3. The locations of the stations were evaluated using GIS by plotting the stations using latitude-longitude coordinates available in the survey reports. A final map was generated showing the location of target wells (fig. 1).

4. Township and range location, basin, and USGS topographic quadrangle location also were determined by using the U.S. Geological Survey National Map Viewer and by using GIS and coverages downloaded from the SFWMD web site.
5. Elevation and time-series data from the Crook's Ranch/Golden Ox Ranch project were converted from NAVD 88 to NGVD 29 using the U.S. Army Corps of Engineers Corpscon6 software.
6. The site information, including location, construction, geologic, and lithologic information, was entered into registration worksheets and hydrogeologic data loader for uploading into the DBHYDRO and WREP databases.
7. Breakpoint data, which were stored in multiple files, were compiled into single files for each station. Average values of breakpoint data for each available date were calculated in order to obtain daily value data.

2.3 Procedures for QA/QC of Water-Level Data

After information and data were compiled, quality assurance was conducted on time-series data from each well using methods derived from SFWMD standard operating procedures (Sangoyomi and others, 2005; Sangoyomi and others, 2006; Sangoyomi and Lambright, 2006). These methods are summarized as follows:

1. Daily value data from the target stations were plotted in order to identify and document anomalies, outliers, and gaps in the record. Gaps, or periods of missing data, are easily identified. Anomalies are shifts in the values that might or might not represent valid hydrologic data. Anomalies could also be periods of flat or suspiciously linear data. Outliers are extreme values that are significantly greater than or less than a specified range within which most of the data occur. Anomalies and outliers might represent valid hydrologic conditions such as a drought or excessive rainfall. However, anomalies and outliers that are inconsistent with data from nearby wells and rain gages could indicate errors in the time-series data.
2. Summary statistics (minimum, mean, median, maximum, and standard deviation) were determined for each set of time-series data prior to revision (Appendix A).
3. Box plots of time-series data for each of the target wells were generated in order to quantitatively identify outliers. Box plots consist of a box with one end (lower quartile, Q1) representing the 25th percentile, and the opposite end (upper quartile, Q3) representing the 75th percentile of the time-series data (fig. 2). A line is drawn near the middle of the box to represent the median of the data. The distance between the lower and upper quartiles is the inter quartile range (QR). An outlier is defined as any data point greater than the upper fence (upper quartile plus 1.5*QR), or any data point less than the lower fence (lower quartile minus 1.5*QR).
4. Time-series data from the target wells were plotted with data from nearby monitoring wells and rain gages in order to evaluate anomalies and outliers. For example, heavy rains could explain a sudden increase in water levels in the target well. Trends in

nearby wells also were used to document and verify that anomalies in the time-series data of the target wells represented valid hydrologic conditions.

5. Anomalies and outliers that did not appear to represent valid hydrologic conditions were deleted from the record. The values were coded as an "M" for missing.
6. Gaps in data were coded as an "M", which indicates the data are missing, possibly as a result of equipment failure or some other technical problem.
7. The data were revised, based on the analysis of anomalies, outliers, and gaps. Summary statistics were determined for the revised time-series data (Appendix A). Revisions, deletion of suspect data, caused the summary statistics, including the value and number of outliers, to change. Final hydrographs (Appendix A) of the revised data were reviewed to verify that the data were valid.

Revised time-series data are submitted with this report for approval and uploading into DBHYDRO.

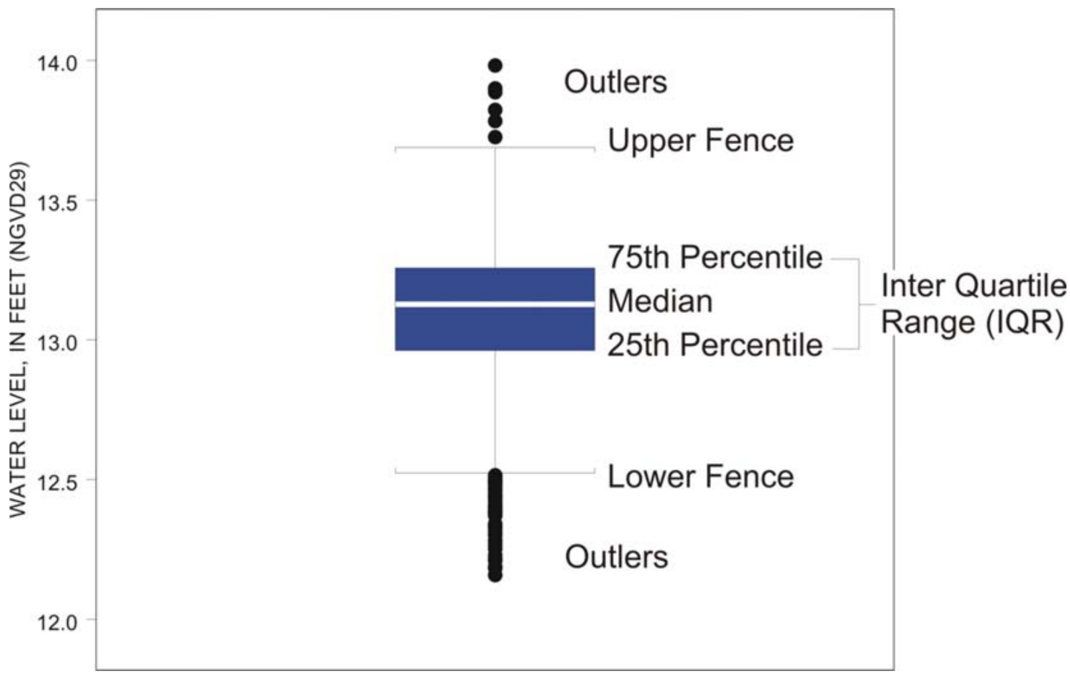


Figure 2 Sample box plot showing lower (Q1) and upper (Q3) quartiles.

Well depths (strata) are listed as feet below land surface, unless otherwise noted. Water-level data and reference and land-surface elevations are listed as feet above mean sea level (NGVD29), unless otherwise noted. Horizontal locations are based on North American Datum of 1983 (NAD83).

3 RESULTS AND DISCUSSION

The site information and time-series data from 37 stations were reviewed and analyzed according to SFWMD quality-assurance protocols (eg, Sangoyomi and Lambright, 2006). Site-information data were verified and (or) corrected using the methods described in the previous section. The site information and locations of the target stations for this report generally were in agreement with GIS and other information; therefore, the site information for the wells was considered accurate. The locations of the wells are shown in figures 3, 4, and 5.

The stations monitored for the Crook's Ranch and Golden Ox Ranch project consists of 19 wells and stilling wells installed at 7 locations. Each of the seven locations (drill sites HESDS1 – HESDS7) consists of a shallow well tapping the surficial aquifer system and a deep well tapping the Lower Tamiami aquifer. Five of the locations (HESDS1, HESDS2, HESDS4, HESDS6, and HESDS7) also had nearby stilling wells installed to monitored water levels in wetlands. The water levels in these 19 wells were recorded at 1-hour increments. Sites HESDS1, HESDS3, HESDS5, and HESDS7 also were equipped with tipping-bucket rain stations, which collected data every hour or every tip of the bucket. The time-series data provided by the contractor recorded the bucket tips, which were converted during this project to breakpoint and daily values (sums). One bucket tip was equivalent to 0.01 inch of rain.

The LWDD E-1 and E-2 Canals project consisted of seven stilling wells installed at six locations on the E-1 and E-2 Canals. One site, located on the E-2 Canal at the Florida Turnpike and Lake Worth Road, had two stilling wells installed (ELWN_H and ELWS_T) on the headwater and tailwater side of a gate for controlling flow.

The Loxahatchee Mitigation Bank project consisted of five stilling wells and two groundwater wells installed in Palm Beach County. Little site information was available for these sites. Most of the time-series data were obtained from the contractor (Maura Saks, Tetra Tech EC, Inc., written commun., 2008).

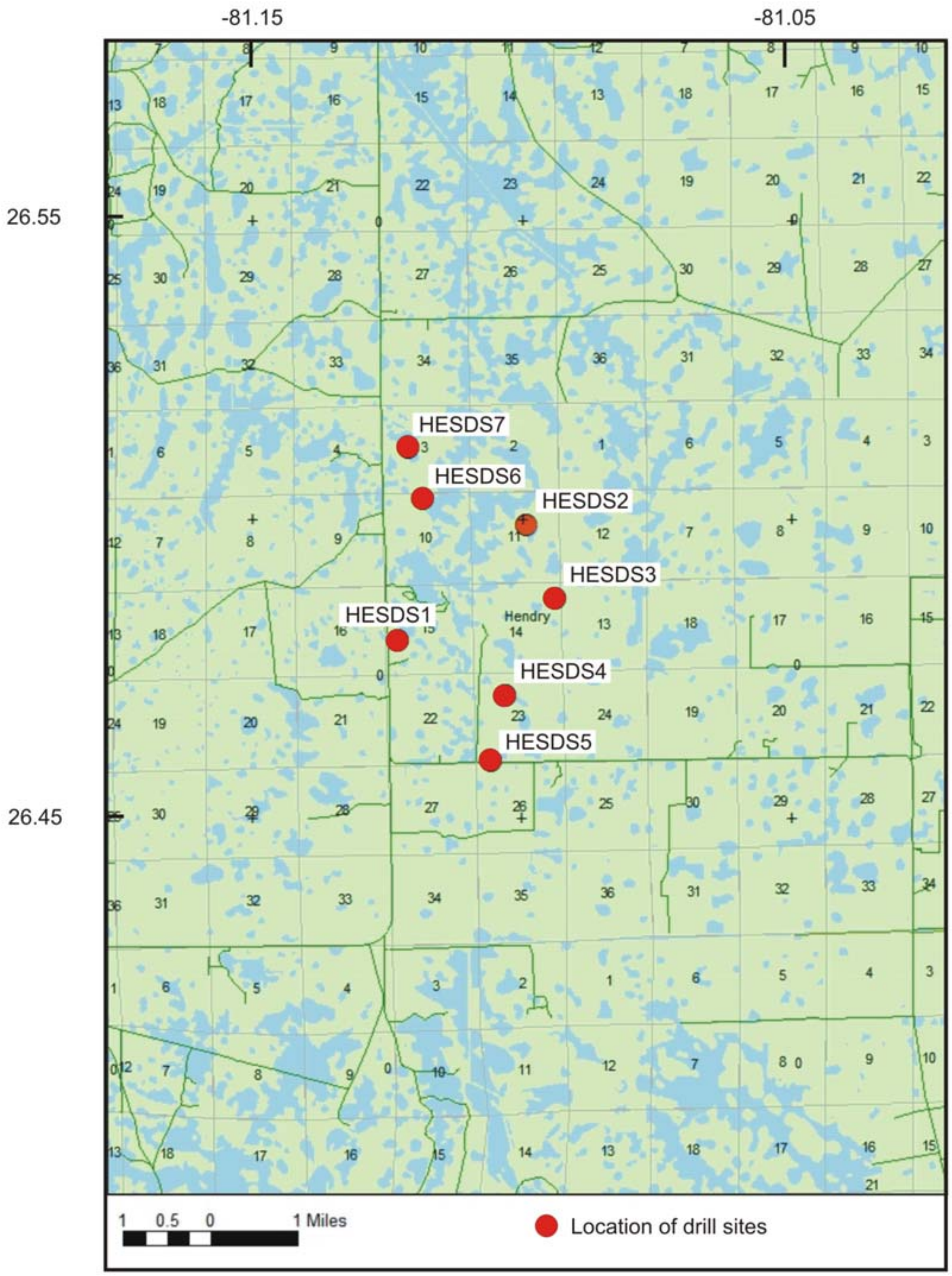


Figure 3 Location of target wells at the Crook's and Golden Ox Ranches in Hendry County, Florida.

3.1 Station 1: HES-1

HES-1 is a 15 ft deep well located in Hendry County (figs. 1 and 3). HES-1 is located at drill site 1 (HESDS1) on Crook's Ranch, which also includes well HES-2, and stilling well HES-3. The site was briefly instrumented with rain station HESDS1_R.

3.1.1 Site and data description

Variable	Original value	Revised value
Station	HES-1	HES-1
Source DBKEY		
MOD1 DBKEY		
Latitude	26 28 47.9	26 28 47.9
Longitude	81 07 23.1	81 07 23.1
X Coordinate	616128.16	616128.16
Y Coordinate	782640.2	782640.2
Land-surface elevation (feet) (NGVD 29)	28.478	28.478
Reference elevation (feet) (NGVD 29)	31.245	31.245
Measuring point (feet)	2.35	2.35
Well bottom elevation (feet) (NGVD 29)	13.895	13.895
Strata (feet)	15	15
Sensor elevation (feet) (NGVD 29)	18.05	18.05

Table 2 Site information was obtained for Station 1: HES-1

Analysis: HES-1 is a shallow well that taps the surficial aquifer system. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 29, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. A photograph of HES-1 and adjacent well HES-2 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Stations HES1 and HES-2

3.1.2 Data analysis and revision

The period of record analyzed for well HES-1 extends from March 16, 2005 to September 26, 2007 (Appendix A). The time-series data from that period contain 925 observations with no outliers and 27 missing values. The summary statistics for well HES-1 are provided in table 3.

Problem: The time-series data from well HES-1 contain 27 missing values.

Analysis: The missing values occurred from October 8 to November 3, 2006, and possibly result from budgetary constraints during the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water levels in well HES-1 roughly coincide with peaks and declines in water levels in nearby wells (HES-4, HES-7, and HES-9) drilled to similar depths. The water levels in well HES-1 also increase as a result of rain storms and decrease during periods of dry weather. Therefore, the water-level data from well HES-1 appear to be valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	24.128	24.128
Mean (feet)	25.619	25.619
Median (feet)	25.711	25.711
Maximum (feet)	27.243	27.243
Standard deviation	0.705	0.705
Variance	0.497	0.497
Outliers	0	0
Missing values	27	27

Table 3 Summary statistics of original time-series data for Station 1: HES-1

3.2 Station 2: HES-2

HES-2 is a 78 ft deep well located in Hendry County (figs. 1 and 3). HES-2 is located at drill site 1 (HESDS1) on Crook's Ranch, which also includes well HES-1, and stilling well HES-3. The site was briefly instrumented with rain station HESDS1_R.

3.2.1 Site and data description

Variable	Original value	Revised value
Station	HES-2	HES-2
Source DBKEY		
MOD1 DBKEY		
Latitude	26 28 47.9	26 28 47.9
Longitude	81 07 23.1	81 07 23.1
X Coordinate	616130.79	616130.79
Y Coordinate	780181.2	780181.2
Land-surface elevation (feet) (NGVD 29)	28.168	28.168
Reference elevation (feet) (NGVD 29)	30.995	30.995
Measuring point (feet)	2.41	2.41
Well bottom elevation (feet) (NGVD 29)	-49.415	-49.415
Strata (feet)	78	78
Sensor elevation (feet) (NGVD 29)	10.78	10.78

Table 4 Site information obtained for Station 2: HES-2

Analysis: HES-2 is a monitoring well that taps the Lower Tamiami aquifer. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 29, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. A photograph of HES-2 and adjacent well HES-1 is shown in the discussion of HES-1. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

3.2.2 Data analysis and revision

The period of record analyzed for well HES-2 extends from March 16, 2005 to October 20 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 89 missing values. The summary statistics for well HES-2 are provided in table 5.

Problem: The time-series data from well HES-2 contain 89 missing values.

Analysis: Missing values occurred from October 8 to November 3, 2006, and probably result from budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). Missing values also occurred from May 6 to July 6, 2007, possibly as a result of equipment problems, as data from adjacent (HES-1) and nearby wells (HES-8, HES-10, and HES-15) were available during this period. The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-2 closely coincide with peaks and declines in water-level data from nearby wells (HES-8, HES-10, and HES-15) drilled to a similar depth (Appendix A). In addition, water levels in the target well decline as expected during periods of low rainfall, and increase as expected during periods of excessive rainfall recorded by nearby rain gages. Some of the declines in water levels happened quickly, and possibly indicate drawdown as a result of withdrawals from nearby production wells. The sharp declines in water levels in well HES-2 coincide with similar declines in nearby wells. Therefore, the time-series data from well HES-2 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	16.547	16.547
Mean (feet)	23.132	23.132
Median (feet)	23.173	23.173
Maximum (feet)	27.378	27.378
Standard deviation	2.658	2.658
Variance	7.065	7.065
Outliers	0	0
Missing values	89	89

Table 5 Summary statistics of original time-series data for Station 2: HES-2

3.3 Station 3: HES-3

HES-3 is a 4 ft deep stilling well located in Hendry County (figs. 1 and 3). HES-3 is located at drill site 1 (HESDS1) on Crook's Ranch, which also includes wells HES-1 and HES-2. The site was briefly instrumented with rain station HESDS1_R.

3.3.1 Site and data description

Variable	Original value	Revised value
Station	HES-3	HES-3
Source DBKEY		
MOD1 DBKEY		
Latitude	26 28 47.8	26 28 47.8
Longitude	81 07 23.1	81 07 23.1
X Coordinate	616005	616005
Y Coordinate	780025	780025
Land-surface elevation (feet) (NGVD 29)	26.83	26.83
Reference elevation (feet) (NGVD 29)	30.325	30.325
Well bottom elevation (feet) (NGVD 29)	22.83	22.83
Strata (feet)	4	4
Sensor elevation (feet) (NGVD 29)	23.005	23.005

Table 6 Site information obtained for Station 3: HES-3

Analysis: HES-3 is a stilling well that monitors the water level in a wetland. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 29, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun., 2008). The median water level in the well is less than the land-surface elevation (calculated), which indicates the site was only seasonally inundated. A photograph of HES-3 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Station HES-3

3.3.2 Data analysis and revision

The period of record analyzed for well HES-3 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 27 missing values. The summary statistics for this station are provided in table 7.

Problem: The time-series data from well HES-3 contain 27 missing values.

Analysis: Missing values occurred from October 8 to November 3, 2006, and probably result from budgetary constraints at the start of the new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from station HES-3 roughly coincide with peaks and declines in water-level data from nearby stilling wells (HES-6, HES-16, and HES-19) drilled to a similar depth (Appendix A). In addition, water levels in the target well decline as expected during periods of low rainfall, and increase as expected during periods of excessive rainfall recorded by nearby rain gages. Therefore, the time-series data from well HES-3 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required.

Statistics	Original series	Revised series
Minimum (feet)	24.077	24.077
Mean (feet)	25.606	25.606
Median (feet)	25.667	25.667
Maximum (feet)	27.024	27.024
Standard deviation	0.747	0.747
Variance	0.558	0.558
Outliers	0	0
Missing values	27	27

Table 7 Summary statistics of time-series data for Station 3: HES-3

3.4 Station 4: HESDS1_R

HESDS1_R is a rain station located in Hendry County (figs. 1 and 3). The station is located at drill site 1 (HESDS1) on Crook's Ranch, which also includes wells HES-1 and HES-2, and stilling well HES-3.

3.4.1 Site and data description

Variable	Original value	Revised value
Station	HESDS1_R	HESDS1_R
Source DBKEY		
MOD1 DBKEY		
Latitude	26 28 47.9	26 28 47.9
Longitude	81 07 23.1	81 07 23.1
X Coordinate	616130.79	616130.79
Y Coordinate	780181.2	780181.2

Table 8 Site information obtained for Station 4: HESDS1_R

3.4.2 Data analysis and revision

The period of record analyzed for station HESDS1_R extends from April 7 through October 26, 2007 (Appendix A). The time-series data contain 203 observations with 28 outliers and no missing values.

Problem: The time-series data contain 28 outliers, all of which are greater than the upper fence of 0.36 inches.

Analysis: The median value for the time-series data is 0, which indicates that no precipitation occurred during at least half the period of record. Therefore, days with even moderate precipitation (greater than 0.36 inch) are statistical outliers. These outliers coincide with moderate to heavy rainfalls recorded at nearby stations. Hence, the outliers are valid data that accurately represent hydrologic conditions at the site.

Summary: The precipitation recorded at HESDS1_R coincides with precipitation data from nearby wells (ALICO_R, DEVILS_R, and HESDS5_R), particularly with excessive rainfall of 1 inch or more (Appendix A). In addition, periods of low rainfall also coincide with dry periods recorded at nearby stations. The time-series data from HESDS1_R probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required.

Statistics	Original series	Revised series
Minimum (feet)	0.000	0.000
Mean (feet)	0.181	0.181
Median (feet)	0.000	0.000
Maximum (feet)	4.260	4.260
Standard deviation	0.458	0.458
Variance	0.210	0.210
Outliers	28	28
Missing values	0	0

Table 9 Summary statistics of original time-series data for Station 4: HESDS1_R

3.5 Station 5: HES-4

HES-4 is a 15-ft deep well located in Hendry County (figs. 1 and 3). HES-4 is located at drill site 2 (HESDS2) ON Crook's Ranch, which also includes well HES-5 and stilling well HES-6.

3.5.1 Site and data description

Variable	Original value	Revised value
Station	HES-4	HES-4
Source DBKEY		
MOD1 DBKEY		
Latitude	26 29 56.8	26 29 56.8
Longitude	81 05 57.3	81 05 57.3
X Coordinate	623740.75	623740.75
Y Coordinate	787127.9	787127.9
Land-surface elevation (feet) (NGVD 29)	28.642	28.642
Reference elevation (feet) (NGVD 29)	31.469	31.469
Measuring point (feet)	2.41	2.41
Well bottom elevation (feet) (NGVD 29)	14.059	14.059
Strata (feet)	15	15
Sensor elevation (feet) (NGVD 29)	18.239	18.239

Table 10 Site information obtained for Station 5: HES-4

Analysis: HES-4 is a shallow well that taps the surficial aquifer system. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 29, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. A photograph of HES-4 and adjacent well HES-5 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Stations HES-4 and HES-5

3.5.2 Data analysis and revision

The period of record analyzed for well HES-4 extends from March 16, 2005 through September 7, 2007 (Appendix A). The time-series data from that period contain 906 observations with no outliers and 51 missing values. The summary statistics for this well are provided in table 11.

Problem: The time-series data from well HES-4 contain 51 missing values.

Analysis: Missing values occurred from January 18 through February 10, 2006, and possibly result from equipment problems as data from nearby wells are available from that period. Missing values also occurred from October 8 through November 3, 2006, and probably result from budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-4 roughly coincide with peaks and declines in water-level data from nearby wells (HES-1, HES-7, and HES-9) drilled to similar depths (Appendix A). In addition, water levels in the target well increase modestly during periods of excessive rainfall recorded by nearby rain gages, and decline during dry periods. Other factors, such as pumping from nearby productions wells, also appear to be affecting water levels in the target well. Therefore, the time-series data from well HES-4 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required.

Statistics	Original series	Revised series
Minimum (feet)	25.365	25.365
Mean (feet)	26.995	26.995
Median (feet)	27.207	27.207
Maximum (feet)	28.362	28.362
Standard deviation	0.698	0.698
Variance	0.487	0.487
Outliers	0	0
Missing values	51	51

Table 11 Summary statistics of time-series data for Station 5: HES-4

3.6 Station 6: HES-5

HES-5 is a 61-ft deep well located in Hendry County (figs. 1 and 3). HES-5 is located at drill site 2 (HESDS2) on Crook's Ranch, which also includes well HES-4 and stilling well HES-6.

3.6.1 Site and data description

Variable	Original value	Revised value
Station	HES-5	HES-5
Source DBKEY		
MOD1 DBKEY		
Latitude	26 29 56.8	26 29 56.8
Longitude	81 05 57.3	81 05 57.3
X Coordinate	623738.94	623738.94
Y Coordinate	787118.4	787118.4
Land-surface elevation (feet) (NGVD 29)	28.722	28.722
Reference elevation (feet) (NGVD 29)	31.619	31.619
Measuring point (feet)	2.48	2.48
Well bottom elevation (feet) (NGVD 29)	-31.861	-31.861
Strata (feet)	61	61
Sensor elevation (feet) (NGVD 29)	11.479	11.479

Table 12 Site information obtained for Station 6: HES-5

Analysis: HES-5 is a monitoring well that taps the Lower Tamiami aquifer. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 29, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. A photograph of HES-5 and adjacent well HES-4 is shown in the discussion of HES-4. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

3.6.2 Data analysis and revision

The period of record analyzed for well HES-5 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 68 missing values. The summary statistics for this well are provided in table 11.

Problem: The time-series data from well HES-5 contain 68 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, and possibly result from budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). Missing values also occurred from July 8 through August 17, 2007, and possibly result from equipment problems as data from nearby wells are available for the same period. The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-5 closely coincide with peaks and declines in water-level data from nearby wells (HES-2, HES-8, and HES-15) drilled to a similar depth (Appendix A). In addition, water levels in the target well show a general pattern of increase during periods of rain and decrease during the dry season. Other factors, such as withdrawals from nearby production wells, also appear to be affecting water levels in the target wells, as indicated by abrupt oscillations of the water levels, particularly during dry periods. Therefore, the time-series data from well HES-5 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting data from NAVD 88 to NGVD 29.

Statistic	Original series	Revised series
Minimum (feet)	17.326	17.326
Mean (feet)	24.121	24.121
Median (feet)	24.416	24.416
Maximum (feet)	28.046	28.046
Standard deviation	2.678	2.678
Variance	7.174	7.174
Outliers	0	0
Missing values	68	68

Table 13 Summary statistics of original time-series data for Station 6: HES-5

3.7 Station 7: HES-6

HES-6 is a 4-ft deep stilling well located in Hendry County (figs. 1 and 3). HES-6 is located at drill site 2 (HESDS2) on Crook's Ranch, which also includes wells HES-4 and HES-5.

3.7.1 Site and data description

Variable	Original value	Revised value
Station	HES-6	HES-6
Source DBKEY		
MOD1 DBKEY		
Latitude	26 29 56.7	26 29 56.7
Longitude	81 05 53.7	81 05 53.7
X Coordinate	624073.12	624073.12
Y Coordinate	796986.2	796986.2
Land-surface elevation (feet) (NGVD 29)	27.79	27.79
Reference elevation (feet) (NGVD 29)	31.289	31.289
Well bottom elevation (feet) (NGVD 29)	23.79	23.79
Strata (feet)	4	4
Sensor elevation (feet) (NGVD 29)	24.139	24.139

Table 14 Site information obtained for Station 7: HES-6

Analysis: HES-6 is a stilling well that monitors the water level in a wetland. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 29, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The median water level in the well is less than the land-surface elevation (calculated), which indicates the site was only seasonally inundated. A photograph of HES-6 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

HES-6

3.7.2 Data analysis and revision

The period of record analyzed for stilling well HES-6 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 27 missing values. The summary statistics for this station are provided in table 15.

Problem: The time-series data from well HES-6 contain 27 missing values.

Analysis: Missing values from well HES-6 occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from stilling well HES-6 generally coincide with peaks and declines in water-level data from nearby stilling wells (HES-3, HES-16, and HES-19) installed to a similar depth (Appendix A). In addition, water levels in the target well decline as expected during periods of low rainfall, and increase as expected during periods of excessive rainfall recorded by nearby rain gages. Therefore, the time-series data from well HES-6 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	24.778	24.778
Mean (feet)	26.828	26.828
Median (feet)	26.997	26.997
Maximum (feet)	28.500	28.500
Standard deviation	0.944	0.944
Variance	0.891	0.891
Outliers	0	0
Missing values	27	27

Table 15 Summary statistics of time-series data for Station 7: HES-6

3.8 Station 8: HES-7

HES-7 is a 16-ft deep well located in Hendry County (figs. 1 and 3). HES-7 is located at drill site 3 (HESDS3) at Crook's Ranch which also includes well HES-8. The site was briefly equipped with rain station HESDS3_R.

3.8.1 Site and data description

Variable	Original value	Revised value
Station	HES-7	HES-7
Source DBKEY		
MOD1 DBKEY		
Latitude	26 29 12.8	26 29 12.8
Longitude	81 05 37.8	81 05 37.8
X Coordinate	625473.02	625473.02
Y Coordinate	782640.2	782640.2
Land-surface elevation (feet) (NGVD 29)	28.445	28.445
Reference elevation (feet) (NGVD 29)	31.422	31.422
Measuring point (feet)	2.56	2.56
Well bottom elevation (feet) (NGVD 29)	12.862	12.862
Strata (feet)	16	16
Sensor elevation (feet) (NGVD 29)	18.162	18.162

Table 16 Site information obtained for Station 8: HES-7

Analysis: HES-7 is a shallow well that taps the surficial aquifer system. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. A photograph of HES-7 and adjacent well HES-8 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Stations HES-7 and HES-8

Analysis: The value in DBHYDRO was the elevation of the well bottom (ft above mean sea level) listed on the recorder registration worksheet. The Strata is defined as the depth of well in ft below land surface (Sangoyomi and Lambright, 2006). The correct Strata value is 49.6 ft below land surface, which was revised and verified in DBHYDRO during this project.

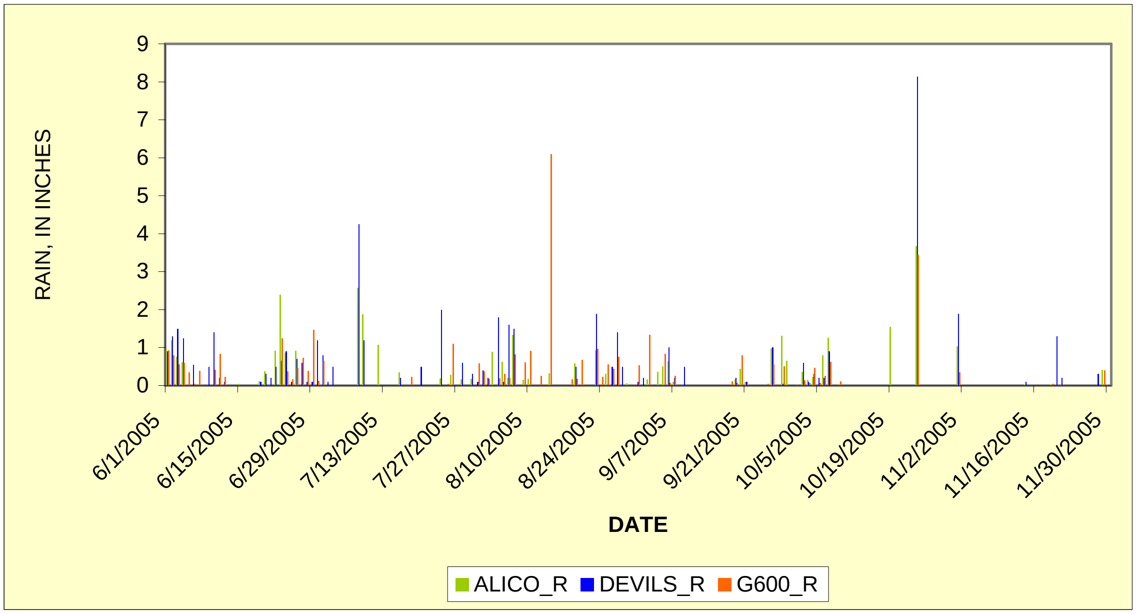
Overall, the site information is consistent, and appears to be accurate. No other revisions were required.

3.8.2 Data analysis and revision

The period of record analyzed for well HES-7 extends from March 16, 2005 through August 18, 2007 (Appendix A). The time-series data from that period contain 886 observations with 80 outliers and 27 missing values. The summary statistics for this well are provided in table 17.

Problem: The time-series data from well HES-7 contain 80 outliers, all of which exceeded the upper outlier of 26.825 ft above mean sea level.

Analysis: The outliers generally coincide with peaks in water levels in nearby wells (HES-1, HES-4, and HES-9) drilled to similar depths. In addition, the outliers occurred shortly after periods of excessive rain. For example, the water level in the target well increased from 24.874 ft above mean sea level on October 23, 2005, to 26.953 ft above mean sea level on the following day. The increase coincided with excessive rainfall of 3.44 to 81.4 inches recorded at three rain stations on October 24 (fig. 6). Hence, the outliers probably result from the water level response to meteorological events and are valid data.



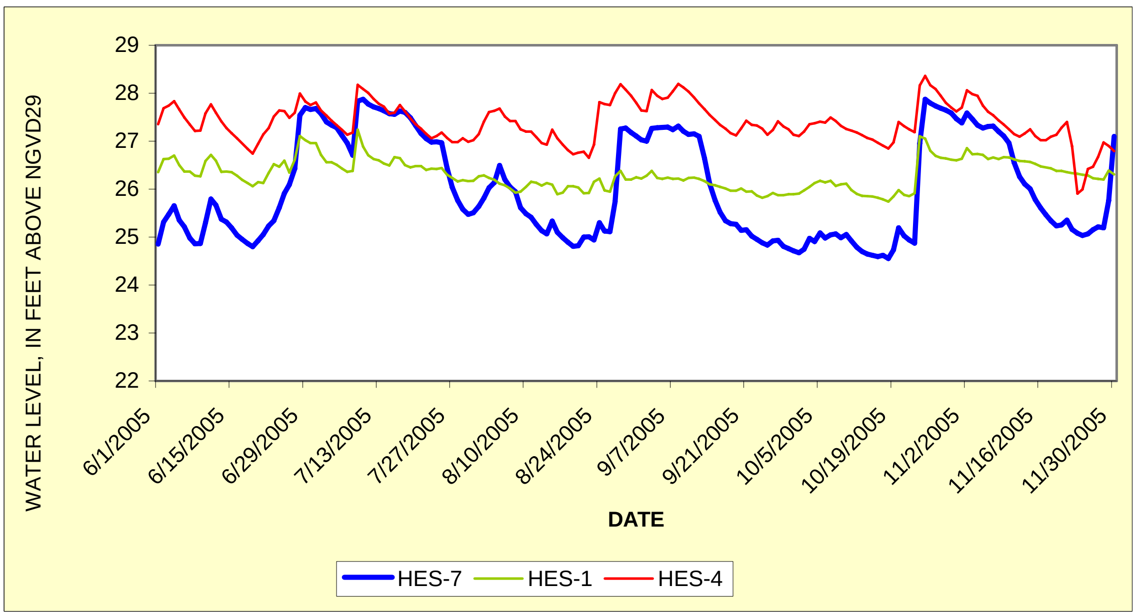


Figure 6 Rain and water level data at well HES-7 and nearby sites.

Problem: The time-series data from HES-7 contain 27 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, and probably result from budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-7 generally coincide with peaks and declines in water-level data from nearby wells (HES-1, HES-4, and HES-9) drilled to similar depths (Appendix A). In addition, water levels in the target well decline as expected during periods of low rainfall, and increase as expected during periods of excessive rainfall recorded by nearby rain gages. Therefore, the time-series data from well HES-7 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	23.303	23.303
Mean (feet)	24.936	24.936
Median (feet)	24.756	24.756
Maximum (feet)	27.876	27.876
Standard deviation	1.002	1.002
Variance	1.004	1.004
Outliers	80	80
Missing values	27	27

Table 17 Summary statistics of original time-series data for Station 8: HES-7

3.9 Station 9: HES-8

HES-8 is an 87-ft deep well located in Hendry County (figs. 1 and 3). HES-8 is located at drill site 3 (HESDS3) on Crook's Ranch, which also includes HES-7. Rainfall at the site was briefly monitored with station HESDS3_R.

3.9.1 Site and data description

Variable	Original value	Revised value
Station	HES-8	HES-8
Source DBKEY		
MOD1 DBKEY		
Latitude	26 29 12.8	26 29 12.8
Longitude	81 05 37.8	81 05 37.8
X Coordinate	625472.53	625472.53
Y Coordinate	782650.1	782650.1
Land-surface elevation (feet) (NGVD 29)	28.525	28.525
Reference elevation (feet) (NGVD 29)	31.442	31.442
Measuring point (feet)	2.5	2.5
Well bottom elevation (feet) (NGVD 29)	-58.058	-58.058
Strata (feet)	87	87
Sensor elevation (feet) (NGVD 29)	11.272	11.272

Table 18 Site information obtained for Station 9: HES-8

Analysis: HES-8 is a monitoring well that taps the Lower Tamiami aquifer. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. A photograph of HES-8 and adjacent well HES-7 is shown in the discussion of HES-7. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

3.9.2 Data analysis and revision

The period of record analyzed for well HES-8 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 54 missing values. The summary statistics for this well are provided in table 19.

Problem: The time-series data from well HES-8 contain 54 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). Missing values also occurred from June 10 through July 6, 2007, possibly indicating equipment issues. However, nearby wells (HES-2, HES-5, and HES-15) are also missing values before, after, and (or) during the same period. The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-8 closely coincide with peaks and declines in water-level data from nearby wells (HES-2, HES-5, and HES-15) drilled to similar depths (Appendix A). In addition, water levels in the target well generally decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. Water levels in the target well also appear to be affected by other factors, such as the withdrawal of water from nearby production wells, as indicated by abrupt oscillations of the data, particularly during periods of low rainfall. The time-series data from well HES-8 appear to be valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	17.308	17.308
Mean (feet)	23.590	23.590
Median (feet)	23.724	23.724
Maximum (feet)	27.313	27.313
Standard deviation	2.388	2.388
Variance	5.703	5.703
Outliers	0	0
Missing values	54	54

Table 19 Summary statistics of time-series data for Station 9: HES-8

3.10 Station 10: HESDS3_R

HESDS3_R is a rain station located in Hendry County (figs. 1 and 3). The station is located at drill site 3 (HESDS3) on Crook's Ranch, which also includes wells HES-7 and HES-8.

3.10.1 Site and data description

Variable	Original value	Revised value
Station	HESDS3_R	HESDS3_R
Source DBKEY		
MOD1 DBKEY		
Latitude	26 29 12.8	26 29 12.8
Longitude	81 05 37.8	81 05 37.8
X Coordinate	625472.53	625472.53
Y Coordinate	782650.1	782650.1

Table 20 Site information obtained for Station 10: HESDS3_R

3.10.2 Data analysis and revision

The period of record analyzed for station HESDS3_R extends from January 6 through October 26, 2007 (Appendix A). The time-series data contain 294 observations with 56 outliers and no missing values.

Problem: The time-series data from HESDS3_R contain 56 outliers, all of which exceed the upper fence of 0.273 inch.

Analysis: The median value for the time-series data is 0, which indicates that no precipitation occurred during at least half the period of record. Therefore, days with even moderate precipitation (greater than 0.27 inch) are statistical outliers. These outliers coincide with moderate to heavy rainfalls recorded at nearby stations. Hence, the outliers are valid data that accurately represent hydrologic conditions at the site.

Summary: The precipitation recorded at HESDS3_R coincides with precipitation data from nearby wells (ALICO_R, DEVILS_R, and HESDS5_R), particularly with excessive rainfall of 1 inch or more (Appendix A). In addition, periods of low rainfall also coincide with dry periods recorded at nearby stations. The time-series data from HESDS3_R probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required.

Statistics	Original series	Revised series
Minimum (feet)	0.000	0.000
Mean (feet)	0.134	0.134
Median (feet)	0.000	0.000
Maximum (feet)	2.670	2.670
Standard deviation	0.371	0.371
Variance	0.138	0.138
Outliers	56	56
Missing values	0	0

Table 21 Summary statistics of time-series data for Station 10: HESDS3_R

3.11 Station 11: HES-9

HES-9 is a 14-ft deep well located in Hendry County (figs. 1 and 3). HES-9 is located at drill site 4 (HESDS4) on Crook's Ranch, which also includes well HES-10 and stilling well HES-11.

3.11.1 Site and data description

Variable	Original value	Revised value
Station	HES-9	HES-9
Source DBKEY		
MOD1 DBKEY		
Latitude	26 28 14	26 28 14
Longitude	81 06 10.9	81 06 10.9
X Coordinate	622468.79	622468.79
Y Coordinate	776542	776542
Land-surface elevation (feet) (NGVD 29)	27.545	27.545
Reference elevation (feet) (NGVD 29)	30.452	30.452
Measuring point (feet)	2.49	2.49
Well bottom elevation (feet) (NGVD 29)	13.962	13.962
Strata (feet)	14	14
Sensor elevation (feet) (NGVD 29)	17.232	17.232

Table 22 Site information obtained for Station 11: HES-9

Analysis: HES-9 is a shallow well that taps the surficial aquifer system. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. The maximum water level in the well is slightly higher than the land-surface elevation, indicating the site is periodically inundated. A photograph of HES-9 and adjacent well HES-10 (below) shows the site with standing water. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Stations HES-9 and HES-10

3.11.2 Data analysis and revision

The period of record analyzed for well HES-9 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 27 missing values. The summary statistics for this well are provided in table 23.

Problem: The time-series data from well HES-9 contain 27 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-9 coincide with peaks and declines in water-level data from nearby wells (HES-1, HES-4, and HES-7) drilled to similar depths (Appendix A). In addition, water levels in the target well generally decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. The time-series data from well HES-9 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	22.719	22.719
Mean (feet)	25.687	25.687
Median (feet)	26.005	26.005
Maximum (feet)	27.829	27.829
Standard deviation	1.390	1.390
Variance	1.932	1.932
Outliers	0	0
Missing values	27	27

Table 23 Summary statistics of time-series data for Station 11: HES-9

3.12 Station 12: HES-10

HES-10 is a 91-ft deep well located in Hendry County (figs. 1 and 3). HES-10 is located at drill site 4 (HESDS4) on Crook's Ranch, which also includes well HES-9 and stilling well HES-11.

3.12.1 Site and data description

Variable	Original value	Revised value
Station	HES-10	HES-10
Source DBKEY		
MOD1 DBKEY		
Latitude	26 28 14	26 28 14
Longitude	81 06 10.9	81 06 10.9
X Coordinate	622478.96	622478.96
Y Coordinate	776540.9	776540.9
Land-surface elevation (feet) (NGVD 29)	27.585	27.585
Reference elevation (feet) (NGVD 29)	30.482	30.482
Measuring point (feet)	2.48	2.48
Well bottom elevation (feet) (NGVD 29)	-62.998	-62.998
Strata (feet)	91	91
Sensor elevation (feet) (NGVD 29)	10.262	10.262

Table 24 Site information obtained for Station 12: HES-10

Analysis: HES-10 is a monitoring well that taps the Lower Tamiami aquifer. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft)

from the benchmark elevation. A photograph of HES-10 and adjacent well HES-9 is shown in the discussion of HES-9. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

3.12.2 Data analysis and revision

The period of record analyzed for well HES-10 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 27 missing values. The summary statistics for this well are provided in table 25.

Problem: The time-series data from well HES-10 contain 27 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-10 closely coincide with peaks and declines in water-level data from nearby wells (HES-2, HES-8, and HES-13) drilled to similar depths (Appendix A). In addition, water levels in the target well generally decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. Other factors, such as withdrawals from nearby productions wells, appears to be affecting water levels in the target well, as indicated by abrupt oscillations in the data, particularly during dry periods. Oscillations are present in water levels in nearby wells, so equipment malfunctions are not likely the cause. Therefore, the time-series data from well HES-10 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	16.435	16.435
Mean (feet)	22.731	22.731
Median (feet)	23.025	23.025
Maximum (feet)	26.938	26.938
Standard deviation	2.634	2.634
Variance	6.938	6.938
Outliers	0	0
Missing values	27	27

Table 25 Summary statistics of time-series data for Station 12: HES-10

3.13 Station 13: HES-11

HES-11 is a 5-ft deep stilling well located in Hendry County (figs. 1 and 3). HES-11 is located at drill site 4 (HESDS4) on Crook's Ranch. The drill site also includes wells HES-9 and HES-10.

3.13.1 Site and data description

Variable	Original value	Revised value
Station	HES-11	HES-11
Source DBKEY		
MOD1 DBKEY		
Latitude	26 28 13.8	26 28 13.8
Longitude	81 06 11.5	81 06 11.5
X Coordinate	622370	622370
Y Coordinate	775720	775720
Land-surface elevation (feet) (NGVD 29)	27.09	27.09
Reference elevation (feet) (NGVD 29)	30.592	30.592
Well bottom elevation (feet) (NGVD 29)	22.09	22.09
Strata (feet)	5	5
Sensor elevation (feet) (NGVD 29)	23.442	23.442

Table 26 Site information obtained for Station 13: HES-11

Analysis: HES-11 is a stilling well that monitors the water level in a wetland. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The median water level in the well is less than the land-surface elevation (calculated), which indicates the site was only seasonally inundated. A photograph of HES-11 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Station HES-11

3.13.2 Data analysis and revision

The period of record analyzed for well HES-11 extends from March 16, 2005 through October 20, 2006 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 27 missing values. The summary statistics for this well are provided in table 27.

Problem: The time-series data from well HES-11 contain 27 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Problem: The water-level data in the target well appear anomalously flat from March 20 through May 7, 2007.

Analysis: The water level in the target well appears to have declined below the level of the pressure transducer in the well, which would result in a flat, steady period of data. The pressure transducer is set at an elevation of 23.442 ft above mean sea level. The water level in the target well recorded during this period ranges from 23.18 to 23.26 ft above mean sea level. The daily values were coded with a less than sign (<) for uploading into DBHYDRO. For the preferred data set (MOD1), the suspect data were deleted and coded as M for uploading into DBHYDRO (figure 7).

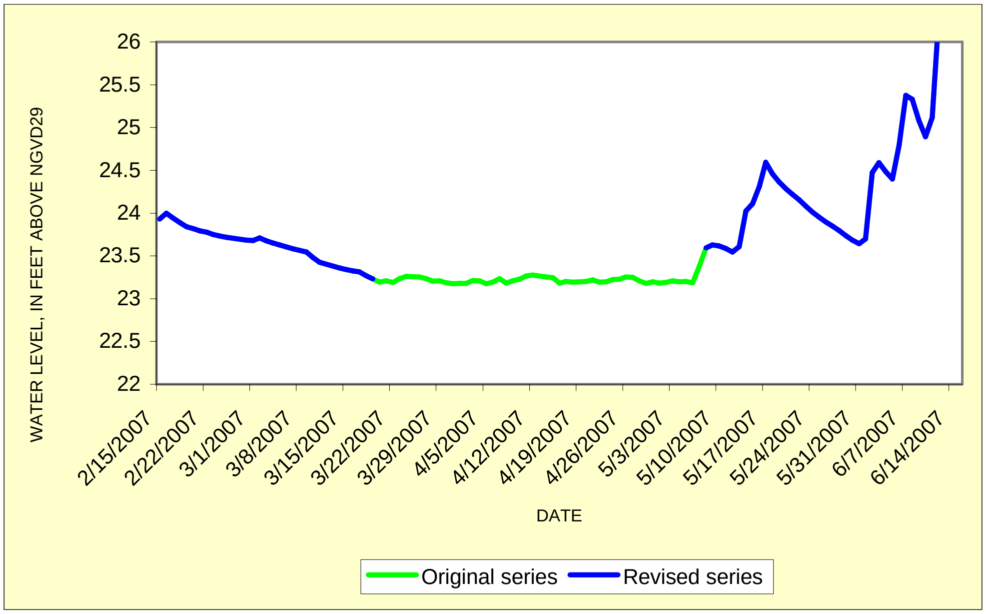


Figure 7 Water-level data from stilling well HES-11 (blue). The water levels from March 20 – May 7 (green) were below the sensor, so the data were deleted in the revised series.

Summary: The peaks and declines in water-level data from stilling well HES-11 generally coincide with peaks and declines in water-level data from nearby wells (HES-3, HES-6, and HES-16) drilled to similar depths (Appendix A). In addition, water levels in the target well decline as expected during periods of low rainfall, and increase as expected during periods of excessive rainfall recorded by nearby rain gages. Therefore, the time-series data from stilling well HES-11 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than deleting the suspect data that resulted from the water level declining below the elevation of the pressure transducer. The data also were converted from NAVD88 to NGVD29.

Statistics	Original series	Revised series
Minimum (feet)	23.176	23.223
Mean (feet)	25.799	25.944
Median (feet)	26.433	26.548
Maximum (feet)	27.900	27.900
Standard deviation	1.448	1.349
Variance	2.098	1.820
Outliers	0	0
Missing values	27	76

Table 27 Summary statistics of time-series data for Station 13: HES-11

3.14 Station 14: HES-12

HES-12 is a 31-ft deep well located in Hendry County (figs. 1 and 3). The well is located at drill site 5 (HSDS5) on Crook's Ranch. A second well, HES-13, and rain station HESDS5_R are also located at the same drill site.

3.14.1 Site and data description

Variable	Original value	Revised value
Station	HES-12	HES-12
Source DBKEY		
MOD1 DBKEY		
Latitude	26 27 34.3	26 27 34.3
Longitude	81 06 20.4	81 06 20.4
X Coordinate	621596.4	621596.4
Y Coordinate	772738.8	772738.8
Land-surface elevation (feet) (NGVD 29)	27.198	27.198
Reference elevation (feet) (NGVD 29)	30.315	30.315
Measuring point (feet)	2.7	2.7
Well bottom elevation (feet) (NGVD 29)	-3.385	-3.385
Strata (feet)	31	31
Sensor elevation (feet) (NGVD 29)	17.215	17.215

Table 28 Site information obtained for Station 14: HES-12

Analysis: HES-12 is a shallow well that taps the surficial aquifer system. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. The maximum water level in the well is slightly higher than the land-surface elevation, indicating the site is periodically inundated. A photograph of HES-12 and adjacent well HES-13 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Stations HES-12 and HES-13

3.14.2 Data analysis and revision

The period of record analyzed for well HES-12 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 45 missing values. The summary statistics for this well are provided in table 29.

Problem: The time-series data from well HES-12 contain 45 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). Missing values also occurred from July 31 through August 17, 2007. Data are available from nearby wells (HES-1, HES-7, and HES-9) during the same period, so the missing data from the target well possibly resulted from equipment malfunctions specific to that well. Missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-12 coincide with peaks and declines in water-level data from nearby wells (HES-1, HES-7, and HES-9) drilled to similar depths (Appendix A). In addition, water levels in the target well decline as expected during periods of low rainfall, and increase as expected during periods of excessive rainfall recorded by nearby rain gages. Therefore, the time-series data from well HES-12 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required.

Statistics	Original series	Revised series
Minimum (feet)	22.312	22.312
Mean (feet)	24.139	24.139
Median (feet)	23.870	23.870
Maximum (feet)	27.409	27.409
Standard deviation	1.168	1.168
Variance	1.365	1.365
Outliers	0	0
Missing values	45	45

Table 29 Summary statistics of time-series data for Station 14: HES-12

3.15 Station 15: HES-13

HES-13 is an 88-ft deep well located in Hendry County (figs. 1 and 3). HES-13 is located at Crook's Ranch drill site 5 (HESDS5), along with adjacent well HES-12 and rain station HESDS5_R.

3.15.1 Site and data description

Variable	Original value	Revised value
Station	HES-13	HES-13
Source DBKEY		
MOD1 DBKEY		
Latitude	26 27 34.3	26 27 34.3
Longitude	81 06 20.4	81 06 20.4
X Coordinate	621585	621585
Y Coordinate	772740	772740
Land-surface elevation (feet) (NGVD 29)	27.318	27.318
Reference elevation (feet) (NGVD 29)	30.325	30.325
Measuring point (feet)	2.59	2.59
Well bottom elevation (feet) (NGVD 29)	-60.265	-60.265
Strata (feet)	88	88
Sensor elevation (feet) (NGVD 29)	10.005	10.005

Table 30 Site information obtained for Station 15: HES-13

Analysis: HES-13 is a monitoring well that taps the Lower Tamiami aquifer. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft)

from the benchmark elevation. A photograph of HES-13 and adjacent well HES-12 is shown in the discussion of HES-12. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

3.15.2 Data analysis and revision

The period of record analyzed for well HES-13 extends from March 16, 2005 through September 8, 2007 (Appendix A). The time-series data from that period contain 907 observations with no outliers and 38 missing values. The summary statistics for this well are provided in table 31.

Problem: The time-series data from well HES-13 contain 38 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year. Missing values also occurred from August 7 – 17, 2007. Data were available from nearby wells (HES-2, HES-8, and HES-10) during the same period, so the missing data from the target well probably resulted from equipment malfunction at that specific well. Missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-13 closely coincide with peaks and declines in water-level data from nearby wells (HES-2, HES-8, and HES-10) drilled to similar depths (Appendix A). In addition, water levels in the target well decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. Other factors, such as withdrawals from nearby production wells, also appear to be affecting water levels in the target well, as indicated by oscillations in the data, particularly during dry periods. Therefore, the time-series data from well HES-13 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the data from NAVD88 to NGVD29.

Statistics	Original series	Revised series
Minimum (feet)	15.444	15.444
Mean (feet)	21.890	21.890
Median (feet)	22.231	22.231
Maximum (feet)	25.828	25.828
Standard deviation	2.445	2.445
Variance	5.980	5.980
Outliers	0	0
Missing values	38	38

Table 31 Summary statistics of time-series data for Station 15: HES-13

3.16 Station 16: HESDS5_R

HESDS5_R is a rain station located in Hendry County (figs. 1 and 3). HESDS5_R is located at Crook's Ranch drill site 5 (HESDS5), along with adjacent wells HES-12 and HES-13.

3.16.1 Site and data description

Variable	Original value	Revised value
Station	HESDS5_R	HESDS5_R
Source DBKEY		
MOD1 DBKEY		
Latitude	26 27 34.3	26 27 34.3
Longitude	81 06 20.4	81 06 20.4
X Coordinate	621585	621585
Y Coordinate	772740	772740

Table 32 Site information obtained for Station 16: HESDS5_R

3.16.2 Data analysis and revision

The period of record analyzed for well HESDS5_R extends from January 6 through October 26, 2007 (Appendix A). The time-series data contain 294 observations with 55 outliers and no missing values.

Problem: The time-series data from HESDS5_R contain 55 outliers, all of which exceed the upper fence of 0.283 inch.

Analysis: The median value for the time-series data is 0, which indicates that no precipitation occurred during at least half the period of record. Therefore, days with even moderate precipitation (greater than 0.28 inch) are statistical outliers. These outliers coincide with moderate to heavy rainfalls recorded at nearby stations. Hence, the outliers are valid data that accurately represent hydrologic conditions at the site.

Summary: The precipitation recorded at HESDS5_R coincides with precipitation data from nearby wells (ALICO_R, DEVILS_R, and HESDS3_R), particularly with excessive rainfall of 1 inch or more (Appendix A). In addition, periods of low rainfall also coincide with dry periods recorded at nearby stations. The time-series data from HESDS5_R probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required.

Statistics	Original series	Revised series
Minimum (feet)	0.000	0.000
Mean (feet)	0.135	0.135
Median (feet)	0.000	0.000
Maximum (feet)	2.530	2.530
Standard deviation	0.343	0.343
Variance	0.117	0.117
Outliers	55	55
Missing values	0	0

Table 33 Summary statistics of time-series data for Station 16: HESDS5_R

3.17 Station 17: HES-14

HES-14 is a 20-ft deep well located in Hendry County (figs. 1 and 3). HES-14 is located Golden Ox Ranch drill site 6 (HESDS6), along with adjacent well HES-15, and stilling well HES-16.

3.17.1 Site and data description

Variable	Original value	Revised value
Station	HES-14	HES-14
Source DBKEY		
MOD1 DBKEY		
Latitude	26 30 12.5	26 30 12.5
Longitude	81 07 06.4	81 07 06.4
X Coordinate	617286.36	617286.36
Y Coordinate	788221.2	788221.2
Land-surface elevation (feet) (NGVD 29)	25.388	25.388
Reference elevation (feet) (NGVD 29)	28.355	28.355
Measuring point (feet)	2.55	2.55
Well bottom elevation (feet) (NGVD 29)	5.805	5.805
Strata (feet)	20	20
Sensor elevation (feet) (NGVD 29)	15.23	15.23

Table 34 Site information obtained for Station 17: HES-14

Analysis: HES-14 is a shallow well that taps the surficial aquifer system. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. The maximum water level in the well is higher than the land-surface elevation, indicating the site is periodically inundated. A photograph of HES-14 and adjacent well HES-15 (below) shows the site inundated with water. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Stations HES-14 and HES-15

3.17.2 Data analysis and revision

The period of record analyzed for well HES-14 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 27 missing values. The summary statistics for this well are provided in table 35.

Problem: The time-series data from well HES-14 contain 27 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). Missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-14 roughly coincide with peaks and declines in water-level data from nearby wells (HES-1, HES-4, and HES-17) drilled to similar depths (Appendix A). In addition, water levels in the target well generally decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. Short-term oscillations in the water levels from the target well could indicate effects of withdrawals from nearby production wells. The time-series data from well HES-14 probably are valid data that accurately represent hydrologic conditions at the site. No other revisions were required, other than converting the time-series data from NAVD88 to NGVD29.

Statistics	Original series	Revised series
Minimum (feet)	19.720	19.720
Mean (feet)	23.131	23.131
Median (feet)	23.170	23.170
Maximum (feet)	26.184	26.184
Standard deviation	1.834	1.834
Variance	3.365	3.365
Outliers	0	0
Missing values	27	27

Table 35 Summary statistics of time-series data for Station 17: HES-14

3.18 Station 18: HES-15

HES-15 is a 71-ft deep well located in Hendry County (figs. 1 and 3). HES-15 is located at the Golden Ox Ranch drill site 6 (HESDS6), which also includes well HES-14 and stilling well HES-16.

3.18.1 Site and data description

Variable	Original value	Revised value
Station	HES-15	HES-15
Source DBKEY		
MOD1 DBKEY		
Latitude	26 30 12.5	26 30 12.5
Longitude	81 07 06.4	81 07 06.4
X Coordinate	617288.17	617288.17
Y Coordinate	788231.5	788231.5
Land-surface elevation (feet) (NGVD 29)	25.428	25.428
Reference elevation (feet) (NGVD 29)	28.475	28.475
Measuring point (feet)	2.63	2.63
Well bottom elevation (feet) (NGVD 29)	-45.155	-45.155
Strata (feet)	71	71
Sensor elevation (feet) (NGVD 29)	8.15	8.15

Table 36 Site information obtained for Station 18: HES-15

Analysis: HES-15 is a monitoring well that taps the Lower Tamiami aquifer. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft)

from the benchmark elevation. A photograph of HES-15 and adjacent well HES-14 is shown in the discussion of HES-14. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

3.18.2 Data analysis and revision

The period of record analyzed for well HES-15 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 70 missing values. The summary statistics for this well are provided in table 37.

Problem: The time-series data from well HES-15 contain 70 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). Missing values also occurred from March 11 through April 6, 2007, and from May 24 through June 8, 2007. These gaps probably result from equipment malfunctions. Well HES-2 also was missing data from the latter period, but the overlapping gaps could be a coincidence. Missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-15 coincide with peaks and declines in water-level data from nearby wells (HES-2, HES-5, and HES-15) drilled to similar depths (Appendix A). In addition, water levels in the target well decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. Short-term oscillations indicate that the water level in the target well could be affected by other factors, such as withdrawals from nearby production wells. The time-series data from well HES-15 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the time-series data from NAVD88 to NGVD29.

Statistics	Original series	Revised series
Minimum (feet)	18.888	18.888
Mean (feet)	23.101	23.101
Median (feet)	23.152	23.152
Maximum (feet)	26.125	26.125
Standard deviation	1.818	1.818
Variance	3.305	3.305
Outliers	0	0
Missing values	70	70

Table 37 Summary statistics of time-series data for Station 18: HES-15

3.19 Station 19: HES-16

HES-16 is a 5-ft deep stilling well located in Hendry County (figs. 1 and 3). HES-16 is located at the Golden Ox Ranch drill site 6 (HESDS6), which also includes well HES-14 and HES-15.

3.19.1 Site and data description

Variable	Original value	Revised value
Station	HES-16	HES-16
Source DBKEY		
MOD1 DBKEY		
Latitude	26 30 14.4	26 30 14.4
Longitude	81 07 03.2	81 07 03.2
X Coordinate	617450	617450
Y Coordinate	788485	788485
Land-surface elevation (feet) (NGVD 29)	26.38	26.38
Reference elevation (feet) (NGVD 29)	29.875	29.875
Well bottom elevation (feet) (NGVD 29)	21.38	21.38
Strata (feet)	5	5
Sensor elevation (feet) (NGVD 29)	22.745	22.745

Table 38 Site information obtained for Station 19: HES-16

Analysis: HES-16 is a stilling well that monitors the water level in a wetland. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on July 1, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The median water level in the well is less than the land-surface elevation (calculated), which indicates the site was only seasonally inundated. A photograph of HES-16 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Station HES-16

3.19.2 Data analysis and revision

The period of record analyzed for well HES-16 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data from that period contain 949 observations with no outliers and 27 missing values. The summary statistics for this well are provided in table 39.

Problem: The time-series data from well HES-16 contain 27 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, probably as a result of budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). The missing values were coded as M for uploading into DBHYDRO.

Problem: The time-series data from well HES-16 contain two periods of anomalously flat data.

Analysis: The anomalous data occurred from May 4 through July 20, 2006, and from February 28 through June 10, 2007, during periods of low rain fall. The water level in the stilling well appears to have declined below the elevation of the pressure transducer. The water level during these two periods averaged about 21.6 ft above mean sea level (fig. 8), which is less than the listed elevation of 22.745 ft for the pressure transducer. The suspect data were coded with less than signs (<) for the standard data set, and deleted from the preferred data set (MOD1). The missing values were coded as M for uploading into DBHYDRO.

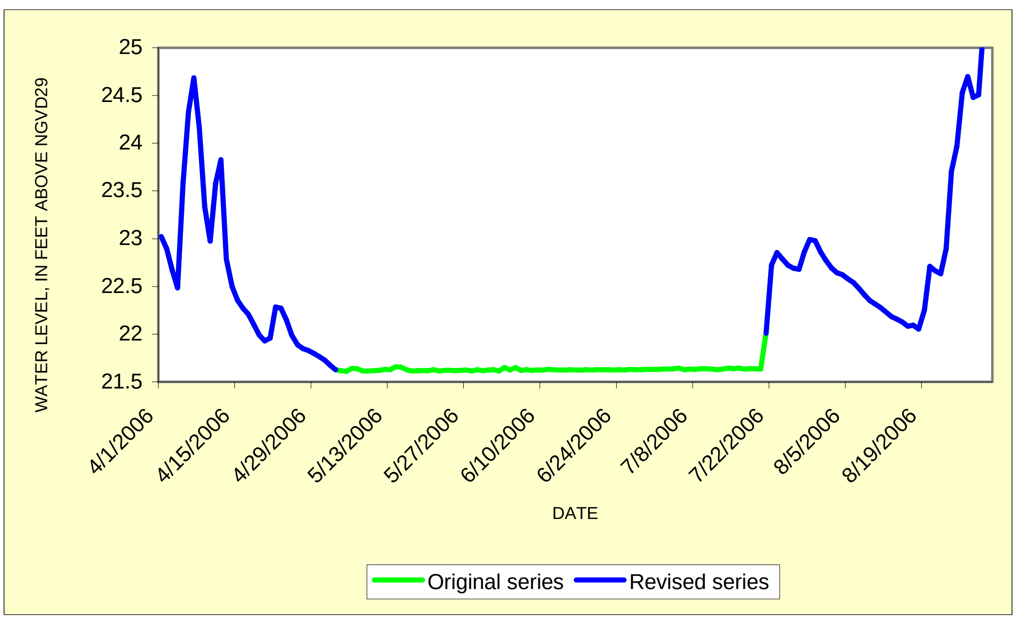


Figure 8 Water-level data from target well (blue) contained anomalously flat periods, which resulted from the water level declining below the pressure transducer. The suspect data (green) were deleted for the preferred data set.

Summary: The peaks and declines in water-level data from stilling well HES-16 roughly coincide with peaks and declines in water-level data from nearby wells (HES-3, HES-6, and HES-19) drilled to similar depths (Appendix A). In addition, water levels in the target well generally decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. The time-series data from stilling well HES-16 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than deleting the suspect data resulting from declining water levels. The time-series data also were converted from NAVD88 to NGVD29.

Statistics	Original series	Revised series
Minimum (feet)	21.608	21.624
Mean (feet)	23.822	24.355
Median (feet)	23.795	24.719
Maximum (feet)	26.401	26.401
Standard deviation	1.652	1.396
Variance	2.729	1.949
Outliers	0	0
Missing values	27	208

Table 39 Summary statistics of time-series data for Station 19: HES-16

3.20 Station 20: HES-17

HES-17 is a 10-ft deep well located in Hendry County (figs. 1 and 3). The well is located at the Golden Ox Ranch drill site 7 (HESDS7), which also includes well HES-18, stilling well HES-19, and rain station HESDS7_R.

3.20.1 Site and data description

Variable	Original value	Revised value
Station	HES-17	HES-17
Source DBKEY		
MOD1 DBKEY		
Latitude	26 30 43.6	26 30 43.6
Longitude	81 07 15.6	81 07 15.6
X Coordinate	616570	616570
Y Coordinate	791845	791845
Land-surface elevation (feet) (NGVD 29)	30.935	30.935
Reference elevation (feet) (NGVD 29)	33.932	33.932
Measuring point (feet)	2.58	2.58
Well bottom elevation (feet) (NGVD 29)	21.352	21.352
Strata (feet)	10	10
Sensor elevation (feet) (NGVD 29)	22.732	22.732

Table 40 Site information obtained for Station 20: HES-17

Analysis: HES-17 is a shallow well that taps the surficial aquifer system. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. A photograph of HES-17 and adjacent well HES-18 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Stations HES-17 and HES-18

3.20.2 Data analysis and revision

The period of record analyzed for well HES-17 extends from March 16, 2005 to June 9, 2007 (Appendix A). The time-series data for that period contain 816 observations with 89 outliers and 50 missing values. The summary statistics for well HES-17 are provided in table 41.

Problem: The time-series data from well HES-17 contain 50 missing values.

Analysis: Missing values occurred from August 17 through September 8, 2006, and from October 8 through November 3, 2006. The first gap probably resulted from equipment malfunction, as data were available from nearby wells (HES-1, HES-4, and HES-14). The latter gap probably resulted from budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). Missing values were coded as M for uploading into DBHYDRO.

Problem: The time-series data from well HES-17 contain 89 outliers, most of which were less than the lower fence.

Analysis: Outliers less than the lower fence of 26.351 ft above mean sea level occurred from May 10 through July 21, 2006 (fig. 9) and from May 1 – 7, 2007. These declines in water levels in the target well coincide dry periods and with similar declines in nearby wells, particularly HES-14, and therefore probably are valid data.

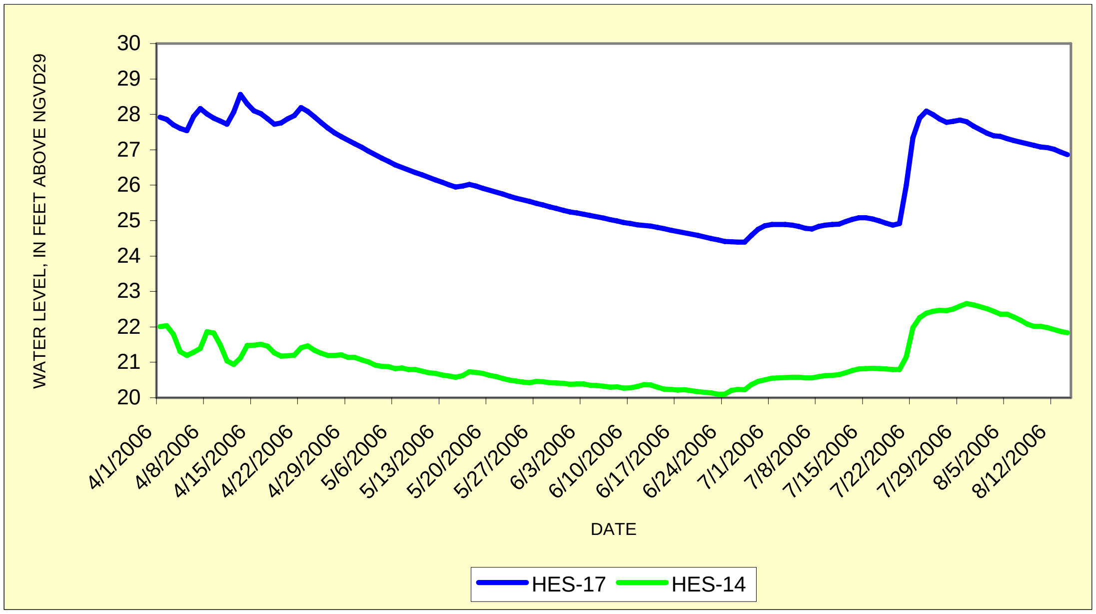


Figure 9 Water level data from target well (blue) contained lower outliers from May 10 through July 31 that coincide with water-level declines in a nearby well HES-14 (green).

Outliers that exceeded the upper fence of 29.995 ft above mean sea level occurred from July 9 – 15, 2005, after excessive (greater than 1 inch) rainfalls on July 8, 9 and 12 resulted in a rapid increase in water level in the target well. This peak in the water level in the target well coincided with similar peaks in nearby wells (HES-1 and HES-4). The outliers probably are valid data that accurately represent hydrologic conditions at the site.

Summary: The peaks and declines in water-level data from well HES-17 roughly coincide with peaks and declines in water-level data from nearby wells (HES-1, HES-4, and HES-14) drilled to similar depths (Appendix A). In addition, water levels in the target well decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. The time-series data from well HES-17 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	24.393	24.393
Mean (feet)	27.967	27.967
Median (feet)	28.281	28.281
Maximum (feet)	30.331	30.331
Standard deviation	1.163	1.163
Variance	1.353	1.353
Outliers	89	89
Missing values	50	50

Table 41 Summary statistics of time-series data for Station 17: HES-17

3.21 Station 21: HES-18

HES-18 is a 56-ft deep well located in Hendry County (figs. 1 and 3). HES-18 is located at Golden Ox Ranch drill site 7 (HESDS7), which also includes well HES-17, stilling well HES-19, and rain station HESDS7_R.

3.21.1 Site and data description

Variable	Original value	Revised value
Station	HES-18	HES-18
Source DBKEY		
MOD1 DBKEY		
Latitude	26 3043.6	26 3043.6
Longitude	81 07 15.6	81 07 15.6
X Coordinate	616570	616570
Y Coordinate	791855	791855
Land-surface elevation (feet) (NGVD 29)	30.205	30.205
Reference elevation (feet) (NGVD 29)	33.352	33.352
Measuring point (feet)	2.73	2.73
Well bottom elevation (feet) (NGVD 29)	-25.378	-25.378
Strata (feet)	56	56
Sensor elevation (feet) (NGVD 29)	13.012	13.012

Table 42 Site information obtained for Station 21: HES-18

Analysis: HES-18 is a monitoring well that taps the Lower Tamiami aquifer. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The land-surface elevation was not surveyed, but was calculated by subtracting the pad height (0.417 ft) from the benchmark elevation. A photograph of HES-18 and adjacent well HES-17 is shown in the discussion of HES-17. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

3.21.2 Data analysis and revision

The period of record analyzed for well HES-18 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data for that period contain 949 observations with no outliers and 27 missing values. The summary statistics for well HES-18 are provided in table 43.

Problem: The time-series data from well HES-18 contain 27 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, and probably result from budgetary constraints at the start of a new fiscal year. Missing values were coded as M for uploading into DBHYDRO.

Summary: The peaks and declines in water-level data from well HES-18 coincide with peaks and declines in water-level data from nearby wells (HES-2, HES-5, and HES-15) drilled to similar depths (Appendix A). Water levels in the target well generally decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. Other factors, such as withdrawals from nearby production wells, probably also affect water levels in the target well, as indicated by the short-term fluctuations in data, particularly during dry periods. The time-series data from well HES-18 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than converting the data from NAVD 88 to NGVD 29.

Statistics	Original series	Revised series
Minimum (feet)	21.293	21.293
Mean (feet)	26.557	26.557
Median (feet)	26.612	26.612
Maximum (feet)	29.905	29.905
Standard deviation	1.865	1.865
Variance	3.476	3.476
Outliers	0	0
Missing values	27	27

Table 43 Summary statistics of time-series data for Station 21: HES-18

3.22 Station 22: HES-19

HES-19 is a 5-ft deep well located in Hendry County (figs. 1 and 3). HES-19 is located at Golden Ox Ranch drill site 7 (HESDS7), which also includes wells HES-17 and HES-18, and rain station HESDS7_R.

3.22.1 Site and data description

Variable	Original value	Revised value
Station	HES-19	HES-19
Source DBKEY		
MOD1 DBKEY		
Latitude	26 30 43.6	26 30 43.6
Longitude	81 07 15.6	81 07 15.6
X Coordinate	616530	616530
Y Coordinate	792000	792000
Land-surface elevation (feet) (NGVD 29)	30.11	30.11
Reference elevation (feet) (NGVD 29)	33.612	33.612
Well bottom elevation (feet) (NGVD 29)	25.11	25.11
Strata (feet)	5	5
Sensor elevation (feet) (NGVD 29)	26.472	26.472

Table 44 Site information obtained for Station 22: HES-19

Analysis: HES-19 is a stilling well that monitors the water level in a wetland. The benchmark and reference elevations are consistent with water-level data collected at the site, and appear to be accurate. The well was surveyed on June 30, 2005 (Scott, Jones, PE, Johnson-Prewitt and Associates, Inc., written commun.,, 2008). The median water level in the well is less than the land-surface elevation (calculated), which indicates the site was only seasonally inundated. A photograph of HES-19 is shown below. No revisions were necessary, other than converting elevations from NAVD 88 to NGVD 29.

Station HES-19

3.22.2 Data analysis and revision

The period of record analyzed for well HES-19 extends from March 16, 2005 through October 20, 2007 (Appendix A). The time-series data for that period contain 949 observations with 1 outlier and 27 missing values. The summary statistics for well HES-19 are provided in table 45.

Problem: The time-series data from HES-19 contain 1 outlier.

Analysis: The single outlier occurred near the end of the wet season on September 25, 2007, and exceeded the upper fence of 31.67 ft above mean sea level. The outlier also coincided with similar peaks in nearby stilling wells (HES-3, HES-6, and HES-16). Hence, the outlier probably is a valid data point that accurately represents hydrologic conditions at the site.

Problem: The time-series data for well HES-19 contain 27 missing values.

Analysis: Missing values occurred from October 8 through November 3, 2006, and probably results from budgetary constraints at the start of a new fiscal year (Cindy Bevier, SFWMD, personal commun., 2008). Missing values were coded as M for uploading into DBHYDRO.

Problem: The time-series data from well HES-19 contain four periods of anomalously flat data.

Analysis: The anomalous data occurred from May 9 through July 22, 2006, August 9 – 19, 2006 (fig. 10), April 21 through May 14, 2007, and from May 24 through June 10, 2007, during periods of low rain fall. The water level in the stilling well appears to have declined below the elevation of the pressure transducer. The water level during these periods averaged less than 26.4 ft above mean sea level, which is less than the listed elevation of 26.472 ft for the pressure transducer. The suspect data were coded with less than signs (<) for the standard data set, and deleted from the preferred data set (MOD1). The missing values were coded as M for uploading into DBHYDRO.

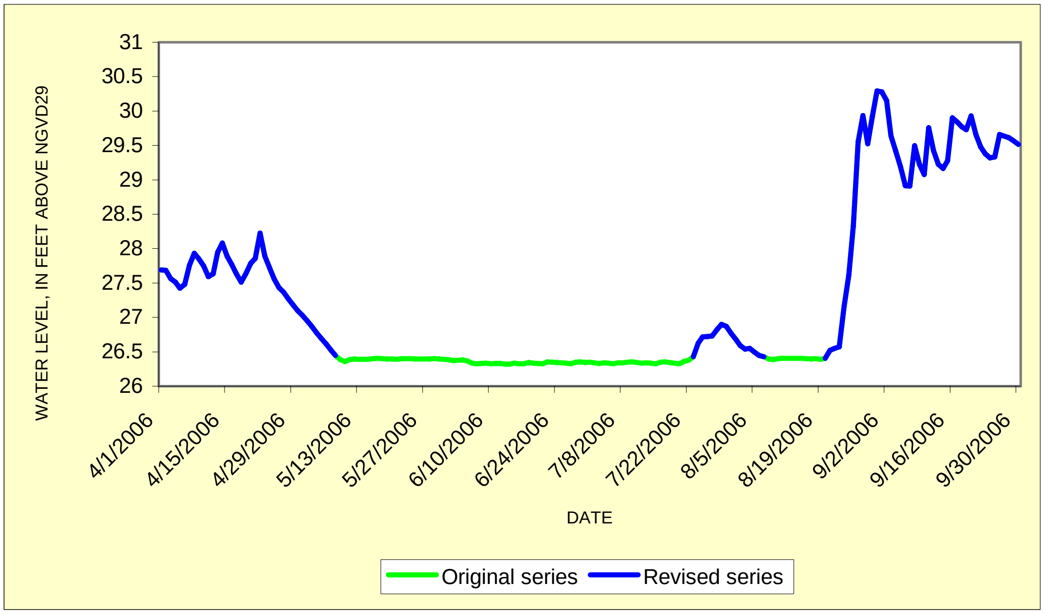


Figure 10 Water-level data from target well (blue) contained anomalously flat periods, which resulted from the water level declining below the pressure transducer. The suspect data (green) were deleted for the preferred data set.

Summary: The peaks and declines in water-level data from stilling well HES-19 roughly coincide with peaks and declines in water-level data from nearby wells (HES-3, HES-6, and HES-16) drilled to similar depths (Appendix A). In addition, water levels in the target well generally decline during periods of low rainfall, and increase during periods of excessive rainfall recorded by nearby rain gages. The time-series data from stilling well HES-19 probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required, other than deleting anomalous data from dry periods. The time-series data also were converted from NAVD88 to NGVD29.

Statistics	Original series	Revised series
Minimum (feet)	26.305	26.318
Mean (feet)	28.212	28.515
Median (feet)	28.185	28.385
Maximum (feet)	31.690	31.690
Standard deviation	1.245	1.072
Variance	1.551	1.149
Outliers	1	8
Missing values	27	156

Table 45 Summary statistics of time-series data for Station 22: HES-19

3.23 Station 23: HESDS7_R

HESDS7_R is a rain station located in Hendry County (figs. 1 and 3). HESDS7_R is located at Golden Ox Ranch drill site 7 (HESDS7), which also includes wells HES-17 and HES-18, and stilling well HES-19.

3.23.1 Site and data description

Variable	Original value	Revised value
Station	HESDS7_R	HES-18
Source DBKEY		
MOD1 DBKEY		
Latitude	26 3043.6	26 3043.6
Longitude	81 07 15.6	81 07 15.6
X Coordinate	616570	616570
Y Coordinate	791855	791855

Table 46 Site information obtained for Station 23: HESDS7_R

3.23.2 Data analysis and revision

The period of record analyzed for station HESDS7_R extends from January 6 through August 18, 2007 (Appendix A). The time-series data contain 225 observations with 44 outliers and no missing values.

Problem: The time-series data from HESDS7_R contain 44 outliers, all of which exceeded the upper fence of 0.253 inch.

Analysis: The median value for the time-series data is 0, which indicates that no precipitation occurred during at least half the period of record. Therefore, days with even moderate precipitation (greater than 0.25 inch) are statistical outliers. These outliers coincide with moderate to heavy rainfalls recorded at nearby stations. Hence, the outliers are valid data that accurately represent hydrologic conditions at the site.

Summary: The precipitation recorded at HESDS7_R coincides with precipitation data from nearby wells (ALICO_R, DEVILS_R, and HESDS3_R), particularly with excessive rainfall of 1 inch or more (Appendix A). In addition, periods of low rainfall also coincide with dry periods recorded at nearby stations. The time-series data from HESDS7_R probably are valid data that accurately represent hydrologic conditions at the site. No revisions were required.

Statistics	Original series	Revised series
Minimum (feet)	0.000	0.000
Mean (feet)	0.106	0.106
Median (feet)	0.000	0.000
Maximum (feet)	1.770	1.770
Standard deviation	0.290	0.290
Variance	0.084	0.084
Outliers	44	44
Missing values	0	0

Table 47 Summary statistics of time-series data for Station 23: HESDS7_R

4 SUMMARY

The site and time-series data from 37 target stations were reviewed as part of this project. The stations, which included 4 rain gages, 17 stilling wells, and 16 groundwater monitor wells, were installed for projects conducted by South Florida Water Management District at Crook's and Golden Ox Ranches, the E-1 and E-2 Canals, and for the Loxahatchee Mitigation Bank. Site information and time-series data were obtained from electronic files stored at South Florida Water Management District (SFWMD) and from various contractors that worked on the projects. In general, the site information for the stations appeared to be accurate, but the quantity of available data varied between the three projects. Location coordinates, reference and land-surface elevations, well depth, and lithologic information were readily available for the 19 wells and stilling wells at Crook's and Golden Ox Ranches. No information on well depth or lithology was available for the two wells installed as part of the Loxahatchee Mitigation Bank. Recorder registration worksheets were produced for each station or set of stations for uploading of site information into the SFWMD databases. Lithologic and geologic data, when available, were placed in the Hydrogeologic Data Loader for uploading into SFWMD database.

Continuous water-level and (or) rainfall data were collected at the stations in 15-min or 1-hr increments. During this project, the data were reviewed, daily values (means for water levels; sums for rainfall) were calculated, and summary statistics were generated. The time-series data were reviewed for quality assurance according to SFWMD protocols.

The time-series data (water-level and rainfall data) from the 37 stations generally appeared to be valid data that accurately represents hydrologic conditions at the sites. However, 27 of the 33 wells and stilling wells had periods of missing data. The gaps in original time-series data ranged in length from 1 day to 183 days. No attempt was made to estimate values for the missing data.

A total of seven sites had anomalous data that were inconsistent with nearby stations, and determined to be erroneous. Three stations (HES-11, HES-16, and HES-19) had periods of anomalous data that probably resulted from the water level declining below the instrument in these stilling wells. The anomalous data from these stations were deleted and the missing values coded as M. Correction factors were applied to portions of the time-series data from two stations (E2LWN_H and US441). Finally, the time-series data from Double72s had two periods of anomalous data that were subsequently deleted. Deletion of erroneous data resulted in a higher number of missing values for each of these stations.

A series of comma-delimited files were produced for uploading time-series data into DBHYDRO. One or more files were generating for each station for uploading the extensive sets of breakpoint (raw incremental) data. Two more files for each station contain the initial daily values and the daily values revised after the in-depth quality-assurance analysis.

5 REFERENCES

Lukasiewicz, John, Rectenwald, Ed, Medellin, Don, and Petrey, Paul, in press, Crook's and Golden Ox Ranches hydrogeologic assessment: South Florida Water Management District, Final Draft Report, 85 p.

Sangoyomi, T., Chong, A., and Dawkins, D., 2005, QA/QC of stage data procedures: South Florida Water Management District Procedure Q201, 63 p.

Sangoyomi, T., Wu, G., Abtew, W., Pathak, C., and Dawkins, D., 2006, QA/QC of meteorological and evapotranspiration (ET) data procedures: South Florida Water Management District Procedure Q204, 87 p.

Sangoyomi, T., and Lambright, D., 2006, QA/QC of groundwater level data procedures: South Florida Water Management District Procedure Q205, 70 p.

E

Monitor Well Construction Diagrams

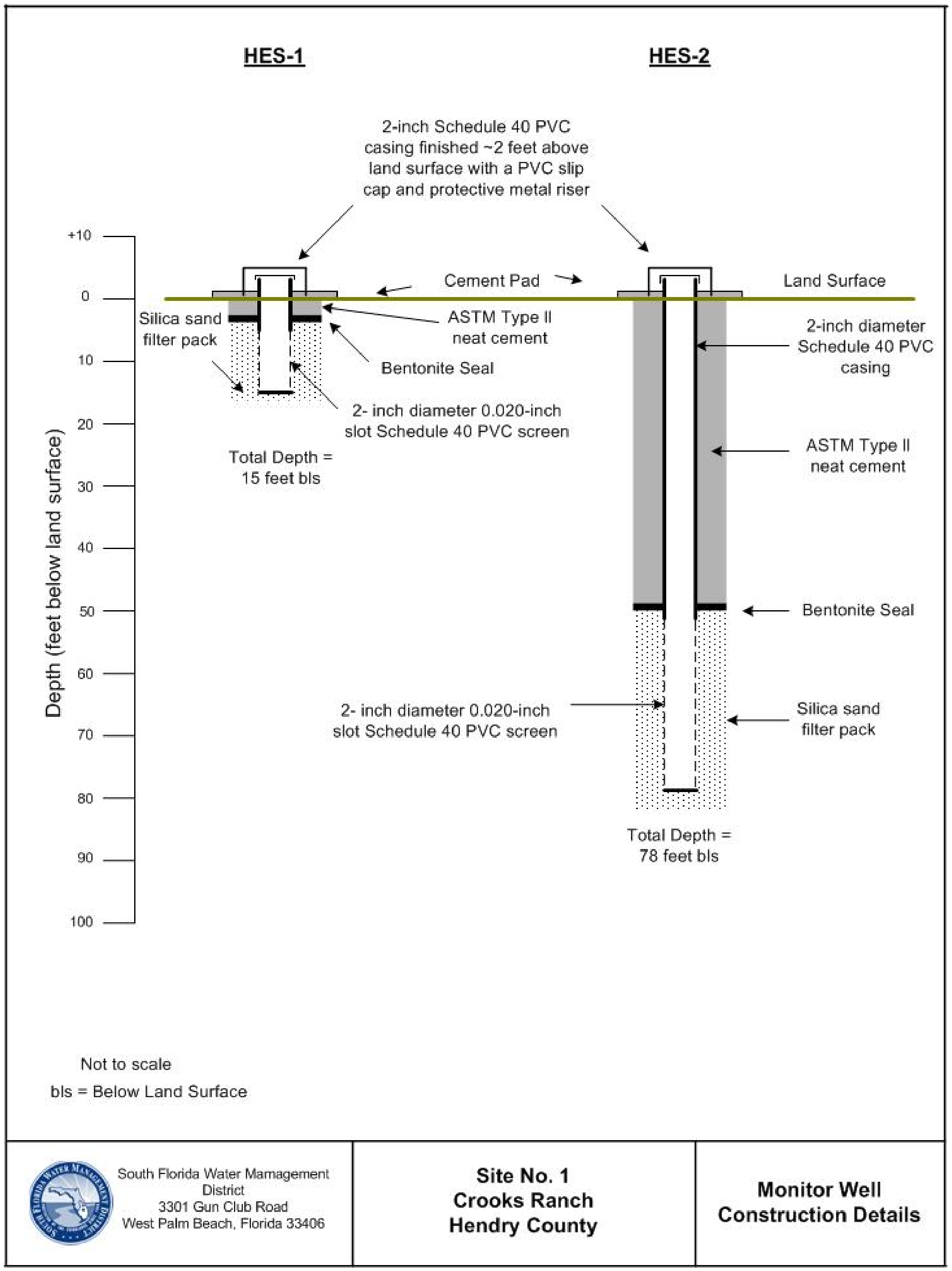


Figure E-1. Site No. 1 Monitor Well Construction Details.

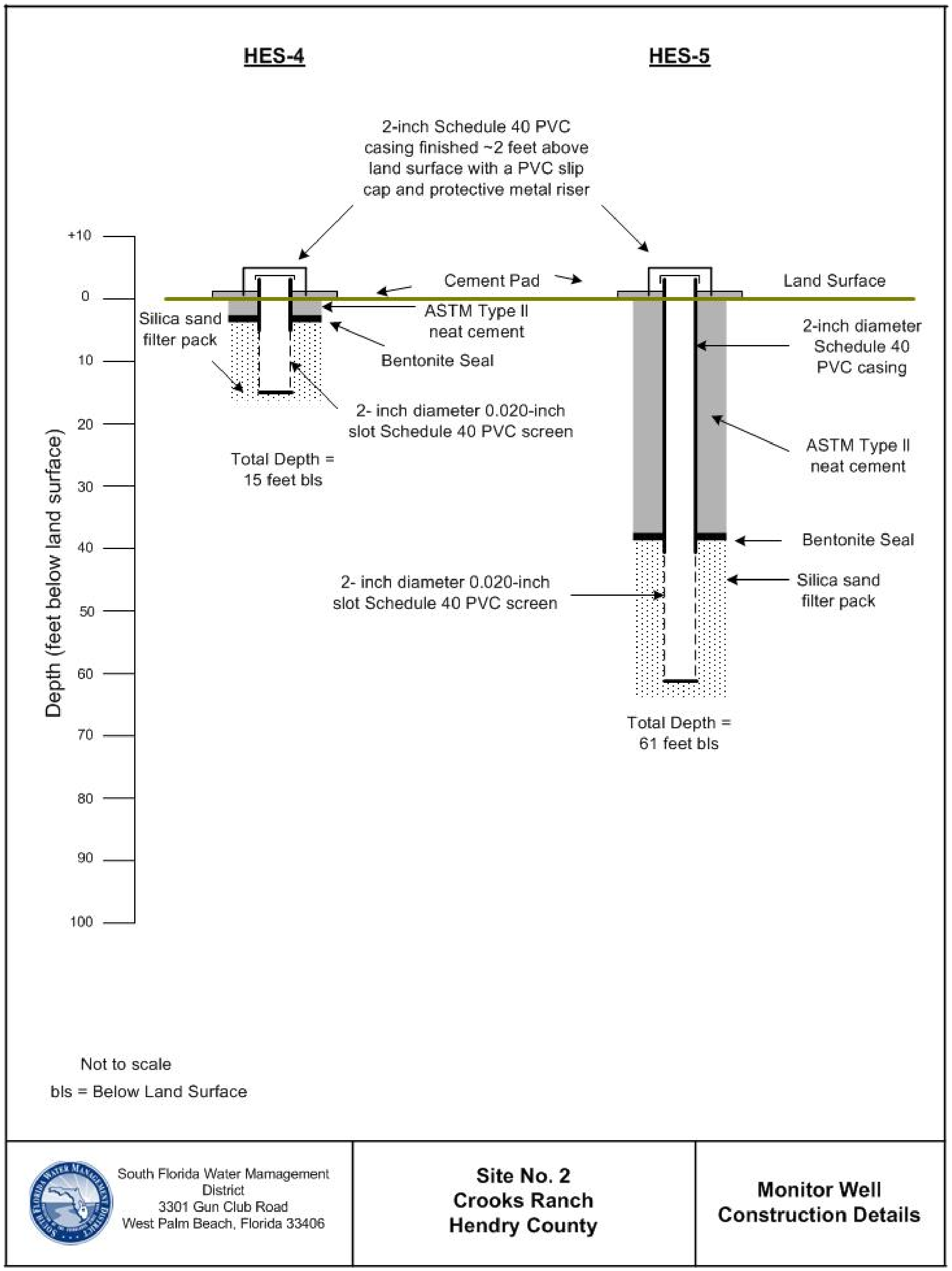


Figure E-2. Site No. 2 Monitor Well Construction Details.

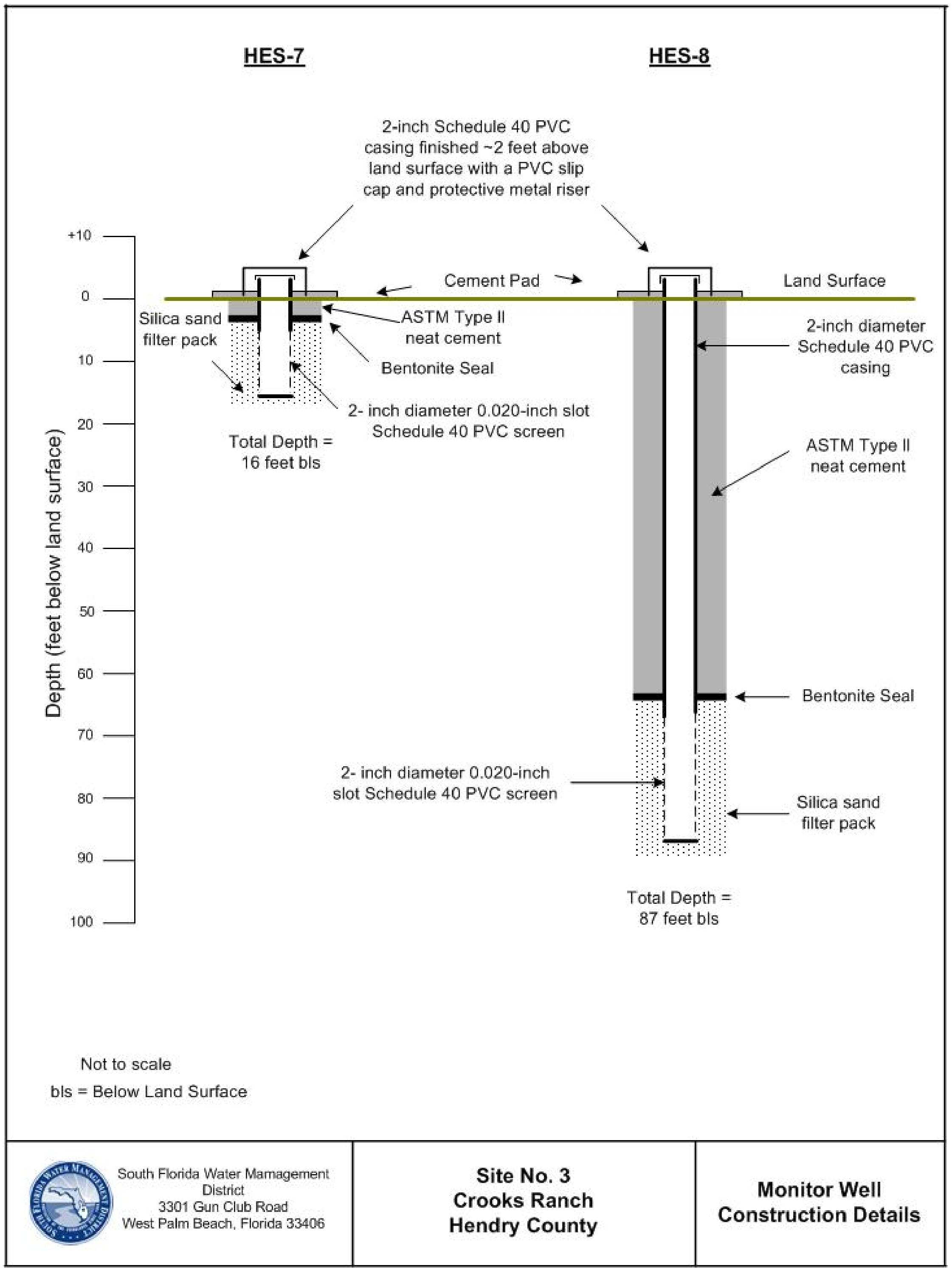


Figure E-3. Site No. 3 Monitor Well Construction Details.

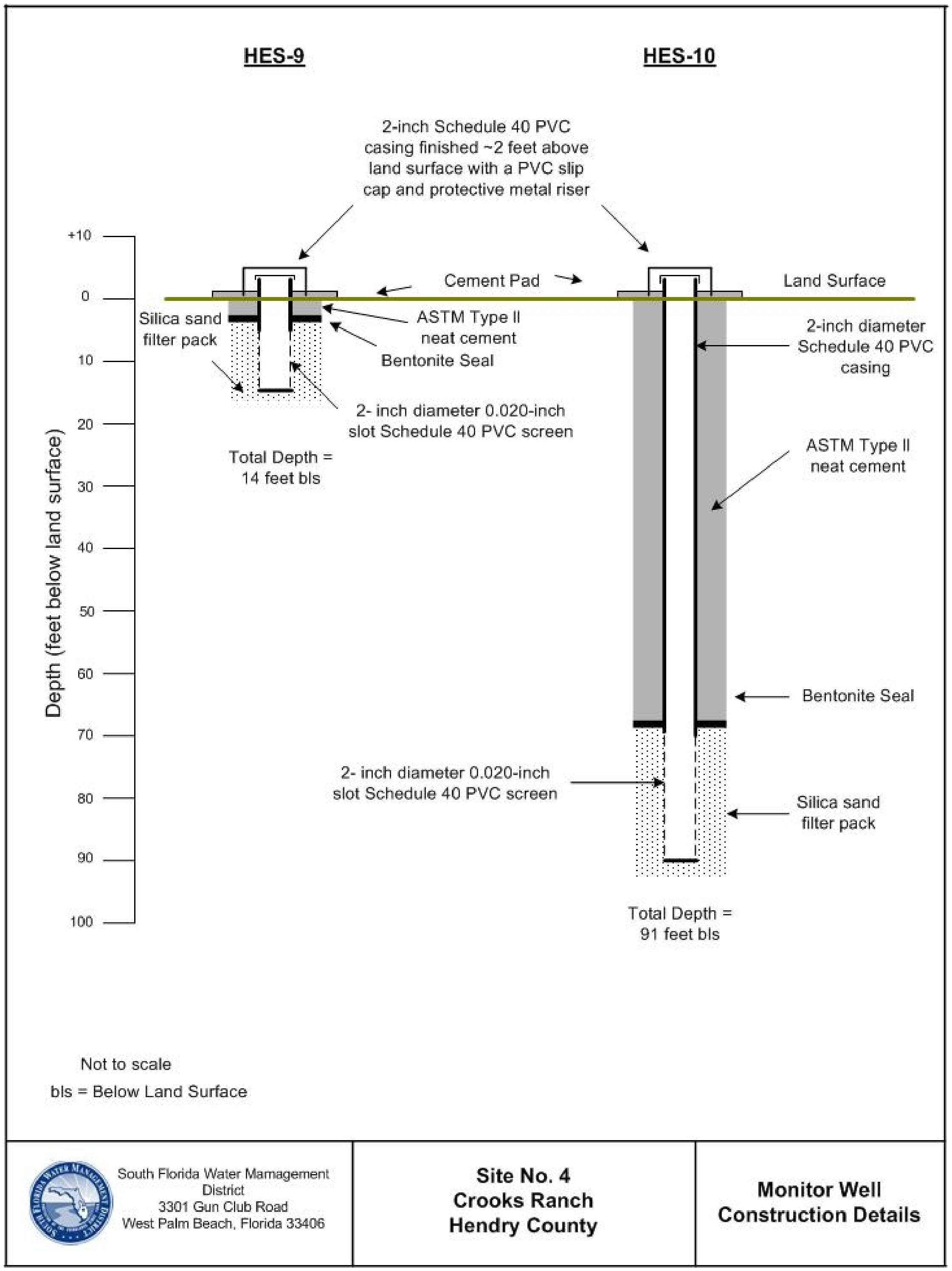


Figure E-4. Site No. 4 Monitor Well Construction Details.

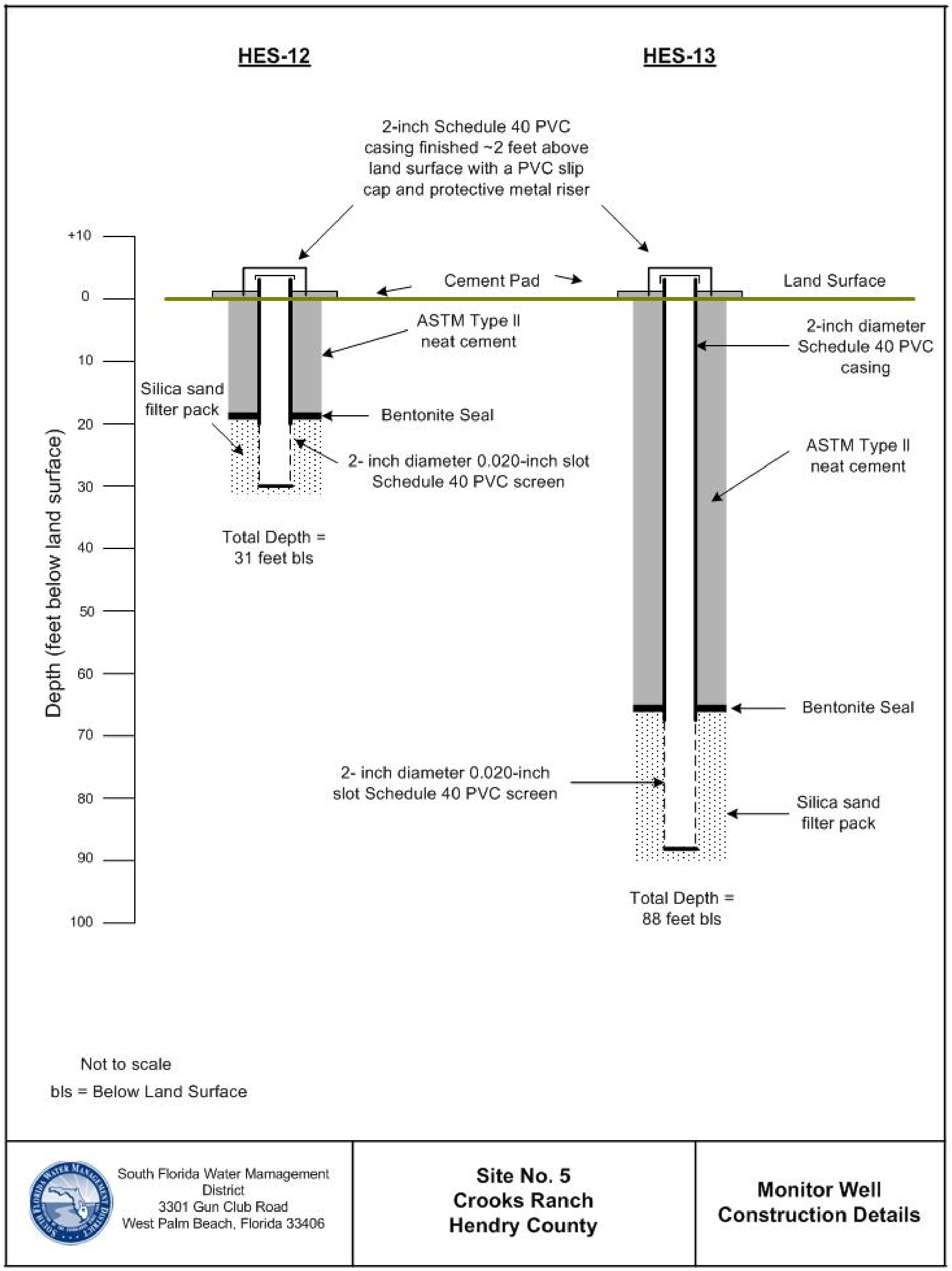


Figure E-5. Site No. 5 Monitor Well Construction Details.

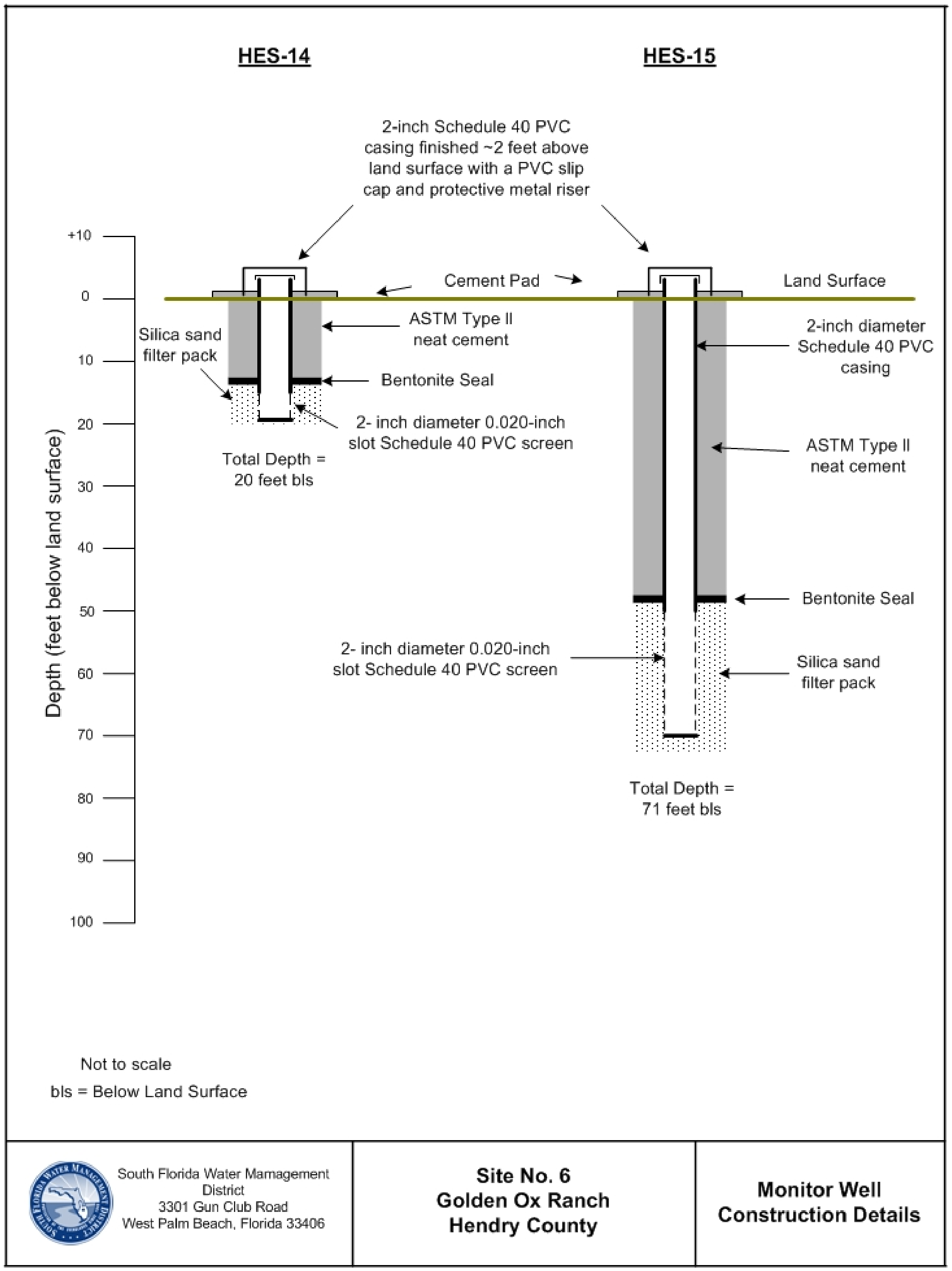


Figure E-6. Site No. 6 Monitor Well Construction Details.

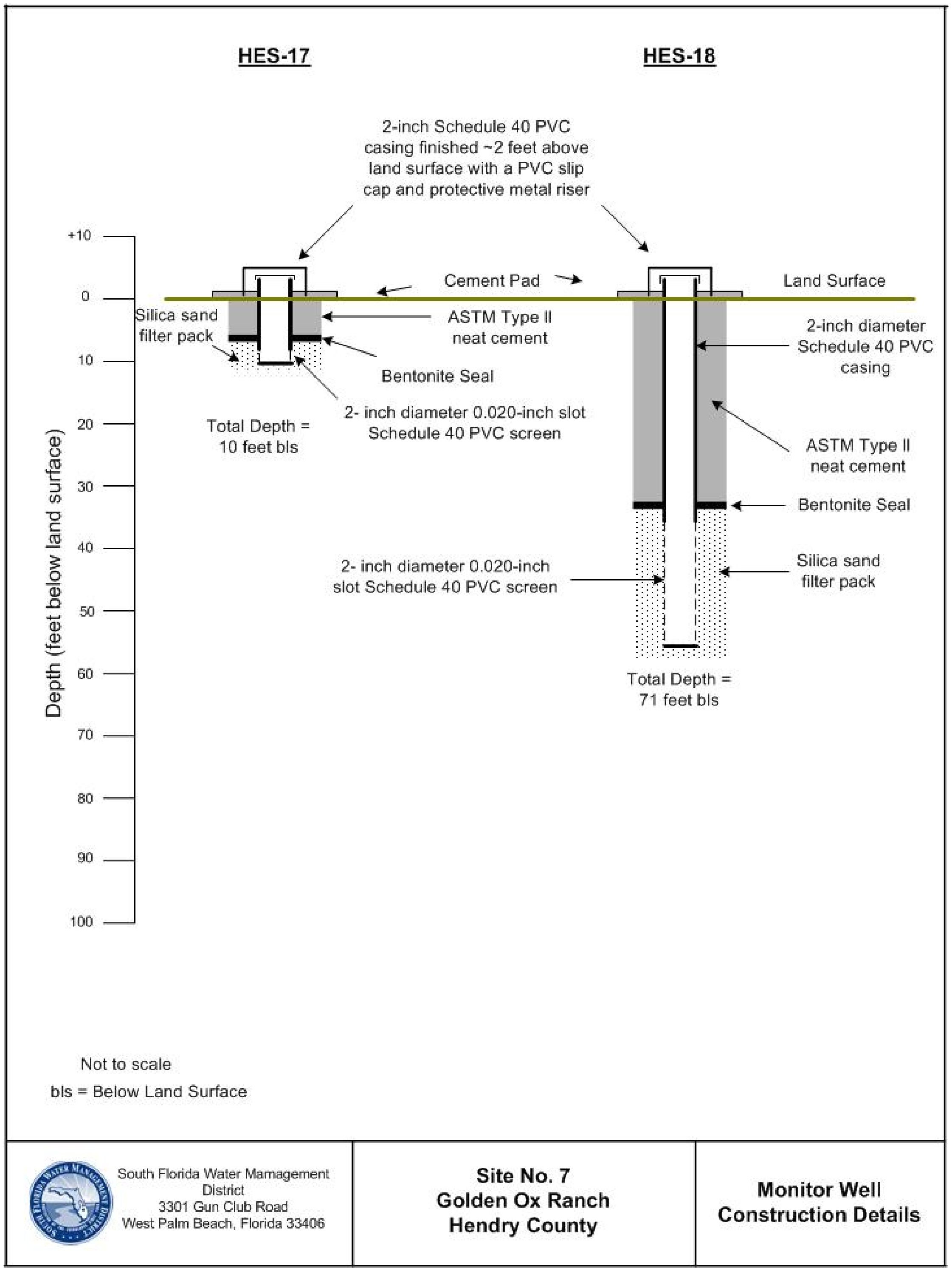


Figure E-7. Site No. 7 Monitor Well Construction Details.

F

Monitor Well Photographs

HES-1 and HES-2, Site 1

HES-4 and HES-5, Site 2

HES-7 and HES-8, Site 3

HES-9 and HES-10, Site 4

HES-12 and HES-13, Site 5

HES-14 and HES-15, Site 6

HES-17 and HES-18, Site 7

G

Stilling Well Construction Diagrams

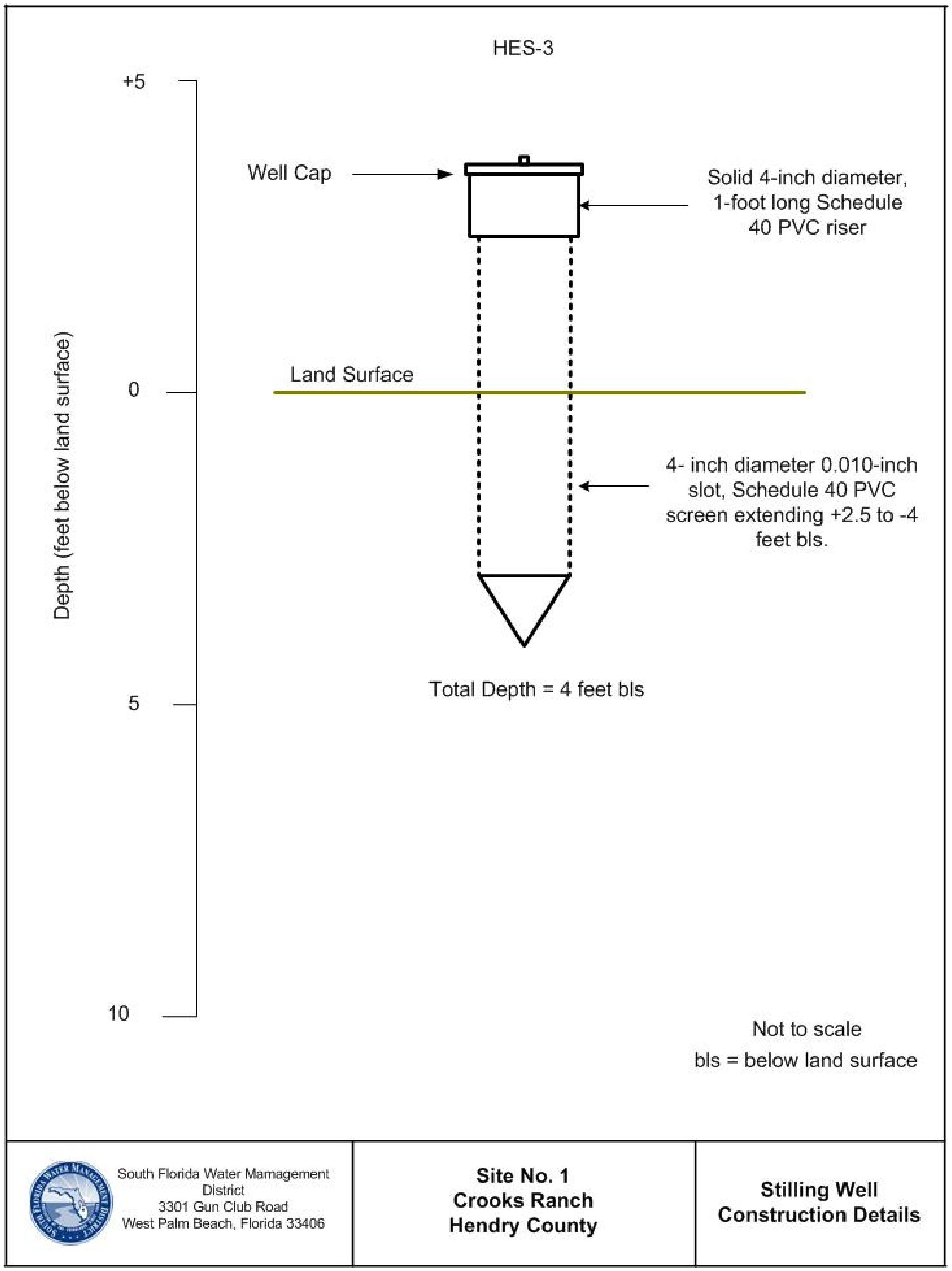


Figure G-1. Site No. 1 Stilling Well Construction Details.

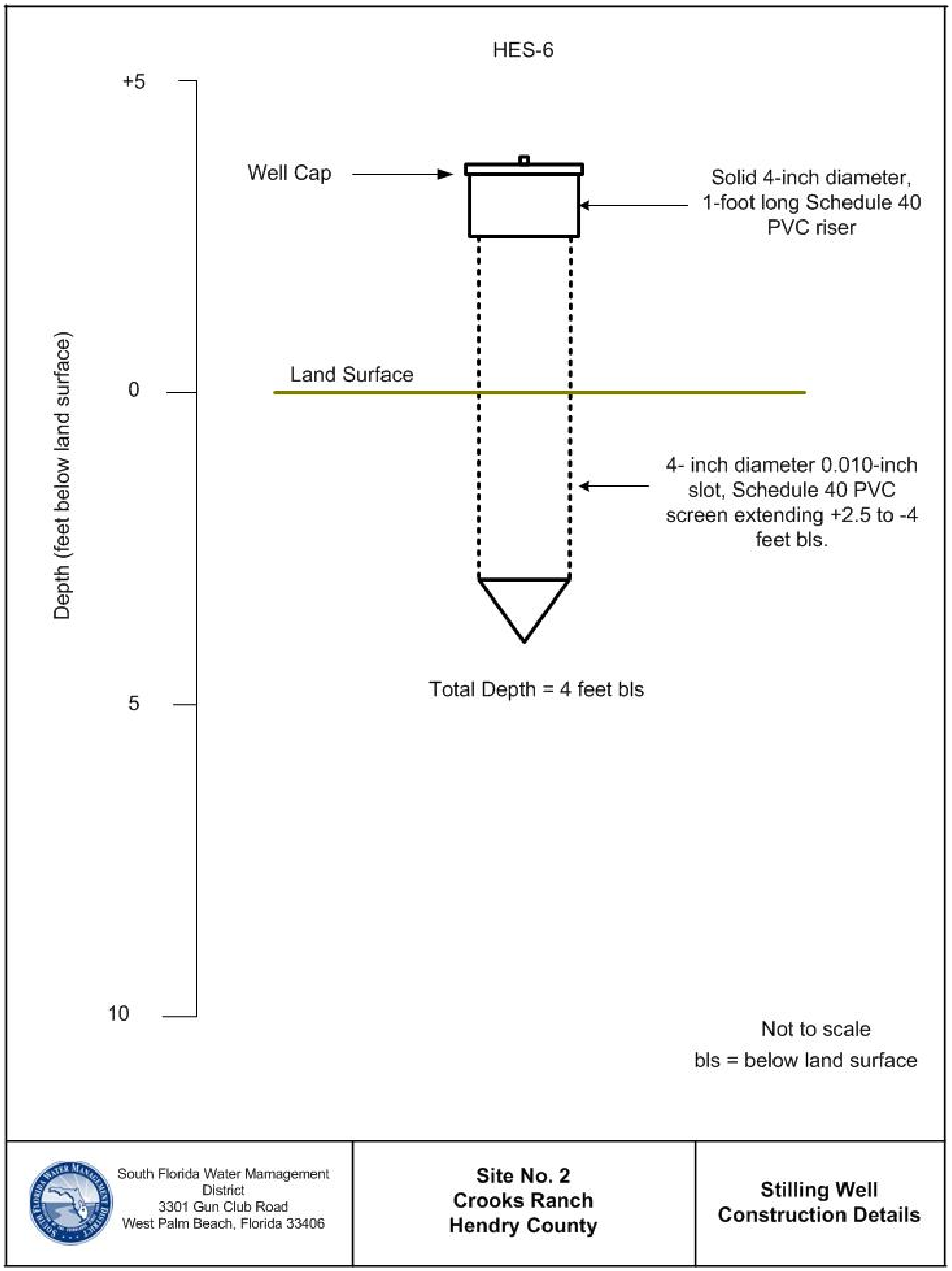


Figure G-2. Site No. 2 Stilling Well Construction Details.

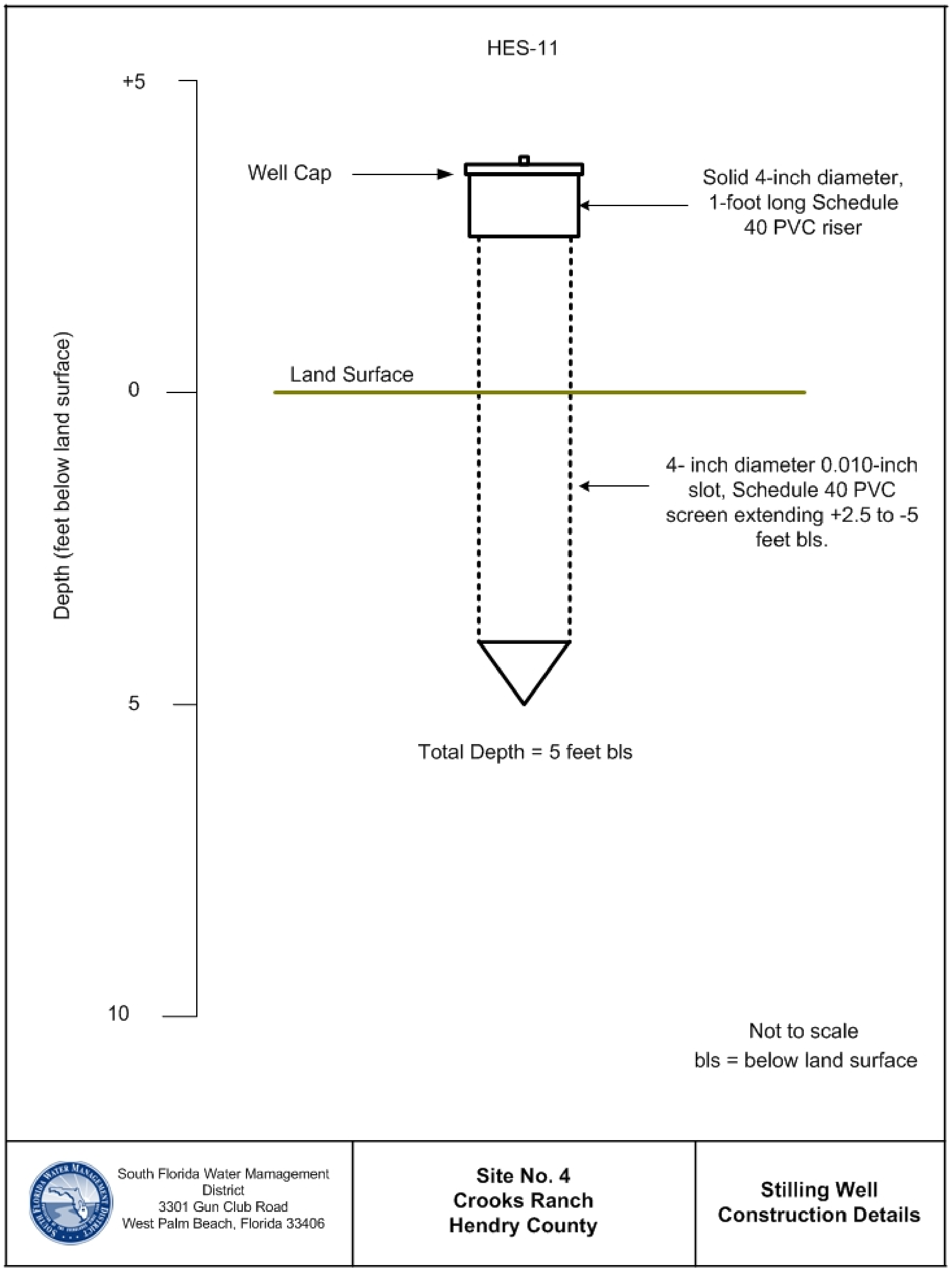


Figure G-3. Site No. 4 Stilling Well Construction Details.

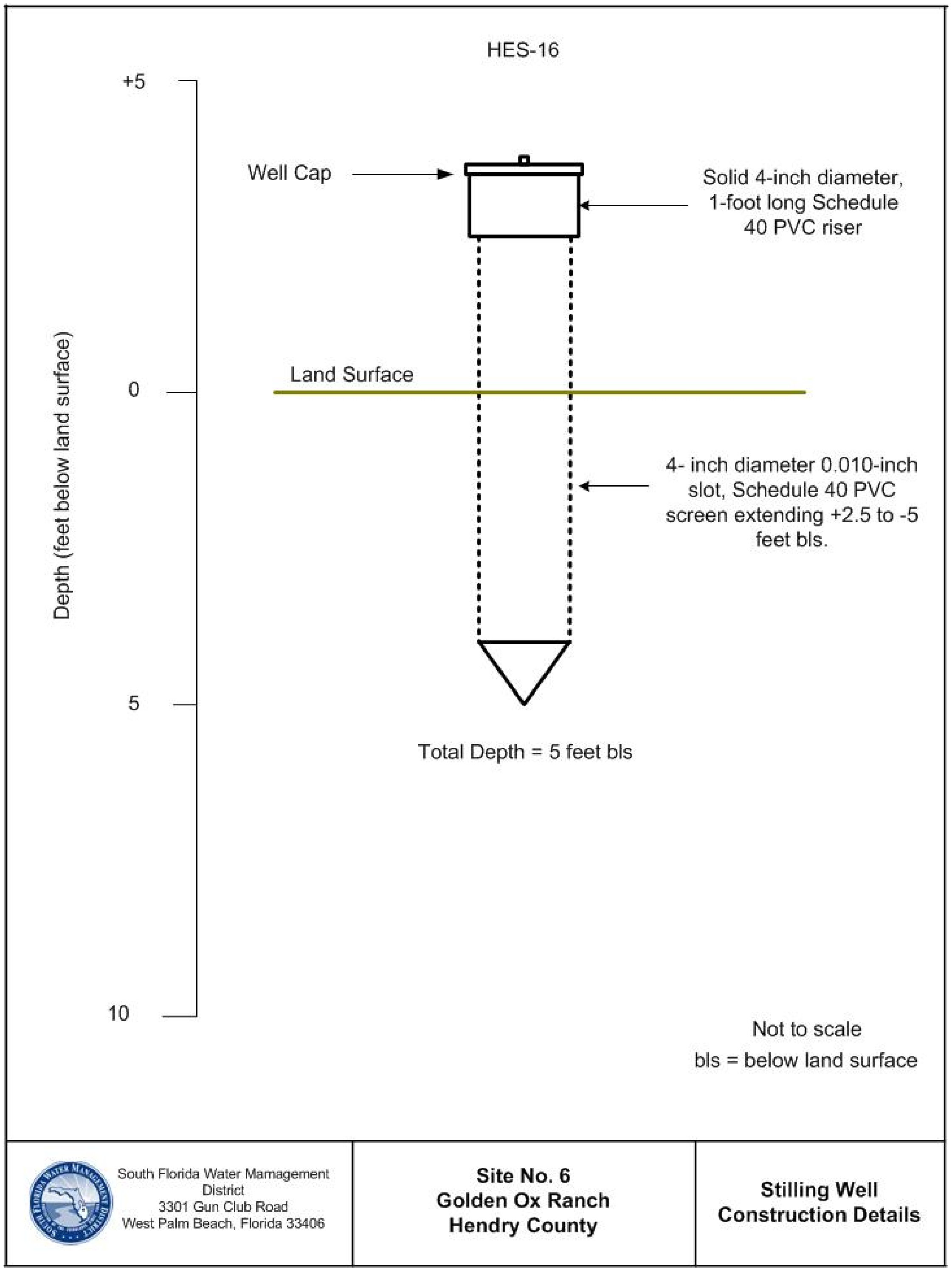


Figure G-4. Site No. 6 Stilling Well Construction Details.

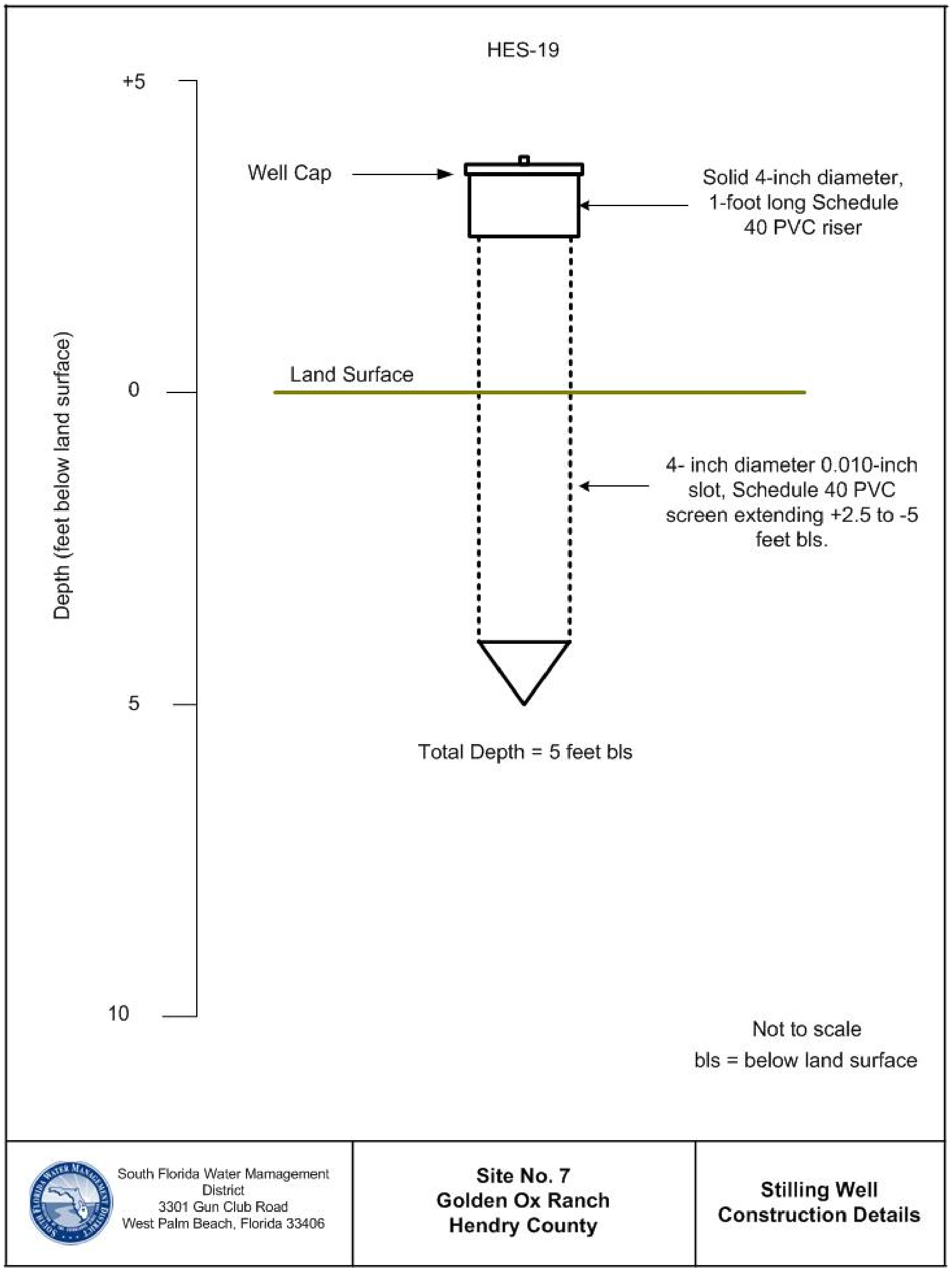


Figure G-5. Site No. 7 Stilling Well Construction Details.

H

Stilling Well Photographs

HES-3, Site 1

HES-6, Site 2

HES-11, Site 4

HES-16, Site 6

HES-19, Site 7

I

APT Test Well Construction Diagrams

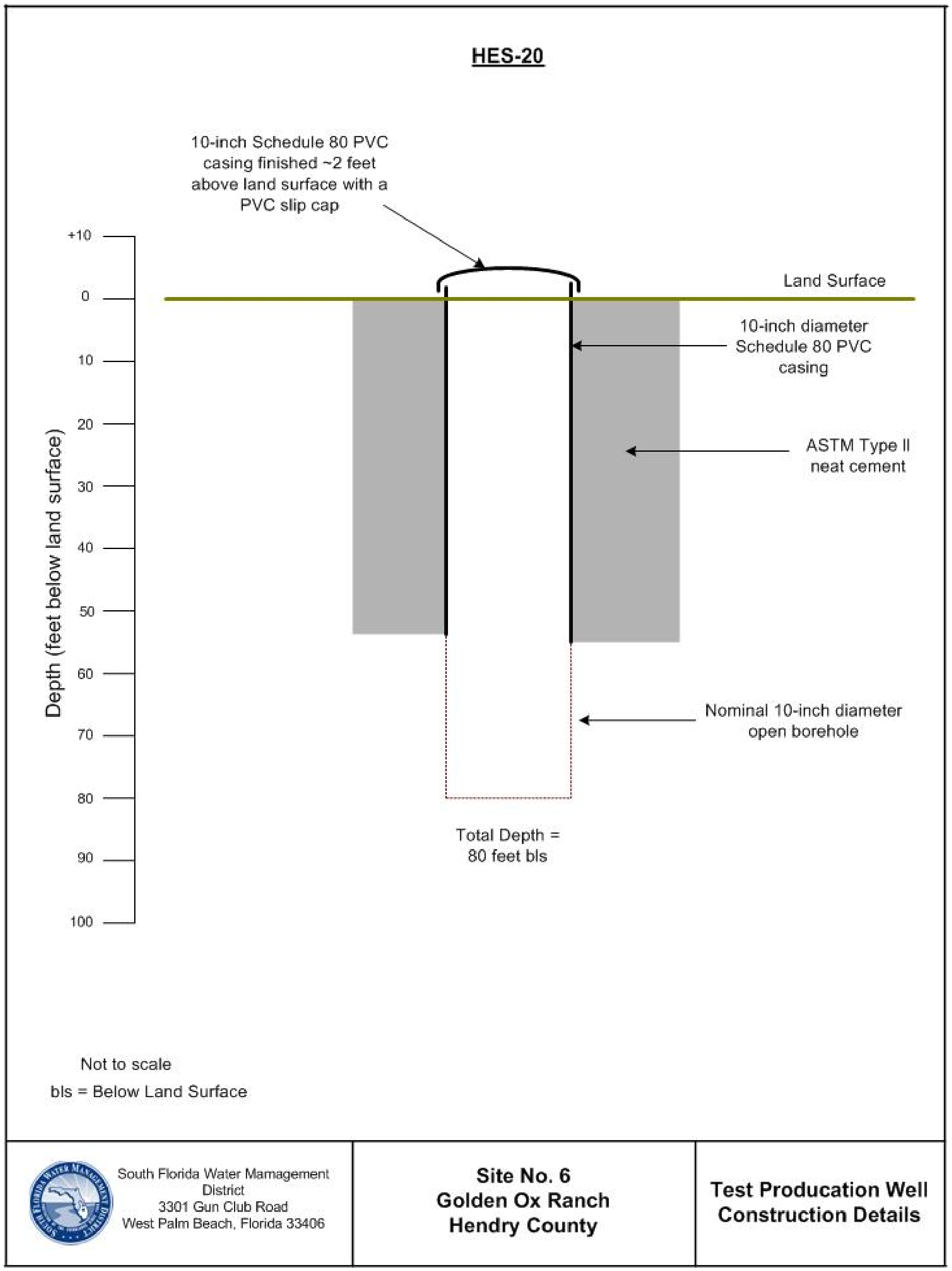


Figure I-1. Site No. 6 APT Test Well Constructions Details.

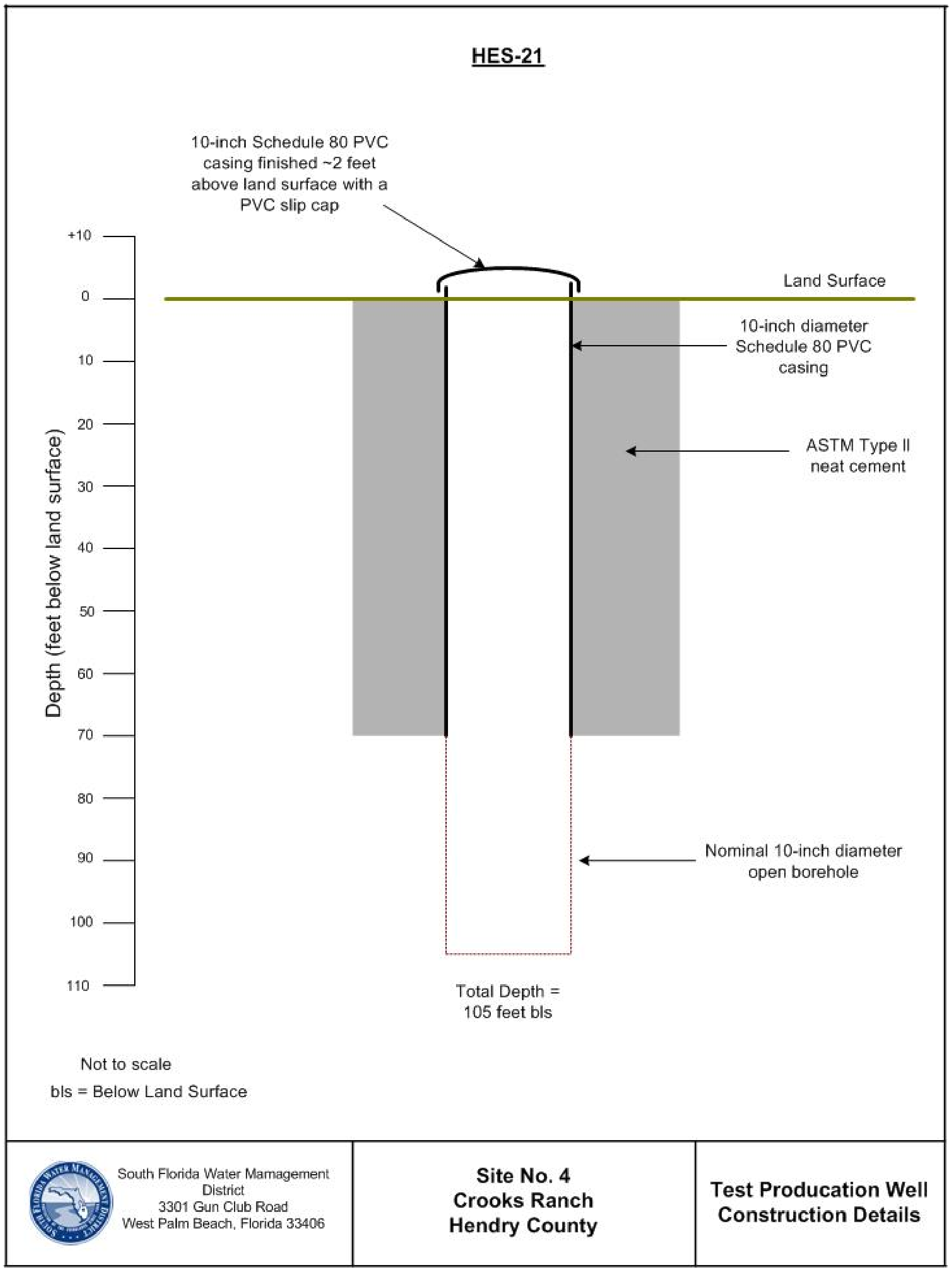


Figure I-2. Site No. 4 APT Test Well Constructions Details.

J
Core Photographs

Golden Ox Ranch, Site 6, HES-20, 0-10 feet bls

Golden Ox Ranch, Site 6, HES-20, 20-25 feet bls

Golden Ox Ranch, Site 6, HES-20, 35-30 feet bls

Golden Ox Ranch, Site 6, HES-20, 40-35 feet bls

Golden Ox Ranch, Site 6, HES-20, 40-45 feet bls

Golden Ox Ranch, Site 6, HES-20, 50-45 feet bls

Golden Ox Ranch, Site 6, HES-20, 50-55 feet bls

Golden Ox Ranch, Site 6, HES-20, 58-55 feet bls

Golden Ox Ranch, Site 6, HES-20, 58-60 feet bls (Lower Tamiami aquifer)

Crooks Ranch, Site 4, HES-21, 35-40 feet bls

Crooks Ranch, Site 4, HES-21, 40-45 feet bls

Crooks Ranch, Site 4, HES-21, 45-50 feet bls

Crooks Ranch, Site 4, HES-21, 55-60 feet bls

Crooks Ranch, Site 4, HES-21, 65-70 feet bls

K

Lithologic Descriptions

Site 1 (Crooks Ranch)

Feet bls	Description
0 – 5	Quartz sand: tan, fine-grained, unconsolidated, with traces of shell fragments
5 – 10	Shell bed: white, with moderate amounts of quartz sand
10 – 22	Quartz sand: tan, fine-grained, unconsolidated, with trace amounts of shell fragments and limestone
22 – 40	Mudstone: grey, plastic, silty, with trace amounts of shell fragments
40 – 55	Mudstone: dark olive grey, sticky
55 – 60	Wackestone: white and tan, hard, with moderate amounts of shell fragments
60 – 70	Limestone: sparse biomicrite, grey, hard, moldic, with abundant shell fragments
70 – 78	Limestone: sparse biomicrite, off white, hard, moldic, with abundant shell fragments

Bottom of Hole

Site 2 (Crooks Ranch)

Feet bls	**Description**
0 – 5	Quartz sand: light brown, fine-grained, consolidated, thin layers of limestone
5 – 10	Packstone: tan and grey, moderately hard, micritic, very sandy, with trace amounts of clay
10 – 18	Wackestone: grey, soft, with moderate amounts of limestone
18 – 20	Mudstone: grey, silty, loose
20 – 30	Mudstone: grey, very sticky
30 – 35	Mudstone: light grey, sticky
35 – 40	Mudstone: greenish grey, very sticky
40 – 45	Limestone: sparse biomicrite, grey, hard, moldic, with mild shell fragments
45 – 63	Limestone: sparse biomicrite, grey, hard, moldic, with abundant shell fragments

Bottom of Hole

Site 3 (Crooks Ranch)

Feet bls	Description
0 – 17	Quartz sand: tan, fine-grained, consolidated
17 – 66	Mudstone: grey, silty, sticky
66 – 88	Limestone: sparse biomicrite, grey, hard, moldic, with minor shell fragments and traces of quartz sand

Bottom of Hole

Site 4 (Crooks Ranch)

Feet bls	Description
0 – 4	Quartz sand: light brown, fine-grained, consolidated
4 – 6	Packstone: grey, hard, moldic, with moderate shell fragments
6 – 13	Shell bed with minor limestone
13 – 19	Mudstone: grey, silty
19 – 47	Mudstone: dark grey, sticky, with minor silt
47 – 71	Mudstone: grey, sticky, with minor silt
71 – 93	Limestone: sparse biomicrite, light grey, moderately hard, moldic, with minor shell fragments

Bottom of Hole

Site 5 (Crooks Ranch)

Feet bls	Description
0 – 18	Quartz sand: light grey, fine-grained, with thin layers of mudstone
18 – 32	Shell bed
32 – 36	Packstone: grey, moderately hard, moldic, with moderate shell
36 – 50	Mudstone: greenish grey, sticky
50 – 63	Wackestone: tan, loose, with moderate limestone
63 – 66	Mudstone: white, sticky
66 – 80	Limestone: sparse biomicrite, grey, hard, moldic, with moderate shell
80 – 90	Limestone: sparse biomicrite, light grey, hard

Bottom of Hole

Site 6 (Golden Ox Ranch)

Feet bls	Description
0 – 13	Quartz sand: brown, fine-grained, consolidated
13 – 15	Mudstone: grey, loose
15 – 20	Packstone: white, moderately hard, micritic
20 – 35	Mudstone: grey, sticky, silty, with moderate shell fragments
35 – 50	Mudstone: grey, very silty, with abundant shell fragments
50 – 105	Limestone: sparse biomicrite, dark grey, hard, moldic, with moderate shell fragments

Bottom of Hole

Site 7 (Golden Ox Ranch)

Feet bls	Description
0 – 5	Packstone: tan, mildly hard, micritic, with abundant quartz sand
5 – 10	Packstone: off white, moderately hard, micritic
10 – 33	Wackestone: grey, sticky, with thin layers of hard grey limestone
33 – 35	Packstone: tan, moderately hard, micritic, with trace amounts of clay
35 – 45	Limestone: sparse biomicrite, tan, moderately hard, moldic, with moderate shell fragments
45 – 58	Limestone: sparse biomicrite, grey, hard, moldic, with abundant shell fragments

Bottom of Hole

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