Lake Goodwin Landfill 2013 2nd Quarter Environmental Monitoring Report

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1.0 INTRODUCTION

The following report presents the second quarter ground water monitoring results for 2013 at the Lake Goodwin Landfill (*Lake Goodwin Landfill, Site*). The site is located immediately west of Frank Waters Road in northwestern Snohomish County, about one and one half (*1.5*) miles northwest of Lake Goodwin and about five-(*5*) miles south of Stanwood (*T31N, R4E, sections 17, 20 Willamette Meridian*). The landfill is located at 18520 Frank Waters Road, Stanwood, Washington, 98292. The location of the site relative to existing municipal improvements is shown on the **Vicinity Map** (*figure 1*).

The Snohomish Health District approved a new Sampling Analysis Plan for this landfill in June, 2012. The changes include eliminating LG-03 from the analysis, reducing the suite of metals analyzed, and eliminating volatile organic compounds.

1.1 BACKGROUND

The Lake Goodwin Landfill is sited within a former County gravel pit. Waste disposed at the landfill reportedly consisted of municipal waste, including garbage and demolition debris, and some industrial waste. Waste was placed in the landfill starting in the early 1960's under the direction of **Snohomish County's Road Maintenance Division**. The landfill was closed in September 1982. Upon closure a cover system was installed. The landfill is not lined nor does it have leachate or gas collection systems. The Lake Goodwin Landfill is currently permitted for post-closure monitoring by the **Snohomish Health District** (*SHD*) with a Solid Waste Facility Permit (*SW-085, 2013*). Monitoring results are reviewed by both the **SHD** and the **Department of Ecology**.

1.2 PERMIT INFORMATION

Monitoring activities at the landfill are governed by the Solid Waste Facility Permit SW-085 (*landfill permit, Snohomish Health District 2013*). This permit requires post-closure ground water monitoring on a quarterly basis until the facility has been shown to be stable and/or not harmful to human health or the environment. The **SHD** permits and evaluates post-closure conditions at the Lake Goodwin Landfill using the Snohomish Health District Sanitary Codes, *Chapter 3.1, Solid Waste Handling Regulations*; *Chapter 173-304 WAC Minimum Functional Standards for Solid Waste*; *Chapter 173-200 WAC Water Quality Standards for Ground Waters*;

and *Chapter 246-290 WAC Drinking Water Regulations.* There is an approved Sampling & Analysis Plan (SAP) for this landfill.

1.3 SITE DESCRIPTION AND PHYSICAL CONDITIONS

The closed landfill is approximately 11.5 acres in size and is part of a larger County owned parcel of land. The Lake Goodwin Landfill is bounded by private residential property or commercial forest to the south, west and north. The Frank Waters Road is located along the eastern side of the site. Access into the site is from a partially paved and partially graveled driveway off of the Frank Waters Road. Existing site improvements are shown on the **Site Map** (*figure 2*).

The Lake Goodwin Landfill is located on a topographic feature known as the Tulalip Plateau, a rolling upland area bounded by the Stillaguamish River to the north, the Puget Sound to the west and south, and by a topographic low called the Marysville Trough to the east. The general topography in the immediate vicinity of the site is typical of glaciated areas within western Washington State – gently rolling landscapes bisected by seasonal and/or year round drainages, creeks and rivers. Several small to medium sized lakes are found in the immediate vicinity of the site. Lake Martha, Lake Howard and Lake Goodwin are all located within a few miles of the Landfill. There are no named drainages, creeks or rivers located in the immediate vicinity of the site. Elevations in the immediate vicinity of the landfill range from approximately el. 320 to el. 380 feet above mean sea level. Relative to existing surrounding topography the landfill itself is approximately 60 ft high. It has been graded and slopes gently in a north to northeast direction. Site Topography is shown on the **Topographic Map** (*figure 3*). In most places the landfill cover is well vegetated with grass, clover and weeds. A few Douglas fir have naturally reseeded in the fill cover near the edge of the site. There are no stormwater detention ponds or leachate collection ponds located on the site.

1.4 LOCAL HYDROGEOLOGY

Surficial geology of the site area is shown on the **Geologic Map** (*figure 4*). Based on the Geologic Map and the site explorations, surficial geology at the landfill site consists of Advance Outwash (*Qva*) sands and gravels locally overlain by sandy silts to silty sands and gravels – Glacial Till (*Qvt*).

The Lake Goodwin Landfill is located on an upland area known as the Tulalip Plateau. Below the Tulalip Plateau the most productive aquifer is the Advance Outwash (*Qva*) aquifer which is underlain by Transitional Bed (*Qtb*) silts and clays. Where overlain by Glacial Till (*Qvt*), the aquifer is confined. In the vicinity of the Lake Goodwin Landfill where Glacial Till (*Qvt*) is absent, the aquifer is unconfined. With the exception of the surficial Glacial Till (*Qvt*) found overlying the Advance Outwash (*Qva*) sands and gravels along the southern edge of the landfill (*LG-02*), permeable soils were encountered from the surface down in all site explorations at the landfill. Ground water elevations below the landfill ranged from el. 152.79 to el. 154.85 with a north to northwest gradient in an unconfined condition within the Advance Outwash (*Qva*) aquifer.

1.5 EXISTING MONITORING NETWORK

As outlined in the Solid Waste Facility Permit SW-085, quarterly monitoring of ground water is required at the Lake Goodwin Landfill. There are currently four-(4) ground water monitoring wells (*LG-01, LG-02, LG-04, and LG-05*) at the Lake Goodwin Landfill site that are read on a quarterly basis. Well locations are shown on the **Network Monitoring Map** (*figure 5*). Of these wells, one-(*1*) is considered to be an up-gradient well monitoring background ground water conditions in the immediate vicinity of the site (*LG-02*). The remaining three-(3) wells are located in and/or down gradient of the landfill (*LG-01, and LG-04 and LG-05*) and monitor ground water conditions that may be impacted from the site. Second quarter monitoring results are discussed in section 2.0 below.

2.0 GROUND WATER MONITORING

Second quarter 2013 monitoring of the ground water wells at the Lake Goodwin Landfill was performed by **Snohomish County** personnel. Depth to water was measured and ground water samples were collected following approved sampling protocol. The following sections describe field procedures used and analytical results derived from the sampling event.

2.1 Ground Water Level Measurements

The depth to ground water within each well was measured prior to ground water sampling activities. The depth to ground water was measured using an electronic water level indicator in increments to the nearest 0.01 ft. as taken from a marked survey point on the top of each well casing.

Second Quarter Ground Water Measurements are shown in *Table 1* below. **Hydrographs** of the second quarter 2013 monitoring well readings are contained in *Appendix A* of this report. Second quarter well readings show a general increase in water levels in the wells except in LG-

01 which dropped 4.56'. This may be an operator error. Readings confirm that the aquifer is unconfined in the immediate vicinity of the site. The **Second Quarter Ground Water Contour Map** developed from the field data is shown in *Figure 6* of this report.

Measured precipitation at the Stanwood Weather Station (WA-SN-11 http://www.cocorahs.org/state.aspx?state=wa) during the second quarter monitoring period was 4.83" through June 30, 2013. For reference purposes, precipitation measured at station WA-SN-11 during the monitoring period has been included on the hydrographs.

Table 1 – Second Quarter Groundwater Measurements and Elevations

Well Numbers	Casing Elevation	2nd Quarter Delta/Elevation	
LG-01	239.18	- 4.56	149.31
LG-02	268.67	+2.33	157.18
LG-04	206.93	+1.63	154.42
LG-05	235.00	+1.36	154.86

2.2 Second Quarter Ground Water Sampling Event

Purging and sampling of each of the four-(4) sampled monitoring wells was performed during the second quarter by Snohomish County personnel in accordance with the facilities closure permit. Approximately 1.4 to 3.6 gallons of water were purged from each well prior to sampling. Water samples were collected by slowly filling laboratory-supplied containers in such a manner as to reduce aeration. Sample containers were filled so that no headspace or air bubbles remained within the container. Samples were placed in coolers and packed in ice to keep samples at approximately 4C for delivery to the laboratory for testing. Samples were picked up by **Amtest** and taken to their Kirkland, WA laboratory for analysis of dissolved metals and conventional chemistry parameters. Per the newly approved SAP, VOCs and certain metals are no longer part of the analysis program. Analytical Data is included in *Appendix B*, Ground Water Analytical Data of this report. The analytical data was compared to the maximum contaminant levels (*MCL's*). A complete statistical analysis of the data was also performed utilizing **DUMPStat.** Results are discussed below.

2.3 Evaluation of Second Quarter Ground Water Analytical Results

Second Quarter Ground Water Test Results for each well are summarized in *Table 2* below. Comparison of results to regulatory criteria (MCL's) shows:

First Quarter: Other than arsenic in all wells and pH in LG-01, LG-04 and LG-05, there were no measured exceedances of the MCL's in any well except LG-05. There were measured exceedances of the MCL's for conductivity, nitrate nitrogen, pH, sodium, total dissolved solids and arsenic in well LG-05. No other dissolved metals were observed exceeding WAC level MCL's during this sampling event.

Table 2 - Summary of Test Results – Second Quarter

Well	2nd Quarter 2013 Groundwater Standard Exceedances
LG-01	pH, arsenic
LG-02	Arsenic
LG-04	pH, arsenic
LG-05	Conductivity, nitrate nitrogen, pH, sodium, TDS, arsenic

2.4 Statistical Evaluation

State health regulations under which the Lake Goodwin Landfill closure is permitted require that the landfill "...shall not cause exceedances of *Chapter 173-200 WAC*, **Water Quality Standards for Groundwater**, and *Chapter 246-290 WAC*, **Drinking Water Regulations**." The intent of these state regulations is to limit the impact that a landfill will have on the surrounding ground water resources. Collected ground water samples are tested for Primary and Secondary Drinking Water Standards, and Dissolved Metals – and compared to the standards listed in the above referenced WAC's. Where an exceedance to the standards occurs, a statistical analysis is provided to determine the significance of the change or exceedance. Each of these exceedances has been statistically analyzed using **DUMPStat Software** (*version 2.1.9 by Robert D. Gibbons Lt., 2000*) per the *Subtitle D* regulations and as specifically referenced in the **U.S. EPA** guidance manual. Mean, standard deviation, prediction limits, and confidence values were calculated by **DUMPStat**.

The Sens Trend analysis test was performed for the entire data set stretching back to 1988 and the results of that analysis – increasing or decreasing trends are recorded on the spreadsheet in Appendix B. The trend analysis in Appendix C is run between 2005 and current time. This allows us to place multiple constituents on a single graph to better see any potential correlation between the geochemistry and dissolved metals. Per Ecology and Snohomish Health District request, the prediction limit is updated in the first quarter of the year and subsequent data sets are compared against that prediction limit.

Based on the statistical analysis, exceedances to the prediction limits in down-gradient wells LG-01 and LG-05 were high for conventional chemistry parameters and minimal for the dissolved metals. Down-gradient well LG-04 was less impacted by leachate and had only minimal exceedances to the calculated prediction limits during the 2nd quarter sampling event. There were no exceedances to the calculated prediction limits for up-gradient well LG-02 during this quarter. Calculated exceedances to the prediction limits in the second quarter are shown in *Table 3* below.

Table 3 - Statistical Summary – Second Quarter Prediction Limit Exceedances for 2013

Well	2nd Quarter 2013 Exceedances
LG-01	Alkalinity, bicarbonate, magnesium, barium, manganese
LG-02	None
LG-04	pH, barium, manganese
LG-05	Alkalinity, bicarbonate, calcium, chloride, conductivity, magnesium, nitrate, nitrite, potassium, sodium, sulfate, TDS, barium, manganese

Stiff Diagrams, Trilinear Diagrams and **Statistically Significant Trends Analyses** results are included in *Appendix C* of this report.

3.0 GAS PROBE MEASUREMENTS

We reported in our SAP and to SHD that neighbors removed / damaged the bar hole probes at the Lake Goodwin Landfill. We will perform another gas study in 2013.

4.0 SUMMARY AND RECOMMENDATIONS

The ground water data collected during the 2013 second quarter sampling events indicates the following:

- Even though precipitation during the second quarter decreased when compared to that of the first quarter, overall ground water elevations below the landfill continued to increase during this quarter. The ground water elevation trend of all wells has been steadily rising since 2005.
- Measured conductivity was above background levels (*LG-02*) in all down gradient wells during this sampling event. The conductivity level observed at well LG-05 was significantly higher than the surrounding wells during this sampling event.
- Statistical analysis did show significant impacts to well LG-05. Lesser impacts where indicated in wells LG-01 and minimal impacts were measured for LG-04. Time series plots based on the **DUMPStat** analysis indicates that there were more significant decreasing trends *(11)* than increasing trends *(8)* during this sampling event.

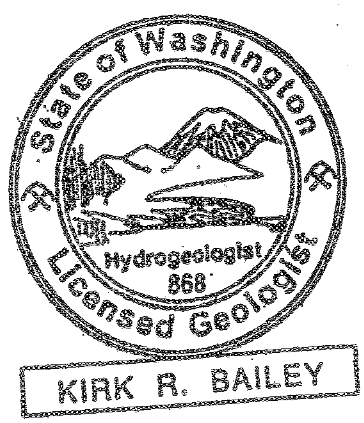
- There were very minimal impacts to the ground water from dissolved metals. Small exceedances to the calculated prediction limits for barium and manganese were found in the down-gradient wells.
- The arsenic level in the "Implementation Guidance for the Ground Water Quality Standards" is so low that every well exceeded it.

4.1 CONCLUSIONS/RECOMMENDATIONS

Second quarter 2013 data indicates a continued moderate leachate impact to the underlying Advance Outwash (*Qva*) aquifer below the Lake Goodwin Landfill. Statistical analysis indicates a large number of significantly decreasing trends which would suggest that the leachate impact to the ground water below the landfill is decreasing at this time, however, increasing trends were calculated for down gradient well LG-01 during this sampling event. Interpretation of the data suggests that a leachate plume impacting ground water extends beyond the landfill boundaries following the ground water gradient to the north-northeast in the immediate vicinity of LG-05.

4.2 SIGNATURES and CERTIFICATIONS

Kirk R. Bailey, LEG, LHG
SCPW – Engineering Services



Deanna Carveth
SCPW – Solid Waste Division

August 10, 2013

Figure 1

Lake Goodwin Landfill

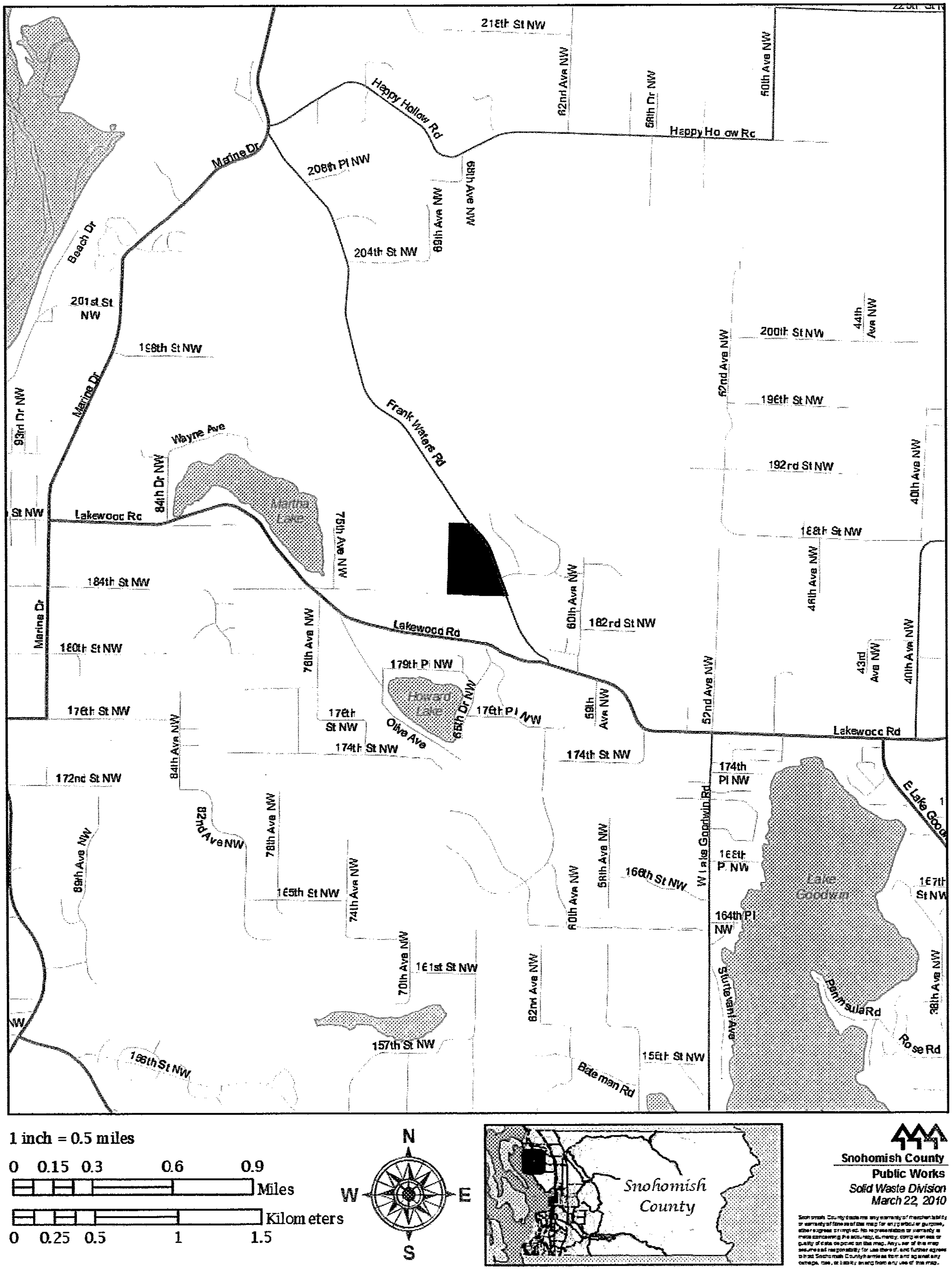


Figure 2

Lake Goodwin Landfill Site Map

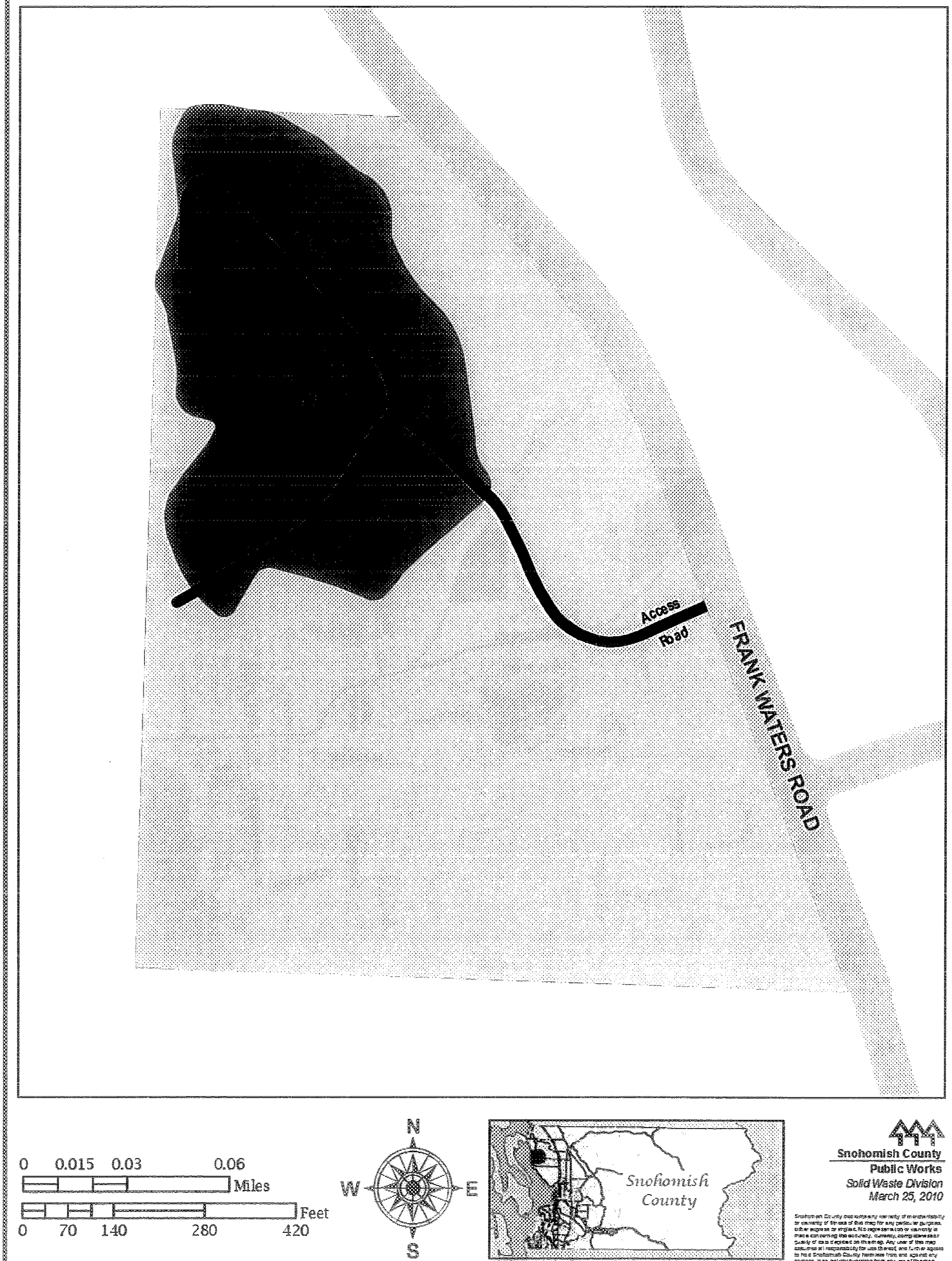


Figure 3
Lake Goodwin Landfill
Topography

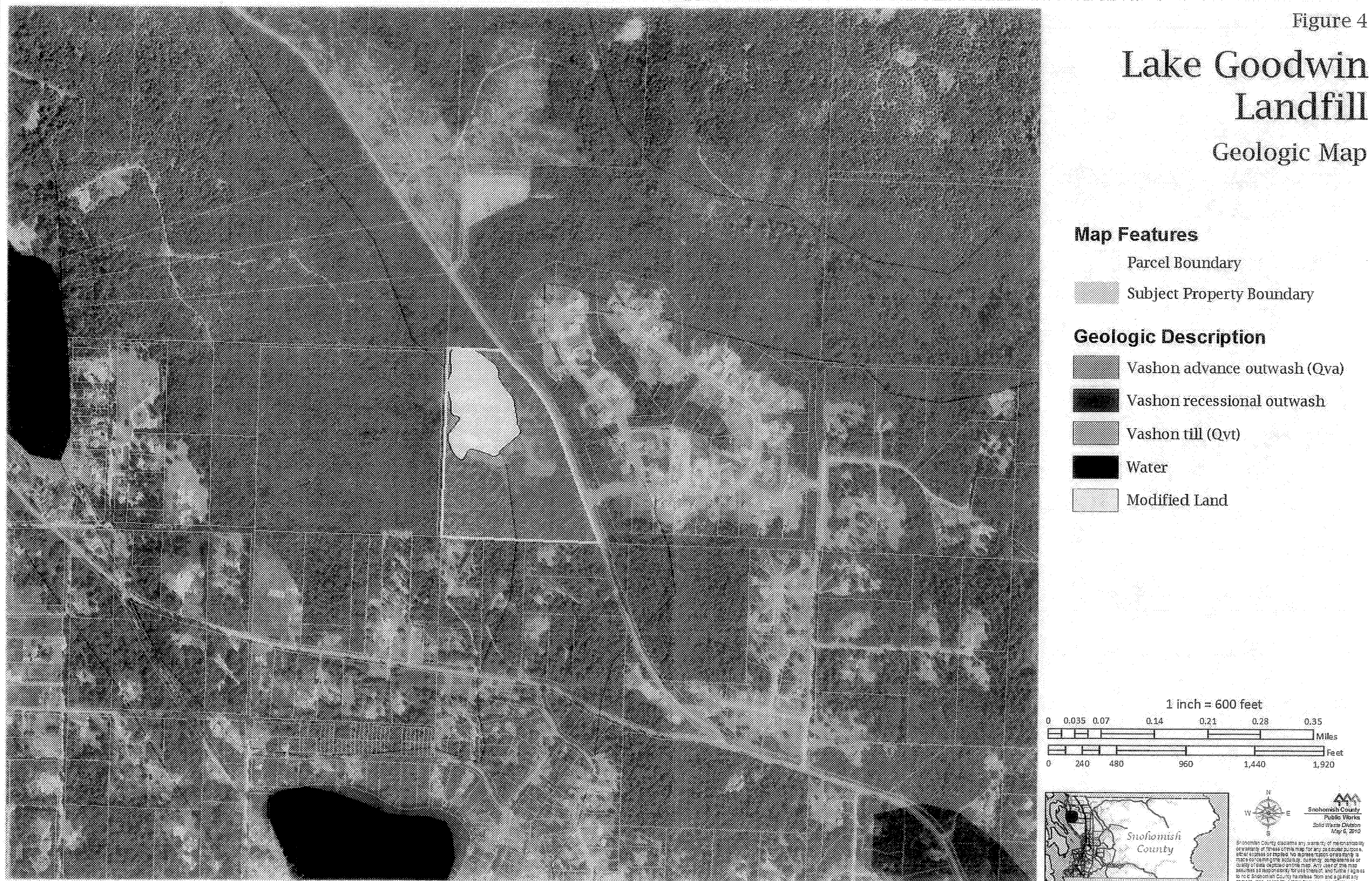


Figure 4

Lake Goodwin Landfill

Geologic Map

Figure 5

Lake Goodwin Landfill

Groundwater Monitoring Network

Map Features

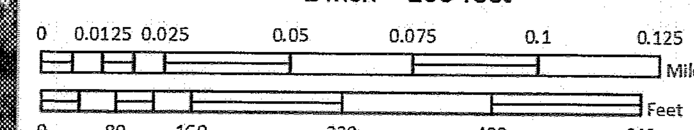
Parcel Boundary

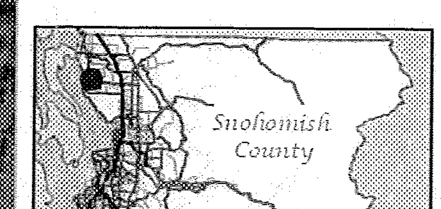
Subject Property Boundary

Aquifer Unit (Active Wells)

Deep Aquifer

1 inch = 200 feet





Snohomish County
Public Works
Solid Waste Division
April 15, 2010

Figure 6

Lake Goodwin Landfill

Water Elevation Contours 3rd Quarter 2013

DIRECTION OF GROUNDWATER FLOW
1.34 ft/day
488 ft/year
70.12 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

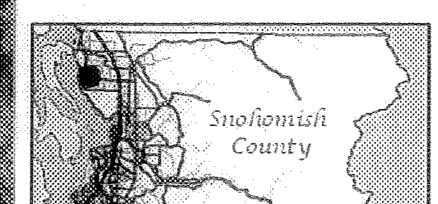
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
LG-01	7/9/2013	155.61
LG-02	7/9/2013	156.85
LG-04	7/9/2013	154.14
LG-05	7/9/2013	154.75

0 0.015 0.03 0.06 0.09 0.12 Miles

0 80 160 320 480 640 Feet

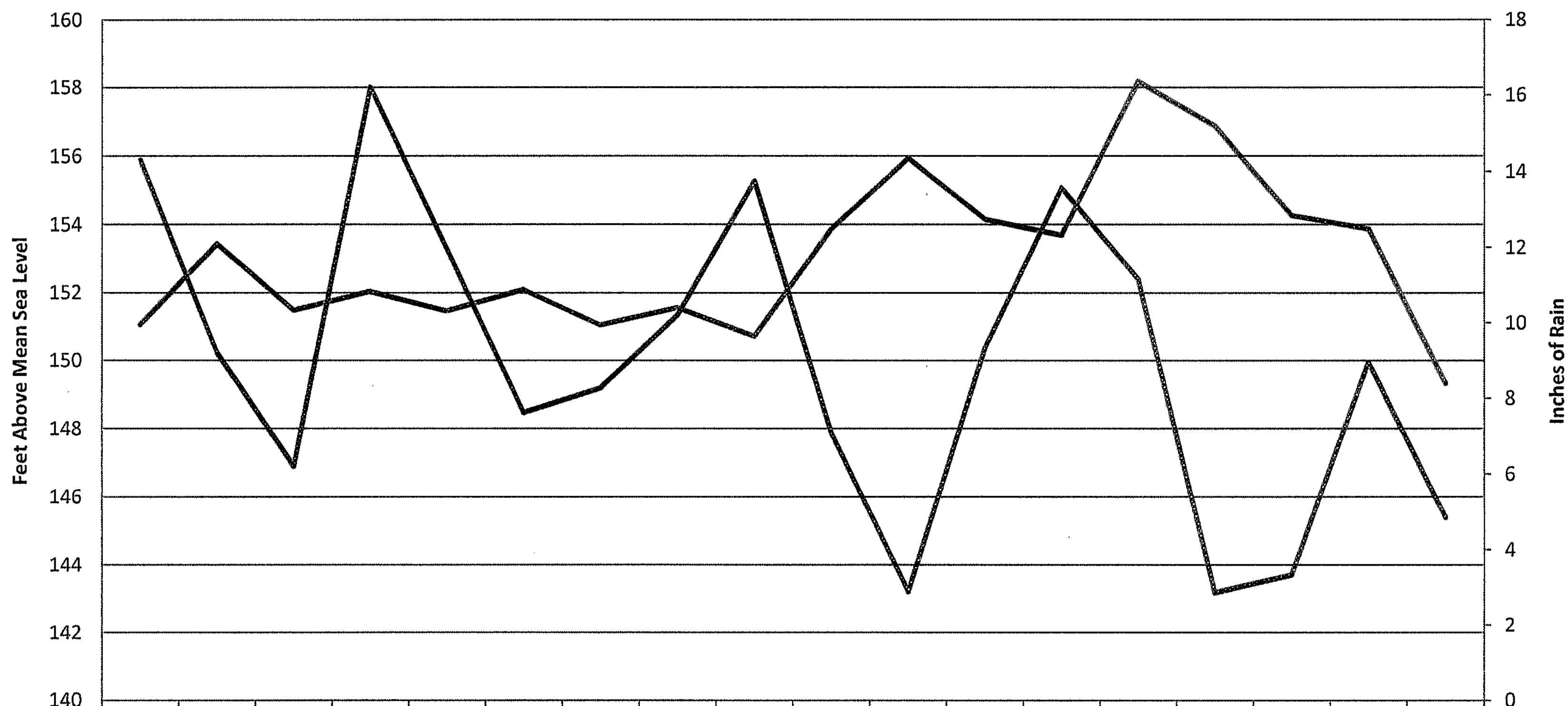


Snohomish County Public Works Solid Waste Division September 3, 2013

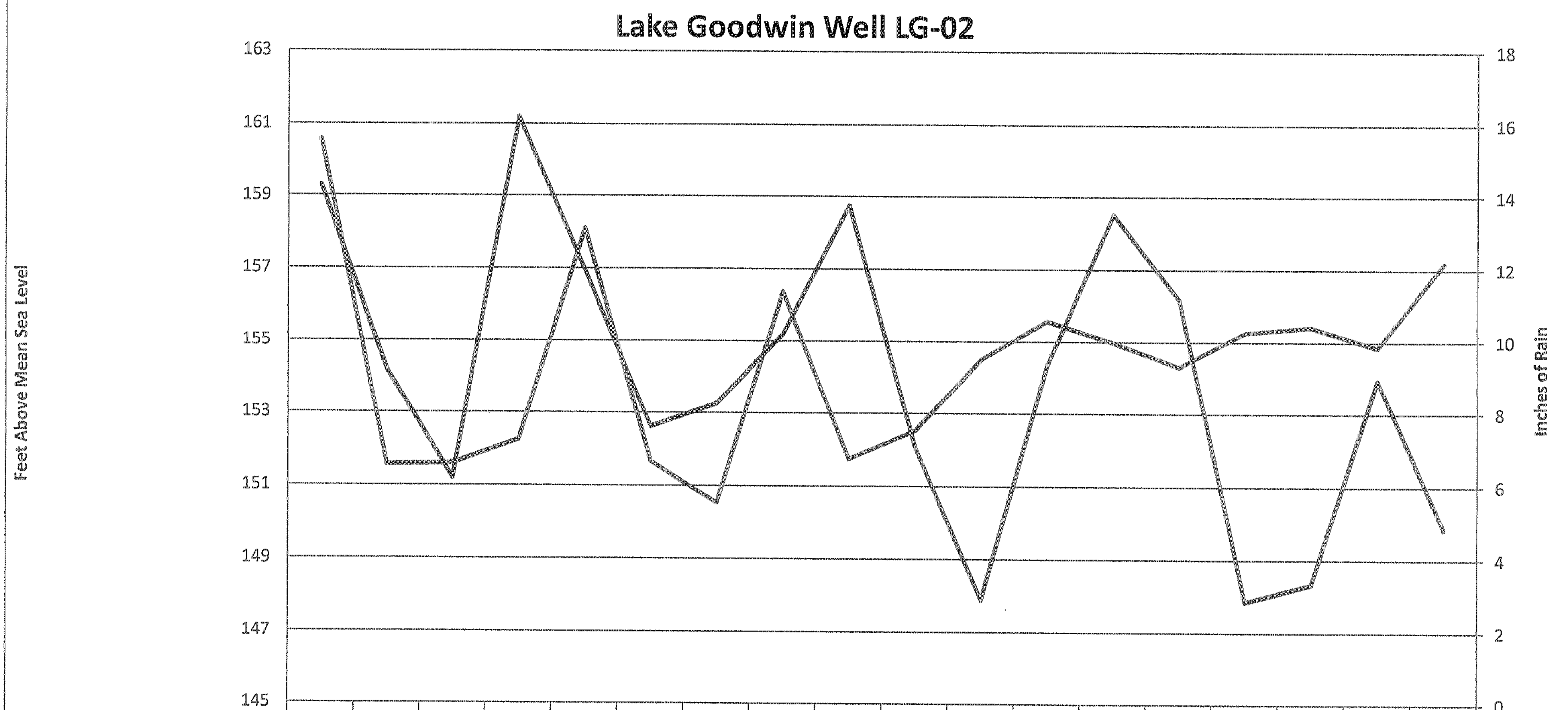
Appendix A

Hydrographs

Lake Goodwin Well LG-01

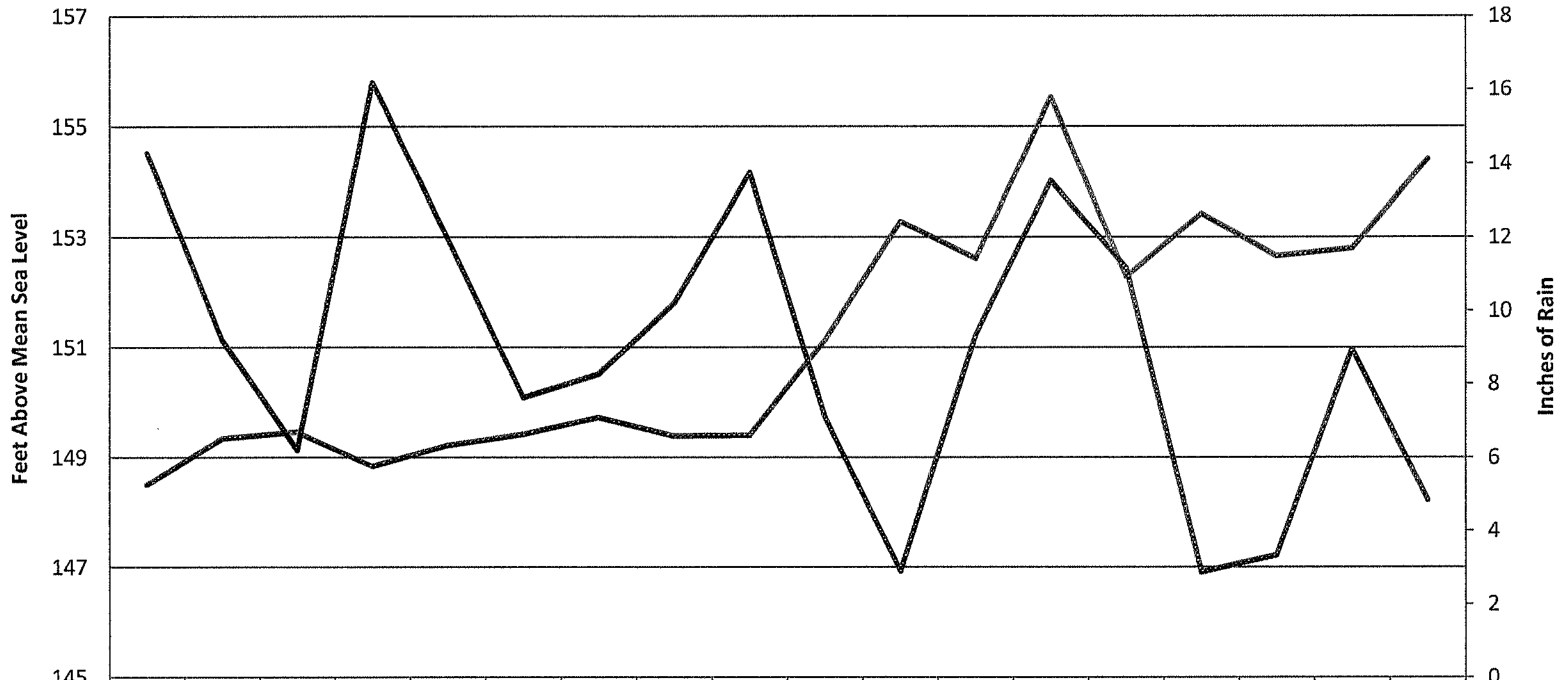


	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4 2011	Q-1 2012	Q-2 2012	Q-3 2012	Q-4 2012	Q-1 2013	Q-2 2013
Depth to Water	151.06	153.43	151.48	152.04	151.46	152.09	151.05	151.56	150.71	153.87	155.94	154.15	153.69	158.17	156.86	154.26	153.87	149.31
Precipitation	14.3	9.2	6.2	16.2	11.96	7.62	8.26	10.2	13.75	7.08	2.89	9.33	13.56	11.16	2.86	3.32	8.94	4.83



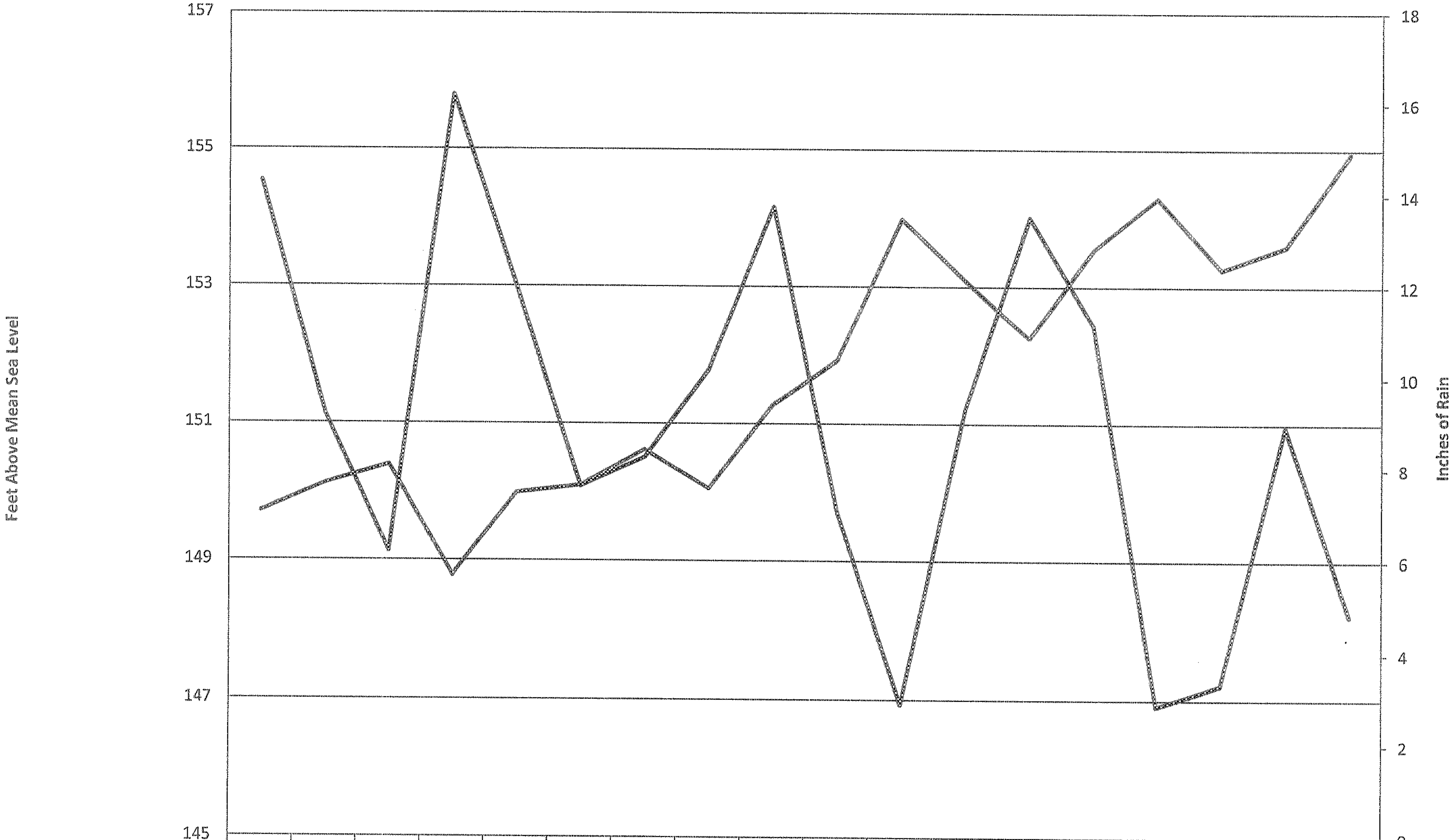
	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4 2011	Q-1 2012	Q-2 2012	Q-3 2012	Q-4 2012	Q-1 2013	Q-2 2013
Groundwater Elevation	160.57	151.56	151.59	152.25	158.1	151.67	150.54	156.37	151.74	152.53	154.5	155.59	154.99	154.30	155.27	155.43	154.85	157.18
Precipitation	14.3	9.2	6.2	16.2	11.96	7.62	8.26	10.2	13.75	7.08	2.89	9.33	13.52	11.16	2.86	3.32	8.94	4.83

Lake Goodwin Well LG-04



	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4 2011	Q-1 2012	Q-2 2012	Q-3 2012	Q-4 2012	Q-1 2013	Q-2 2013
Groundwater Elevation	148.5	149.34	149.46	148.84	149.22	149.42	149.72	149.39	149.4	151.14	153.29	152.61	155.52	152.28	153.43	152.65	152.79	154.42
Precipitation	14.3	9.2	6.2	16.2	11.96	7.62	8.26	10.2	13.75	7.08	2.89	9.33	13.52	11.16	2.86	3.32	8.94	4.83

Lake Goodwin Well LG-05



	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4- 2011	Q-1 2012	Q-2 2012	Q-3 2012	Q-4 2012	Q-1 2013	Q-2 2013
Groundwater Elevation	149.71	150.11	150.39	148.79	149.98	150.09	150.62	150.05	151.28	151.93	153.99	153.09	152.25	153.54	154.3	153.25	153.59	154.95
Precipitation	14.3	9.2	6.2	16.2	11.96	7.62	8.26	10.2	13.75	7.08	2.89	9.33	13.52	11.16	2.86	3.32	8.94	4.83

Appendix B

Analytical Data

Groundwater Summary: Second Quarter 2013 Lake Goodwin Landfill, Snohomish County, WA

	Statistical Method	No. of Samples	No. of Detects	Prediction Limit (a)	MCL	Downgradient LG-01 4/2/13	D	V	T	C	Downgradient LG-04 4/2/13	D	V	T	C	Downgradient LG-05 4/2/13	D	V	T	C	Upgradient LG-02 4/2/13	D	V	T	C
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L unless noted)																									
Alkalinity (as CaCO3)	normal	35	35	**146.5294**	--	**160**		V			120					**410**		V	I	N	92			I	N
Ammonia Nitrogen	nonpar	31	8	**0.069**	--	0.01	U				0.01	U				0.01	U				0.01	U			
Bicarbonate	normal	35	35	**130.7348**	--	**160**		V			120					**410**		V			92				
Calcium, Dissolved	normal	35	35	**23.2667**	--	18.7		P	I	N	19.8					**47.3**		V			18.9				
Chemical Oxygen Demand	nonpar	27	2	**26**	--	10	U				10	U				10	U				10	U			
Chloride	nonpar	35	35	**9.4**	250	5.6			I	N	7					**23**		V			5.7				
Conductivity (umhos/cm)	normal	35	35	**332.9631**	700	290		P			290					**960**		V			270				
Magnesium, Dissolved	normal	35	35	**20.2949**	--	**24.6**		V	I	N	17.6		P			**62.3**		V			16.1				
Nitrate Nitrogen (mg-N/L)	nonpar	34	34	**6**	10	2.1			I	N	1.1					**18**		V			1.6				
Nitrite Nitrogen (mg-N/L)	nonpar	32	8	**0.003**	1	0.002	U				0.002	U				**0.006**			D	N	0.002	U			
pH (std units)	nonpar	35	35	**6.06-7.51**	6.5-8.5	**6.46**			D	N	**6.05**		E	D	N	6.35		P	D	N	7.04			D	N
Potassium, Dissolved	normal	35	35	**3.5853**	--	3.52		P			3.1					**7.37**		V			2.96				
Sodium, Dissolved	nonpar	34	34	**13.8**	20	8.22			D	N	8.02			D	N	40.5		V	D	N	8.62				
Sulfate	nonpar	35	35	**24**	250	14					11.7			D	N	**39**		V	D	N	13.4				
Total Dissolved Solids	nonpar	35	35	**550**	500	220					190					640		V			170				
Total Organic Carbon	nonpar	35	35	**19**	--	3.5					2					2.6					2				
DISSOLVED METALS EPA Methods 6010B/7131A (mg/L)																									
Arsenic	nonpar	29	29	**0.0078**	0.00005	0.00049					0.00033					0.000987					0.00306				
Barium	normal	30	30	**0.0151**	2	**0.0162**		V	I	N	**0.187**		V	D	N	**0.0668**		V			0.0114			I	N
Beryllium	nonpar	35	0	**0.0005**	0.004	0.0005	U				0.0005	U				0.0005	U				0.0005	U			
Cadmium	nonpar	31	12	**0.0002**	0.005	0.000079					0.000026					0.000035					0.000025	U			
Chromium	normal	32	24	**0.0091**	0.1	0.001	U				0.001	U				0.001	U				0.0024				
Cobalt	nonpar	35	6	**0.008**	--	0.001	U				0.001	U				0.001					0.001	U			
Copper	nonpar	31	10	**0.007**	1.3	0.001	U				0.001	U				0.003					0.001	U			
Iron	nonpar	35	6	**0.032**	0.3	0.005	U	P			0.005	U				0.005	U	P			0.005	U			
Manganese	nonpar	32	12	**0.0061**	0.05	**0.0084**		V			**0.0115**		V			**0.0126**		V			0.0046				
Nickel	nonpar	35	0	**0.005**	0.1	0.005	U				0.005					0.005	U	P			0.005	U			

mg/L = milligrams per liter (ppm), µg/L = micrograms per liter (ppb).

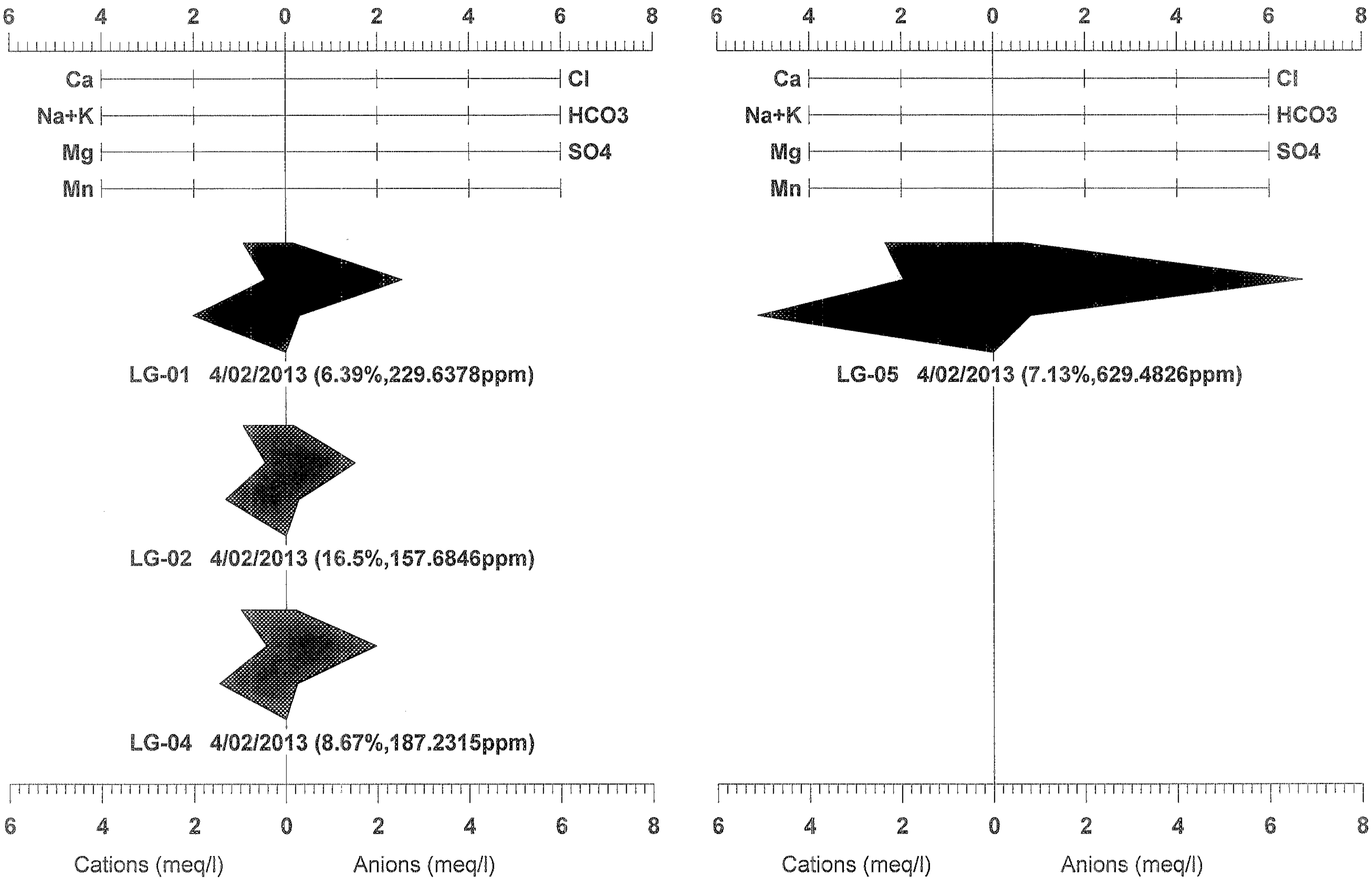
D Column: U = Compound not detected in any sample. V Column: V = verified hit, E = exceedance, waiting verification; P = Passed, exceedance not verified

I means increasing trend, D means decreasing trend via Mann-Kendall Analysis. Ch? = a change in the trend analysis, N is no, Y is yes. Compared to previous quarter.

Appendix C

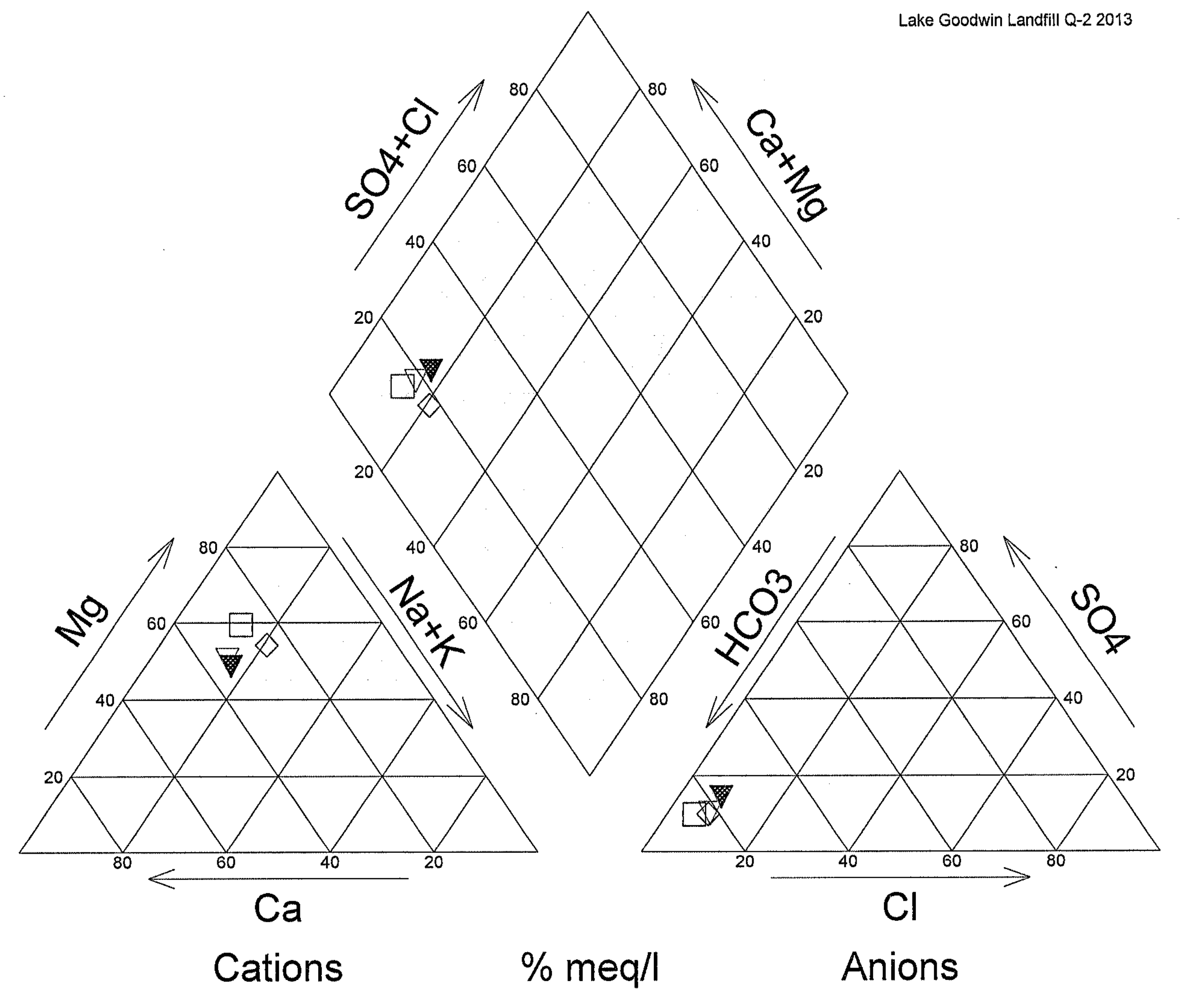
Stiff, Tri-linear and Trend Analysis

Goodwin Landfill



Goodwin Landfill

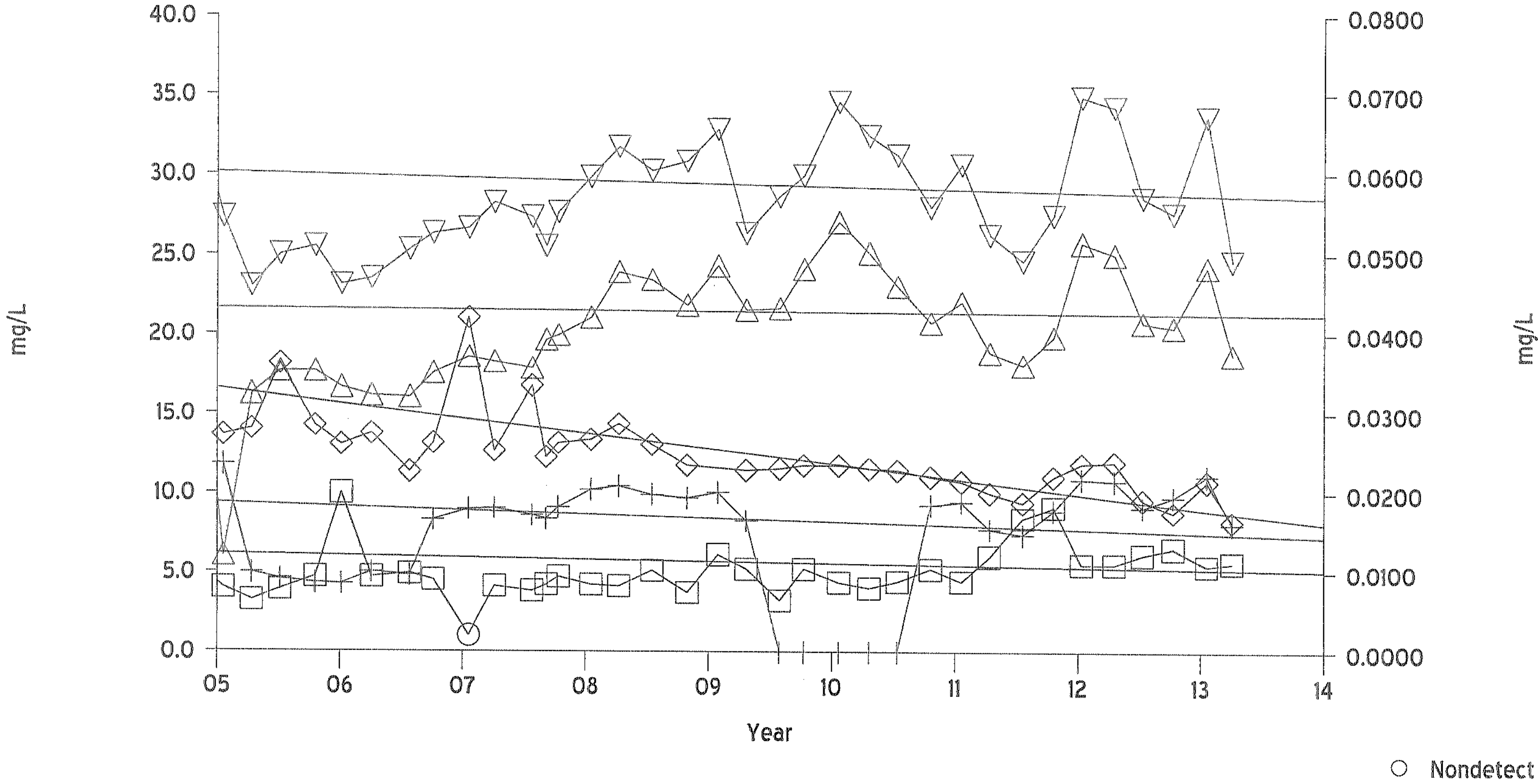
□	LG-01	4/02/2013 (6.39%,229.63ppm)
▼	LG-02	4/02/2013 (16.5%,157.68ppm)
▽	LG-04	4/02/2013 (8.66%,187.22ppm)
◇	LG-05	4/02/2013 (7.13%,629.47ppm)



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Q-2 2013 Time Series Plot for LG-01



△ Dissolved calcium (cc: -.030)
▽ Dissolved magnesium (cc: -.125)
◇ Dissolved sodium (cc: -.818)
□ Chloride (cc: -.204)

+ Dissolved barium (cc: -.279)

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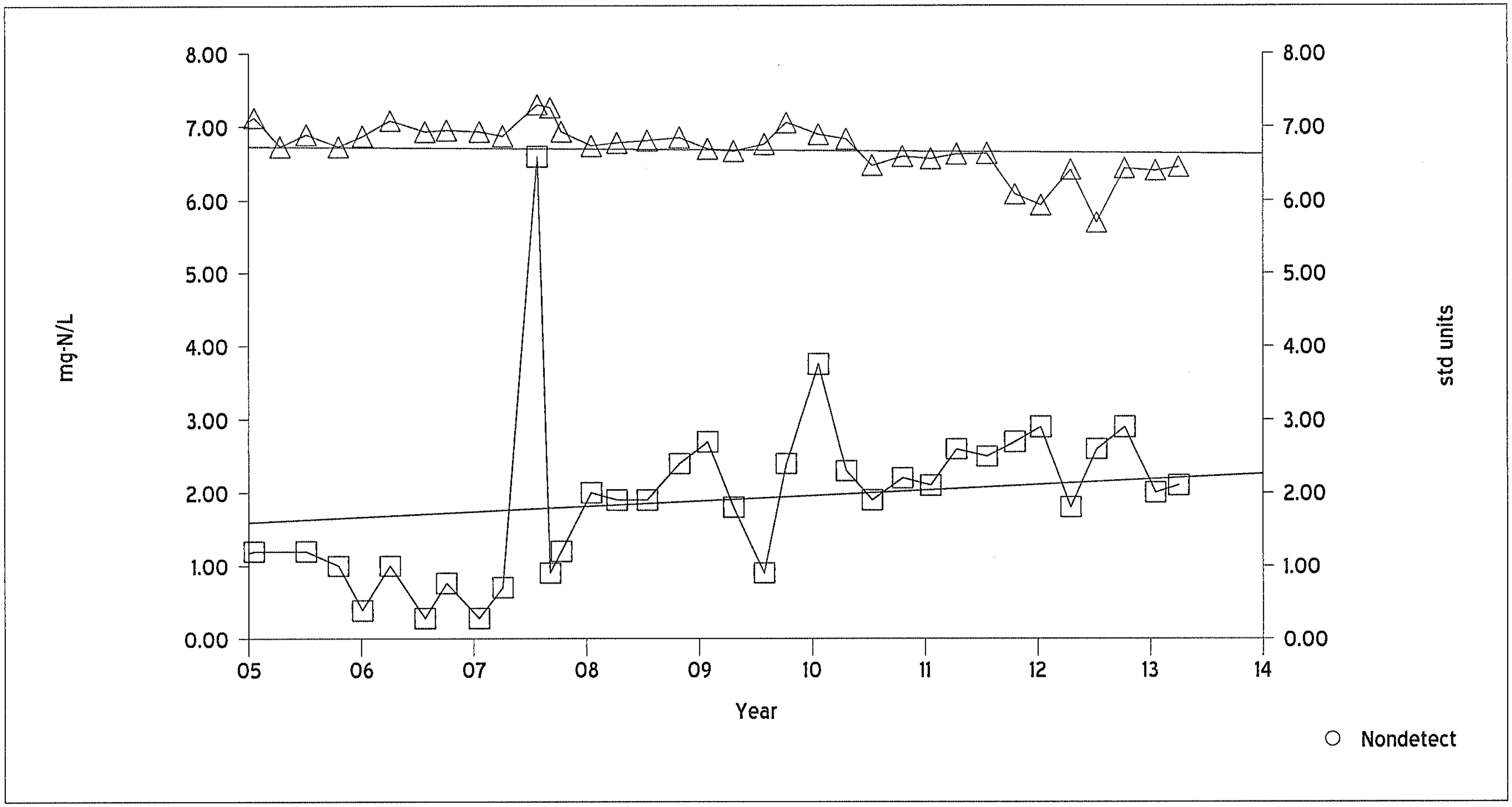
Goodwin Landfill

Time Series Plot for LG-01



☐ Nitrate nitrogen (cc: .509)

△ pH (cc: -.272)

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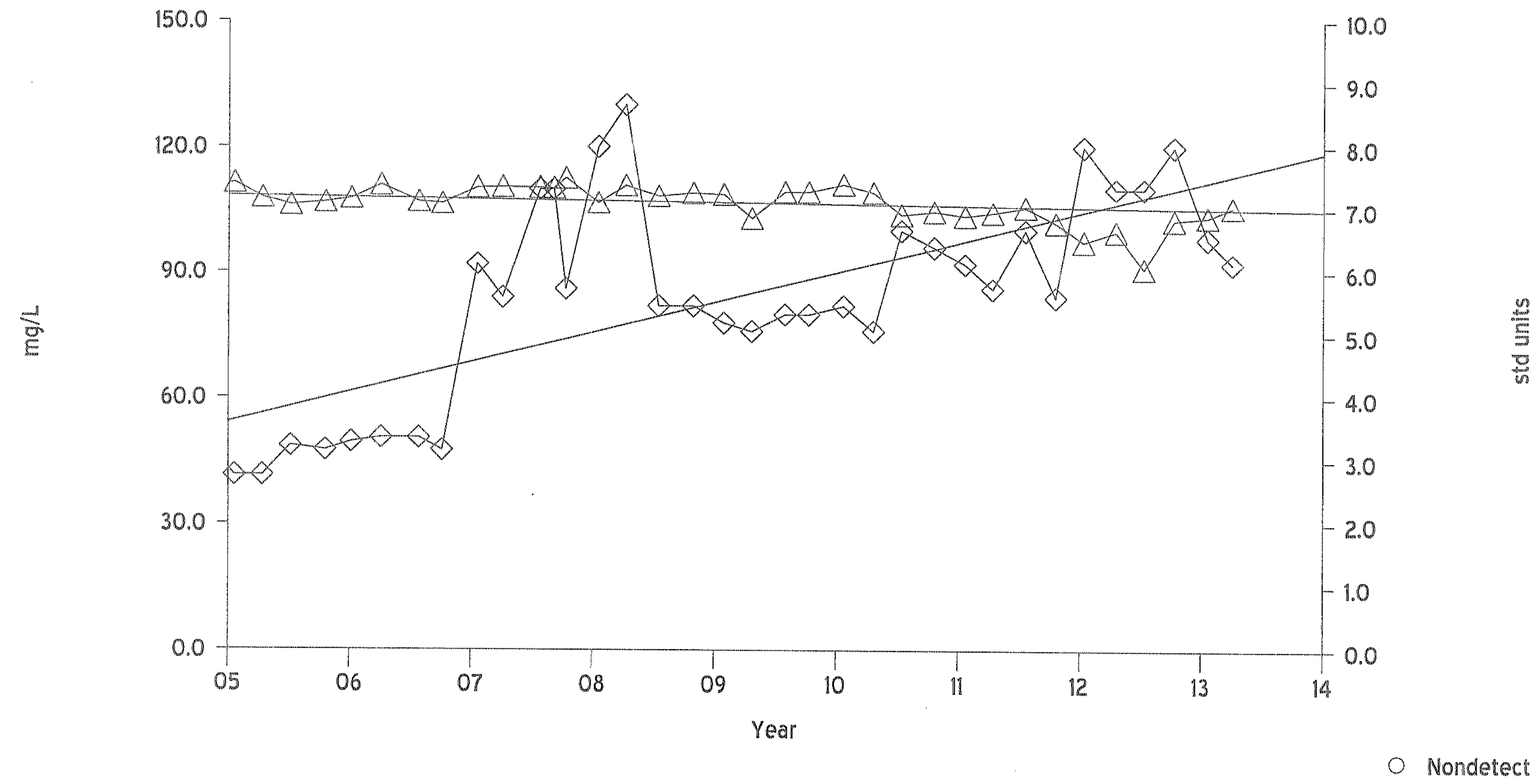
Time Series Plot for LG-02



◇ Alkalinity (as caco3) (cc: .778)

△ pH (cc: -.485)

1

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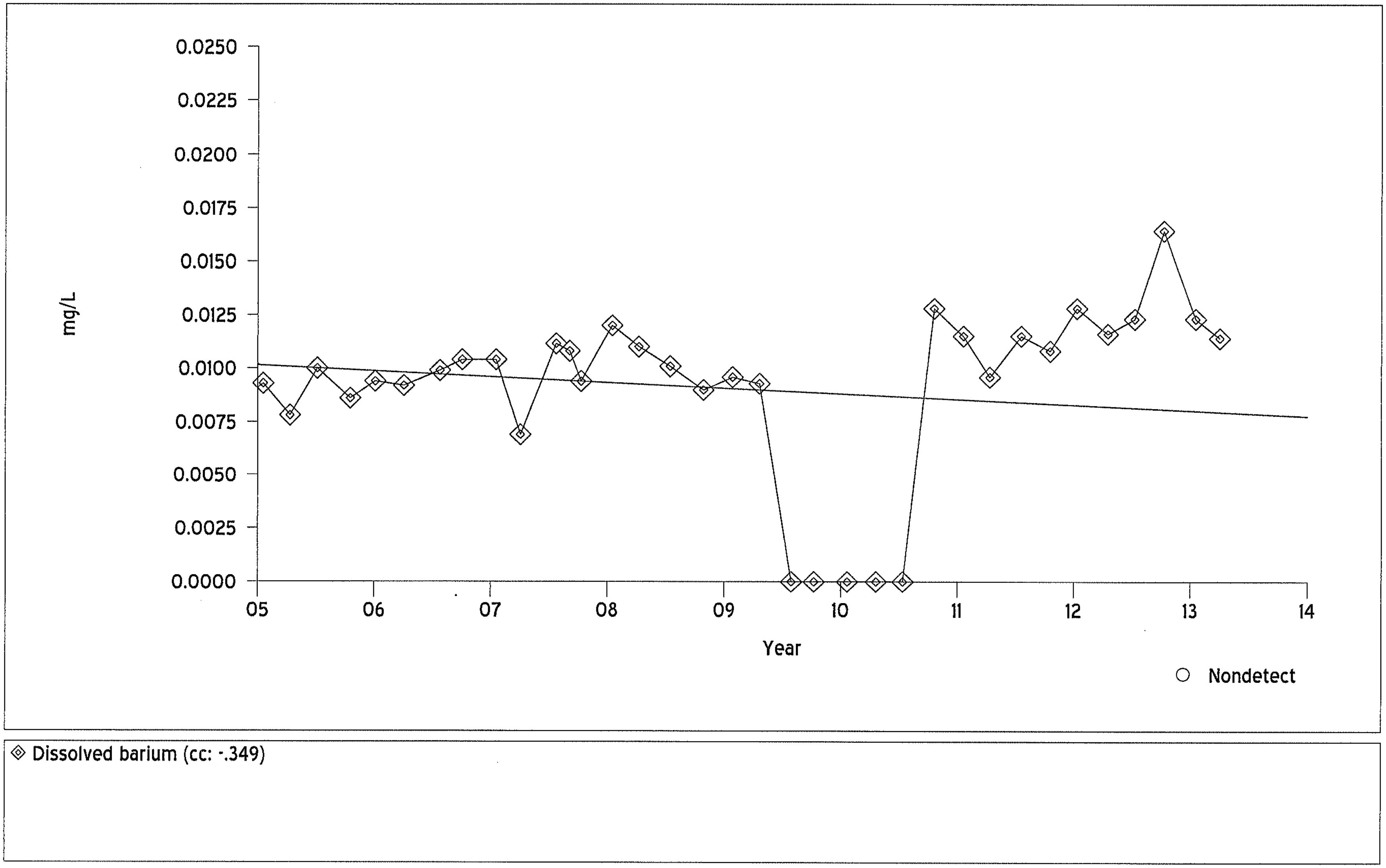
Time Series Plot for LG-02



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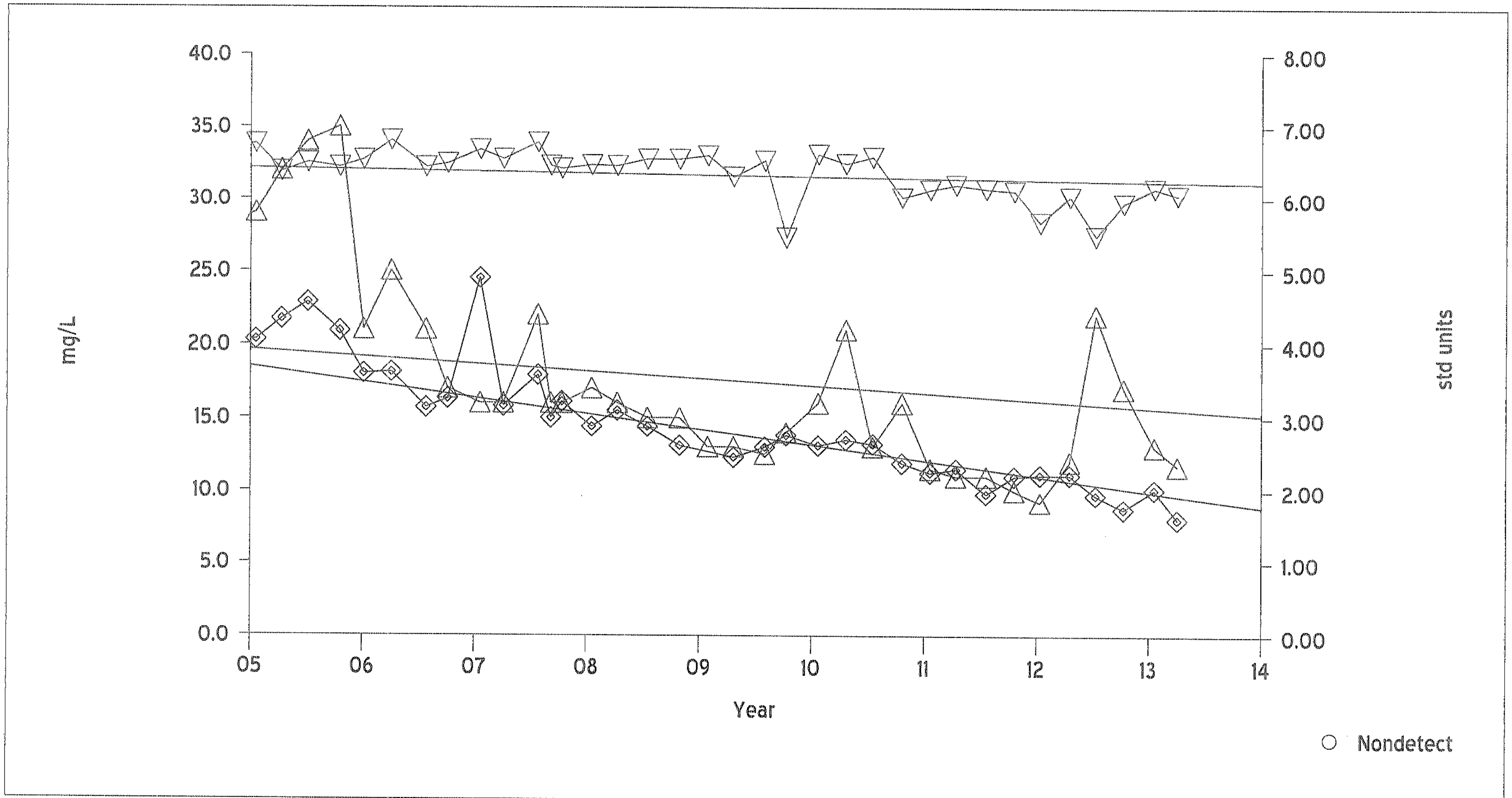
Time Series Plot for LG-04



◇ Dissolved sodium (cc: -.793)
△ Sulfate (cc: -.298)

▽ pH (cc: -.528)

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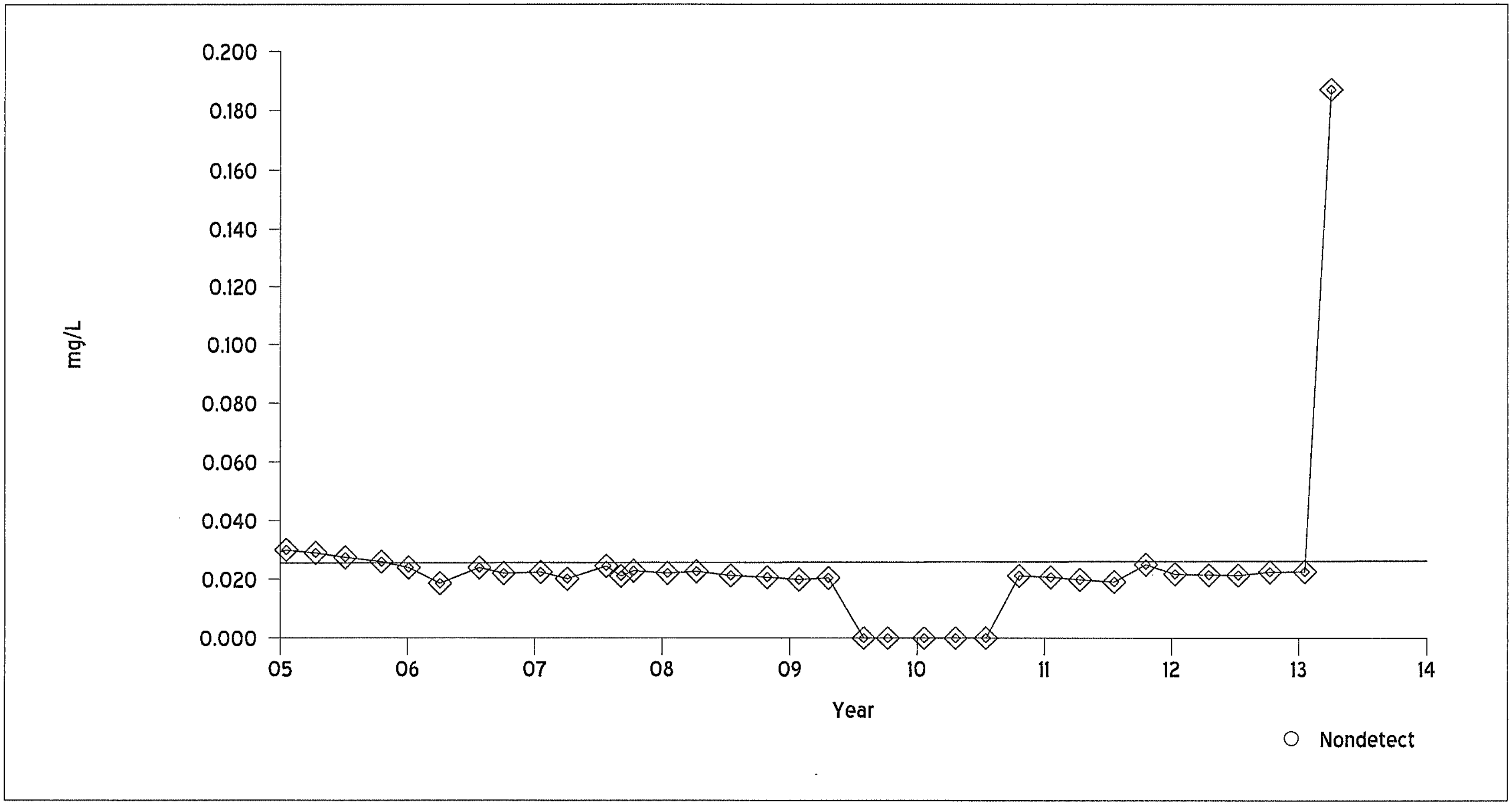
Time Series Plot for LG-04



◇ Dissolved barium (cc: .027)

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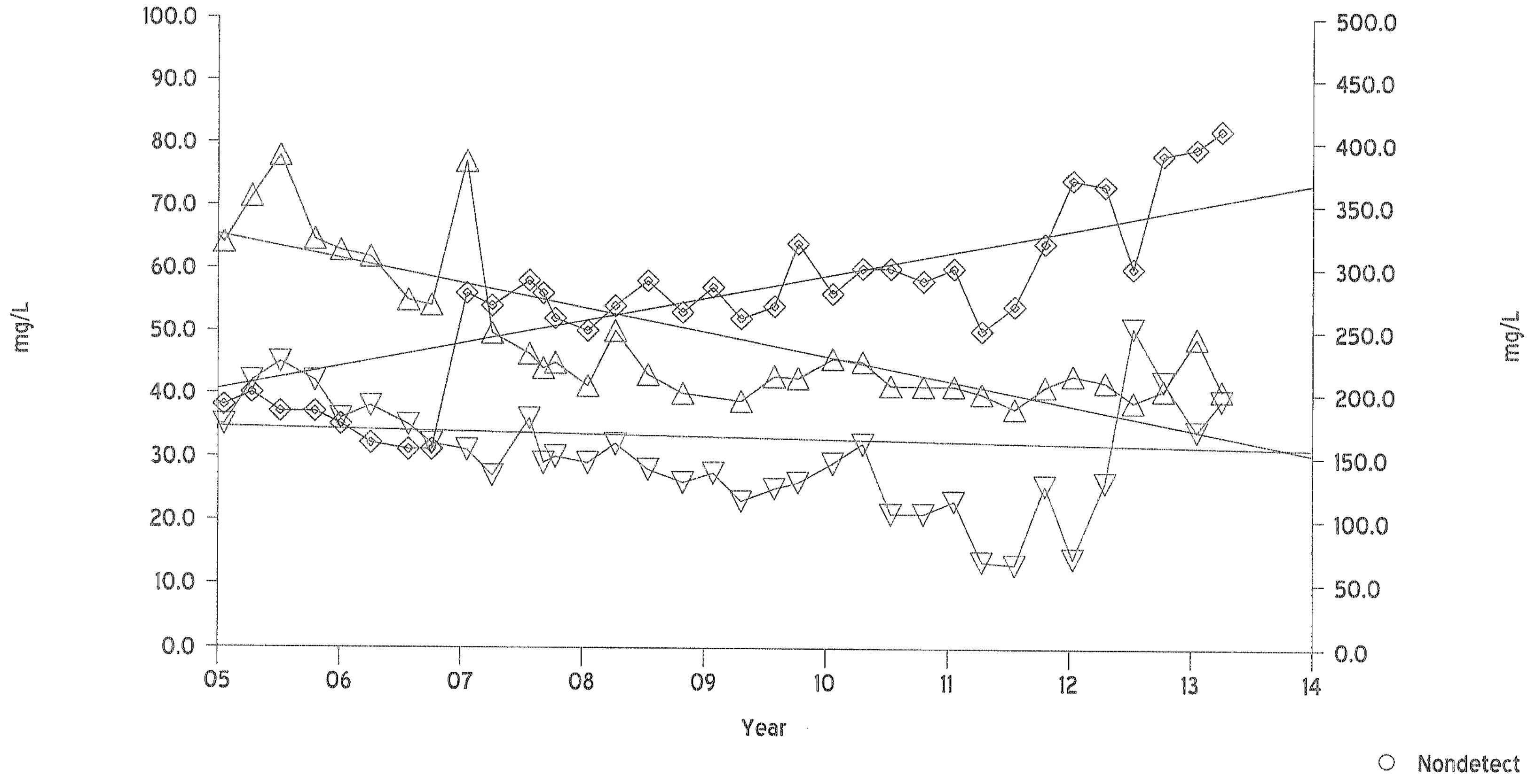
Time Series Plot for LG-05



△ Dissolved sodium (cc: -.852)
▽ Sulfate (cc: -.226)

◈ Alkalinity (as caco3) (cc: .829)

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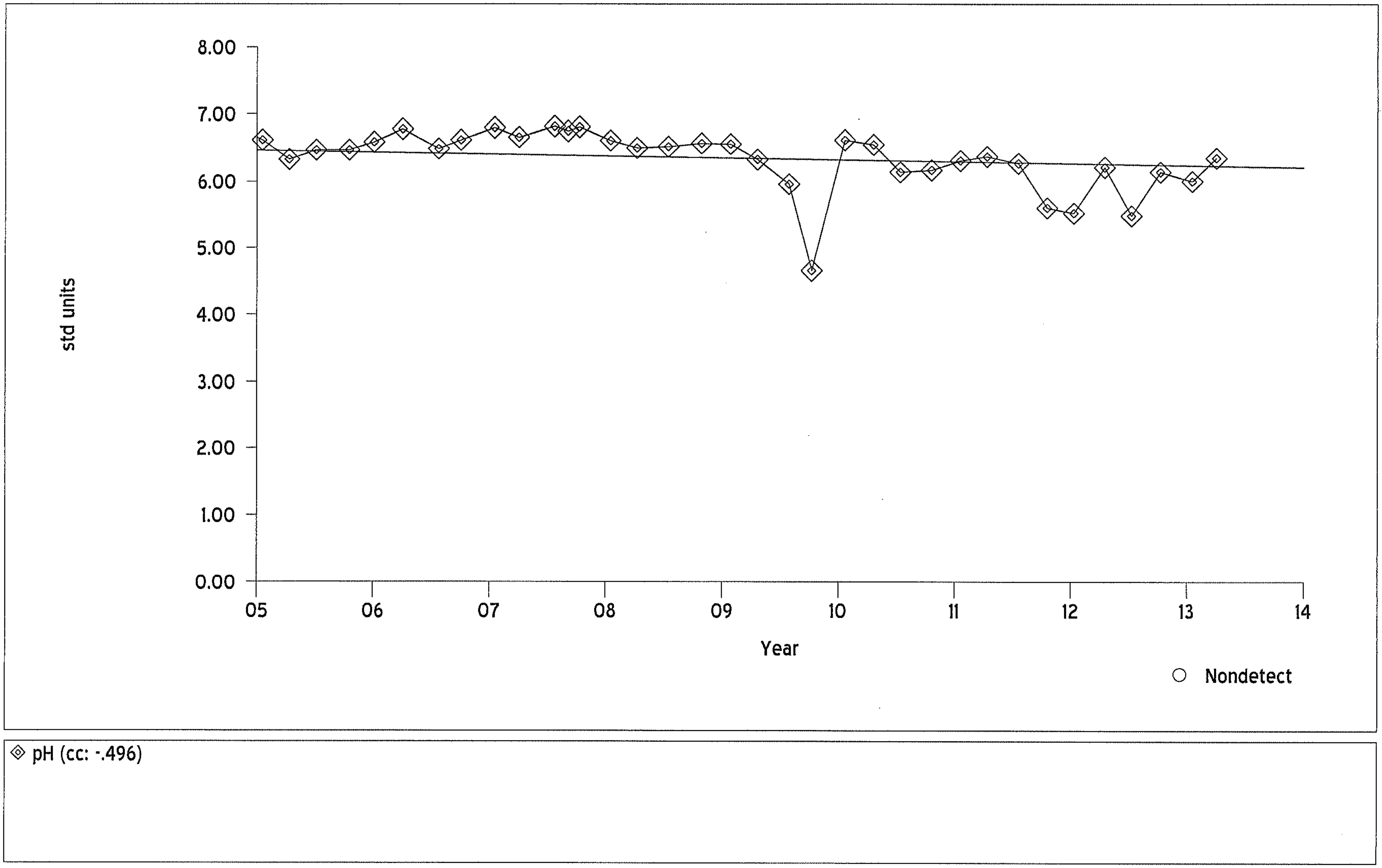
Time Series Plot for LG-05



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