



SARASOTA COUNTY

"Dedicated to Quality Service"

January 11, 2012

Susan Pelz, P.E.
Solid Waste Section
Department of Environmental Protection
Southwest District Office
13051 North Telecom Parkway
Temple Terrace, Florida 33637-0926

Dept. Of Environmental Protection

JAN 13 2012

Southwest District

RE: Central County Solid Waste Disposal Complex
WACS ID No. 51614
Permit Number 130542-007-SO/01
Site Assessment Activities

Dear Ms. Pelz:

As a follow up to the meeting that was held with the Department on May 4, 2011, Sarasota County is submitting to the Department the following items for informational purposes only:

1. An Assessment of background Groundwater Quality at the Central County Solid Waste Disposal Complex (Site), prepared by Innovative Waste Consulting Services, LLC and Atkins North America, Inc., dated January 3, 2012.
2. Historical Site Data Central County Solid Waste Disposal Complex, 1990 - 1998.

These items provide information and evaluation of historical/background site data, historical and recent site data in regards to constituents of concern and the "other constituents" that have been identified through monitoring of the Phase II groundwater wells, and the direction of groundwater flow at the site.

If you have any questions, you can contact me at lerose@scgov.net or (941) 861-1589.

Sincerely,

Lois Rose
Manager, Solid Waste

cc: Richard Tedder, FDEP

January 3, 2012

Ms. Lois Rose
Sarasota County Solid Waste Operations
4000 Knights Trail Road
Nokomis, FL 34275

Re: An Assessment of Background Groundwater Quality at the Central County Solid Waste
Disposal Complex (Site)

Dept. Of Environmental Protection

Dear Lois:

JAN 13 2012

Southwest District

The County contracted Atkins North America, Inc (Atkins) to conduct an evaluation of the quality of the groundwater before the development of the Site. The attached memorandum presents an evaluation of the groundwater quality before the Site development conducted by Atkins and their sub-consultant Innovative Waste Consulting Services, LLC. If you have any questions, please contact me at ttown@iwcs.biz or on my cell phone at 352-494-8605.

Sincerely,



Tim Townsend, PhD, PE

CC:

David Deans, Atkins North America, Inc.

Encl. Background Groundwater Quality Assessment Memorandum

TO: Gary Bennett, Lois Rose, Sarasota County Solid Waste Operations

FROM: Tim Townsend, Pradeep Jain, Innovative Waste Consulting Services, LLC
David Deans, Atkins North America, Inc.

DATE: 3 January 2012

PROJECT: Background Groundwater Quality Assessment

1.0 OVERVIEW AND OBJECTIVES

Atkins (formerly PBS&J) prepared a contamination evaluation report (CEP) and a site assessment report (SAR) describing groundwater exceedances for iron, arsenic, and ammonia at the Sarasota County Central County Solid Waste Disposal Complex (site) and submitted the reports to the Florida Department of Environmental Protection (FDEP) in 2008 and 2009, respectively. Subsequently, Innovative Waste Consulting Services, LLC (IWCS) and Atkins proposed natural attenuation with monitoring (NAM) as a site rehabilitation approach and prepared a NAM plan. The plan was submitted to FDEP in August 2010. The Sarasota County Environmental Services (County), Atkins, and IWCS engineers met with FDEP in September 2010 to discuss the proposed NAM plan.

While the NAM plan was being submitted to FDEP, the newly installed Phase II cell groundwater monitoring wells registered elevated levels of a number of other contaminants such as aluminum, manganese, and TDS in addition to iron, arsenic, and ammonia. FDEP sought to establish a true background level for each of the different contaminants of concern at the site to further evaluate the exceedance causes and the rehabilitation approach proposed for the site for iron, arsenic, and ammonia exceedances. FDEP also sought to identify the causes of exceedances of parameters other than iron, arsenic, and ammonia. The County contracted Atkins to conduct the following specific tasks:

1. Review, compile, and analyze all available groundwater data for the site and provide an assessment of background groundwater quality from locations and times representative of *undeveloped* conditions. Undeveloped conditions are those existing at the site in the absence of any site development. The County collected groundwater quality data from 1990-1994, before the development of the site. These data were compiled to assess the background groundwater quality representative of the undeveloped conditions. A review of the literature was conducted to assess the background groundwater quality of the surficial aquifer in the Southwest Florida Water Management District.
2. Review, compile, and analyze all available groundwater data for the site and provide an assessment of background groundwater quality from locations and times representative of *developed* conditions. Developed conditions are those that exist at the site as a result of permitted site development activities such as earth moving, land clearing, landfill cell construction, road construction, stormwater control, and yard trash processing. The groundwater quality data collected during the first 3 sampling events immediately following the start of waste placement in Phase I were analyzed to assess the background water quality representative of the developed conditions.

3. Review and assess Phase II detection and compliance well monitoring results. As expected, site development activities associated with Phase II construction resulted in groundwater quality changes through the release of naturally-occurring soil constituents. These constituents included iron, arsenic, and ammonia, as well as several other commonly encountered constituents (e.g., sodium, chloride, manganese, sulfate). The Phase II wells' quality data were analyzed in concert with the results of Tasks 1 and 2, information from the previous assessments conducted at the site, and the best available scientific data to assess the cause of exceedances of the constituents of concern.
4. Prepare a comprehensive groundwater table contour map that uses all available measuring locations.
5. Develop a set of recommendations for site rehabilitation to minimize risk to human health and the environment.

This memorandum presents the evaluation conducted by Atkins and their subcontractor IWCS.

2.0 SITE HISTORY

The site has two lined areas (Phase I and Phase II) with 9 cells for waste disposal, among other waste management facilities such as a yard waste processing area and a construction and demolition debris processing facility. Although the site does not have an unlined disposal area, elevated levels of iron, arsenic, and ammonia have been detected in groundwater monitoring wells around the Phase I cell in this cell in 1998. A series of laboratory tests conducted by University of Florida researchers on the site's soil samples suggested that reductive dissolution of naturally occurring iron is the source of the elevated concentrations of these contaminants in groundwater. An evaluation of the historical groundwater quality data, leachate quality data, and contaminant fate and transport modeling along with the site development timeline suggested that activities such as land clearing and liner construction (collectively referred to herein as *site developments*) are the potential causes of elevated levels of exceedances observed at the site. The contaminant fate and transport modeling suggested that the naturally-occurring contaminants, which mobilized due to the disturbances at the site, would revert back to their solid phase as the groundwater traverses through the undisturbed aquifer conditions surrounding the area developed for site operations.

Waste disposal in Phase II began in August 2010 and the groundwater monitoring for Phase II wells started in May 2010. Aluminum, sulfate, TDS, lead, and vanadium in addition to iron, arsenic, and ammonia concentrations greater than the respective GCTLs were measured for Phase II monitoring well samples collected in May 2010, October 2010, and April 2011. A table presenting the groundwater sampling results for Phase II wells is presented later in the report.

3.0 EXISTING BACKGROUND GROUNDWATER QUALITY

As a requirement of the current operating permit for the site, the County samples a series of groundwater wells (background wells, detection wells, and compliance wells) to track the impact of the site operation on the groundwater quality. The historical groundwater quality data for background wells were analyzed to assess the current background quality of the

groundwater at the site. Well MW-1, located on the northeast corner of Phase I and upgradient of all the site development activities, is used for assessing the current background groundwater quality at the site; MW-1 was replaced by MW-1R in 2007. Figure 3-1 below presents the box-and-whisker plot showing the concentration distribution of different constituents along with the respective GCTL for MW-1/MW-1R. It can be seen that the median iron, TDS, sodium, and chloride concentrations at this well are more than the respective GCTL. Lead was below detection for the most part at this well.

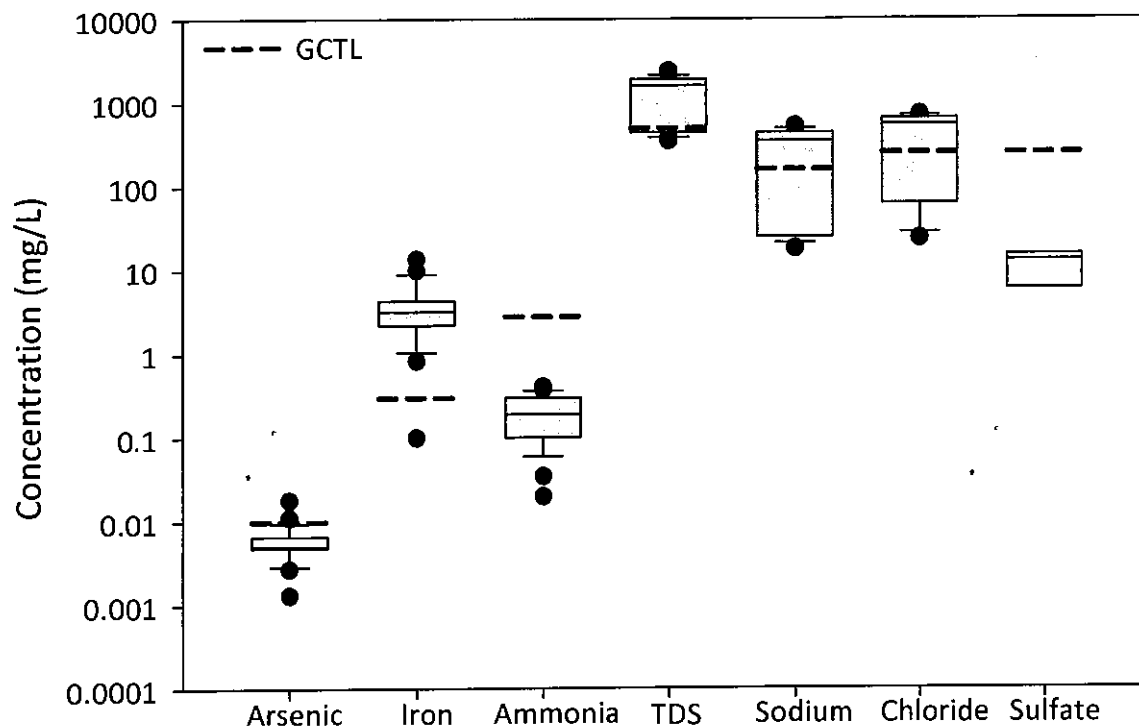


Figure 3-1. Groundwater Quality of Background Well MW-1/MW1-R

4.0 GROUNDWATER QUALITY BEFORE DISTURBANCE TO NATURAL CONDITIONS

IWCS analyzed all the available groundwater data for the site to assess the impact of site developments on the background groundwater quality. Undeveloped conditions are those existing at the site in the absence of any site development. Land clearing of a portion of the site started in January 1996 during Phase I cell construction. The cell construction was completed in early 1998 and Phase I waste disposal began in June 1998. The County collected groundwater quality data from July 1990 through February 1994 from 16 wells installed as a part of hydrogeological investigation before developing the site for waste management and disposal. The locations of these wells are presented in Figure 4-1.

Data from these wells were compiled to assess the background groundwater quality before the site was developed. Table 4-1 presents the number of measurements, range, media, and number of samples with concentrations measured above GCTL before the site development. It can be seen that the maximum concentration recorded for all the parameters measured

exceeded the GCTL. All of the iron concentration values except 3 measurements were above the GCTL of 0.3 mg/L. The median aluminum, iron, and total dissolved solids (TDS) concentration was greater than the respective GCTL. Arsenic concentration was below detection for more than 50% of the samples collected; as presented in Table 4-1, 50 samples out of 91 samples collected had arsenic below detection. Figure 4-2 presents the distribution of the constituents listed in Table 4-1.

Table 4-1. Background Groundwater Quality at the Site before Disturbance to Natural Conditions

Constituent	Number of Samples ¹	Median Concentration (mg/L)	Concentration Range (mg/L)	GCTL (mg/L)	Number of Samples Exceeding GCTL
Arsenic	91(50)	0.003	<0.001-0.063	0.01	7
Iron	91(2)	5.68	<0.1-54	0.3	87
Ammonia	60(3)	0.3	<0.04-19	2.8	8
TDS	91	539	105-3200	500	50
Sodium	91	52.1	6.45-730	160	4
Chloride	91	82.51	4.13-1200	250	8
Sulfate	17(1)	12.9	<2-1360	250	1
Aluminum	13	0.21	0.023-1.67	0.2	7
Manganese	29(9)	0.02	<0.002-0.157	0.05	2

¹ The number in parentheses represents the number of samples the constituent was below the detection limit.

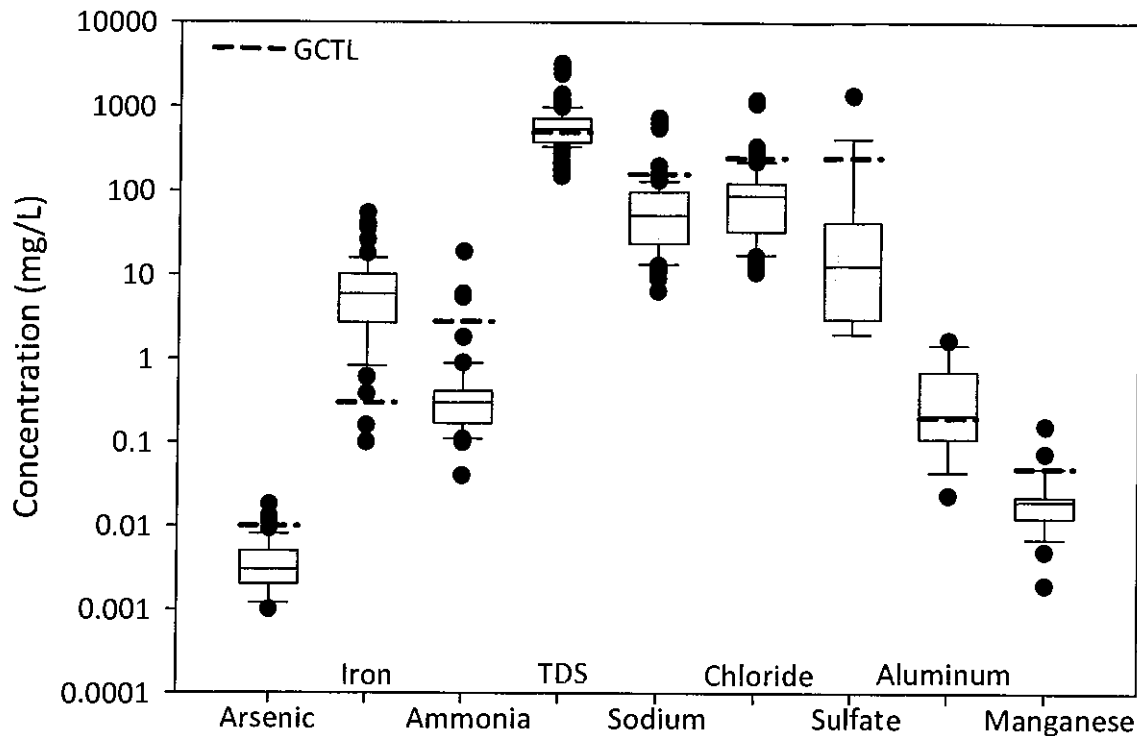


Figure 4-2. Groundwater Quality at the Site before Disturbance to Natural Conditions

The background quality of the surficial aquifer at the site was compared with that of the Southwest Florida Water Management District (SWFWMD); Sarasota County is in SWFWMD. The Florida Department of Environmental Protection (formerly known as the Department of Environmental Regulation) established the background water quality of Florida's major aquifers by sampling approximately 1600 wells in five water management districts from 1984 through 1988 for various contaminants including iron and TDS. The background quality of groundwater was established to meet one of the requirements of the Water Quality Assurance Act passed in 1983 by the Florida Legislature. Approximately 577 wells were sampled to establish the quality of the surficial aquifer system. Florida Geological Survey published the results of this study in 1992 (FGS 1992).

Table 4-2 below presents the number of samples, medians, concentration ranges, and the number of samples exceeding GCTL for the site relevant parameters presented in FGS (1992). It can be seen that the median iron concentration of the background concentration in the surficial aquifer in SWFWMD was reported to be higher than the GCTL. It can also be seen that except for iron, the range of background concentrations for all of the parameters measured at the site was within the range shown in Table 4-2.

Table 4-2. Background Surficial Groundwater Quality in Southwest Florida Water Management District

Constituent	Number of Samples	Median Concentration (mg/L)	Concentration Range (mg/L)	GCTL (mg/L)	Number of Samples Exceeding GCTL
Iron	39	2.14	<0.1-43.90	0.3	30
TDS	83	187	1-177,000	500	11
Sodium	85	6.4	0.7-3,730	160	2
Chloride	86	12.9	0.6-8,520	250	3
Sulfate	85	8.1	<0.1-1,480	250	9
Lead	53	0.036	<0.02-1.63	0.05	11

5.0 GROUNDWATER QUALITY AFTER DISTURBANCE TO NATURAL CONDITIONS

The project team analyzed the groundwater data for the site for the times representative of developed conditions. Developed conditions are those that exist at the site as a result of permitted site development activities such as earth moving, land clearing, landfill cell construction, road construction, and stormwater control. The data for two successive semi-annual groundwater sampling events (September 1998 and April 1999) immediately after Phase I started receiving waste were compiled. The maximum groundwater velocity at the site has been estimated to be 36 ft per year. Neglecting diffusion, the maximum distance that the contaminants introduced into groundwater with a hypothetical leachate release could migrate in this 10-month timeframe is 30 ft. A release of leachate from the landfill, therefore, should not impact the groundwater quality at Phase I background and detection wells, which are located approximately 50 ft from the edge of the liner, during this 10-month timeframe. Figure 5-1 presents box-and-whisker plots of arsenic and ammonia concentrations before and after site development. It can be seen that both the arsenic and ammonia concentrations significantly increased immediately after the construction and waste placement in Phase I. This clearly supports the findings presented by the project team in the past that these constituents are naturally occurring and the changes in the hydrogeochemical conditions of the aquifer introduced by the permitted site development activities have resulted in mobilization of these naturally-occurring constituents.

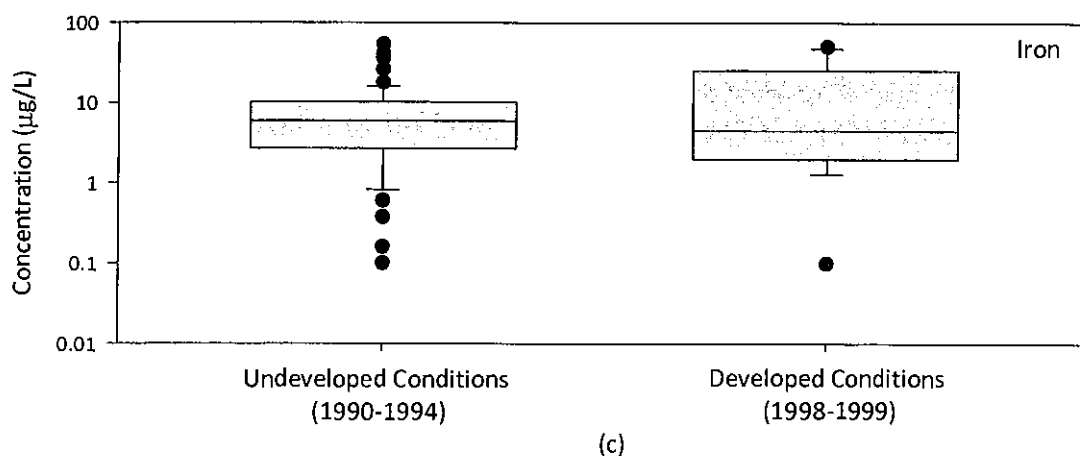
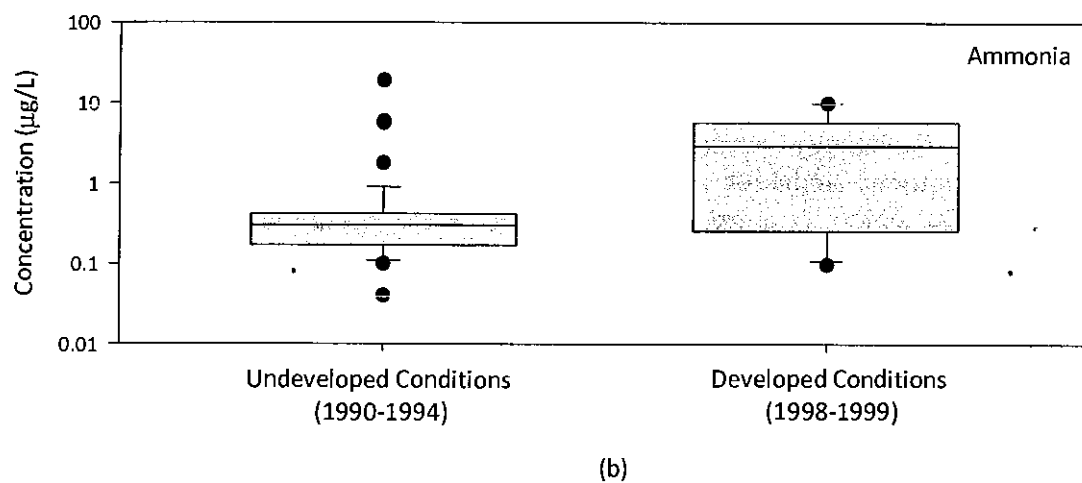
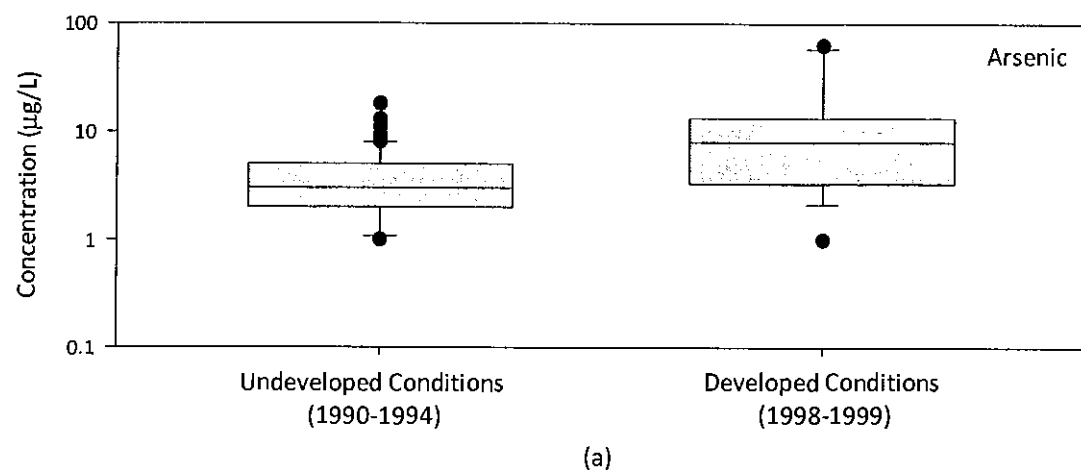


Figure 5-1. Box-and-Whisker Plot of Concentrations before and after Site Development for (a) Arsenic, (b) Ammonia, (c) Iron

6.0 PHASE II WELL MONITORING DATA

The Phase II surficial aquifer monitoring system consists of 6 detection wells (MW-15, MW-16, MW-17, MW-18, MW-19, and MW-20) and 4 compliance wells (CW-15, CW-16, CW-19, and CW-20). Waste disposal in Phase II began in August 2010. The detection well monitoring was started in May 2010 (before waste placement began in Phase II). As expected, site development activities associated with Phase II construction resulted in groundwater quality changes for constituents including iron, arsenic, and ammonia, as well as several other commonly encountered standard constituents (sodium, chloride, manganese, sulfate, aluminum, lead, and vanadium). As a result of exceedances measured at the detection wells, 4 compliance wells were installed for Phase II in October 2010. The detection wells were sampled three times and the compliance wells have been sampled twice. Table 6-1 presents the groundwater quality summary for Phase II wells.

IWCS reviewed and assessed Phase II detection and compliance well monitoring results. The causes of iron, arsenic, and ammonia exceedances at the site have been associated with the release of naturally-occurring iron because of changes in the biogeochemistry of the surficial aquifer system introduced by site development activities. This section presents an assessment of the parameters other than iron, arsenic, and ammonia that have been measured at concentrations above the GCTL in Phase II detection and compliance wells.

Dept. Of Environmental Protection

JAN 13 2012

Southwest District

Table 6-1. Phase II Groundwater Monitoring Wells Data Summary

Well ID	Date	Arsenic (µg/L)	Iron (mg/L)	Ammonia (mg/L)	TD5 (mg/L)	Sodium (mg/L)	Chloride (mg/L)	Manganese (µg/L)	Sulfate (mg/L)	Aluminum (µg/L)	Vanadium (µg/L)	Lead (µg/L)
GCTL	-	10	0.3	2.8	500	160	250	50	250	200	49	15
CW-15	10/13/2010	16.8	59.9	25.1	1700	193	283	64.1	47.8	75.2	<5	<5
	4/19/2011	24.2	87	11.4	2310	125	187	368	371	1900	12	<5
CW-16	10/13/2010	24.9	71.9	14.4	930	173	158				10.9	<5
	4/19/2011	29.6	10.5	25.7	946	128	127	3.3	156	4290	17.1	<5
CW-19	10/13/2010	23.1	11.8	2.9	371	10.5	12.1			<50	<5	<5
	4/19/2011	29.3	30.2	3.5	414	9	<12.5	31.7	<12.5	<50	<5	
CW-20	10/13/2010	26.6	7.1	0.89	604	24.1	18.2				<5	<5
	4/19/2011	25.1	12	1.5	520	31.4	13.7	21.5	14.5	<50	<5	<5
MW-15	5/13/2010	47.3	46.9	4.1	3540	69.9	132	1010	639		7.9	<5
	10/13/2010	48.6	49.6	5	2810	77.5	131	995	392		<25	<25
	4/25/2011	45.9	75.3	7.6	1400	77.2	130	462	198	848	8.4	<5
MW-16	5/13/2010	40.7	55.9	12.5	1830	256	305	10.8	<50		8.2	<5
	10/13/2010	48.3	62	20.4	1630	275	317		<12.5		10.4	<5
	4/25/2011	55.7	87.8	11.8	1490	282	372	14.5	<12.5	36200	66.4	35.2
MW-17	5/13/2010	70	105	25.1	948	61.2	75.9		<25	435	<5	<5
	10/13/2010	65.5	116	25.2	910	64.6	68.5		<12.5		<5	<5
	4/19/2011	78	123	25.1	880	60	68.4	14.7	<12.5	177	5.3	<5
MW-18	5/13/2010	<5	28.1	1.3	605	5	<25		<25		<5	<5
	10/13/2010	10.3	37.1	2.3	746	9.2	16.4		<5		21.7	7.21
	4/12/2011	5.9	30.4	2.2	746	6.7	18.8	31.2	<5	53.3	<5	<5
MW-19	5/13/2010	42.2	63.3	22.4	461	23.9	12.2		<5	2830	16	<5
	10/13/2010	38	76	12.5	497	18.5	12.7		4.9	471	8.9	<5
	4/19/2011	49.5	66.2	14.3	440	17.9	13.9	18	<5	1300	9.7	<5
MW-20	5/13/2010	76.7	58.2	3.2	1180	113	95.2		<25		65.6	15.9
	10/13/2010	55.6	38.9	2.6	1350	110	86		27.4		<5	<5
	4/19/2011	81.7	38.7	3	1030	103	96.1	12.1	<12.5	<50	<5	<5

TDS

As can be seen from Table 6-1, TDS concentrations in excess of the GCTL of 500 mg/L were measured for Phase II wells. TDS concentrations measured at Phase II wells ranged from 371 mg/L to 3,540 mg/L. FGS (1992) reported the background surficial aquifer system TDS concentration in SWFWMD to range from 1 to 17,700 mg/L. All of the TDS concentrations measured for Phase II wells are within the background concentration range reported by FGS (1992) in SWFWMD. Although the magnitude of the impact of the saltwater for the site is not known, high TDS, chloride, sodium, and sulfate concentrations have been associated with coastal saltwater intrusion in the SWFWMD (FGS 1992).

The background concentrations of TDS measured at the site prior to 1995 suggest that the background TDS concentration ranged from 150 mg/L to 3,200 mg/L, and as shown in Figure 4-2, the median concentration was approximately 530 mg/L, which is higher than the TDS GCTL. All but one of the TDS concentrations measured at Phase II wells were within the range of background TDS concentrations measured at the site before the development activities began at the site; TDS at MW-15 measured in May 2010 was 3,540 mg/L, greater than the maximum background concentration measured at the site.

The elevated concentrations of TDS were recorded in Phase II detection wells even before placement of waste in Phase II began. The maximum TDS concentration for Phase II wells was recorded for MW-15 for the May 2010 sampling event before the waste placement began in August 2010; the TDS concentration at MW-15 was reduced by more than 50% from 3,540 mg/L in May 2010 to 1,400 mg/L in April 2011. With the exception of MW-18, CW-15, and CW-16, TDS concentrations in all of the Phase II wells have either held steady or decreased over the last two semi-annual monitoring events.

Exceedances of TDS and high background TDS concentrations in Phase II wells even before the beginning of waste placement in Phase II suggest that the TDS concentrations measured at Phase II wells are naturally occurring and are not associated with leachate release from the lined cells at the site.

Manganese

Manganese was measured at concentrations in excess of the GCTL (50 µg/L) at only two wells – CW-15 and MW-15. MW-15 has shown a greater than 50% reduction in the amount of Manganese concentration over the last three monitoring events. Manganese in a fashion similar to iron, mobilizes under anaerobic conditions. The following list presents electron acceptors used by different organisms, in order of most favorable to least (i.e., organisms that use electron acceptors higher on the list can outcompete organisms that use electron acceptors lower on the list).

- Oxygen $\frac{1}{4}\{CH_2O\} + \frac{1}{4}O_2 = \frac{1}{4}CO_2 + \frac{1}{4}H_2O$
- Nitrate $\frac{1}{4}\{CH_2O\} + \frac{1}{8}NO_3^- + \frac{1}{4}H^+ = \frac{1}{4}CO_2 + \frac{1}{8}NH_4^+ + \frac{1}{8}H_2O$

- Manganese $\frac{1}{4}\{CH_2O\} + \frac{1}{2}MnO_2(s) + H^+ = \frac{1}{4}CO_2 + \frac{1}{2}Mn^{2+} + \frac{1}{8}H_2O$
- Iron $\frac{1}{4}\{CH_2O\} + FeOOH(s) + 2H^+ = \frac{1}{4}CO_2 + \frac{7}{4}H_2O + Fe^{2+}$
- Sulfate $\frac{1}{4}\{CH_2O\} + \frac{1}{8}SO_4^{2-} + \frac{1}{8}H^+ = \frac{1}{4}CO_2 + \frac{1}{8}HS^- + \frac{1}{4}H_2O$
- Carbon dioxide $\frac{1}{4}\{CH_2O\} = \frac{1}{8}CH_4 + \frac{1}{8}CO_2$

As implied above, the chemicals used as electron acceptors are reduced in the process. Oxygen is reduced to carbon dioxide. Nitrate is reduced to ammonium. Oxidized manganese (Mn^{+4}) is transformed to reduced manganese (Mn^{+2}). Oxidized iron (Fe^{+3}) is converted to reduced iron (Fe^{+2}). The changes to the chemical conditions underneath a landfill can result in the disruption of the equilibrium developed in the soil-groundwater system, and thus a release of soil-bound elements to the water can occur.

Oxidized manganese (Mn^{+4}), like iron, tends to exist as a solid, i.e., as part of the soil matrix. The reduced form (Mn^{+2}) tends to exist as a dissolved chemical. In other words, similar to iron, the onset of reducing conditions in an aquifer media that contains naturally occurring Mn^{+4} in the soils, can release manganese into the groundwater in the dissolved form and the groundwater concentration increases, often dramatically. Exceedance of manganese in MW-15 wells even before the beginning of waste placement in Phase II suggests that the manganese concentrations measured at Phase II wells are a result of the release of naturally-occurring manganese due to the development of anaerobic conditions and are not associated with leachate release from the lined cells at the site. The manganese exceedances have not been raised to the same level of concern as iron, because unlike iron, manganese, historically, has not been routinely monitored at the site; manganese was first measured for Phase I wells in 2009. Similar to iron, manganese would naturally attenuate as it oxidizes while migrating through an aerated aquifer zone.

Sulfate

The sulfate concentrations in Phase II wells have ranged from below detection (< 5 mg/L) to approximately 640 mg/L. Sulfate concentrations greater than the GCTL were measured at only two wells: MW-15 and CW-15. The surficial aquifer background sulfate concentration in SWFWMD has been reported to range from below detection (<0.1 mg/L) to 1,480 mg/L (FGS 1992). High sulfate concentrations have been associated with coastal saltwater intrusion in the SWFWMD (FGS 1992). Before any development activities commenced at the site, the sulfate concentration ranged from below detection (< 2 mg/L) to 1,362 mg/L. The sulfate concentrations measured at Phase II wells are within the background sulfate concentrations reported for SWFWMD and the background sulfate concentrations measured for the site from 1990-1994. Sulfate at MW-15 was measured at an elevated level (greater than GCTL) even before waste placement began in Phase II. The concentrations in MW-15 have decreased to below the GCTL since the start of monitoring in May 2010. These observations suggest that the sulfate concentration measured at Phase II wells are naturally occurring and are not associated with leachate release from the lined cells at the site.

Sodium

Sodium concentrations in Phase II wells have ranged from 5 mg/L to 282 mg/L. Sodium concentrations greater than the GCTL were measured at only three wells: MW-16, CW-15, and CW-16. The surficial aquifer background sodium concentration in SWFWMD has been reported to range from 0.7 mg/L to 3,730 mg/L (FGS 1992). The sodium concentrations at the site before any development activities ranged from below detection (6.45 mg/L) to 730 mg/L. The sodium concentrations measured at Phase II wells were within the background sodium concentrations reported for SWFWMD and the background sodium concentrations measured for the site from 1990-1994. Sodium at MW-16 was measured at elevated levels (greater than GCTL) even before the waste placement in Phase II began. These observations suggest that the sodium concentrations measured at Phase II wells are naturally occurring and are not associated with leachate release from the lined cells at the site.

Chloride

Chloride concentrations in Phase II wells have ranged from below detection (12.5 mg/L) to 372 mg/L. Chloride concentrations greater than the GCTL were measured at only two wells: MW-16 and CW-15. The surficial aquifer background chloride concentration in SWFWMD has been reported to range from 0.6 mg/L to 8,520 mg/L (FGS 1992). Before any development activities began at the site, the chloride concentrations ranged from below detection 4.13 mg/L to 1,200 mg/L. The chloride concentrations measured at Phase II wells were within the background chloride concentrations reported for SWFWMD and the background sulfate concentrations measured for the site in 1990-1994. Chloride at MW-16 was measured at an elevated level (greater than GCTL) even before the waste placement in Phase II began. These observations suggest that the chloride concentrations measured at Phase II wells are naturally occurring and are not associated with leachate release from the lined cells at the site.

Aluminum

Aluminum concentrations in Phase II wells have been measured to range from below detection (<0.05 mg/L) to 36.2 mg/L. Like manganese, aluminum has not been routinely monitored at the site; aluminum has been occasionally monitored since 2009. Aluminum concentrations have exceeded the GCTL (0.2 mg/L) at six wells: MW-15, MW-16, MW-17, MW-19, CW-15, and CW-16. An aluminum concentration of 2.83 mg/L was measured at MW-19 even before waste placement in Phase II began; aluminum was measured only at MW-19 before waste placement in Phase II began. Aluminum concentration at this well location has declined to 1.4 mg/L in April 2011. Aluminum is the most abundant metal in the earth's crust (comprising almost 9% by weight), and the phase partitioning of aluminum in soils and groundwater is highly dependent on pH and the humic acid content of water (ATSDR 2008). The median of the background aluminum concentrations measured at the site is greater than the GCTL.

Another factor that can result in elevated aluminum concentration is the sample turbidity. Abbott (2007) reported a correlation between the groundwater sample aluminum concentrations and turbidity. Abbott (2007) reported that the samples with elevated turbidity often show elevated aluminum as most geologic materials, and thus colloids—which are the primary source of turbidity—are composed of aluminosilicates. Figure 6-1 presents the Phase II

well aluminum concentrations distribution for turbidity levels less than 2 Nephelometric Turbidity Units (NTU) and more than 2 NTU. It can be seen that higher aluminum concentrations are associated with higher turbidity in samples collected at the site.

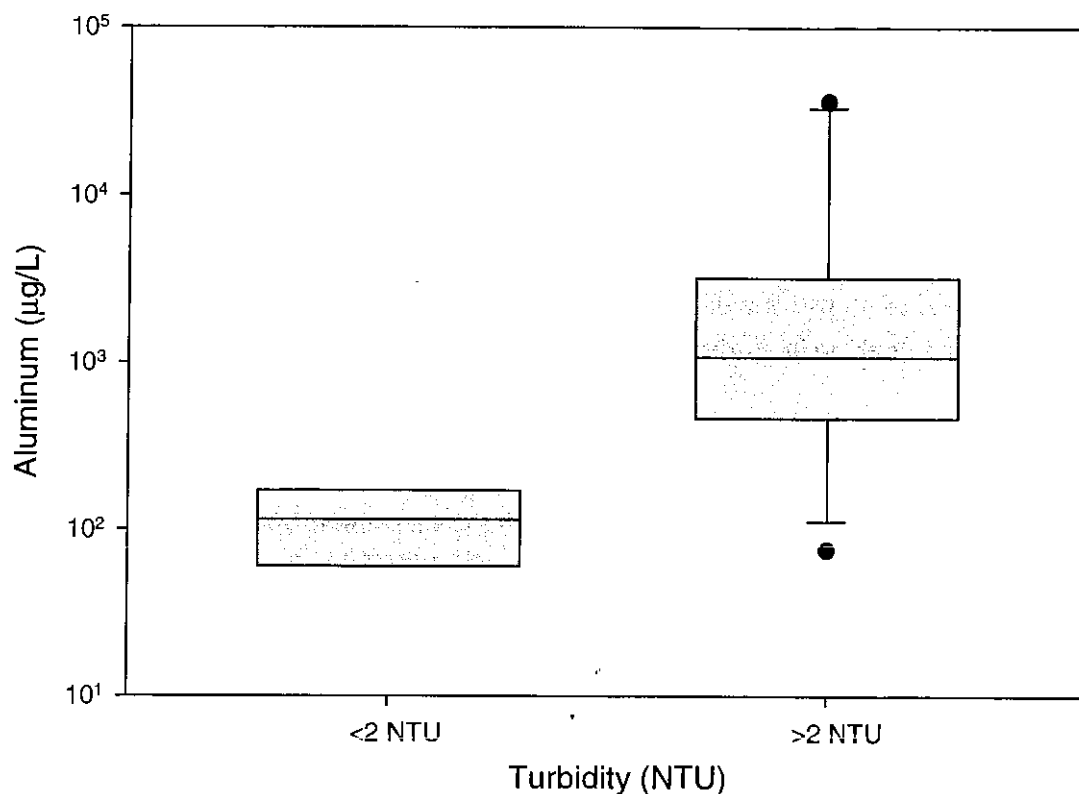


Figure 6-1. Box-and-Whisker Plot of Aluminum Concentration Distribution as a Function of Turbidity

Sampling practices such as high flow rate sampling potentially result in physical mobilization of sediments that contain insoluble metals such as aluminum, surrounding the well (Heidlauf and Bartlett 1993; Puls and Powell 1992). Furthermore, insufficient turbidity removal from inadequate sample filtration results in the transfer of suspended aluminum to the laboratory sample, which eventually would solubilize upon preservation with acids. Low-flow sampling of groundwater is important in order to minimize the amount of turbidity obtained (Heidlauf and Bartlett 1993; Puls and Powell 1992).

These observations suggest that aluminum concentrations measured at Phase II wells are probably naturally occurring and are not associated with leachate release from the lined cells at the site. Aluminum should be routinely monitored to further understand its temporal and spatial variation. Sampling should be conducted to minimize turbidity.

Lead

Lead concentrations in Phase II wells have ranged from below detection (0.005 mg/L) to 0.0352 mg/L. Lead was below detection in 22 out of 25 samples collected for Phase II wells. Lead concentrations greater than the GCTL were measured at only two wells: MW-16 and MW-20. Only one sample at each of these wells exceeded the GCTL. The lead concentration at MW-20 in May 2010, before beginning of waste placement in Phase II, was 0.0159 mg/L and has been

below the detection limit for the last two sampling events. The lead concentration in MW-16 has gone up from below detection (<0.005 mg/L) in October 2010 to 0.0352 mg/L in April 2011. The background lead concentration in the surficial aquifer in SWFWMD is reported to range from below detection (<0.020 mg/L) to 1.63 mg/L (FGS 1992).

Lead is one of the least mobile of the common metal contaminants in the environment; the mobility of lead in soil depends on many factors including soil pH, soil type, particle size, organic matter content of soil, and the presence of inorganic colloids and iron oxides (ATSDR 2007). In general, lead is relatively immobile in subsurface soils under lower acidic conditions and increases in high acidity conditions (Federal Register 1998). Based on the review of lead geochemistry conducted by Deutsch (1997), lead is generally likely to be confined to the upper soil layers because of adsorption. Iron and manganese oxides in subsurface soils may play a role in minimizing lead migration through the upper soil layers by adsorption and chemical precipitation. The mobilization of naturally-occurring iron and manganese under anaerobic conditions, therefore, can result in the mobilization of naturally-occurring lead.

Vanadium

Vanadium concentrations in Phase II wells have ranged from below detection (0.005 mg/L) to 0.0664 mg/L. Vanadium was below detection in 12 out of 25 samples collected for Phase II wells. Vanadium concentrations greater than the GCTL were measured at only two wells: MW-16 and MW-20. Only one sample at each of these wells exceeded the GCTL. The vanadium concentration at MW-20 in May 2010, before the beginning of waste placement in Phase II, was 0.0656 mg/L and was below the detection limit for the two subsequent sampling events. The vanadium concentration in MW-16 has gone up from below detection (<0.005 mg/L) in October 2010 to 0.0664 mg/L in April 2011. The elevated level of Vanadium in MW-20 even before the placement of waste in Phase II suggests that Vanadium is naturally occurring.

7.0 GROUNDWATER FLOW DIRECTION

In order to gain a comprehensive view of the groundwater flow patterns at the site, the County measured water levels at all of the available surveyed measuring locations (including monitoring wells, piezometers, and staff gauges) during a single day. The water level measurements included all monitoring wells (MW-), all compliance wells (CW-), the perimeter permanent monitoring wells (PW-), and the remaining temporary wells (GW-). The water level measuring event took place on May 18, 2011. Attachment A is the groundwater contour map developed from the May 18, 2011 data. The overall general groundwater flow direction was towards the south and west, which is generally consistent with the groundwater flow pattern shown in Figure 4-1 for the site's pre-development hydrogeologic survey. On the day of the water level measurements (in May – the dry season), the water level elevations in the ponds were elevated in comparison to nearby monitoring wells. This suggested that mounding of the water table was occurring at the ponds, which indicated that they were recharging water to the surficial aquifer.

8.0 SUMMARY AND RECOMMENDATIONS

In response to the County's proposal to use natural attenuation with monitoring as a site rehabilitation approach to address the iron, arsenic, and ammonia exceedances at the site, FDEP sought to establish a true background level of these contaminants. FDEP also requested additional information on exceedances of a number of additional contaminants including aluminum, manganese, TDS, sodium, chloride, sulfate, vanadium and lead in Phase II groundwater monitoring wells. Atkins and IWCS analyzed the groundwater quality data collected before the start of site developmental activities to establish a background level for various contaminants and identify causes of exceedance of various other contaminants observed for Phase II monitoring wells.

With respect to iron, arsenic and ammonia, the analysis presented here (see section 5.0 for example) corroborates the numerous previous reports that have been presented to the FDEP concluding that these chemicals are naturally occurring in origin and are associated with the reductive dissolution process induced by landfill cell construction and site disturbance. Chloride, sodium, and TDS (in addition to iron and at times arsenic) have been historically observed as elevated in the site's background well (MW-1/MW-1R) compared to GCTLs, thus supporting that these are naturally occurring on site. Data collected by the County on groundwater quality from 1990 through 1994, prior to any major site disturbance, finds that arsenic, iron, ammonia, TDS, sodium, chloride, aluminum, and manganese were all measured above GCTLs at times, with some parameters exceeding the GCTL more than one-half of the time (iron, TDS, aluminum).

The research that went into the previous extensive evaluations of groundwater quality issues at the site and an additional review of the science were used to provide plausible explanations why each of these parameters might be naturally occurring in Florida groundwater. For example, manganese is known to behave in a very similar fashion as iron and to undergo reductive dissolution. High aluminum levels were observed to be associated with high turbidity levels, a common observation from groundwater sampling practice. Since vanadium and lead were not measured in the historical data set, some of the same comparisons made for the other parameters are not possible, but plausible scientific explanations for occasional exceedances of these elements are provided.

In summary, the results support that the chemical parameters evaluated here merit the same consideration and treatment as proposed for iron, arsenic and ammonia in the NAM plan provided to FDEP. The measurements collected and the science support that all of these contaminants are the result of naturally occurring elements and not a result of a release from the landfill unit. Including these parameters as part of a NAM approach, or some similar approach such as an expanded zone of discharge for selected parameters, is appropriate.

9.0 REFERENCES

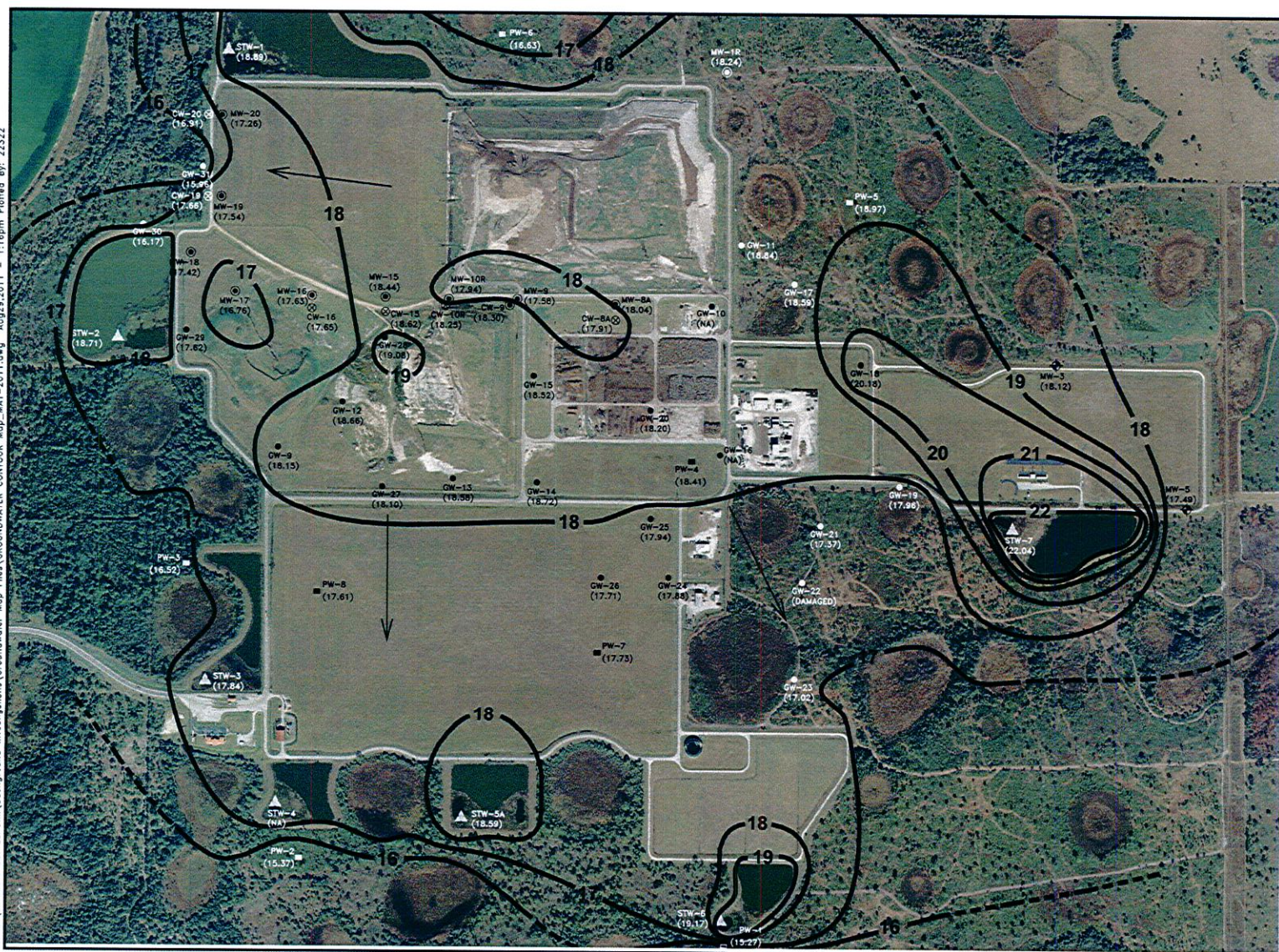
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ATTACHMENT A
GROUNDWATER CONTOUR MAP BASED ON MAY 18, 2011
DATA

F:\COMMON\BRAD_BAYNE\Sarasota Co. Landfill\Background Investigations\Groundwater Map Files\GROUNDWATER CONTOUR Map MAY-2011.dwg Aug 29, 2011 - 1:16pm Plotted By: 23322



- LEGEND:
- GW-31 TEMPORARY WELLS
 - ⊗ CW-16 EXISTING COMPLIANCE WELLS
 - PW-5 PERIMETER WELLS INSTALLED IN 2010
 - △ STW-7 STAFF GAUGES
 - MW-10R EXISTING GROUNDWATER MONITORING WELLS
 - WATER TABLE CONTOURS
 - - - WATER TABLE CONTOURS INFERRED
 - ESTIMATED GROUNDWATER FLOW DIRECTION

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ATKINS

SARASOTA COUNTY
 CENTRAL COUNTY SOLID WASTE
 DISPOSAL COMPLEX

GROUNDWATER CONTOUR MAP
 MAY 18, 2011

FIGURE
 1

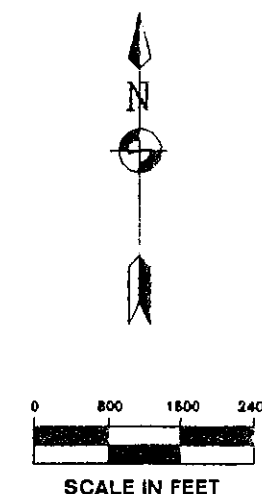
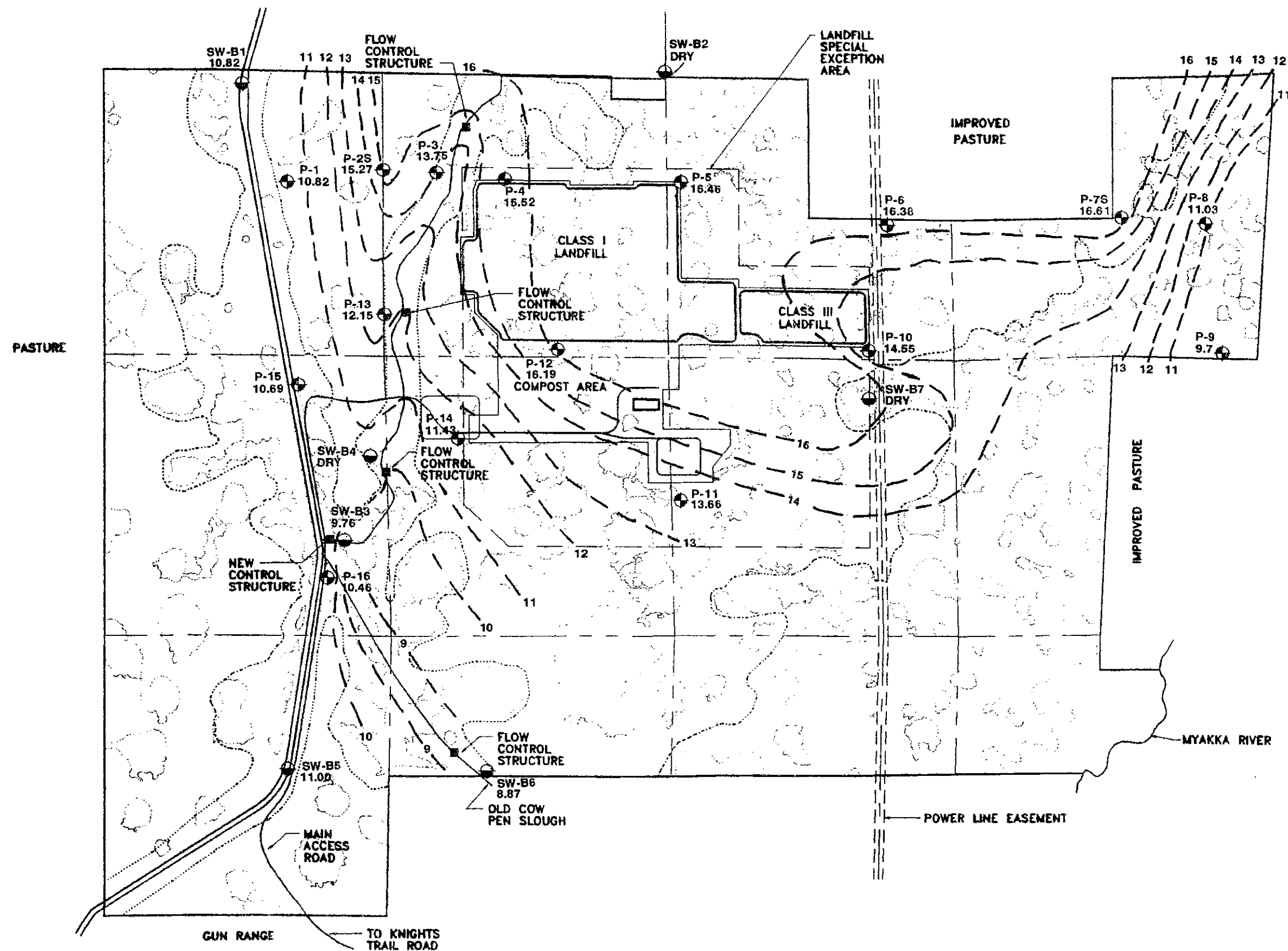
Historical Site Data Central County Solid Waste Disposal Complex 1990 - 1998

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Pinelands Historical Data 1990-1994																					
			P-1	P-2S	P-2D	P-3	P-4	P-5	P-6	P-7S	P-7D	P-8	P-9	P-10	P-11	P-12	P-13	P-14S	P-14D	P-15	P-16
Chloride	mg/l	7/19/1990			106.5					36.76			72.11		82.51						
	mg/l	5/18/1993	16.5	13.9	118	185	10.8	92.9													
	mg/l	5/19/1993							53.6					225	176	103	29.5	99.8	86.5		
	mg/l	8/23/1993	20	17	134	150	14	91	139					55							
	mg/l	8/24/1993													199	101	34	117	96		33
	mg/l	12/13/1993	19	18	137	160	12	94	67					211	219						
	mg/l	12/14/1993														94	31	106	97		30
	mg/l	2/24/1994	18.1	35.8		115	26.8	76.4	51.9					148							
	mg/l	2/25/1994			124										169	81.8	41.4	57.1	90.4		24.4
Sodium	mg/l	7/19/1990			83.5					6.45			46.7		51.2						
	mg/l	5/18/1993	11.3	16.6	100	126	14.2	55.9													
	mg/l	5/19/1993							49.4					134	115	73.5	23.5	43.9	52.1		
	mg/l	8/23/1993	11.2	15.1	97.9	106	12.3	45.5	83.6					59.9							
	mg/l	8/24/1993													139	71.5	25.6	45.4	54.5		22.4
	mg/l	12/13/1993	11	23.7	95.7	114	12.3	47.2	45.4					106	114						
	mg/l	12/14/1993														68	24.6	40.6	47.4		20.9
	mg/l	2/24/1994	13.2	33.2		99	14.5	58	32					106							
	mg/l	2/25/1994			84.5										94.2	75.5	33	28.8	53		24.9
Sulfate	mg/l	7/19/1990			48.5					12.9			1361.9		22						
	mg/l	5/18/1993	22	13	46	178	2	6													
	mg/l	5/19/1993							3					12	7	2	<2	3	39		
Aluminum	mg/l	5/18/1993	0.023	0.449	1.15	0.076	0.963	0.11													
	mg/l	5/19/1993							0.297					0.235	0.111	0.154	0.211	0.142	1.67		
Manganese	mg/l	7/19/1990			0.007					0.005			0.025		0.016						
	mg/l	5/18/1993	0.02	0.011	0.009	0.157	0.011	0.017													
	mg/l	5/19/1993							0.013					0.042	0.017	0.002	0.075	0.012	0.013		
Iron	mg/l	7/19/1990			0.16					5.15			54.2		0.6						
	mg/l	5/18/1993	5.22	4.03	0.6	12.3	8.43	10.2													
	mg/l	5/19/1993							11					9.44	8.03	9.76	4.28	3.66	1.27		
	mg/l	8/23/1993	5.39	5.94	0.61	9.46	9.24	9.79	12.1					2.66							
	mg/l	8/24/1993													12.5	10.3	4.18	3.3	2.31		1.66
	mg/l	12/13/1993	4.6	3.99	4.03	8.43	8.13	8.08	10.1					9.42	10.2						
	mg/l	12/14/1993														8.27	3.92	2.43	1.95		1.14
	mg/l	2/24/1994	4.4	2.5		5.68	8.61	3.45	8.25					7.62							
	mg/l	2/25/1994			<0.10										6.85	8.19	3.96	2.4	<0.10		1.22
Arsenic	mg/l	7/19/1990			ND					ND			0.0052		ND						
	mg/l	5/18/1993	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005													
	mg/l	5/19/1993						<0.005						<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		
	mg/l	8/23/1993	0.004	0.003	<0.001	<0.001	0.004	<0.001	0.011					0.001							
	mg/l	8/24/1993													0.013	0.018	<0.001	0.001	0.008		<0.001
	mg/l	12/13/1993	0.004	0.002	<0.0012	<0.0012	0.0033	<0.0012	0.0092					0.003	0.00394						
	mg/l	12/14/1993														0.00803	<0.0012	<0.0012	0.0013		<0.0012
	mg/l	2/24/1994	0.004	<0.002		<0.002	<0.002	<0.002	0.007					0.003							
	mg/l	2/25/1994			0.002										<0.002	0.008	<0.002	<0.002	<0.002		<0.002
Ammonia	mg/l	8/23/1993	0.2	0.04	0.3	0.6	0.2	0.1	<0.1					<0.1							
	mg/l	8/24/1993													0.4	0.2	0.3	0.3	0.3		5.6
	mg/l	2/24/1994	0.11	0.11		0.44	0.39	0.22	0.11					0.17							
	mg/l	2/25/1994			0.33										0.44	0.17	0.33	0.22	0.22		5.94
TDS	mg/l	7/19/1990			604.2					180			2477.3		459.1						
	mg/l	5/18/1993	367	336	596	1000	312	500													
	mg/l	5/19/1993							480					1020	830	566	422	686	522		
	mg/l	8/23/1993	340	360	580	830	340	490	630					330							
	mg/l	8/24/1993													950	450	440	720	540		690
	mg/l	12/13/1993	420	408	666	909	353	474	464					900	837						
	mg/l	12/14/1993														579	398	663	539		672
	mg/l	2/24/1994	370	377		746	349	483	381					664							
	mg/l	2/25/1994			576										682	530	398	529	491		657



LEGEND

- MONITOR WELL
P-16
(10.46)
WATER LEVEL ELEVATION (FT. NGVD)
FEBRUARY 17, 1992
- STAFF GAUGE
SW-B1
(10.82)
WATER LEVEL ELEVATION (FT. NGVD)
FEBRUARY 17, 1992

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FEBRUARY 17, 1992 WATER TABLE MAP

Ardaman & Associates, Inc.
Geotechnical Environmental and
Materials Consultants

HYDROGEOLOGIC SURVEY
SARASOTA CENTRAL COUNTY
LANDFILL COMPLEX
SARASOTA COUNTY, FLORIDA

DRAWN BY: KJS CHECKED BY: DGS DATE: 02/28/92
FILE NO: 89-135 APPROVED BY: H.B. Stangland

FIGURE 8

Central County Historical Data 1994 & 1998 Initial Sampling Event														
			MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11	MW-12
Chloride	mg/l	5/24/1994	1200	96	16	18								
	mg/l	5/25/1994					110	290	35	37				
	mg/l	5/26/1994									340	120	42	88
	mg/l	11/30/1994	1100	270	16	19	110	300						
	mg/l	12/1/1994							38	74	340	110	25	73
	mg/l	9/2/1998	713	74.3		21.1				33.5				
	mg/l	9/9/1998									33.6	107	5.84	4.13
Sodium	mg/l	5/24/1994	730	110	14	9.2								
	mg/l	5/25/1994					64	140	24	24				
	mg/l	5/26/1994									160	68	49	67
	mg/l	11/30/1994	570	200	16	23	73	120						
	mg/l	12/1/1994							31	48	160	82	45	100
	mg/l	9/2/1998	443	54.5		10.8				72.9				
	mg/l	9/9/1998									75	80.9	10.4	20.1
Sulfate	mg/l													
Aluminum	mg/l													
Manganese	mg/l	5/24/1994	<0.02	<0.02	<0.02	<0.02								
	mg/l	5/25/1994					<0.02	<0.02	<0.02	<0.02				
	mg/l	5/26/1994									<0.02	0.03	0.04	0.05
Iron	mg/l	5/24/1994	2.7	0.38	7.4	2								
	mg/l	5/25/1994					16	41	26	5.4				
	mg/l	5/26/1994									0.1	14	12	18
	mg/l	11/30/1994	4	2	10	4	15	36						
	mg/l	12/1/1994							26	15	3	16	13	18
	mg/l	9/2/1998	4.33	1.79		2.63				35.4				
	mg/l	9/9/1998									50.5	26.6	3.33	4.67
Arsenic	mg/l	5/24/1994	0.003	0.003	<0.002	<0.002								
	mg/l	5/25/1994					0.003	0.003	0.007	0.013				
	mg/l	5/26/1994									0.002	0.005	0.008	0.008
	mg/l	11/30/1994	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002						
	mg/l	12/1/1994							<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
	mg/l	9/2/1998	0.00886	0.00805		0.0026				0.0161				
	mg/l	9/9/1998									0.063	0.00801	0.0139	0.00583
Ammonia	mg/l	5/24/1994	0.12	0.12	0.35	0.39								
	mg/l	5/25/1994					0.33	0.34	0.34	0.33				
	mg/l	5/26/1994									19	0.18	0.17	0.17
	mg/l	11/30/1994	0.39	0.17	1.8	<0.22	0.36	0.56						
	mg/l	12/1/1994							0.17	0.9	0.22	0.59	0.78	0.78
	mg/l	9/2/1998	0.098	0.151		0.113				2.92				
	mg/l	9/9/1998									9.73	3.21	2.91	5.94
TDS	mg/l	5/24/1994	3200	780	220	150								
	mg/l	5/25/1994					580	830	210	350				
	mg/l	5/26/1994									1400	680	520	760
	mg/l	11/30/1994	2800	1100	280	310	580	840						
	mg/l	12/1/1994							360	370	1200	670	370	730
	mg/l	9/2/1998	1930	431		105				684				
	mg/l	9/9/1998									1250	678	392	379
Landfill began accepting waste 6/15/1998. 1998 data is first sampling event after landfill began accepting wastes. Per DEP letter wells were not required to be sampled after last 1994 event during landfill construction, but then were required to be sampled during first 6 months of operation.														

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