SIT 3.10

Lake Goodwin Landfill 2012 Annual Environmental Monitoring Report

Photo taken 8/1/08 J. Greninger

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1.0 INTRODUCTION

The following report summarizes the annual 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*).

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 (*DOE*)**.

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 a current approved **Sampling & Analysis Plan** (*SAP*) for this landfill. The SAP, as approved by the Snohomish Health District, eliminated one well from sampling, removed VOA analysis from the standard sampling suite, and pared down the metals to ones recently detected in the last 10 years.

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 Stillaquamish 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 1.5 miles of the Landfill. There are no named drainages, creeks or rivers located in the immediate vicinity of the site. The Stillaquamish River is located approximately 3 miles north 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 GEOLOGY

Surficial geology of the site area has been mapped by the **USGS** and is shown on the "Geologic Map of the Stanwood Quadrangle, Snohomish County, Wa." By J.P. Minard dated 1985. Surficial soil types mapped in the vicinity of the project site are typical for glaciated landscapes throughout Snohomish County. As shown on the **Geologic Map** (*figure 4*), Vashon Glacial Till (*Qvt*) and Vashon Advance Outwash (*Qva*) are the predominately mapped surficial soil units in the immediate vicinity of the project site.

Glacial Till (*Qvt*) consists of a nonsorted mixture of silt, sand and gravel deposited as a lodgment till below the Vashon aged glaciers as they advanced through this area. The deposits are generally very compact and where undisturbed will have a consistency similar to concrete. In this area Glacial Till (*Qvt*) is fairly sandy, with significant amounts of gravels and cobbles. Glacial Till (*Qvt*) is generally considered to be an aquiclude, not readily transmitting ground water through it. Locally, ground water may travel through and along discontinuous lenses of sand and gravel or through sandier portions of the Glacial Till (*Qvt*) within the upper couple of feet of the section. However, these discontinuous lenses of sand and gravel are difficult to characterize or quantify and are not considered to be reliable sources of ground water.

Advance Outwash (*Qva*) consists primarily of fine- to coarse-grained layers of sand and gravel deposited as the Vashon aged glaciers advanced into this area. At depth, these deposits can contain significant amounts of silt and/or clay. There is a gradational contact with the underlying Transitional Beds (*Qtb*) found below this geologic unit, with the silt/clay beds becoming thicker and more predominant with depth. The Advance Outwash (*Qva*) sands and gravels are generally very compact, having been overridden by thousands of feet of glacial ice. Advance Outwash (*Qva*) sands and gravels contain significant amounts of ground water and because of their relative shallow stratigraphic depth throughout the County, are the predominant source for ground water.

Glacial Till (*Qvt*) was encountered within on upgradient well at the site (*LG-02*). The Glacial Till (*Qvt*) was overlying basal Advance Outwash (*Qva*) sands and gravels. All other explorations at the site (*LG-01, LG-03, LG-04 and LG-05*) encountered only and were completed within Advance Outwash (*Qva*) sands and gravels. Several test borings were terminated in the gradational zoned at the base of the Advance Outwash (*Qva*) unit

1.5 LOCAL HYDROGEOLOGY

Hydrogeologic conditions in the vicinity of the landfill have been studied by many including **EPA**, **USGS** and the **Army Corp of Engineers**. In the early to late 1980's, the **Seven Lakes Water Association** petitioned the **EPA** for consideration of a sole source aquifer area that included the landfill site. This petition was made in order to protect their rapidly degrading ground water resource which was the only source of ground water for the residences of the area at that time. The **EPA** consulted with the **USGS**, who, upon closer investigation, recommended that the boundaries of the proposed sole source aquifer be expanded to include a much larger area, which was named the **Tulalip Sole Source Aquifer**. The **USGS** expanded the boundaries of the Seven Lakes proposed sole source aquifer in order to protect the recharge source for a deep aquifer, found below the Tulalip Plateau and a larger area of Snohomish County. Recharge areas for this deep aquifer were determined to be located along the west margins of the Cascade Mountains. This deep aquifer is within pre-Glacial Undifferentiated Sands and Gravels (*Qu*) that are found stratigraphically lower than the Advance Outwash (*Qva*) aquifer. A thick sequence of Transitional Bed (*Qtb*) silts and clays act as an aquitard between the Advance Outwash (*Qva*) and Undifferentiated (*Qu*) aquifers. The petition for the **Tulalip Sole Source Aquifer** was eventually denied because other sources of water were available for domestic and commercial use over a large portion of the area.

Hydrogeologic conditions at the landfill were investigated by **Converse Consultants NW**. The results of their investigations were reported in their study titled "Hydrogeologic Study, Lake Goodwin Landfill" date July 1991. Subsequent site explorations were completed by **Golder Associates** and were documented in their report titled "Snohomish County Lake Goodwin Landfill" dated December 1991.

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. At the observed elevations, ground water could be projected to discharge to the surface out of the exposed slopes above Puget Sound, north of Warm Beach or along the Stillaquamish River just south of Stanwood.

1.6 EXISTING MONITORING NETWORK

As outlined in the Solid Waste Facility Permit SW-085, quarterly monitoring of ground water, monthly monitoring of methane gas production and annual monitoring of landfill settlement has been carried out by Snohomish County personnel. Landfill gas was monitored at the landfill via 9 bar hole punches. The bar hole probes placed in the landfill were vandalized and are no longer usable.

There are currently four-(*4*) ground water monitoring wells (*LG-01 and LG-02, and LG-04 and LG-05*) at the Lake Goodwin Landfill site that are monitored on a quarterly basis. Ground Water Monitoring 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, LG-05*) and monitor ground water conditions that may be impacted from the site. Ground water monitoring results are discussed in *section 2.0* below.

There is no methane gas collection system at the landfill. During the fourth quarter of 2011 a monthly methane gas monitoring program was initiated at the Lake Goodwin Landfill. Monitoring of methane gas production at the landfill is accomplished by a walking gas probe survey. Nine-(*9*) bar hole punch probe locations are shown on the **Network Monitoring Map** (*figure 5*). This survey was performed on a monthly basis through March 2012 at which time vandals destroyed the bar hole probes. **Monitoring Results for Methane Gas** production is discussed in *section 3.0* below.

Lastly, an annual settlement monitoring program was initiated during the last quarter of 2011 at the Lake Goodwin Landfill. New topographic survey data was compared to previous recorded surveys to delineate changes to the landfill cap. The **Annual Settlement Monitoring Program** is discussed in detail in *section 4.0* of the report.

2.0 GROUND WATER MONITORING

Quarterly monitoring of the ground water wells at the Lake Goodwin Landfill was performed by **Snohomish County** personnel during 2012. 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.

Quarterly Ground Water Measurements are shown in *Table 1* below. **Hydrographs** of the monitoring well readings are contained in *Appendix A* of this report. Ground water elevations rose over the course of the year in all monitoring wells between one-(*1*) to six-(*6*) feet. Readings confirm that the aquifer is unconfined in the immediate vicinity of the site. **Quarterly Ground Water Contour Maps** developed from the field data are included in *Appendix B* of this report.

Measured quarterly precipitation at the Stanwood Weather Station (*WA-SN-11 http://www.cocorahs.org/state.aspx?state=wa*) during the year was 13.56 inches (*1st quarter*), 11.16 inches (*2nd quarter*), 2.86 inches (*3rd quarter*) and 3.82 inches for a total measured precipitation of 30.9 inches of rain. For reference purposes, precipitation measured at station WA-SN-11 during the monitoring period has been included on the quarterly Hydrographs (*Appendix A*).

Table 1 - Annual Groundwater Measurements and Elevations

Well Number	Casing Elevation	1st Quarter Reading	2nd Quarter Reading	3rd Quarter Reading	4th Quarter Reading	Annual Trend
LG-01	239.18	153.69	158.17	156.86	154.26	+0.57
LG-02	268.67	154.99	154.30	155.27	155.75	+0.76
LG-03	241.20	152.56	153.25	156.08	153.62	+1.06
LG-04	206.93	155.52	152.28	153.43	152.65	-2.87
LG-05	235.00	152.25	153.54	154.3	153.25	+1.00

2.2 Annual Ground Water Sampling Results

Purging and sampling of each of the four-(*4*) monitoring wells was performed during each quarters sampling event by Snohomish County personnel in accordance with the facilities closure permit and newly approved 2012 Sampling and Analysis Plan. 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. Analytical Data from each quarters sampling event is included in *Appendix C*, **Ground Water Analytical Data** of this report. The quarterly analytical data was compared to the maximum contaminant levels (*MCL's*). A complete statistical analysis of each quarterly data set was also performed utilizing **DUMPStat**. Sens Trend analyses were performed for the entire data set stretching back to 1988 and the results of these analyses – increasing or decreasing trends, are also recorded on the **Ground Water Analytical Data** spreadsheet in *Appendix C*. Results are discussed below.

2.3 Evaluation of Quarterly Ground Water Analytical Results

Quarterly ground water standard (*MCL's*) exceedances for each well are summarized in *Table 2* below.

Table 2 - Summary of Ground Water Standard Exceedances

Well	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
LG-01	pH, Arsenic	pH, Arsenic	pH, Arsenic	pH, Arsenic
LG-02	Arsenic	Arsenic	pH, Arsenic	pH, Arsenic
LG-03	pH, sodium, Arsenic	Deleted for all but water level	Deleted for all but water level	Deleted for all but water level
LG-04	pH	pH, Arsenic	pH, arsenic	pH, Arsenic
LG-05	Conductivity, nitrate nitrogen, pH, sodium, TDS, Arsenic	Conductivity, nitrate nitrogen, pH, sodium, TDS, Arsenic	Conductivity, nitrate nitrogen, pH, sodium, TDS, Arsenic	Conductivity, nitrate nitrogen, pH, sodium, TDS, arsenic, cadmium

Other than arsenic and cadmium in the 4th qtr LG-05 well, there were no measured exceedances to any dissolved metals or VOC's during the 2012 sampling events at the Lake Goodwin Landfill. Arsenic levels were compared to the "Implementation Guidance for the Ground Water Quality Standards". Although arsenic levels observed were not out of normal, exceedances were recorded when compared to these new standards. This is true in every well at all four Snohomish County closed landfills.

Multiple exceedances to the MCL's during 2012 were observed in down gradient well LG-05 as shown on table 2 above. The constituent exceedences in well LG-05 were consistent throughout the year. Observation well LG-03 was drilled through a portion of the landfill and as such is not representative of actual down-gradient ground water conditions. The Snohomish Health District approved the 2012 Sampling and Analysis Plan and deleted this well from the sampling program although we still measure the water level. As shown on the **Quarterly Ground Water Contour Maps**, *Appendix B*, observation well LG-05 is located along the calculated ground water flow gradient directly down-gradient from the landfill.

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, Dissolved Metals and Volatile Organic Compounds – 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**.

Quarterly Stiff Diagrams, Trilinear Diagrams and **Statistically Significant Trends Analyses** results are included in *Appendix D* of this report. The quarterly Trends Analyses have been run utilizing data sets from 2005 through 2012, allowing us to place multiple constituents on a single graph to better see potential correlations. 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. The calculated statistical prediction limit may or may not be lower than the MCL. **Quarterly Statistical Summary Exceedances** are shown in *Table 3* below.

Constituents and their trends over the year do not appear to respond directly or indirectly to precipitation. Statistical analysis over the year indicates no changes to the up-gradient ground water quality at the landfill (*LG-02*). Trends within the down-gradient wells were consistently decreasing, with minor increases in various constituents (*although with no apparent pattern*) shown quarterly over the year. Calcium and Nitrate were increasing trends in LG-01 over the year, although not at levels exceeding the MCL's. Based on the quarterly analyses in 2011, down-gradient ground water quality still shows an impact from the landfill in LG-05.

Table 3 – Quarterly Statistical Summary Exceedances for 2012

Well	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
LG-01	Alkalinity, bicarbonate, calcium, conductivity, magnesium, pH, potassium, sulfate, selenium	Alkalinity, bicarbonate, calcium, conductivity, magnesium, pH, potassium, sulfate, barium, manganese	Alkalinity, bicarbonate, conductivity, magnesium, nitrate, pH, potassium, sulfate, barium, manganese	Alkalinity, bicarbonate, conductivity, magnesium, nitrate, pH, potassium, sulfate, barium
LG-02	None	None	pH, Sulfate	Calcium, pH, Barium
LG-03	Alkalinity, bicarbonate, calcium, chloride, conductivity, magnesium, pH, potassium, sodium, sulfate, barium, nickel	Deleted from sampling plan	Deleted from sampling plan	Deleted from sampling plan
LG-04	Bicarbonate, Calcium, magnesium, pH, potassium, barium	Bicarbonate, calcium, magnesium, pH, potassium, barium	Bicarbonate, calcium, conductivity, magnesium, pH, potassium, sulfate, barium	Calcium, conductivity, magnesium, pH, potassium, barium
LG-05	Alkalinity, bicarbonate, calcium, chloride, conductivity, magnesium, nitrate, pH, potassium, sodium, TDS, barium.	Alkalinity, bicarbonate, calcium, chloride, conductivity, magnesium, nitrate, pH, potassium, sodium, sulfate, TDS, barium, cadmium, manganese, nickel	Alkalinity, bicarbonate, calcium, chloride, conductivity, magnesium, nitrate, pH, potassium, sodium, sulfate, TDS, barium, manganese	Alkalinity, ammonia nitrogen, bicarbonate, calcium, chloride, conductivity, magnesium, nitrate, pH, potassium, sodium, sulfate, TDS, barium, cadmium, copper, manganese

3.0 METHANE GAS MONITORING

Monthly methane gas monitoring of the Lake Goodwin Landfill was initiated during the 4th quarter of 2011. The landfill is not lined and there is no gas collection system. Gas monitoring is provided through a walking gas probe survey via a series of bar hole punch probes. Bar holes for the purpose of monitoring landfill generated methane gas were placed at appropriate locations on the top of the biomass. The bar holes were installed with a 12" powered auger. Probe locations are shown on the **Monitoring Network Map** (*figure5*). **Bar Hole Punch Gas Probe Installation Details** are shown in *table 4* below. The probes were vandalized in March of 2012.

Table 4 Bar Hole Punch Gas Probe Installation Details

Probe I.D.	Depth of Bar Hole *(inches)*	Depth to Garbage *(inches)*	Depth to Screen *(inches)*
A-1	46	18	30
A-2	42	16	30
A-3	45	25	32
B-1	41	None	34
B-2	44	14	32
B-3	44	34	32
C-1	51	16	31
C-2	37	17	31
C-3	45	16	35

3.1 Landfill Gas Monitoring Requirements

The Lake Goodwin Landfill is not subject to gas monitoring by regulation. A monthly monitoring program has been initiated by Snohomish County Solid Waste personnel in order to establish a data base to be used in part for landfill stability determination and for Post Closure planning. Because the bar holes are placed through the cap and into the garbage, we anticipate measureable amounts of methane gas to be present for many years.

3.2 Landfill Gas Monitoring Procedures

Initiated during the last quarter of 2011, each of the nine-(9) gas probes will be sampled using a Gastech TLV Meter. This meter is designed to measure small concentrations of methane gas escaping through the probe monitoring ports. Methane concentrations will be measured in parts per million (*ppm*) and recorded by field personnel. Three months of data was collected in 2012 and those **Landfill Gas Monitoring Results** are included in *table 5* below.

Table 5 2012 Landfill Gas Monitoring Results

Probe	Date	Flow	% Methane	Oxygen	CO2	Barometer	Probe Details
LG-A1	12/28/11	0	14	3	15	746	Entire screened area in garbage
	1/5/12	0	12	3	14	758	
	2/21/12	0	13	3	8	754	
	3/7/12	0	12	3	12	755	Full moon

Probe	Date	Flow	% Methane	Oxygen	CO2	Barometer	Probe Details
LG-A2	12/28/11	0	0	13	4	746	Entire screened area in garbage
	1/5/12	0	0	21	0	758	
	2/21/12	0	15	12	2		
	3/7/12	0	39	3	6	755	
LG-A3	12/28/11	0	44	11	6	746	Lower 7" of screened area in garbage
	1/5/12	0	18	14	4	758	
	2/21/12	0	75	6	1	754	
	3/7/12	0	8	3	9	755	
LG-B1	12/28/11	0	0	19	1	746	No garbage in bore hole
	1/5/12	0	0	19	1	758	
	2/21/12	0	0	19	1	754	
	3/7/12	0	0	19	1	755	
LG-B2	12/28/11	0	9	3	10	746	Entire screen in garbage
	1/5/12	0	0	21	0	758	
	2/21/12	0	0	21	0	754	
	3/7/12	0	18	3	10	755	
LG-B3	12/28/11	0	15	3	6	746	Garbage 2" below screened area
	1/5/12	0	0	21	0	758	
	2/21/12	0	0	21	0	754	
	3/7/12	0	15	3	4	755	
LG-C1	12/28/11	0	17	3	10	746	Entire screen in garbage
	1/5/12	0	0	21	0	758	
	2/21/12	0	0	21	0	754	
	3/7/12	0	8	3	11	755	
LG-C2	12/28/11	0	22	3	10	746	Entire screen in garbage
	1/5/12	0	0	21	0	758	
	2/21/12	0	0	21	0	754	
	3/7/12	0	24	3	11	755	
LG-C3	12/28/11	0	16	3	11	746	Entire screen in garbage
	1/5/12	0	16	3	12	758	
	2/21/12	0	17	3	9	754	
	3/7/12	0	16	3	10	755	

4.0 SETTLEMENT MONITORING

Settlement monitoring has now been performed at this site. Annual settlement monitoring was initiated by Snohomish County Solid Waste personnel in 2011 in order to establish landfill biomass stability for custodial care planning.

4.1 Settlement Monitoring Requirements

In order to comply with post closure requirements, cover surface slopes must remain between 2 and 5 percent grade, side slopes must remain below 33 percent slope and localized settlements must not impair cover drainage or cover integrity. Existing biomass stability will be determined based on these annual surveys.

4.2 Settlement Monitoring Methodology

Settlement monitoring will be performed on an annual basis by taking direct measurements through topographic surveys and comparing them to existing and previous topographic surveys and/or to other appropriate data sets, such as Lidar Mapping, that covers the Lake Goodwin Landfill. Survey crews will perform field survey of the side slopes, grade breaks and additional points necessary to prepare a topographic contour map with maximum two-(*2*) ft contours.

4.3 Settlement Monitoring Procedures

Topographic survey data will be compared to previous and/or existing data for any changes, which includes historic topographic surveys and also current Lidar information, if available. Areas where settlement has occurred will be highlighted on a maximum two-(*2*) foot contour topographic map of the site. Existing surface slope grades will also be analyzed. Areas exceeding the maximum percent slope grades given in *section 4.1* above will be highlighted and shown on an annual contour topographic map of the site.

The second Lake Goodwin Landfill survey was completed by the *Snohomish County Public Works Survey Group* in Jan. 2013. The second ground survey of the Lake Goodwin Landfill was compared to the first survey and the yearly settlement results are shown on the **Lake Goodwin Landfill Settlement and Monitoring Exhibit**, *Figure 6* of this report. Comparing the 2011 to the 2012 survey shows no significant settlements occurring at the landfill during 2012. A small area of the landfill, totally less than 201 square feet (*of approximately 127,000 sq. ft total*), showed settlement over 0.50' during this time period.

The **Slope Range Analysis** results from the 2012 annual survey is shown in *Figure 7.*

5.0 SUMMARY AND CONCLUSIONS/RECOMMENDATIONS

5.1 Summary

A new Sampling and Analysis Plan (SAP) was approved in 2012. This is the first annual summary report prepared under this new SAP. The ground water data collected during the 2012 quarterly sampling events indicates the following:

- Although LG-04 had a slight decrease in elevation over the year, overall ground water elevations below the landfill continue to rise, which is a continuing trend that has been documented since 2005.
- Other than arsenic, there were no measured exceedances to the MCL's for any dissolved metals or VOC's during the 2012 sampling events at the Lake Goodwin Landfill.
- pH and arsenic were all reoccurring exceedances to the MCL's in both up-gradient and down-gradient wells during 2012. Conductivity levels observed at well LG-05 were significantly higher than the surrounding wells.
- 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 many more significant decreasing trends (*6 to 9 per quarter*) than increasing trends (*3 to 4 per quarter*) 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, manganese, nickel and copper were found in various down-gradient wells over the year.
- The new arsenic level in the "Implementation Guidance for the Ground Water Quality Standards" is so low that every well exceeded it. 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.
- Monitoring well LG-03 was drilled through a section of the landfill, it cannot be considered representative of down-gradient ground water conditions of the landfill. It will be utilized for ground water depth and ground water contour map development. Our 2012 SAP eliminated this well from our sampling network.
- Methane gas readings taken through the landfill cap were initiated during 2011. The initial readings were within acceptable levels for the age of the Lake Goodwin

Landfill. Vandals destroyed the probes and the last readings from the probes were taken 3/7/12.

- Annual settlement readings of the landfill cap were initiated during 2011. Initial readings indicate an overall stable landfill mass and cap with measured settlements within tolerable limits. The 2012 survey indicates minimal changes, if any, to the landfill cap from the 2011 survey.

5.2 CONCLUSIONS/RECOMMENDATIONS

Settlement surveys and landfill gas monitoring suggests that the landfill mass is fairly stable at this time. 2012 data indicates a continued moderate leachate impact to the underlying Advance Outwash (*Qva*) aquifer below the Lake Goodwin Landfill. The monitoring data also suggests that leachate impacted ground water extends beyond the landfill boundaries following the ground water gradient to the north-northeast. 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, two increasing trends have been monitored in down gradient well LG-01. We recommend that quarterly ground water testing continue through 2013.

5.3 SIGNATURES and CERTIFICATIONS

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

State of Washington
Hydrogeologist
868
Licensed Geologist
KIRK R. BAILEY

Deanna Carveth
SCPW – Solid Waste Division

March 11, 2013

Figure 1

Lake Goodwin Landfill

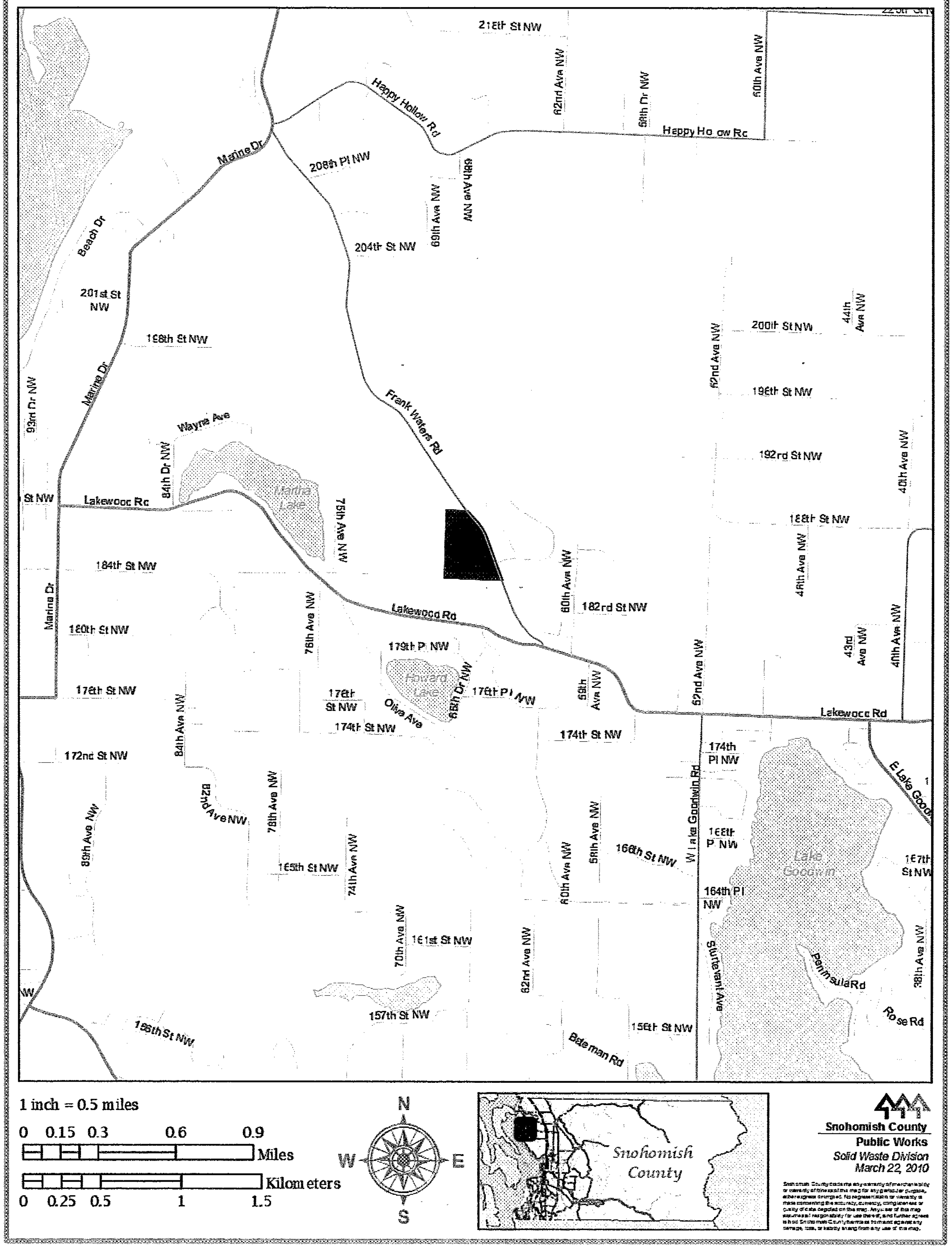


Figure 2

Lake Goodwin Landfill Site Map

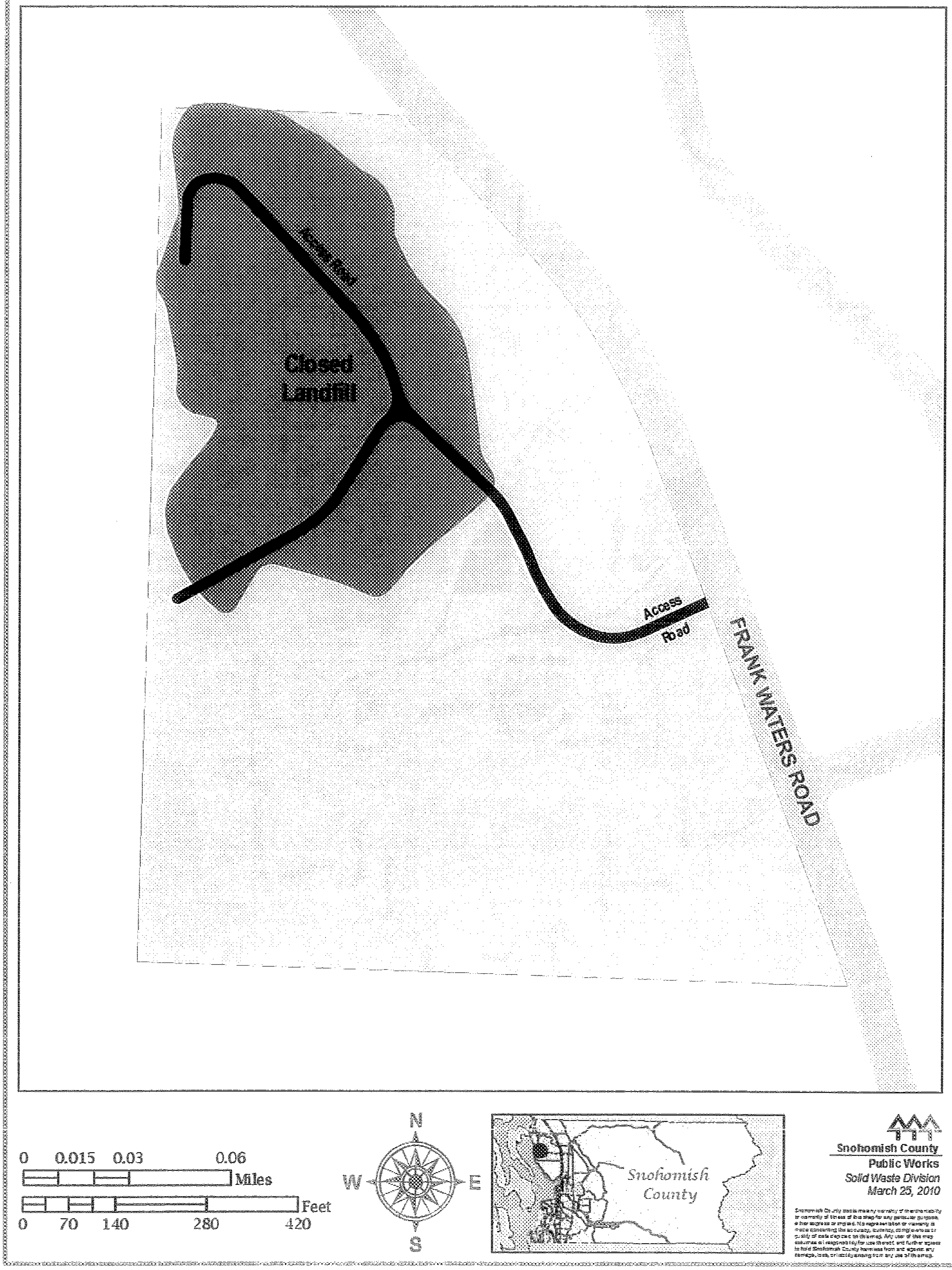


Figure 3

Lake Goodwin Landfill

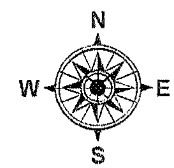
Topography

Map Features

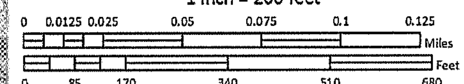
Parcel Boundary

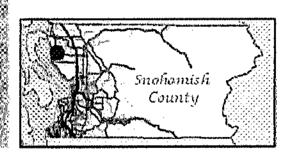
Subject Property Boundary

5 Foot Contours



1 inch = 200 feet





Snohomish County Public Works

Solid Waste Division

March 23, 2010

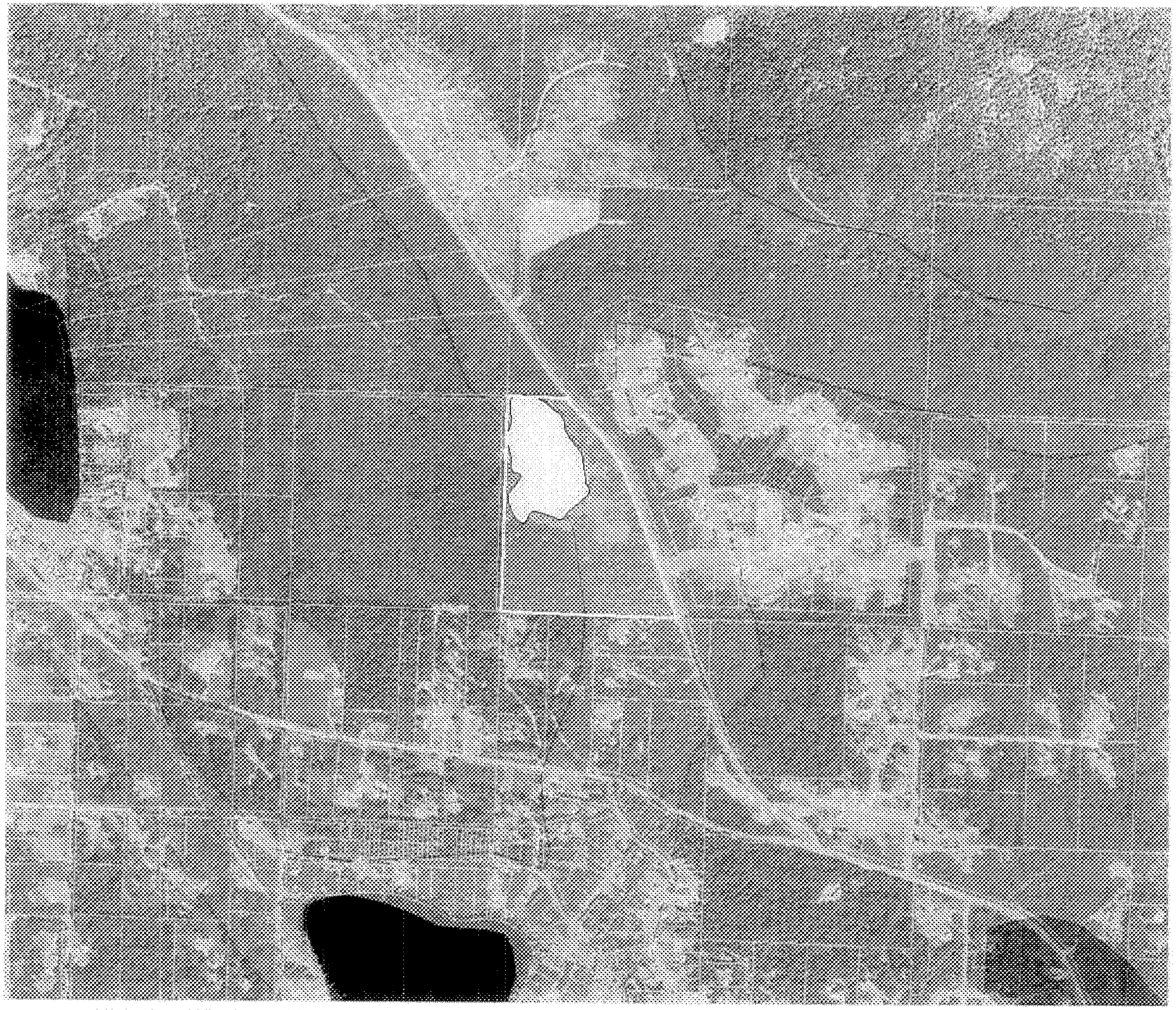


Figure 4

Lake Goodwin Landfill

Geologic Map

Map Features

Parcel Boundary

Subject Property Boundary

Geologic Description

Vashon advance outwash (Qva)

Vashon recessional outwash

Vashon till (Qvt)

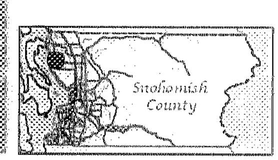
Water

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



Snohomish County Public Works
Solid Waste Division

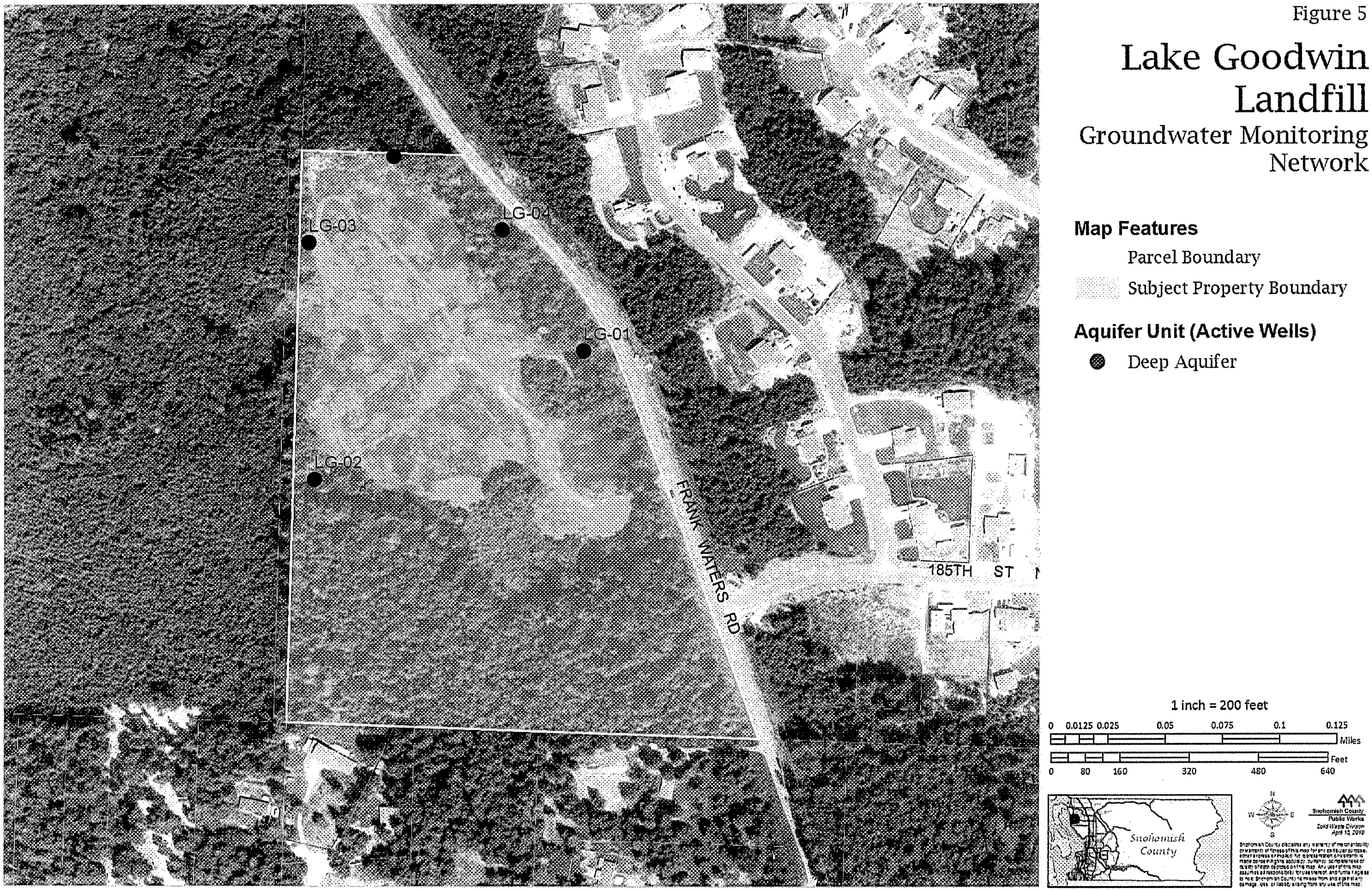
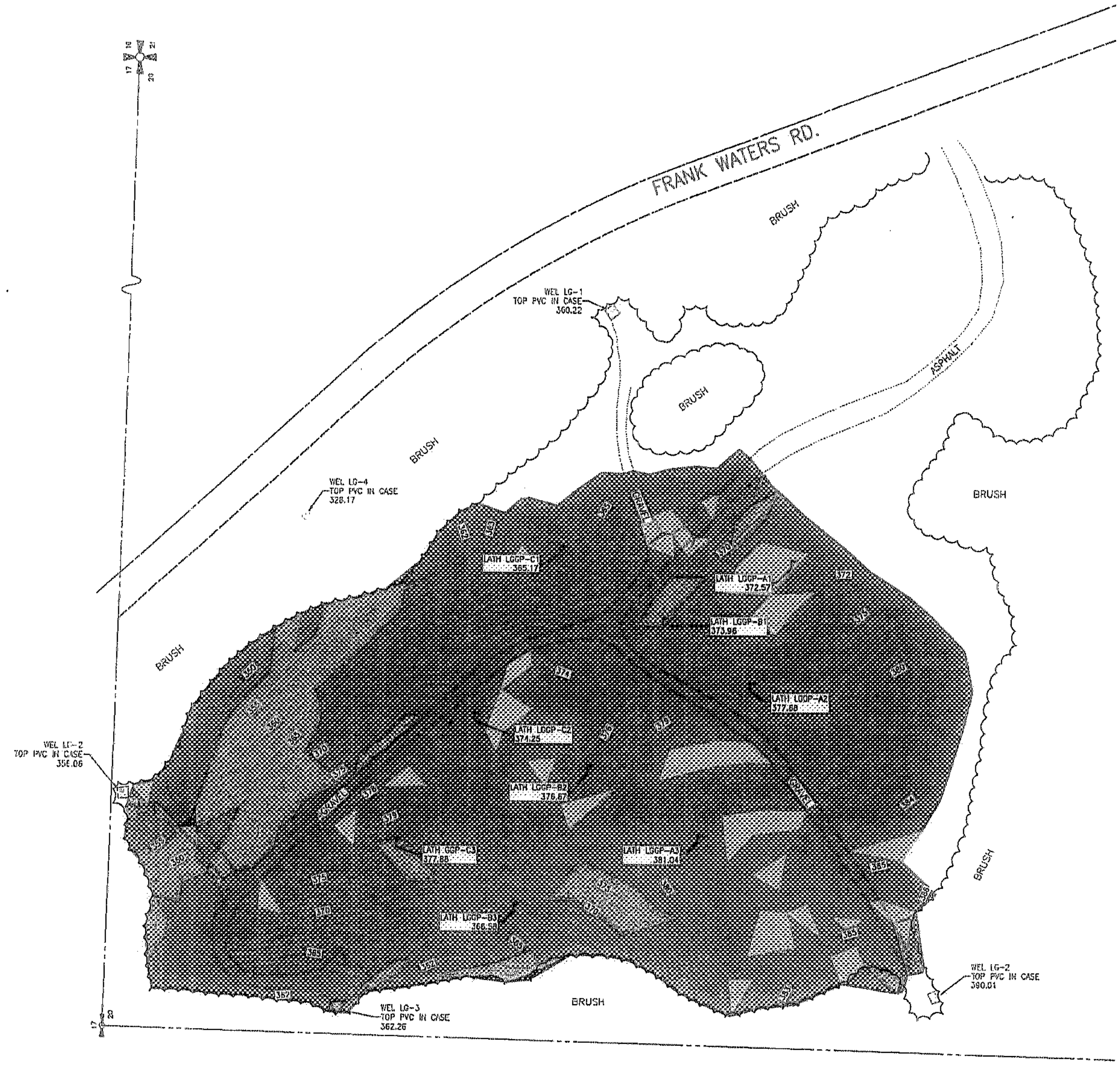


Figure 5
Lake Goodwin Landfill
Groundwater Monitoring Network
Map Features
Parcel Boundary
Subject Property Boundary
Aquifer Unit (Active Wells)
Deep Aquifer
LG-03
LG-04
LG-01
LG-02
FRANK WATERS RD
185TH ST
1 inch = 200 feet
0 0.0125 0.025 0.05 0.075 0.1 0.125
Miles
0 80 160 320 480 640
Feet
Snohomish County



N

60 0 60 120
SCALE IN FEET

HORIZONTAL DATUM: STATE PLANE.
(WASHINGTON NORTH ZONE, NAD 83/2007 ADJUSTMENT)

DATUM

VERTICAL DATUM: NAVD 88
BASED ON MULTI-SESSION GPS

NAVD 88

BASED ON:
COUNTY FIELD MAPPING ON JANUARY, 2013.

CONTOUR INTERVAL = 1 FOOT

Slope Range Table				
Number	Min. Slope	Max. Slope	Area	Color
1	0.41%	2.00%	16397	
2	2.00%	20.00%	236528	
3	20.00%	33.00%	31340	
4	33.00%	434.00%	481	

LEGEND

- PROPERTY LINE
- RIGHT-OF-WAY REFERENCE LINE OR SURVEY BASELINE
- EDGE OF EXISTING RIGHT-OF-WAY
- EDGE OF EXISTING PAVEMENT OR GRAVEL
- EDGE OF CONCRETE
- EDGE OF CREEK OR CENTERLINE OF DITCH
- FENCE
- EXISTING CONTOUR LINE
- EDGE OF VEGETATION
- MONITOR WELL
- SNOHOMISH COUNTY GPS CONTROL POINT
- (6/640) SNOHOMISH COUNTY SURVEY DEPARTMENT PAGE NUMBER / FIELD BOOK NUMBER
- BENCHMARK

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT NO. RR 8019

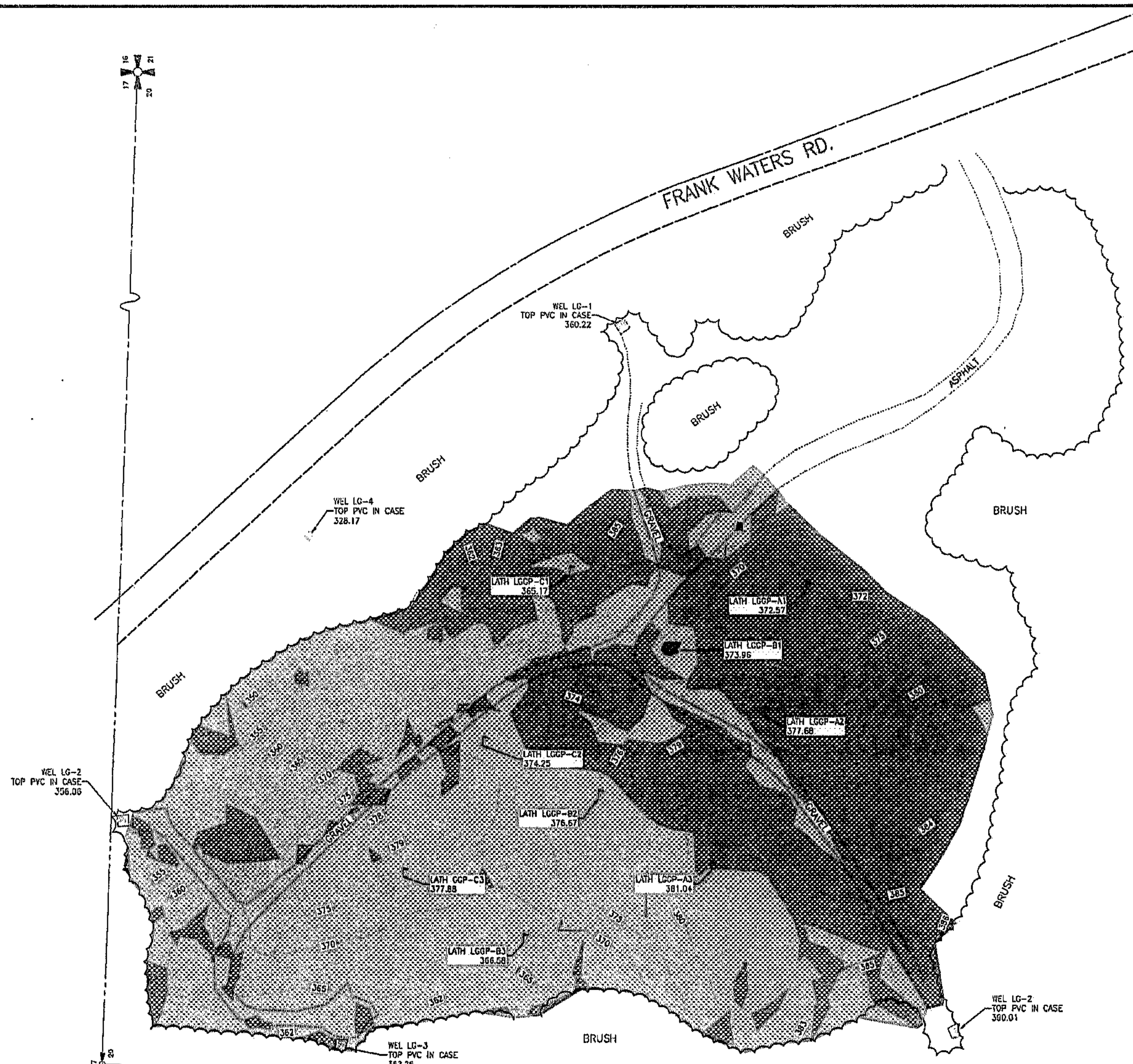
SURVEY NO. 3069
FIELD BOOK(S): 1740
DRAWN BY: ALJ
UPI# 09-0064-1A

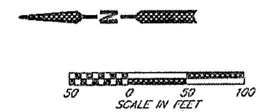
LAKE GOODWIN LANDFILL

REFERENCE SHEET NO.

TOPOGRAPHIC SURVEY SLOPE RANGE ANALYSIS

SHEET 2 OF 2 SHEETS





HORIZONTAL DATUM: STATE PLANE.
(WASHINGTON NORTH ZONE, NAD 83/2007 ADJUSTMENT)

VERTICAL DATUM: NAVD 88

NAVD 88

NOTE: THIS IS A COMPOSITE VERTICAL SURFACE COMPARISON BETWEEN GROUND MAPPING POINTS ON NOV., 2011 AND THE GROUND MAPPING POINTS ON JAN. 2013.

NOTE: THE EDGE OF ASPHALT, GRAVEL, AND WELL LOCATIONS & DESCRIPTIONS ARE BASED ON NOV. 2011 MAPPING.

CONTOUR INTERVAL = 1 FOOT

LEGEND

- PROPERTY LINE
- RIGHT-OF-WAY REFERENCE LINE OR SURVEY BASELINE
- EDGE OF EXISTING RIGHT-OF-WAY
- EDGE OF EXISTING PAVEMENT OR GRAVEL
- EDGE OF CONCRETE
- EDGE OF CREEK OR CENTERLINE OF DITCH
- FENCE
- EXISTING CONTOUR LINE
- EDGE OF VEGETATION
- MONITOR WELL
- SNOHOMISH COUNTY GPS CONTROL POINT
- (0/845) SNOHOMISH COUNTY SURVEY DEPARTMENT PAGE NUMBER / FIELD BOOK NUMBER
- BENCHMARK

Settlement Range Table

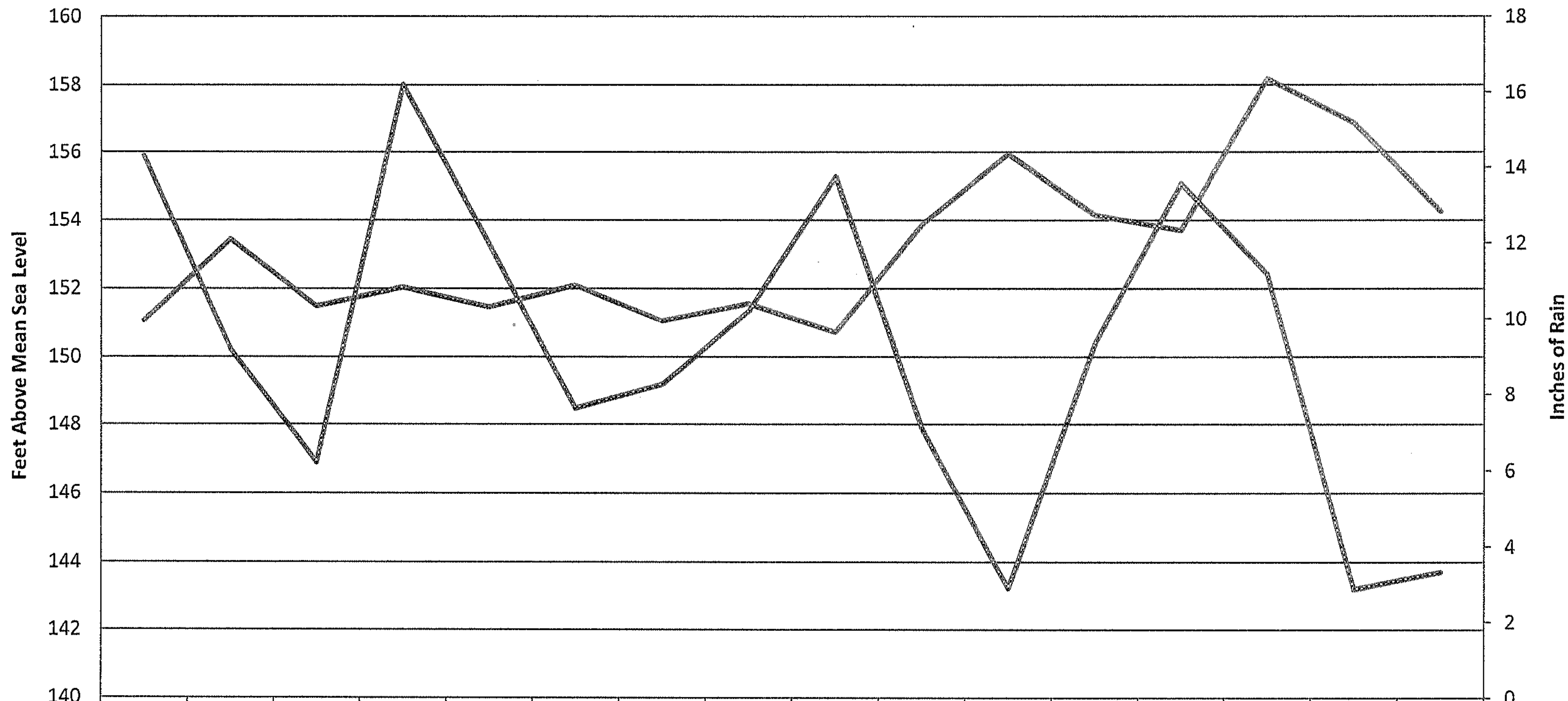
Number	Min. Range	Max. Range	Area sq. ft.	Color
1	-0.49'	0.00'	126865	
2	0.00'	0.50'	160413	
3	0.50'	0.75'	201	

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS PROJECT NO. RR 8019	SURVEY NO. 3069 FIELD BOOK(S): 1740 DRAWN BY: ALJ UPI# 09-0064-1A
LAKE GOODWIN LANDFILL SETTLEMENT AND MONITORING EXHIBIT	REFERENCE SHEET NO. SHEET 1 OF 2 SHEETS

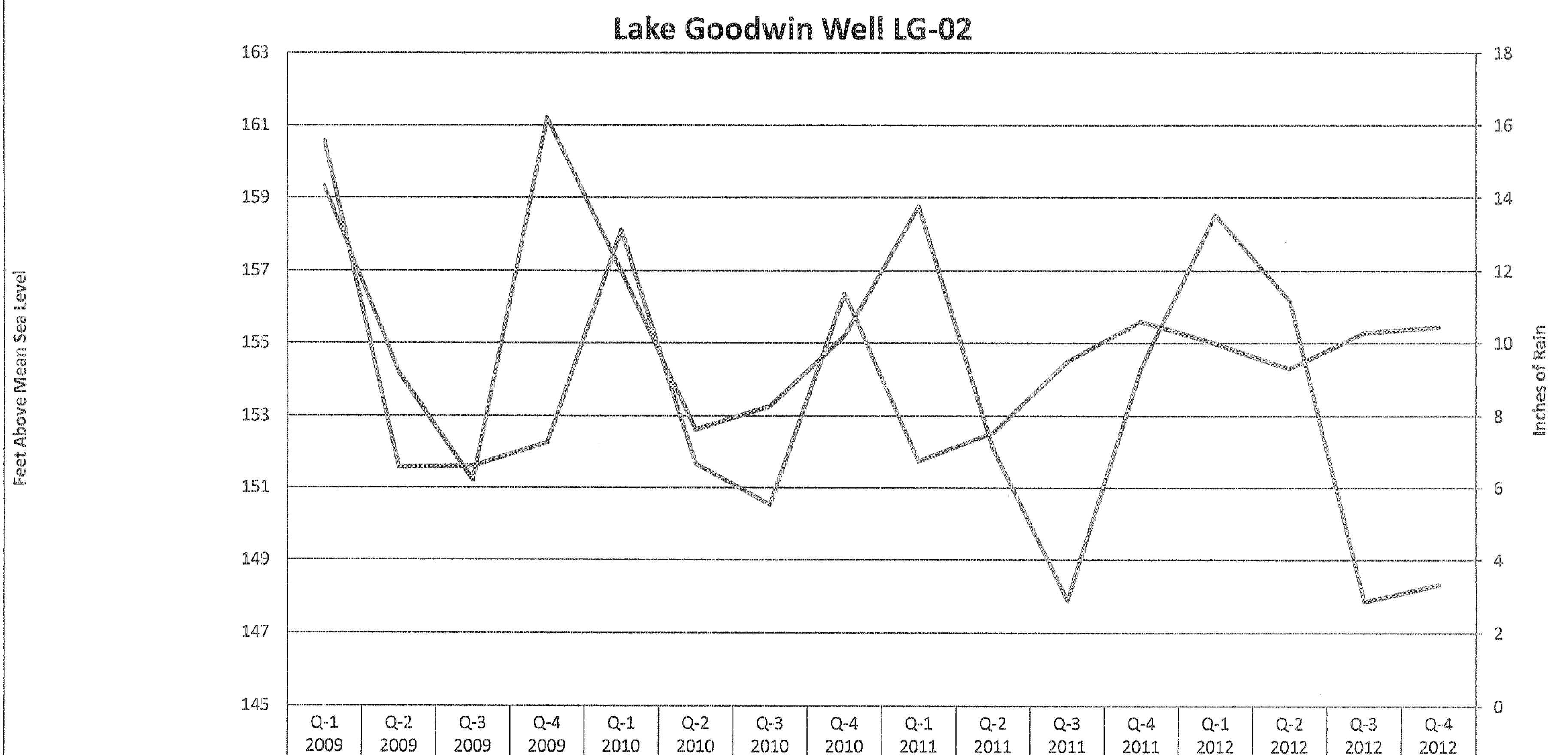
Appendix A

Hydrographs

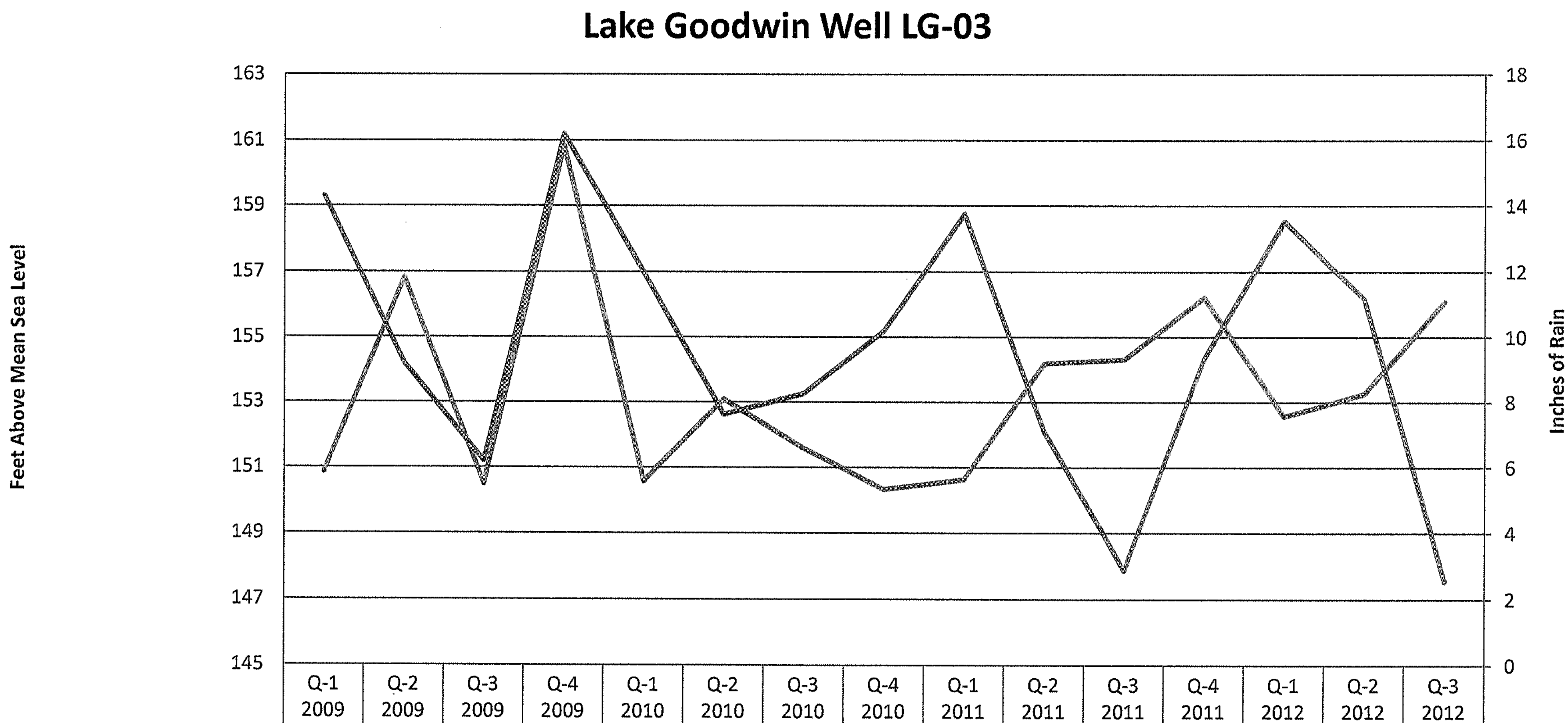
Lake Goodwin Well LG-01



	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
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

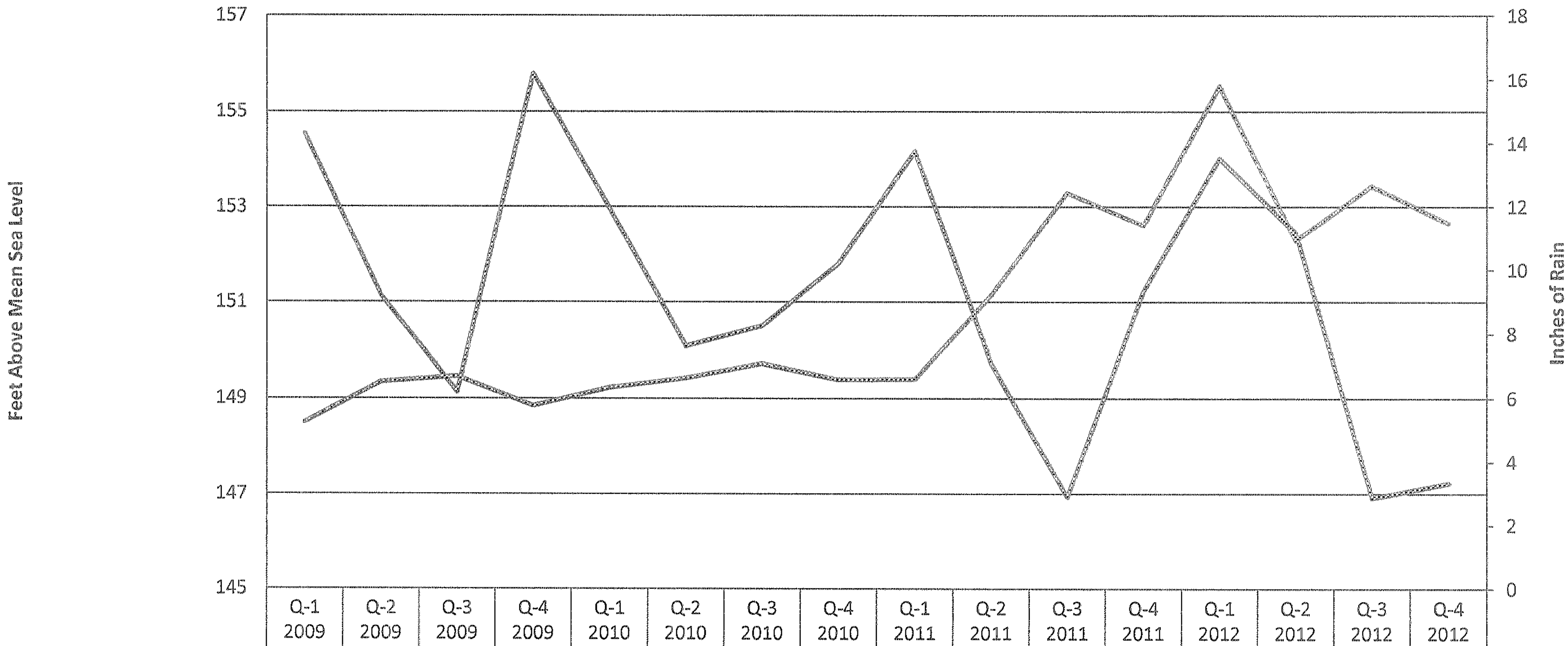


	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4 2011	Q-1 2012	Q-2 2012	Q-3 2012	Q-4 2012
Groundwater Elevation	160.57	151.56	151.59	152.25	158.1	151.67	150.54	156.37	151.74	152.53	154.5	155.59	154.99	154.30	155.27	155.43
Precipitation	14.3	9.2	6.2	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

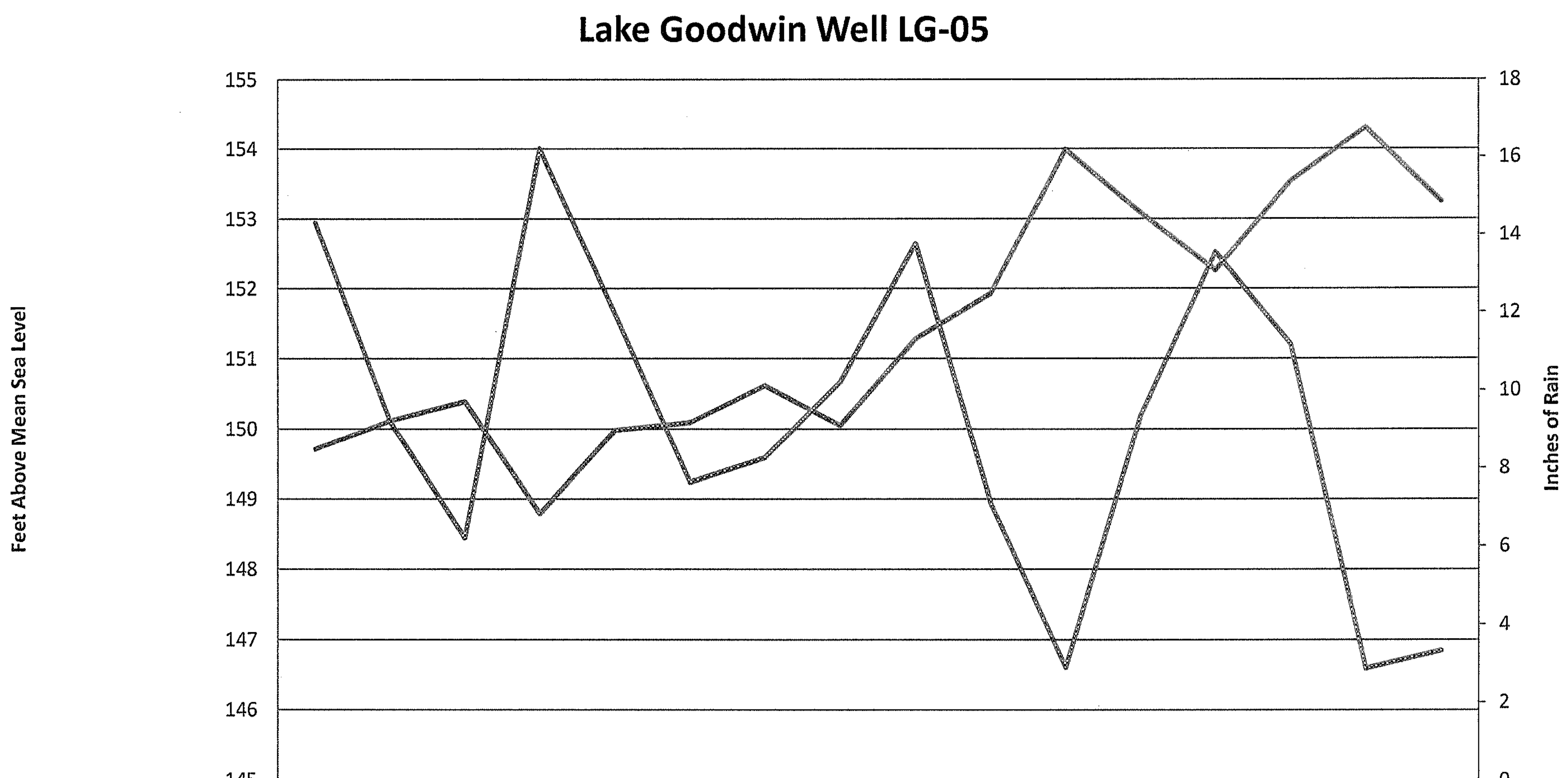


	Q-1 2009	Q-2 2009	Q-3 2009	Q-4 2009	Q-1 2010	Q-2 2010	Q-3 2010	Q-4 2010	Q-1 2011	Q-2 2011	Q-3 2011	Q-4 2011	Q-1 2012	Q-2 2012	Q-3 2012
Groundwater Elevations	150.86	156.82	150.51	160.84	150.59	153.1	151.59	150.35	150.64	154.19	154.31	156.21	152.56	153.25	156.08
Precipitation	14.3	9.2	6.2	16.2	11.96	7.62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

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



	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

Appendix B

Analytical Data

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

	Statistical Method	No. of Samples	No. of Detects	Prediction Limit (a)	MCL	Downgradient LG-01 1/10/12	D V T C	Downgradient LG-03 1/10/12	D V T C	Downgradient LG-04 1/10/12	D V T C	Downgradient LG-05 1/10/12	D V T C	Upgradient LG-02 1/10/12	D V T C
CONVENTIONAL CHEMISTRY PARAMETERS															
(mg/L unless noted)															
Alkalinity (as CaCO3)	normal	30	30	**142.62**	--	**190**	E	**250**	V I Y	140		**370**	V I Y	120	I Y
Ammonia Nitrogen	nonpar	26	8	**0.069**	--	0.009		0.017		0.005 U		0.005 U		0.005 U	
Bicarbonate	lognor	30	30	**131.72**	--	**190**	V	**250**	V	**140**	V	**370**	V	120	
Calcium, Dissolved	normal	30	30	**22.72**	--	**25.6**	E I N	**31.1**	V	**23**	E	**45.5**	V	21.8	
Chemical Oxygen Demand	nonpar	22	2	**26**	--	10 U		10 U		10 U		10 U		10 U	
Chloride	nonpar	30	30	**9.4**	250	5.5		**12**	V	6.4		**19**	V	6.5	
Conductivity (umhos/cm)	normal	30	30	**330.95**	700	**420**	V	**570**	V	300	D	840	V	280	
Magnesium, Dissolved	normal	30	30	**20.34**	--	**34.8**	V I Y	**45.5**	V	**21.8**	V	**61.9**	V	18.4	
Nitrate Nitrogen (mg-N/L)	nonpar	29	29	**6**	10	3	I N	5.2	I N	1.4		22	P	6	
Nitrite Nitrogen (mg-N/L)	nonpar	26	7	**0.03**	1	0.001 U		0.001 U		0.001 U		0.003	D Y	0.001 U	
pH (std units)	normal	30	30	**6.53-7.81**	6.5-8.5	6.37	V D N	6.39	V	5.86	V	6.17	V D N	6.94	
Potassium, Dissolved	normal	30	30	**3.57**	--	**4.32**	V	**4.69**	V	**3.68**	E D Y	**7.5**	V	3.25	
Sodium, Dissolved	nonpar	29	29	**13.8**	20	11.7	D N	25	V	11.1	D N	42.9	V D N	9.9	
Sulfate	normal	30	30	**17**	250	**22**	E	**22**	V	9.2	D	14	P D N	8.4	
Total Dissolved Solids	nonpar	30	30	**550**	500	270		350		200		550		170	
Total Organic Carbon	nonpar	30	14	**19**	--	2.5		**4.9**		2.3		17		1.8	
DISSOLVED METALS															
EPA Methods 6010B/7131A (mg/L)															
Antimony	nonpar	30	6	**0.01**	0.006	0.00007		0.00006		0.00008		0.00009		0.00009	
Arsenic	nonpar	25	25	**0.0078**	0.0005	0.00059		0.00057		0.0004		0.00096		0.00354	
Barium	normal	25	25	**0.0137**	2	**0.0216**	V	**0.0308**	V	**0.0218**	V D Y	**0.0623**	V	0.0128	I Y
Beryllium	nonpar	30	0	**0.0005**	0.004	0.0005 U		0.0005 U		0.0005 U		0.0005 U		0.0005 U	
Cadmium	nonpar	27	11	**0.0002**	0.005	0.00005 U		0.00005 U		0.00005 U		0.00005 U		0.00005 U	
Chromium	normal	27	19	**0.0092**	0.1	0.001 U		0.0011		0.001 U		0.001 U		0.0032	
Cobalt	nonpar	30	5	**0.008**	--	0.001 U		0.001 U		0.001 U		0.001		0.001 U	
Copper	nonpar	26	7	**0.007**	1.3	0.002		0.002		0.002		0.003		0.002	
Iron	nonpar	30	5	**0.032**	0.3	0.005 U		0.005 U		0.005 U		0.005 U		0.005 U	
Lead	nonpar	29	4	**0.001**	0.015	0.00005 U		0.00005 U		0.00005 U		0.00005 U		0.00005 U	
Manganese	nonpar	27	7	**0.0061**	0.05	0.0005 U		0.0005 U		0.0005 U		0.0005 U		0.0005 U	

	Statistical Method	No. of Samples	No. of Detects	Prediction Limit (a)	MCL	Downgradient LG-01 1/10/12 D V T C	Downgradient LG-03 1/10/12 D V T C	Downgradient LG-04 1/10/12 D V T C	Downgradient LG-05 1/10/12 D V T C	Upgradient LG-02 1/10/12 D V T C
Nickel	nonpar	30	0	**0.005**	0.1	0.005 U	**0.006** V	0.005 U	0.005 U	0.005 U
Selenium	nonpar	29	4	**0.002**	0.05	**0.00285**	0.0005 U	0.0005 U	0.00061	0.00061
Silver	nonpar	29	3	**4.25**	0.1	0.00005 U	0.00005 U	0.00005 U	0.00005 U	0.00005 U
Thallium	nonpar	29	1	**0.001**	0.002	0.00005 U	0.00005 U	0.00005 U	0.00005 U	0.00005 U
Vanadium	nonpar	28	6	**0.01**	--	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Zinc	normal	28	14	**0.0073**	5	0.001	0.002 V	0.001 U P	0.002	0.001 U

VOLATILE ORGANIC COMPOUUS (VOCs)

EPA Method 8260 (µg/L)

1,1,1-Trichloroethane	Too Many Non-Detects	N/A	200	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	Too Many Non-Detects	N/A	--	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	Too Many Non-Detects	N/A	--	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	Too Many Non-Detects	N/A	1	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethylene	Too Many Non-Detects	N/A	7	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	Too Many Non-Detects	N/A	--	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	Too Many Non-Detects	N/A	5	5 U	5 U	5 U	5 U	5 U
1,2-Dibromoethane	Too Many Non-Detects	N/A	1	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	Too Many Non-Detects	N/A	600	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	Too Many Non-Detects	N/A	5	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	Too Many Non-Detects	N/A	5	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	Too Many Non-Detects	N/A	75	4 U	4 U	4 U	4 U	4 U
2-Butanone	Too Many Non-Detects	N/A	--	5 U	5 U	5 U	5 U	5 U
2-Hexanone	Too Many Non-Detects	N/A	--	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-Pentanone (MIBK)	Too Many Non-Detects	N/A	--	5 U	5 U	5 U	5 U	5 U
Acetone	Too Many Non-Detects	N/A	--	5 U	5 U	5 U	5 U	5 U
Acrylonitrile	Too Many Non-Detects	N/A	5	5 U	5 U	5 U	5 U	5 U
Benzene	Too Many Non-Detects	N/A	5	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	Too Many Non-Detects	N/A	1	1 U	1 U	1 U	1 U	1 U
Bromoform	Too Many Non-Detects	N/A	5	1 U	1 U	1 U	1 U	1 U
Bromomethane	Too Many Non-Detects	N/A	--	1 U	1 U	1 U	1 U	1 U
Carbon Disulfide	Too Many Non-Detects	N/A	--	1 U	1 U	1 U	1 U	1 U
Carbon Tetrachloride	Too Many Non-Detects	N/A	5	1 U	1 U	1 U	1 U	1 U

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

	Statistical Method	No. of Samples	No. of Detects	Prediction Limit (a)	MCL	Downgradient LG-01 1/10/12	D	V	T	C	LG-03 1/10/12	D	V	T	C	LG-04 1/10/12	D	V	T	C	LG-05 1/10/12	D	V	T	C	Upgradient LG-02 1/10/12	D	V	T	C
Chlorobenzene	Too Many Non-Detects			N/A	100	1	U				1	U				1	U				1	U				1	U			
Chlorodibromomethane	Too Many Non-Detects			N/A	1	1	U				1	U				1	U				1	U				1	U			
Chloroethane	Too Many Non-Detects			N/A	--	1	U				1	U				1	U				1	U				1	U			
Chloroform	Too Many Non-Detects			N/A	7	1	U				1	U				1	U				1	U				1	U			
Chloromethane	Too Many Non-Detects			N/A	--	1	U				1	U				1	U				1	U				1	U			
cis-1,2-Dichloroethene	Too Many Non-Detects			N/A	70	1	U				1	U				1	U				1	U				1	U			
cis-1,3-Dichloropropene	Too Many Non-Detects			N/A	--	1	U				1	U				1	U				1	U				1	U			
Dibromomethane	Too Many Non-Detects			N/A	--	1	U				1	U				1	U				1	U				1	U			
Ethyl Benzene	Too Many Non-Detects			N/A	700	1	U				1	U				1	U				1	U				1	U			
m,p-Xylene	Too Many Non-Detects			N/A	10000	1	U				1	U				1	U				1	U				1	U			
Methyl Iodide	Too Many Non-Detects			N/A	--	5	U				5	U				5	U				5	U				5	U			
Methylene Chloride	Too Many Non-Detects			N/A	5	1.5	U				1.5	U				1.5	U				1.5	U				1.5	U			
o-Xylene	Too Many Non-Detects			N/A	10000	1	U				1	U				1	U				1	U				1	U			
Styrene	Too Many Non-Detects			N/A	100	1	U				1	U				1	U				1	U				1	U			
Tetrachloroethylene	Too Many Non-Detects			N/A	5	1	U				1	U				1	U				1	U				1	U			
Toluene	Too Many Non-Detects			N/A	1000	1	U				1	U				1	U				1	U				1	U			
trans-1,2-Dichloroethene	Too Many Non-Detects			N/A	100	1	U				1	U				1	U				1	U				1	U			
trans-1,3-Dichloropropene	Too Many Non-Detects			N/A	--	1	U				1	U				1	U				1	U				1	U			
trans-1,4-Dichloro-2-butene	Too Many Non-Detects			N/A	--	5	U				5	U				5	U				5	U				5	U			
Trichlorethene (1,1,2-Trichloroethylene)	Too Many Non-Detects			N/A	5	1	U				1	U				1	U				1	U				1	U			
Trichlorofluoromethane	Too Many Non-Detects			N/A	--	1	U				1	U				1	U				1	U				1	U			
Vinyl Acetate	Too Many Non-Detects			N/A	--	5	U				5	U				5	U				5	U				5	U			
Vinyl Chloride	Too Many Non-Detects			N/A	2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	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.

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

	Statistical Method	No. of Samples	No. of Detects	Prediction Limit (a)	MCL	Downgradient LG-01 4/17/12	D	V	T	C	Downgradient LG-04 4/17/12	D	V	T	C	Downgradient LG-05 4/17/12	D	V	T	C	Upgradient LG-02 4/17/12	D	V	T	C
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L unless noted)																									
Alkalinity (as CaCO3)	normal	31	31	**141.1815**	--	**190**		V			130					**360**		V	I	N	110			I	N
Ammonia Nitrogen	nonpar	27	8	**0.056**	--	0.005	U				0.005	U				0.005	U				0.005	U			
Bicarbonate	normal	31	31	**130.7366**	--	**190**		V			**130**		V	D	Y	**360**		V			110				
Calcium, Dissolved	normal	31	31	**20.8776**	--	**25**		V	I	N	**22.7**		P			**44.4**		V			19.4				
Chemical Oxygen Demand	nonpar	23	2	**26**	--	10	U				10	U				10	U				10	U			
Chloride	nonpar	31	31	**9.4**	250	5.5					7.1					**21**		V			7.1				
Conductivity (umhos/cm)	normal	31	31	**325.3534**	700	**400**		V			310			D	N	840		V			270				
Magnesium, Dissolved	normal	31	31	**19.5453**	--	**34.2**		V	I	N	**21.2**		V			**61.6**		V			17.2				
Nitrate Nitrogen (mg-N/L)	nonpar	30	30	**2.6**	10	1.8			I	N	1.2					19		V			0.91				
Nitrite Nitrogen (mg-N/L)	nonpar	27	7	**0.003**	1	0.001	U				0.001	U				0.001	U		D	N	0.001	U			
pH (std units)	normal	31	31	**6.7-7.75**	6.5-8.5	6.39		V	D	N	5.96		V	D	Y	6.14		V	D	N	6.9			D	Y
Potassium, Dissolved	normal	31	31	**3.443**	--	**4.18**		V			**3.55**		P			**7.24**		V			3.04				
Sodium, Dissolved	nonpar	30	30	**13.8**	20	11.9			D	N	11.1			D	N	41.85		V	D	N	10.1				
Sulfate	normal	31	31	**16.2676**	250	**25**		V			12			D	N	**26**		E	D	N	12				
Total Dissolved Solids	nonpar	31	31	**550**	500	300					220					575		E			180				
Total Organic Carbon	nonpar	31	14	**13**	--	0.5	U				0.5	U				2.1					0.5	U			
DISSOLVED METALS EPA Methods 6010B/7131A (mg/L)																									
Arsenic	nonpar	26	26	**0.078**	0.00005	0.00058					0.00039					0.00118					0.00342				
Barium	normal	26	26	**0.0138**	2	**0.0215**		V			**0.0215**		V	D	N	**0.0605**		V			0.0116			I	N
Beryllium	nonpar	31	0	**0.0005**	0.004	0.0005	U				0.0005	U				0.0005	U				0.0005	U			
Cadmium	nonpar	28	12	**0.0002**	0.005	0.00005	U				0.00005	U				**0.00099**		E			0.00017				
Chromium	normal	28	20	**0.0102**	0.1	0.0017					0.001	U				0.001	U				0.0035				
Cobalt	nonpar	31	5	**0.008**	--	0.001	U				0.001	U				0.001	U				0.001	U			
Copper	nonpar	27	8	**0.004**	1.3	0.003					0.002					0.003					0.001				
Iron	nonpar	31	5	**0.031**	0.3	0.007					0.005	U				0.016					0.005	U			
Manganese	nonpar	28	8	**0.0061**	0.05	**0.0122**		E			0.0037					**0.0084**		E			0.0034				
Nickel	nonpar	31	0	**0.005**	0.1	0.005	U				0.005	U				**0.006**		E			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.

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

	Statistical Method	No. of Samples	No. of Detects	Prediction Limit (a)	MCL	Downgradient LG-01 7/10/12	D	V	T	C	LG-04 7/10/12	D	V	T	C	LG-05 7/10/12	D	V	T	C	Upgradient LG-02 7/10/12	D	V	T	C
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L unless noted)																									
Alkalinity (as CaCO3)	normal	32	32	**141.1815**	--	**160**		V			140					**300**		V	I	N	110			I	N
Ammonia Nitrogen	nonpar	28	8	**0.056**	--	0.005	U				0.005	U				0.005	U				0.005	U			
Bicarbonate	normal	32	32	**130.7366**	--	**160**		V			**140**		V		Y	**300**		V			110				
Calcium, Dissolved	normal	32	32	**20.8776**	--	20.7		P	I	N	**21.9**					**42.08**		V			20				
Chemical Oxygen Demand	nonpar	24	2	**26**	--	10	U				10	U				10	U				10	U			
Chloride	nonpar	32	32	**9.4**	250	6.1			I	Y	7.3					**21**		V			7				
Conductivity (umhos/cm)	normal	32	32	**325.3534**	700	**370**					**330**			D	N	880		V			280				
Magnesium, Dissolved	normal	32	32	**19.5453**	--	**28.5**		V	I	N	**21.5**		V			**63.75**		V			17.2				
Nitrate Nitrogen (mg-N/L)	nonpar	31	31	**2.6**	10	**2.6**			I	N	1.1					17.5		V			1.8				
Nitrite Nitrogen (mg-N/L)	nonpar	28	7	**0.003**	1	0.002	U				0.002	U				0.002	U		D	N	0.002	U			
pH (std units)	nonpar	32	32	**6.7-7.75**	6.5-8.5	5.69		E	D	N	5.48		V	D	N	5.48		E	D	N	6.06			D	N
Potassium, Dissolved	normal	32	32	**3.443**	--	**3.72**		V			**3.52**					**6.955**		V			3				
Sodium, Dissolved	nonpar	31	31	**13.8**	20	9.57			I	Y	9.7			D	N	38.65		V	D	N	9.11				
Sulfate	nonpar	32	32	**16.2676**	250	**37**		V			**22**			D	N	**50.5**		V	D	N	**24**				
Total Dissolved Solids	nonpar	32	32	**550**	500	250					230					550		P			190				
Total Organic Carbon	nonpar	32	14	**13**	--	0.5	U				0.5	U				2.3					0.5	U			
DISSOLVED METALS EPA Methods 6010B/7131A (mg/L)																									
Arsenic	nonpar	27	27	**0.078**	0.01	0.000068					0.000525					0.00143					0.00357				
Barium	normal	27	27	**0.0138**	2	**0.0182**		V			**0.0214**		V	D	N	**0.0594**		V			0.0123			I	N
Cadmium	nonpar	29	12	**0.0002**	0.005	0.000025	U				0.000025	U				0.000053		P			0.000025	U			
Chromium	normal	29	21	**0.0102**	0.1	0.0025					0.0014					0.0036					0.0046				
Cobalt	nonpar	32	5	**0.008**	--	0.001	U				0.001	U				0.001	U				0.001	U			
Copper	nonpar	28	9	**0.004**	1.3	0.001					0.002					0.003					0.003				
Iron	nonpar	32	5	**0.031**	0.3	0.005	U				0.005	U				0.026					0.005	U			
Manganese	nonpar	29	9	**0.0061**	0.05	**0.0065**		V			0.0052					**0.0106**		V			0.004				
Nickel	nonpar	32	0	**0.005**	0.1	0.005	U				0.005	U				0.005	U	P			0.005	U			
Zinc	normal	30	15	**0.007**	5	0.001		P			0.003					0.002					0.001	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.

	Statistical Method	No. of Samples	No. of Detects	Prediction Limit (a)	MCL	Downgradient															Upgradient				
						LG-01					LG-04					LG-05					LG-02				
						10/9/12	D	V	T	C	10/9/12	D	V	T	C	10/9/12	D	V	T	C	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			

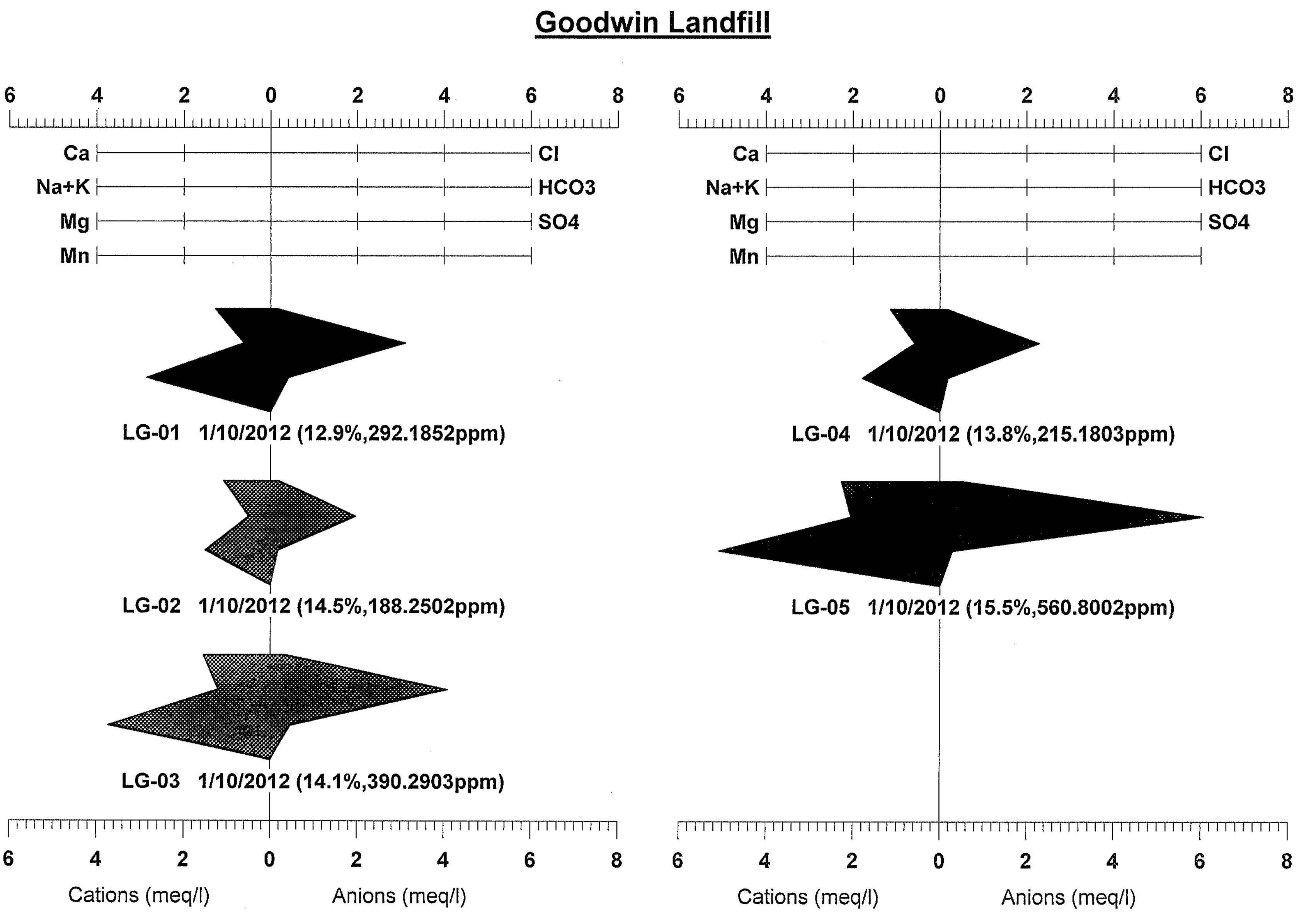
D Column: U = Compound not detected in any sample; V Column: V = verified hit, E = exceedance, waiting verification; P = Passed, exceedance not verified

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

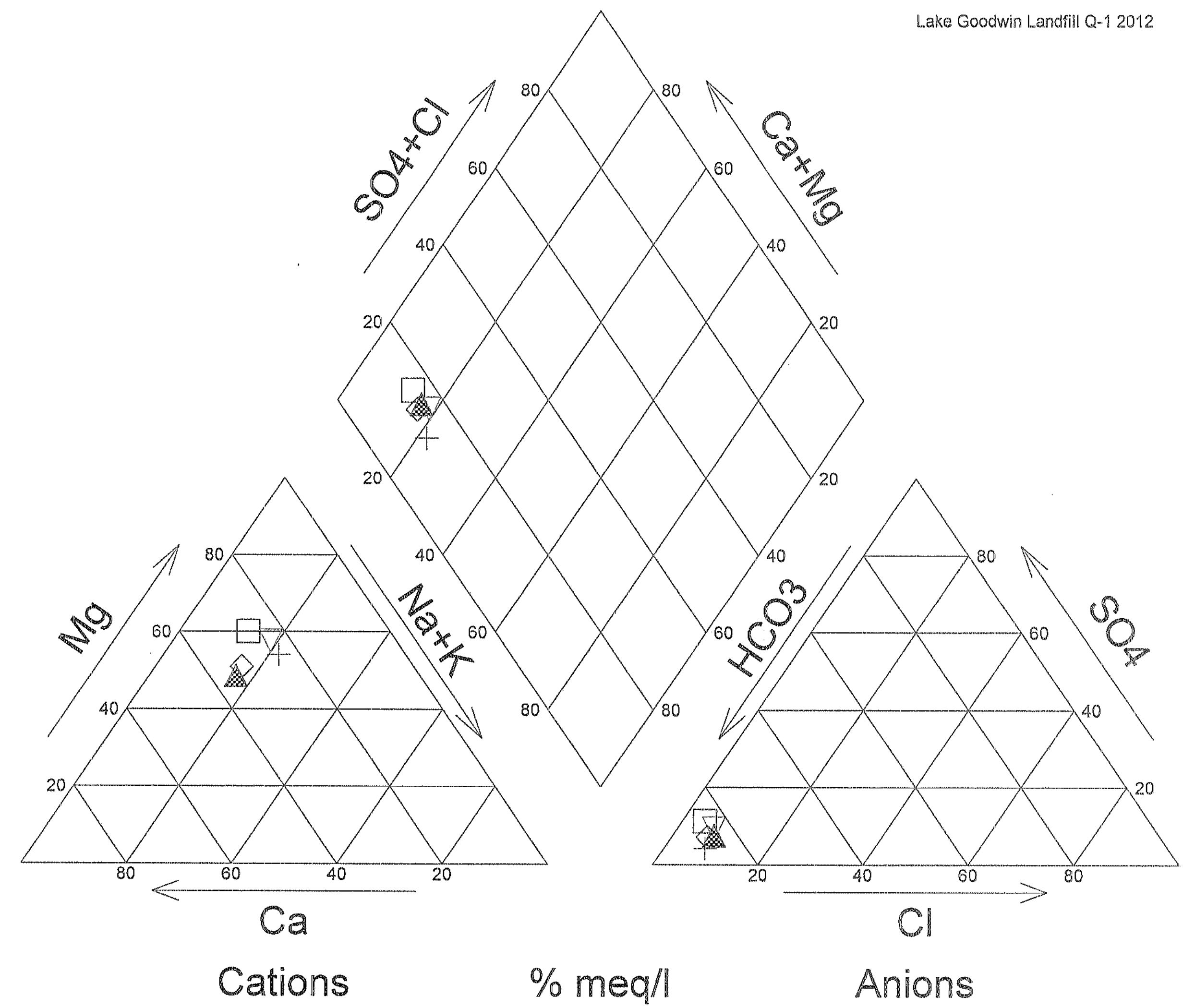
Quarter 1



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

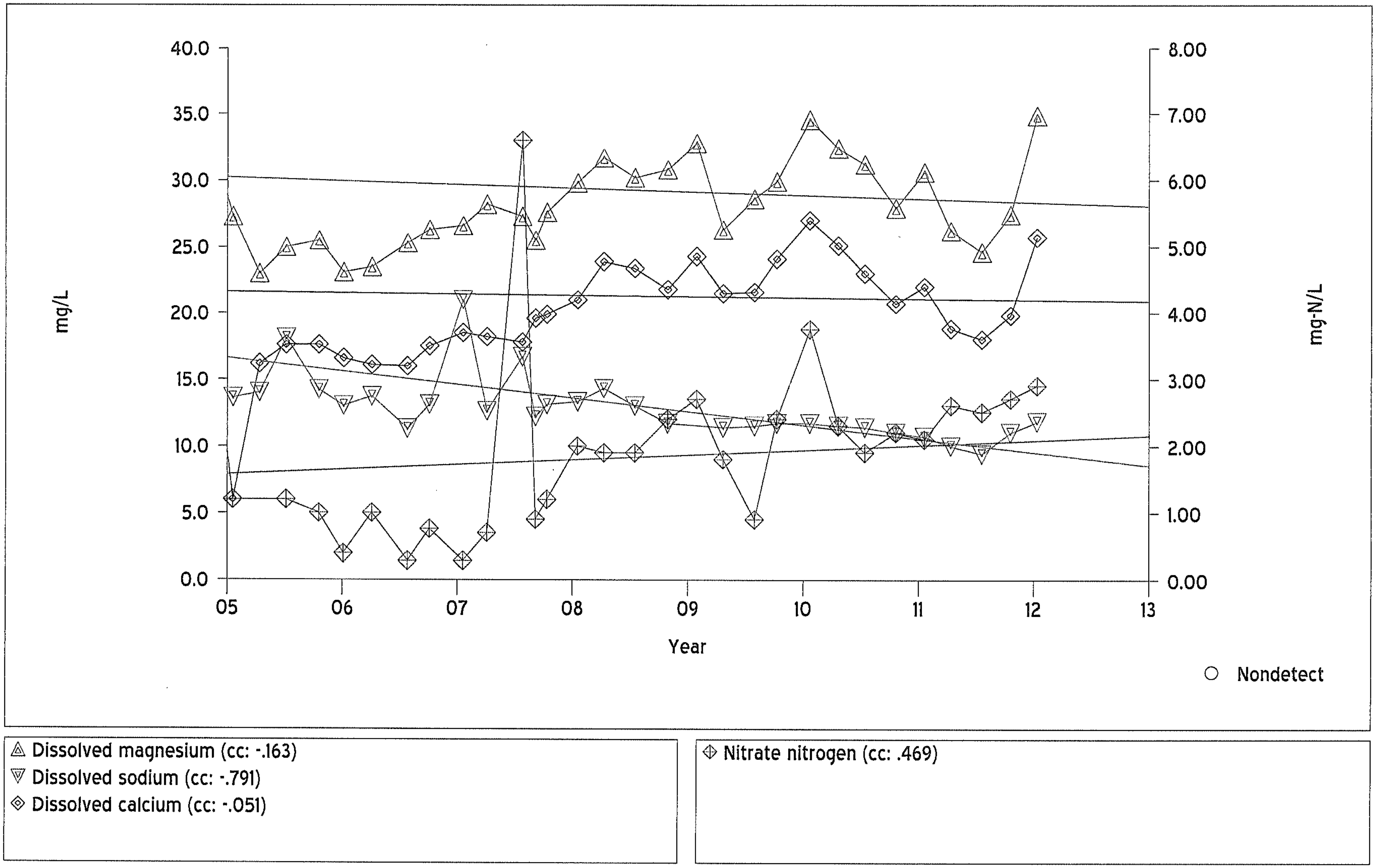
□	LG-01	1/10/2012 (12.9%,292.185ppm)
▲	LG-02	1/10/2012 (14.5%,188.25ppm)
▽	LG-03	1/10/2012 (14.1%,390.29ppm)
◇	LG-04	1/10/2012 (13.8%,215.18ppm)
+	LG-05	1/10/2012 (15.5%,560.8ppm)



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

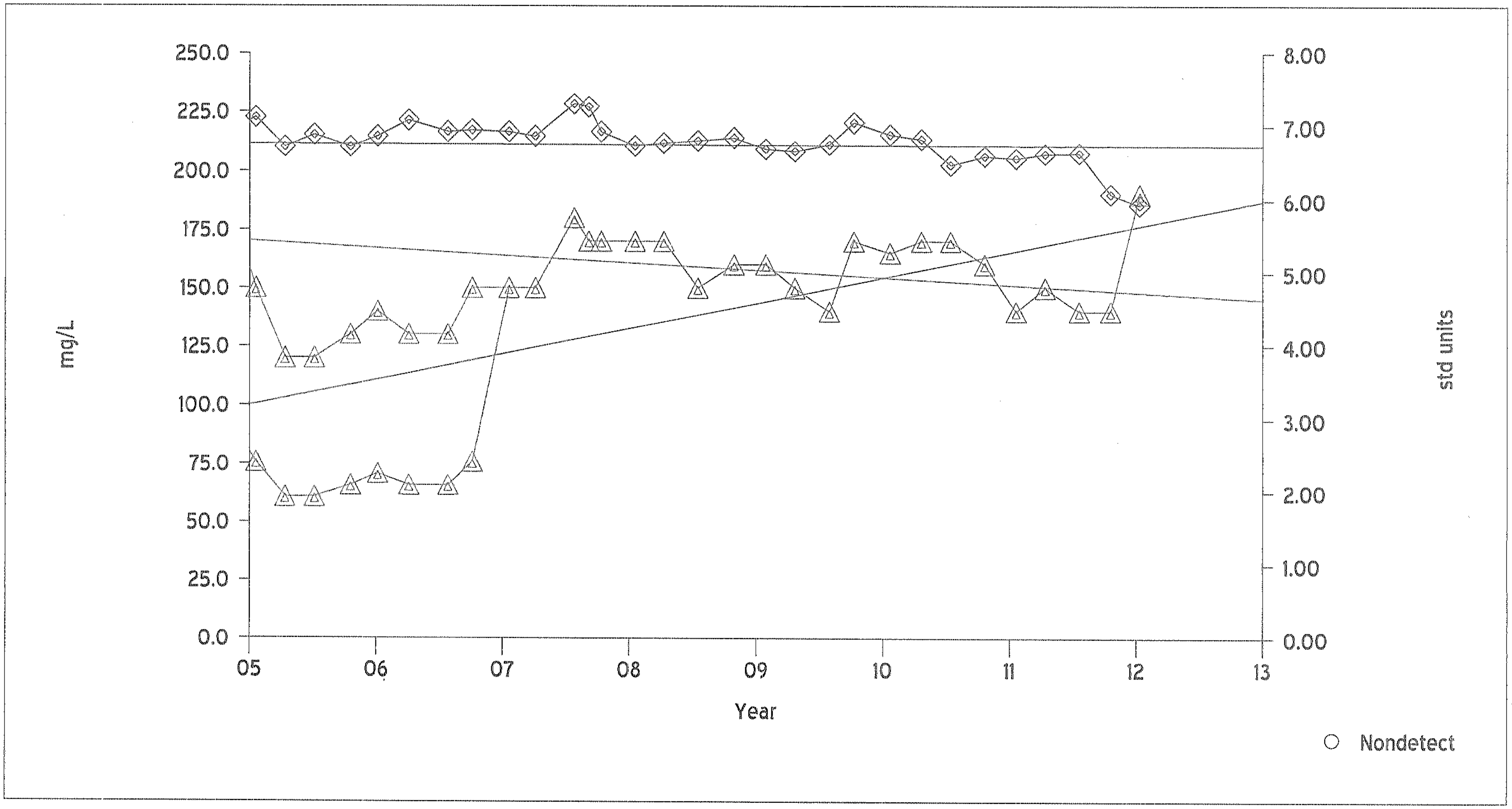
Time Series Plot for LG-01



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-01



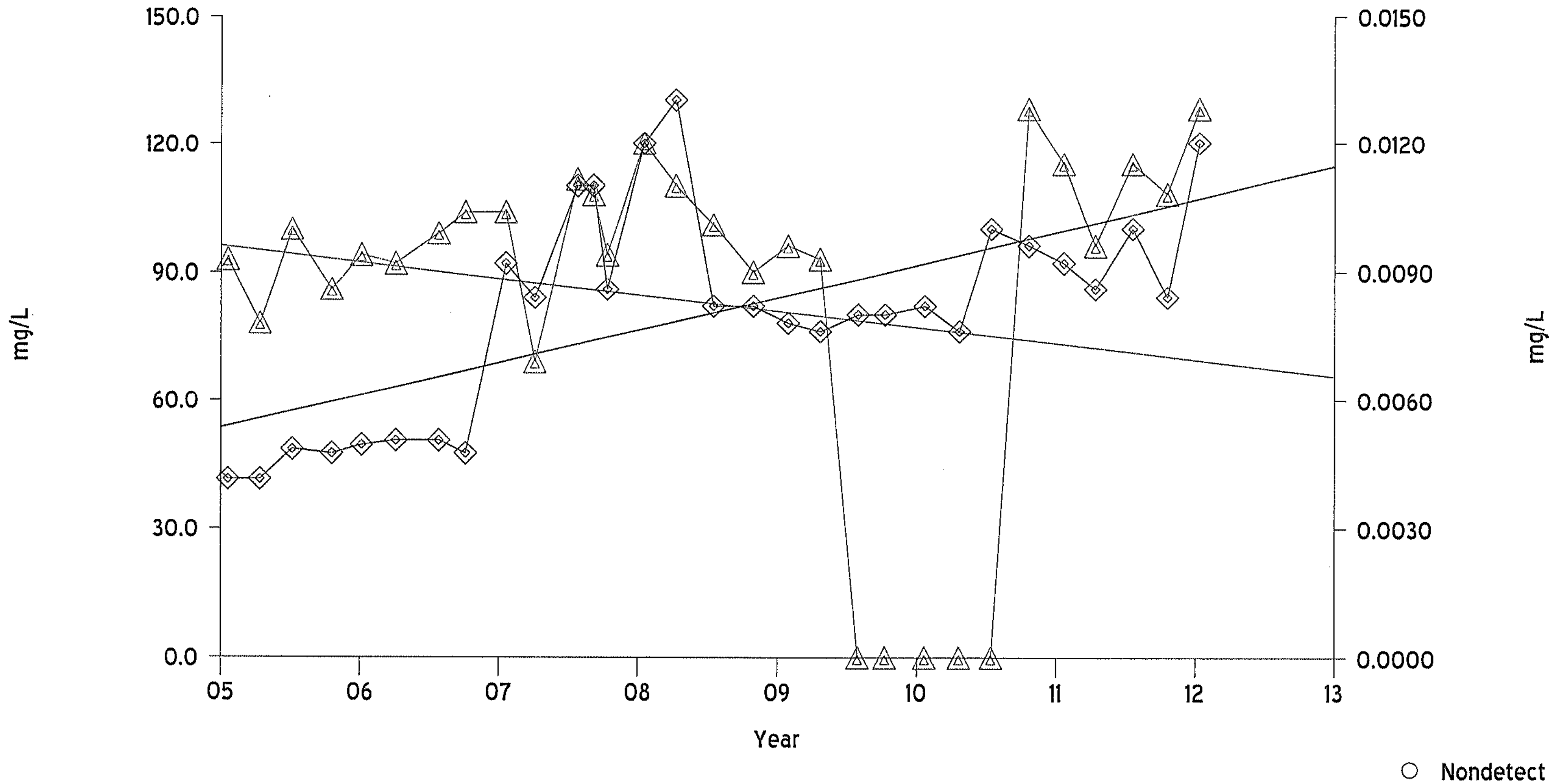
Bicarbonate (cc: -.320)
Alkalinity (as caco3) (cc: .686)

pH (cc: -.132)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-02



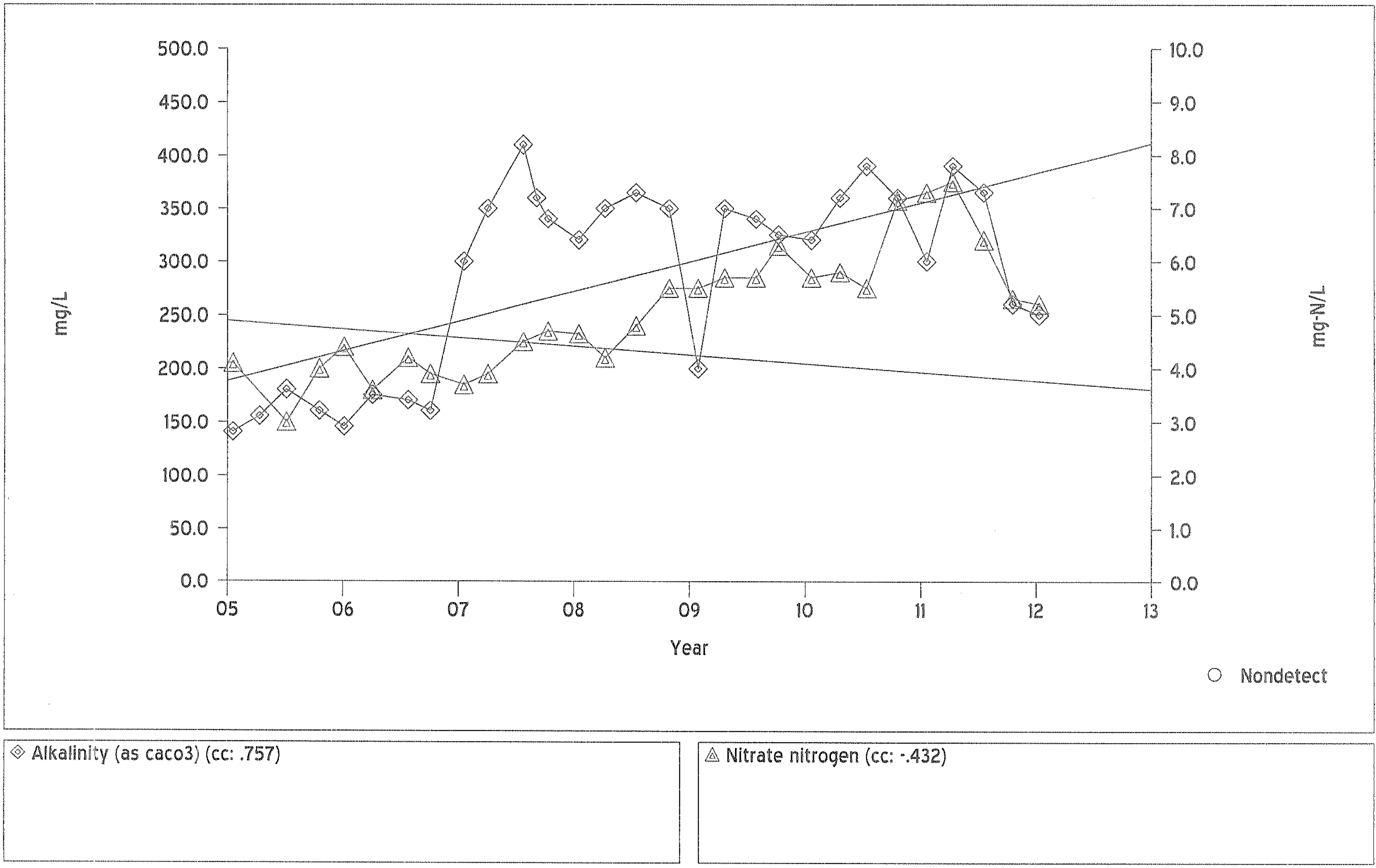
◇ Alkalinity (as caco3) (cc: .748)

△ Dissolved barium (cc: -.464)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

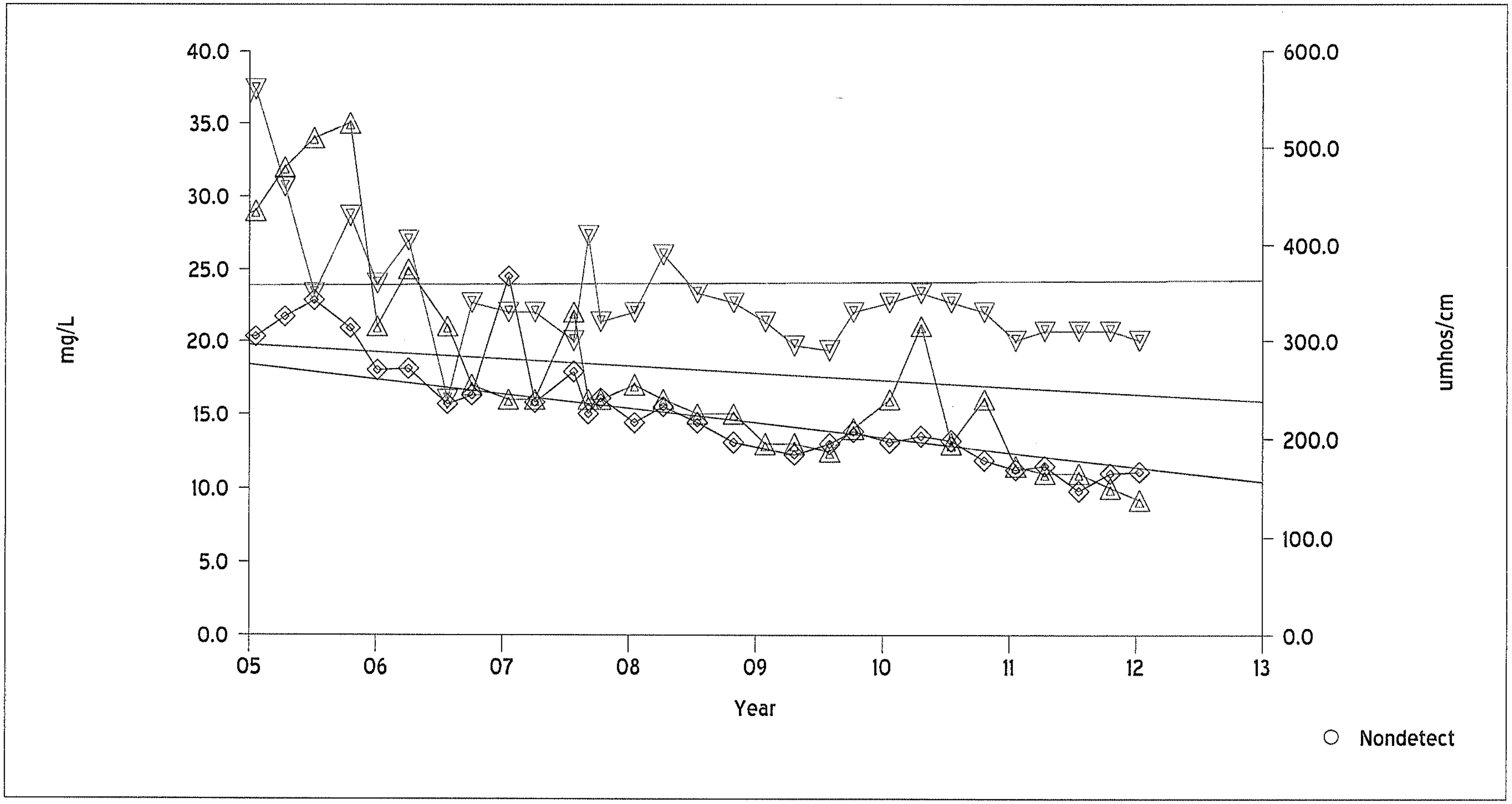
Time Series Plot for LG-03



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



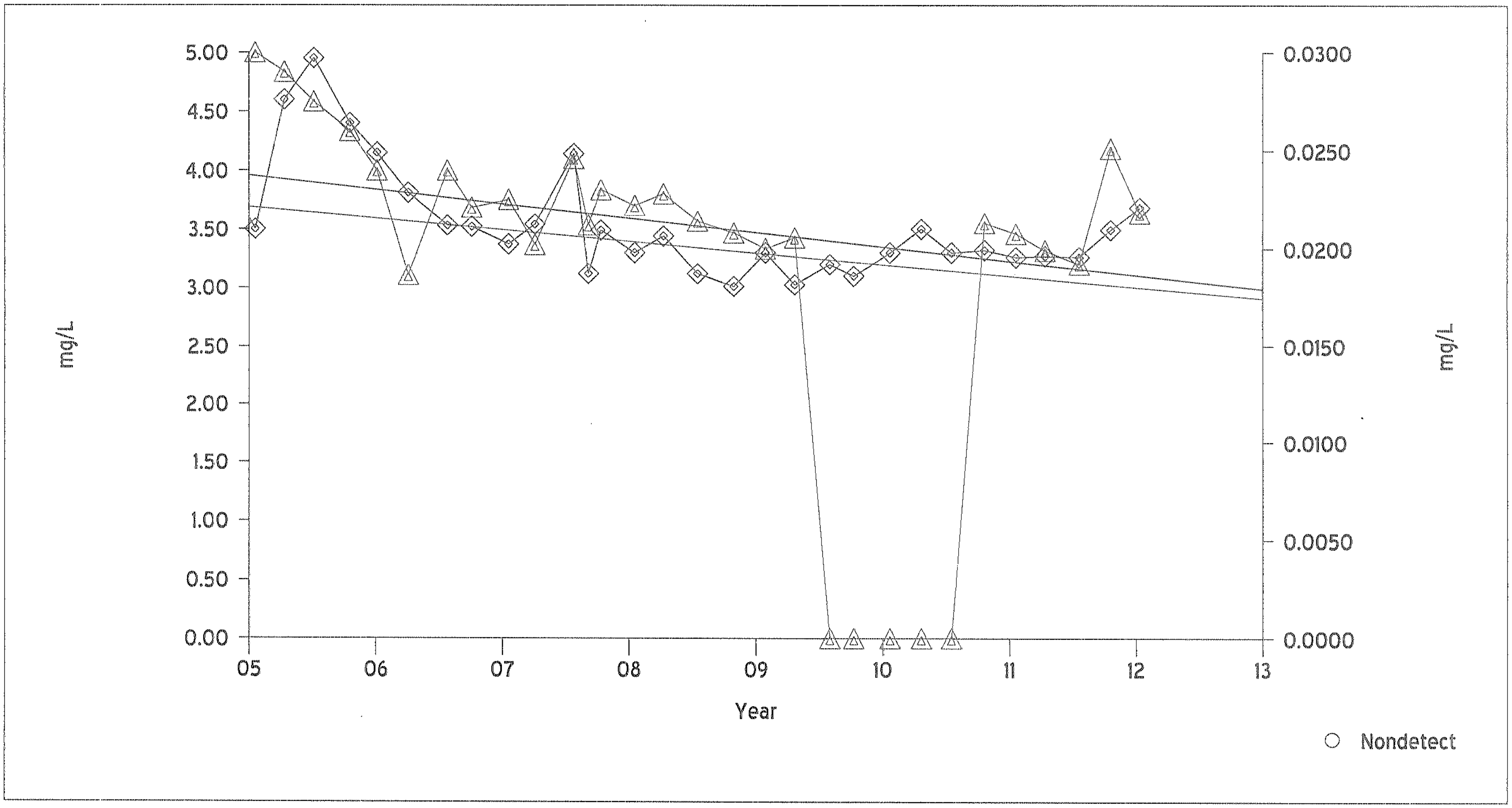
Sulfate (cc: -.271)
Dissolved sodium (cc: -.710)

Conductivity (cc: .066)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



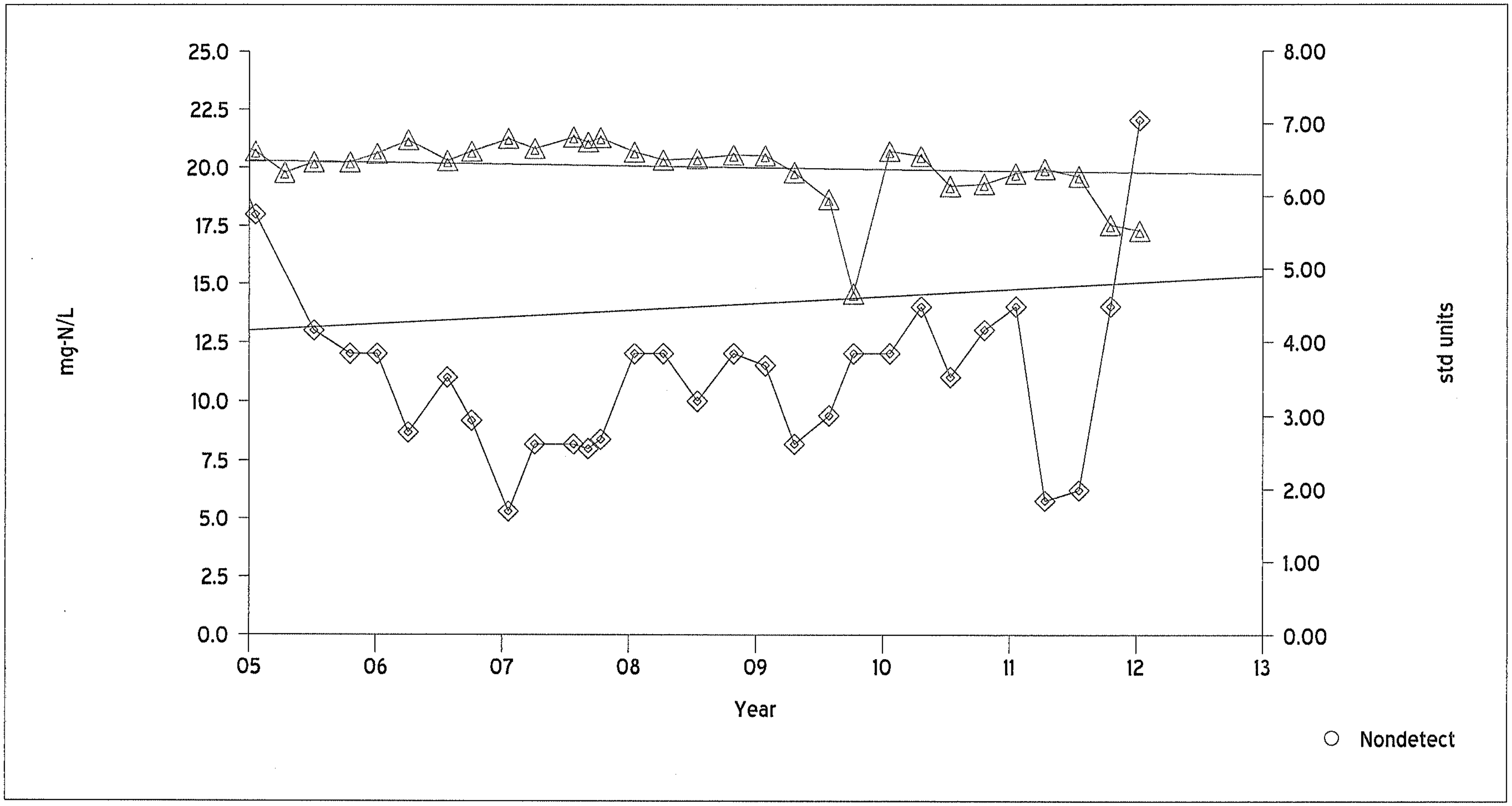
◇ Dissolved potassium (cc: -.655)

△ Dissolved barium (cc: -.402)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



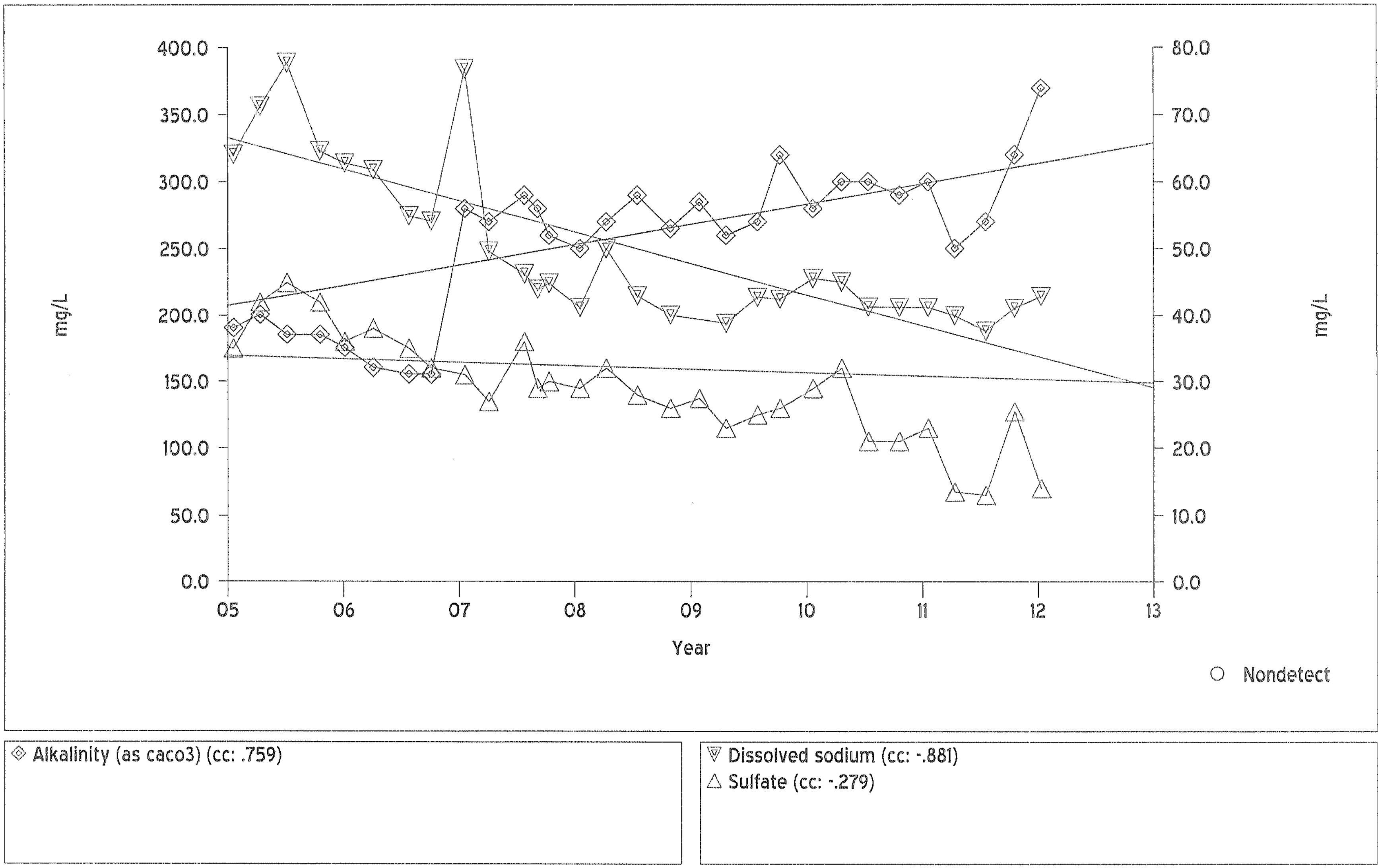
◇ Nitrate nitrogen (cc: .257)

△ pH (cc: -.429)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

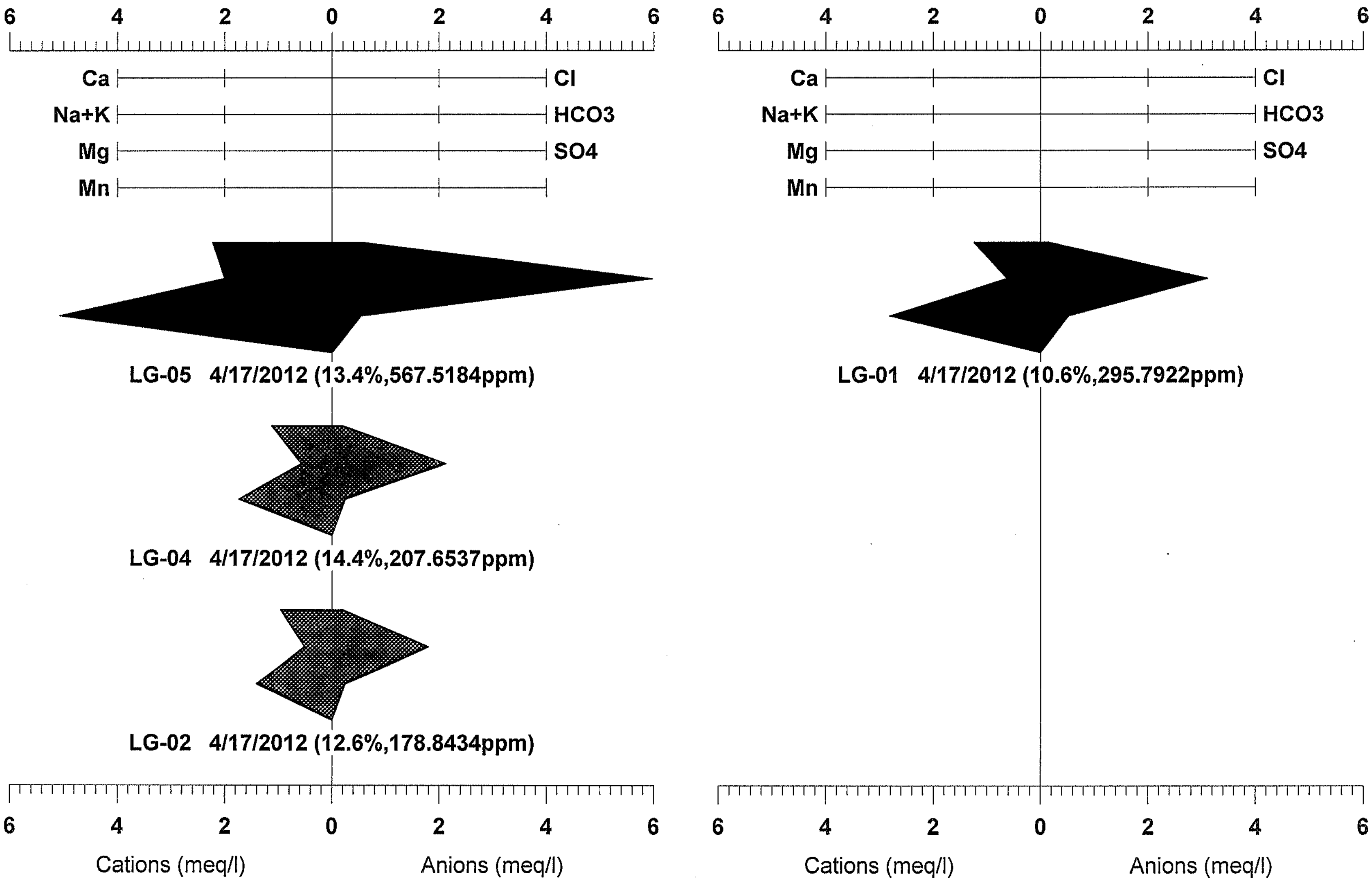
Time Series Plot for LG-05



Prepared by: Snohomish County Solid Waste

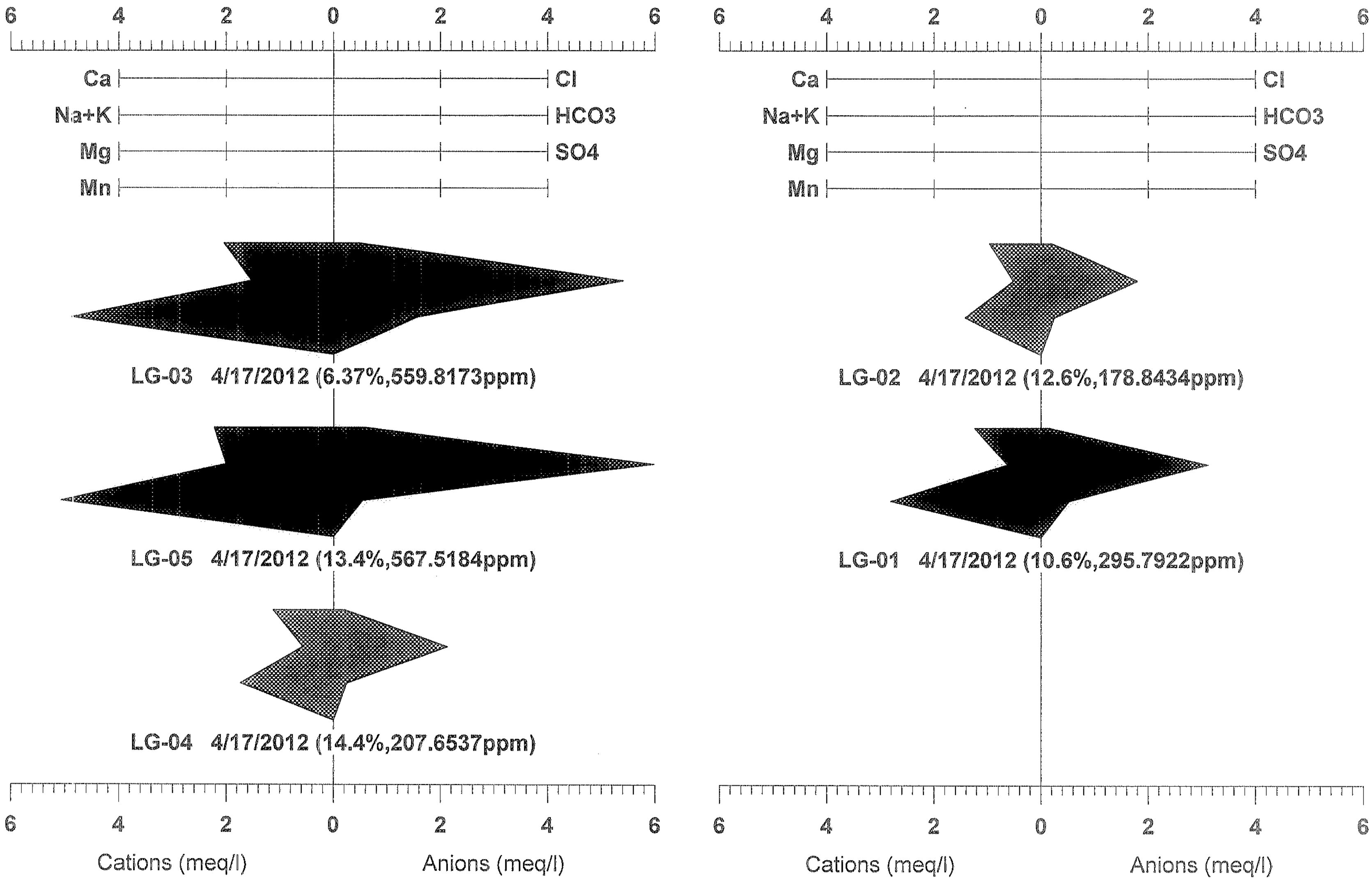
Quarter 2

Goodwin Landfill



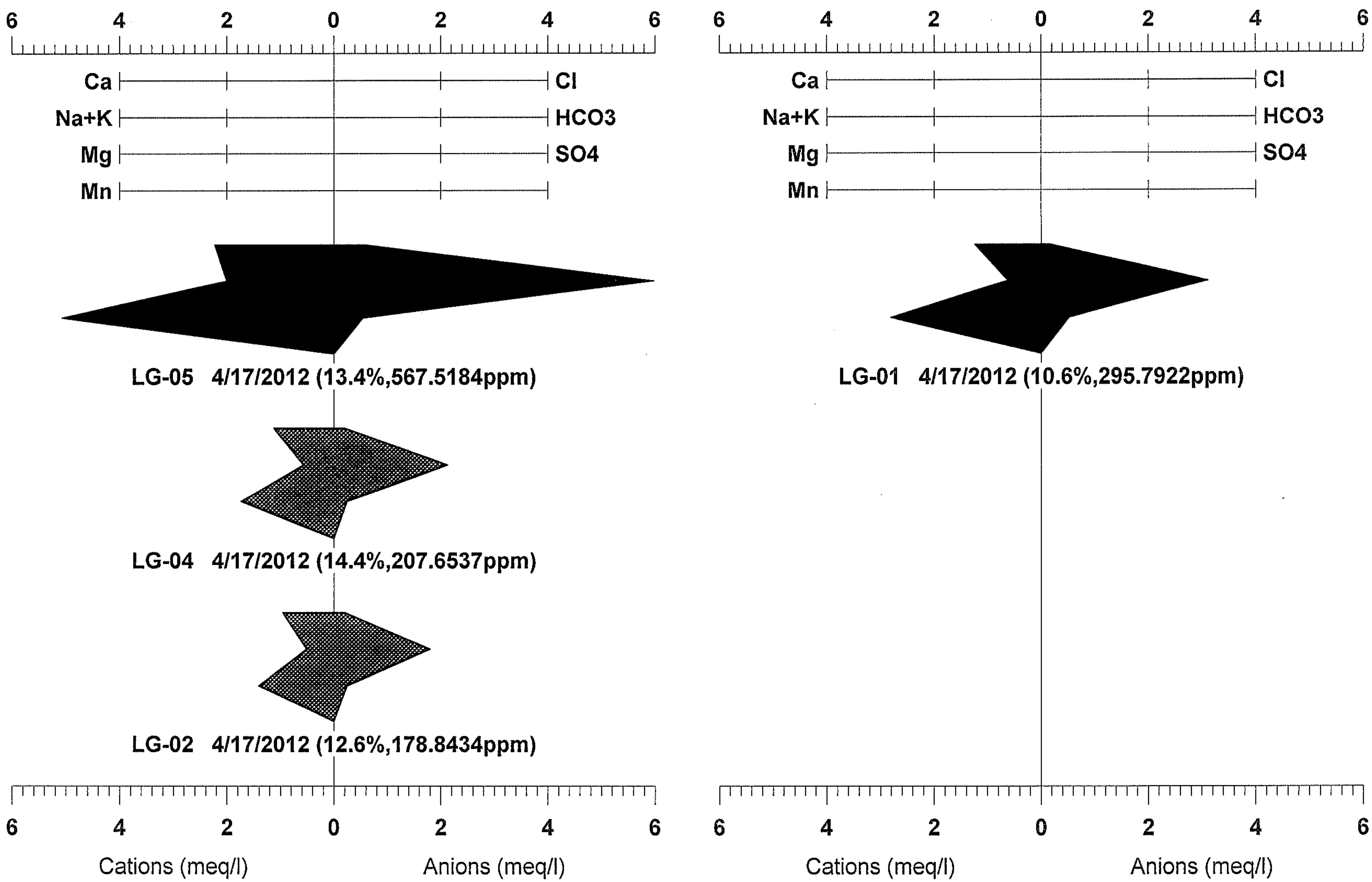
Prepared by: Snohomish County Solid Waste

Goodwin Landfill



Prepared by: Snohomish County Solid Waste

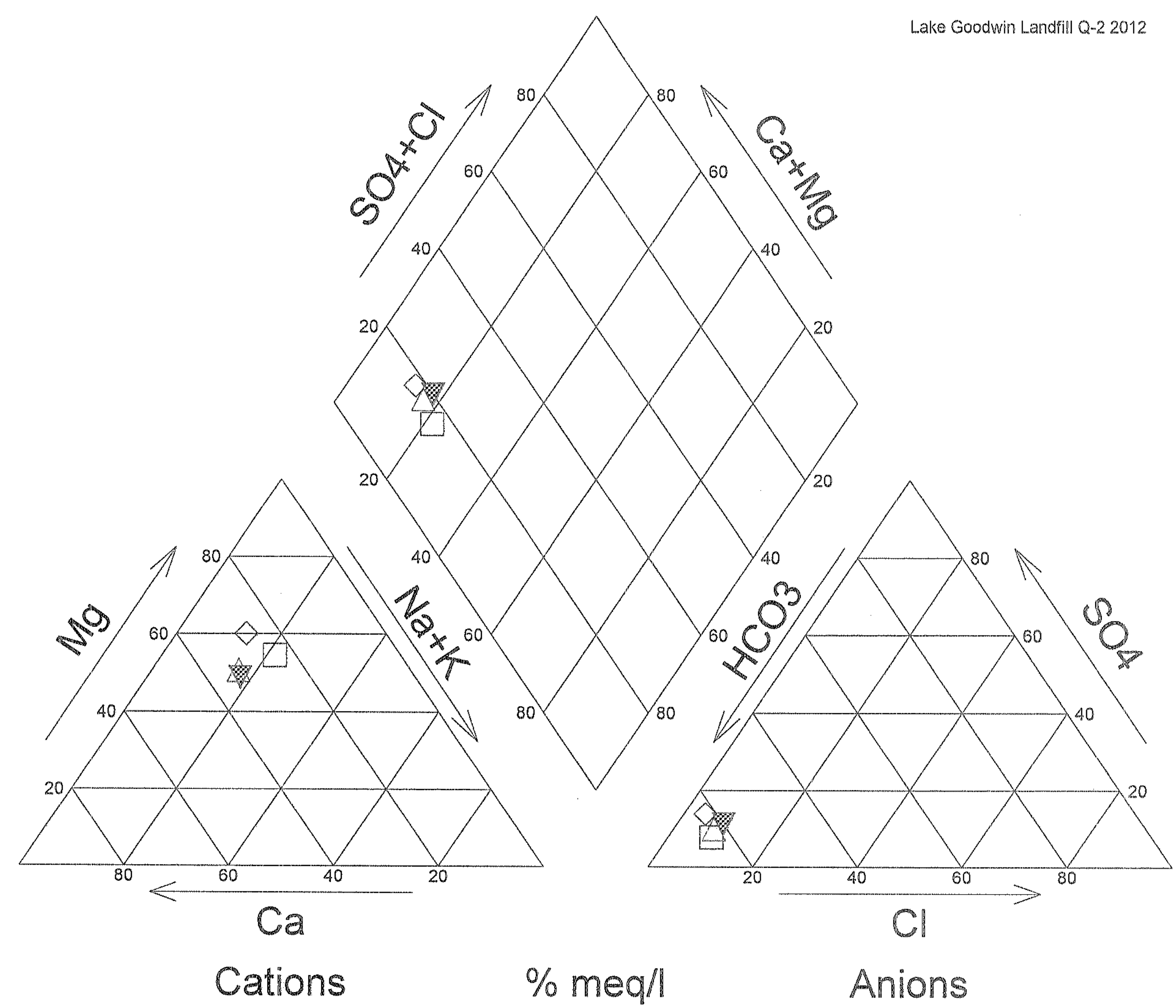
Goodwin Landfill



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

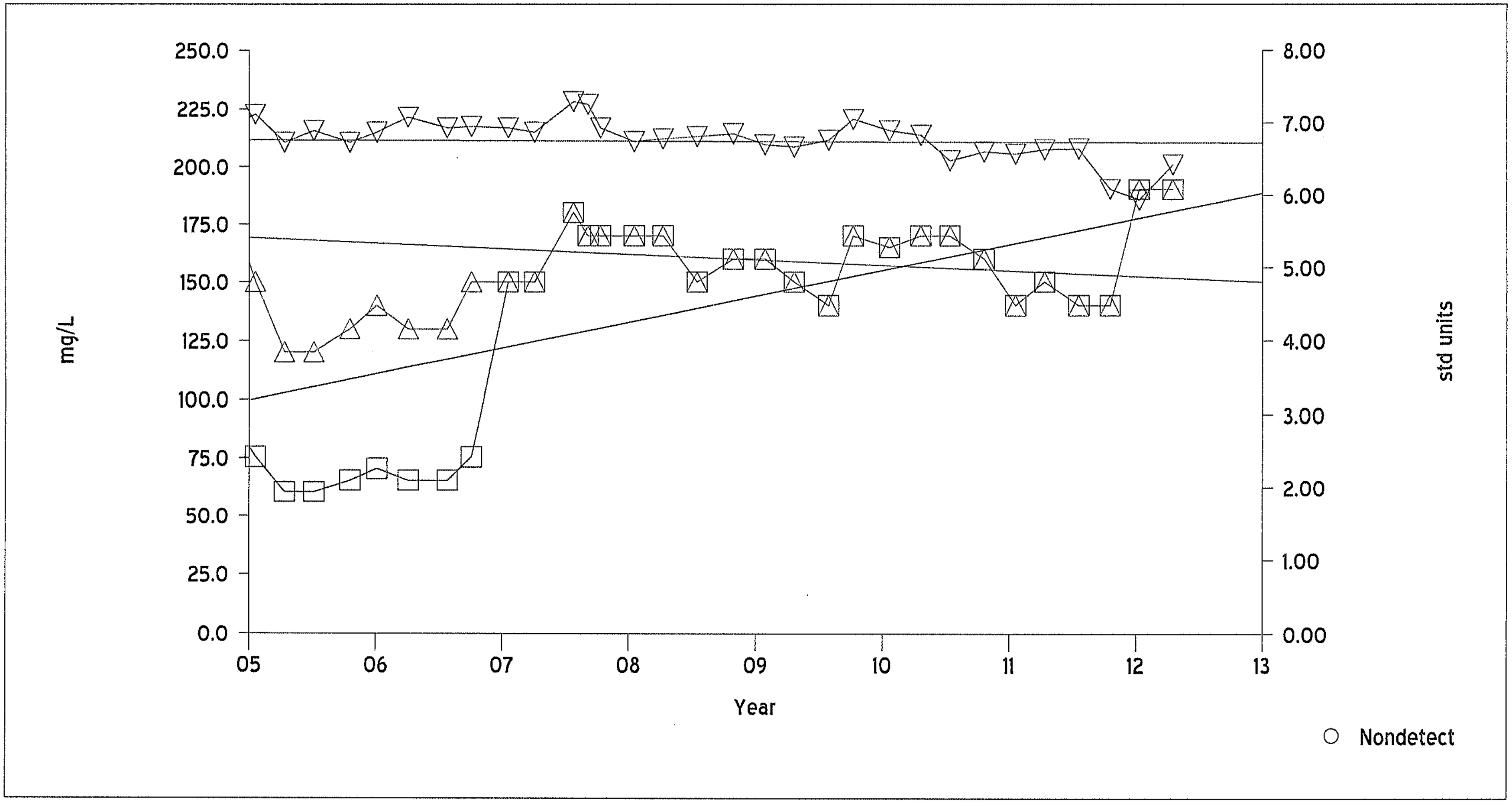
□	LG-05	4/17/2012 (13.4%,567.51ppm)
△	LG-04	4/17/2012 (14.4%,207.65ppm)
▽	LG-02	4/17/2012 (12.6%,178.84ppm)
◇	LG-01	4/17/2012 (10.6%,295.78ppm)



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-01



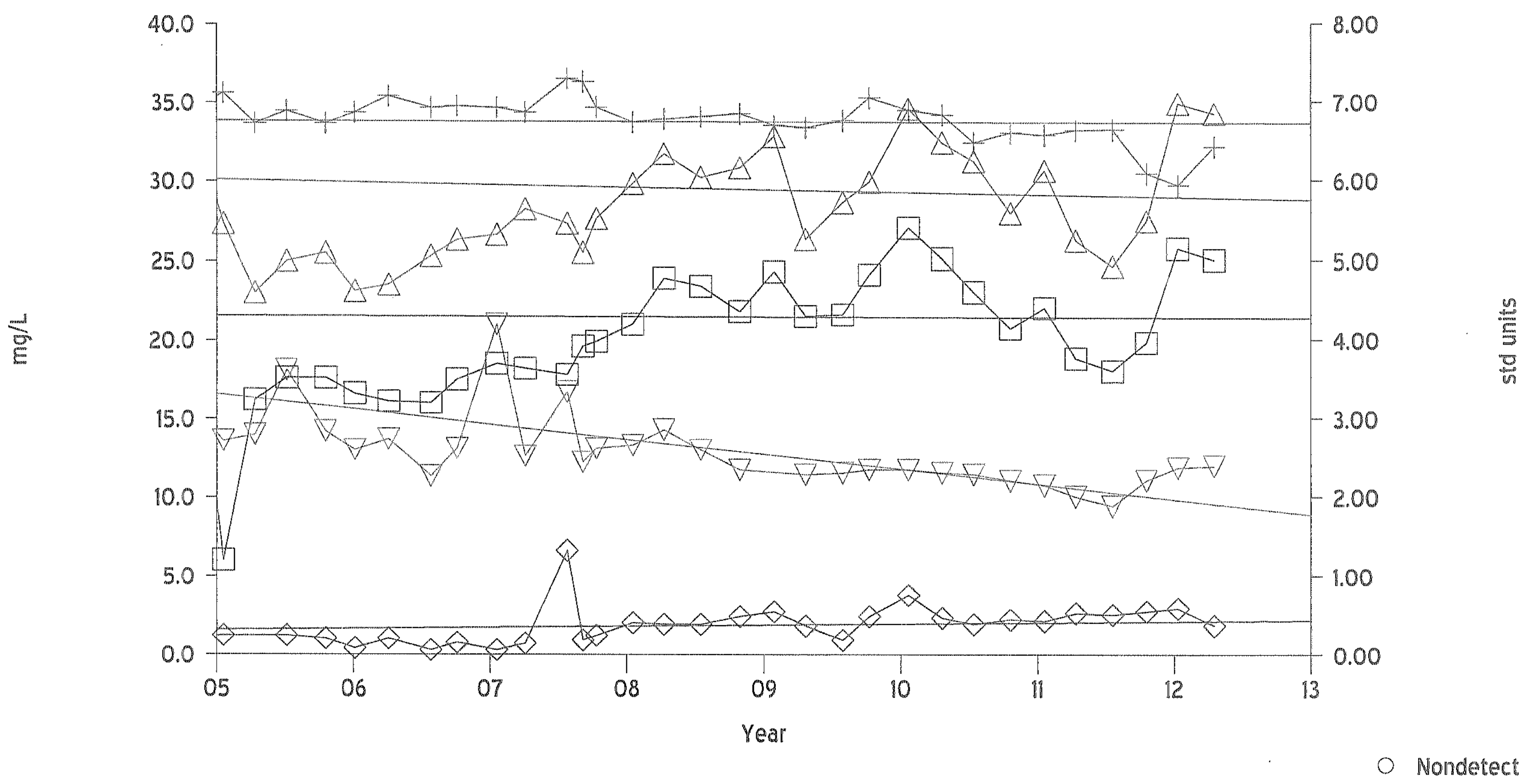
□ Alkalinity (as caco3) (cc: .706)
△ Bicarbonate (cc: -.251)

▽ pH (cc: -.158)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-01



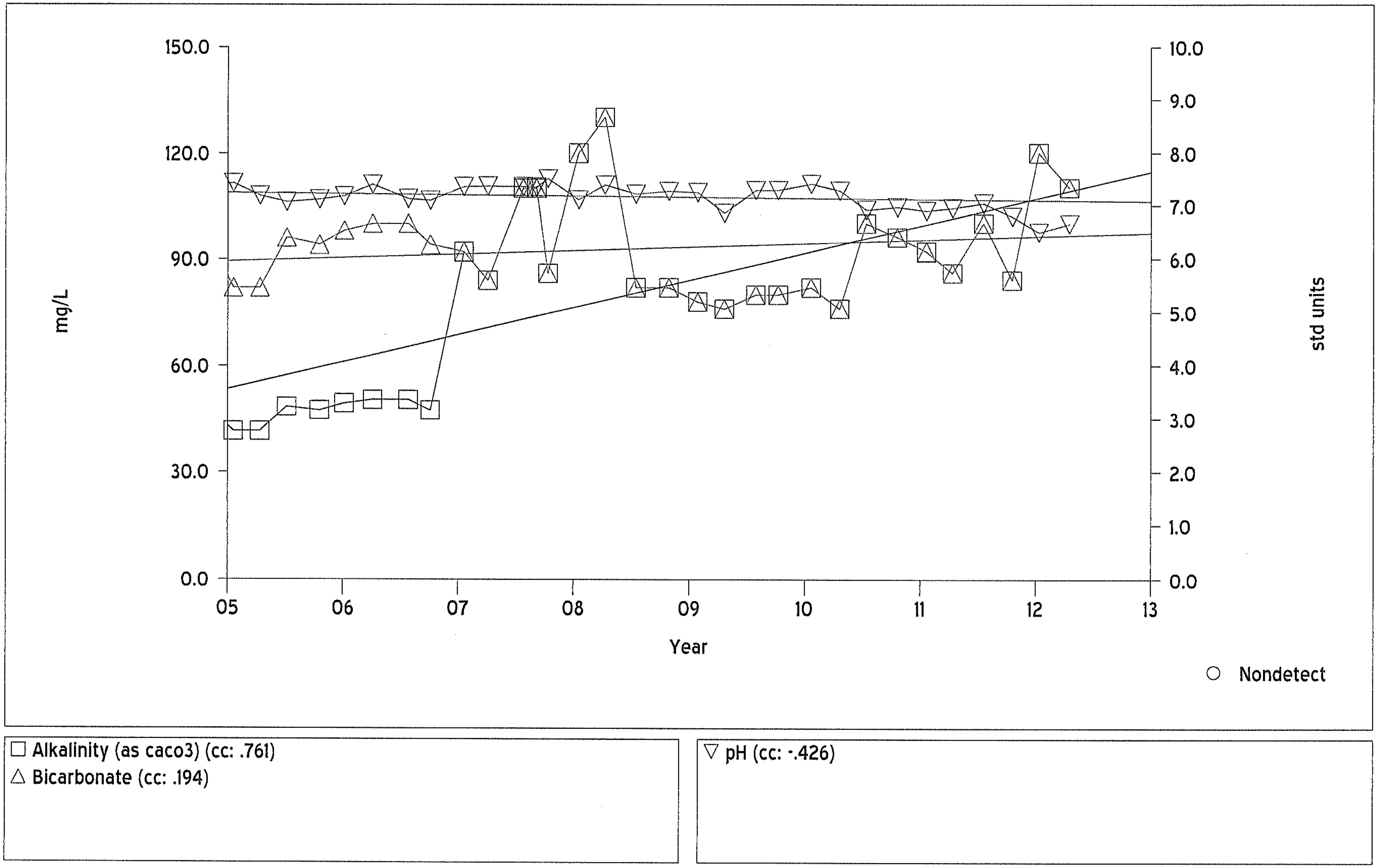
◇ Nitrate nitrogen (cc: .470)
□ Dissolved calcium (cc: -.015)
△ Dissolved magnesium (cc: -.104)
▽ Dissolved sodium (cc: -.783)

+ pH (cc: -.158)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

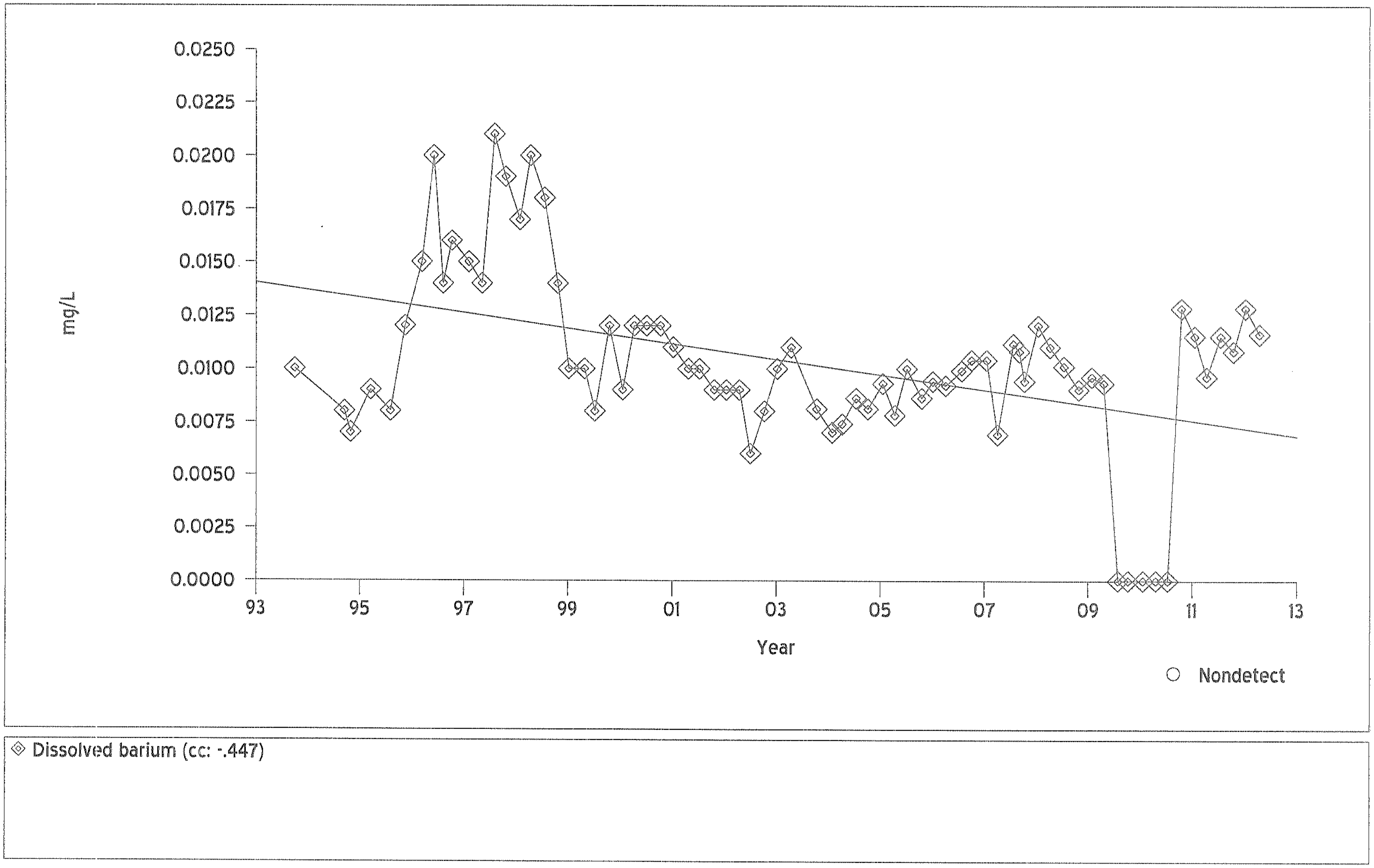
Time Series Plot for LG-02



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

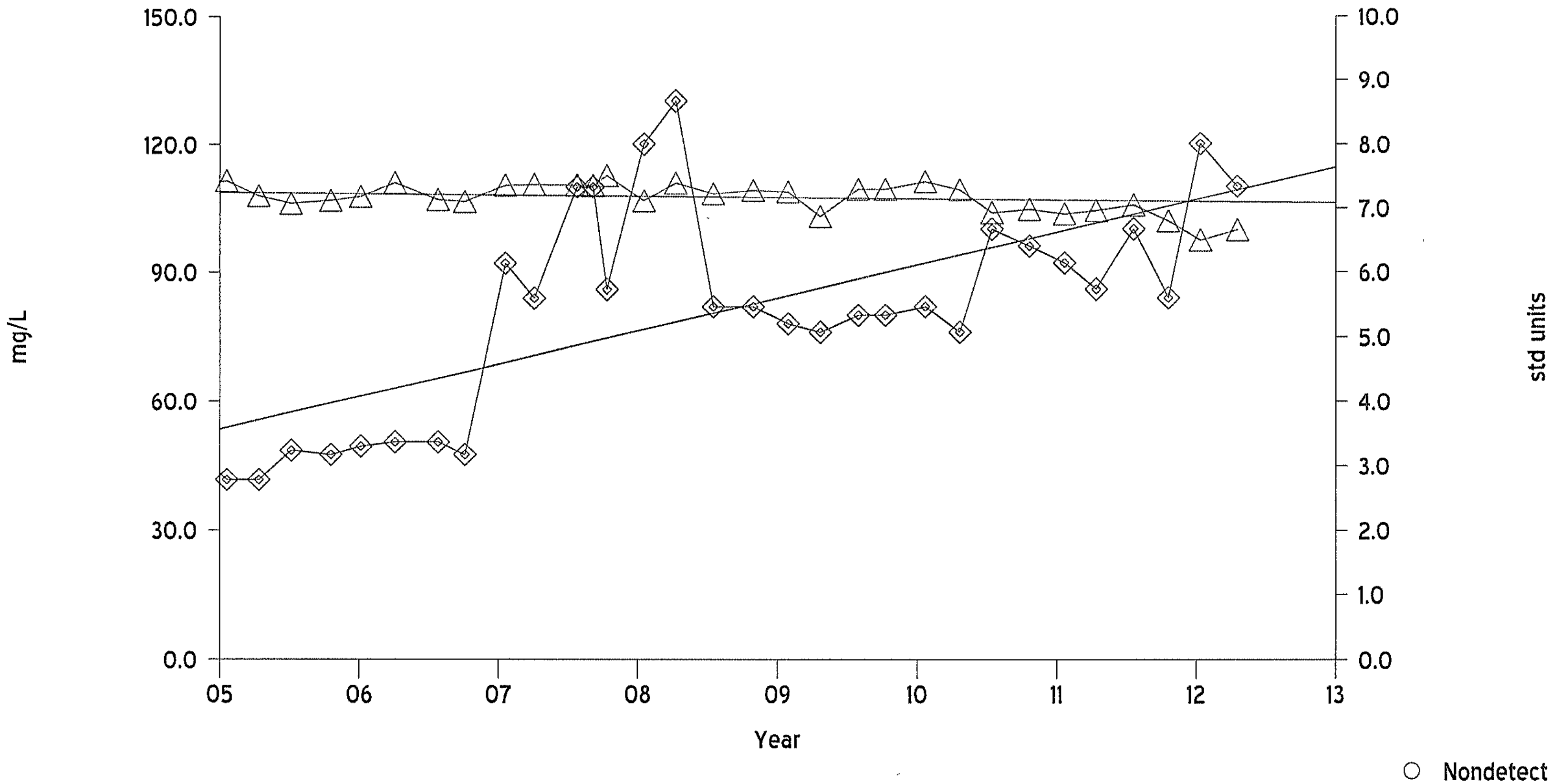
Time Series Plot for LG-02



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-02



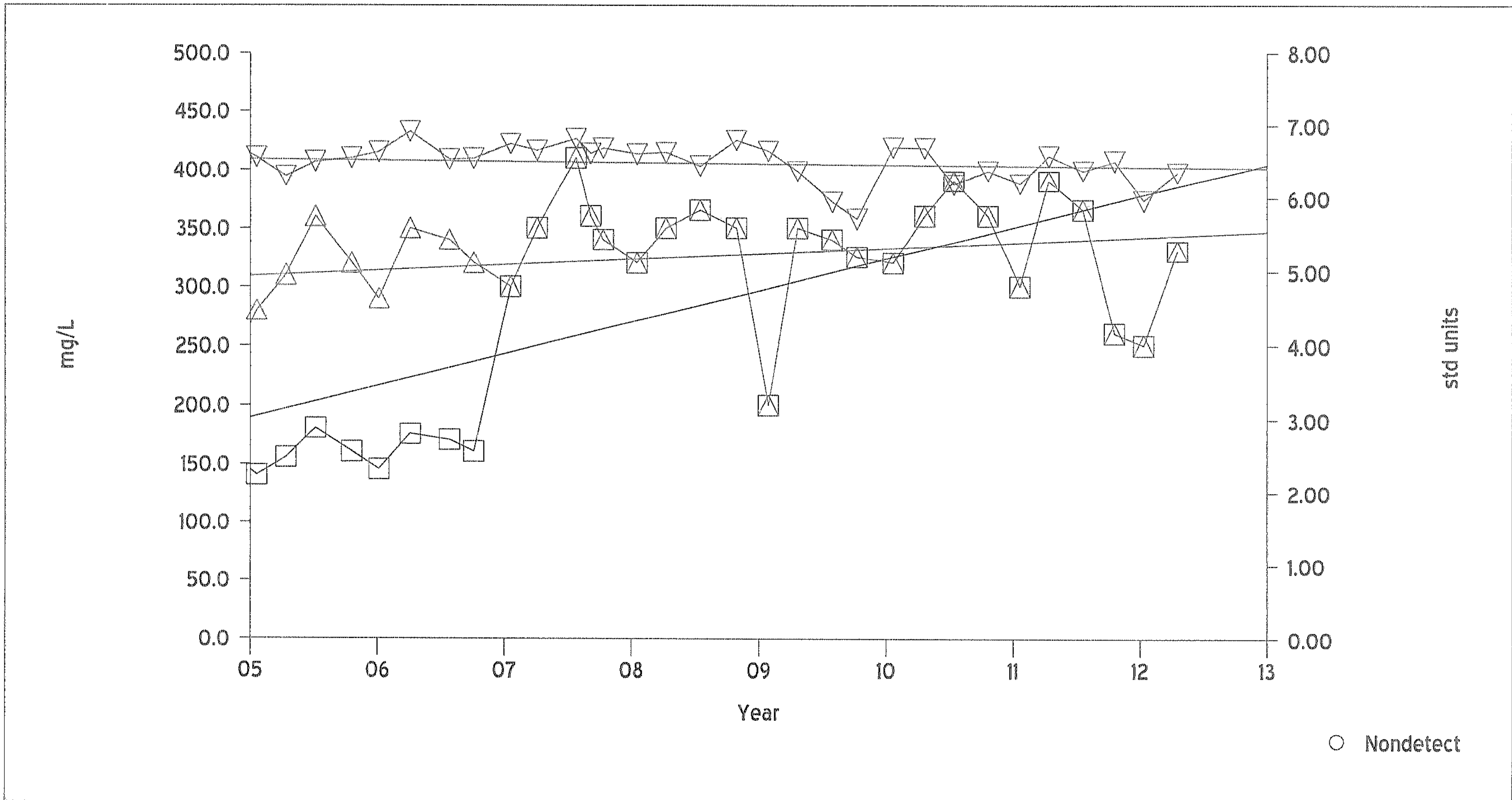
◇ Alkalinity (as caco3) (cc: .761)

△ pH (cc: -.426)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-03



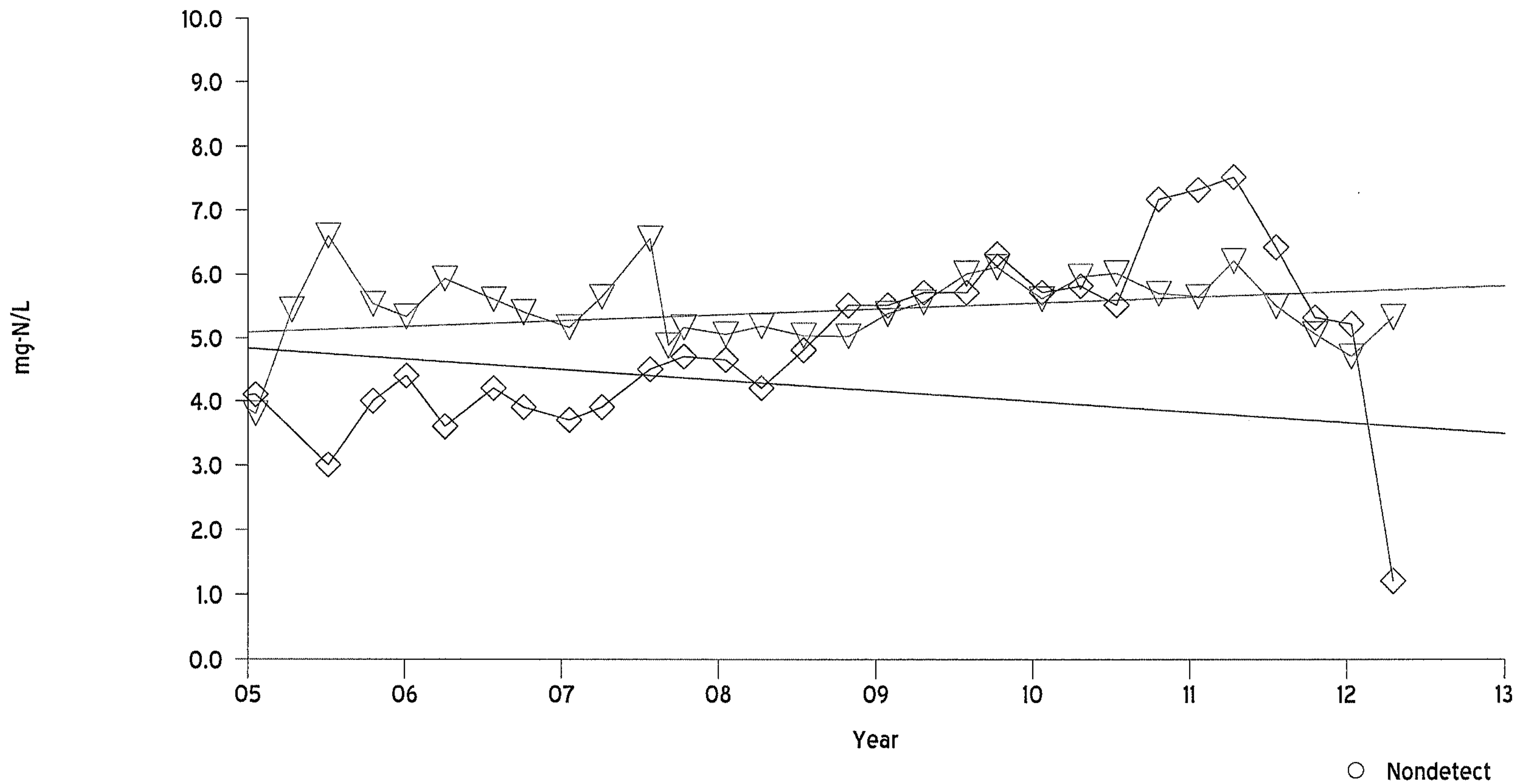
□ Alkalinity (as caco3) (cc: .754)
△ Bicarbonate (cc: .274)

▽ pH (cc: -.425)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-03

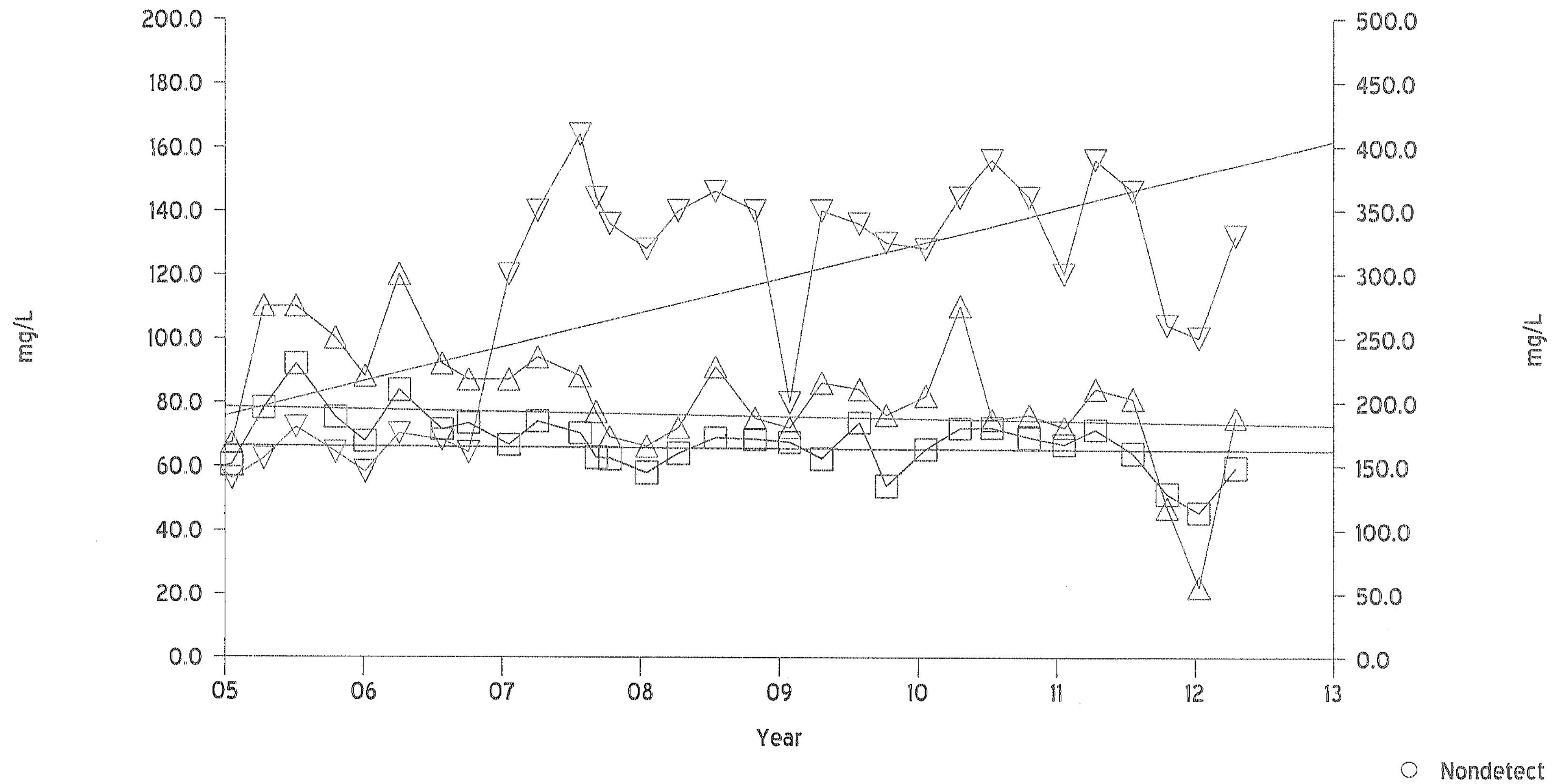


◇ Nitrate nitrogen (cc: -.454)
▽ Dissolved potassium (cc: .396)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-03

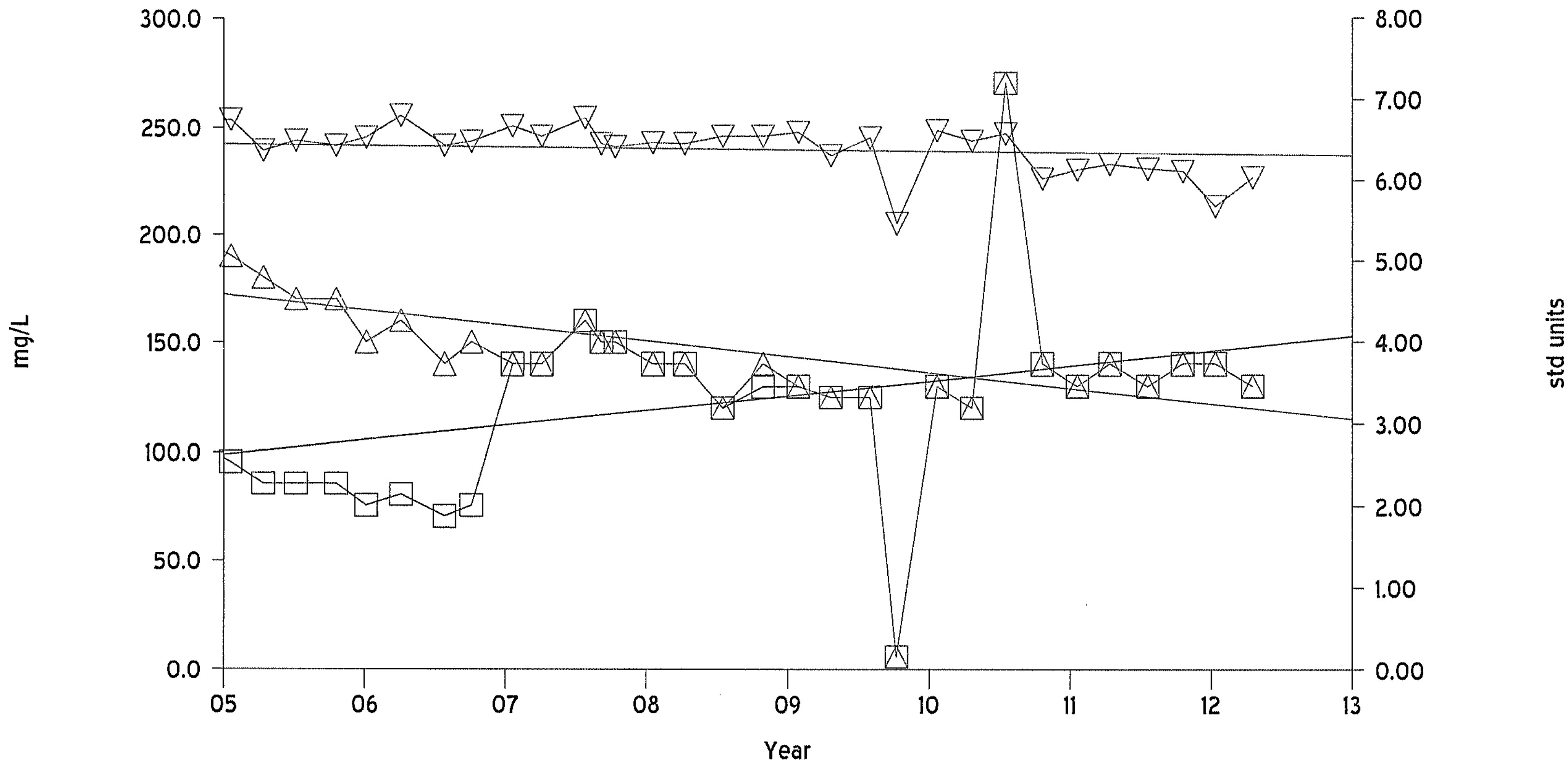


□ Dissolved magnesium (cc: -.064) △ Sulfate (cc: -.205)	▽ Alkalinity (as caco3) (cc: .754)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



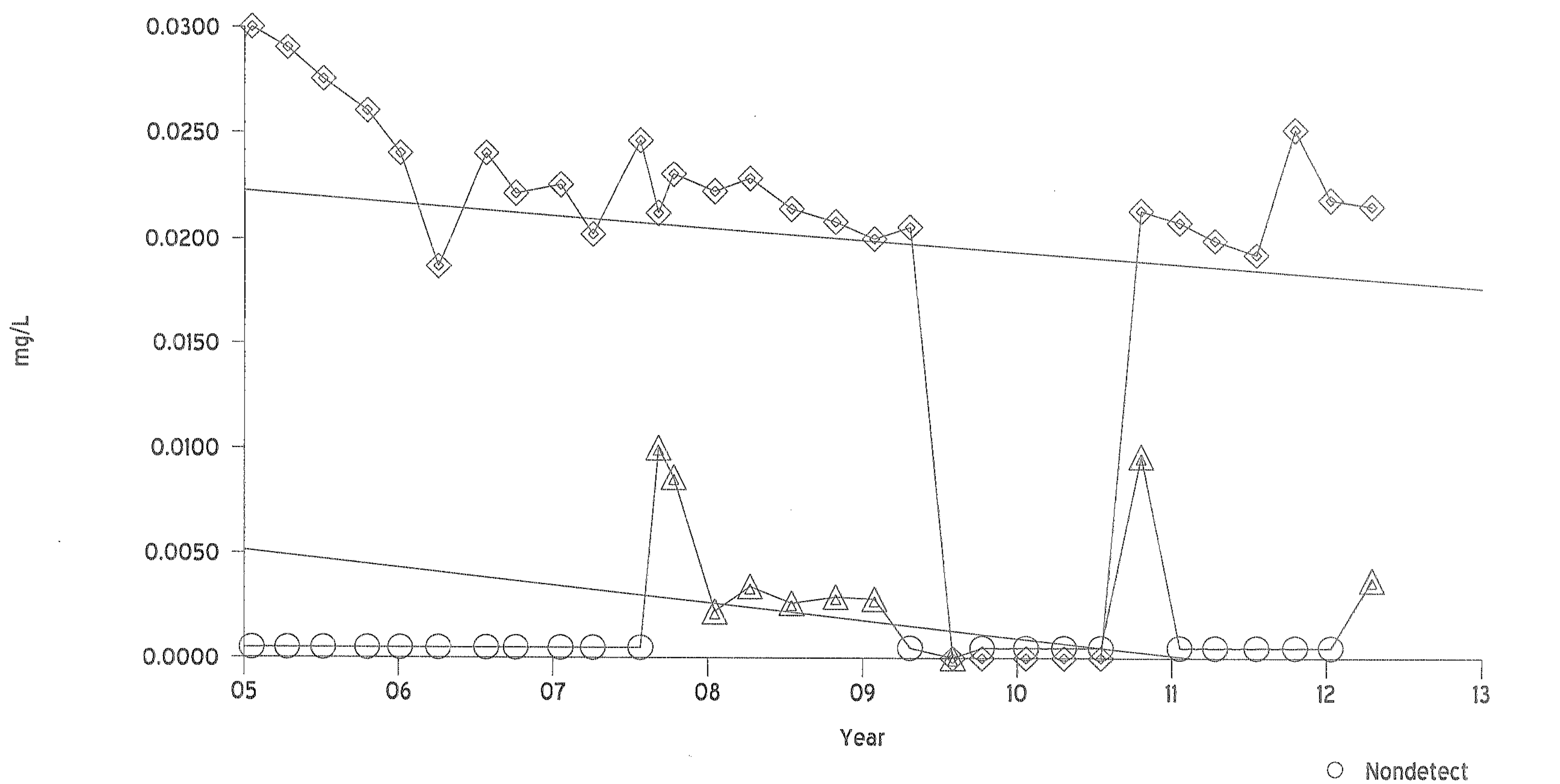
□ Alkalinity (as caco3) (cc: .446)
△ Bicarbonate (cc: -.484)

▽ pH (cc: -.458)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04

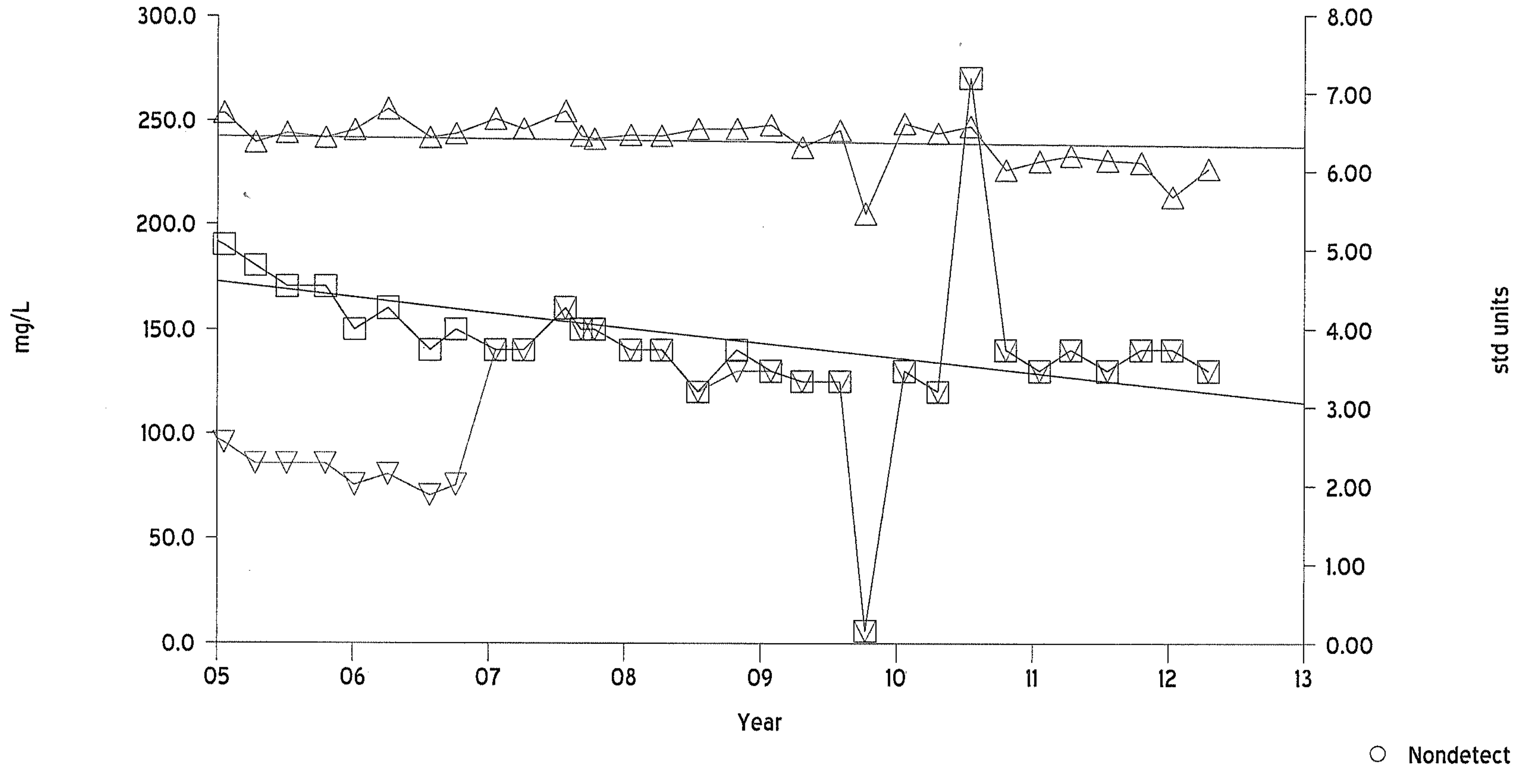


Dissolved manganese (cc: -.246)
Dissolved barium (cc: -.399)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



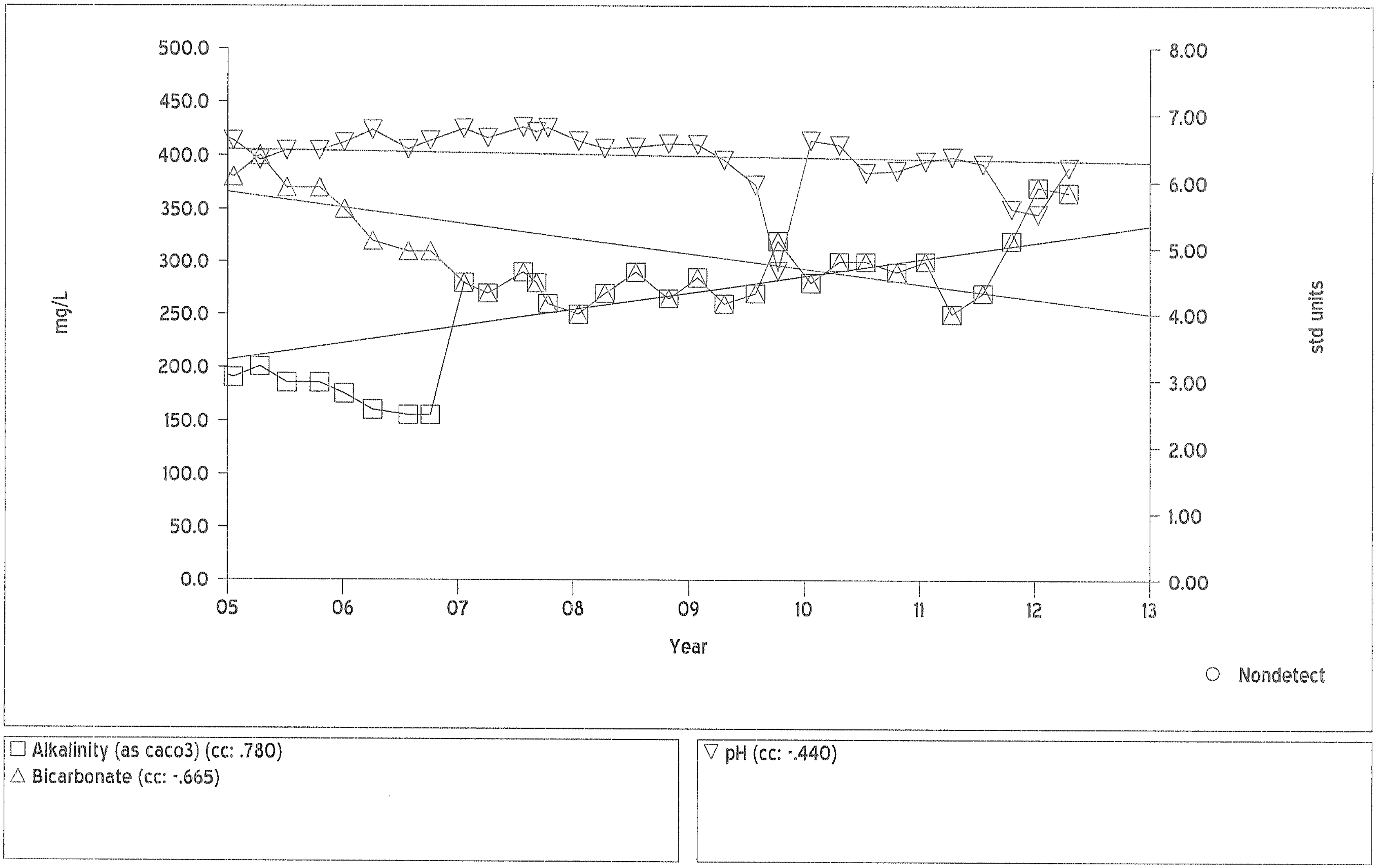
▽ Alkalinity (as caco3)
□ Bicarbonate (cc: -.484)

△ pH (cc: -.458)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

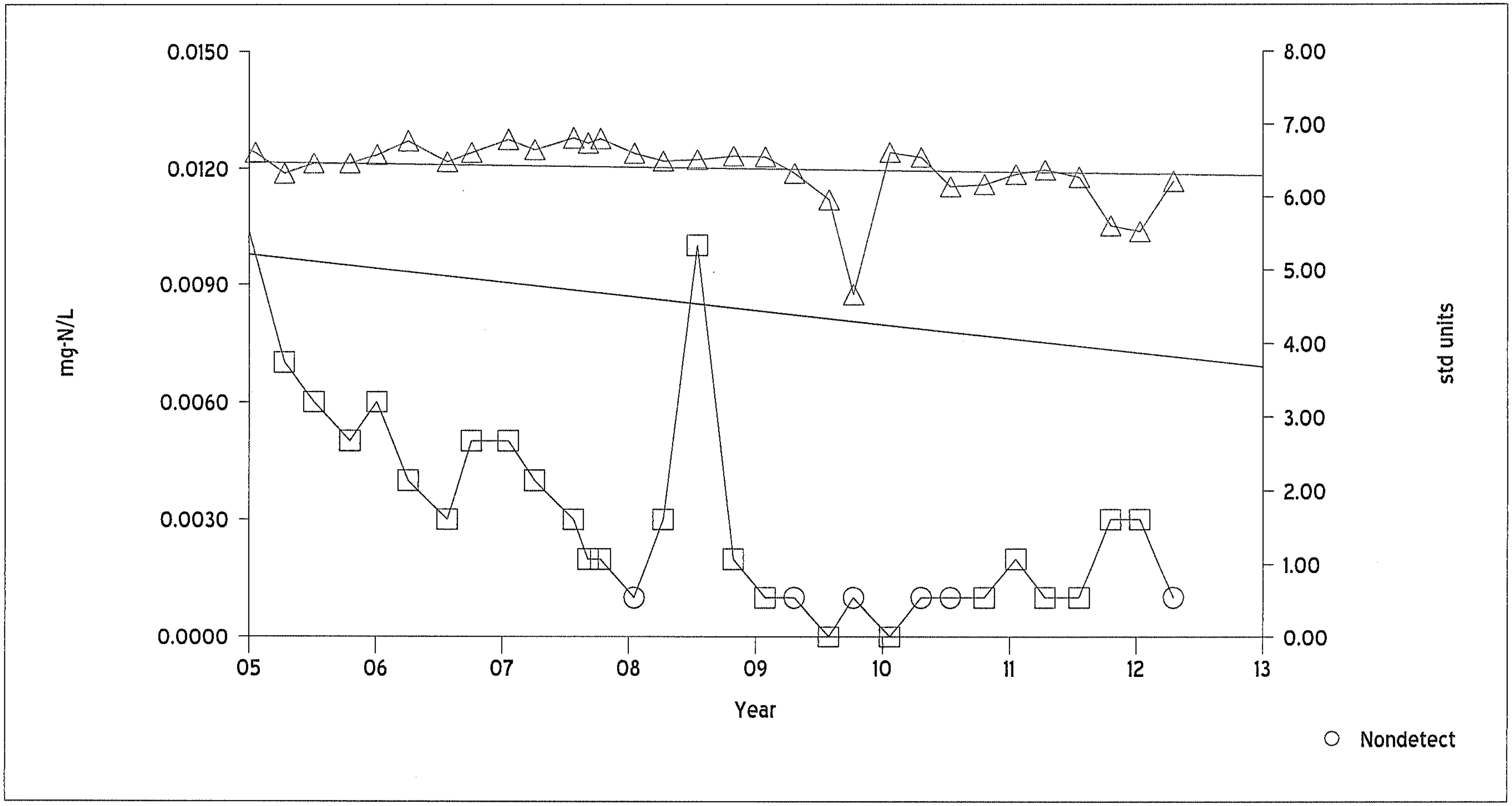
Time Series Plot for LG-05



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



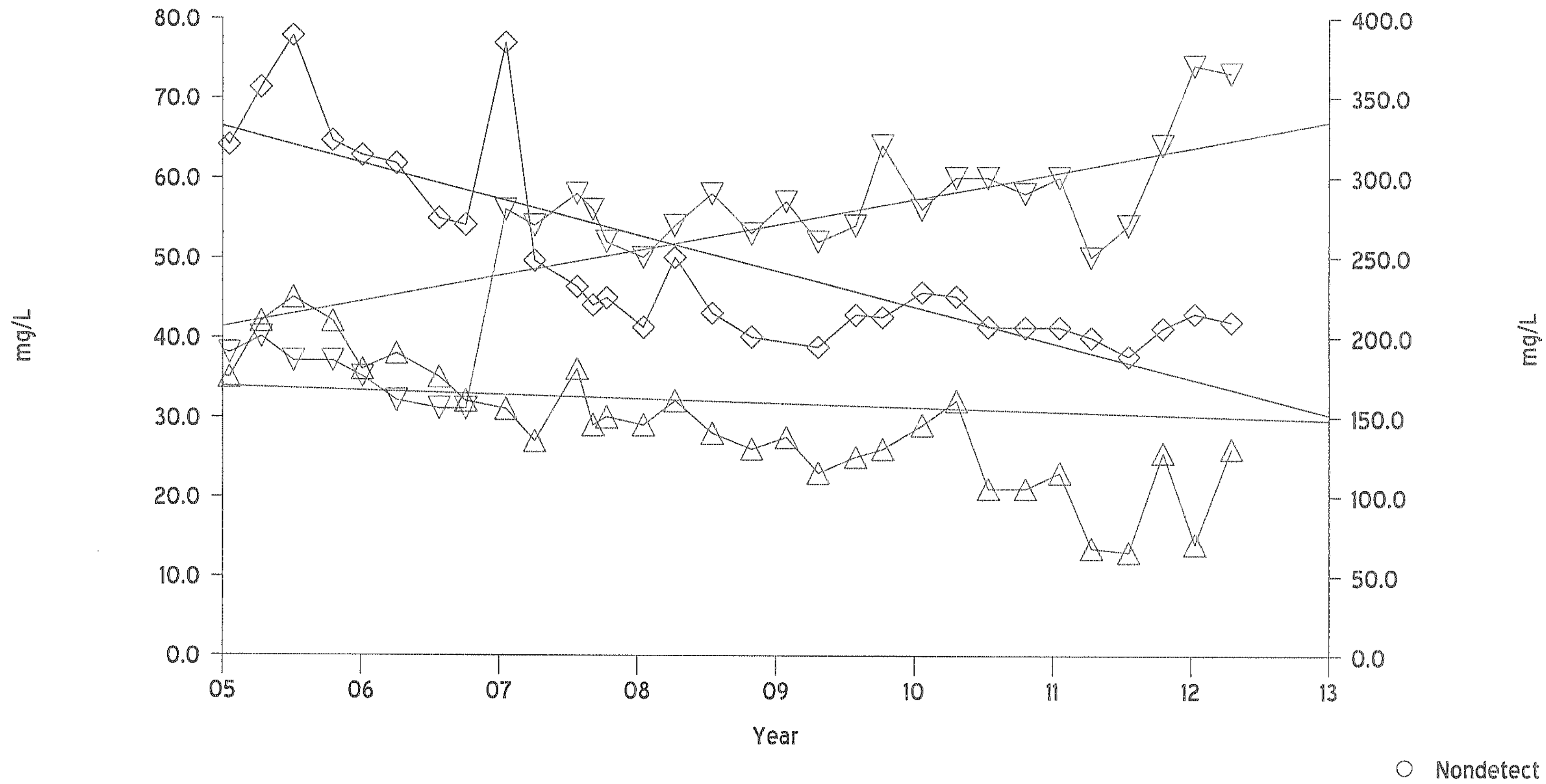
□ Nitrite nitrogen (cc: -.217)

△ pH (cc: -.440)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



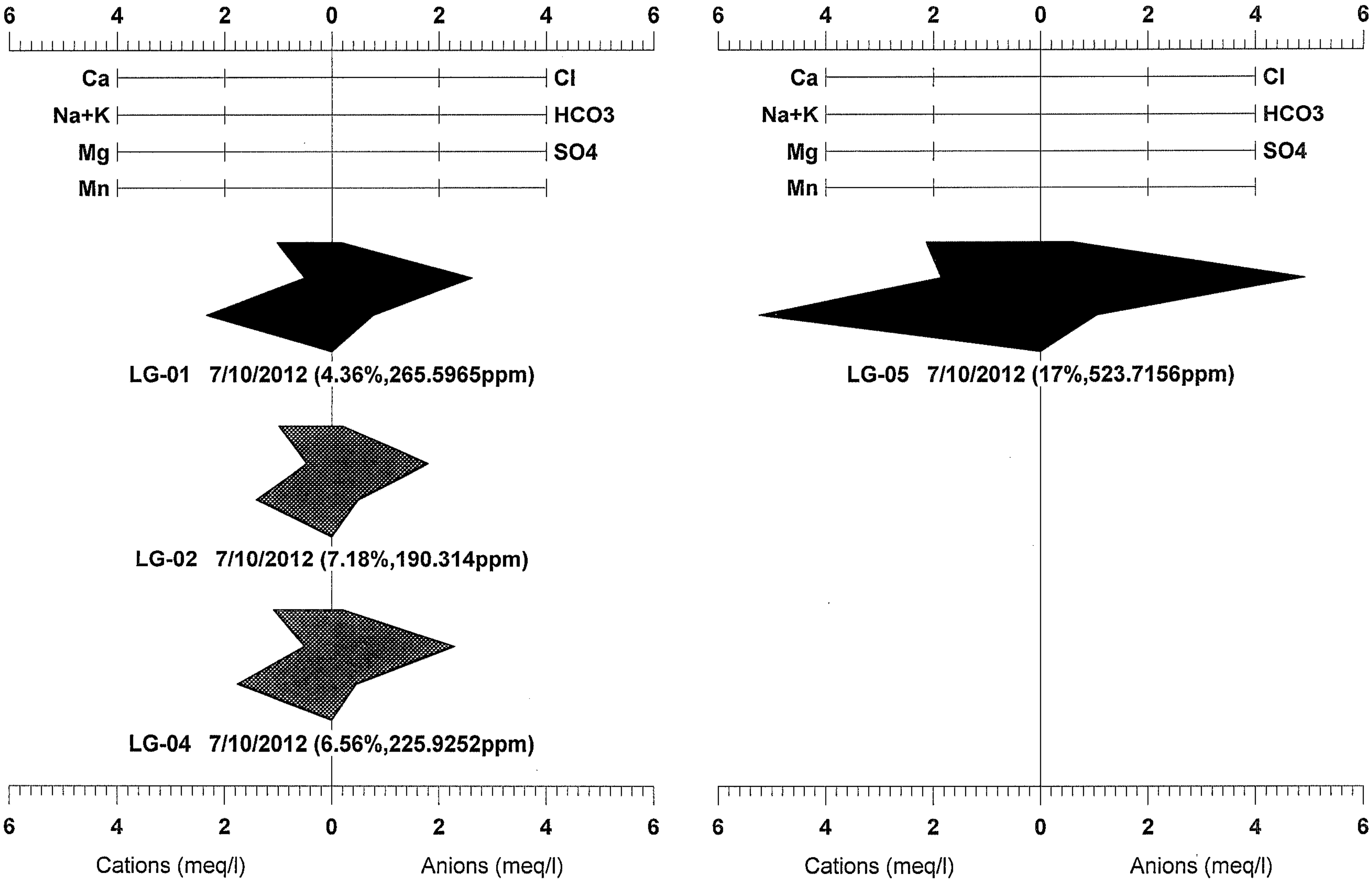
◇ Dissolved sodium (cc: -.877)
△ Sulfate (cc: -.290)

▽ Alkalinity (as caco3) (cc: .780)

Prepared by: Snohomish County Solid Waste

Quarter 3

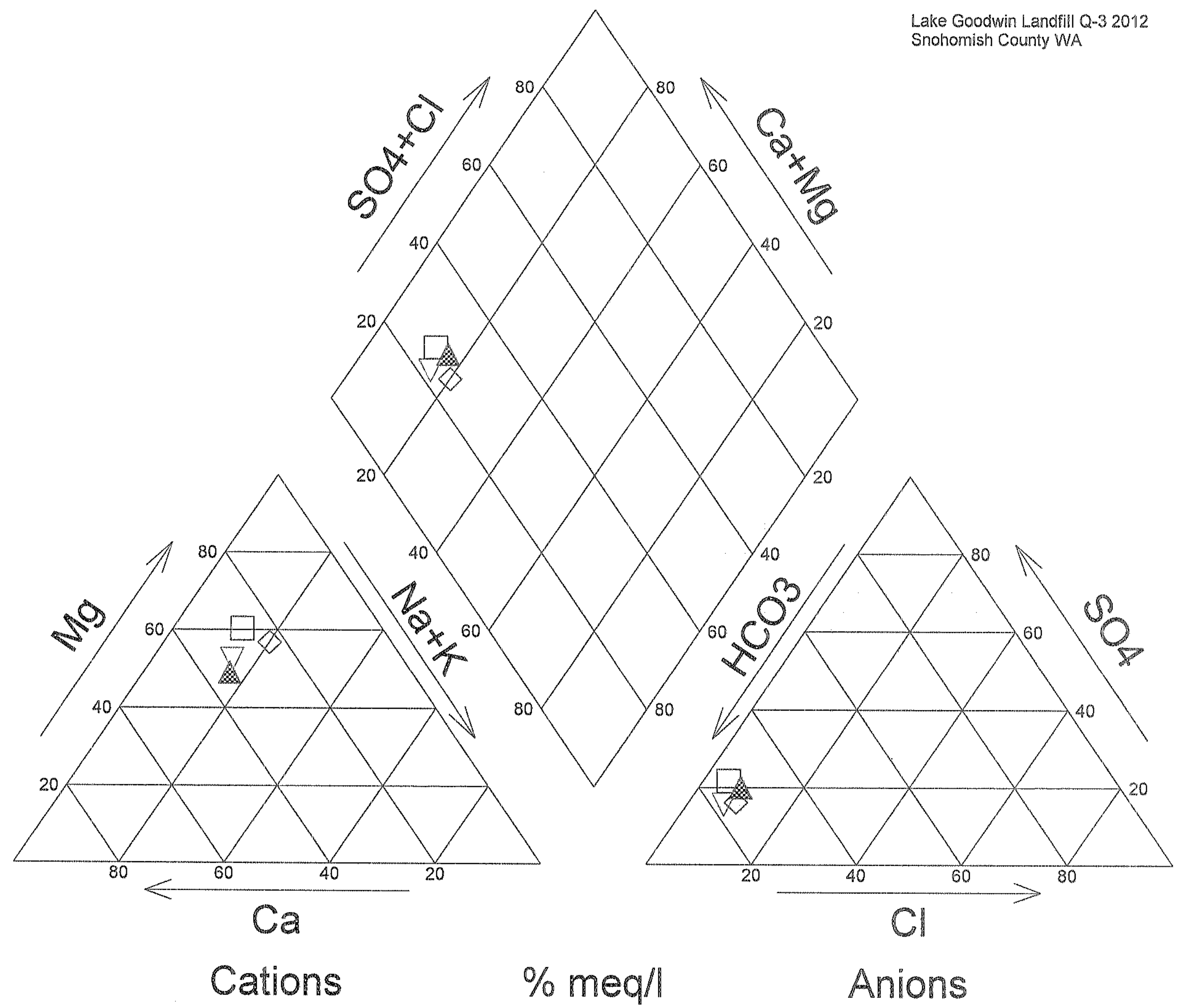
Goodwin Landfill



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

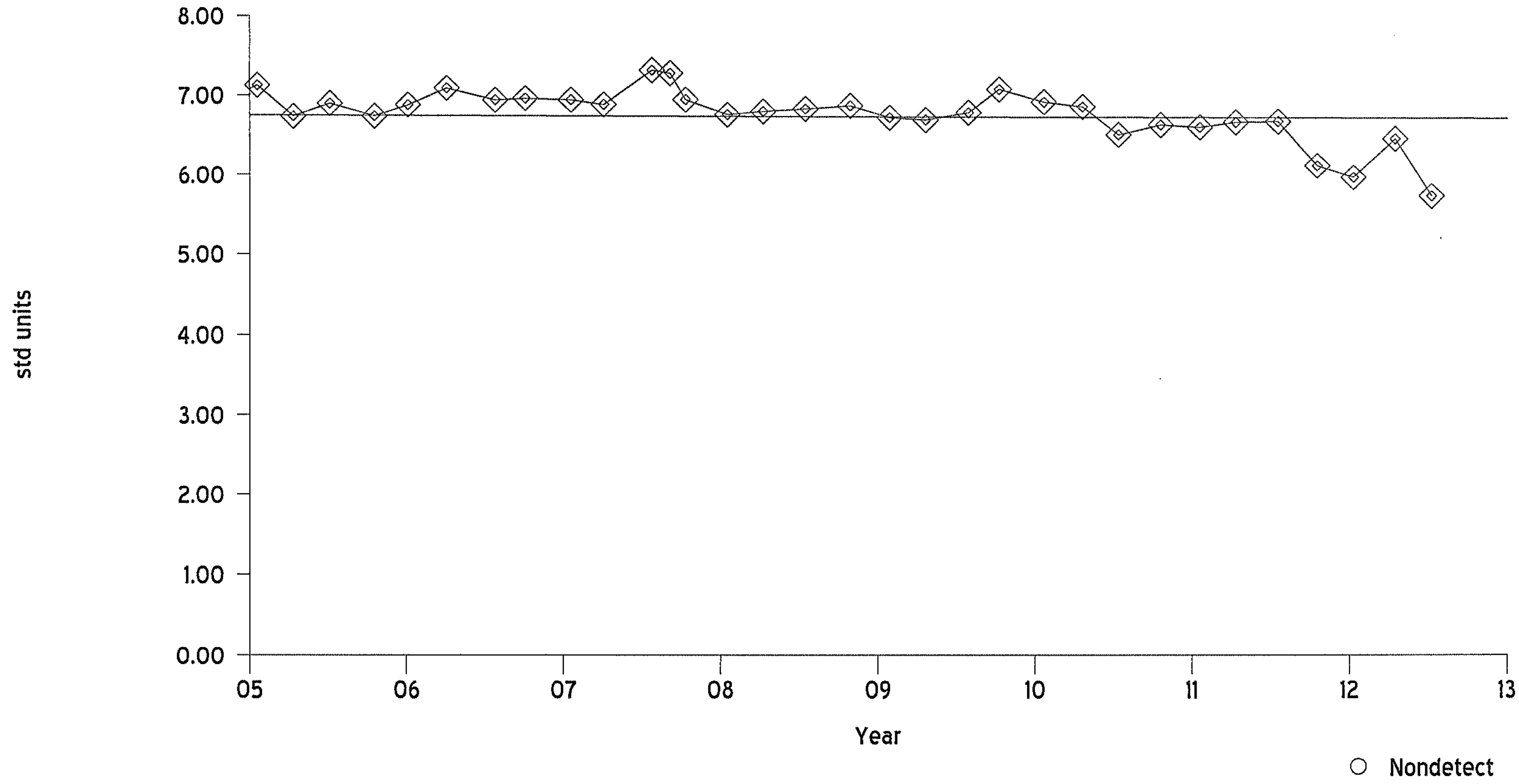
□	LG-01	7/10/2012 (4.36%,265.59ppm)
▲	LG-02	7/10/2012 (7.17%,190.31ppm)
▽	LG-04	7/10/2012 (6.56%,225.92ppm)
◇	LG-05	7/10/2012 (17%,523.705ppm)



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-01

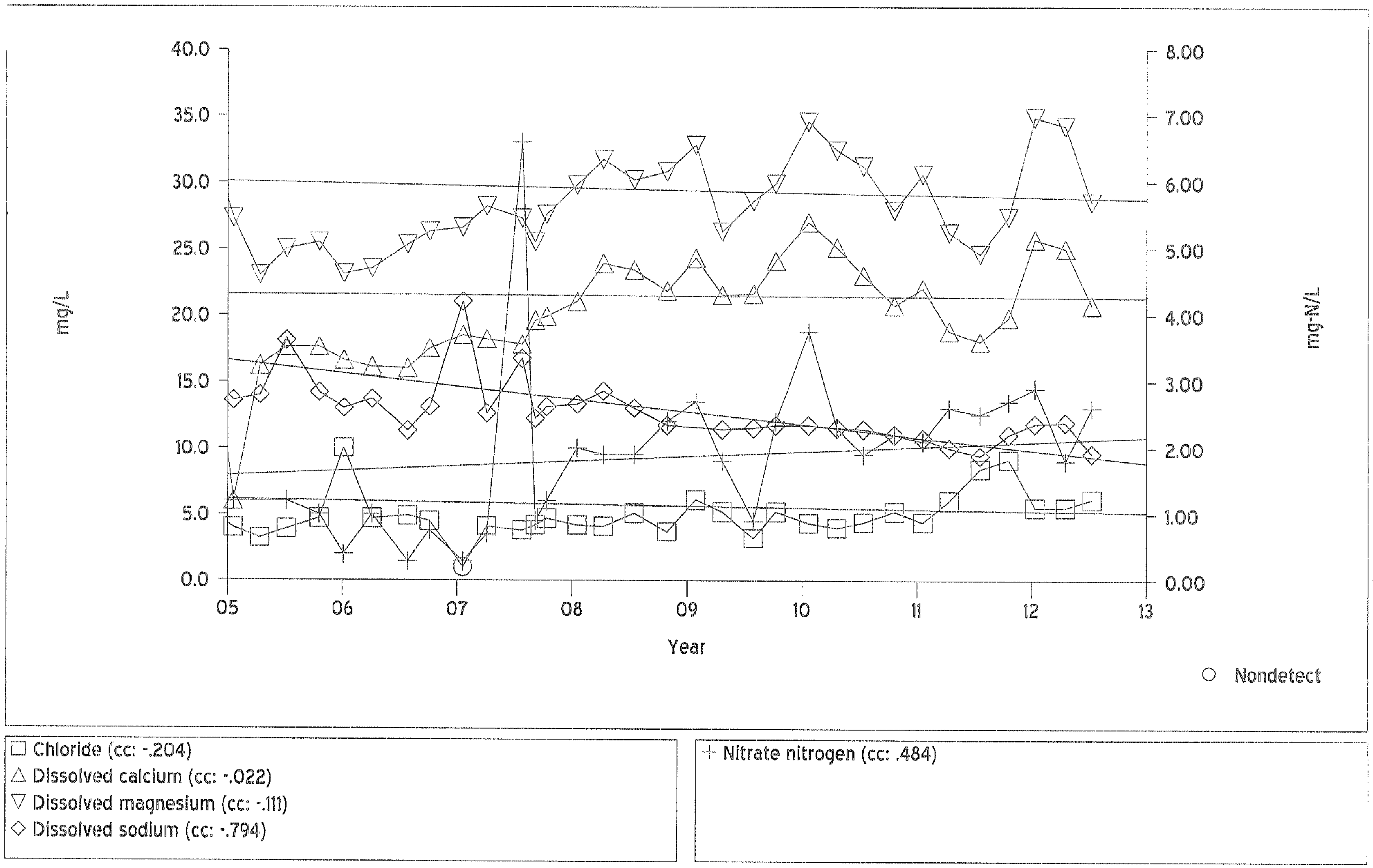


pH (cc: -.219)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

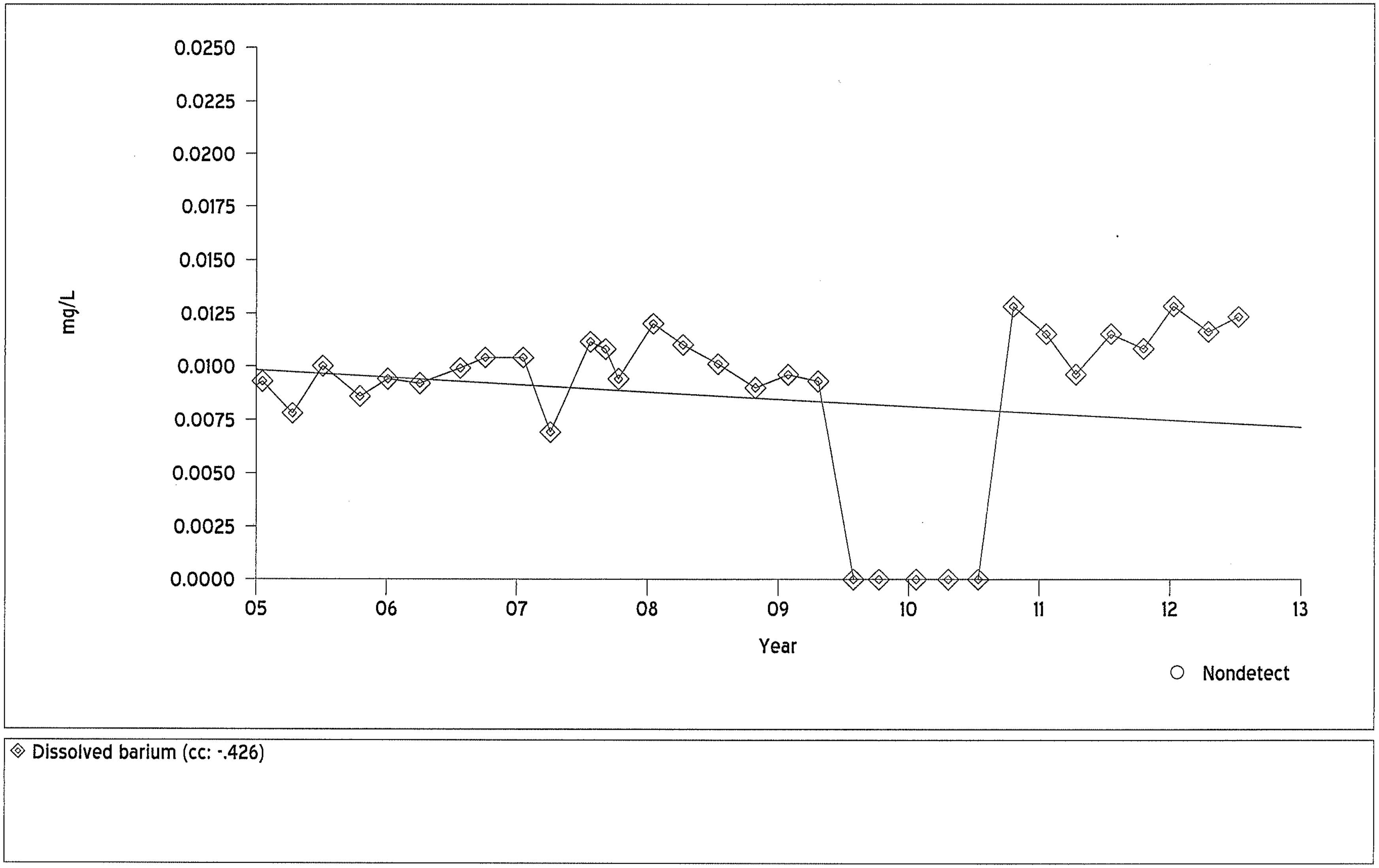
Time Series Plot for LG-01



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

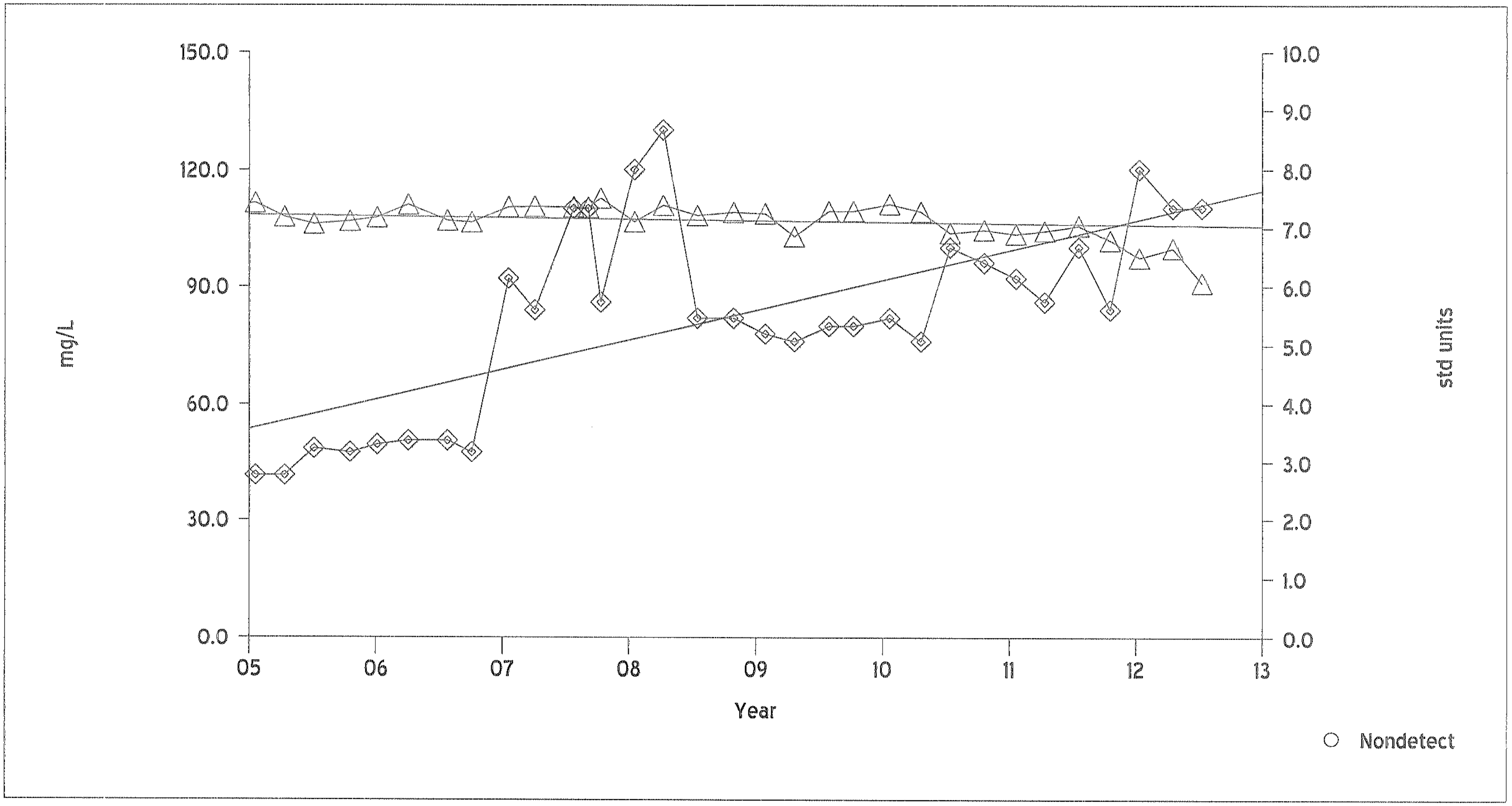
Time Series Plot for LG-02



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-02



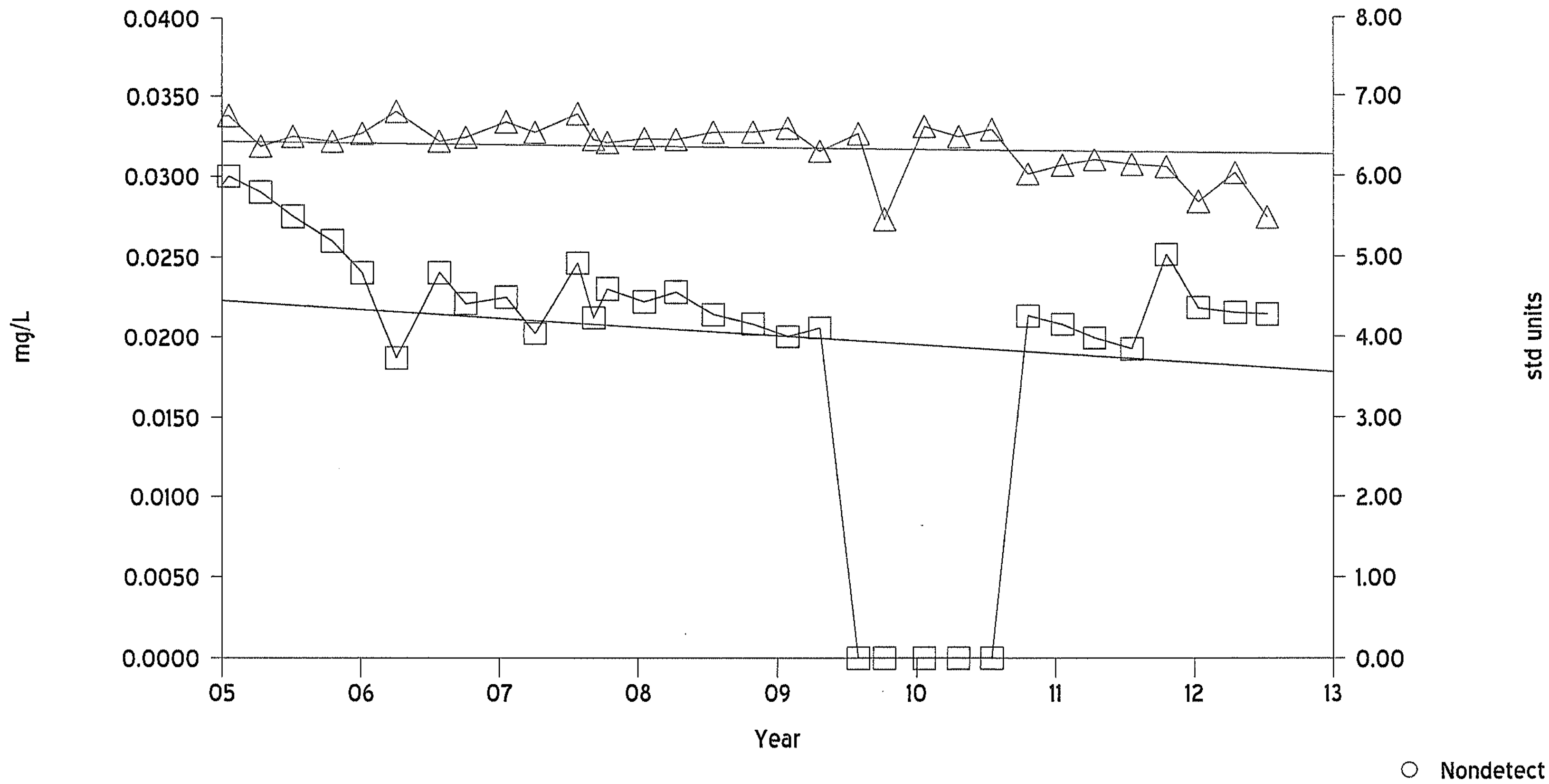
◇ Alkalinity (as caco3) (cc: .773)

△ pH (cc: -.456)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



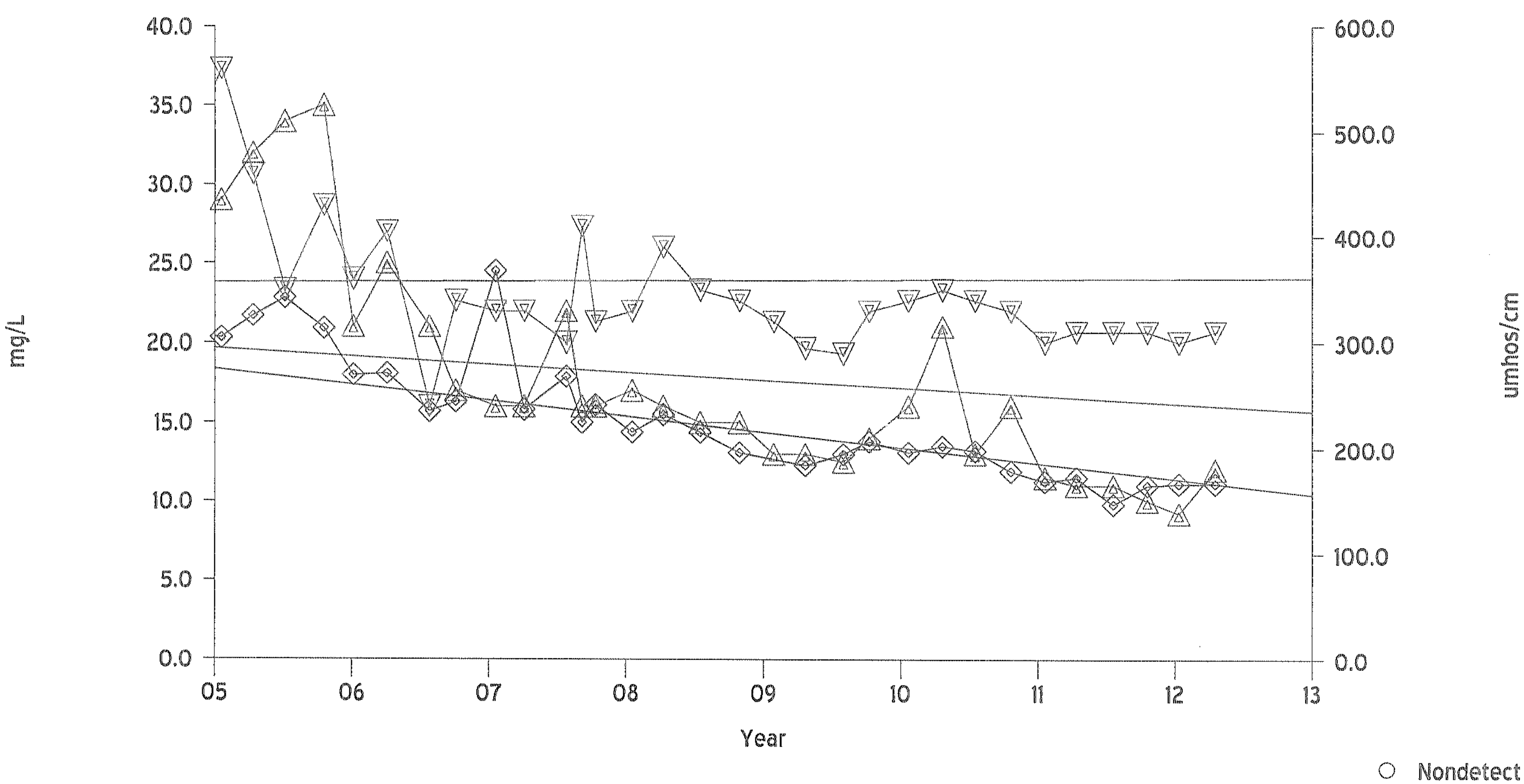
□ Dissolved barium (cc: -.397)

△ pH (cc: -.485)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



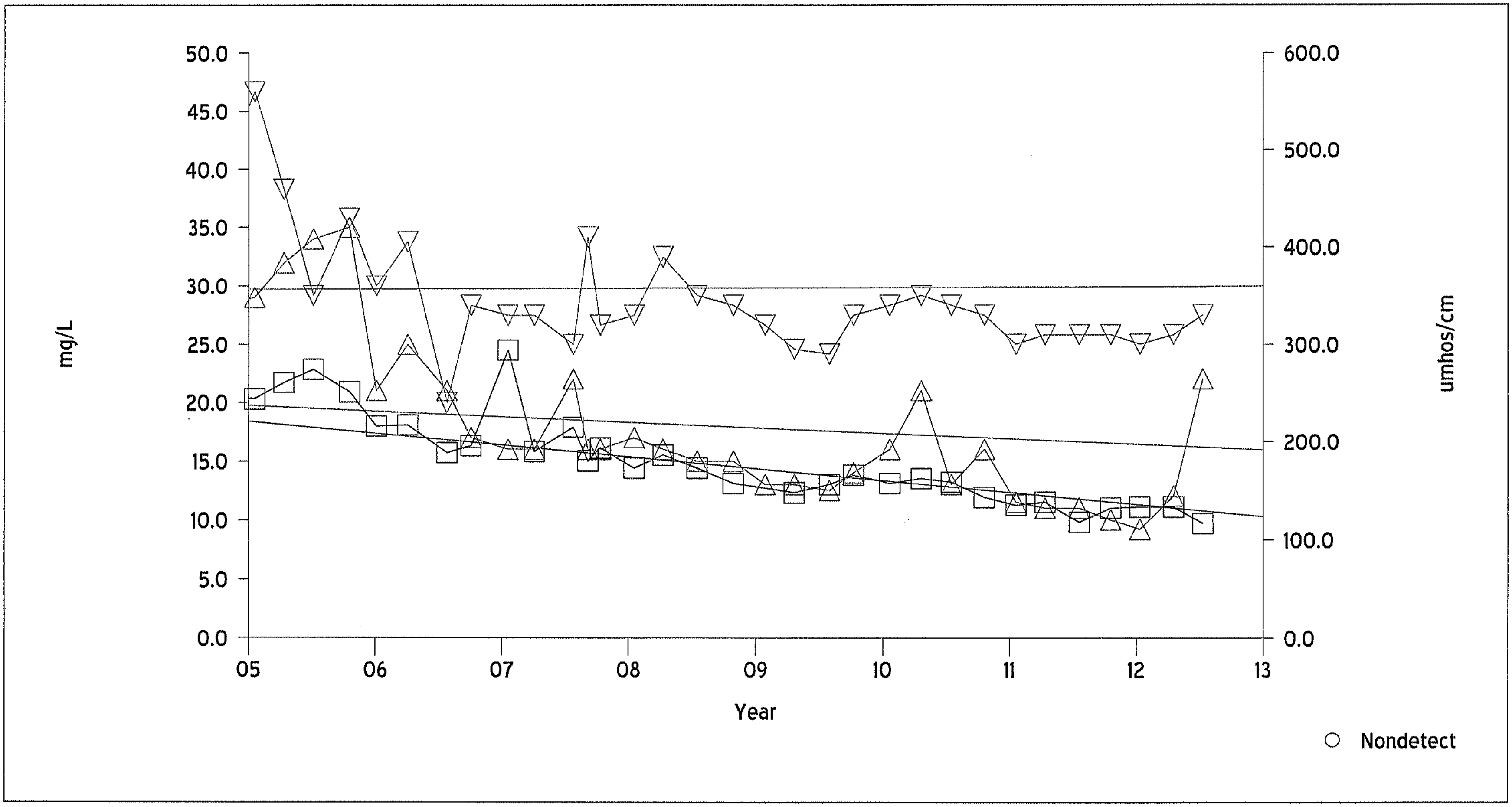
◇ Dissolved sodium (cc: -.725)
△ Sulfate (cc: -.282)

▽ Conductivity (cc: .049)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



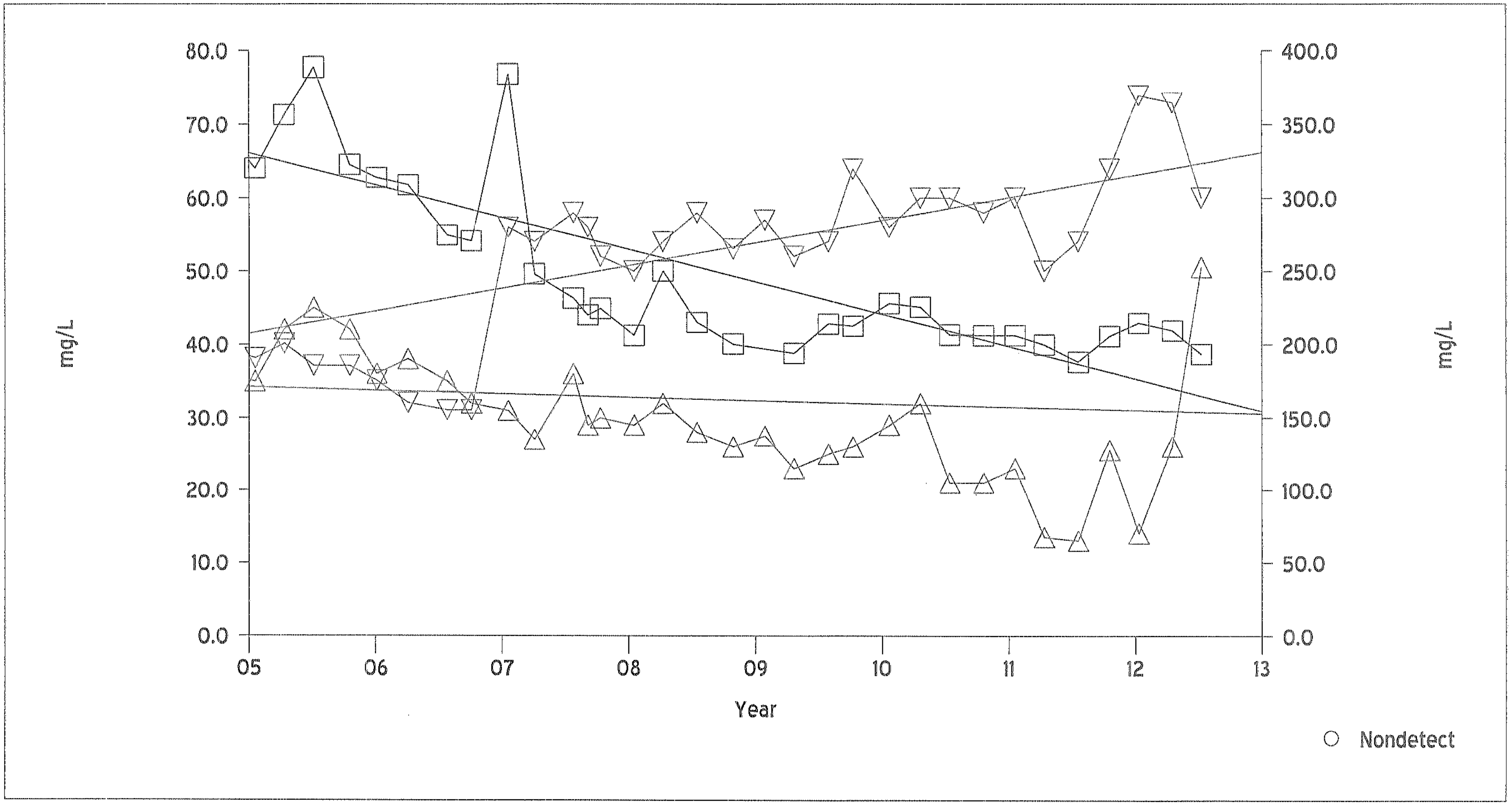
□ Dissolved sodium (cc: -.744)
△ Sulfate (cc: -.276)

▽ Conductivity (cc: .039)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



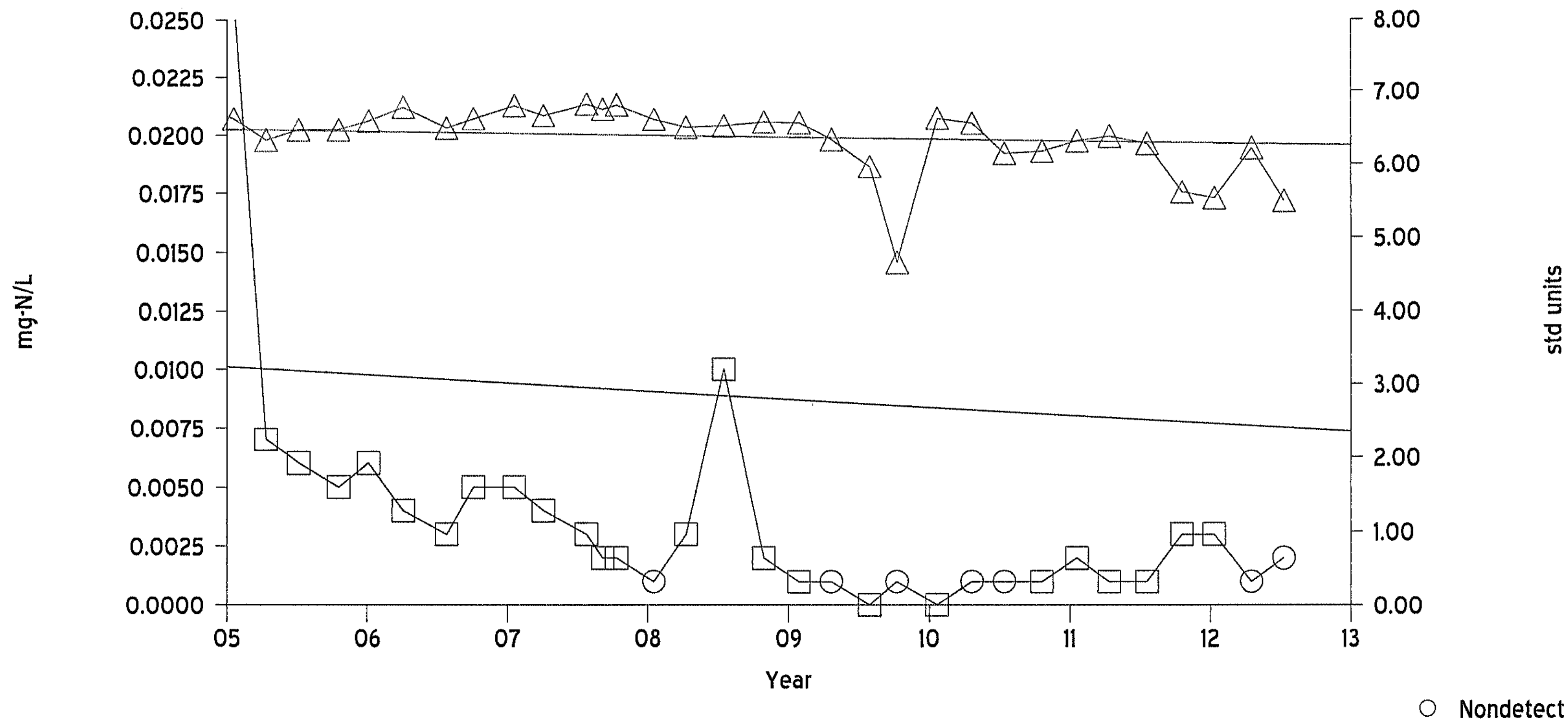
□ Dissolved sodium (cc: -.878)
△ Sulfate (cc: -.254)

▽ Alkalinity (as caco3) (cc: .782)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



☐ Nitrite nitrogen (cc: -.203)

△ pH (cc: -.469)

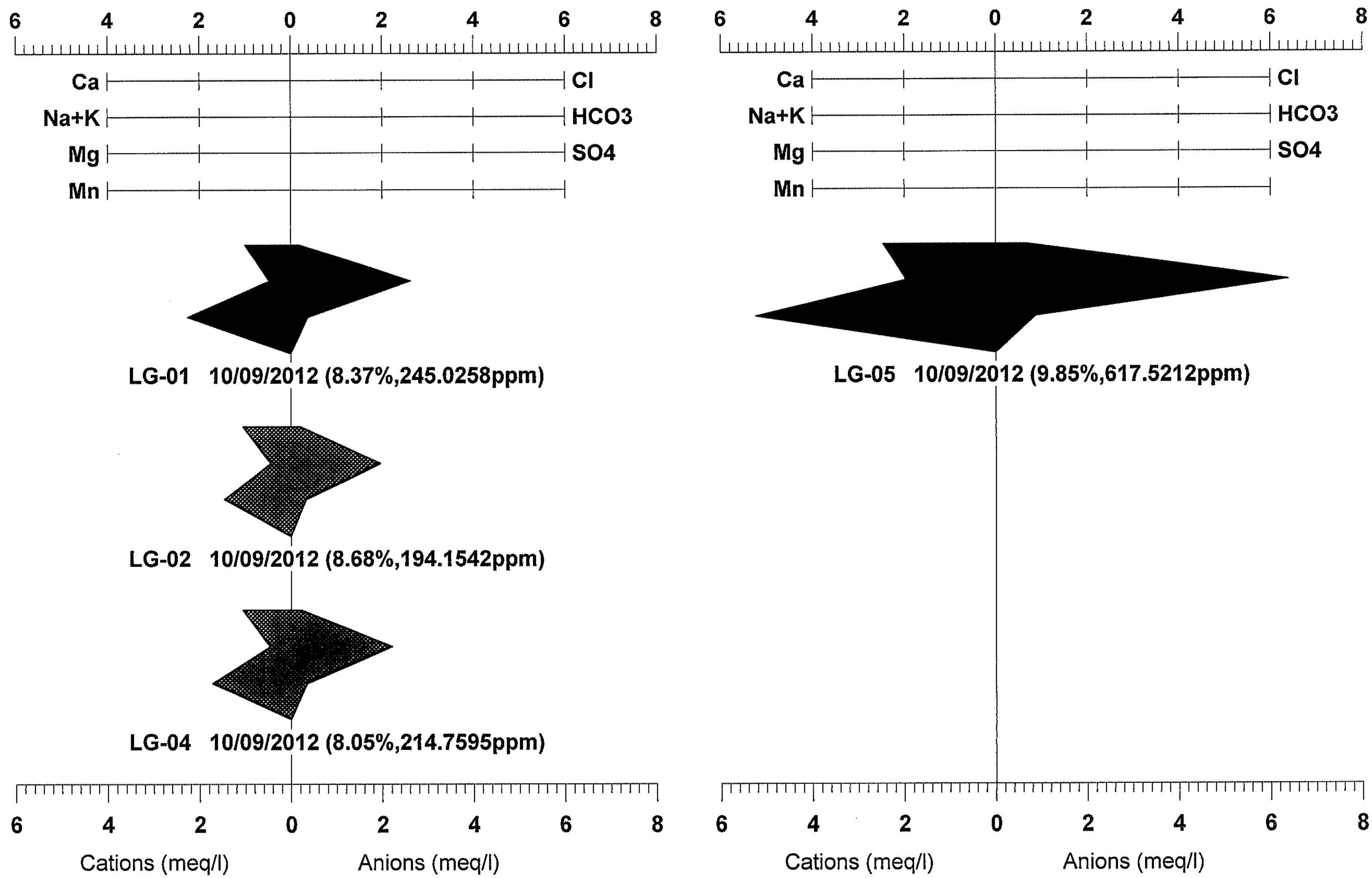
Offscale Points

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

Prepared by: Snohomish County Solid Waste

Quarter 4

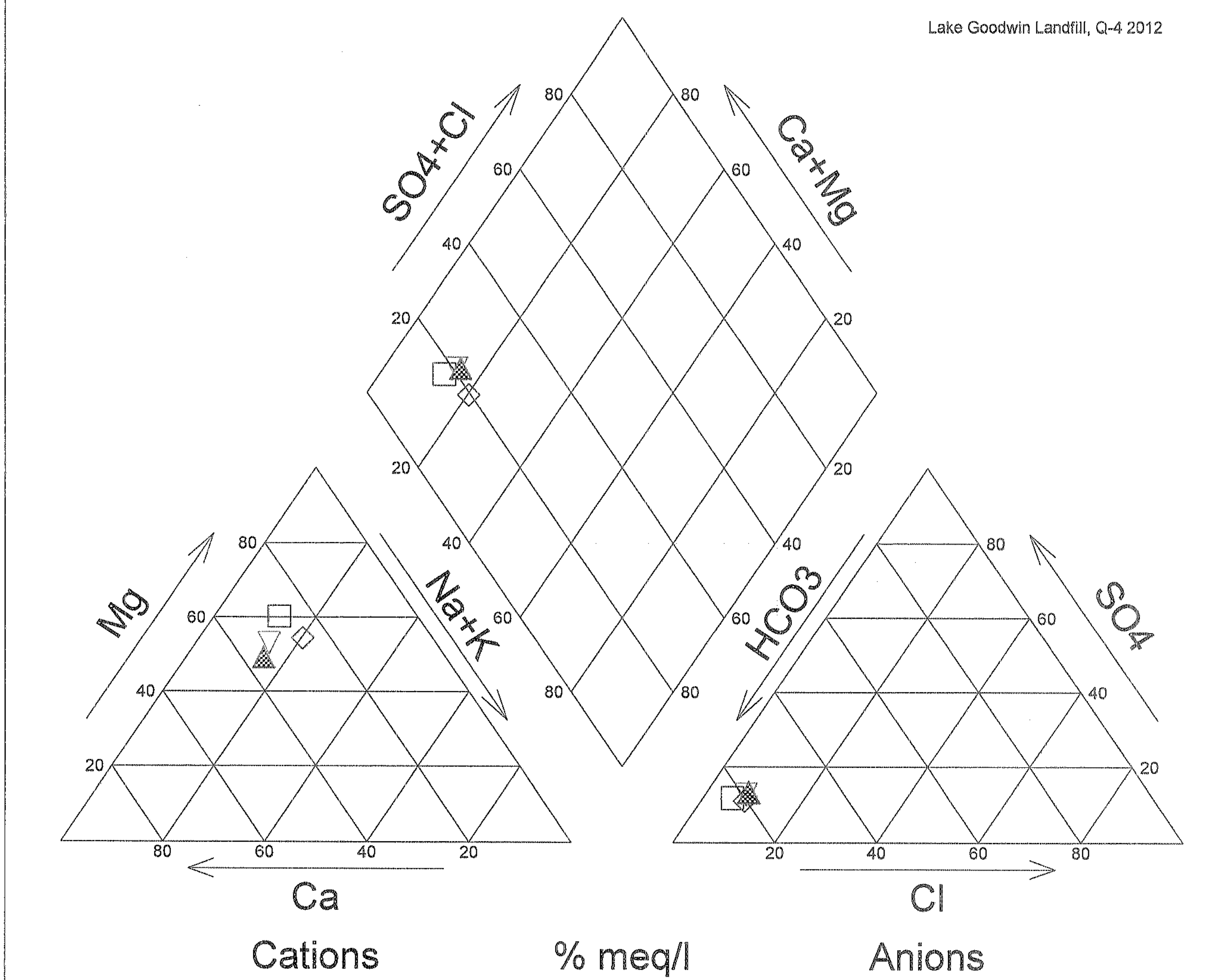
Goodwin Landfill



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

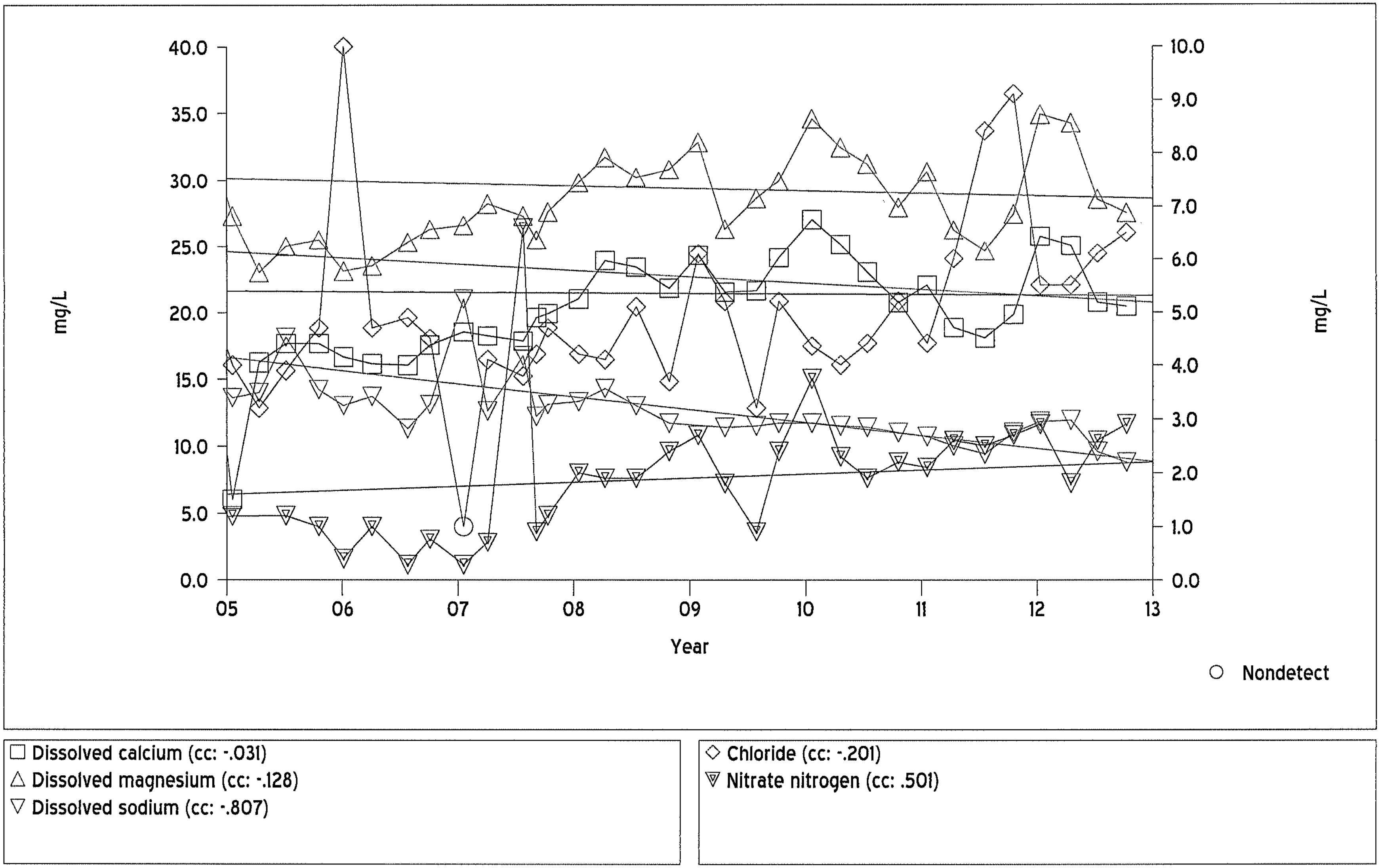
□	LG-01	10/09/2012 (8.36%,245.02ppm)
▲	LG-02	10/09/2012 (8.67%,194.15ppm)
▽	LG-04	10/09/2012 (8.05%,214.755ppm)
◇	LG-05	10/09/2012 (9.84%,617.51ppm)



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

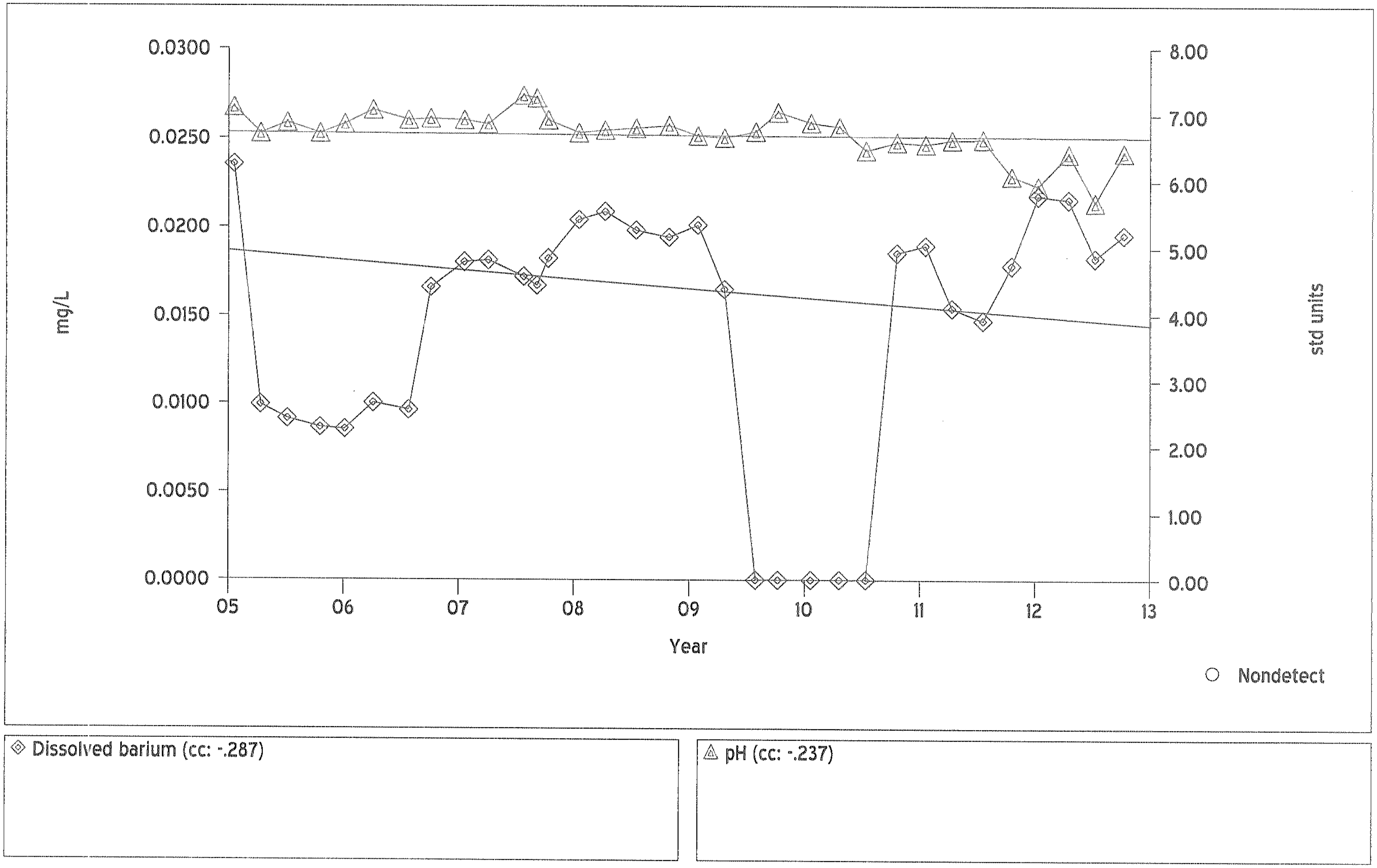
Time Series Plot for LG-01



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-01

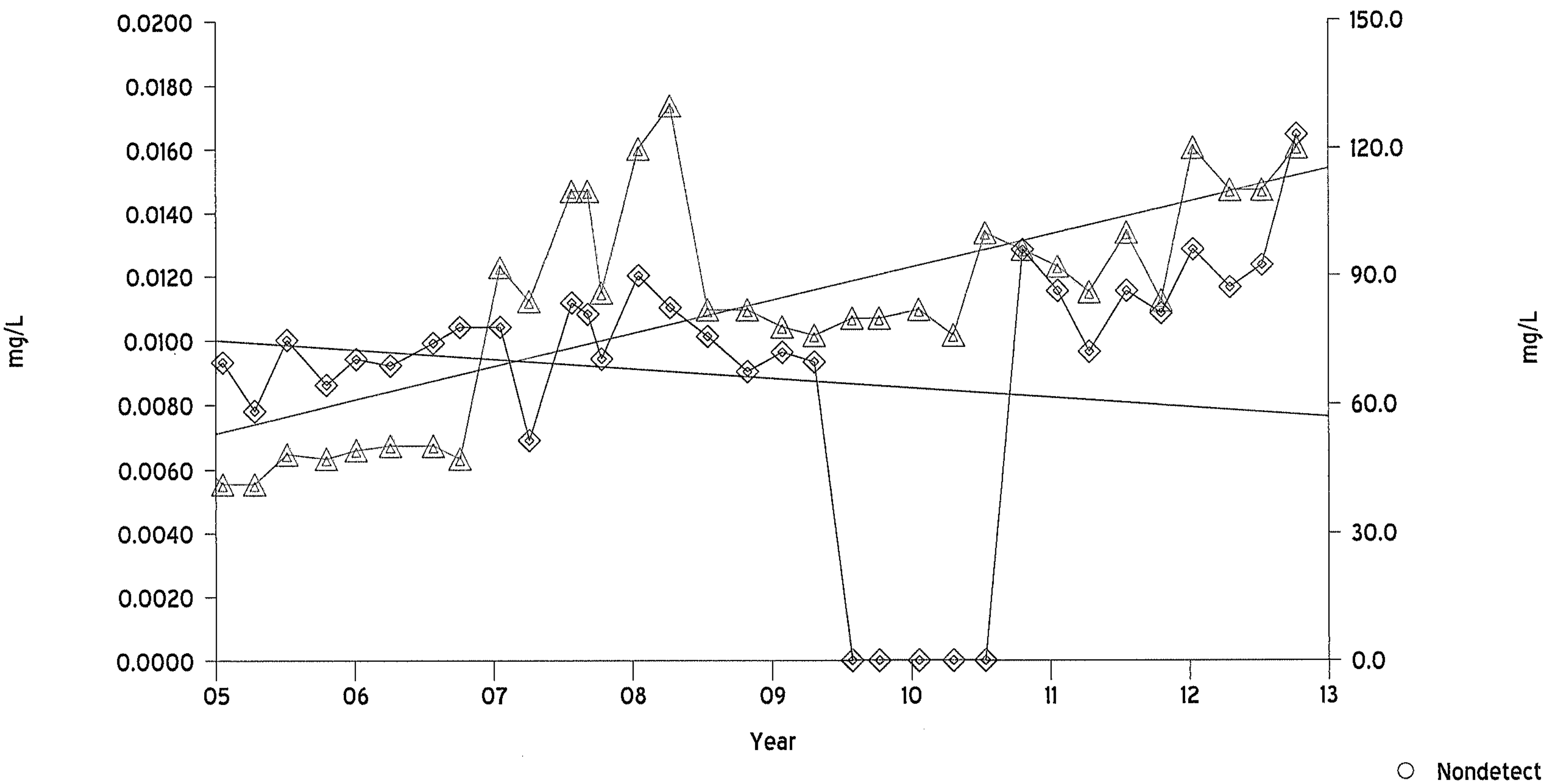


1

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-02



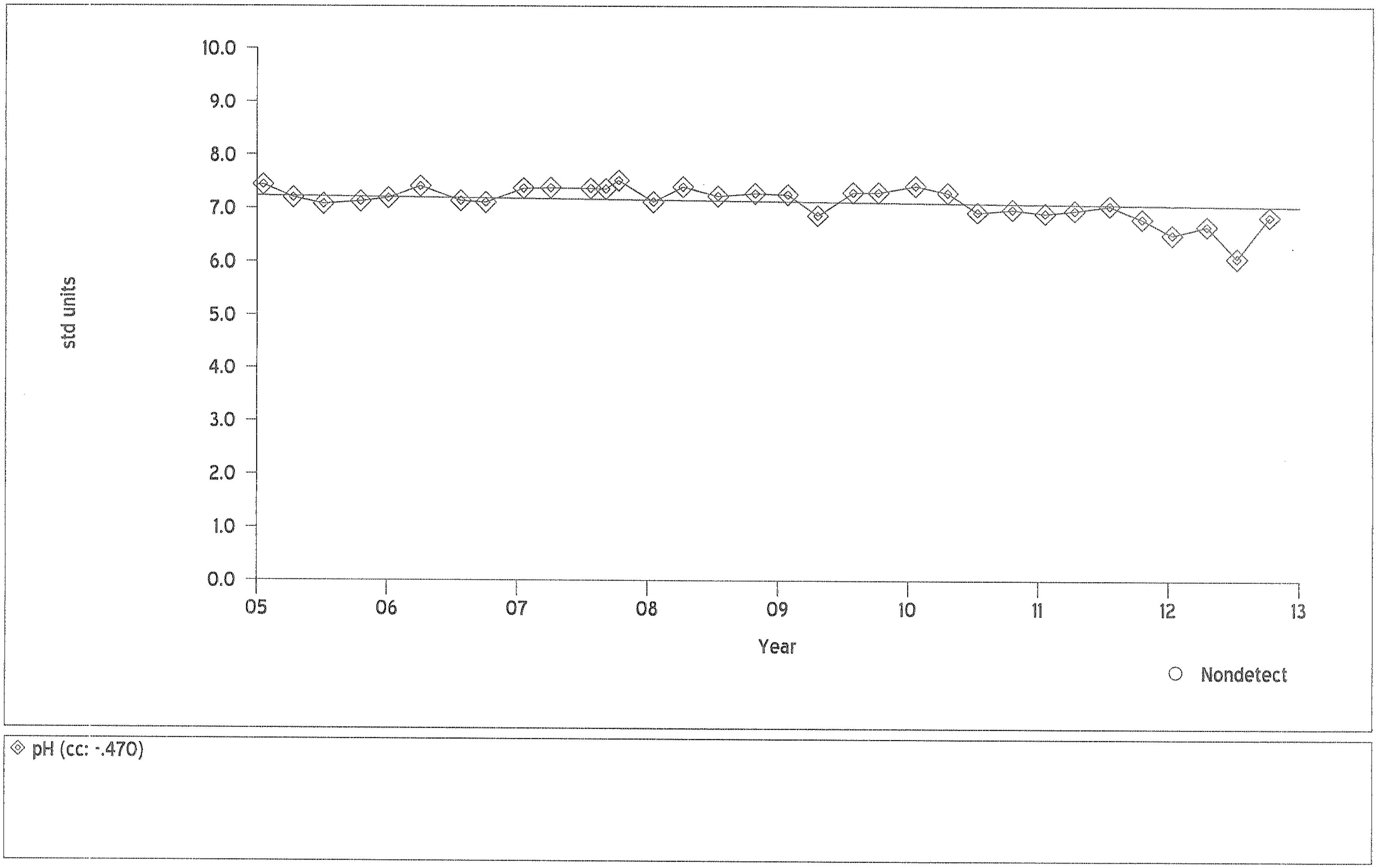
Dissolved barium (cc: -.379)

Alkalinity (as caco3) (cc: .789)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

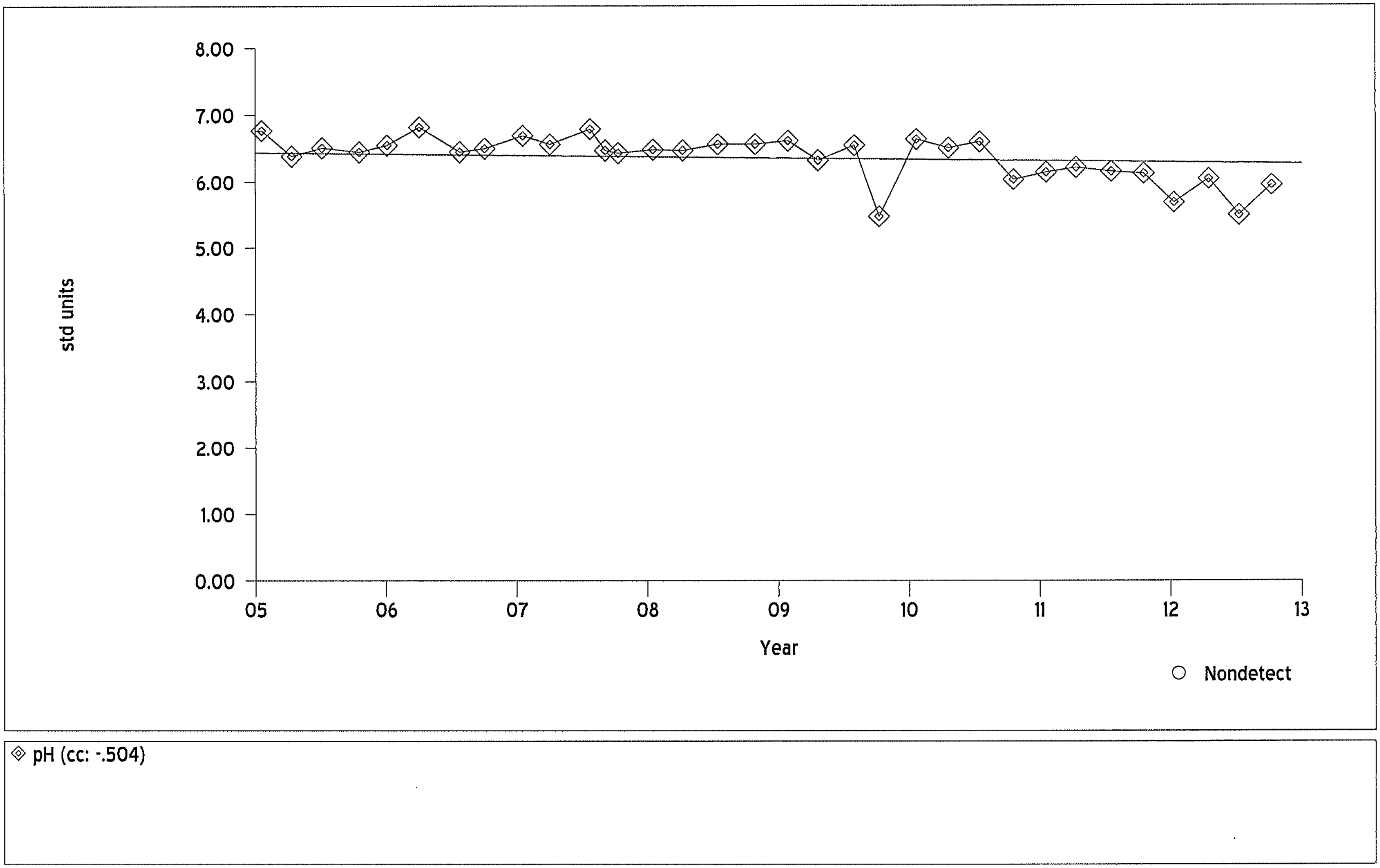
Time Series Plot for LG-02



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

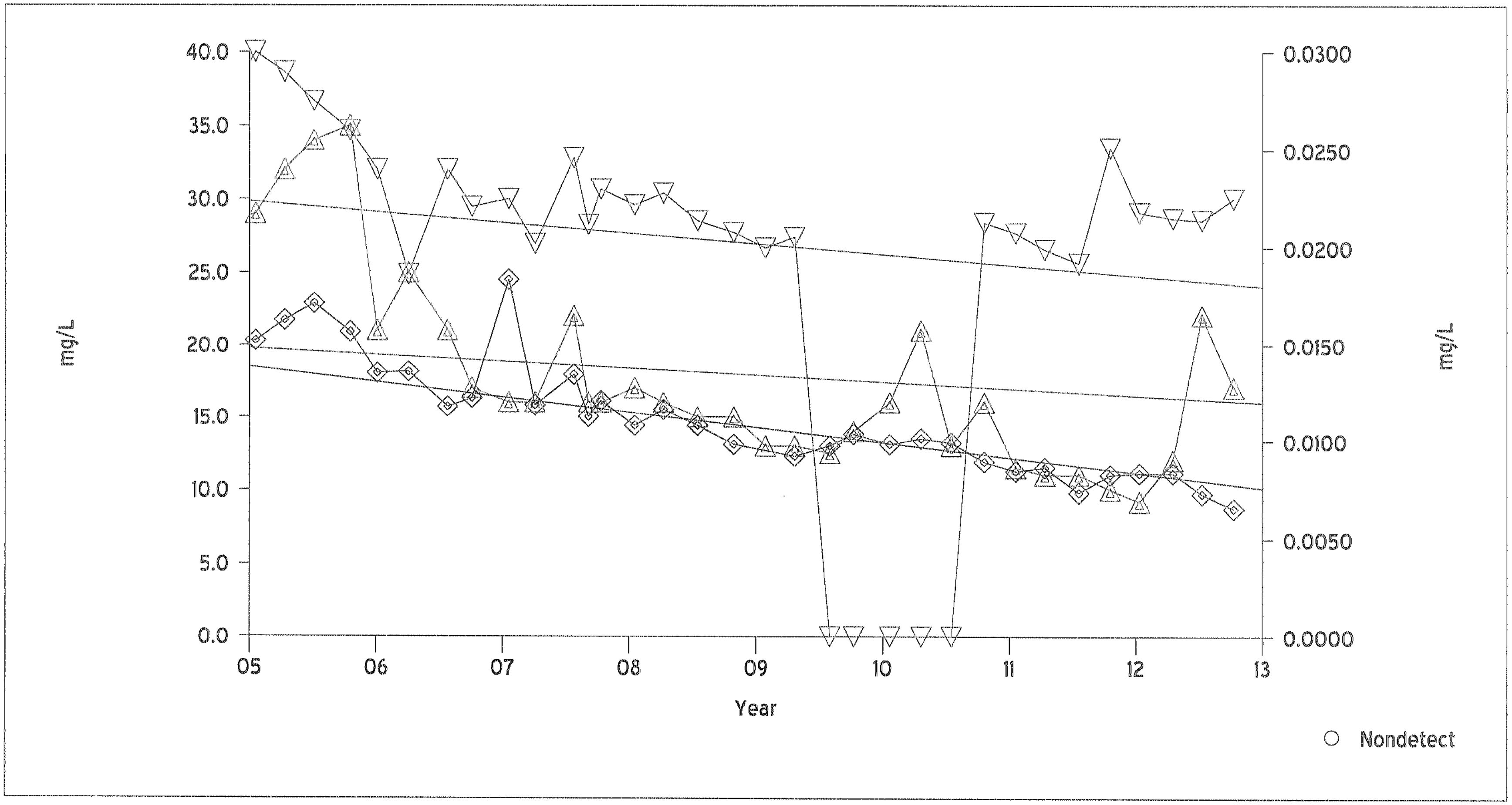
Time Series Plot for LG-04



Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-04



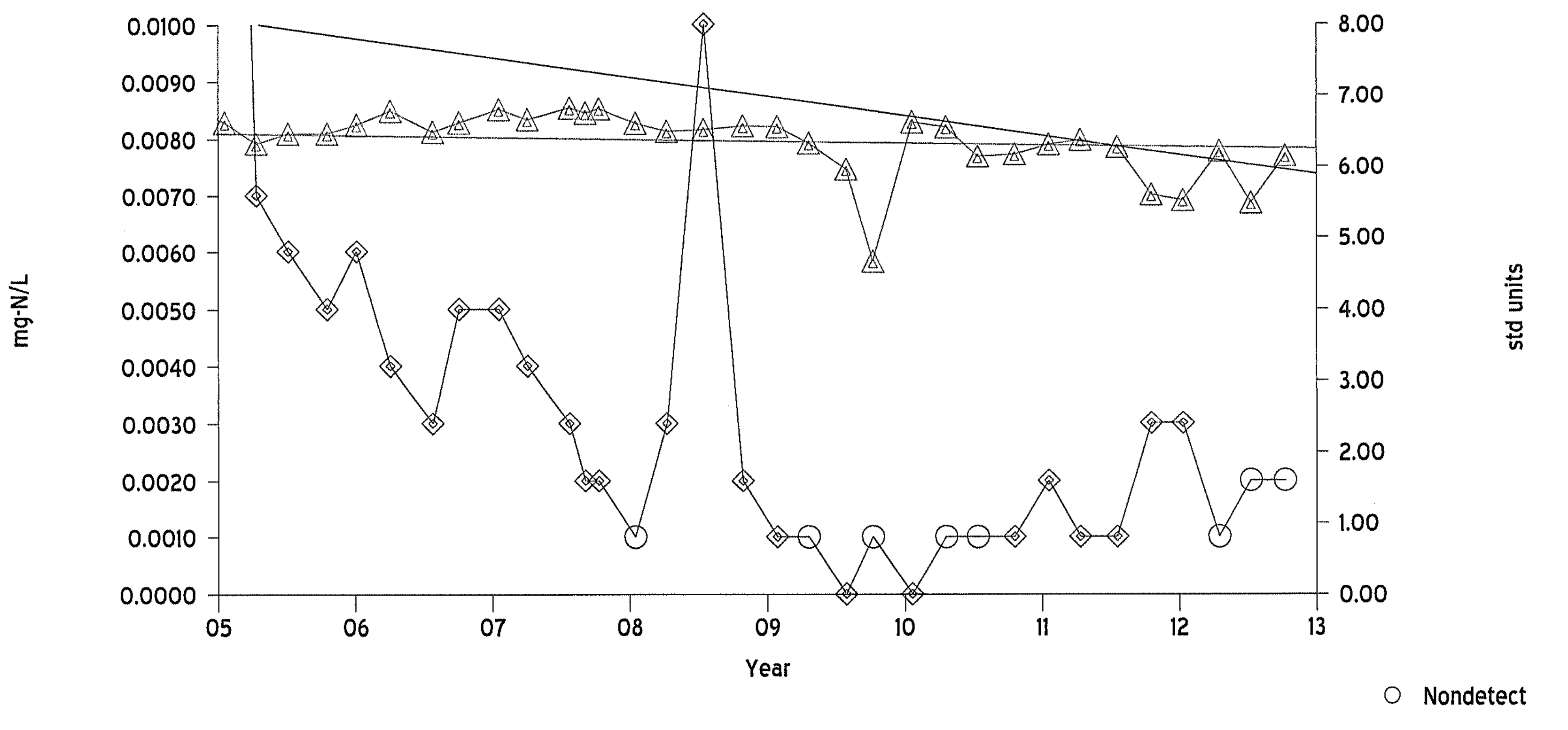
Dissolved sodium (cc: -.764)
Sulfate (cc: -.279)

Dissolved barium (cc: -.392)

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



◈ Nitrite nitrogen (cc: -.203)	◬ pH (cc: -.480)

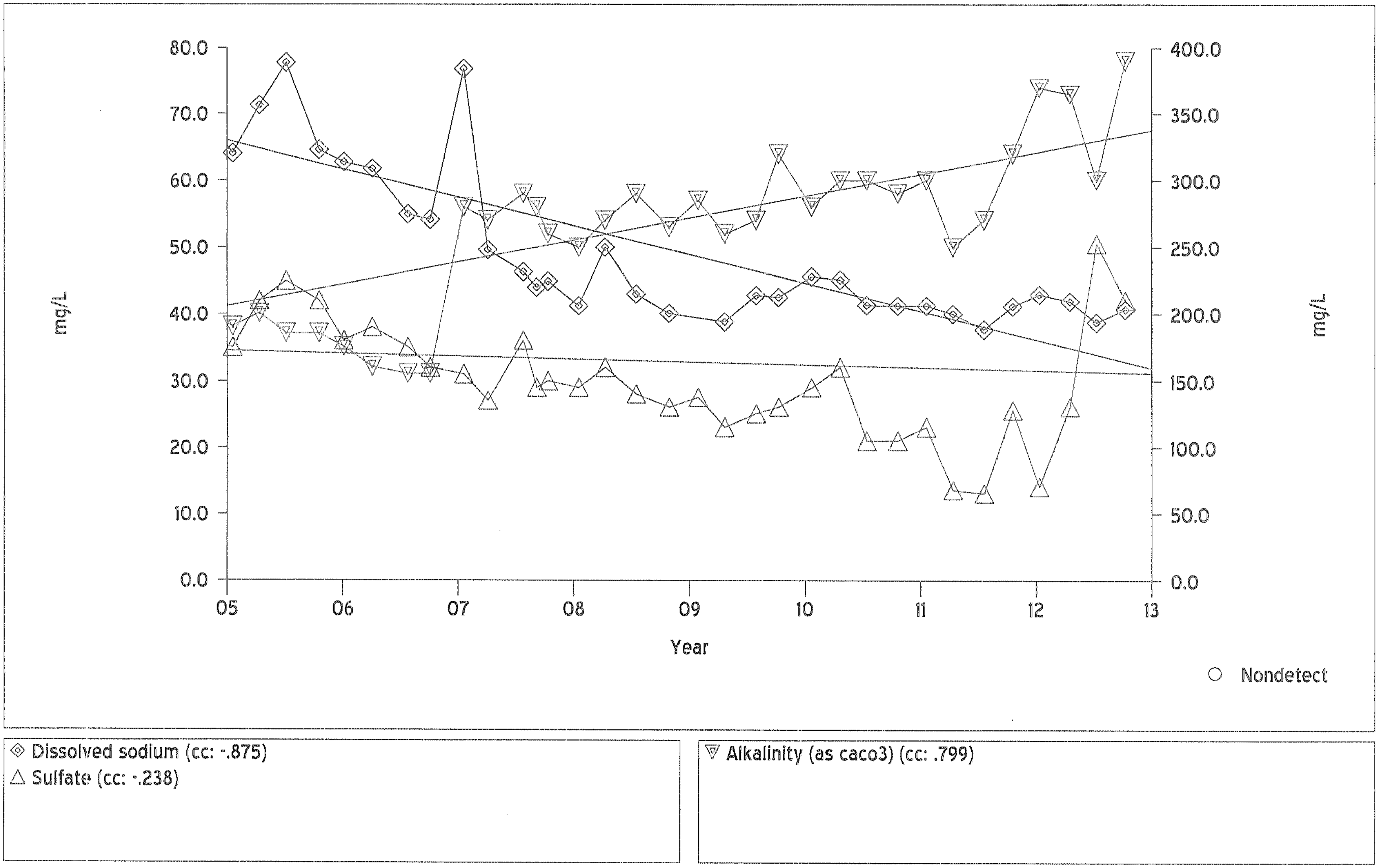
Offscale Points

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

Prepared by: Snohomish County Solid Waste

Goodwin Landfill

Time Series Plot for LG-05



Prepared by: Snohomish County Solid Waste

Appendix D

Water Flow Vector Maps

Figure 6

Lake Goodwin Landfill

Water Elevation Contours 1st Quarter 2012

DIRECTION OF GROUNDWATER FLOW
1.44 ft/day
524 ft/year
113.98 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

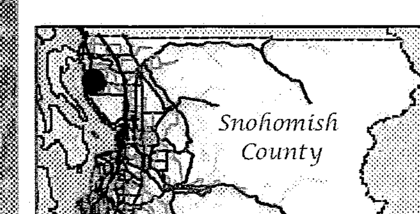
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
LG-01	1/10/2012	153.69
LG-02	1/10/2012	155.31
LG-03	1/10/2012	152.56
LG-04	1/10/2012	155.52
LG-05	1/10/2012	152.25

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
February 9, 2012

Figure 6

Lake Goodwin Landfill

Water Elevation Contours 2nd Quarter 2012

DIRECTION OF GROUNDWATER FLOW
2.67 ft/day
976 ft/year
137.23 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

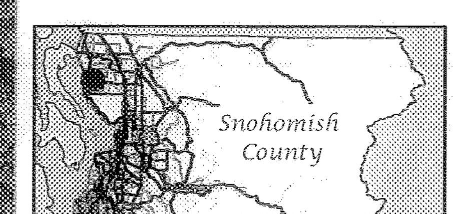
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
LG-01	4/17/2012	158.17
LG-02	4/17/2012	154.62
LG-03	4/17/2012	153.25
LG-04	4/17/2012	152.28
LG-05	4/17/2012	153.54

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
June 14, 2012

Figure 6

Lake Goodwin Landfill

Water Elevation Contours 3rd Quarter 2012

DIRECTION OF GROUNDWATER FLOW
1.05 ft/day
382 ft/year
97.86 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

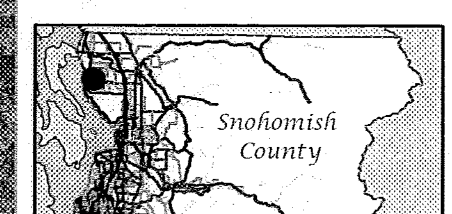
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
LG-01	7/10/2012	156.86
LG-02	7/10/2012	155.59
LG-03	7/10/2012	156.08
LG-04	7/10/2012	153.43
LG-05	7/10/2012	154.30

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
July 31, 2012

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

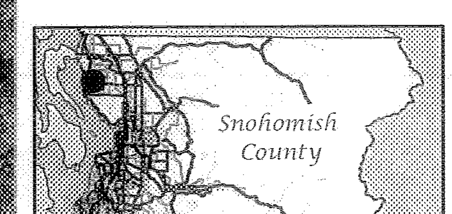
1 FT CONTOUR

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



Snohomish County
Public Works
Solid Waste Division
November 16, 2012