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Groundwater Flow Evaluation For The Hardee County Landfill

Prepared for:

Hardee County

Board of County Commissioners
412 West Orange Street
Wauchula, Florida 33873

Prepared by:

SCS ENGINEERS
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Tampa, Florida 33610
(813) 621-0080

June 1, 2009
File No. 09199033.19

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1 INTRODUCTION

Hardee County owns and operates an 18.6-acre landfill located on a 115 acres parcel (the site). The site is located on Airport Road, approximately one mile north of State Road 636 near Wauchula, Florida, as shown on Figure 1-1.

This groundwater flow evaluation is being submitted in accordance with Florida Department of Environmental Protection (FDEP) Permit Number 38414-011-SO/01 Specific Condition Number E.11 for the Hardee County Class I Landfill.

SPECIFIC CONDITION E.11 - MONITORING PLAN EVALUATION

The following is an excerpt from FDEP Permit Number 38414-011-SO/01 Specific Condition Number E.11.

> "By June 1, 2009, the permittee shall submit to the Department a report that evaluates ground water velocity in the vicinity of the Phase II, Section I disposal footprint. At a minimum, this report shall include the results of the monthly ground water and surface water level measurements described in Specific Condition Number E.4.a., and Number E.B.a., respectively, and the results of slug tests conducted at wells MW-10R, MW-11 and MW-12R described in the "Water Quality Sampling and Analysis" sub-section of the document entitled "Revised Ground Water Monitoring Plan, Attachment M-1 to the Construction Permit Application for Hardee County Landfill Expansion," prepared by SCS Engineers, revised March 10, 2008 [ref SC#A.2.a.(3)]. This report shall include a recommendation regarding the appropriate routine ground water sampling frequency based on the range of ground water velocity values calculated using the water levels measured between June 2008 and May 2009 and the slug test results. In the event that this report recommends implementing a quarterly frequency for routine ground water sampling, submittal of a request for minor permit modification shall be submitted in accordance with Specific Condition Number A.3".

This report is in response to the above permit condition and meets the requirements.

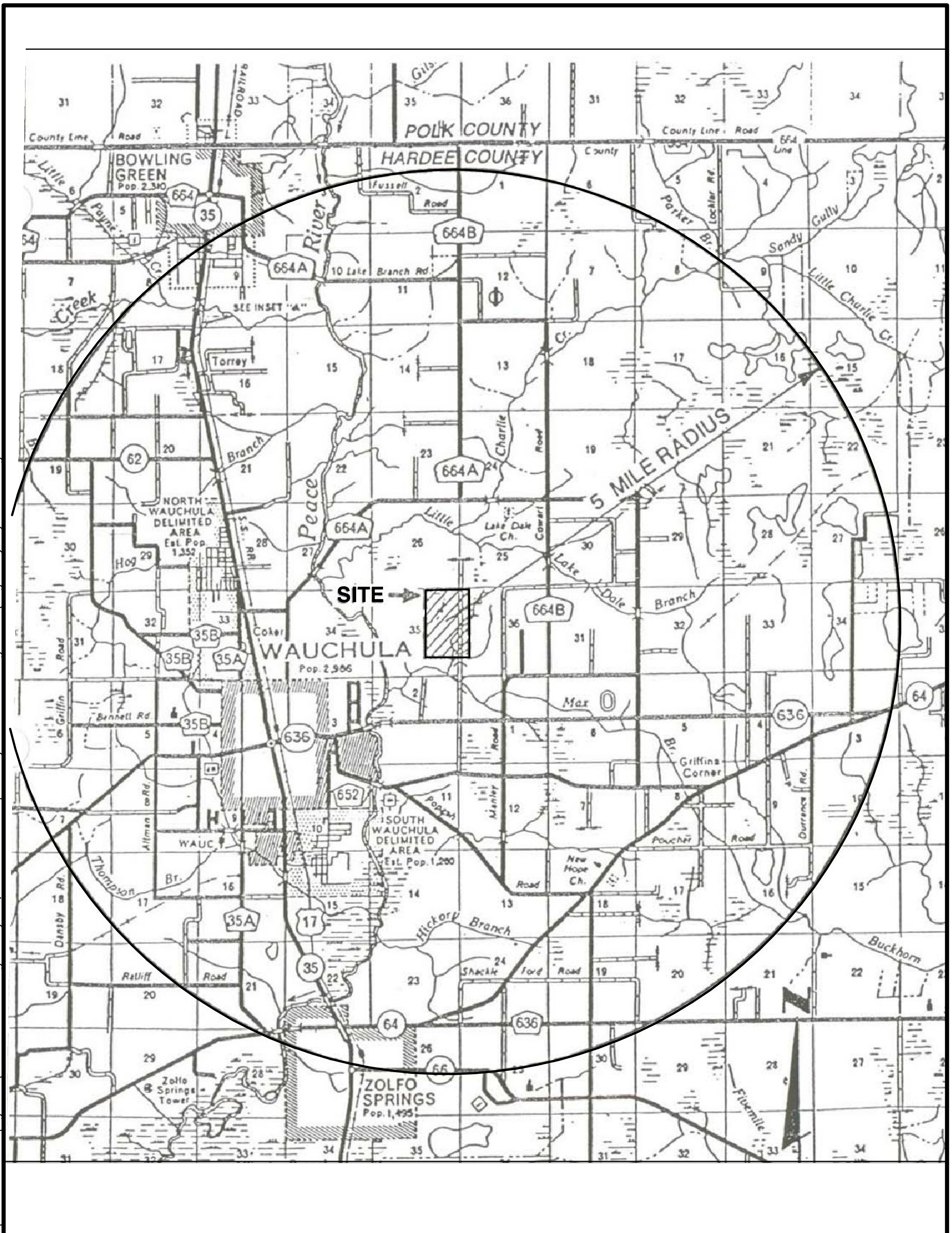

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Figure 1–1. Regional Map, Hardee County Landfill, Hardee County, Florida.

2 GEOLOGIC AND HYDROGEOLOGIC CHARACTERISTICS

TOPOGRAPHY

The portion of the 1955 United States Geological Survey (USGS) Quadrangle map of Wauchula, Hardee County showing the site is provided on Figure 2-1. The figure shows the unaltered topographic of the site varies from a high of approximately 85 feet NGVD at the north end of the property to a low of approximately 75 feet NGVD at the south end.

The topography of the site has subsequently been altered by land filling operations (Figure 2-2). Currently the topographic high is 160 feet NGVD at the top of the fill area. The topographic low is 75 feet above NGVD.

SITE SPECIFIC GEOLOGY

The hydrogeologic system underlying the Hardee County Landfill consists of a thick sequence of carbonate rocks overlain by clastic deposits ranging in age from Holocene to Paleocene. These units are listed in Table 2-1 and are described below based on a study by Duerr and Enos[1].

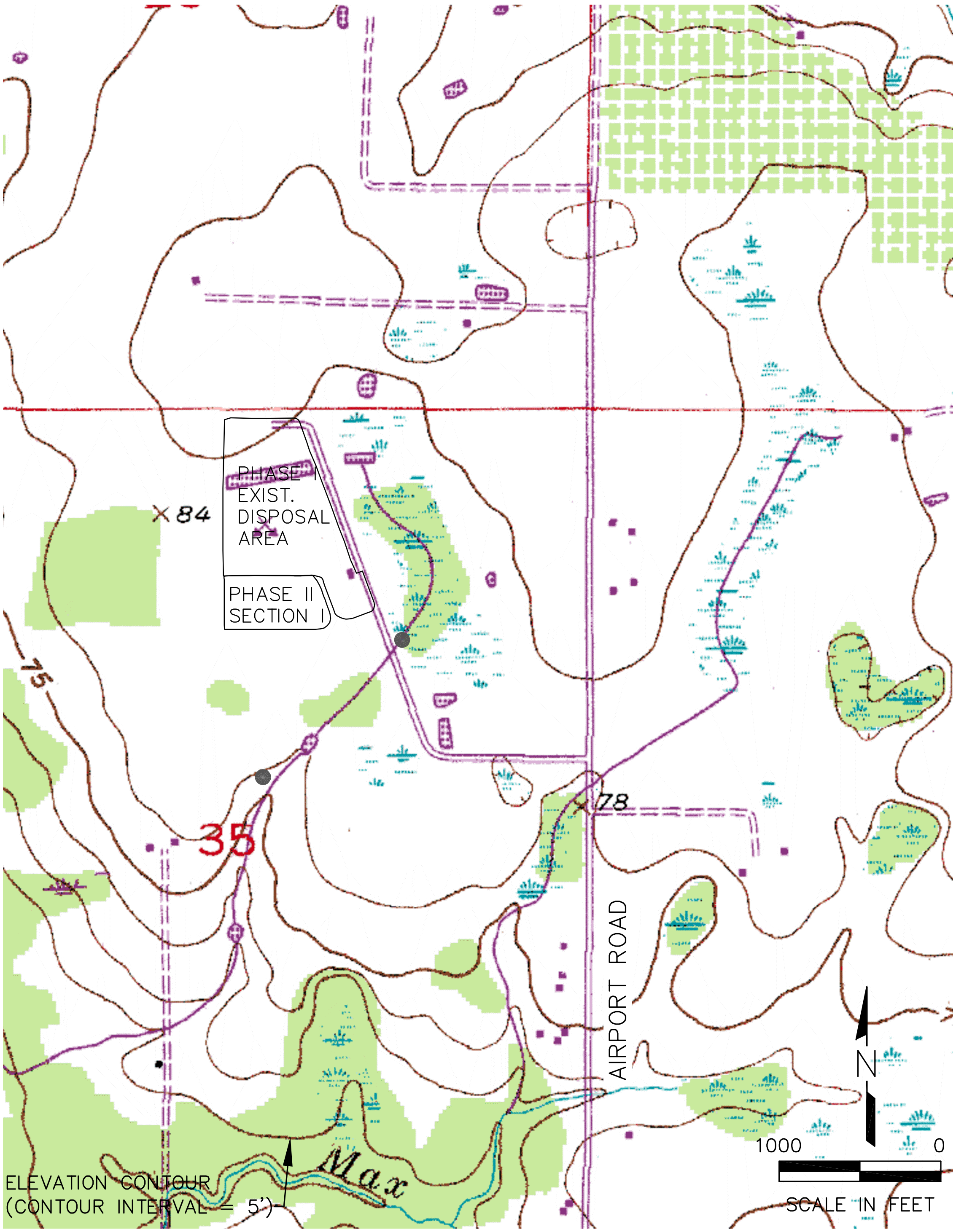
The youngest deposits are surficial sands, terrace sands, and phosphorites of Holocene and Pleistocene age, with an average depth of 25 feet. Clayey and pebbly sand, clay marl and shell underlie the surficial sands.

The carbonates and clastics of the Miocene age consist of the Hawthorn Formation and the underlying Tampa Limestone. The top of the Hawthorn Formation occurs at depths of approximately 160-370 feet below land surface (bls). The Hawthorn Formation consists of dolomite and limestone that is soft, chalky, fine grained to sandy or pebbly and includes phosphorite grains. The Tampa Limestone consists of sandy and phosphatic fossiliferous limestone that can have sand and clay units. The Tampa Limestone represents the top of the Floridan aquifer.

The materials that underlie the Tampa Limestone are primarily limestone units and dolomitic limestone units that range in age from Oligocene to Eocene and are designated, in downward order as, the Suwannee Limestone, the Ocala Group, and the Avon Park Limestone.

The Suwannee Limestone is primarily composed of sandy fossiliferious carbonate sediments. The Ocala Group underlies the Suwannee, which is a fossiliferous cream white limestone, sometimes with foraminifers and dolomite occurring near the base of the limedstone. The Avon Park underlies the Ocala Group and consists of limestone and hard brown dolomite with intergranular evaporites in lower parts of the formation.

[1] Duer A.G. and Enos G.M., 1991, *Hydrogeology of the Intermediate Aquifer System & Upper Floridan Aquifer, Hardee & DeSoto Counties, Florida:* U.S. Geological Survey Water Resources Investigations Report 90-4104.



SOURCE: WAUCHULA USGS QUADRANGLE MAP, 1955, Photo Revised 1987

SECTION: 35 TOWNSHIP: 33S RANGE: 25E
SECTION: 26 TOWNSHIP: 33S RANGE: 25E

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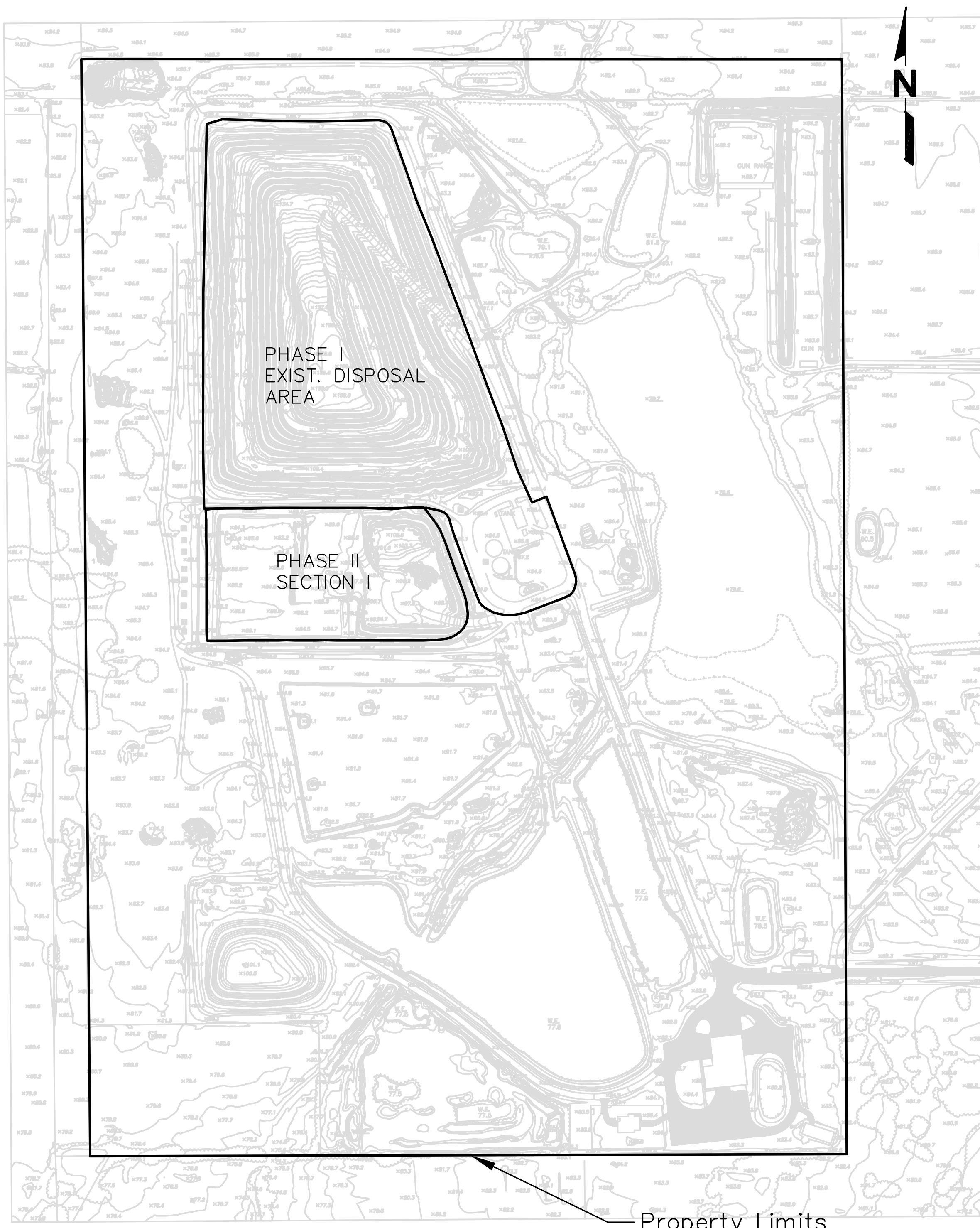
Figure 2–1. Hardee County Landfill and Local Topography, Hardee County, Florida.



SITE TOPOGRAPHY BY PICKETT AND ASSOCIATES, INC., DATED 3/25/09.

Section: 35 Township: 33S Range: 25E
Section: 26 Township: 33S Range: 25E

400 200 0 400

SCALE IN FEET

SCS ENGINEERS

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Figure 2–2. Boundary and Topographic Survey, Hardee County Landfill, Hardee County, Florida

System	Series	Stratigraphic unit	General lithology	Major lithologic unit	Hydrogeologic unit
Quaternary	Holocene and Pleistocene	Surficial sand, terrace sand, phosphorite	Predominantly fine sand; interbedded clay, marl, shell, and phosphorite.	Sand	SURFICIAL AQUIFER
Tertiary	Pliocene	Undifferentiated deposits[1] Tamiami Formation	Clayey and pebbly sand; clay, marl, shell, phosphatic.	Clastic	Confining unit
Tertiary	Miocene	Hawthorn Formation	Dolomite, sand, clay, and limestone; silty, phosphatic.	Carbonate and clastic	Aquifer
Tertiary	Miocene	Tampa Limestone	Limestone, sandy, phosphatic, fossiliferous; sand and clay in lower part in some areas.	Carbonate and clastic / Carbonate	Aquifer / Confining unit
Tertiary	Oligocene	Suwannee Limestone	Limestone, sandy limestone, fossiliferous.	Carbonate	Upper Floridan aquifer
Tertiary	Eocene	Ocala Limestone	Limestone, chalky, foraminiferal, dolomitic near bottom.	Carbonate	Upper Floridan aquifer
Tertiary	Eocene	Avon Park Formation	Limestone and hard brown dolomite; intergranular evaporite in lower part in some areas.	Carbonate / Carbonate with evaporites	Upper Floridan aquifer / Middle confining unit
Tertiary	Eocene / Paleocene	Oldsmar and Cedar Keys Formation	Dolomite and limestone, with intergranular gypsum and anhydrite.	Carbonate with evaporites / Evaporites	Lower Floridan aquifer / Sub-Floridan confining unit

G:\PROJECT\09199033.09\figures\993309Topo.dwg May 18, 2009 - 1:52pm Layout Name: Fig2-1 By: 2190keg

SOURCE: DUERR and ENOS, 1991.

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Table 2–1. Hydrological Framework of the Hardee County Region.

SOIL TYPES

According to the United States Department of Agriculture (USDA) *Soil Survey of Hardee County*, the site is composed of five soil classifications. The dominant soil types are the Pomona fine sand, and Farmton fine sand, followed by the Floridana mucky fine sand, the Kaliga muck, and finally the Immokalee fine sand. A map showing the soil classifications is shown on Figure 2-3.

The Pomona fine sand is a nearly level and poorly drained. Approximately 60 percent of the site is composed of this soil type. The surface layer is black fine sand about 3 inches thick. The subsurface is fine sand about 24 inches thick. Permeability is moderately slow in the lower part of the subsoil and rapid in the other layers.

The Farmton fine sand is poorly drained in nearly level flatwoods. Nearly 15 percent of the site is composed of this material. The surface layer is black fine sand about 6 inches thick. The subsurface layer is fine sand to a depth of about 34 inches.

The Floridana mucky fine sand is very poorly drained in wet depressions. The Floridana muck fine sand makes up approximately 10 percent the site. The surface layer is about 15 inches thick and the subsurface layer extends to a depth of 32 feet. Permeability is rapid in the surface layer and slow or very slow in the subsoil.

The Kaliga muck is a very poorly drained nearly level organic soil in low depressions. Approximately 10 percent of the site is composed of the Kaliga muck. The surface layer is black muck about 25 inches thick. Below the muck there is very dark gray fine sandy loam to a depth of 35 inches, and dark gray sandy clay loam to a depth of 80 inches. Permeability is rapid in the surface layer and slow or very slow between depths of 35 and 60 inches.

Immokalee fine sand is poorly drained; the surface is typically very dark gray fine sand about 5 inches thick. The subsurface layer is gray fine sand to a depth of about 44 inches. The subsoil is fine sand to a depth of 80 inches. The upper 4 inches is black, and the lower 32 inches is dark reddish brown. Permeability is rapid in the surface and subsurface layers and moderate in the subsoil.

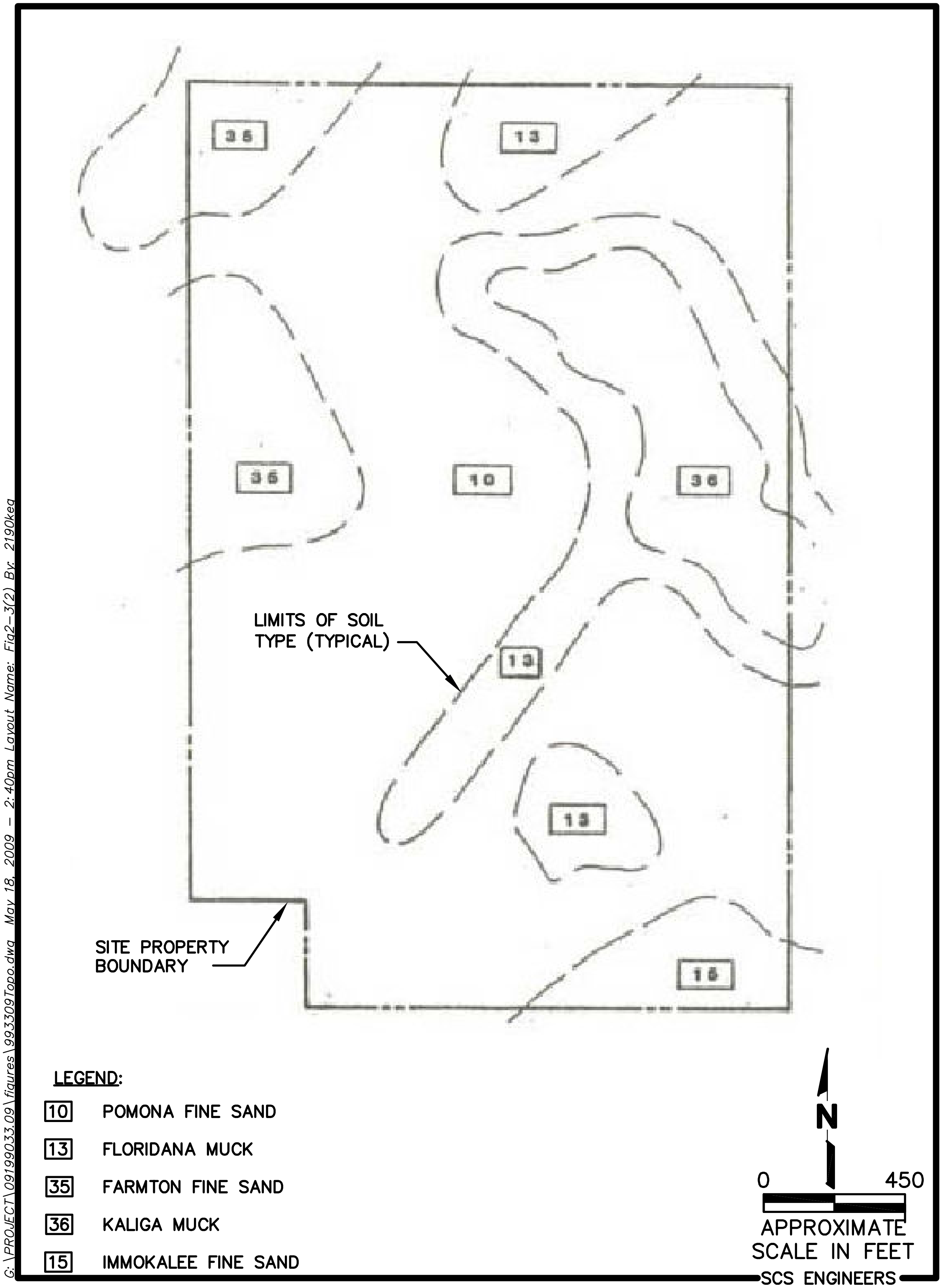

Figure 2—3. USDA Soil Classifications for the Hardee County Landfill Site.

SITE STRATIGRAPHY

Several test borings were completed on the site to assess site stratigraphy. ENVISORS, Inc., conducted the initial borings in 1983 prior to construction of the landfill. PSI conducted borings in 1997 in connection with the PBS&J, Inc., Response to RAI dated January 30, 1998 for the Application for Renewal of the Peration Permit, dated April 1998. and additional borings were conducted in July 2003 by PSI in connection with SCS' Environmental Resource Permit Application dated April 2004. The locations of all borings are shown in Figure 2-4.

The stratigraphy of the site is shown on figures prepared by ENVISORS (Appendix B). The majority of the borings were conducted to verify the presence and extent of the clay confining unit. The top of the borings include gray to brown sand overlying the clay units. The borings show the top of the clay layer ranges from 7 feet below land surface in the south west corner of the site to 15 feet below land surface in the north east corner of the site. The clay ranges in thickness from 12 to 60 feet thick. The west central boring show the clay layer to be 30 feet thick and underlain by limestone at 40 feet below land surface where the boring was terminated. The southwest boring showed clay approximately 7 feet bls and extending to 50 feet below land surface where lime rock was encountered.

In addition to the borings, the lateral extent and depth of clay was mapped using a refraction seismic survey. The results of the survey are shown in Appendix B. The results show that the top of the underlying clay in the fill area ranges from about 8.2 to 18.0 feet below ground surface. The clay layer appeared to be continuous across the site.

The additional borings conducted by PSI in 1997 and 2003 (discussed above) confirm the findings of the 1983 ENVISORS borings.

SITE SPECIFIC HYDROGEOLOGY

Three aquifer systems are present in the geologic sections described above. These are in downward order, the surficial aquifer, the intermediate aquifer, and the Floridan aquifer system. General characteristics for each aquifer are discussed below.

SURFICIAL AQUIFER

The surficial aquifer occurs in deposits that contain clayey sand, shell, shelly marl and some phosphoritic sediments and is unconfined (i.e. contains groundwater under atmospheric pressure). The thickness ranges from 25 to 100 feet in the Hardee County Region and groundwater yield from the aquifer is not a major source of water in the region, although some small diameter wells are used for lawn irrigation and stock watering.

The top of the surficial aquifer at the Hardee County Landfill site generally occurs at land surface to approximately nine feet below land surface. Thickness of the unit averages 15 feet in the site area.

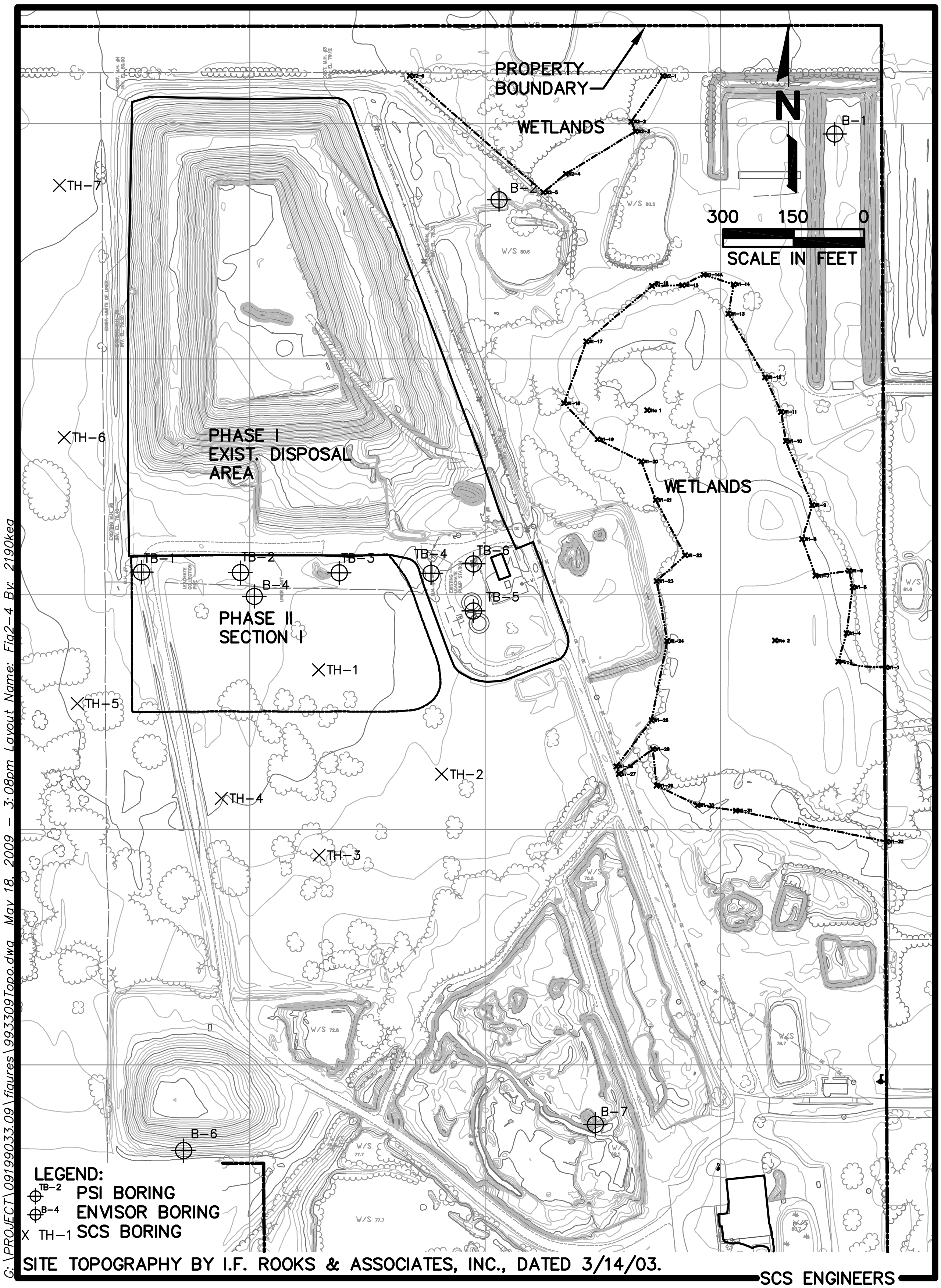

Figure 2–4. Hardee County Landfill Soil Boring Locations.

Slug Testing Methodology

A slug test is used to estimate the hydraulic conductivity of the aquifer in the immediate vicinity of the well being tested. A slug test is conducted by effecting an extremely rapid change in the water level in a monitoring well and measuring the response to the change over time. Inserting a known volume (Falling-Head) in the well or removing a known volume (Rising-Head) from the well creates well water level change ("head" change) that is measured to calculate hydraulic conductivity. The known volume (solid object) that is inserted or removed from the well is called a "slug." Rising-head slug testing was performed on monitoring wells MW-10R, MW-11, and MW-12R. The following describes the procedures used to perform the rising-head solid object slug test:

- The monitoring well was uncapped and the static water level was allowed to come to equilibrium.
- All down-hole equipment was decontaminated prior to use and between wells.
- Depth to water was measured using a water level indicator.
- A pressure transducer was placed within the well close to the bottom of the well.
- The pressure transducer was then connected to a lap top computer to record water level and elapsed time.
- A decontaminated solid slug was lowered into the monitoring well on a line and submerged below the water surface.
- Once the water level stabilized the test was started and water level measurements were recorded at an interval of one reading every second.
- The slug was then rapidly removed from the well using the attached line and rising head measured.
- The water level and elapsed-time data recording was terminated when the water level returned to the approximate pre-test (static) level.

This test was repeated three times on monitoring wells MW-10R and MW-12R. The results from the six slug tests are presented in Appendix C and were averaged to estimate the hydraulic conductivity in the areas of MW-10R, MW-11, and MW-12R.

An attempt to conduct a slug test at monitoring well MW-11 was made; however, due to low water level conditions an accurate test could not be completed.

Surficial Aquifer Groundwater Flow Direction

Ground water levels were measured at active monitor wells and piezometers listed in Specific Condition Number E.3, monthly during the period from June 2008 through May 2009. Staff gage readings were not collected during this reporting period from Staff Gage 1 due to low water level conditions. One staff gage reading was collected (May 2009) from Staff Gage 2 during this reporting period. These data have been plotted and contoured on site figures to evaluate groundwater flow direction. These figures show the potentiometric surface of the surficial aquifer (Appendix A).

The potentiometric map for the October 2008 measurement date is shown on two figures (Figures 5A and 5B, Appendix A) . The groundwater elevation at monitoring well MW-5 appears to be an anomaly and is not consistent with historical data. Therefore Figure 5B, Appendix A, shows the groundwater contours plotted without the data from monitoring well MW-5. When compared to the other potentiometric maps in Appendix A, Figure 5B appears to be more representative of groundwater elevations.

The approximate groundwater flow direction during the period June 2008 to May 2009 in the surficial aquifer was south to southeast.

The HDPE sidewall liner located along the perimeter of the landfill influences surficial aquifer groundwater flow direction. Groundwater flow along the landfill appears to be south, flowing along the side wall liner with exception of the southeast area of the site, near piezometer P-21. Groundwater flow in this area appears to be affected by the cypress heads. The groundwater gradient decreases as half the groundwater flows along the eastern side of the liner and half of the groundwater flows along the western side of the liner.

Hydrographs depicting the groundwater elevations within each well for the monthly measurements from June 2008 through May 2009 were generated and are presented in Appendix D. The groundwater level calculations indicated higher groundwater table elevations in the summer monitoring events and lower groundwater table elevations in the winter and spring monitoring events.

Surficial Aquifer Characteristics

Based on the potentiometric surface figures in Appendix A and the groundwater elevation from June 2008 through May 2009, the maximum hydraulic gradient of the surficial aquifer for Phase II Section I, at the landfill was calculated to be 0.003 feet/foot at the southeastern section of the landfill.

The effective porosity of the surficial aquifer sands was estimated to be 20 percent using porosity and specific retention values listed in Groundwater Hydrology[2.] The porosity value was obtained by taking the difference between the total porosity and specific retention for fine sand.

Surficial Aquifer Groundwater Flow Rate

SCS performed slug test analysis and calculations on the data from monitoring wells MW-10R and MW-12R following the method described by Bouwer and Rice[3] and using computer

[2] Todd, K.D. 1980 *Groundwater Hydrology*: John Wiley & Sons Publishing, p55.
[3] Bouwer, H. and R.C. Rice, "A Slug Test Method for Determining Hydraulic Conductivity of Unconfined Aquifers

software [4]. Slug test results are included in Appendix C. Hydraulic Conductivity results from the slug tests are listed in Table 2-2.

Table 2-2. Hydraulic Conductivity Results From Slug Testing

MW-ID	Test ID	Date	Hydraulic Conductivity (feet per day)
MW-10R	Slug 1	4/24/2009	2.23
	Slug 2	4/24/2009	2.59
	Slug 3	4/24/2009	2.55
	Average		2.46
MW-12R	Slug 1	4/24/2009	0.62
	Slug 2	4/24/2009	0.69
	Slug 3	4/24/2009	0.71
	Average		0.67

The velocity of groundwater in the surficial aquifer beneath the site was calculated using a form of Darcy's law[5], $V = k(dh/dl)/\theta$, where:

- V is the average velocity of groundwater.
- k is the aquifer horizontal hydraulic conductivity.
- dh/dl is the aquifer hydraulic gradient.
- θ is the effective porosity of the aquifer.

The following values were used for the velocity calculation:

- Horizontal hydraulic conductivity: 0.62 to 2.59 ft/day (slug test results).
- Hyrdraulic gradient: 0.003 ft/ft (potentiometric maps).
- Effective porosity: 0.20 (estimated for fine sands).

For the purposes of this evaluation the most conservative (highest) hydraulic conductivity of 2.59 ft/day was utilized to calculate surficial groundwater flow velocity. The effective porosity of the sands of the surficial aquifer was estimated at 0.20. Based on the above information the calculated groundwater flow velocity within the surficial aquifer was calculated to be 0.04 ft/day or approximately 15 feet/year. However, it should be noted that 0.04 feet/day is a liberal estimate of the groundwater flow velocity on site. Groundwater flow velocity may be lower at other locations.

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with Completely or Partially Penetrating Wells." Water Resources Research, Vol. 12, No. 3, pp. 423-428.
[4] Duffield, Glenn M. , "AQTESOLV™, Aquifer Test Design and Analysis Computer Software." Geraghty & Miller, Inc., Modeling Group, December 1994.
[5] Lohman, S. W., "Ground-Water Hydraulics." Geological Survey Professional Paper 708, 1972, pp.10-11.

3 ADEQUACY OF THE WATER QUALITY MONITORING SAMPLING FREQUENCY

Currently, the groundwater-monitoring plan (GWMP) includes nine monitoring wells, seven designated as detection wells and two designated as background wells (MW-1 and MW-4). Monitoring wells MW-10 and MW-12 were abandoned in January 2008 and reinstalled (MW-10R and MW-12R) closer to the edge of liner due to turbidity issues. In addition, it includes ten piezometers that are measured for water levels only. Each monitoring well and piezometer is designed to monitor the surficial aquifer. Table 3-1 lists the monitoring wells with their current permit designation. The table also includes their approximate distance from the edge of liner, their approximate distance to the zone of discharge, and their location relative to waste along the hydraulic gradient. Distances were determined in AutoCAD based on the site location map utilizing the latitude and longitude of each well.

Table 3-1. Monitoring Well Permit Designations and Locations Relative to Edge of Liner and ZOD

Well Number	Permit Designation	Approx. Distance from Edge of Liner (ft)	Approx. Distance from Zone of Discharge (ft)*	Hydraulic Direction
MW-1	Background	52	47	Up gradient
MW-2	Detection	70	30	Cross gradient
MW-4	Background	730	**	Up gradient
MW-5	Detection	43	57	Cross gradient
MW-8	Detection	14	86	Down gradient
MW-9	Detection	Abandoned	Abandoned	Down gradient
MW-10	Detection	Abandoned	Abandoned	Down-gradient
MW-10R	Detection	56	51	Down gradient
MW-11	Detection	53	47	Down gradient
MW-12	Detection	Abandoned	Abandoned	Down-gradient
MW-12R	Detection	50	50	Down gradient

Notes: 1. ZOD: Zone of Discharge.

2. *: ZOD begins at the edge of liner and extends outward 100 feet. Measurements are distance from well to outside edge of ZOD.

3. **: Well is outside the ZOD.

The current permit indicates that MW-2, MW-5, MW-8, and MW-9 are detection wells. Detection wells should be located down gradient from, and approximately 50 feet from disposal units, unless site-specific conditions make such placement impossible. Due to the presence of perimeter ditches on the north and west side of the landfill, monitoring well MW-5 was placed greater than 50 feet from the edge of waste. At the time of installation of MW-8 and MW-9 a leachate containment ditch was located on the southern edge of the landfill. MW-8 and MW-9 were placed down gradient of the leachate containment ditch. Also a heavily traveled road is located on the east side of the landfill. MW-2 was placed east of the access road to avoid traffic. It is located approximately 70 feet west of the edge of waste.

According to Chapter 62-791 F.A.C., background wells are required to be hydraulically up gradient from waste. MW-1 and MW-4 serve this purpose in the monitoring plan.

Up-gradient wells generally are spaced at 1500 foot intervals and side-gradient and downgradient wells are spaced at approximately 500 foot intervals according to the regulations.

MONITORING FREQUENCY

The monitoring locations are sampled and analyzed semi-annually in accordance with the permit. Based on maximum groundwater velocity calculations, groundwater movement between the semi-annual sampling event in the vicinity of the Phase II Section I disposal footprint is approximately 7.2 feet per 180 days. This rate provides adequate time to evaluate and take action on groundwater contamination at the edge of the zone of discharge if contamination is observed at the detection wells in this area.

PARAMETER LISTS

Current routine monitoring parameters include various volatile organic, metals, and inorganic constituents. There have been no findings that indicate a need to modify the routine parameter list. Consequently, Hardee County will maintain the current groundwater quality monitoring parameters.

APPENDIX A

POTENTIOMETRIC MAPS

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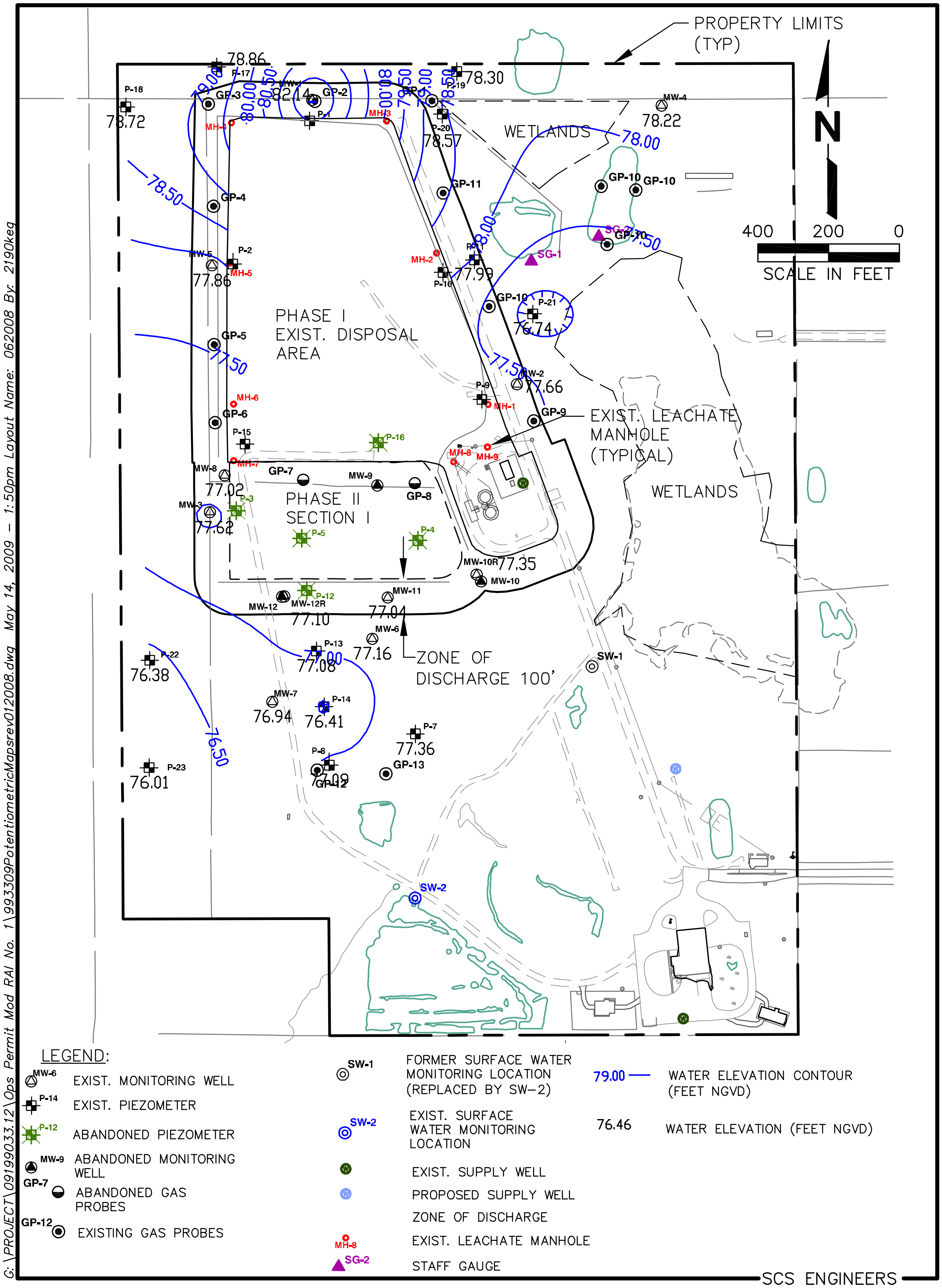

Figure 1. June 2008 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

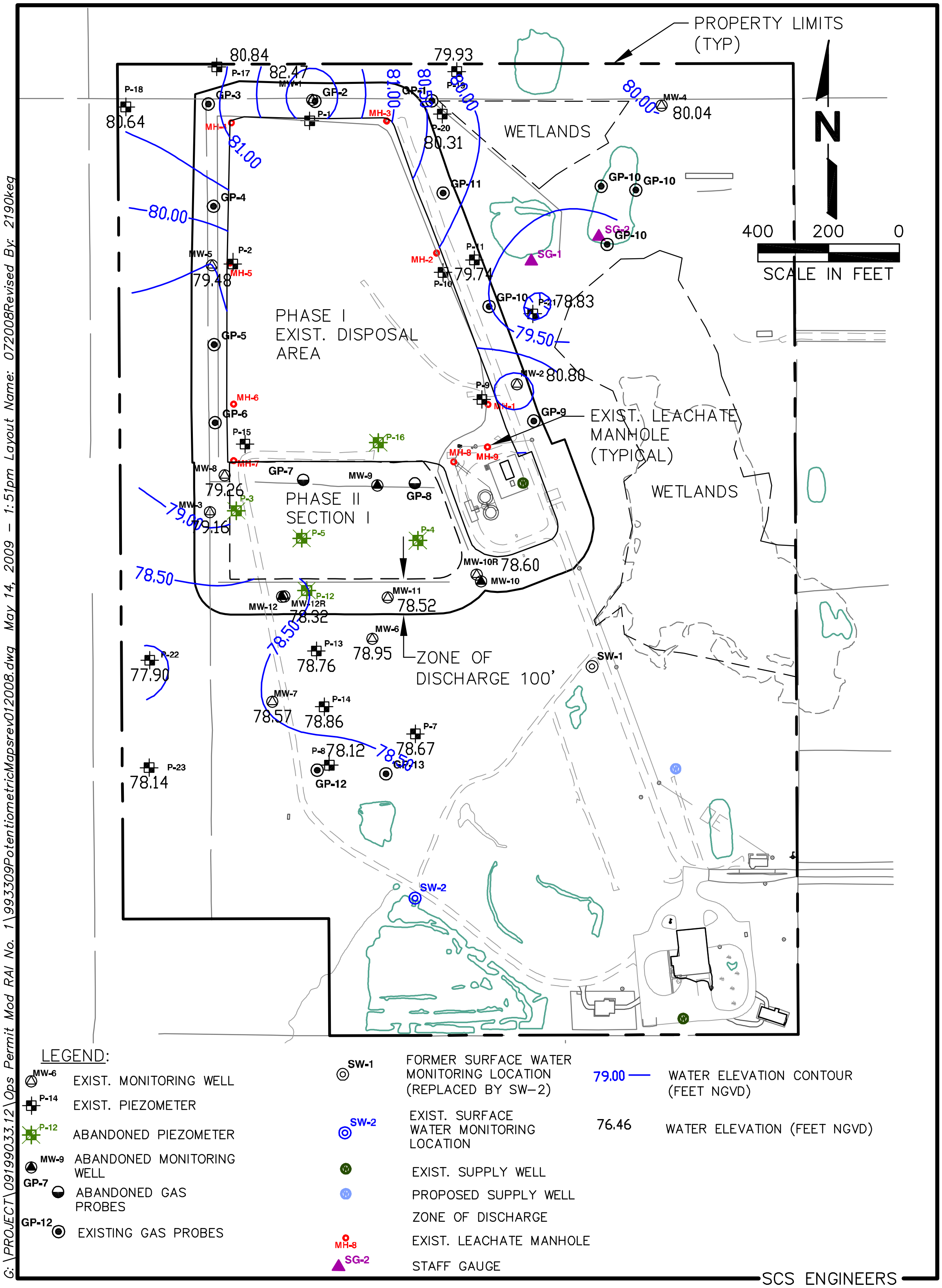

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Figure 2. July 2008 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

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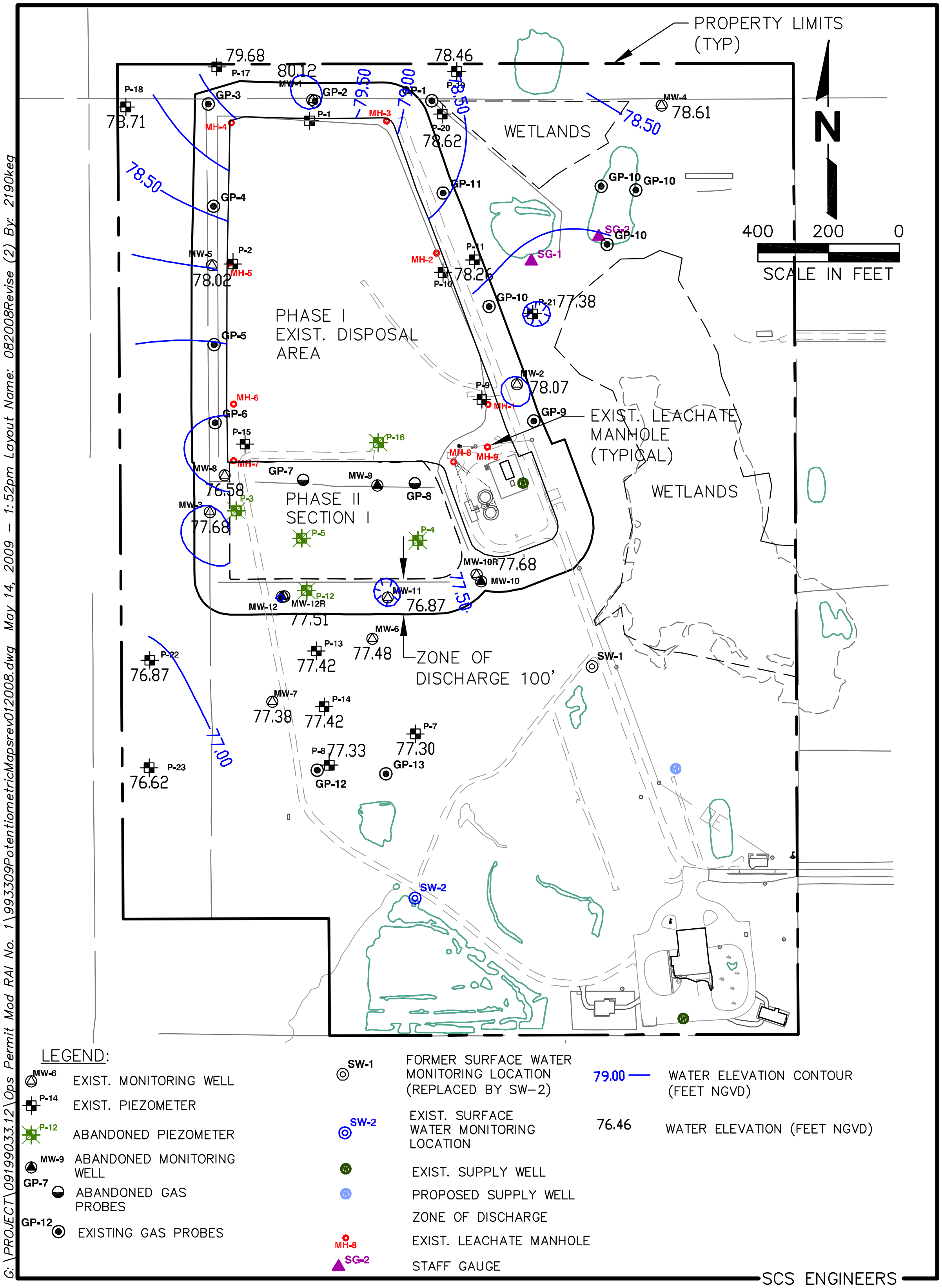

Figure 3. August 2008 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

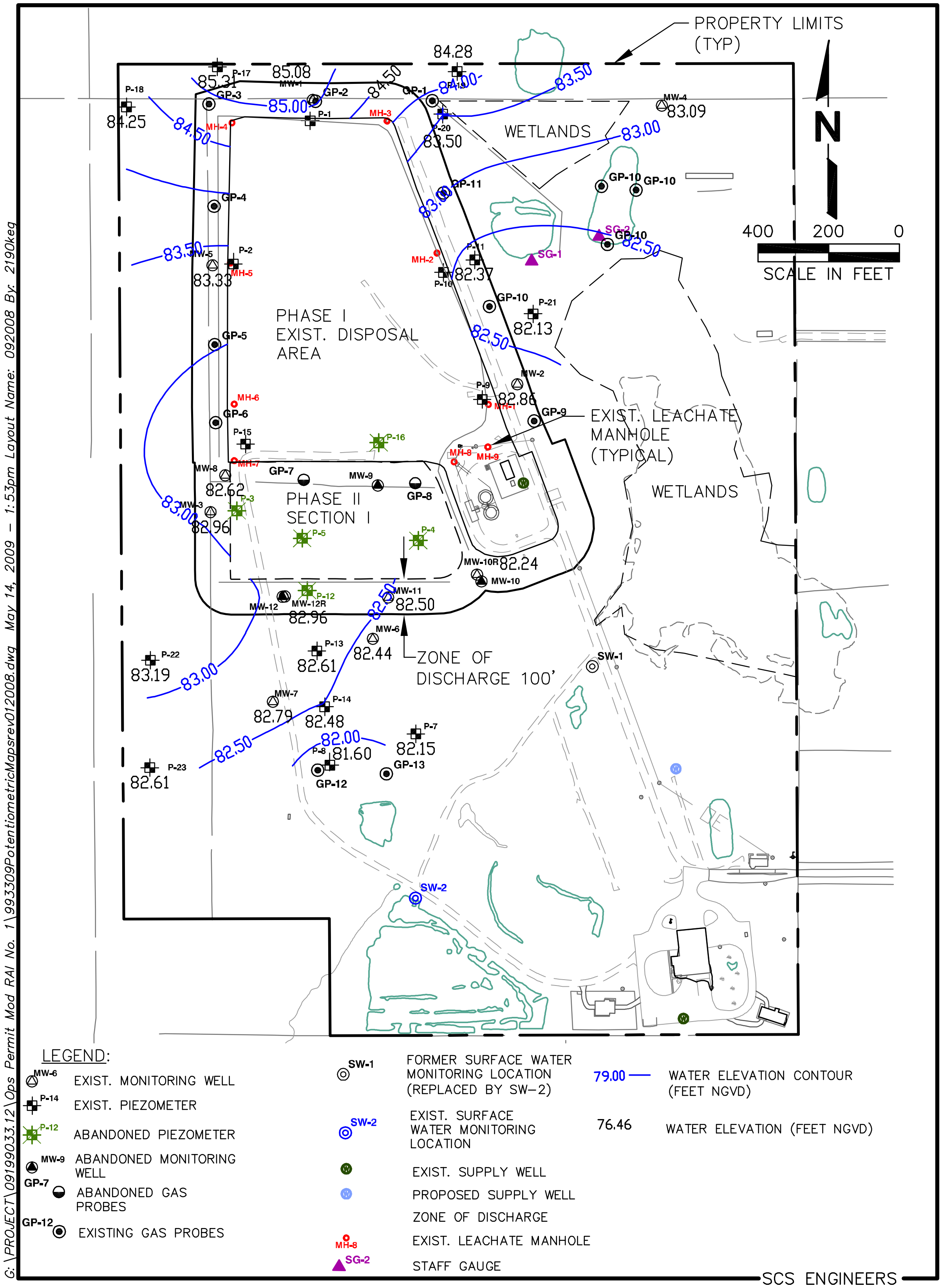

Figure 4. September 2008 Surficial Aquifer Potentiometric Map,
Hardee County Solid Waste Disposal Facility

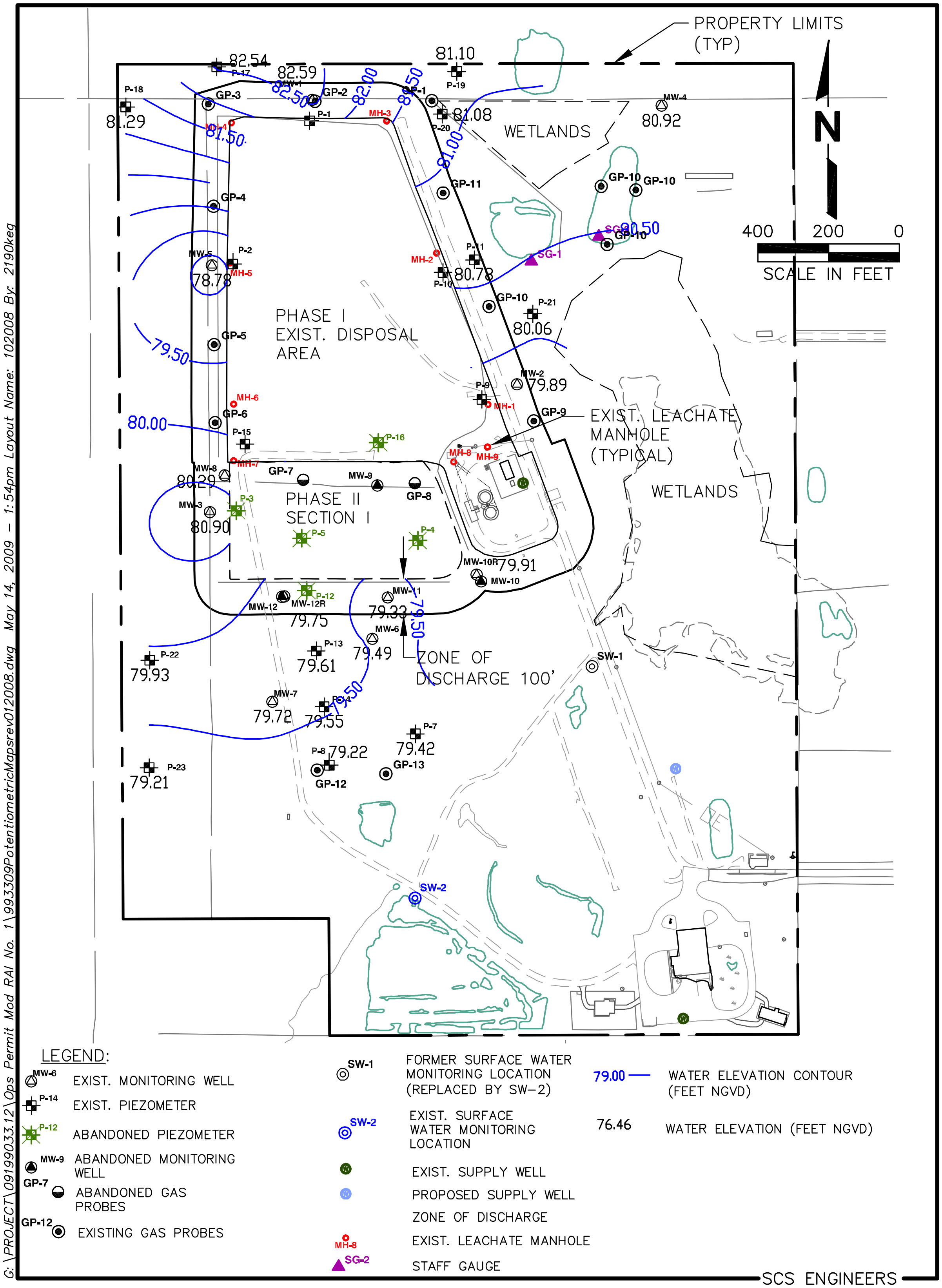

Figure 5A. October 2008 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

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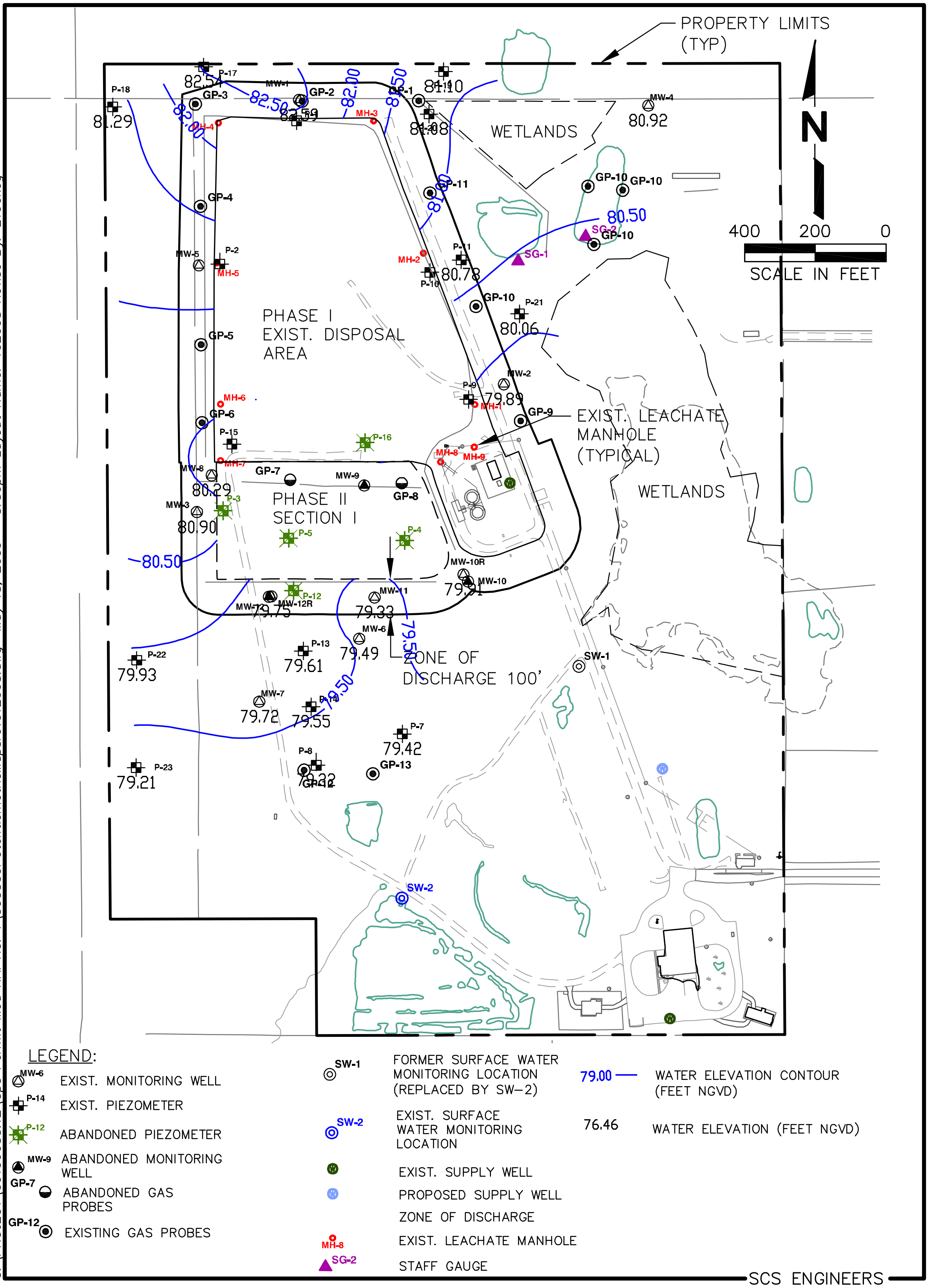

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Figure 5B. October 2008 Surficial Aquifer Potentiometric Map, Modified, Hardee County Solid Waste Disposal Facility

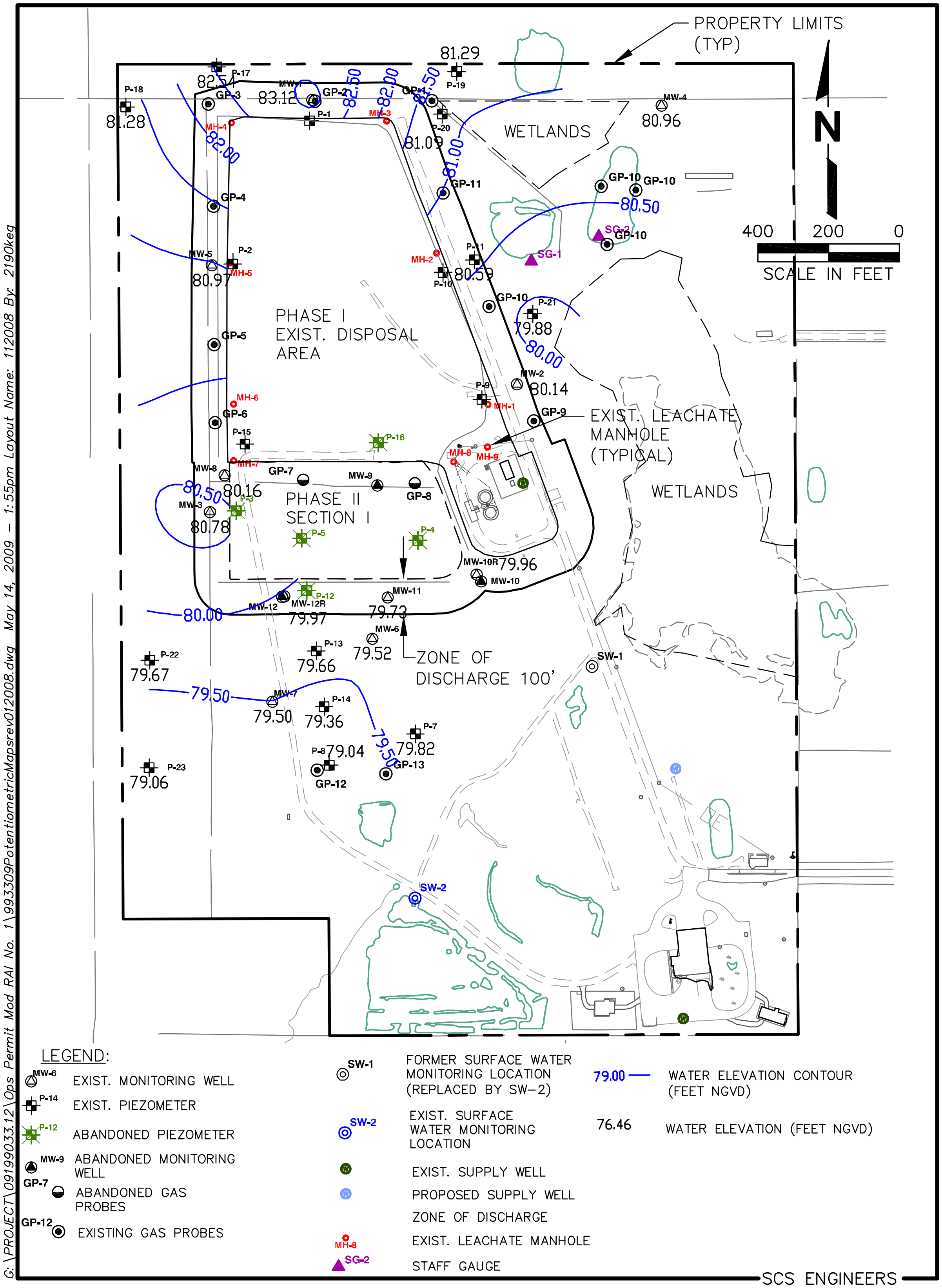

Figure 6. November 2008 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

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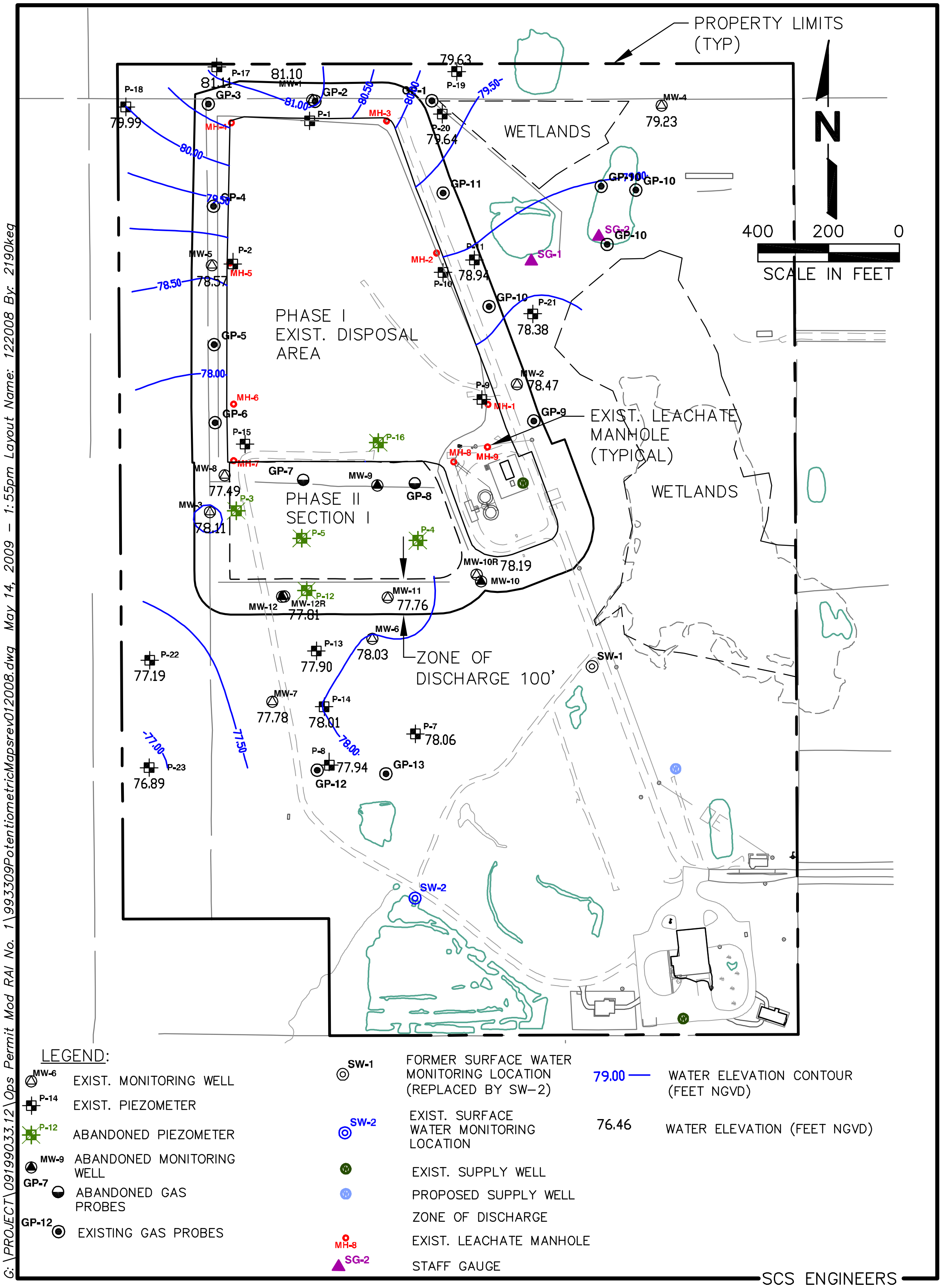

Figure 7. December 2008 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

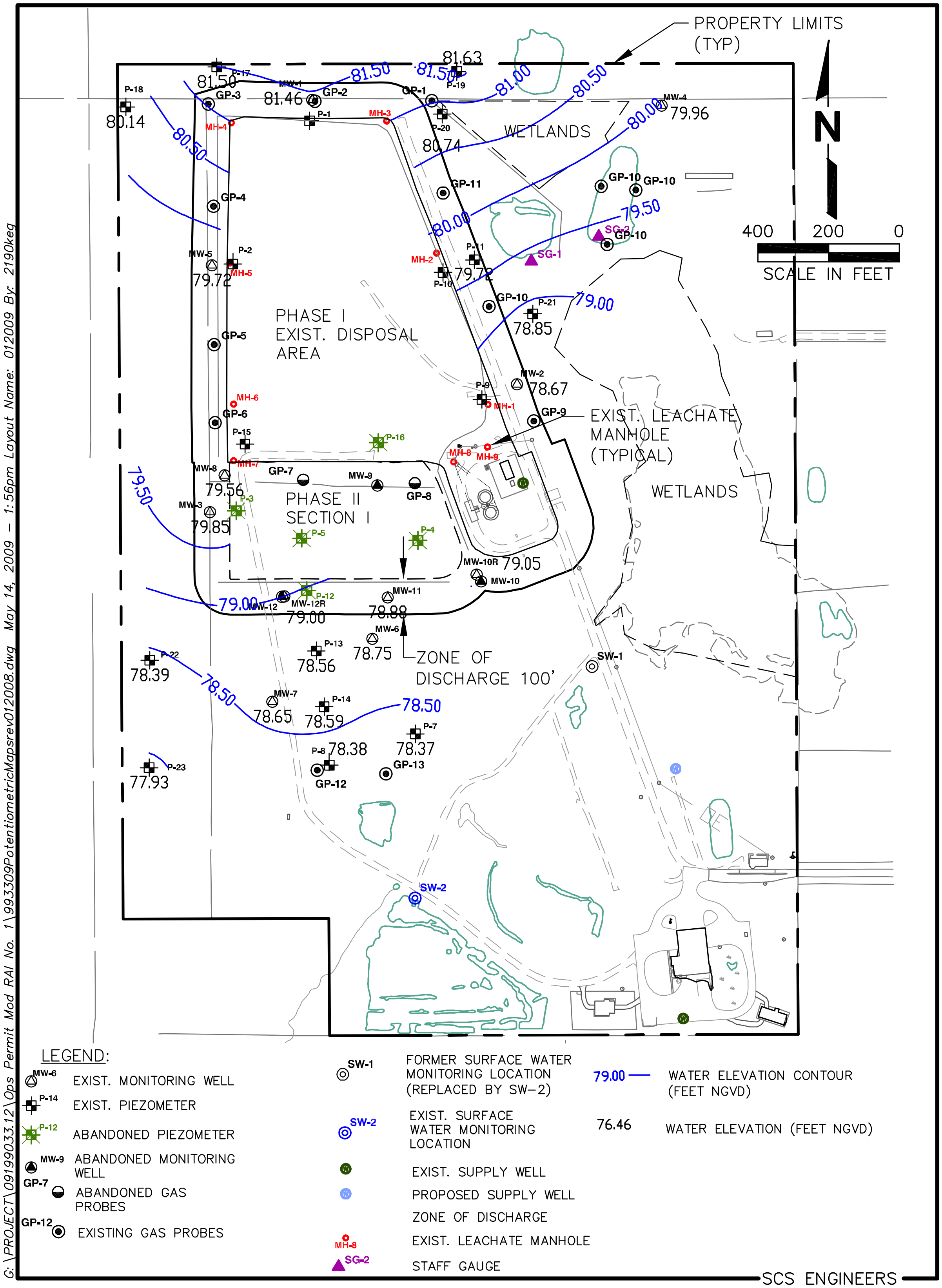

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Figure 8. January 2009 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

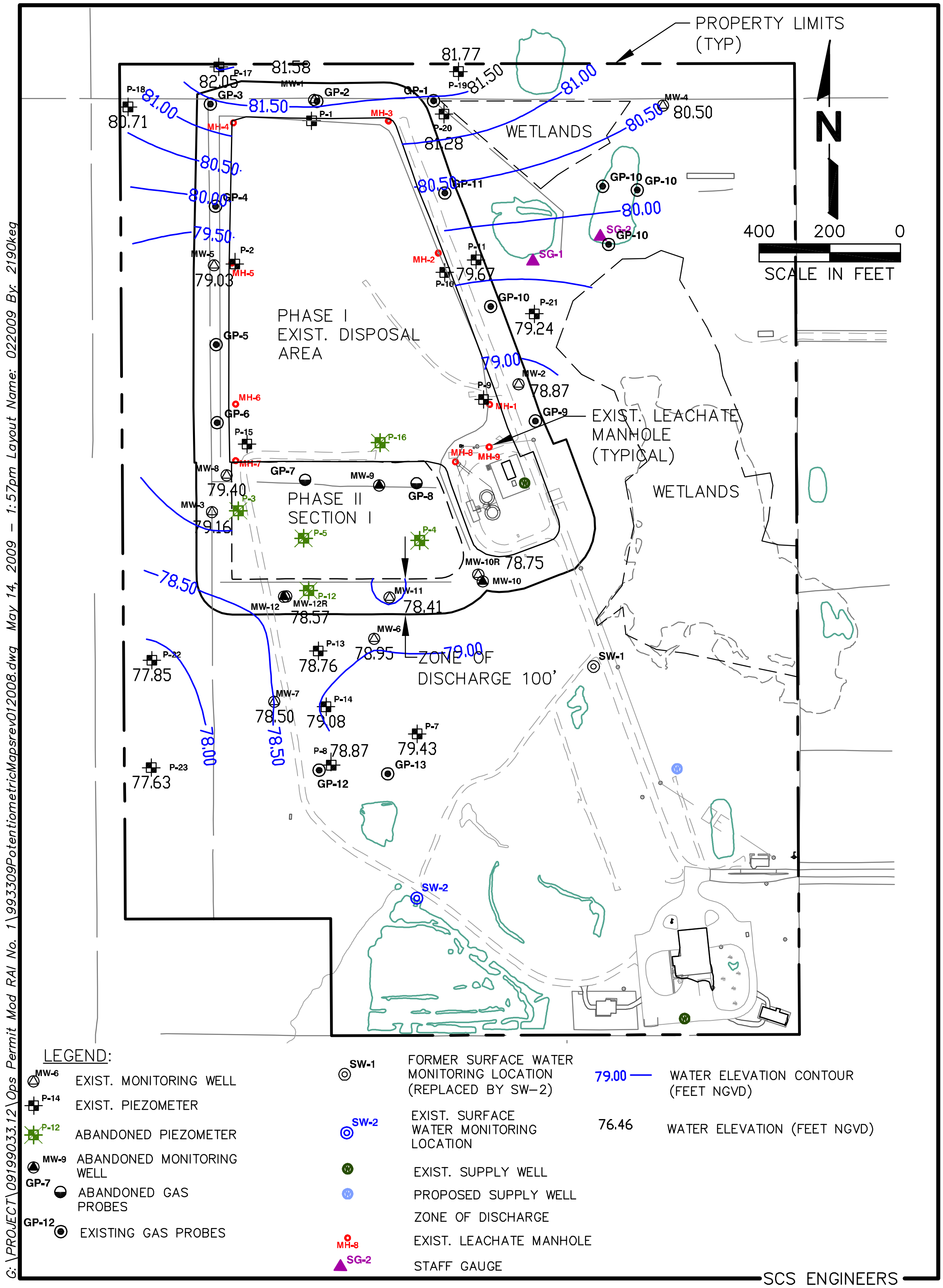


Figure 9. February 2009 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

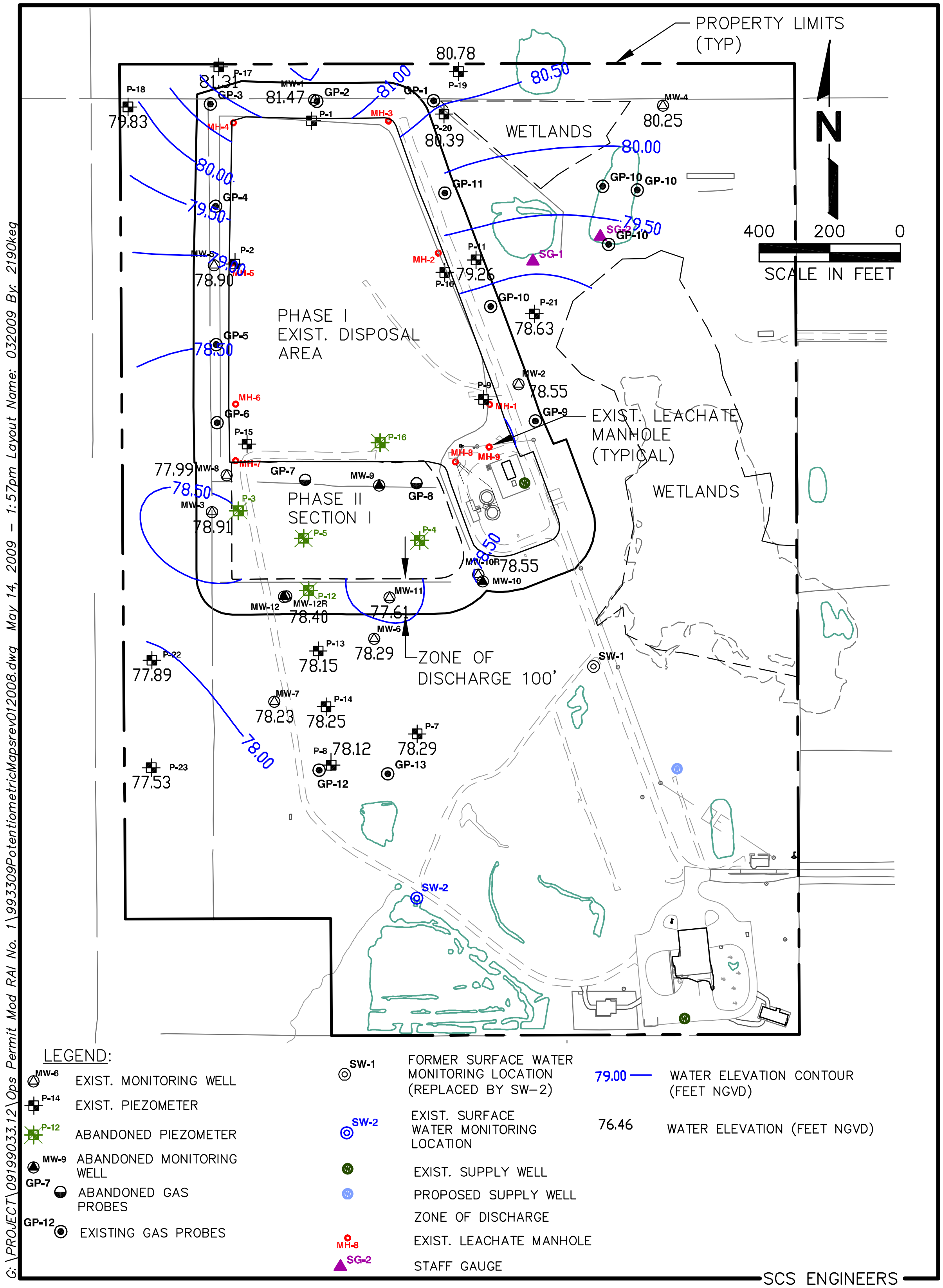


Figure 10. March 2009 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

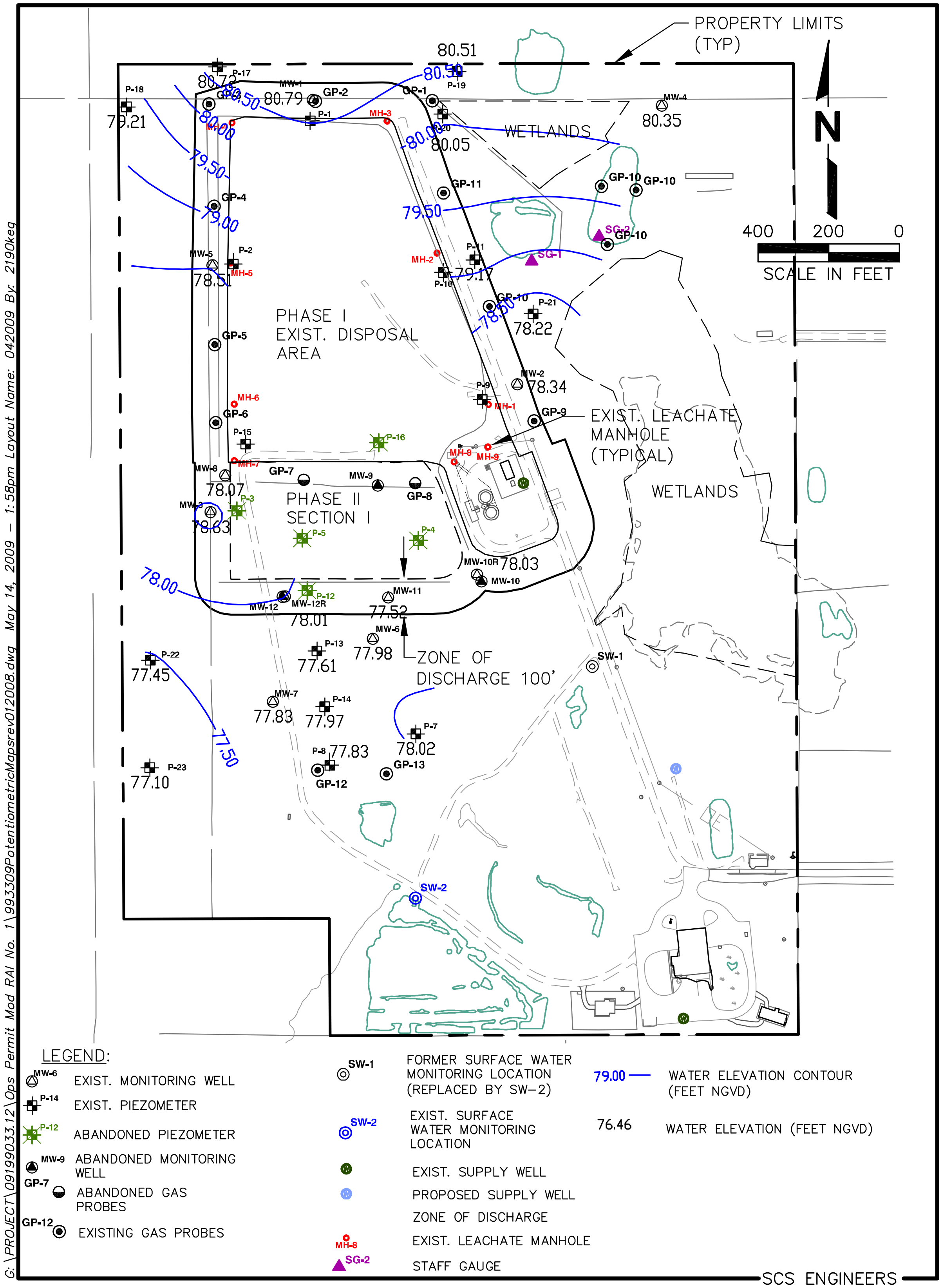


Figure 11. April 2009 Surficial Aquifer Potentiometric Map, Hardee County Solid Waste Disposal Facility

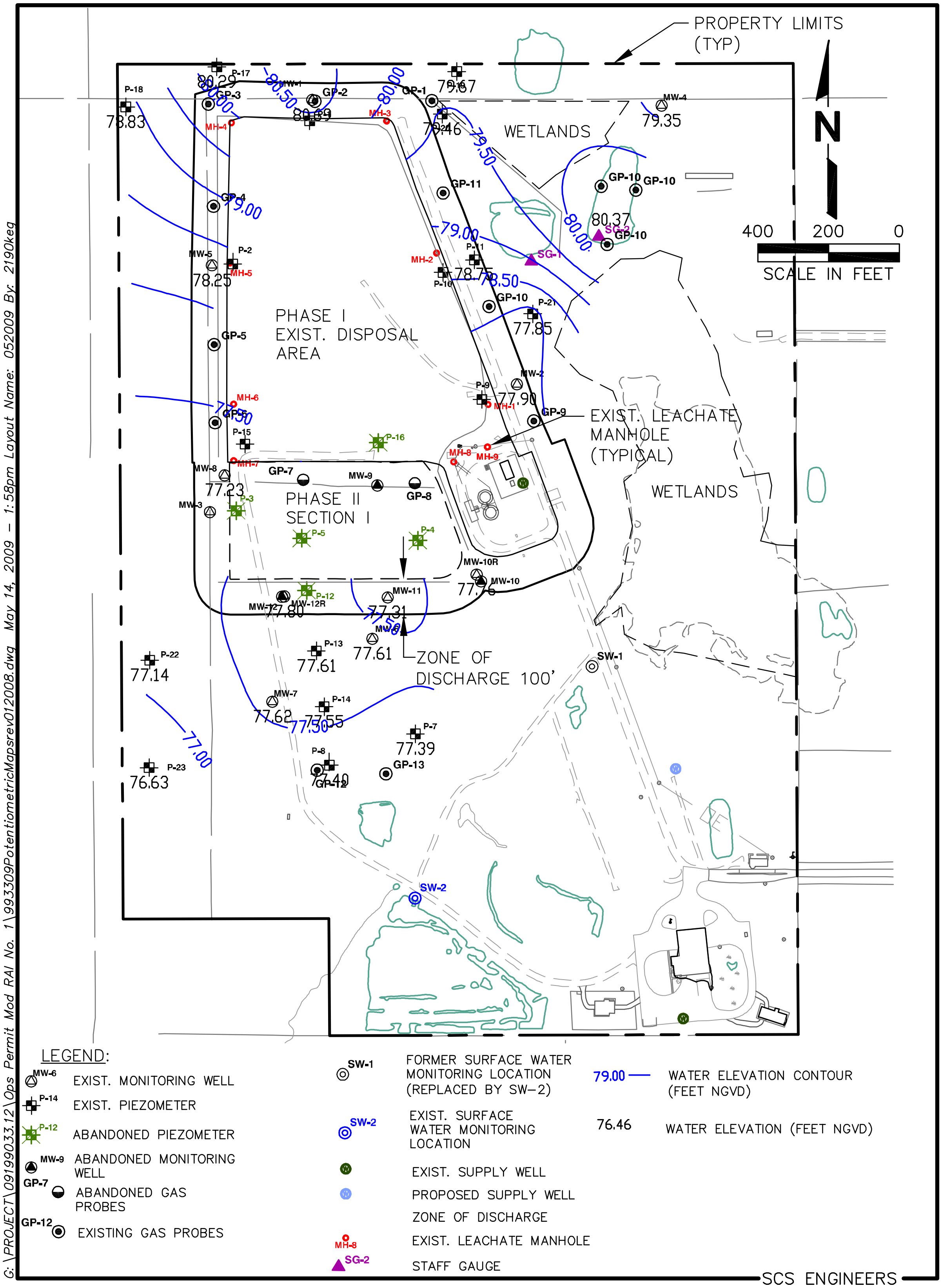
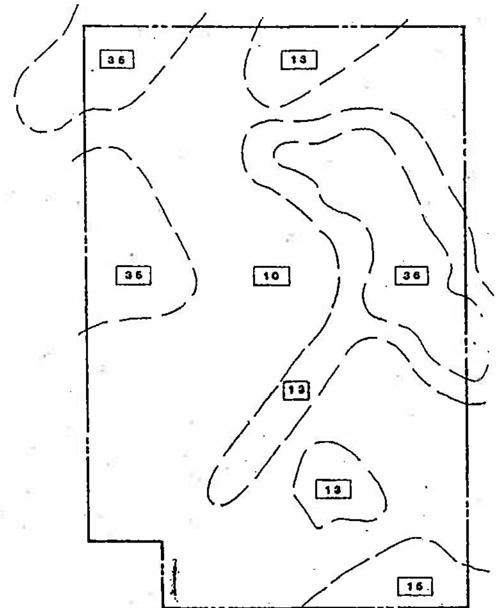


Figure 12. May 2009 Surficial Aquifer Potentiometric Map,
Hardee County Solid Waste Disposal Facility

APPENDIX B

ENVISORS, INC.
TEST BORING RESULTS AND SITE STRATIGRAPHY



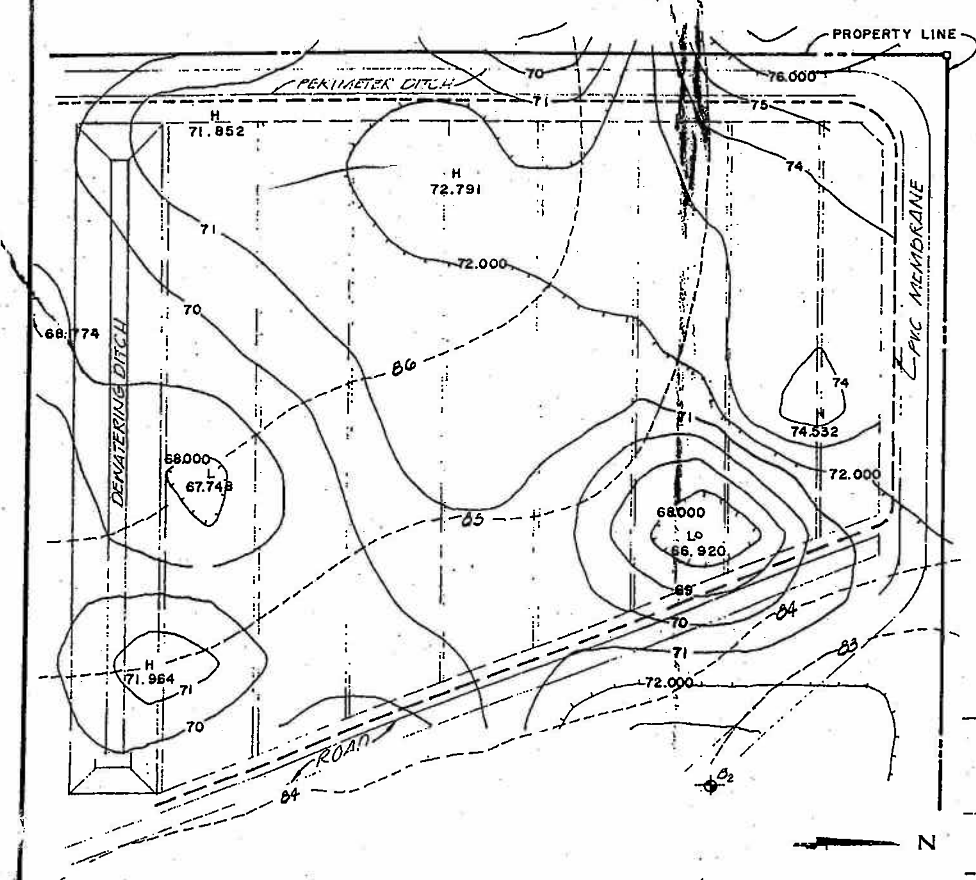
LEGEND

10	POMONA FINE SAND
13	FLORIDANA MUCKY FINE SAND, DEPRESSIONAL
15	IMMOKALEE FINE SAND
35	OLDSMAR FINE SAND
86	TOMOKA MUCK
	SITE BOUNDARY
	LIMITS OF SPECIFIC SOILS ASSOCIATION

Reference: Interim Soil Survey Report, Maps and Interpretations by U.S.D.A. Soil Conservation Service.

SCALE 1" = 400'

SURFACE SOILS ASSOCIATIONS PLAN



CLAY LAYER ELEVATIONS

SCALE: 1" = 100'

NOTES

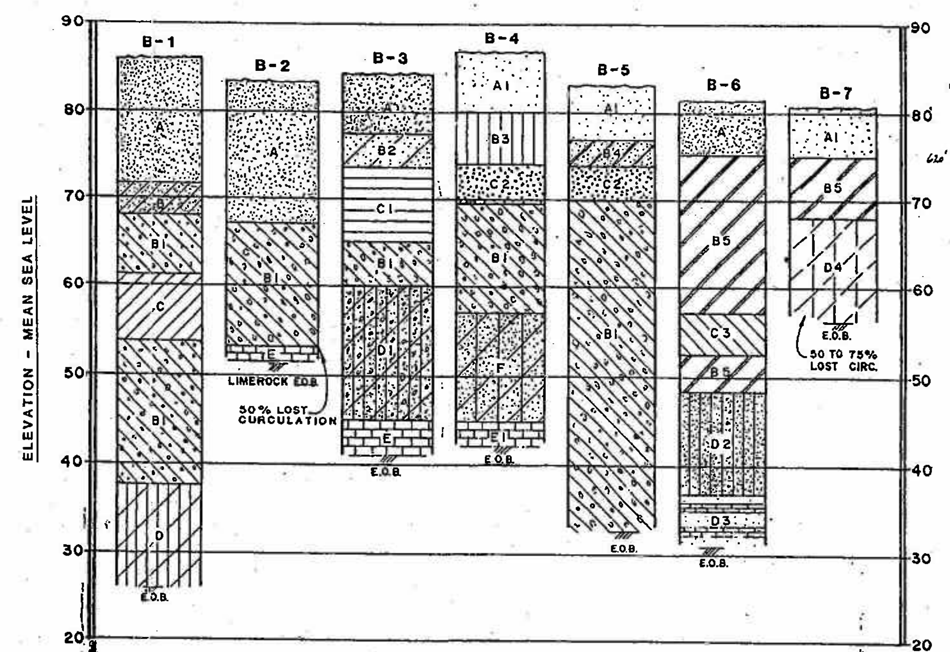
1) THIS FIGURE REPRESENTS THE RESULTS OF A REFRACTION SEISMIC SURVEY OF THE NORTHWEST CORNER OF THE SITE, PERFORMED BY ARMAC ENGINEERS, INC., 8430 NORTH 40TH STREET, TAMPA, FLORIDA 33604. THIS SURVEY WAS PERFORMED IN ORDER TO ESTABLISH THE EXISTENCE OF AND ESTIMATE THE DEPTH TO THE UNDERLYING CONFINING CLAY LAYER. CORRELATION WITH KNOWN SOIL DEPTH DATA WAS ESTABLISHED BY PERFORMING THE SURVEY IN CLOSE PROXIMITY TO PREVIOUSLY PERFORMED SPT BORINGS B-2 AND B-4. CHARACTERISTIC COMPRESSIVE WAVE VELOCITIES WERE ESTABLISHED FOR BOTH THE UPPER SURFICIAL SOILS AND UNDERLYING CLAY SOILS. THESE AVERAGE COMPRESSION WAVE VELOCITIES WERE FOUND TO BE 1362 AND 4824, RESPECTIVELY. THIS HIGH VELOCITY DIFFERENTIAL WAS USED TO IDENTIFY THESE SEPARATE SOIL STRATA.

THE FIGURE SHOWS THE RESULTS OF THIS SEISMOGRAPH INVESTIGATION WHICH INDICATE THAT THE UNDERLYING COHESIVE CLAY LAYER IS ESTIMATED TO LIE AT DEPTHS RANGING FROM ABOUT 8.4 TO 18.0 FEET BELOW GROUND SURFACE (ELEVATION 67.8 TO 77.3 FEET MSL). THE COHESIVE SOIL STRATA WAS FOUND TO BE CONTINUOUS IN THE SUBJECT AREA, BUT POSSIBLE HIGH VELOCITY HARDPAN OR SURFICIAL CLAY LAYERS WERE FOUND TO EXIST AT THREE OUT OF 22 SURVEY GRID LOCATIONS. THESE NEAR-SURFACE HIGH VELOCITY SOIL LAYERS PRODUCED ANOMALOUS WAVE REVERSALS PREVENTING DEEPER SOIL ANALYSIS AT THESE LOCATION.

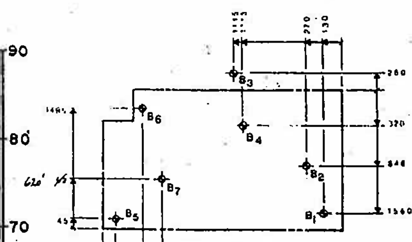
2) CLAY CONTOURS AT ONE FOOT (1') INTERVALS.

LEGEND

68.000	SUBSURFACE CLAY CONTOUR W/ELEVATION
L	LOW CLAY
H	HIGH CLAY
86	GROUND CONTOUR
⊕	BORING LOCATION
- - - -	IMPERMEABLE PVC MEMBRANE BARRIER



SOIL BORING PROFILES

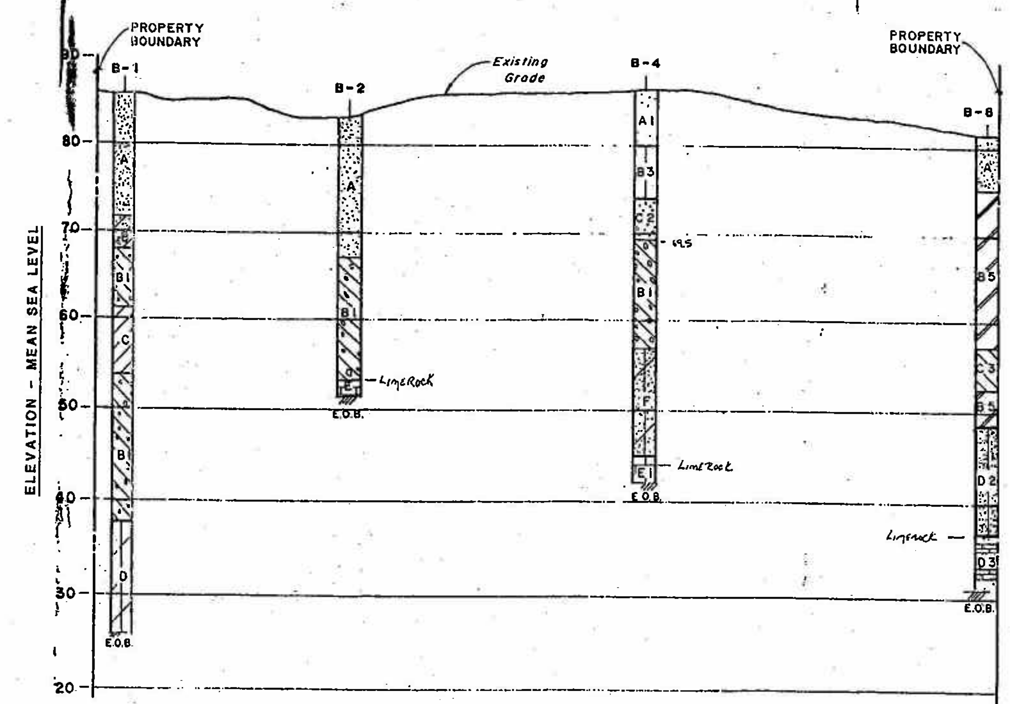


SITE PLAN
N.T.S.

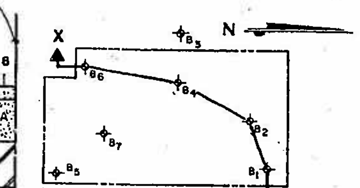
LEGEND

A	GRAY & BROWN SAND
A1	BROWN SAND
B	CLAYEY SAND
B1	GRAY-GREEN SANDY CLAY W/ PHOSPHATE
B2	GRAY SANDY CLAY
B3	HARDPAN
B4	GRAY CLAYEY SAND
B5	GRAY-GREEN SANDY CLAY
C	HARD GRAY-GREEN CLAY
C1	GREEN CLAY
C2	GRAY SAND
C3	GRAY-GREEN CLAY
D	GREEN SANDY CALCAREOUS
D1	GRAY-GREEN CALCAREOUS SANDY CLAY W/ PHOSPHATE
D2	GRAY-GREEN CALCAREOUS
D3	GRAY-GREEN CALCAREOUS CLAY W/ L.R LENSES
D4	GRAY TO TAN CALCAREOUS SANDY CLAY
E	GREENISH GRAY CLAYEY LIMEROCK W/ PHOSPHATE
E1	GREENISH GRAY LIMEROCK & SANDY CLAY
F	YELLOW MOTTLED GRAY-GREEN SANDY CLAY

NOTE: ALL SUBSURFACE SOILS WORK CONDUCTED BY ARMAC ENGINEERING, INC., TAMPA, FLORIDA.



SECTION X-X



SITE PLAN
N.T.S.

LEGEND

A	GRAY & BROWN SAND
A1	BROWN SAND
B	CLAYEY SAND
B1	GRAY-GREEN SANDY CLAY W/ PHOSPHATE
B2	GRAY SANDY CLAY
B3	HARDPAN
B4	GRAY CLAYEY SAND
B5	GRAY-GREEN SANDY CLAY
C	HARD GRAY-GREEN CLAY
C1	GREEN CLAY
C2	GRAY SAND
C3	GRAY-GREEN CLAY
D	GREEN SANDY CALCAREOUS
D1	GRAY-GREEN CALCAREOUS SANDY CLAY W/ PHOSPHATE
D2	GRAY-GREEN CALCAREOUS
D3	GRAY-GREEN CALCAREOUS CLAY W/ L.R. LENSES
D4	GRAY TO TAN CALCAREOUS SANDY CLAY
E	GREENISH GRAY CLAYEY LIMEROCK W/ PHOSPHATE
E1	GREENISH GRAY LIMEROCK & SANDY CCAY
F	YELLOW MOTTLED GRAY-GREEN SANDY CLAY

D.E.P.
JUN - 6 1997
TAMPA

RECORD DRAWING

NOTE: The information presented hereon is based upon drawings, specifications, addenda, shop drawings, modifications, etc. annotated by the contractor during the construction period to reflect the in-situ parameters of the improvements he constructed.

The Engineer, Envisors, Inc., is not responsible for the accuracy or validity of the Record Drawing information depicted hereon.

HARDEE COUNTY, FLORIDA
REGIONAL SANITARY LANDFILL

SOILS INFORMATION

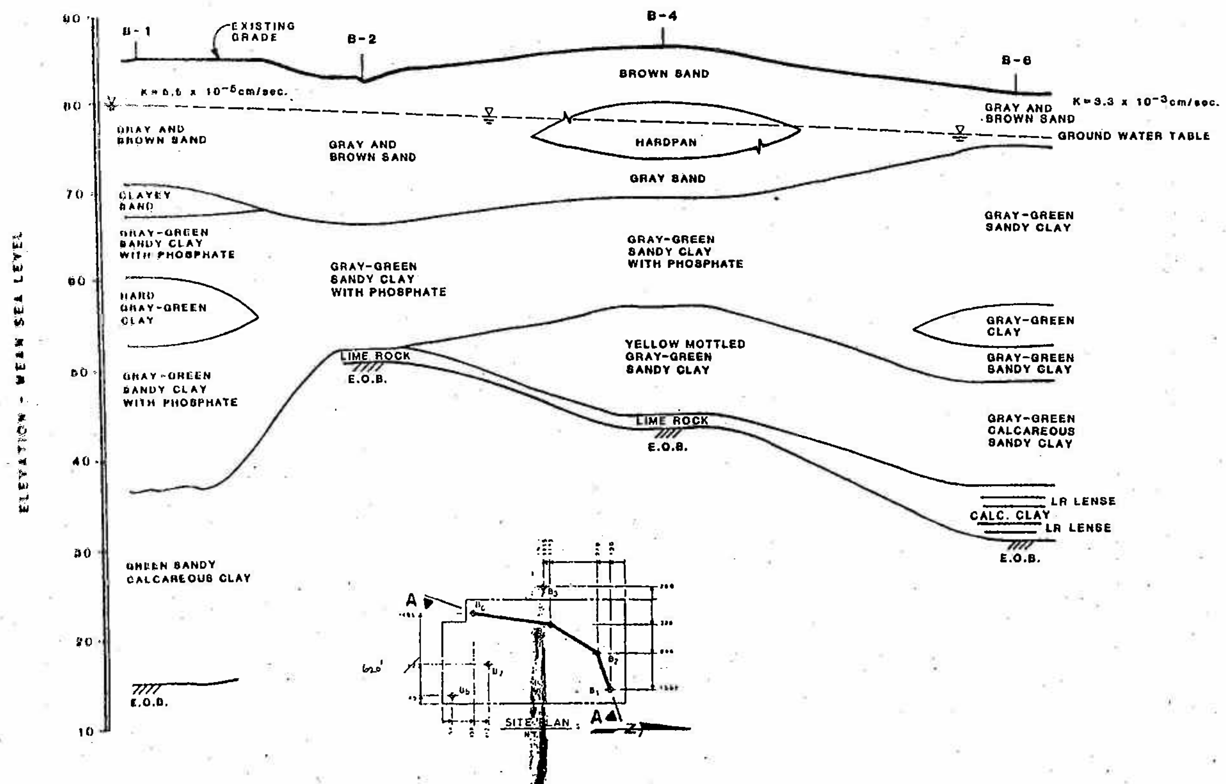
Florida Registered Professional Engineer No. 13097

Designed	—
Drawn	C.S.L.
Checked	D.D.
Approved	D.D.
Job No	81014
Date	10/82

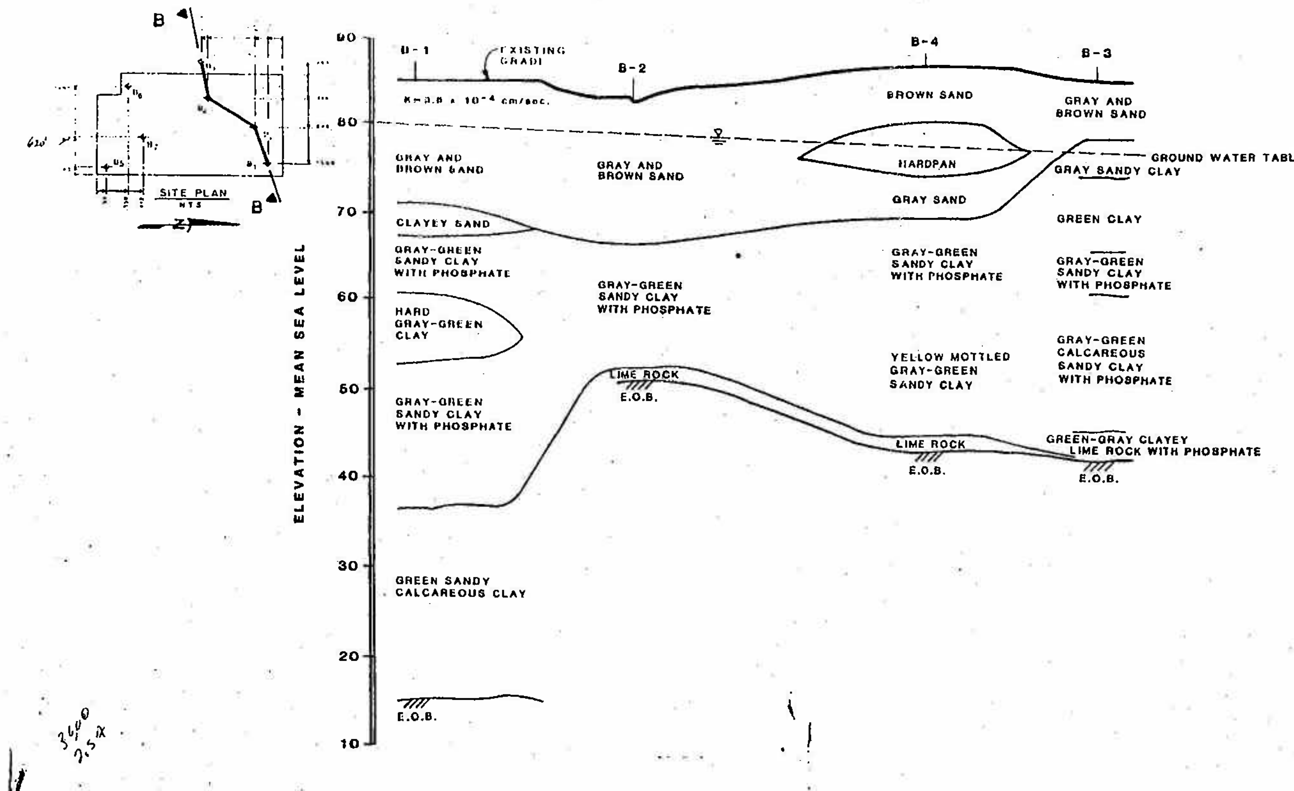
No.	Revision Description	By	Chk.
1	New Sheet	CSL	DD

EVI ENVISORS, Inc.
Consulting Civil & Environmental Engineers
Economists, and Planners
WINTER HAVEN, TAMPA, & MARGATE, FLORIDA

SHEET NUMBER
3
OF 14 SHEETS



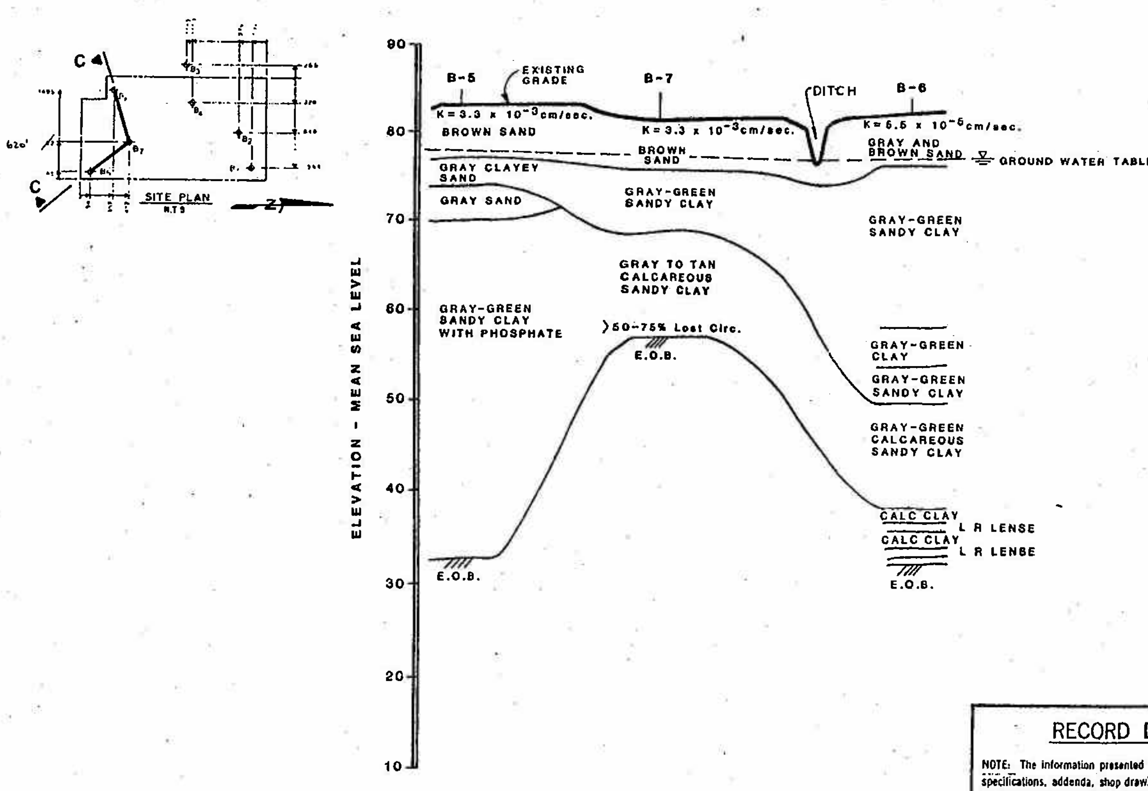
SECTION A-A



SECTION B-B

NOTES: 1.) ALL SUBSURFACE SOILS WORK CONDUCTED BY ARMAC ENGINEERING, INC., TAMPA, FLORIDA

2.) SUBSURFACE CONDITIONS BETWEEN BORING LOCATIONS ARE INTERPOLATED.



SECTION C-C

RECORD DRAWING

NOTE: The information presented hereon is based upon drawings, specifications, addenda, shop drawings, modifications, etc. annotated by the contractor during the construction period to reflect the in-situ parameters of the improvements he constructed.

The Engineer, Envisors, Inc., is not responsible for the accuracy or validity of the Record Drawing information depicted hereon.

HARDEE COUNTY, FLORIDA
REGIONAL SANITARY LANDFILL

SOILS INFORMATION

Florida Registered Professional Engineer No. 13097

Designed	—
Drawn	C.S.L.
Checked	D.D.
Approved	D.D.
Job No.	81014
Date	10/82

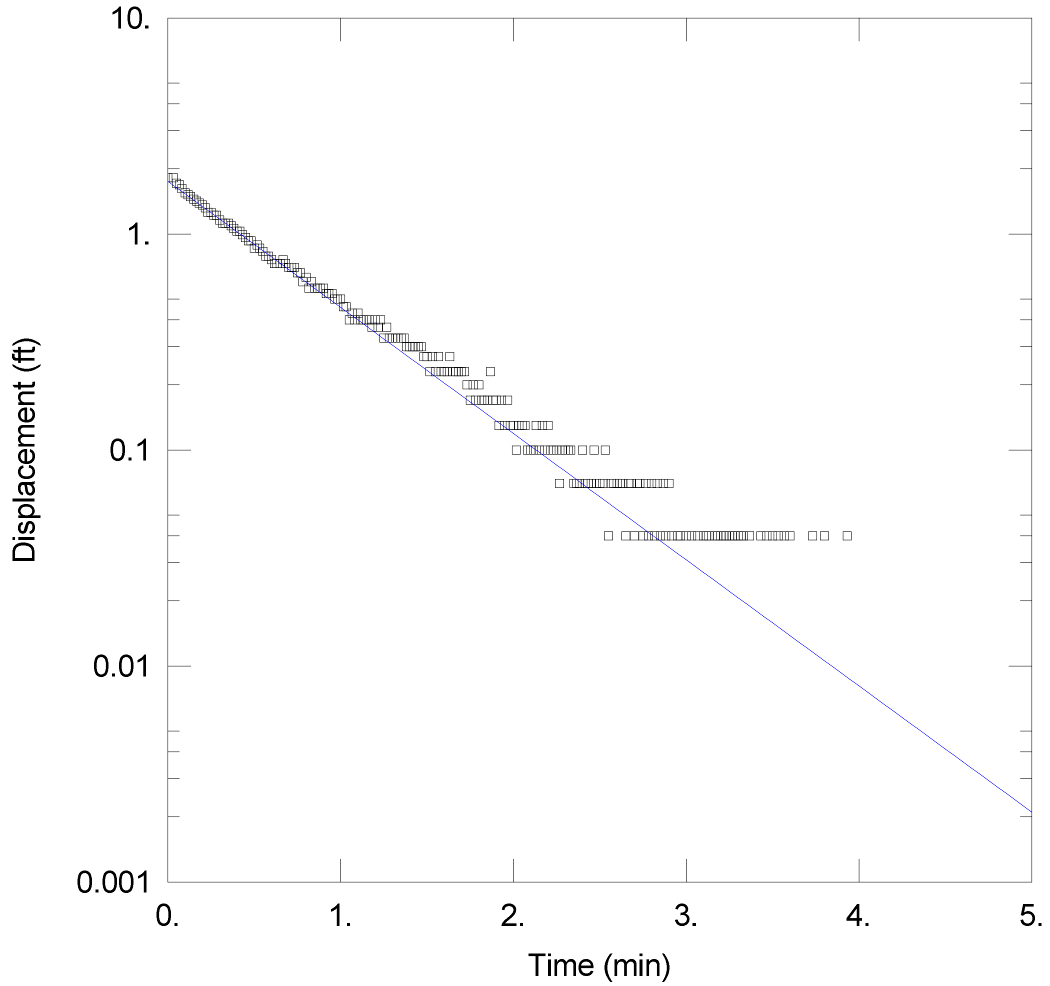
No.	Revision Description	By	Chk.	Date
1	New Sheet			

ENVISORS, Inc.
Consulting Civil & Environmental Engineers
Economists, and Planners
WINTER HAVEN, TAMPA, & MARGATE, FLORIDA

SHEET NUMBER 4 OF 14

APPENDIX C

SLUG TEST RESULTS



WELL TEST ANALYSIS

Data Set: F:\...\MW-10R_A_Slug.aqt
Date: 05/14/09 Time: 14:41:49

PROJECT INFORMATION

Company: SCS Engineers
Client: Hardee County
Project: 09199033.19
Location: Hardee County Landfill
Test Date: 04/24/09

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

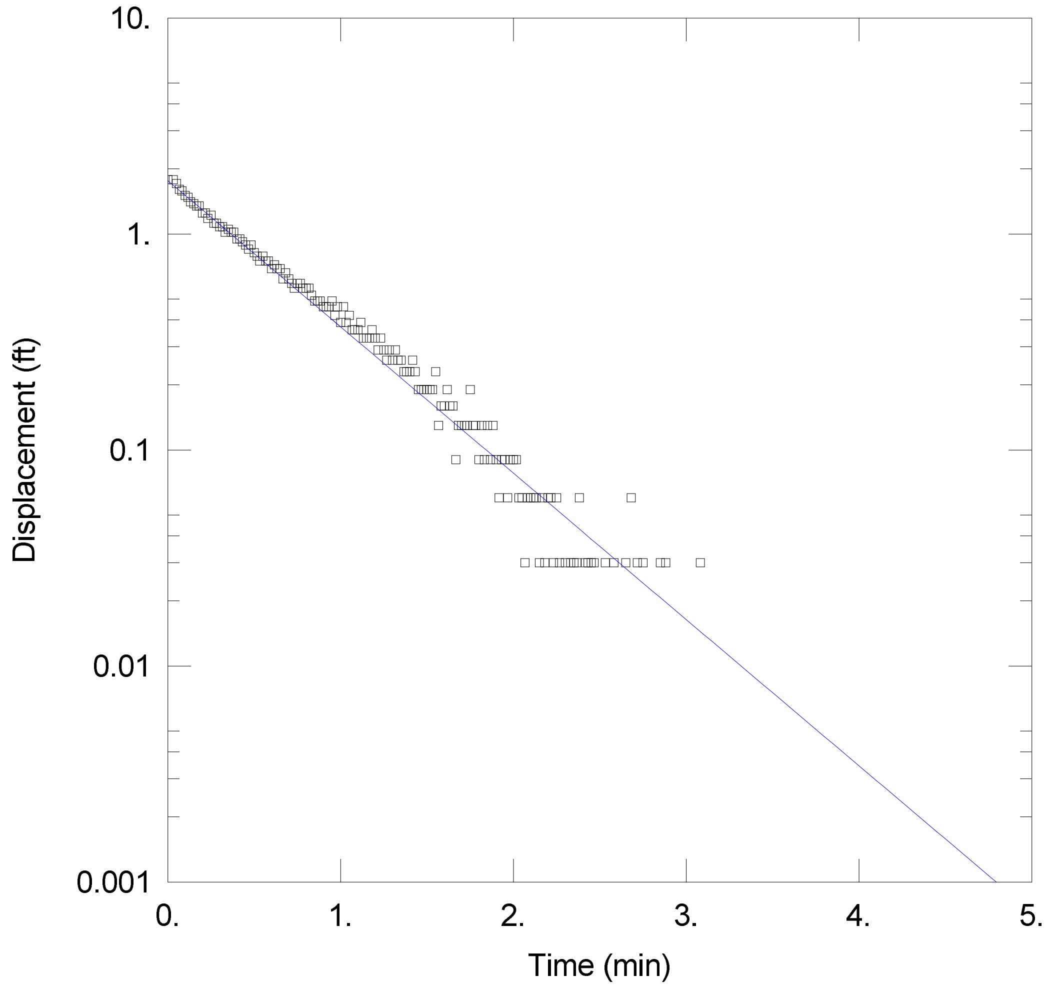
WELL DATA (MW-10R)

Initial Displacement: 1.82 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 10.64 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.001551 ft/min y0 = 1.753 ft



MW-10R B

Data Set: F:\...\MW-10R_B_Slug.aqt
Date: 05/14/09 Time: 14:42:46

PROJECT INFORMATION

Company: SCS Engineers
Client: Hardee County
Project: 09199033.19
Location: Hardee County Landfill
Test Date: 04/24/09

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

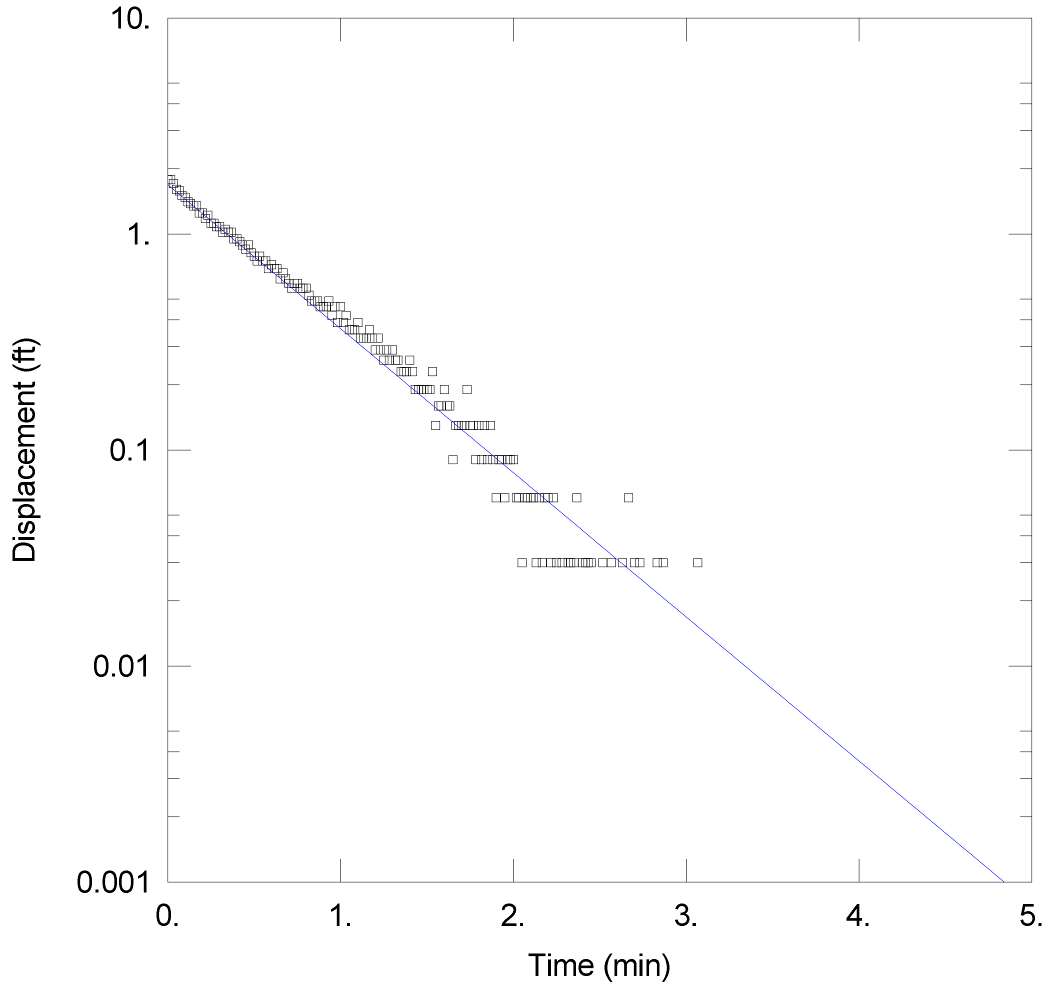
WELL DATA (MW-10R B)

Initial Displacement: 1.78 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.08333 ft
Static Water Column Height: 13.3 ft
Screen Length: 10. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.001799 ft/min y0 = 1.765 ft



MW10R C

Data Set: F:\...\MW-10R_C_Slug.aqt
Date: 05/14/09 Time: 14:43:16

PROJECT INFORMATION

Company: SCS Engineers
Client: Hardee County
Project: 09199033.19
Location: Hardee County Landfill
Test Date: 04/24/09

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

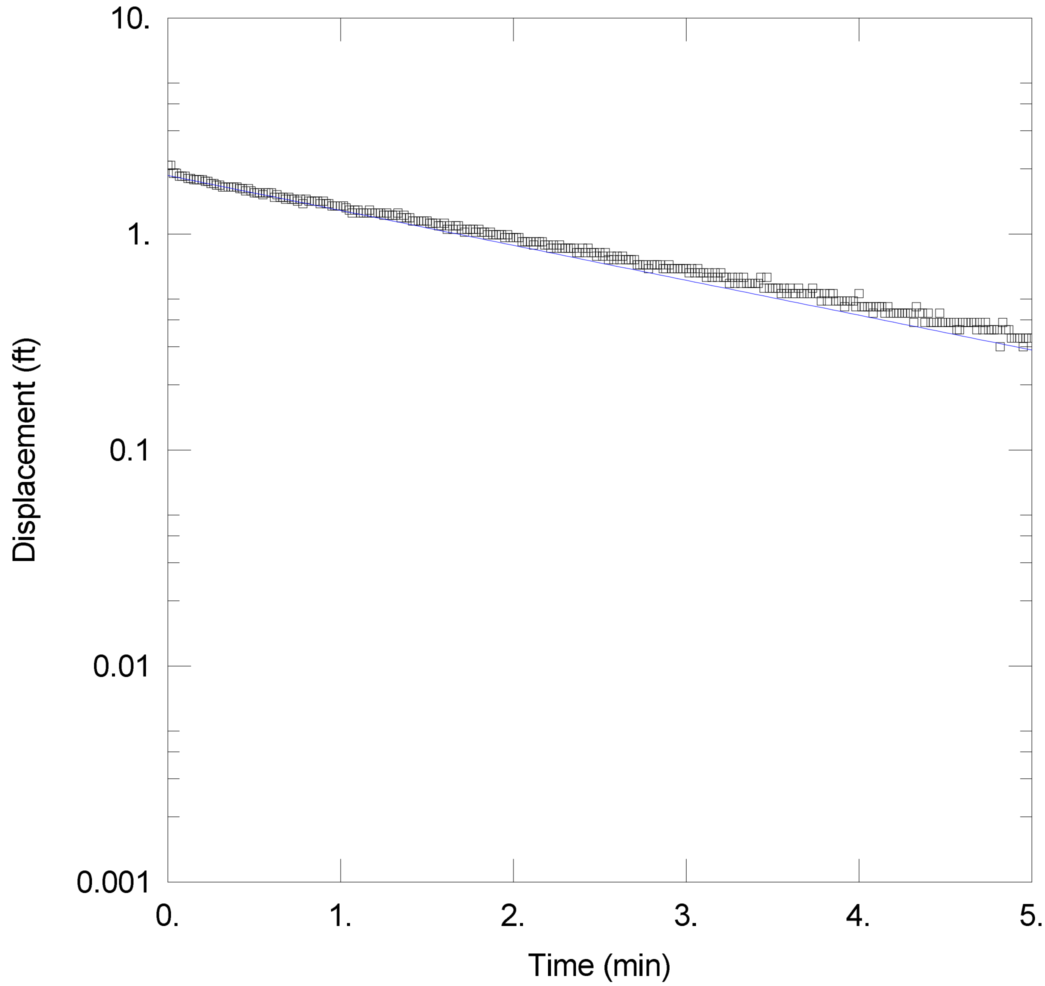
WELL DATA (MW-10R)

Initial Displacement: 1.78 ft Static Water Column Height: 13.3 ft
Total Well Penetration Depth: 10. ft Screen Length: 10. ft
Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.001771 ft/min y0 = 1.69 ft



WELL TEST ANALYSIS

Data Set: F:\...\MW-12R_A_Slug.aqt
Date: 05/14/09 Time: 14:44:00

PROJECT INFORMATION

Company: SCS Engineers
Client: Hardee County
Project: 09199033.19
Location: Hardee County Landfill
Test Date: 04/24/09

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

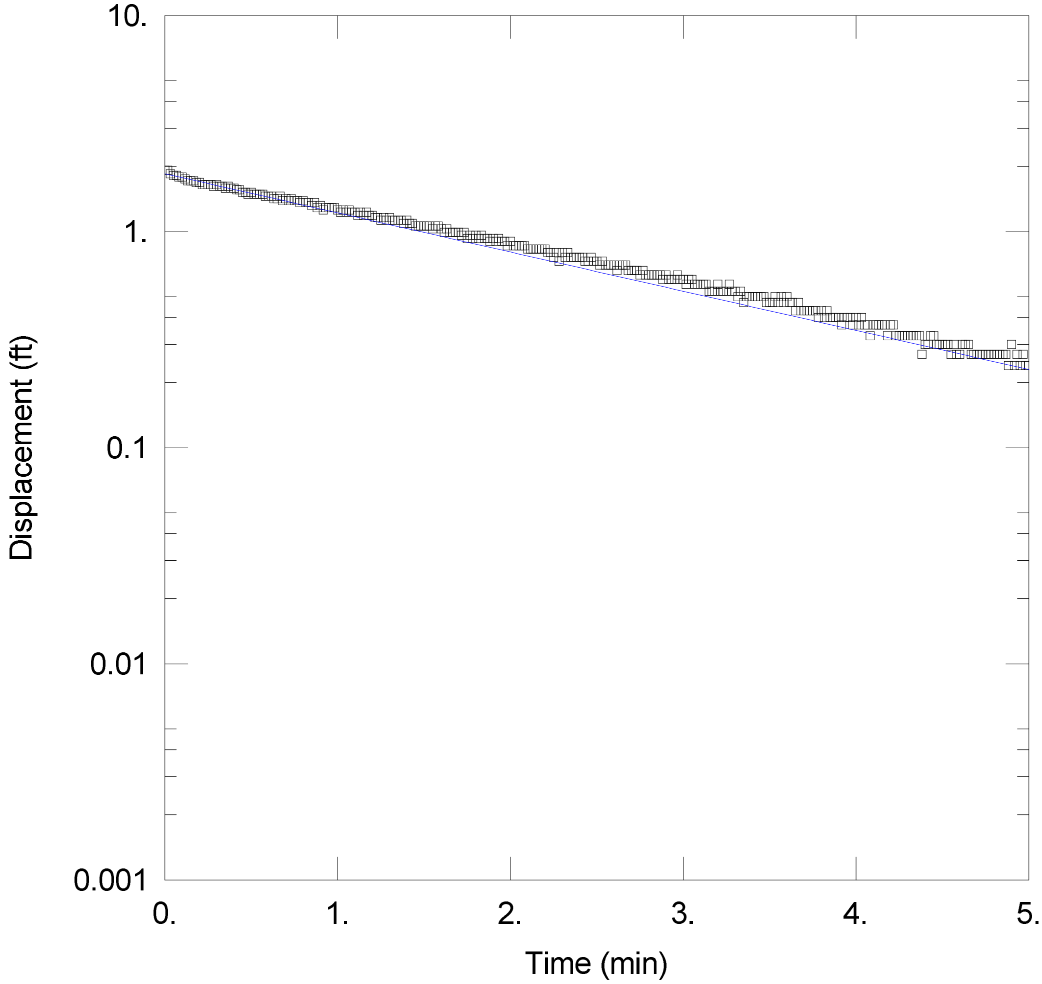
WELL DATA (MW-12R)

Initial Displacement: 2.08 ft Static Water Column Height: 10.64 ft
Total Well Penetration Depth: 10. ft Screen Length: 10. ft
Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.0004292 ft/min y0 = 1.864 ft



MW12R B

Data Set: F:\...\MW-12R_B_Slug.aqt
Date: 05/14/09 Time: 14:44:31

PROJECT INFORMATION

Company: SCS Engineers
Client: Hardee County
Project: 09199033.19
Location: Hardee County Landfill
Test Date: 04/24/09

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

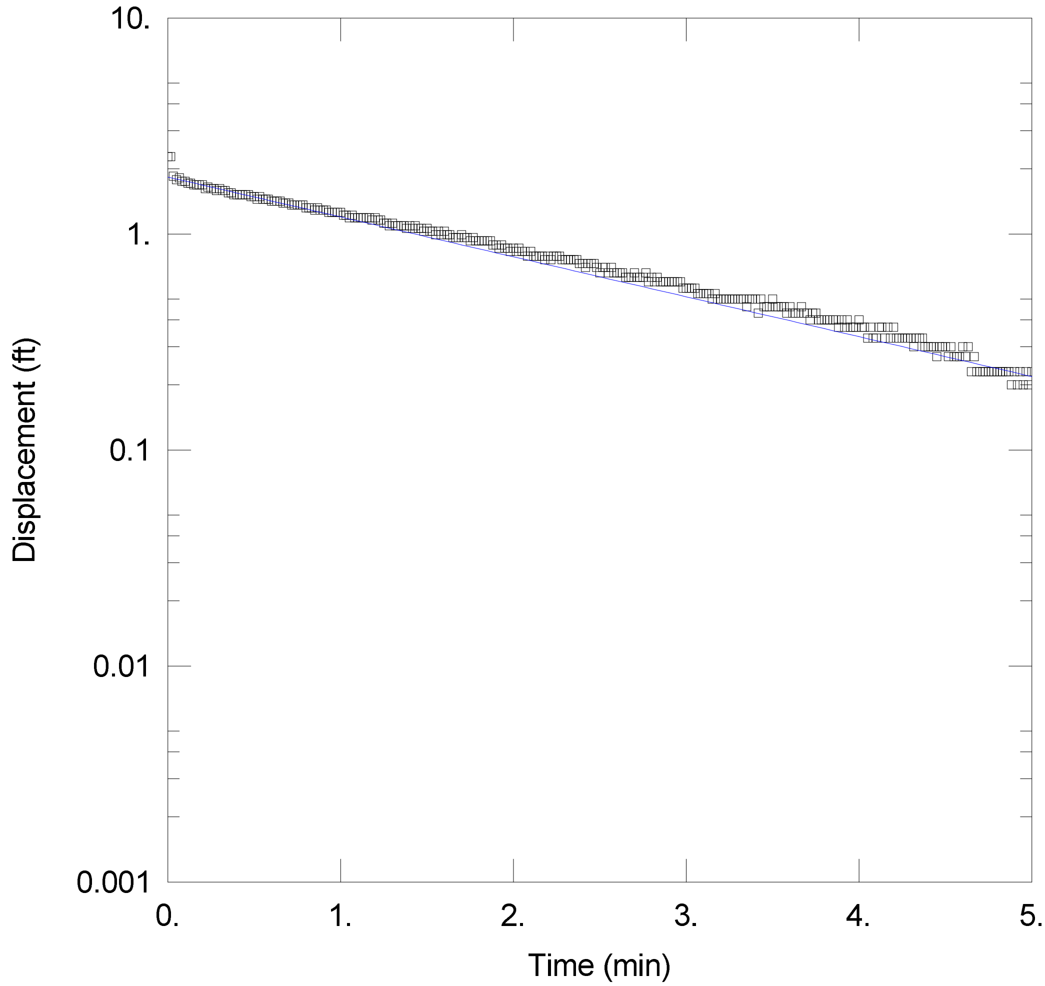
WELL DATA (MW-12R)

Initial Displacement: 1.92 ft Static Water Column Height: 12.55 ft
Total Well Penetration Depth: 10. ft Screen Length: 10. ft
Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.0004813 ft/min y0 = 1.852 ft



MW12R C

Data Set: F:\...\MW-12R_C_Slug.aqt
Date: 05/14/09 Time: 14:45:03

PROJECT INFORMATION

Company: SCS Engineers
Client: Hardee County
Project: 09199033.19
Location: Hardee County Landfill
Test Date: 04/24/09

AQUIFER DATA

Saturated Thickness: 18. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW-12R)

Initial Displacement: 2.28 ft Static Water Column Height: 12.55 ft
Total Well Penetration Depth: 10. ft Screen Length: 10. ft
Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.0004905 ft/min y0 = 1.834 ft

APPENDIX D

HYDROGRAPHS

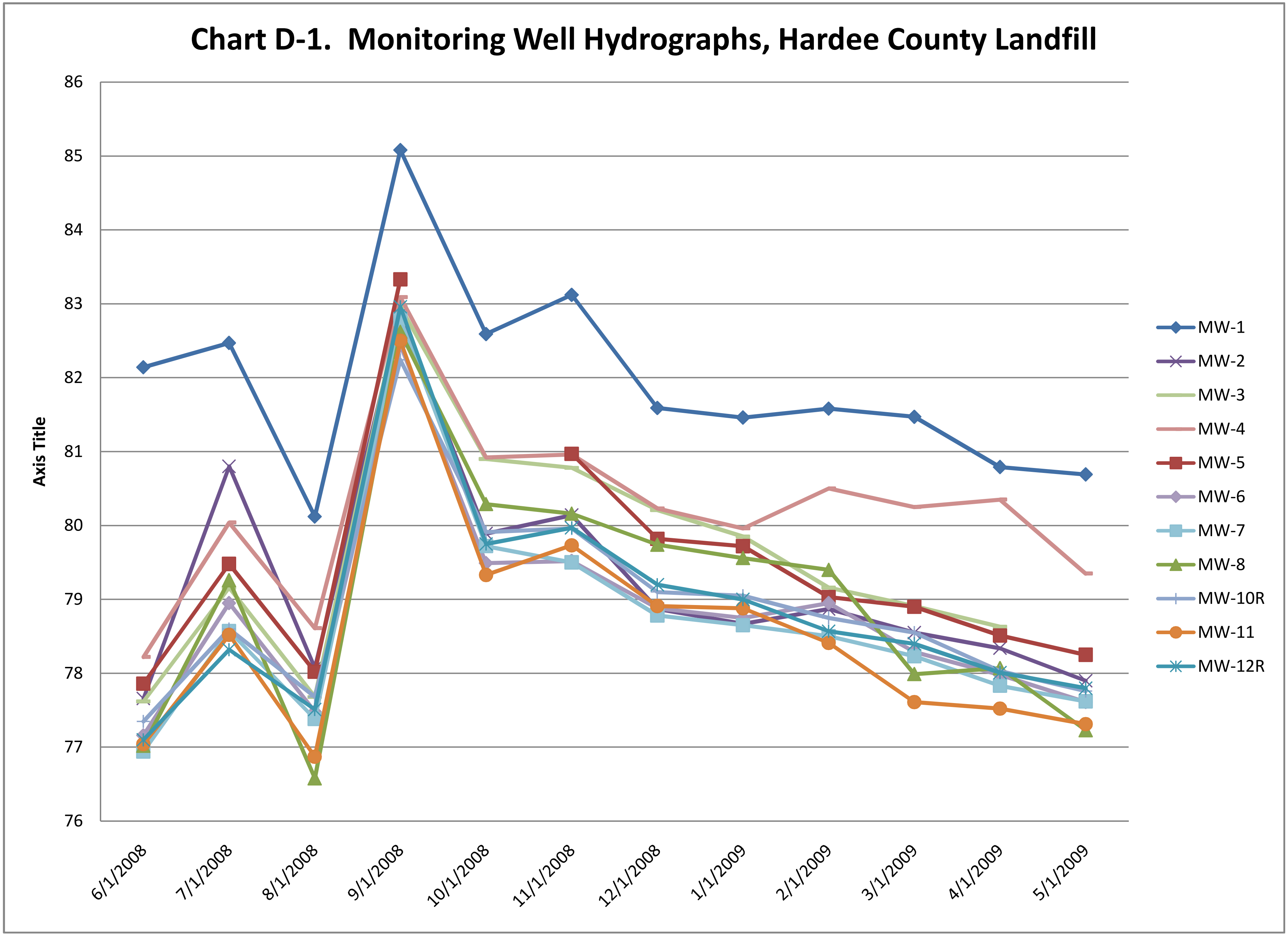


Chart D-1. Monitoring Well Hydrographs, Hardee County Landfill
Axis Title
86
85
84
83
82
81
80
79
78
77
76
6/1/2008
7/1/2008
8/1/2008
9/1/2008
10/1/2008
11/1/2008
12/1/2008
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
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MW-10R
MW-11
MW-12R

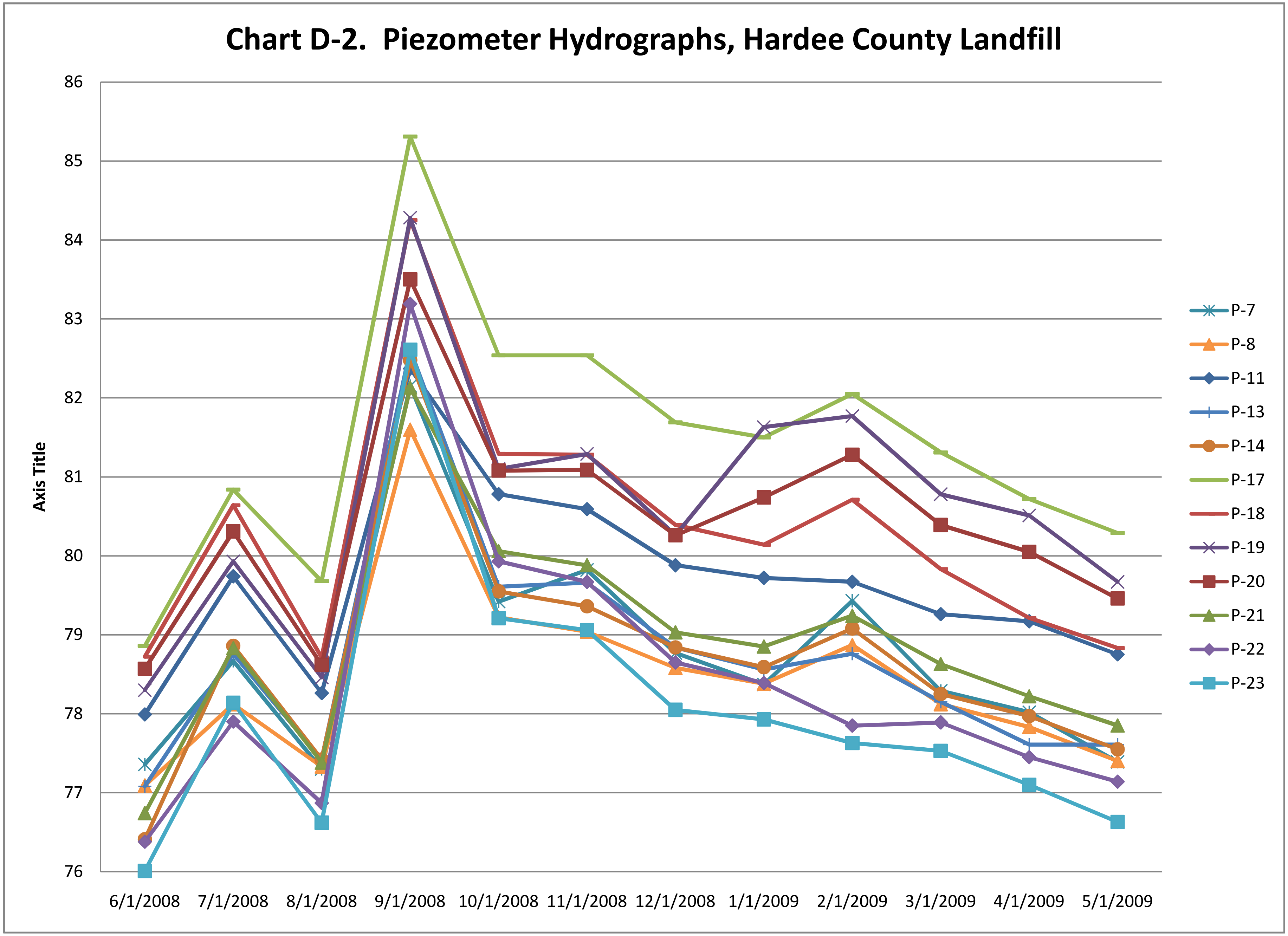

Chart D-2. Piezometer Hydrographs, Hardee County Landfill
Axis Title
86
85
84
83
82
81
80
79
78
77
76
6/1/2008
7/1/2008
8/1/2008
9/1/2008
10/1/2008
11/1/2008
12/1/2008
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
P-7
P-8
P-11
P-13
P-14
P-17
P-18
P-19
P-20
P-21
P-22
P-23