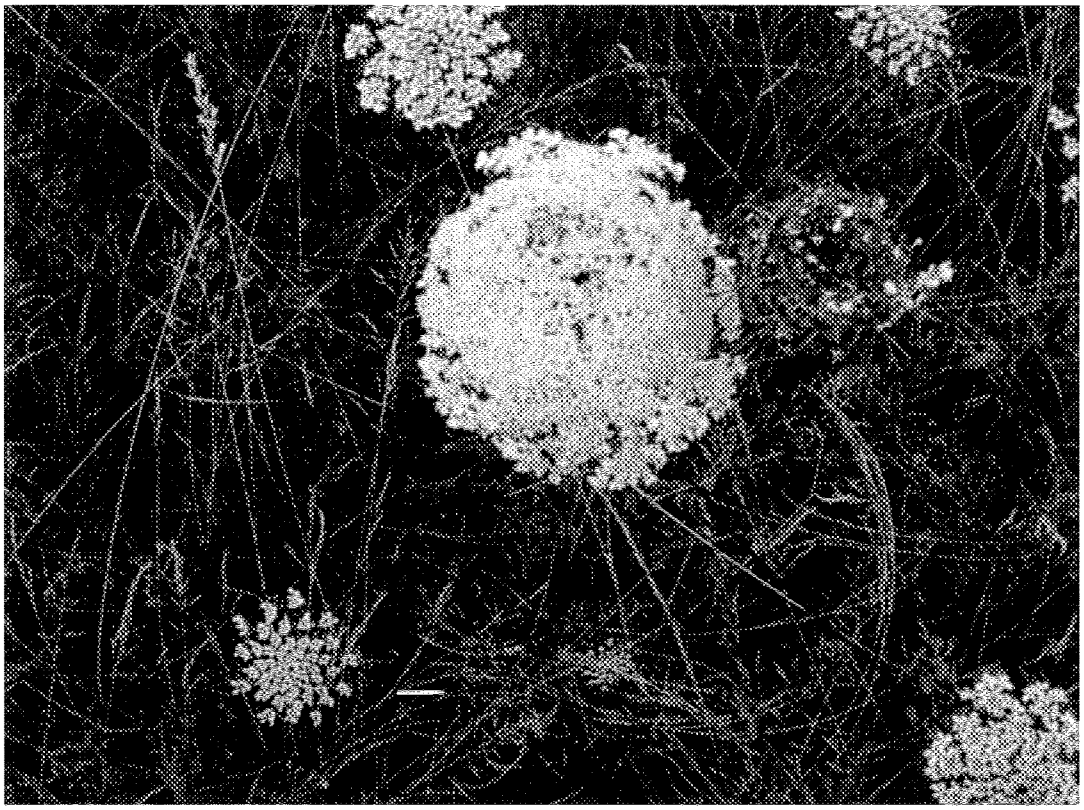
Lake Goodwin Landfill 2012 4th Quarter Environmental Monitoring Report



Contents

Table of Tables

List of Figures

Table of Appendices

1.0 INTRODUCTION

The following report presents the fourth quarter ground water monitoring results for 2012 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. This report reflects those changes.

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, 2012*). 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, ground water 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. 148 to el. 153 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. Fourth quarter monitoring results are discussed in section 2.0 below.

2.0 GROUND WATER MONITORING

Fourth quarter 2012 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.

Fourth Quarter Ground Water Measurements are shown in *Table 1* below. **Hydrographs** of the fourth quarter 2012 monitoring well readings are contained in *Appendix A* of this report. Fourth quarter well readings show a variable response to the much lighter third quarter

precipitation (2.86") and a dryer start to the fourth quarter (3.32" as of 10/28/12). Variances from third quarter measurements are as much as 2.6 feet. Readings confirm that the aquifer is unconfined in the immediate vicinity of the site. The **Fourth 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 fourth quarter monitoring period was 3.32" through October 28, 2012. For reference purposes, precipitation measured at station WA-SN-11 during the monitoring period has been included on the hydrographs.

Table 1 – Fourth Quarter Groundwater Measurements and Elevations

Well Numbers	Casing Elevation	4th Quarter Delta/Elevation	
LG-01	239.18	-2.6	154.26
LG-02	268.67	+0.16	155.75
LG-03	241.20	-2.46	153.62
LG-04	206.93	-0.78	152.65
LG-05	235.00	-1.05	153.25

2.2 Fourth Quarter Ground Water Sampling Event

Purging and sampling of each of the four-(4) sampled monitoring wells was performed during the fourth quarter by Snohomish County personnel in accordance with the facilities closure permit. Per the new SAP, ground water elevations only were taken at LG-03. Approximately 1.9 to 3.3 gallons of water was 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, volatile organic compounds (*VOC's*), and conventional chemistry parameters. Per the newly approved SAP, VOCs and certain metals are no longer be 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 Fourth Quarter Ground Water Analytical Results

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

Fourth Quarter: Other than pH and arsenic in all wells, 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, arsenic, and cadmium 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 – Fourth Quarter

Well	4th Quarter 2012 Groundwater Standard Exceedances
LG-01	pH, arsenic
LG-02	pH, arsenic
LG-04	pH, arsenic
LG-05	Conductivity, nitrate nitrogen, pH, sodium, TDS, arsenic, cadmium

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 all down-gradient wells were high for all of the conventional chemistry parameters and minimal for the dissolved metals. Calculated exceedances to the prediction limits in the fourth quarter are shown in *Table 3* below.

Table 3 - Statistical Summary - Fourth Quarter Prediction Limit Exceedances for 2012

Well	4th Quarter 2012 Exceedances
LG-01	Alkalinity, Bicarbonate, conductivity, magnesium, nitrate, pH, potassium, sulfate, barium
LG-02	Calcium, pH, Barium
LG-04	Calcium, conductivity, magnesium, pH, potassium, barium
LG-05	Alkalinity, ammonia nitrogen, bicarbonate, calcium, chloride, conductivity, magnesium, nitrate, pH, potassium, sodium, sulfate, TDS, barium, cadmium, copper, 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. In fall 2012, we will re-install gas bar hole probes and measure the gas pressure in the landfill cap. We will repeat this study annually and report the results in the annual report.

4.0 SUMMARY AND RECOMMENDATIONS

The ground water data collected during the 2012 fourth quarter sampling events indicates the following:

- Ground water elevations below the landfill continued a slight decline during this quarter. Based on the well readings however; the overall ground water elevation 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 LG-04. Time series plots based on the **DUMPStat** analysis indicates that there were more significant decreasing trends (*12)* than increasing trends (*7)* during this sampling event.

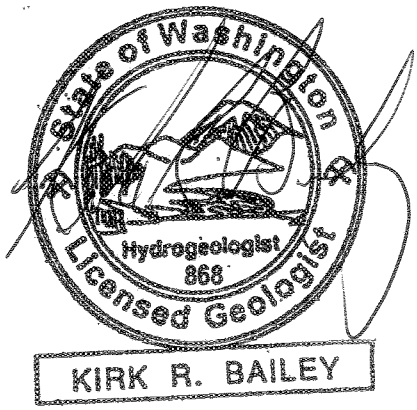
- There were very minimal impacts to the ground water from dissolved metals. Small exceedances to the calculated prediction limits for barium, cadmium, copper, and manganese, were found in the down-gradient wells.
- The arsenic level in the "Intermediate Guidance for the Ground Water Quality Standards" is so low that every well exceeded it, including background well LG-02. Due to the natural background levels of arsenic in the ground water around the Lake Goodwin Landfill, this parameter is no longer a good indication of potential arsenic impacts to the groundwater caused by the landfill.

4.1 CONCLUSIONS/RECOMMENDATIONS

Fourth quarter 2012 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, four-(4) increasing trends have been monitored in down gradient well LG-01. The data also suggests that the leachate plume impacting ground water extends beyond the landfill boundaries following the ground water gradient to the north-northeast through LG-05.

4.2 SIGNATURES and CERTIFICATIONS

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

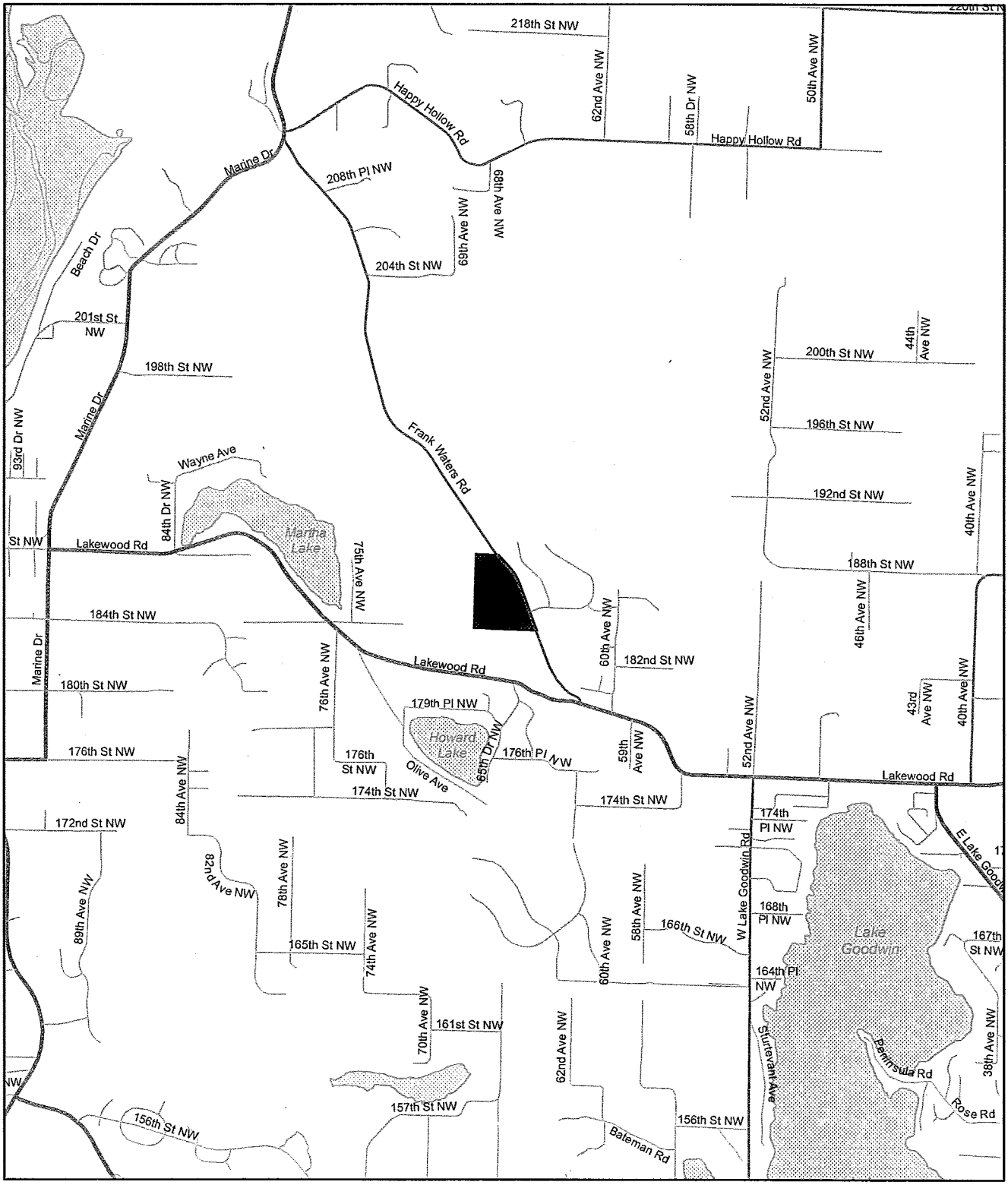


Deanna Carveth
SCPW – Solid Waste Division

November 20, 2012

Figure 1

Lake Goodwin Landfill

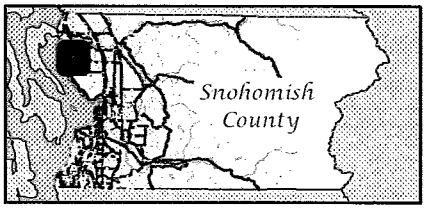


1 inch = 0.5 miles

0 0.15 0.3 0.6 0.9 Miles

0 0.25 0.5 1 1.5 Kilometers

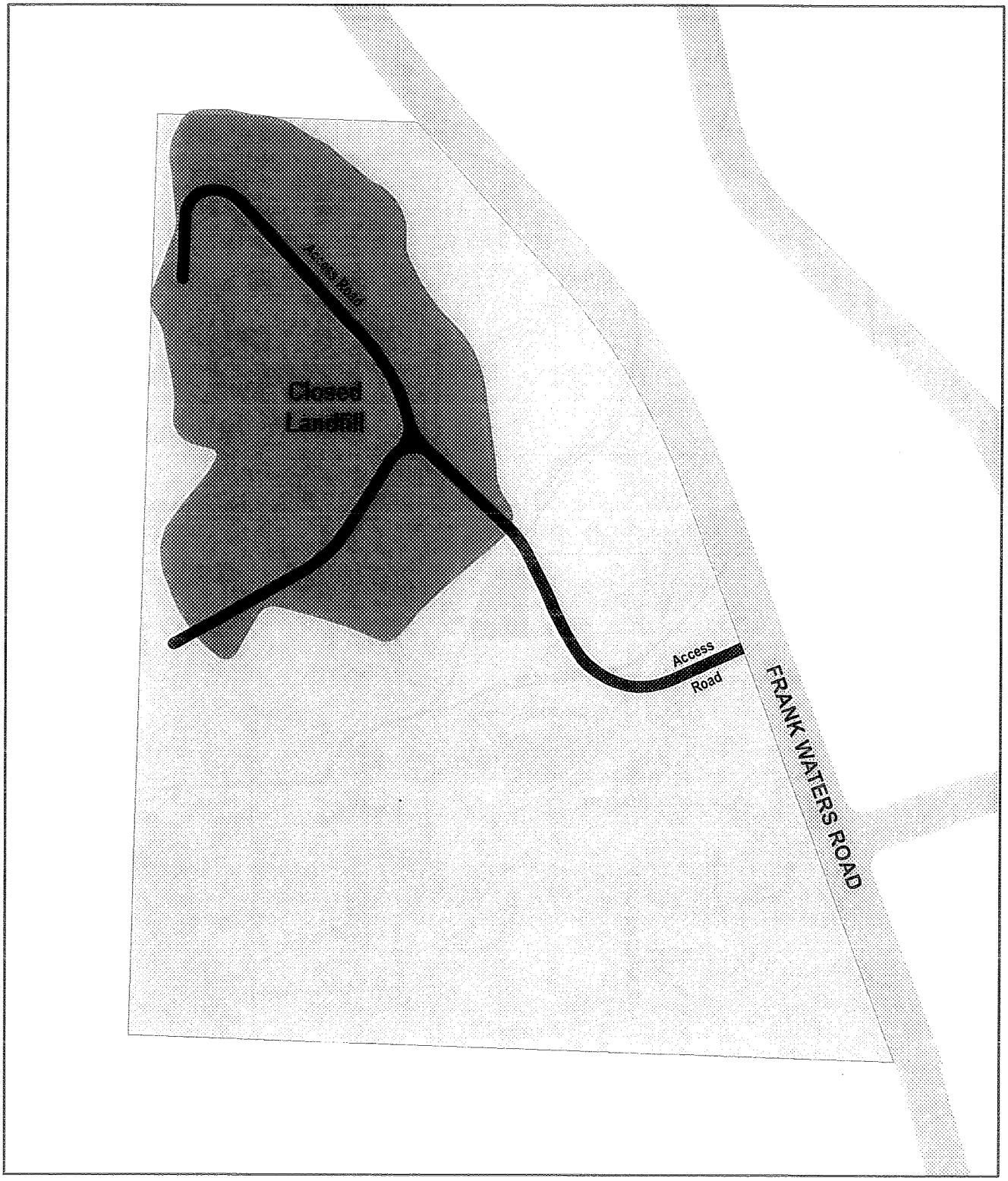
N W E S



Snohomish County
Public Works
Solid Waste Division
March 22, 2010

Figure 2

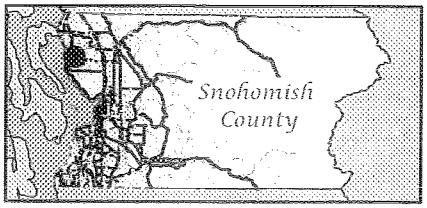
Lake Goodwin Landfill Site Map



0 0.015 0.03 0.06 Miles

0 70 140 280 420 Feet

N
W E
S



Snohomish County
Public Works
Solid Waste Division
March 25, 2010

Figure 3

Lake Goodwin Landfill

Topography

Map Features

- Parcel Boundary
- Subject Property Boundary
- 5 Foot Contours

N

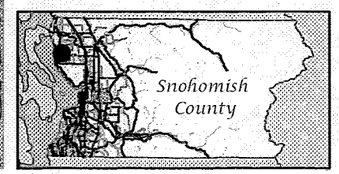
W E

S

1 inch = 200 feet

0 0.0125 0.025 0.05 0.075 0.1 0.125 Miles

0 85 170 340 510 680 Feet



Snohomish County
Public Works
Solid Waste Division
March 23, 2010

Figure 4

Lake Goodwin Landfill

Geologic Map

Map Features

- Parcel Boundary
- Subject Property Boundary

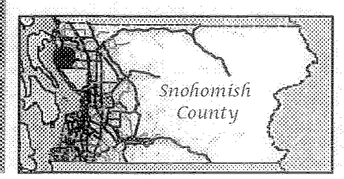
Geologic Description

- Vashon advance outwash (Qva)
- Vashon recessional outwash
- Vashon till (Qvt)
- Water
- Modified Land

1 inch = 600 feet

0 0.035 0.07 0.14 0.21 0.28 0.35 Miles

0 240 480 960 1,440 1,920 Feet



N W E S

Snohomish County
Public Works
Solid Waste Division
May 6, 2010

Figure 5

Lake Goodwin Landfill

Groundwater Monitoring Network

Map Features

- Parcel Boundary
- Subject Property Boundary

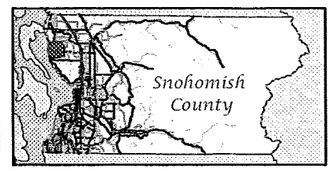
Aquifer Unit (Active Wells)

- Deep Aquifer

1 inch = 200 feet

0 0.0125 0.025 0.05 0.075 0.1 0.125 Miles

0 80 160 320 480 640 Feet



N W E S

Snohomish County
Public Works
Solid Waste Division
April 15, 2010

Figure 6

Lake Goodwin Landfill

Water Elevation Contours 4th Quarter 2012

DIRECTION OF GROUNDWATER FLOW
1.58 ft/day
576 ft/year
74.08 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

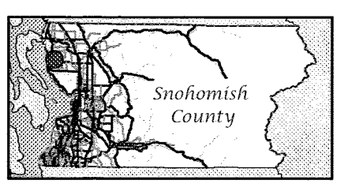
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
LG-01	10/9/2012	154.26
LG-02	10/9/2012	155.75
LG-03	10/9/2012	153.62
LG-04	10/9/2012	152.65
LG-05	10/9/2012	153.25

0 0.015 0.03 0.06 0.09 0.12 Miles

0 80 160 320 480 640 Feet



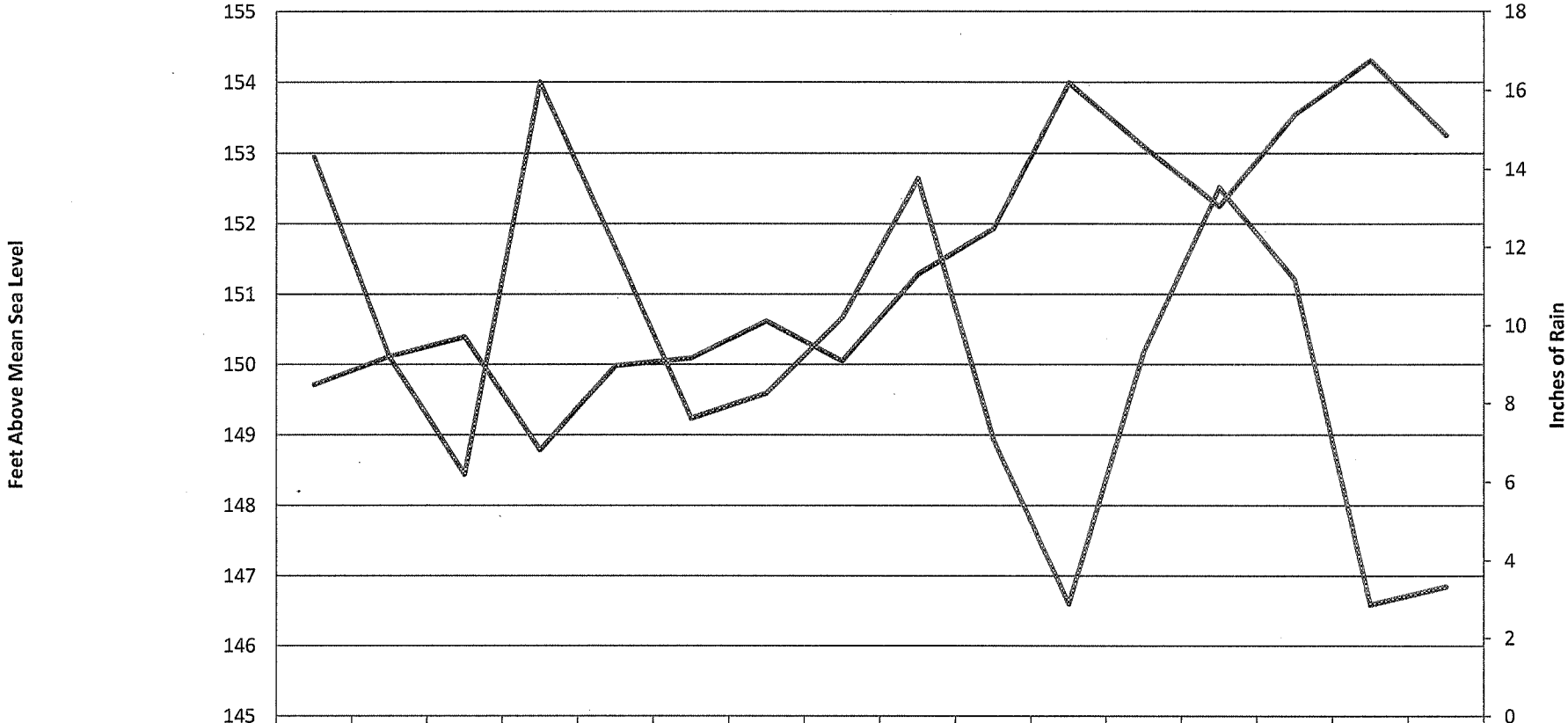
N W E S

Snohomish County
Public Works
Solid Waste Division
November 16, 2012

Appendix A

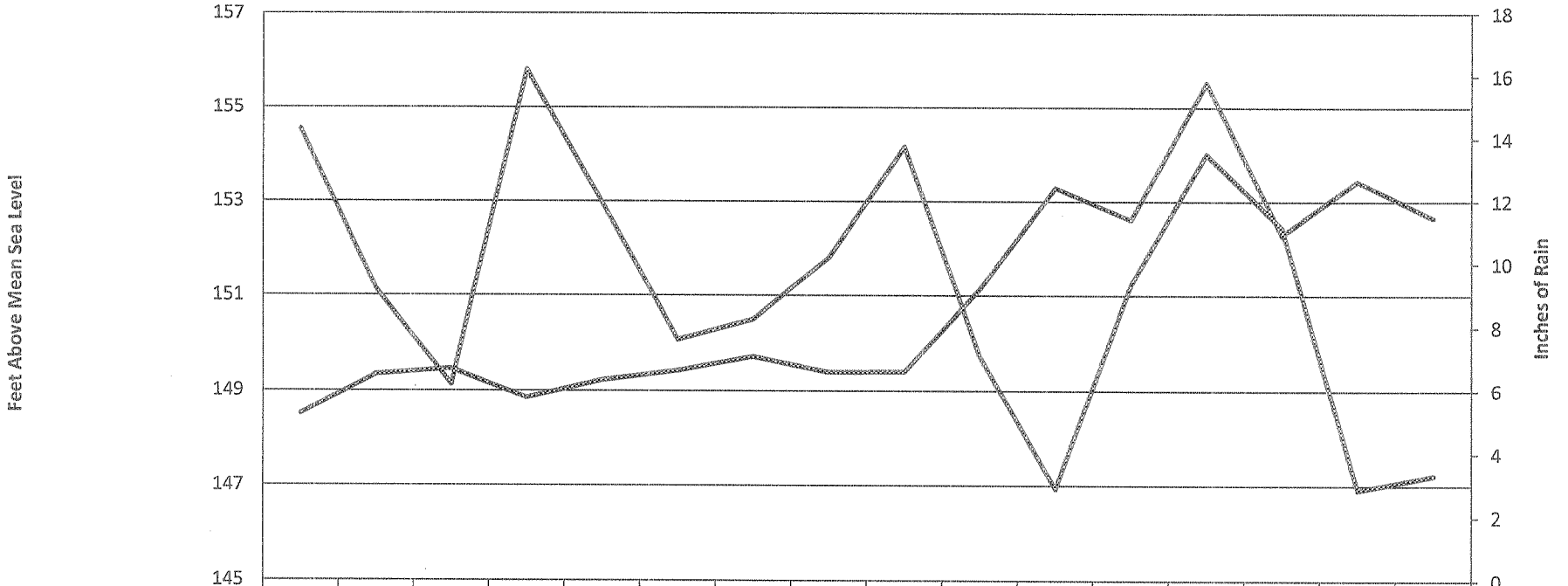
Hydrographs

Lake Goodwin Well LG-05



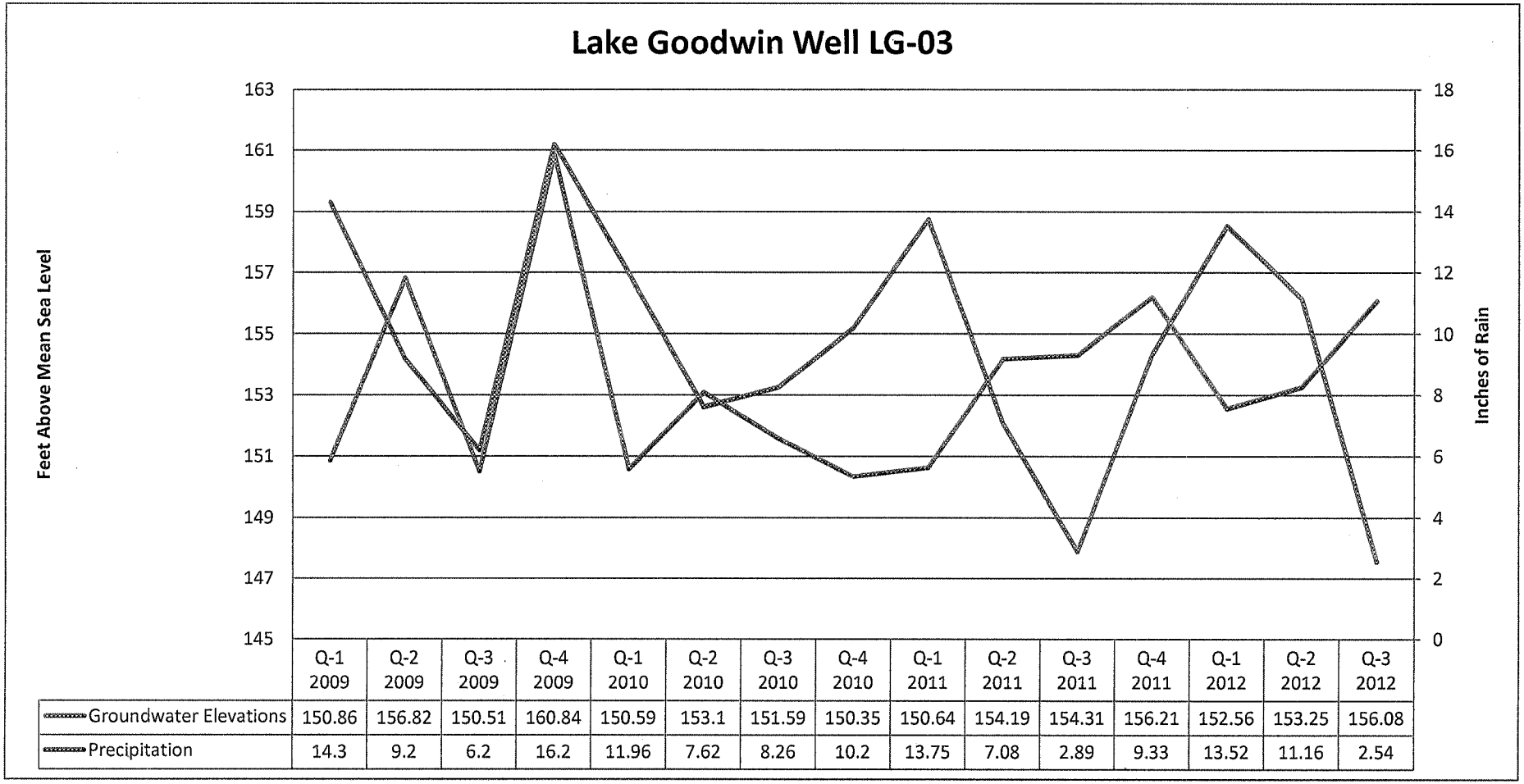
	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4-2011	Q-1 2012	Q-2 2012	Q-3 2012	Q-4 2012
Groundwater Elevation	149.71	150.11	150.39	148.79	149.98	150.09	150.62	150.05	151.28	151.93	153.99	153.09	152.25	153.54	154.3	153.25
Precipitation	14.3	9.2	6.2	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

Lake Goodwin Well LG-04

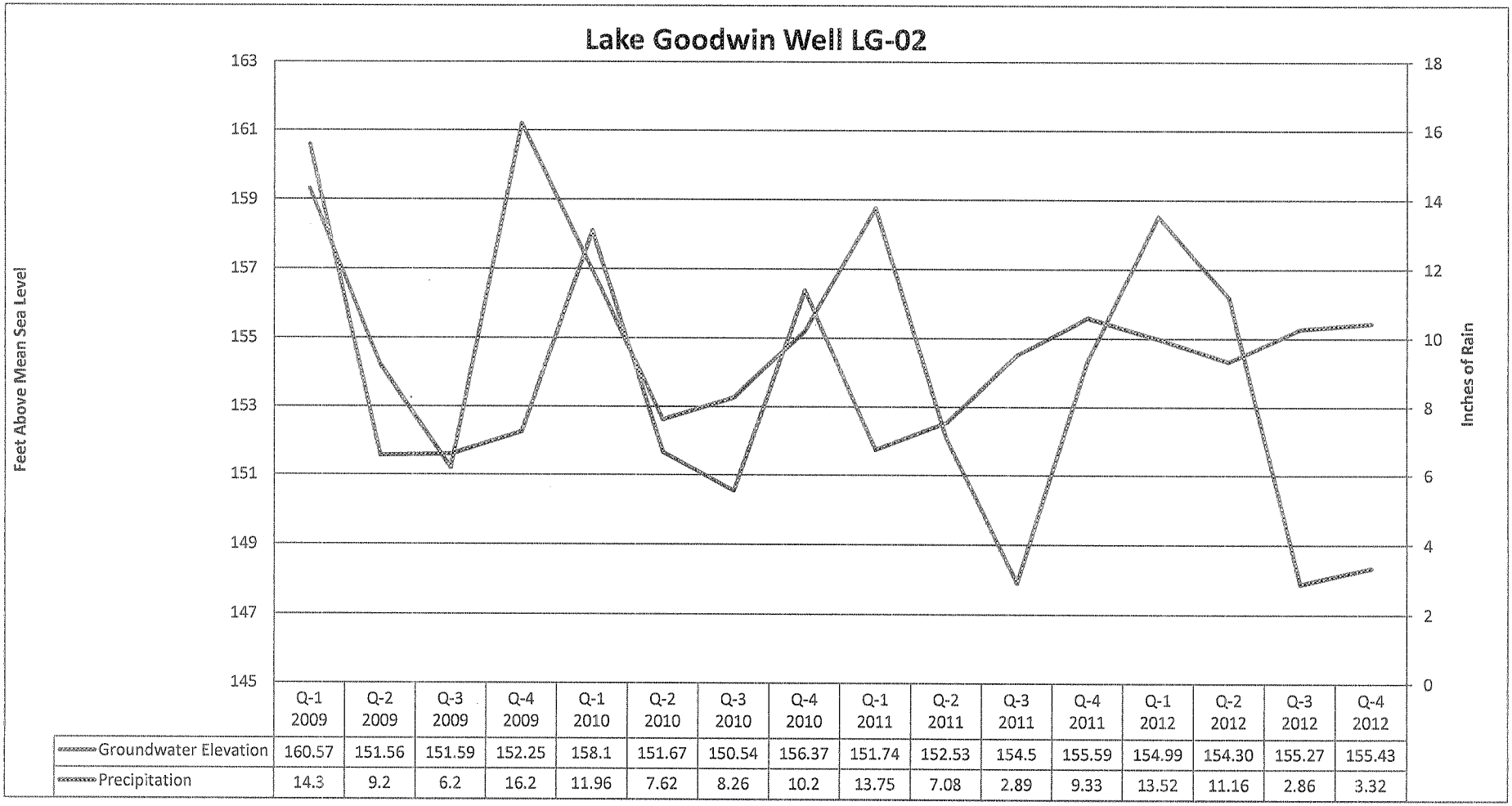


	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4 2011	Q-1 2012	Q-2 2012	Q-3 2012	Q-4 2012
Groundwater Elevation	148.5	149.34	149.46	148.84	149.22	149.42	149.72	149.39	149.4	151.14	153.29	152.61	155.52	152.28	153.43	152.65
Precipitation	14.3	9.2	6.2	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

Lake Goodwin Well LG-03

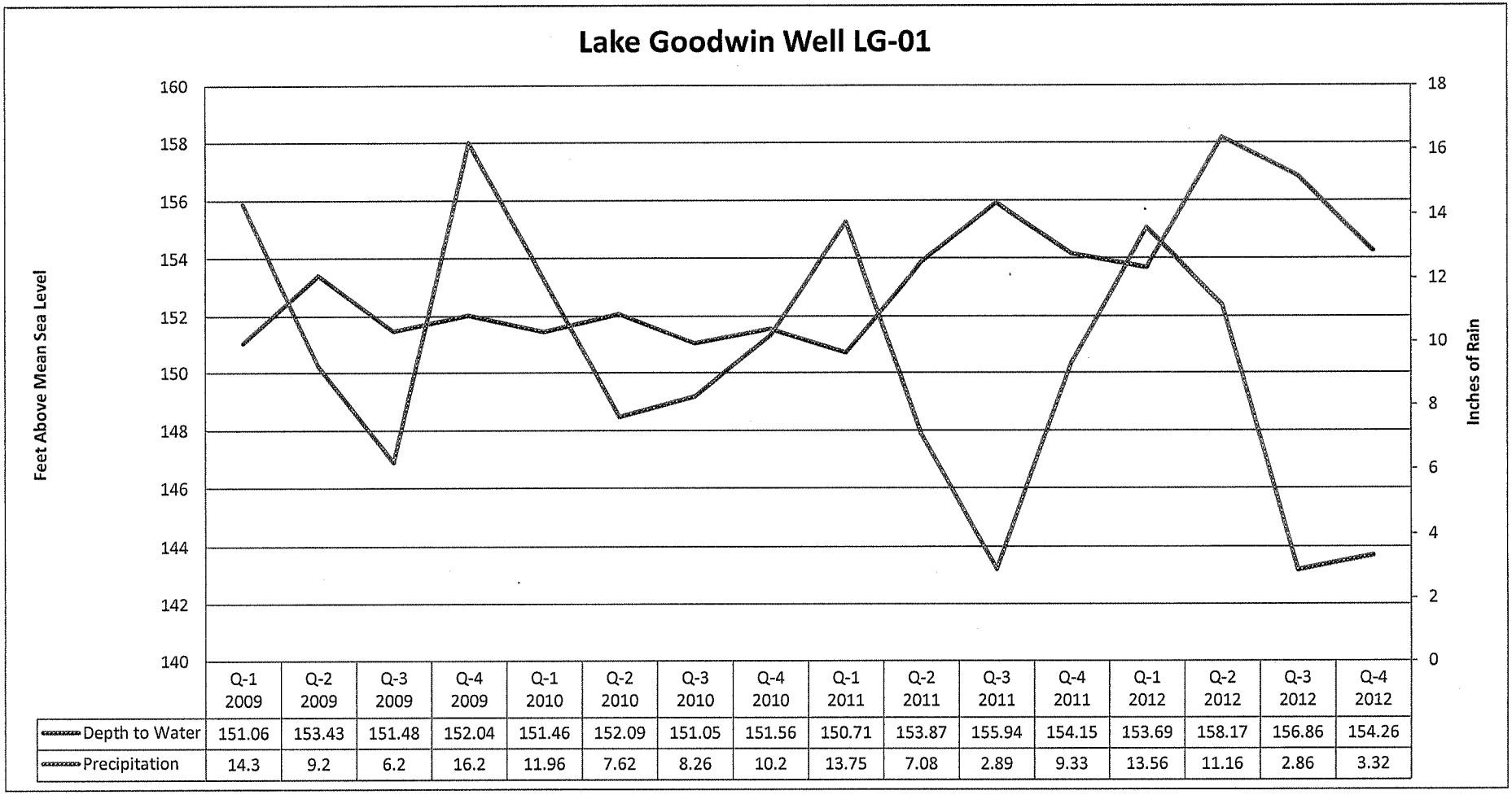


	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4 2011	Q-1 2012	Q-2 2012	Q-3 2012
Groundwater Elevations	150.86	156.82	150.51	160.84	150.59	153.1	151.59	150.35	150.64	154.19	154.31	156.21	152.56	153.25	156.08
Precipitation	14.3	9.2	6.2	16.2	11.96	7.62	8.26	10.2	13.75	7.08	2.89	9.33	13.52	11.16	2.54



	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
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
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

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
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
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

In-Situ Inc. Groundwater Velocity Program (V2.21)

Lake Goodwin Monitoring Wells Fourth Quarter 2012

Output file is : h:\ess\modeling\watervel\LGDQ412.txt
Input file is : h:\ess\modeling\watervel\LGQ4.txt

Isotropic hydraulic cond. = 83.30 ft/d
Effective porosity = 20.00 %

Least squares match to groundwater table:

N	X(ft)	Y(ft)	Meas. head (ft)	Calc. head (ft)
1	646.57	299.26	154.26	154.01
2	21.47	2.50	155.75	155.74
3	9.27	550.56	153.62	153.76
4	458.30	579.89	152.65	153.18
5	205.32	748.45	153.25	152.83

Calc. Head (ft) = -1.039E-03*X - 3.643E-03*Y + 1.558E+02

Natural groundwater flow = 1.58E+00 ft/day (5.76E+02 ft/yr)
at 74.08 deg to the positive X-axis

WATER-VEL COMPLETED.

Appendix B

Analytical Data

Groundwater Statistical Summary: Fourth Quarter 2012 Lake Goodwin Landfill, Snohomish County, WA

	Statistical Method	No. of Samples	No. of Detects	Prediction Limit (a)	MCL	Downgradient LG-01 10/9/12 D V T C	Downgradient LG-04 10/9/12 D V T C	Downgradient LG-05 10/9/12 D V T C	Upgradient LG-02 10/9/12 D V T C
CONVENTIONAL CHEMISTRY PARAMETERS									
(mg/L unless noted)									
Alkalinity (as CaCO3)	normal	33	33	**141.1815**	--	**160** V	130	**390** V I N	120 I N
Ammonia Nitrogen	nonpar	29	8	**0.056**	--	0.005 U	0.005 U	**0.07** E	0.005 U
Bicarbonate	normal	33	33	**130.7366**	--	**160** V	130 V	**390** V	120
Calcium, Dissolved	normal	33	33	**20.8776**	--	20.4 I N	**21.7**	**49.4** V	**21.3**
Chemical Oxygen Demand	nonpar	25	2	**26**	--	10 U	10 U	10 U	10 U
Chloride	nonpar	33	33	**9.4**	250	6.5 I N	7.8	**24** V	7.3
Conductivity (umhos/cm)	normal	33	33	**325.3534**	700	**380** V	**340** E Y	1100 V	310
Magnesium, Dissolved	normal	33	33	**19.5453**	--	**27.5** V I N	**21.2** V	**63.8** V	17.8
Nitrate Nitrogen (mg-N/L)	nonpar	32	32	**2.6**	10	**2.9** D Y	1.2	26	1.8
Nitrite Nitrogen (mg-N/L)	nonpar	29	7	**0.003**	1	0.002 U	0.002 U	0.002 U E D N	0.002 U
pH (std units)	nonpar	33	33	**6.7-7.75**	6.5-8.5	6.44 P D N	5.94 V D N	6.14 P D N	**6.68** D N
Potassium, Dissolved	normal	33	33	**3.443**	--	**3.84** V	**3.57** E	**7.71** V	3.18
Sodium, Dissolved	nonpar	32	32	**13.8**	20	8.78 D Y	9.07 D N	40.6 V D N	8.57
Sulfate	nonpar	33	33	**16.2676**	250	**18** E	16 D N	**42** V D N	16
Total Dissolved Solids	nonpar	33	33	**550**	500	230	200	650 E	190
Total Organic Carbon	nonpar	33	14	**13**	--	0.5 U	0.5 U	3.4	0.5 U
DISSOLVED METALS									
EPA Methods 6010B/7131A (mg/L)									
Arsenic	nonpar	28	28	**0.078**	0.00005	0.000527	0.000379	0.00103	0.00309
Barium	normal	28	28	**0.0138**	2	**0.0195** V I Y	**0.0227** V D N	**0.0825** V	**0.0164** I N
Cadmium	nonpar	29	12	**0.0002**	0.005	0.003900 E	0.0034 E	0.0063 E	0.0028
Chromium	normal	30	22	**0.0102**	0.1	0.0011	0.0015	0.001 U	0.0047
Cobalt	nonpar	33	6	**0.008**	--	0.001	0.002	0.002	0.002
Copper	nonpar	29	10	**0.004**	1.3	0.002	0.001 U	**0.005**	0.002
Iron	nonpar	33	5	**0.031**	0.3	0.005 U	0.005 U	0.005 U	0.005 U
Manganese	nonpar	30	10	**0.0061**	0.05	0.0058 P	0.0045	**0.0112** V	0.0042
Nickel	nonpar	33	33	**0.005**	0.1	0.005 U	0.005 U	0.005 U	0.005 U

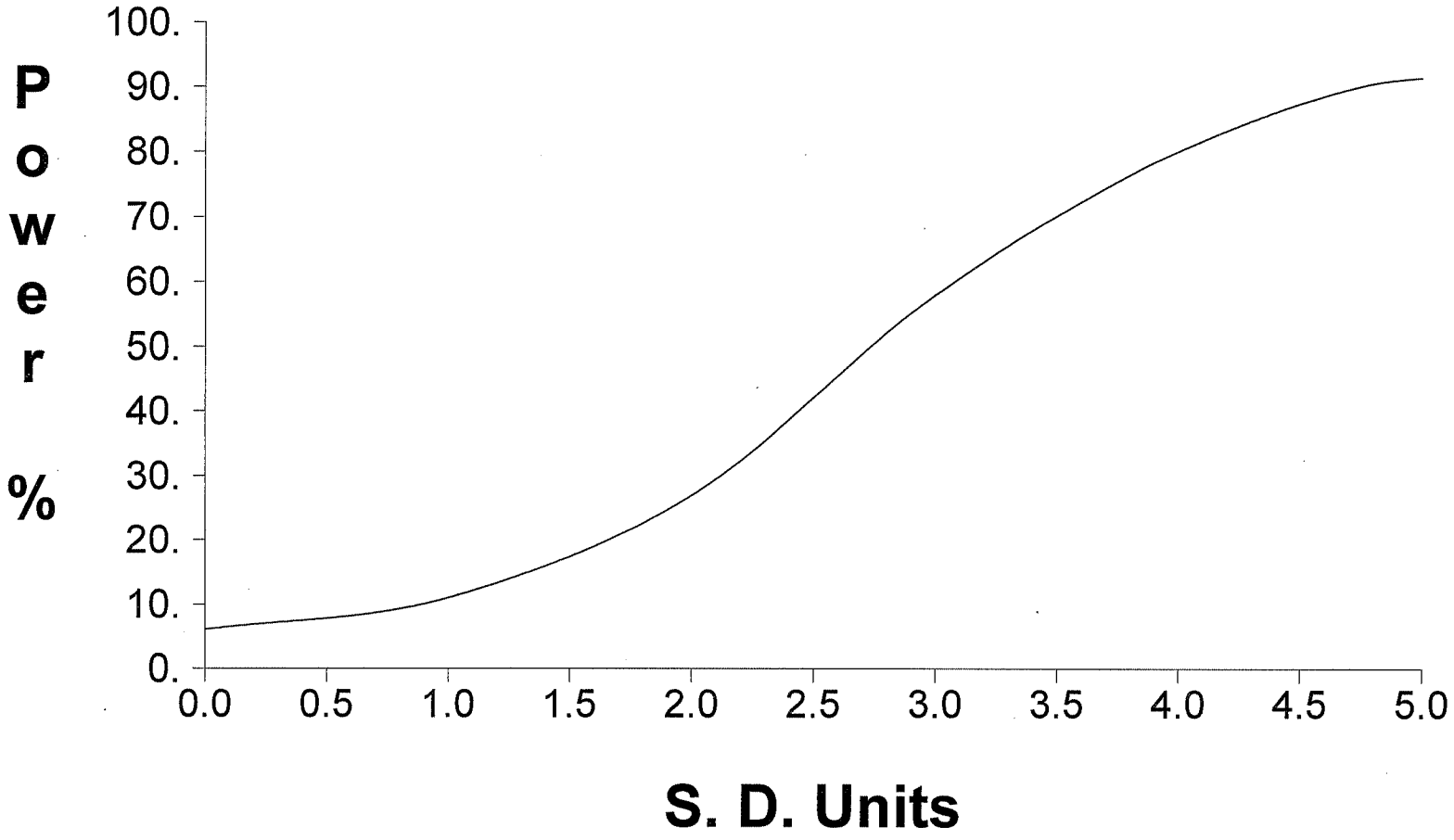
D Column: U = Compound not detected in any sample; V Column: V = verified hit, E = exceedance, waiting verification; P = Passed, exceedance not verified

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.

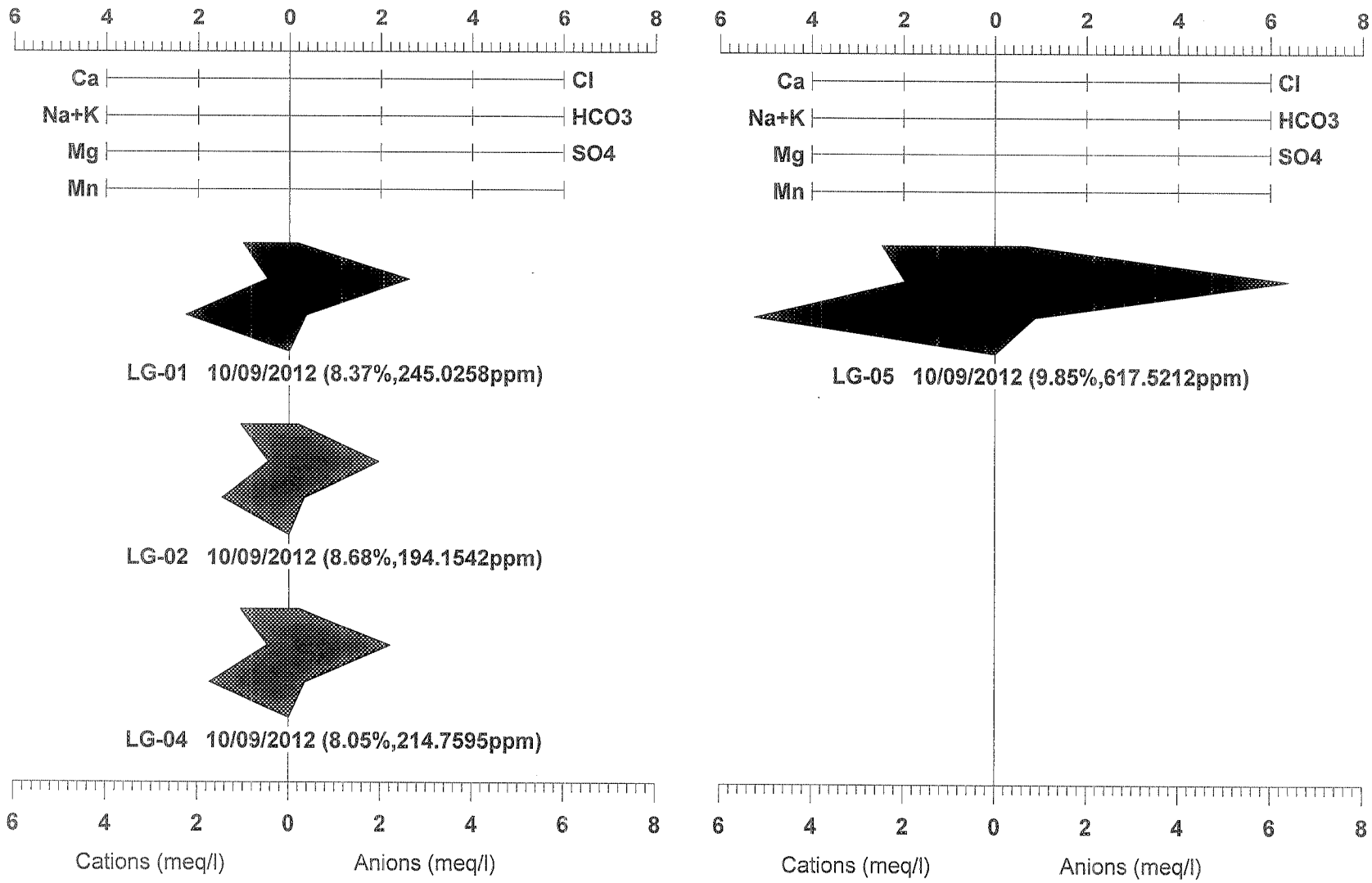
Appendix C

Stiff, Tri-linear and Trend Analysis

False Positive and False Negative Rates for Current Upgradient vs. Downgradient Monitoring Program

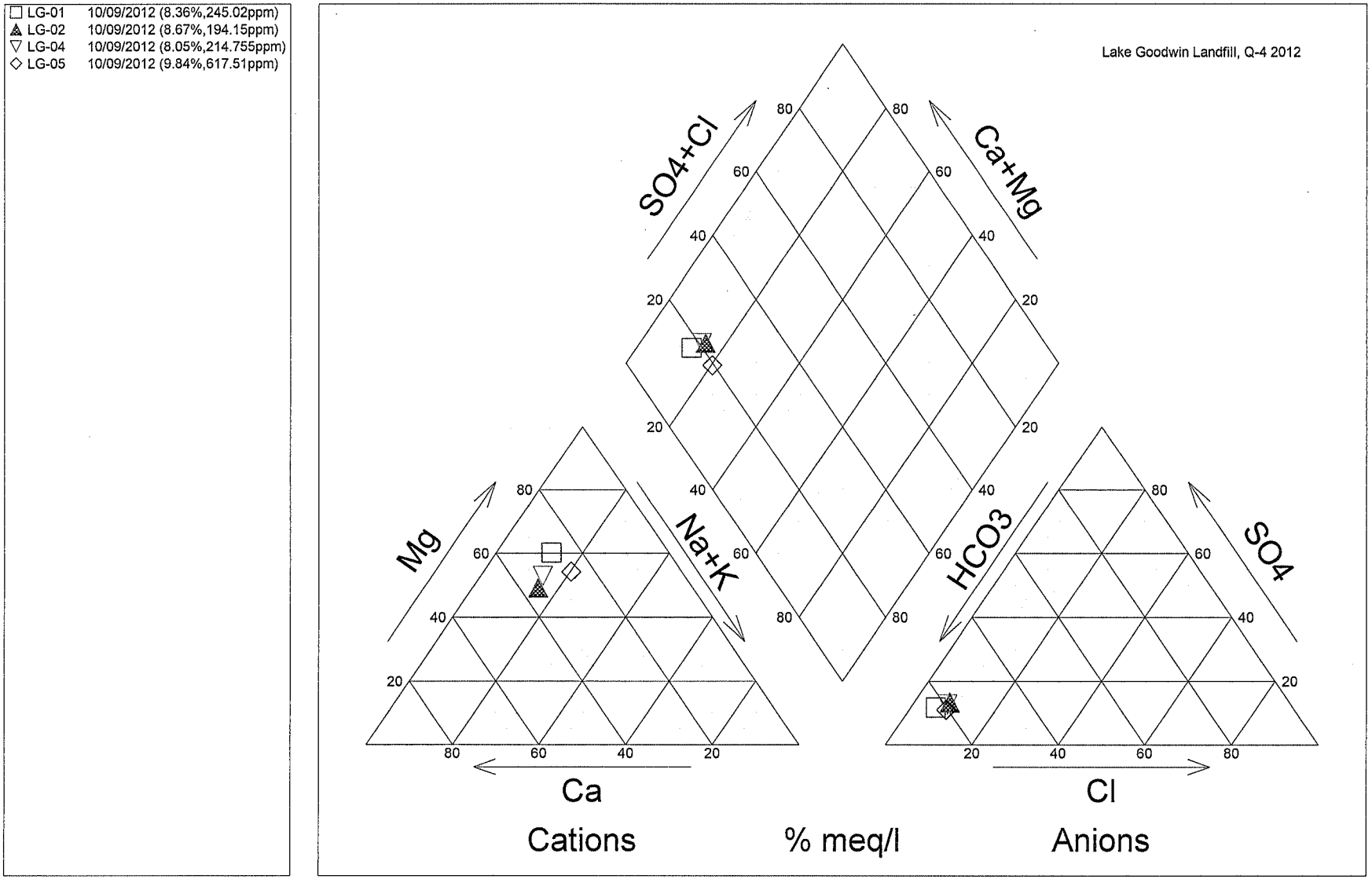


Goodwin Landfill



Prepared by: Snohomish County Solid Waste

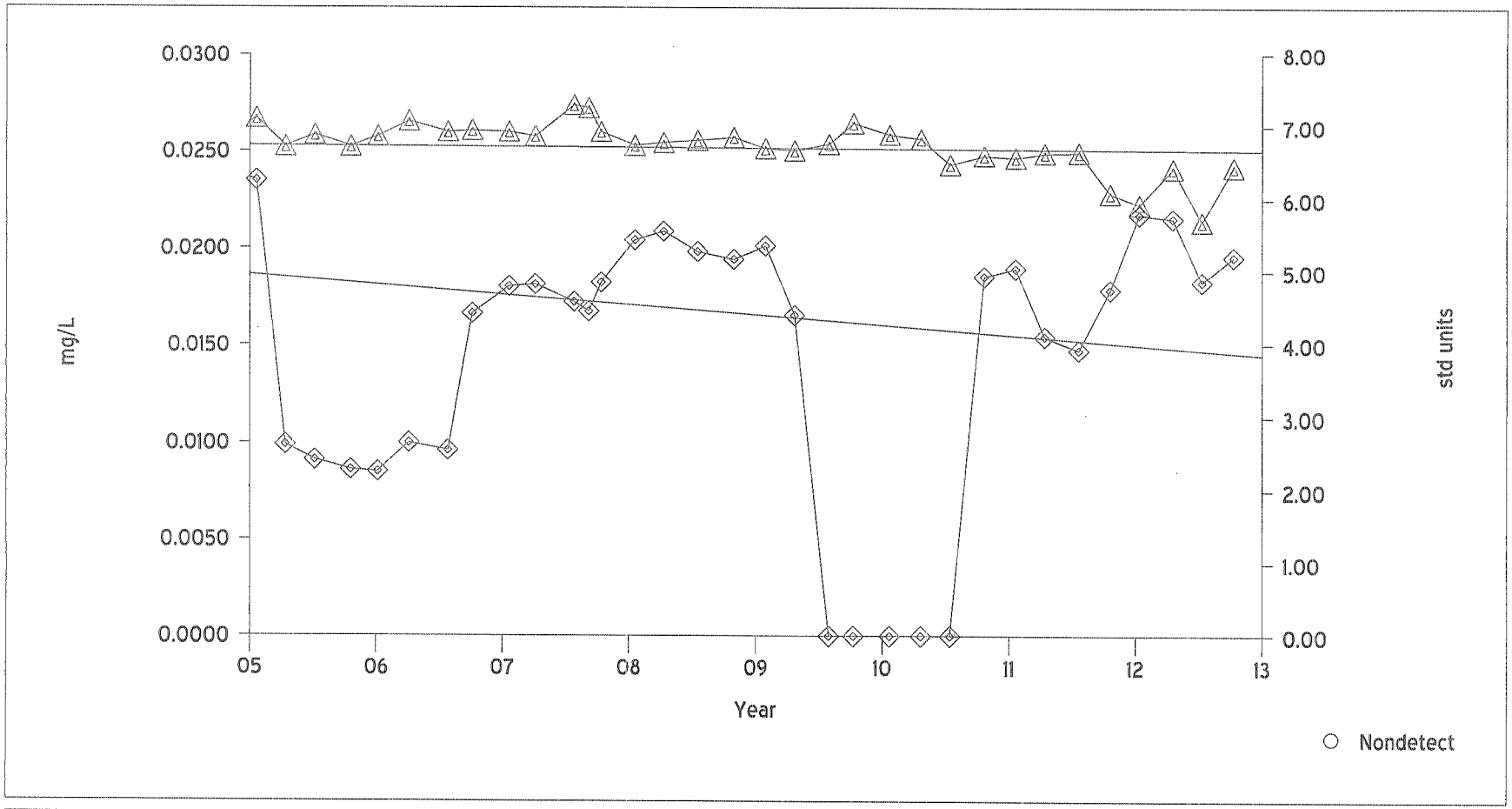
Goodwin Landfill



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-01



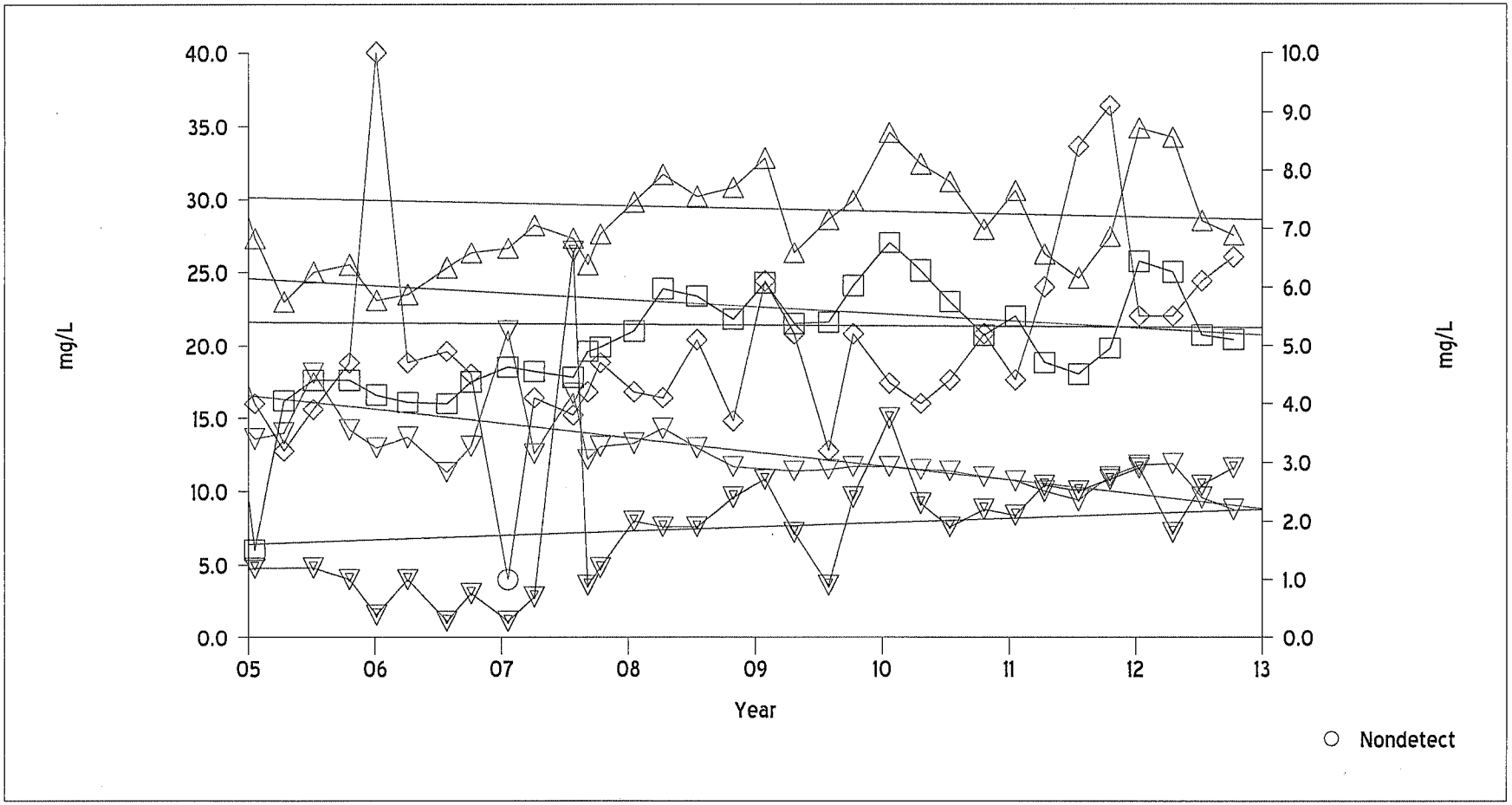
◇ Dissolved barium (cc: -.287)

△ pH (cc: -.237)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-01



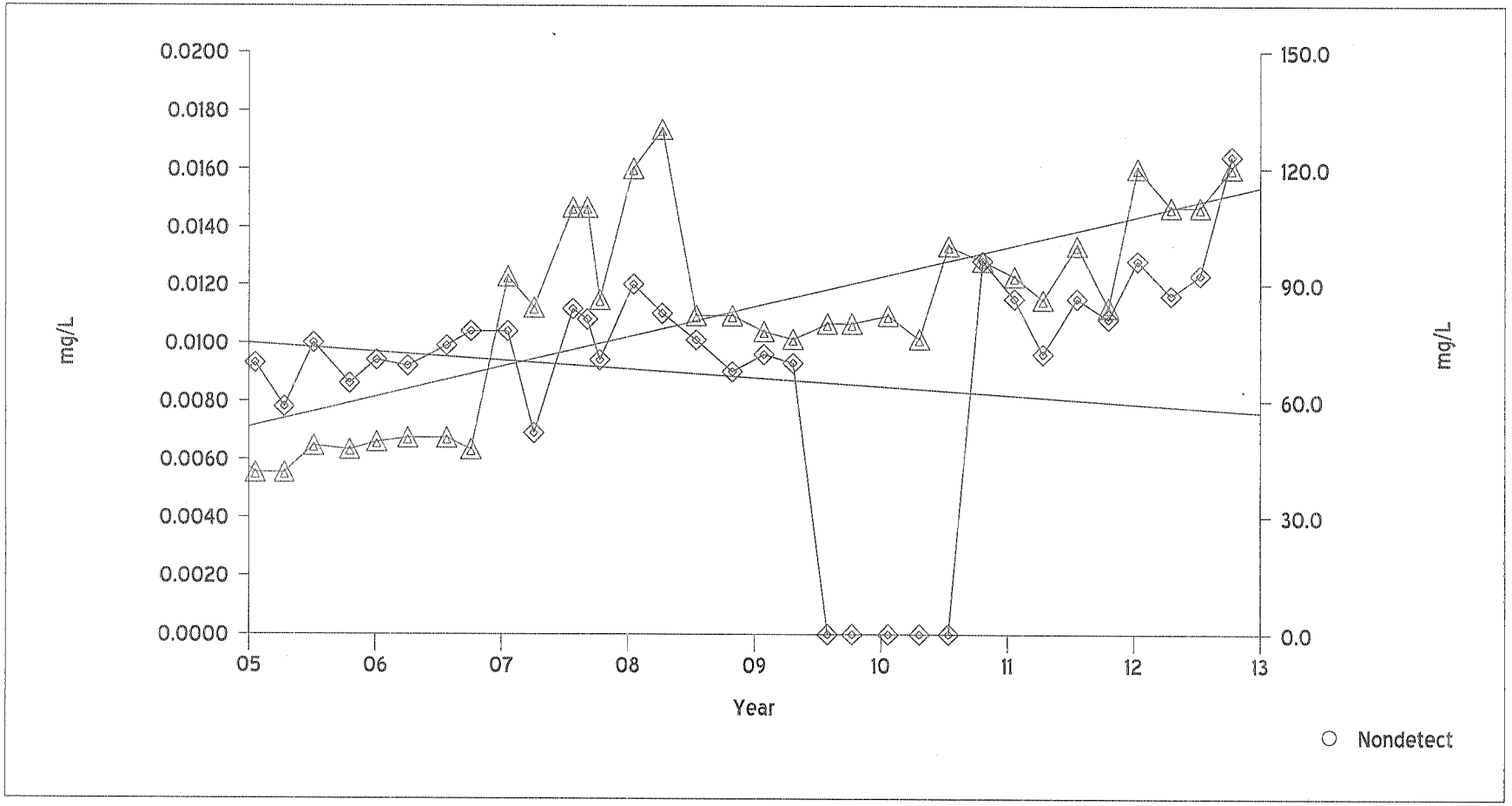
□ Dissolved calcium (cc: -.031)
△ Dissolved magnesium (cc: -.128)
▽ Dissolved sodium (cc: -.807)

◇ Chloride (cc: -.201)
▽ Nitrate nitrogen (cc: .501)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-02



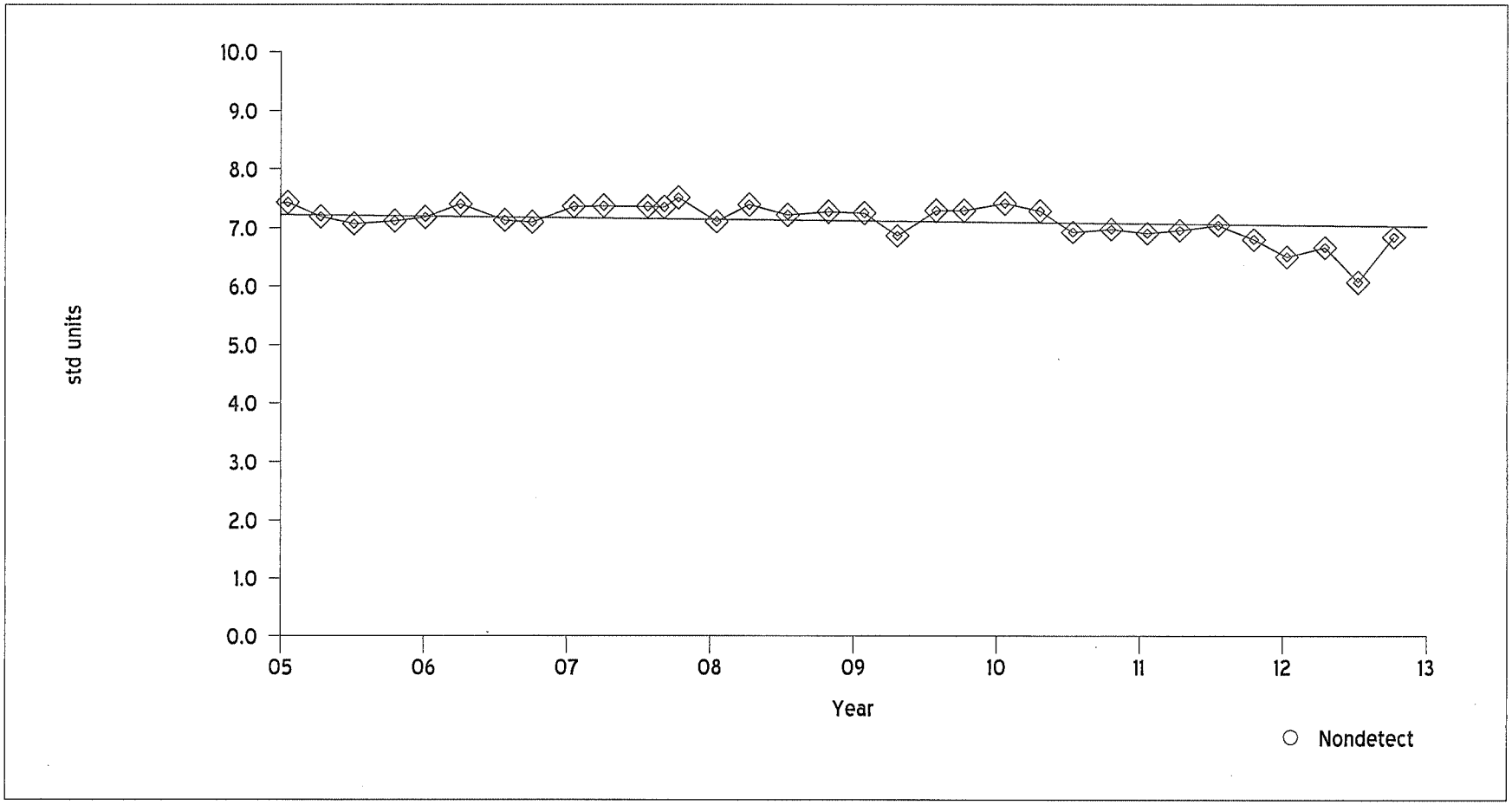
◈ Dissolved barium (cc: -.379)

◬ Alkalinity (as caco3) (cc: .789)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

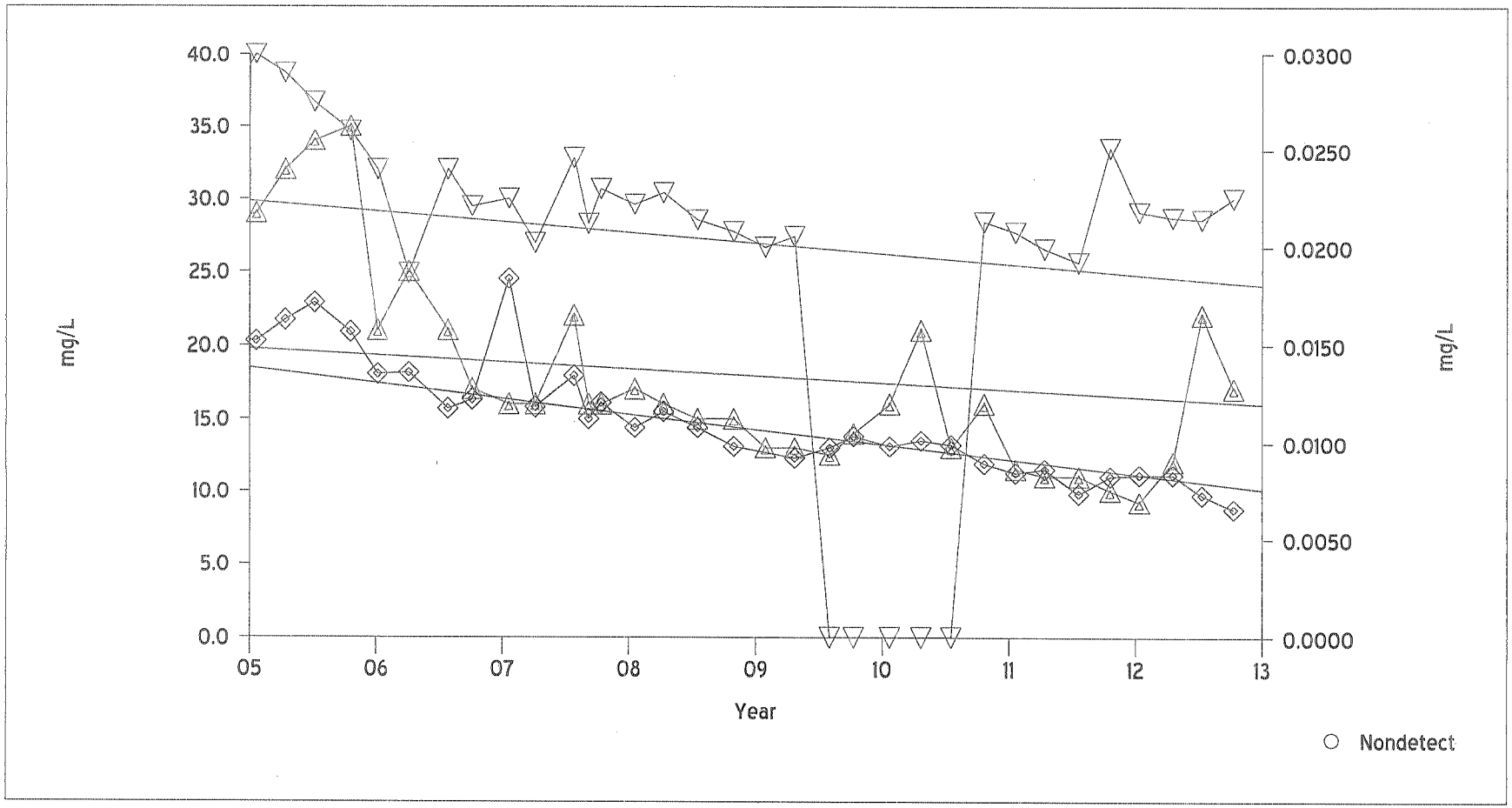
Time Series Plot for LG-02



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



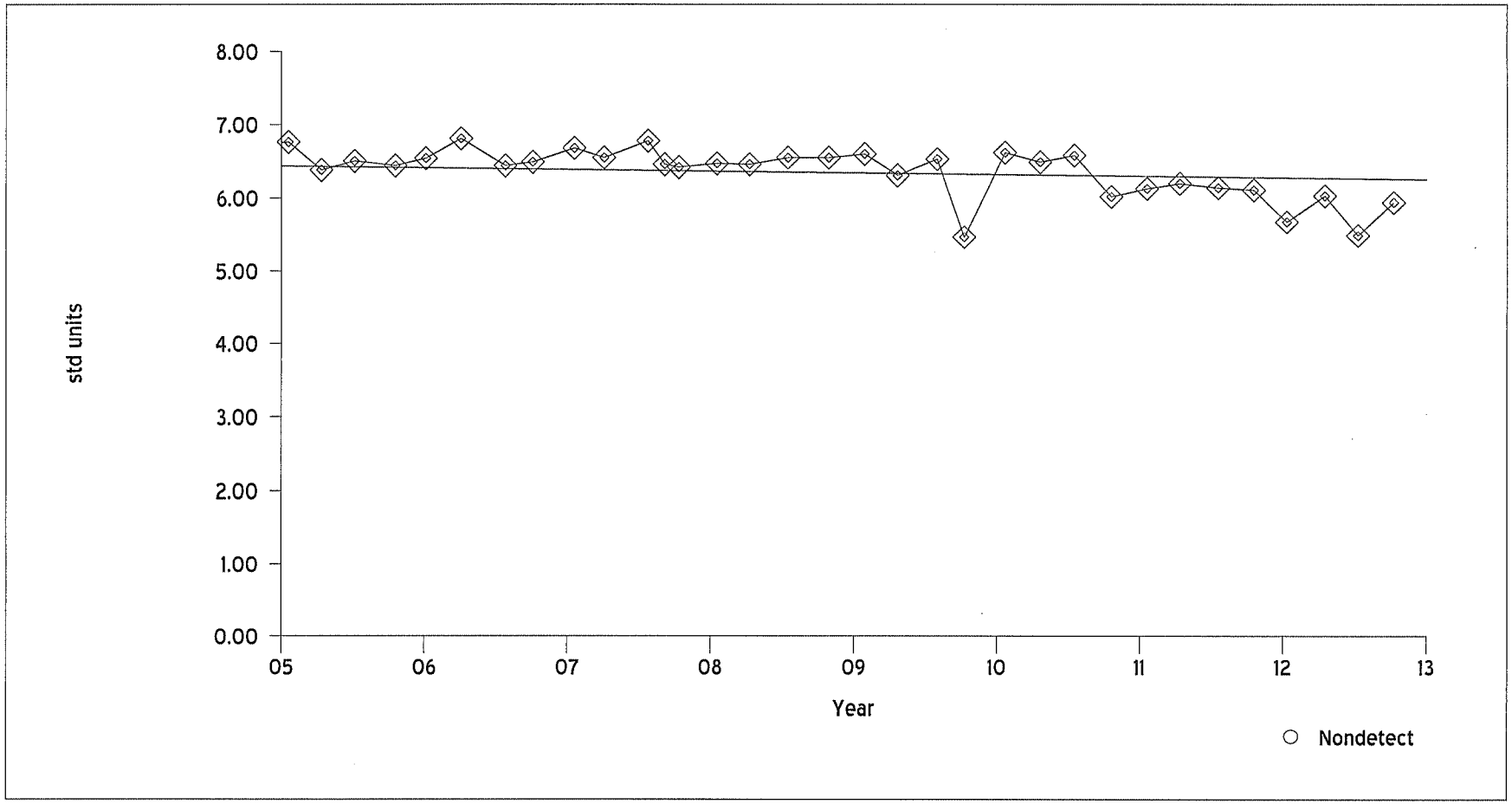
◈ Dissolved sodium (cc: -.764)
◬ Sulfate (cc: -.279)

▽ Dissolved barium (cc: -.392)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

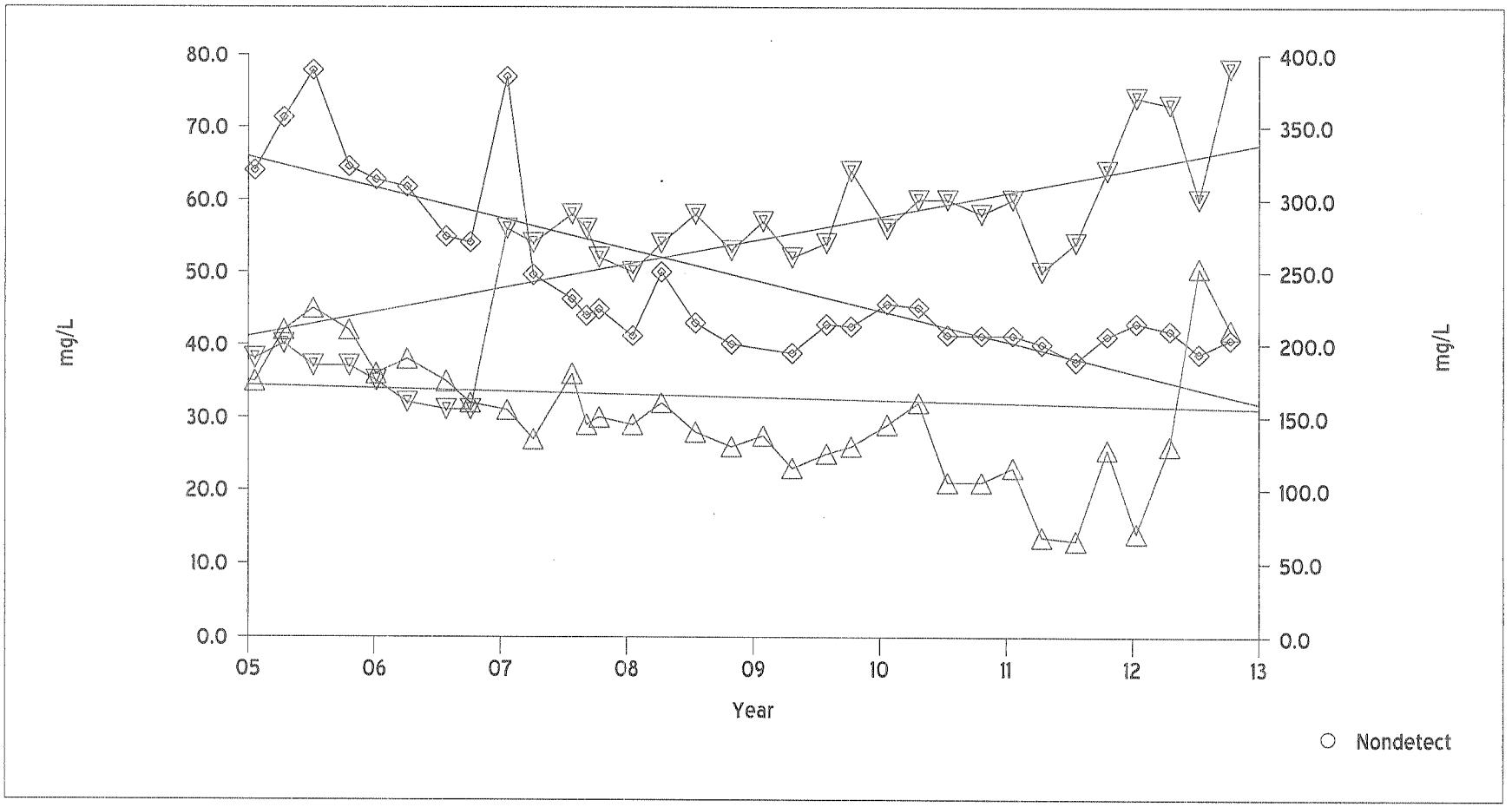
Time Series Plot for LG-04



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



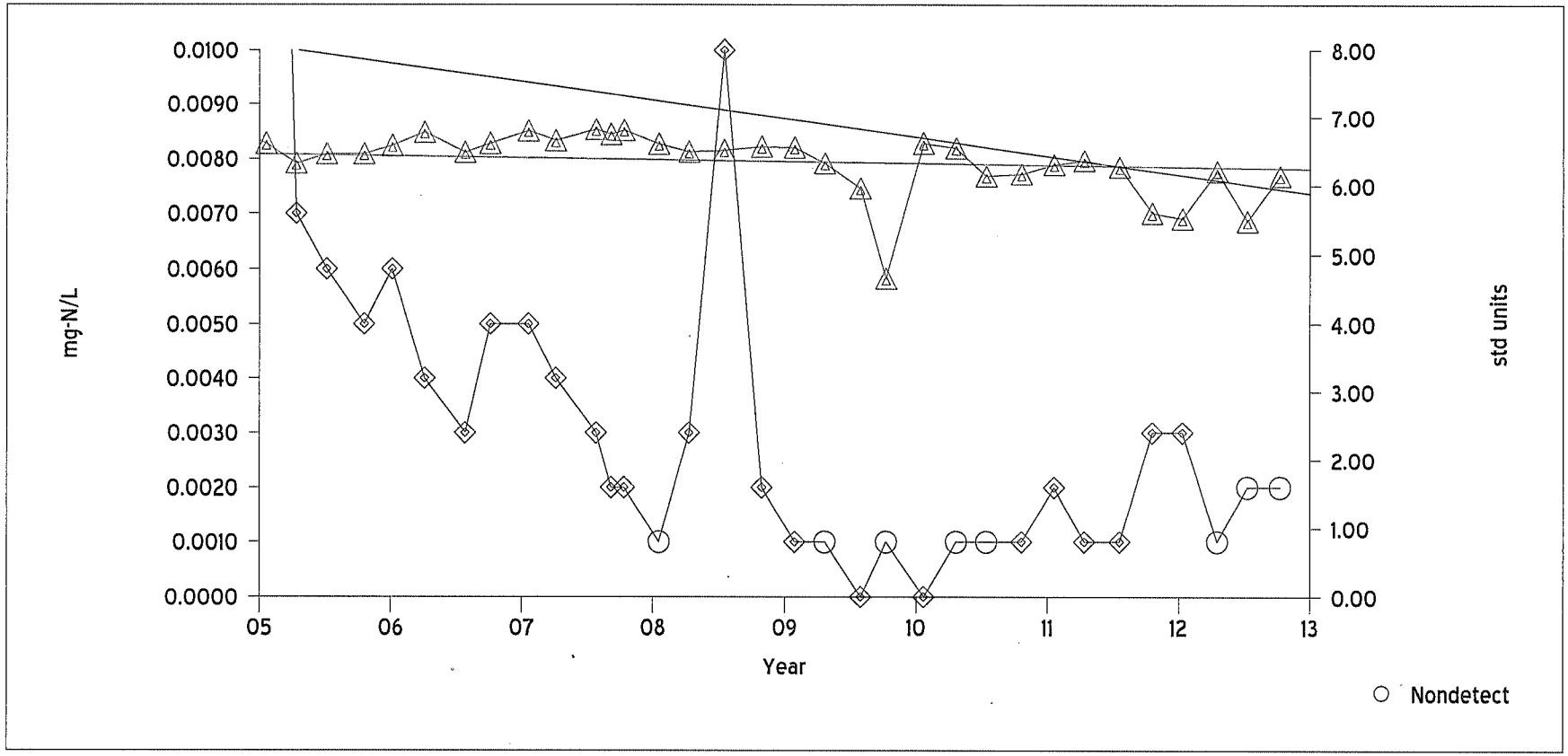
◈ Dissolved sodium (cc: -.875)
△ Sulfate (cc: -.238)

▽ Alkalinity (as caco3) (cc: .799)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



◈ Nitrite nitrogen (cc: -.203)

△ pH (cc: -.480)

Offscale Points

◈ Nitrite nitrogen on 1/17/2005 was 0.026 mg-N/L

Prepared by: Snohomish County Solid Waste