Rio Algom Mining LLC

January 30, 2019

Mr. Jim Webb
Nuclear Regulatory Commission
Mail Stop T-A10
Washington, DC 20555-0001

Re: **Ambrosia Lake Facility**
License SUA-1473, Docket No. 40-8905
License Condition #34
2nd Half 2018 Groundwater Stability Monitoring Report

Dear Mr. Webb:

Pursuant to license condition #34 for License SUA-1473, attached is the Semi-Annual Groundwater Stability Monitoring Report for the Second Half of 2018. This report describes the results associated with the groundwater stability monitoring plan established by Amendment #56.

A digital copy of the report is also included in the package.

If you have any questions or need additional information, please call me at (916) 947-7637.

Sincerely,
Rio Algom Mining LLC

Sandra L, Ross, P.G.
Site Manager

Attachment: As stated

cc: NRC – Document Control (certified mail)
NMED, Kurt Vollbrecht (email), Amber Rhuebottom (email)
DOE, Bernadette Tsosie (email)
Mike Schierman, ERG (email)

RIO ALGOM LLC
AMBROSIA LAKE FACILITY

License SUA-1473 Docket 40-8905

Groundwater Stability Monitoring Report

Second Half 2018

January 30, 2019

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ACRONYMS AND ABBREVIATIONS

ACL	alternate concentration limit
AOD	Assurance of Discontinuance
CAP	corrective action program
EPA	Environmental Protection Agency, United States
GPS	groundwater protection standard
KD	Dakota Sandstone
License	source material license SUA-1473
LTSM	long-term surveillance and maintenance boundary
mg/L	milligrams per liter
NMED	New Mexico Environment Department
NRC	Nuclear Regulatory Commission
pCi/L	picocuries per liter
POC	point of compliance
POE	point of exposure
RAML	Rio Algom Mining LLC
Site	Rio Algom Mining LLC – Ambrosia Lake Facility

RIO ALGOM MINING LLC
AMBROSIA LAKE FACILITY
GROUNDWATER STABILITY MONITORING REPORT – SECOND HALF 2018

Nuclear Regulatory Commission (NRC) source material license SUA-1473 (the "License"), Condition #34.D, requires Rio Algom Mining LLC (RAML) to submit semiannual groundwater monitoring reports associated with the facility's groundwater stability monitoring plan established by Amendment 56. Condition 34.D states:

> *Submit, by February 1 and August 1 of each year groundwater monitoring reports to include a minimum of the following: potentiometric surface maps for each aquifer; time vs. concentration plots for all parameters for which ACLs have been issued, hydrographs for the downgradient most trend well or POE well in each aquifer, hydraulic gradient calculations, and tabulated analytical data for each ACL parameter for each well.*

1.0 BACKGROUND

RAML's Ambrosia Lake facility (Site) is located in McKinley County, approximately 24 miles due north of Grants, New Mexico, in the Ambrosia Lake Valley. Uranium milling activities started at the Site in 1957. The waste management structures were Tailings Impoundments 1 and 2, Decantation Pond 3, and Evaporation Ponds 4 through 10, as shown in **Figure 1**. Tailings Impoundments 1 and 2 were built in 1958, along with Pond 3 at the eastern toe of Tailings Impoundment 1, to accept decanted tailings liquids. Tailings were first produced at the Site in November 1958. In 1976, RAML diverted the natural course of the Arroyo del Puerto east of Ponds 4, 5, and 6, and lined Ponds 9 and 10. The solids fraction of the tailings was disposed through a slurry transfer system to the tailings impoundments, while the liquids fraction was transferred to the evaporation ponds. Evaporation pond residues from Ponds 3, 4, 5, 6, 7, and 8 were placed in Tailings Impoundments 1 and 2 prior to final reclamation. All the aforementioned tailings impoundments and ponds were unlined, except Ponds 9 and 10. Seepage from the tailings impoundments and Evaporation Ponds 3 through 6, along with seepage from unrelated mining and milling operations, saturated and impacted the alluvium of the Arroyo del Puerto. Seepage from the tailings impoundments and Evaporation Ponds 7 and 8 recharged and impacted the Tres Hermanos B sandstones within the Mancos Formation shale, and the Dakota Sandstone, which underlies the Mancos Formation.

Consequently, in 1983, RAML entered into an Assurance of Discontinuance (AOD) with the State of New Mexico Environmental Improvement Division (currently the New Mexico Environment Department [NMED]) to minimize the future impact of mill tailings solutions seepage on groundwater. The approved AOD remedial action required the construction and maintenance of

an interceptor trench (IT-1) and the cessation of discharges to unlined Ponds 4 through 8. These ponds were taken out of service in 1983. In the late 1990s, RAML added interceptor trenches IT-2, IT-3, and IT-4 south of Pond 10 to collect seepage potentially missed by IT-1.

In 1986, after the State of New Mexico relinquished its licensing authority over uranium mill activities, the NRC reasserted jurisdiction at the Site and required that the Site begin a groundwater detection monitoring program. Data from this program were the basis for the groundwater protection standards (GPSs) established for the Site by NRC, and a corrective action program (CAP) for the groundwater was developed based on this information. The CAP required pumping, treating, and discharging treated groundwater into the Arroyo del Puerto. The treated groundwater would sweep through the alluvium, creating a hydraulic barrier between the tailings ponds and the Arroyo del Puerto while flushing existing impacts toward the interceptor trench where it was then captured and disposed of into Tailings Impoundment 1. RAML implemented the CAP beginning in the mid-1980s; however, the CAP and its requirements to pump and treat were removed when the alternate concentration limit (ACL) petition was granted by the NRC in 2006.

Mining and milling operations in the area have had two notable hydrologic effects: creation and maintenance of a saturated zone at the base of the alluvium, and creation of a cone of depression in bedrock aquifers due to dewatering of underground mines. The saturated zone in the alluvium has continued to decrease since the mine dewatering, milling processes, and CAP were terminated.

2.0 SECOND HALF 2018 ACTIVITIES

Activities associated with the groundwater monitoring program at the mill facility during the second half of 2018 consisted of performing sampling pursuant to SUA-1473. The well network was designed to track and assess groundwater impacts between the tailings impoundment and the point of exposure (POE), which is the proposed long-term surveillance and maintenance boundary (LTSM), in the alluvium, Tres Hermanos A, Tres Hermanos B, and the Dakota. The current ACLs for the Site are presented in **Table 1** below.

Table 1. Rio Algom Mining – Ambrosia Lake Operation Alternate Concentration Limits

Parameter	Dakota	Tres Hermanos A	Tres Hermanos B	Alluvium
U-nat (mg/L)	1.6	No ACL	1.6	23
Th-230 (pCi/L)	945	945	945	13,627
Ra-226 and -228 (pCi/L)	218	218	218	3,167
Pb-210 (pCi/L)	88	88	88	1,274
Gross Alpha (pCi/L)	No ACL	No ACL	No ACL	8,402
Molybdenum (mg/L)	No ACL	No ACL	No ACL	176
Nickel (mg/L)	6.8	No ACL	6.8	98
Selenium (mg/L)	No ACL	No ACL	No ACL	49
Chloride (mg/L)	3,200	1,070	2,810	7,110
Nitrate (mg/L)	22.8	9.2	7.7	351
Sulfate (mg/L)	6,480	2,584	4,760	12,000
Total Dissolved Solids (mg/L)	14,100	6,400	11,700	26,100

mg/L = milligrams per liter
pCi/L = picoCuries per liter

Appendix 1 of this report contains the analytical data for the Dakota, Tres Hermanos A, Tres Hermanos B, and alluvial units. **Appendix 2** contains the time versus concentration plots for the ACL parameters for the Dakota, Tres Hermanos A, Tres Hermanos B, and alluvial units.

Appendix 3 contains the hydrographs for the most downgradient monitoring well for the Dakota, Tres Hermanos A, Tres Hermanos B, and alluvial units. The most notable observation in the data is that the potentiometric surface in the alluvium continues to decline. This decrease in groundwater is attributable to the discontinuance of the alluvial CAP, which was maintaining the artificial water mound in the vicinity of the Site. The decreasing groundwater elevation slows the lateral migration rate of milling-related seepage.

RAML determined the hydraulic gradients by calculating the difference in groundwater elevation between the most upgradient point of compliance (POC) well in each unit and the farthest

downgradient well in the same unit. That value was then divided by the distance along a flow path between the two wells. Results of these calculations are summarized below:

- Dakota – 0.028 foot per foot
- Tres Hermanos A – Not applicable, see **Section 4.2**
- Tres Hermanos B – 0.016 foot per foot
- Alluvium – 0.008 foot per foot

Appendix 4 contains monitoring well network and potentiometric surface maps for the Dakota, Tres Hermanos A, Tres Hermanos B, and alluvial units. The monitoring well network is illustrated on **Figure 1.**

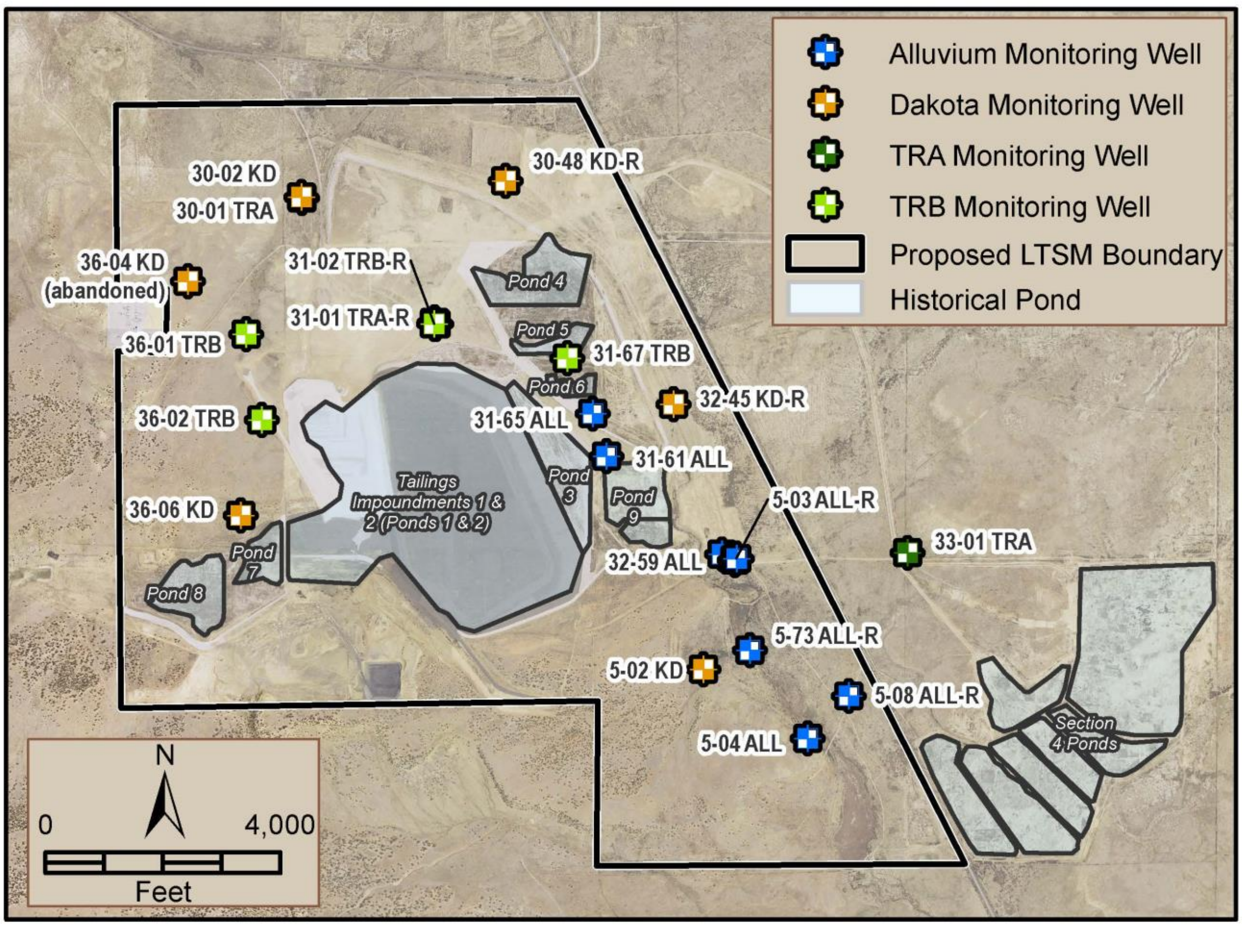

Figure 1. Monitoring Well Network with Historical Site Features

3.0 IMPROVEMENTS TO THE MONITORING PROGRAM

Improvements to the groundwater monitoring program included replacing monitoring wells where measured total depth varied from total depth on construction logs, or wells with visible or suspected damage. The ACL wells that have been replaced are alluvial wells 5-03, 5-08, and 5-73; Dakota wells 30-48 KD and 32-45 KD; Tres Hermanos A well 31-01 TRA; and Tres Hermanos B well 31-02 TRB. The well replacement program was completed in 2013 (INTERA, 2013). Analytical data and time versus concentration plots for the replacement wells are included in **Appendices 1** and **2**, respectively, and sampling results are discussed in **Section 4.0**.

Dedicated pumps have been installed in 17 of the NRC groundwater monitoring network wells, including 5-03 ALL-R, 5-08 ALL-R, 5-73 ALL-R, 30-48 KD-R, 31-02 TRB-R, 32-45 KD-R, 32-50 TRB-R, 36-06 KD, 33-01 TRA, 19-77 TRB, 31-67 TRB, 36-02 TRB, 32-59 ALL, 31-61 ALL, 31-65 ALL, and 5-04 ALL. A dedicated electric submersible pump was installed in 17-01 KD due to its depth.

3.1 Wells Requiring Further Investigation

Monitoring wells 30-02 KD and 30-01 TRA have not contained sufficient water to collect a sample since 2012 and 2009, respectively. Review of the well construction diagrams for 30-02 KD and 30-01 TRA revealed 20 feet of solid casing (or sump) below the bottom of the screened interval in each well. The water column in these wells is below the base of the KD and TRA at 30-02 KD and 30-01 TRA, respectively.

Desaturation of the alluvium and upper bedrock units is expected at the Site due to the termination of surface water discharge associated with the groundwater CAP in 2006. The unusual well construction of 30-02 KD and 30-01 TRA (20-foot sump) creates uncertainty in groundwater elevation measurements, since the water level in those wells is below the screened interval. 30-02 KD is one of six monitoring wells in the Dakota. According to available screen depth and depth-to-water measurements, the last sample collected from within the screened interval of 30-02 KD was in 1988. Similarly, a representative groundwater sample from within the screened interval for 30-01 TRA was last collected in 1998. Collecting a sample from the screened interval of these monitoring wells ensures that the sample is representative of formation groundwater; however, since the water levels are below the screened interval, the water in the sumps is likely stagnant water. For these reasons, RAML proposes to review historical data for these wells and present justification for plugging and abandoning these wells in a request for a License amendment.

4.0 DATA EVALUATION

As a component of the ACL approval process, NRC not only established ACLs for specific parameters, but also maintained the GPSs for those constituents for which ACLs were not proposed. Data collected during the second half of 2018 were compared to ACLs and GPSs. Notable results are described in detail in the following sections.

4.1 Dakota

Analytical results from groundwater samples collected from the Dakota well network are tabulated in **Appendix 1** and presented in time series plots for the ACL parameters in **Appendix 2.** Dakota monitoring wells 36-06 KD and 32-45 KD-R have been sampled monthly due to exceedances of GPSs for beryllium, cadmium, and gross alpha in 36-06 KD, and molybdenum in 32-45 KD-R. The results of monthly sampling are discussed below. Groundwater sampling results from Dakota monitoring wells 17-01 KD and 30-48 KD-R did not reveal any exceedances of ACLs or GPSs in the second half of 2018. Monitoring well 30-02 KD did not contain enough water for sample collection.

4.1.1 36-06 KD

Monitoring well 36-06 KD has been sampled monthly for beryllium, cadmium, gross alpha, and uranium. RAML's interpretation, as previously discussed with NRC, is that fluctuations in groundwater quality in 36-06 KD appear to be linked to surface reclamation work on Ponds 7 and 8 from 1987-1994 and 1999-2006, as shown in the timeseries in **Appendix 2**.

4.1.1.1 Beryllium and Cadmium

Elevated beryllium concentrations were identified in 2006 in Dakota POC monitoring well 36-06 KD. As a result of this condition, RAML submitted a proposed CAP on January 15, 2007, to address the beryllium concentrations present within monitoring well 36-06 KD. This CAP was approved by NRC on April 30, 2007.

The initial increasing trend in beryllium concentrations (2001 to 2007) correlated with surface field work in the vicinity of the well. The increasing trend in beryllium stabilized, and concentrations began trending downward after 2007. RAML proposed to continue monthly sampling of well 36-06 KD for beryllium so that additional data would be available. Beryllium concentrations in 36-06 KD continue to decrease and have been equal to, or below, the GPS in 2018 (**Table 2** and **Figure 2**).

Table 2. Second Half of 2018 Analytical Summary for Beryllium and Cadmium in Monitoring Well 36-06 KD

Date	Beryllium (mg/L)	Cadmium (mg/L)
GPS (mg/L)	**0.01**	**0.01**
7/16/2018	0.00879	0.0055
8/6/2018	0.0092	0.0077
9/6/2018	0.010	0.0052
10/25/2018	0.00682	0.00434
11/6/2018	0.00705	0.00417
12/3/2018	0.00671	0.00408

*Bold values indicate an exceedance of the KD GPS.

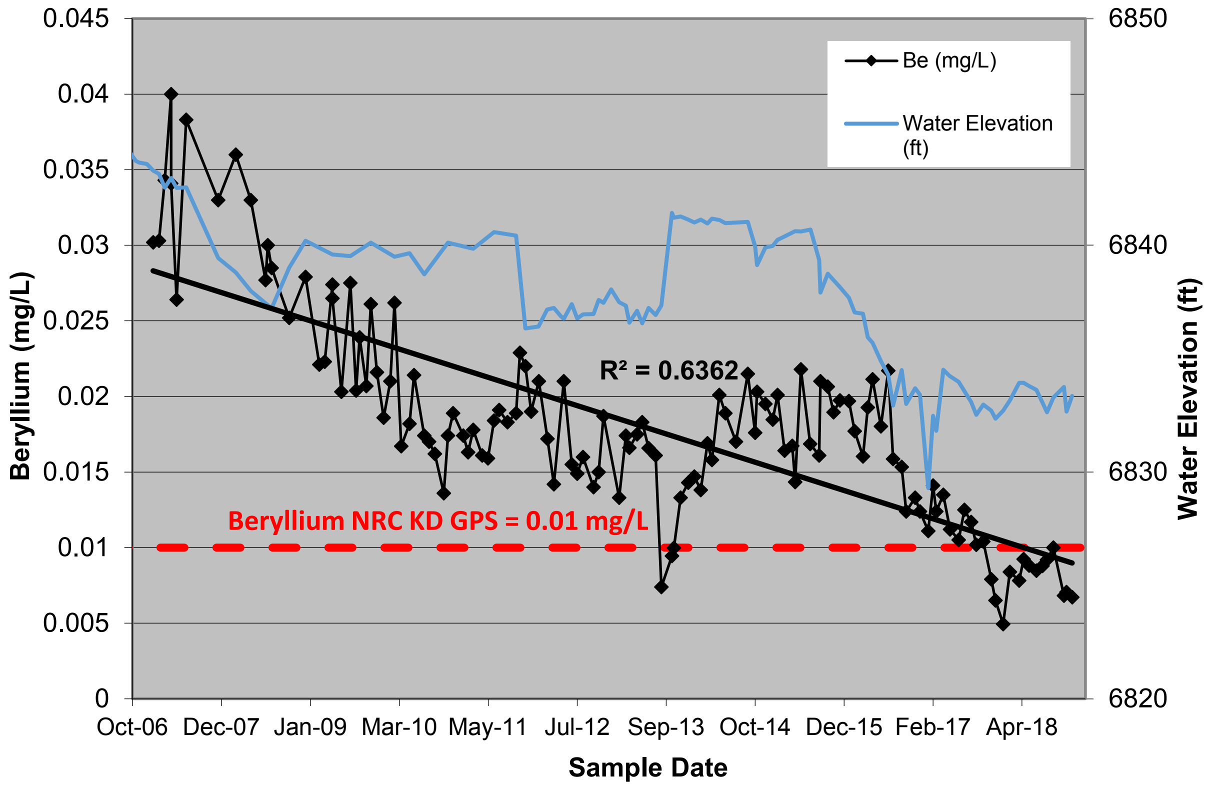

Figure 2. Beryllium Concentrations in Dakota Monitoring Well 36-06 KD

In 2009 RAML instituted a policy of third-party review of laboratory data within five working days of receipt of data. As a result of this policy, RAML was made aware that cadmium concentrations in the samples of groundwater from monitoring well 36-06 KD had exceeded the GPS of 0.01 milligrams per liter (mg/L) during several sampling rounds beginning in November 2007 (**Figure 3**). Cadmium concentrations in monitoring well 36-06 KD follow a pattern that is very

similar to both uranium and beryllium concentrations in the same well. Concentrations of these constituents are sensitive to changes in pH. As with uranium and beryllium, cadmium concentrations continue to exhibit an overall decreasing trend. Cadmium concentrations remained below the GPS throughout the second half of 2018 (**Table 2** and **Figure 3**).

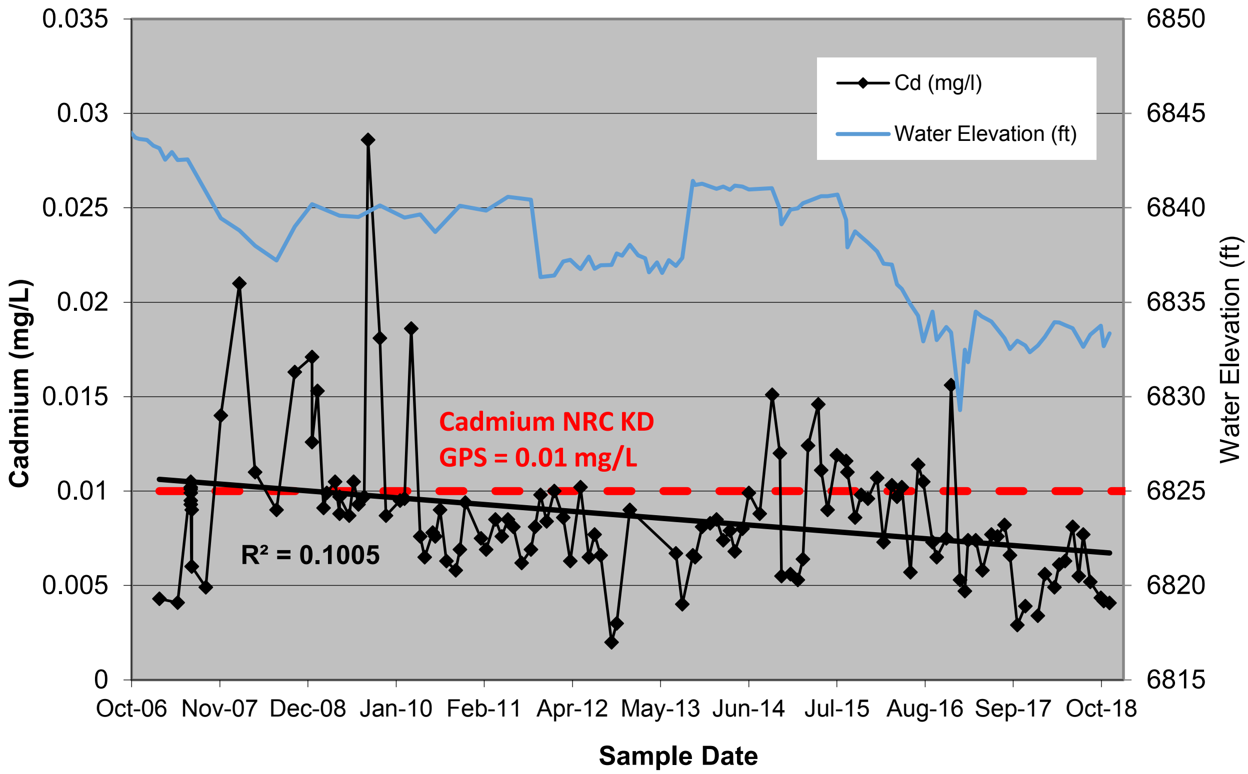

Figure 3. Cadmium Concentrations in Dakota Monitoring Well 36-06 KD

4.1.1.2 Gross Alpha and Uranium

At the time of the Bedrock ACL application (AVM and AHA, 2000), gross alpha, among other constituents, was in exceedance of the GPS in the Dakota. The Bedrock ACL application proposed that the GPS for gross alpha be removed from the License as a hazardous constituent in bedrock aquifers, noting it is unnecessary since the alpha activity hazard is addressed by ACLs for uranium, Th-230, Ra-226, and Pb-210 (which decays to Po-210). Additionally, the Proposed Groundwater Stability Monitoring Plan (included in the December 7, 2005, Response to Request for Additional Information Accession number ML053480214 [RAML, 2005]) does not list gross alpha as a monitoring constituent for any of the bedrock units. In the Technical Evaluation Report, which was prepared by the NRC (NRC, 2006) to document its review of the various submittals during the six-year ACL application process, NRC acknowledges that gross alpha was evaluated as a constituent of concern and that the proposed ACLs (including ACLs for radiologic constituents)

are appropriate and protective of human health and the environment; however, an ACL for gross alpha was never proposed by RAML, likely because the ACLs for the major alpha-emitting constituents were proposed instead and because the GPS for gross alpha was requested to be removed from the License.

Semiannual samples collected from well 36-06 KD were analyzed for alpha emitters Th-230 and Ra-226. The monthly samples were also analyzed for gross alpha and uranium. In order to evaluate the gross alpha activity in water from well 36-06 KD, factors including alpha-emitting constituents, laboratory uncertainty, and alpha-emitter compliance standards were considered. The gross alpha analyses were performed in accordance with U.S. Environmental Protection Agency (EPA) Method 900.0. This method is a commonly used gross alpha screening method for groundwater; however, there are uncertainties with this method when applied to waters with high dissolved solids. Using EPA Method 600/00-02 does not result in decreased uncertainties; both methods are limited by matrix interferences in the 36-06 KD samples (detailed in RAML, 2016b).

The semiannual sample results from 2014 through present for alpha emitters, calculated gross alpha, and measured gross alpha minus uranium are compared to their corresponding ACLs or GPSs as summarized in **Table 3**. It is important to note that individual alpha emitters in the Dakota are subject to ACLs, while gross alpha has a more conservative GPS. The sum of the ACLs for the major alpha emitters (Th-230 and Ra-226) is 1,163 picoCuries per liter (pCi/L), which is 20 times greater than the gross alpha GPS of 56 pCi/L.

Table 3. Summary of Historical Gross Alpha Calculations and Measurements in Monitoring Well 36-06 KD.

Date Sampled	Ra-226 (pCi/L)	Th-230 (pCi/L)	Gross Alpha[A] (Summed Isotopes) (pCi/L)	Gross Alpha (U Corrected) (pCi/L)
GPS/ACL	**218 (ACL)**	**945 (ACL)**	**56 (GPS)**	**56 (GPS)**
6/10/2014	9.2	29	38.2	55.5
9/24/2014	10	25	35	-122
11/6/2014	15	13	28	**68.9**
2/11/2015	12	30	42	-39.4
8/26/2015	11	13	24	-66.1
2/11/2016	16	11	27	-18
7/18/2016	19	84	**103**	34
2/15/2017	17	21	38	**180**
8/14/2017	12	23	35	-23
2/12/2018	17	9.7	26.7	**120**
8/6/2018	11	21	32	-90

*Bold values indicate an exceedance of the KD gross alpha GPS of 56 pCi/L.

AGross Alpha (Summed Isotopes) is calculated from the sum of Ra-226 and Th-230 activities. Isotopes selected for the Gross Alpha summation have long half-lives, are alpha emitters, and are sourced from either U-238 or Th-232, the most abundant isotopes of each element.

Figure 4 shows gross alpha results over time with error bars signifying the range of possible results. This figure illustrates that the uncertainty in the gross alpha results is greater than the GPS of 56 pCi/L.

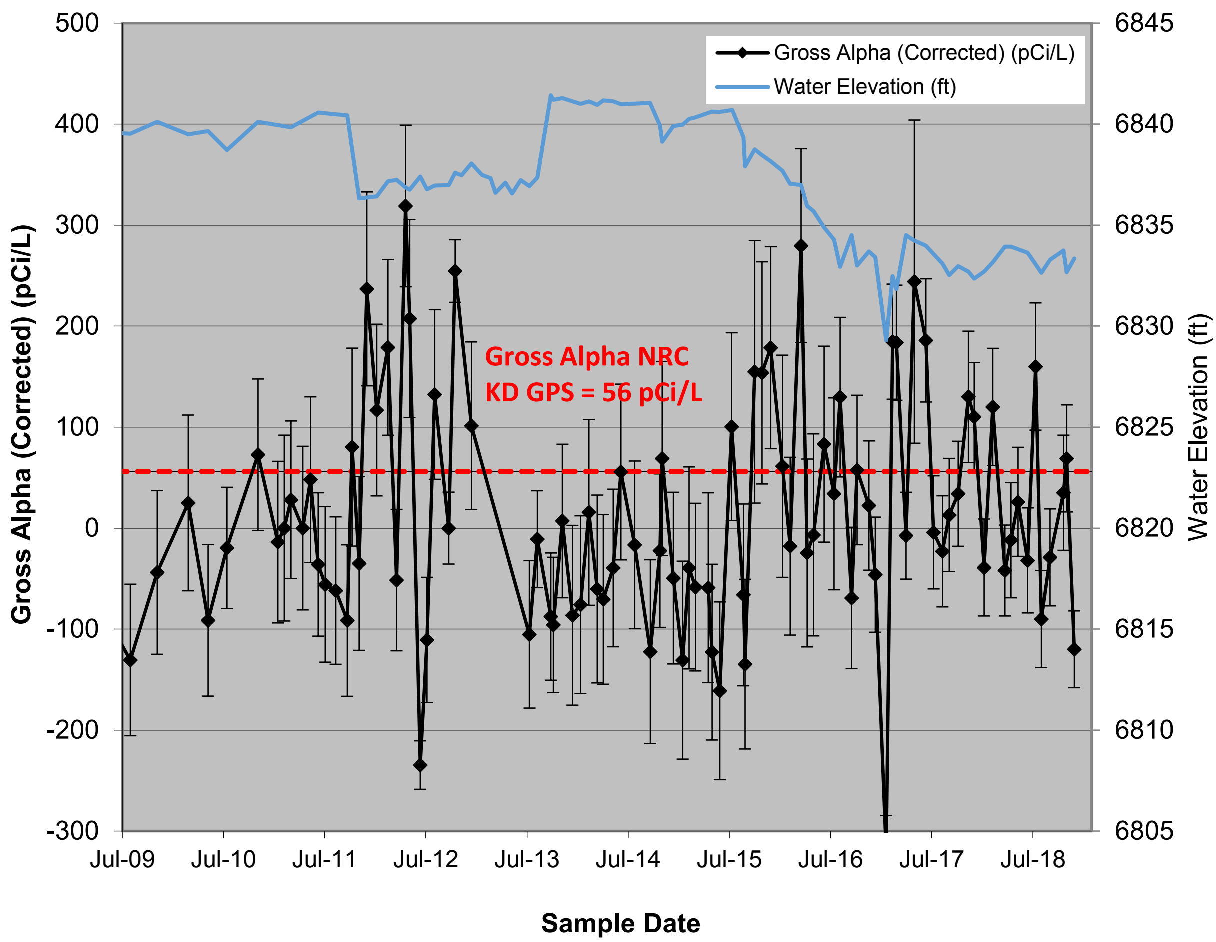

Figure 4. Gross Alpha Activities in Dakota Monitoring Well 36-06 KD

The corrected gross alpha values (gross alpha – gross alpha derived from uranium) for the monthly samples collected during the second half of 2018 are presented in **Table 4.** Two out of six of the corrected gross alpha values were greater than the GPS of 56 pCi/L in the second half of 2018. However, uranium concentrations did not exceed the ACL.

Table 4. Second Half of 2018 Monthly Analytical Summary for Gross Alpha and Uranium in Monitoring Well 36-06 KD

Date	Gross Alpha Value (pCi/L)	Uranium (mg/L)
GPS/ACL	**56 (GPS)**	**1.6 (ACL)**
7/16/2018	**160**	0.354
8/6/2018	-90	0.463
9/6/2018	-29	0.402
10/25/2018	35	0.44
11/6/2018	**69**	0.405
12/3/2018	-120	0.394

*Bold values indicate an exceedance of the KD GPS or ACL.

Monthly sampling and analysis will continue for gross alpha and uranium in 36-06 KD pending preparation of a License amendment with proposed modifications to the gross alpha standards in the upper bedrock units.

4.1.2 32-45 KD-R

Pursuant to Condition 34.F and Criterion 5D of 10 CFR part 40 Appendix A, RAML proposed a CAP to address the exceedances of nitrate and molybdenum in 32-45 KD-R in the Groundwater Stability Monitoring Report, Second Half 2014 (RAML, 2015). Since 32-45 KD-R is a replacement well, RAML proposed the continuation of monthly sampling for these parameters to gather more information as the well continues to stabilize. Nitrate concentrations in monitoring well 32-45 KD-R have continued to decrease and have remained below the ACL of 22.8 mg/L since April 2015. RAML ceased monthly analysis of nitrate in 32-45 KD-R after the February 2016 event, as described in the Groundwater Stability Monitoring Report, Second Half 2015 (RAML, 2016a). Nitrate in 32-45 KD-R will continue to be analyzed on a semiannual basis. Gross alpha exceedances observed during the first half 2018 semiannual monitoring event have initiated monthly sampling for gross alpha and uranium at 32-45 KD-R.

4.1.2.1 Molybdenum

Molybdenum in 32-45 KD-R reached a maximum concentration of 0.505 mg/L in March of 2015. Although concentrations have been decreasing, they continue to exceed the GPS of 0.06 mg/L (**Table 5** and **Figure 5**). **Table 5** presents molybdenum concentrations in monitoring well 32-45 KD-R during the second half of 2018. Time series plots for molybdenum (**Figure 5**) in 32-45 KD-R show that concentrations during the second half of 2018, although above the GPS of 0.06 mg/L, appear to follow a generally decreasing trend.

Table 5. Second Half of 2018 Analytical Result Summary for Molybdenum in Monitoring Well 32-45 KD-R

Sample Date	Molybdenum (mg/L)
GPS/ACL	0.06 (GPS)
7/25/2018	**0.136**
8/6/2018	**0.133**
9/6/2018	**0.135**
10/29/2018	**0.13**
11/6/2018	**0.135**
12/3/2018	**0.146**

*Bold values indicate an exceedance of the KD GPS or ACL.

Molybdenum is known to occur naturally near uranium deposits (Guilbert and Park, 1986). Molybdenum is not included in primary or secondary EPA Maximum Contaminant Levels for drinking water; however, NMED has a molybdenum standard for irrigation, which is 1.0 mg/L, and concentrations of molybdenum in groundwater samples from this well do not exceed that standard.

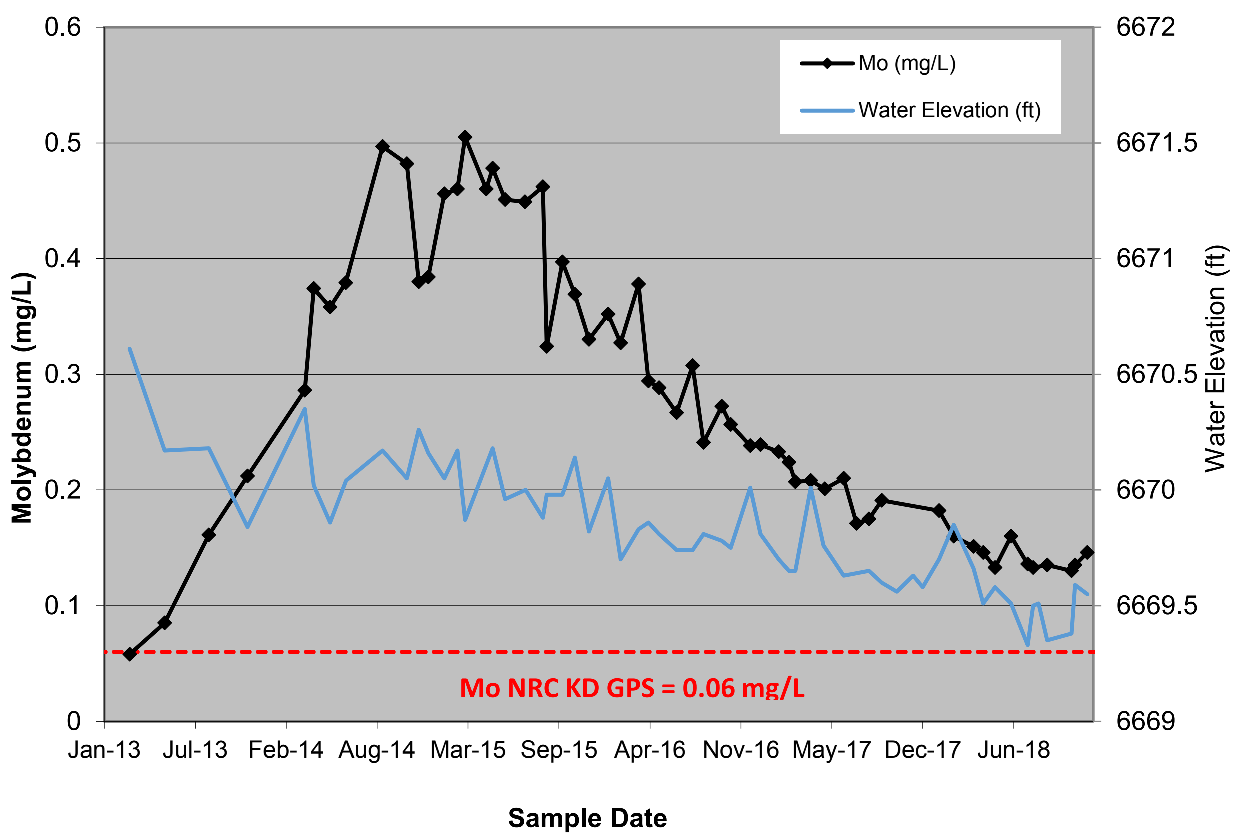

Figure 5. Molybdenum Concentration in Dakota Monitoring Well 32-45 KD-R

Monthly sampling and analysis for molybdenum will continue pending preparation of a License amendment, which may include a proposed GPS modification or an ACL for molybdenum in the Dakota.

4.1.2.2 Gross Alpha and Uranium

Gross alpha activity measured in well 32-45 KD-R during the semiannual sampling and monthly events exceeded the GPS of 56 pCi/L (**Table 6** and **Figure 6**). Re-sampling of the well confirmed the exceedance. Uranium concentrations did not exceed the ACL. Gross alpha in well 32-45 KD-R will be sampled monthly, as reported in the "SUA-1473 Reporting of Monthly Sampling Results for First Quarter 2018" (RAML, 2018). Monthly sampling was initiated in May of 2018, when the results of the March re-sample were reported. In June, the gross alpha activity dropped below the GPS of 56 pCi/L to 50 pCi/L. Uncertainties in gross alpha activities are between 15-27 pCi/L, as reported by the analytical laboratory, ACZ Laboratories. Monthly sampling will continue pending preparation of a License amendment with proposed modifications to the gross alpha standards in the upper bedrock units.

Uranium concentrations in the 32-45 KD-R well did not exceed the ACL during the second half of 2018 (**Table 6**).

Table 6. Second Half of 2018 Analytical Result Summary for Gross Alpha and Uranium in Monitoring Well 32-45 KD-R

Sample Date	Gross Alpha (pCi/L)	Uranium (mg/L)
GPS/ACL	**56 pCi/L (GPS)**	**1.6 mg/L (ACL)**
7/25/2018	**82**	0.0566
8/6/2018	**110**	0.0588
9/6/2018	**92**	0.0573
10/29/2018	**75**	0.0518
11/6/2018	**82**	0.056
12/3/2018	**73**	0.055

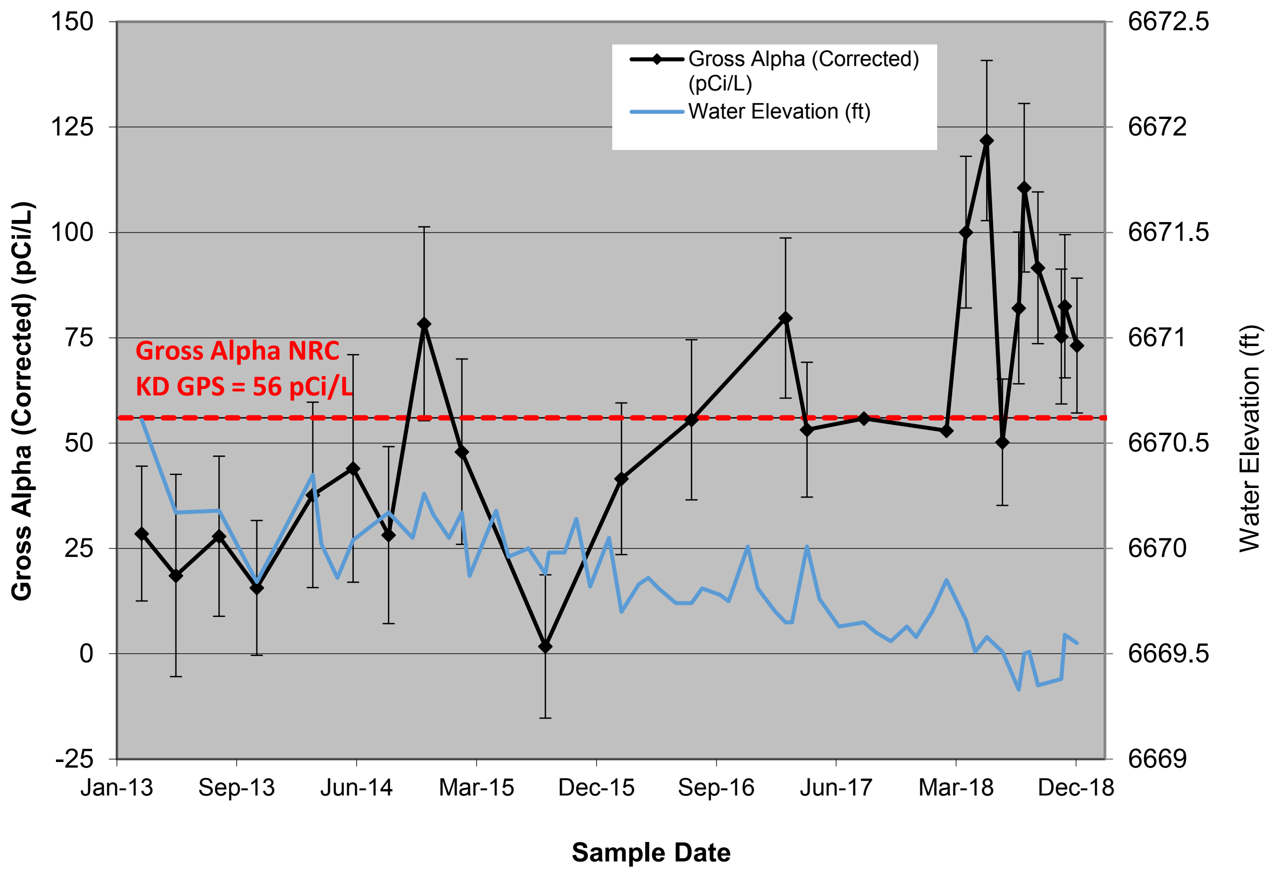

Figure 6. Gross Alpha Activities in Dakota Monitoring Well 32-45 KD-R

4.2 Tres Hermanos A

Analytical results from Tres Hermanos A wells are tabulated in **Appendix 1** and presented graphically as time series plots in **Appendix 2**. As discussed in **Section 3.1**, well 30-01 TRA did not contain enough water to collect a sample. No exceedances of License groundwater standards were observed in groundwater samples from Tres Hermanos A monitoring wells.

Characterization of the potentiometric surface and estimation of the hydraulic gradient require groundwater elevation data from at least three monitoring wells. The groundwater elevation at monitoring well 30-01 TRA indicates that the TRA is dry, leaving 31-01 TRA-R and 33-01 as the only two locations with water. Therefore, the hydraulic gradient and potentiometric surface are not evaluated for the TRA (**Appendix 4**) for the second half of 2018. Three additional TRA wells will be installed as outlined in the Data Collection Work Plan in Support of Additional

ACLs (INTERA, 2017). Groundwater elevation data from these additional wells will allow for characterization of the potentiometric surface and calculation of the hydraulic gradient in the TRA.

4.3 Tres Hermanos B

Analytical results from Tres Hermanos B wells are tabulated in **Appendix 1** and presented graphically as time series plots in **Appendix 2**. Well 36-01 TRB was last sampled in 2009 and has not contained enough water for a sample since then. No new exceedances of ACLs or GPSs were observed in groundwater collected from Tres Hermanos B wells in the second half of 2018.

4.3.1 31-02 TRB-R

Uranium concentrations in groundwater samples collected from former monitoring well 31-02 TRB from July through November of 2011 exceeded the ACL of 1.6 mg/L. RAML continued monthly sampling, and uranium concentrations were observed below the ACL throughout 2012. As part of the Site-wide well-replacement program, monitoring well 31-02 TRB was identified for replacement; and a new well (31-02 TRB-R) was installed on December 14, 2012. Monthly sampling and analysis for uranium and gross alpha in well 31-02 TRB-R continued, and results are provided below.

4.3.1.1 Gross Alpha and Uranium

Results from groundwater sampling for the second half of 2018 are presented in **Table 7.** Gross alpha over time is shown in **Figure 7**. There were no exceedances of gross alpha activity measured in samples from 31-02 TRB-R during the second half of 2018 (**Table 7**). Uranium concentrations in this replacement well have never exceeded the ACL.

Table 7. Second Half 2018 Analytical Summary for Gross Alpha and Uranium in Monitoring Well 31-02 TRB-R

Date	Gross Alpha (pCi/L)	Uranium (mg/L)
ACL/GPS	**21 (GPS)**	**1.6 (ACL)**
7/16/2018	6	0.0037
8/6/2018	6.3	0.0037
9/6/2018	-6.9	0.0038
10/25/2018	11	0.0033
11/7/2018	21	0.0037
12/3/2018	14	0.0048

*Bold values indicate an exceedance of the TRB GPS.

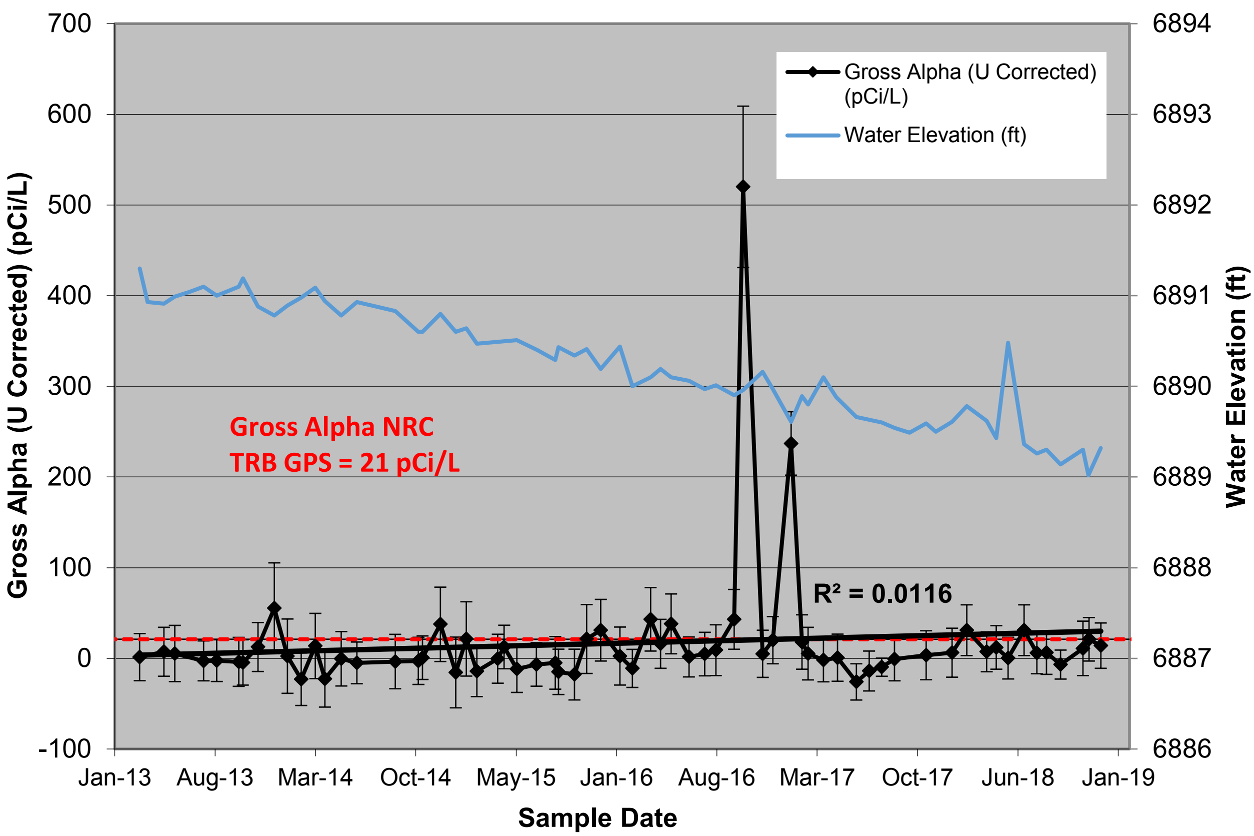

Figure 7. Gross Alpha Activities in Monitoring Well 31-02 TRB-R

As with the gross alpha results in 36-06 KD described in **Section 4.1.1.2**, the Tres Hermanos B does not have an ACL for gross alpha but does have ACLs for the other alpha emitters. Monthly sampling and analysis will continue for gross alpha and uranium in 31-02 TRB-R, pending preparation of a License amendment with proposed modifications to the gross alpha standards in the upper bedrock units.

4.4 Alluvium

Analytical results from the alluvial well network are tabulated in **Appendix 1** and presented graphically as time series plots in **Appendix 2**. MW-24 ALL did not contain enough water to collect a sample. Groundwater from all other NRC alluvial wells did not exceed ACLs.

5.0 CONCLUSIONS

Table 8 summarizes the notable results from the second half of 2018 groundwater monitoring and provides path forward recommendations.

Table 8. Rio Algom Mining – Ambrosia Lake
Second Half 2018 Summary and Path Forward

Well	Summary	Status	Path Forward
36-06 KD	Gross alpha above GPS	CAP submitted for beryllium 2007; monthly sampling (plus uranium)	Continue with monthly sampling until development and approval of ACLs or GPS modification for gross alpha for License amendment.
32-45 KD-R	Molybdenum, gross alpha above GPS	Replacement well stabilizing, monthly sampling	Continue with monthly sampling and quarterly reporting for molybdenum until concentrations drop below the GPS; consider revision of GPS or ACLs for molybdenum and gross alpha in upcoming License amendment.
31-02 TRB-R	Gross alpha above GPS	Replacement well stabilizing; monthly sampling	Continue monthly sampling and quarterly reporting until well stabilizes; consider revision of GPS or ACLs for License amendment.

RAML proposes to continue monthly sampling of constituents exceeding their GPSs. Replacement wells that are in the process of stabilization will also be sampled monthly for constituents exceeding GPSs or ACLs. The path forward for constituents with exceedances of GPSs is to develop ACLs and amend the License to include these values as described in RAML's letter to NRC dated April 13, 2017. Wells with construction specifications that allow for collection of samples that may not be representative of formation conditions will be monitored for total depth and depth to water and sampled if the water level is sufficient.

Monitoring and sampling of the well network is required on a semiannual basis, with the exception of the wells involved in accelerated monthly sampling program. RAML will continue to conduct monthly and semiannual monitoring and sampling in accordance with the requirements in Condition #34 of the License.

6.0 REFERENCES

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INTERA Incorporated (INTERA), 2013. Monitoring Well Replacement Report, Rio Algom Mining LLC. May 2013.

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———, 2016a. Rio Algom LLC Ambrosia Lake Facility, License SUA-1473 Docket 40-8905, Groundwater Stability Monitoring Report, Second Half 2015.

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APPENDIX 1

Stability Monitoring Plan
Analytical Results

RIO ALGOM MINING LLC
2nd HALF 2018
DAKOTA WELL RESULTS - ACL PARAMETERS

Well	Date	Depth To Water	Total Depth	Specific Conductivity	Temp (°C)	pH s.u.	Chloride (mg/L)	Nitrate (mg/L)	T.D.S. (mg/L)	Sulfate (mg/L)
17-01 KD	8/21/2018			1590	15.79	9.45	13.3	<0.02	1110	682
30-02 KD	8/8/2018	307.94	313.01			Insufficient Water				
30-48 KD-R	8/17/2018	327.6		4859	14.93	6.74	504	0.03	4250	1790
32-45 KD-R	8/6/2018	257.9		1693	14.46	6.98	95.2	0.55	1490	605
36-06 KD	8/6/2018	188.76		6254	16.29	2.87	930	<0.02	6050	3050
5-02 KD	9/6/2018	186.79		1289	16.33	7.52	11.9	0.42	836	276
ACL							**3,200**	**22.8**	**14,100**	**6,480**

Well	Date	Ni (mg/L)	U-nat (mg/L)	Th-230 (pCi/L)	Pb-210 (pCi/L)	Ra-226+Ra-228 (pCi/L)
17-01 KD	8/21/2018	<0.0006	<0.0001	0.05	1.2	2.38
30-02 KD	8/8/2018			Insufficient Water		
30-48 KD-R	8/17/2018	<0.003	<0.0005	0.0	3.4	8.3
32-45 KD-R	8/6/2018	0.0018	0.0588	-0.05	2.1	2.7
36-06 KD	8/6/2018	0.131	0.463	21	6.2	18
5-02 KD	9/6/2018	0.0013	0.0013	-0.51	1.5	0.28
ACL		**6.8**	**1.6**	**945**	**88**	**218**

Total depth could not be measured at 17-01 KD, 30-48 KD-R, 32-45 KD-R, 36-06 KD, and 5-02 KD. Depth to water could not be measured at 17-01 KD.
Monitoring well 30-02 KD contained insufficient water for sample collection.
< = constituent was not detected above the method detection limit.

RIO ALGOM MINING LLC
2nd HALF 2018
TRA WELL RESULTS - ACL PARAMETERS

Well	Date	Depth To Water	Total Depth	Specific Conductivity	Temp (°C)	pH s.u.	Chloride (mg/L)	Nitrate (mg/L)	T.D.S. (mg/L)	Sulfate (mg/L)
30-01 TRA	8/8/2018	203.57	207.42			Insufficient Water				
31-01 TRA-R	8/6/2018	204.74	213.65	1703	14.4	7.24	21.2	0.03	1590	1000
33-01 TRA	8/9/2018	118.44	181.31	3436	13.68	7.74	34.5	<0.02	2690	1970
ACL							**1,070**	**9.2**	**6,400**	**2,584**

Well	Date	Th-230 (pCi/L)	Pb-210 (pCi/L)	Ra-226+Ra-228 (pCi/L)
30-01 TRA	8/8/2018		Insufficient Water	
31-01 TRA-R	8/6/2018	0.07	1.2	0.93
33-01 TRA	8/9/2018	-0.18	2	2.53
ACL		**945**	**88**	**218**

< = constituent was not detected above the method detection limit.
Well 30-01 TRA contained insufficient water for sample collection.

RIO ALGOM MINING LLC
2nd HALF 2018
TRB WELL RESULTS - ACL PARAMETERS

Well	Date	Depth To Water	Total Depth	Specific Conductivity	Temp (°C)	pH s.u.	Chloride (mg/L)	Nitrate (mg/L)	T.D.S. (mg/L)	Sulfate (mg/L)
19-77 TRB	8/14/2018	271.69	283	4516	14.79	7.21	17.2	0.31	3540	1870
31-02 TRB-R	8/6/2018	97.45	128.44	7449	13.68	6.44	1150	<0.02	7770	3490
31-67 TRB	8/10/2018	37.81	96.18	8238	12.55	6.23	1220	<0.02	7330	3210
36-01 TRB	8/8/2018	Dry	58.47				Dry			
36-02 TRB	8/8/2018	51.6	57.49	10628	13.89	6.68	2020	<0.02	8500	2700
ACL							**2,810**	**7.7**	**11,700**	**4,760**

Well	Date	Ni (mg/L)	U-nat (mg/L)	Th-230 (pCi/L)	Pb-210 (pCi/L)	Ra-226+Ra-228 (pCi/L)
19-77 TRB	8/14/2018	0.002	0.0117	-0.14	2.5	0.67
31-02 TRB-R	8/6/2018	<0.003	0.0037	0.0	2.5	14.7
31-67 TRB	8/10/2018	0.007	0.0122	-0.2	1.9	16.2
36-01 TRB	8/8/2018			Dry		
36-02 TRB	8/8/2018	0.005	0.0031	-0.24	7.1	1.92
ACL		**6.8**	**1.6**	**945**	**88**	**218**

< = constituent was not detected above the method detection limit.
Monitoring Well 36-01 TRB was dry and therefore not sampled.

RIO ALGOM MINING LLC
2nd HALF 2018
ALLUVIAL WELL RESULTS - ACL PARAMETERS

Well	Date	Depth To Water	Total Depth	Specific Conductivity	Temp (°C)	pH s.u.	Chloride (mg/L)	Nitrate (mg/L)	T.D.S. (mg/L)	Sulfate (mg/L)
5-73 ALL-R	8/7/2018	23.94	35.65	8241	12.12	6.77	1520	5.24	6510	1630
5-03 ALL-R	8/7/2018	29.1	55.8	5182	13.36	7.04	604	0.46	4430	2080
5-04 ALL	8/7/2018	27	60.13	6030	12.42	7.98	970	<0.02	5440	2610
5-08 ALL-R	8/7/2018	39.03	76.52	4034	13.07	7.4	164	21.6	3810	1940
31-61 ALL	8/8/2018	17.64	29.02	15727	12.54	6.16	2010	7.46	14100	6490
31-65 ALL	8/10/2018	15.54	11.25	16759	11.25	5.95	1980	0.24	15500	7300
32-59 ALL	8/8/2018	24.49	28.35	5280	15.39	7.41	547	2.39	4530	1770
MW-24 ALL	8/7/2018	50.16	50.37			Insufficient Water				
ACL							**7,110**	**351**	**26,100**	**12,000**

Well MW-24 ALL contained insufficient water for sample collection.

RIO ALGOM MINING LLC
2nd HALF 2018
ALLUVIAL WELL RESULTS - ACL PARAMETERS

Well	Date	Mo (mg/L)	Ni (mg/L)	Se (mg/L)	U-nat (mg/L)	Th-230 (pCi/L)	Pb-210 (pCi/L)	Ra-226+Ra-228 (pCi/L)	Gross Alpha (pCi/L)
5-73 ALL-R	8/7/2018	0.005	0.011	0.105	1.64	-0.76	3	2.26	-389
5-03 ALL-R	8/7/2018	<0.003	<0.003	0.0016	0.0926	-0.35	1	0.22	-20
5-04 ALL	8/7/2018	<0.003	<0.003	<0.001	<0.0005	-0.08	2.2	0.40	1.9
5-08 ALL-R	8/7/2018	0.004	0.002	0.0095	0.0235	0.17	2.2	2.97	-13.2
31-61 ALL	8/8/2018	<0.005	0.054	0.0070	0.646	-0.19	0.51	2.29	-243
31-65 ALL	8/10/2018	<0.005	0.123	0.0041	0.077	-0.02	8.3	0.95	-19
32-59 ALL	8/8/2018	0.004	<0.003	0.249	0.210	-0.22	0.48	0.44	-57
MW-24 ALL	8/7/2018				Insufficient Water				
ACL		**176**	**98**	**49**	**23**	**13,627**	**1,274**	**3,167**	**8,402**

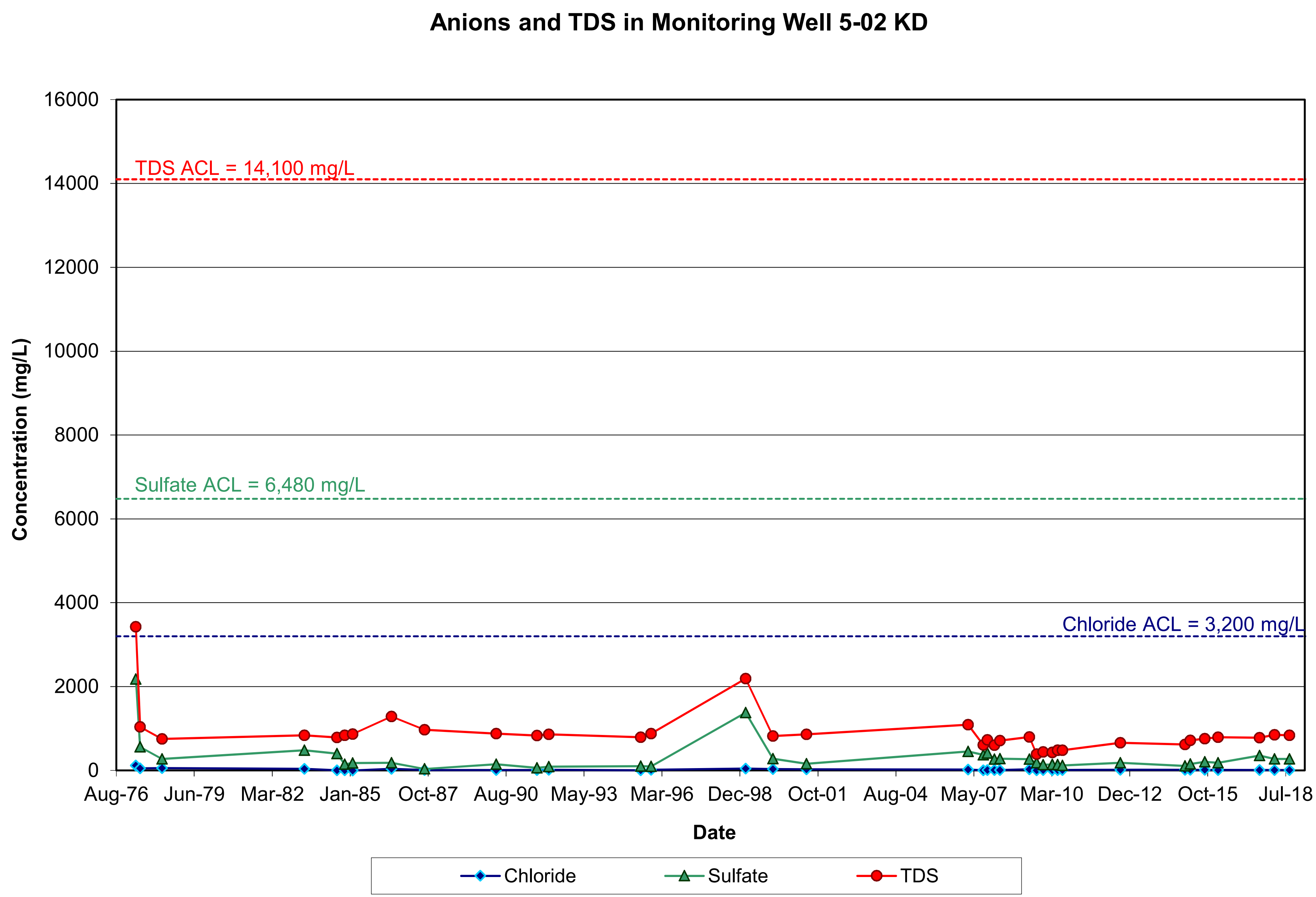
< = constituent was not detected above the method detection limit.

APPENDIX 2

Stability Monitoring Plan
Time Versus Concentration Plots

Stability Monitoring Plan
Time Versus Concentration Plots

Dakota



Anions and TDS in Monitoring Well 5-02 KD
TDS ACL = 14,100 mg/L
Sulfate ACL = 6,480 mg/L
Chloride ACL = 3,200 mg/L
Concentration (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
Aug-76
Jun-79
Mar-82
Jan-85
Oct-87
Aug-90
May-93
Mar-96
Dec-98
Oct-01
Aug-04
May-07
Mar-10
Dec-12
Oct-15
Jul-18
Date
Chloride
Sulfate
TDS

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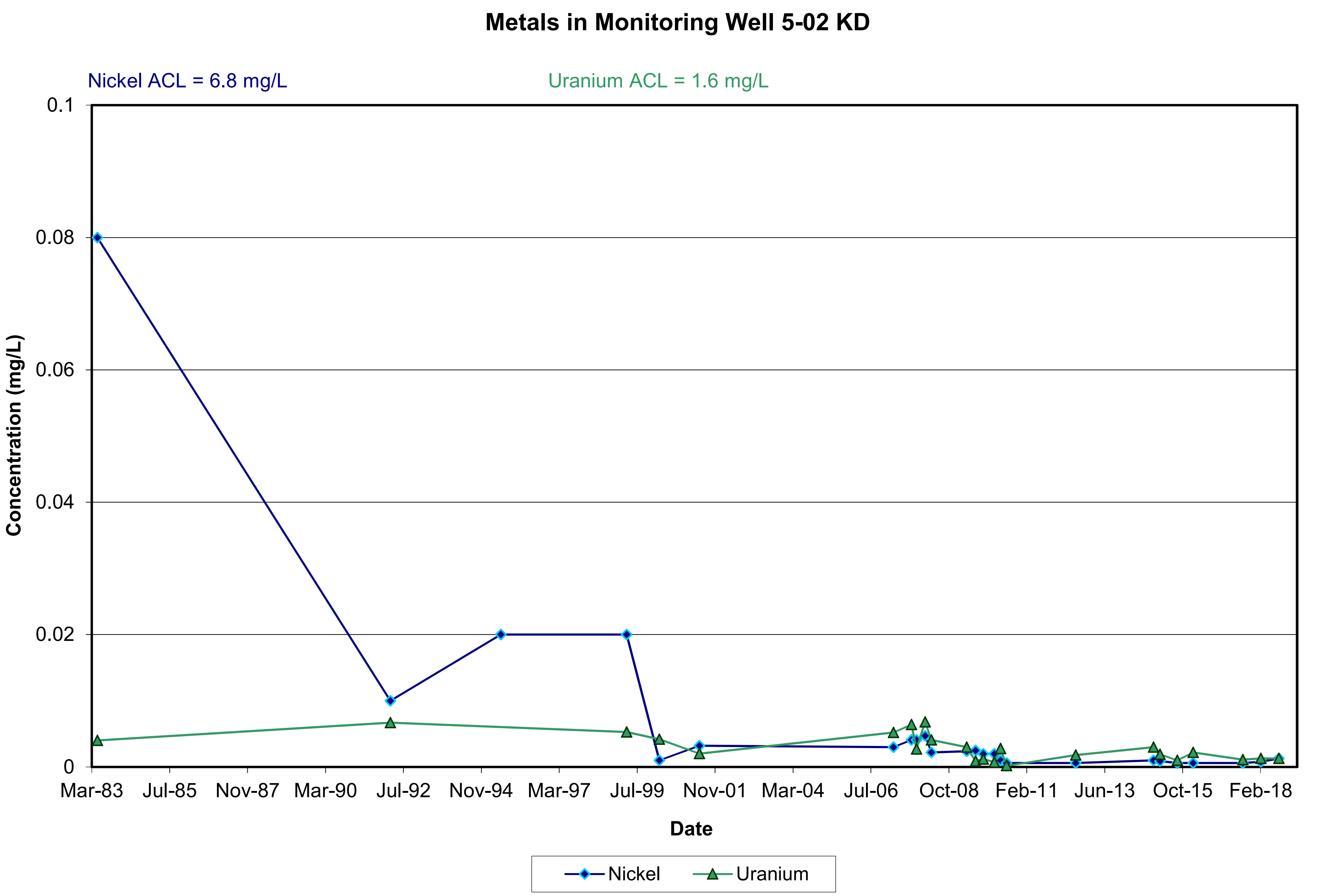
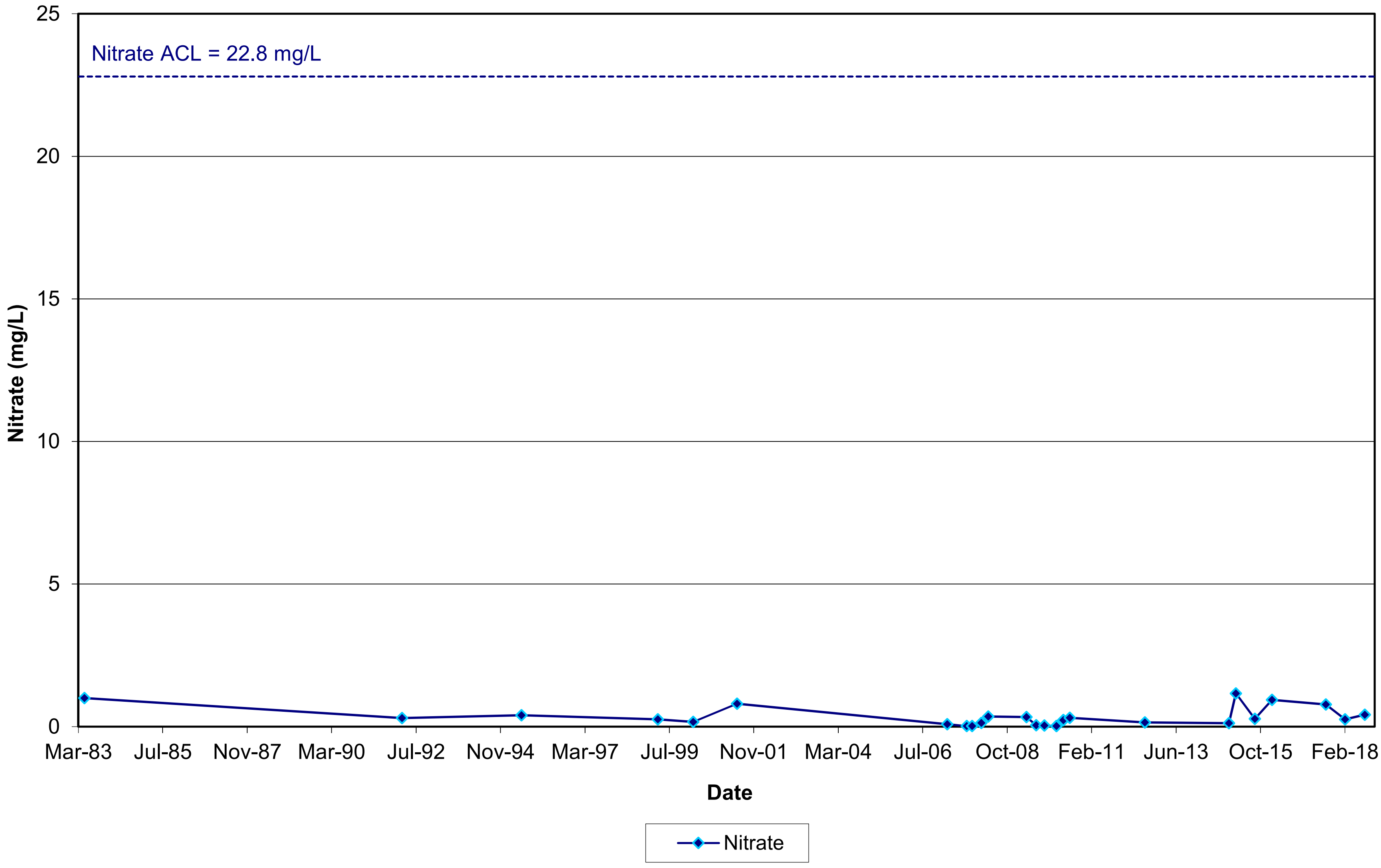


Metals in Monitoring Well 5-02 KD
Nickel ACL = 6.8 mg/L
Uranium ACL = 1.6 mg/L
Concentration (mg/L)
0.1
0.08
0.06
0.04
0.02
0
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Nickel
Uranium

Nitrate in Monitoring Well 5-02 KD



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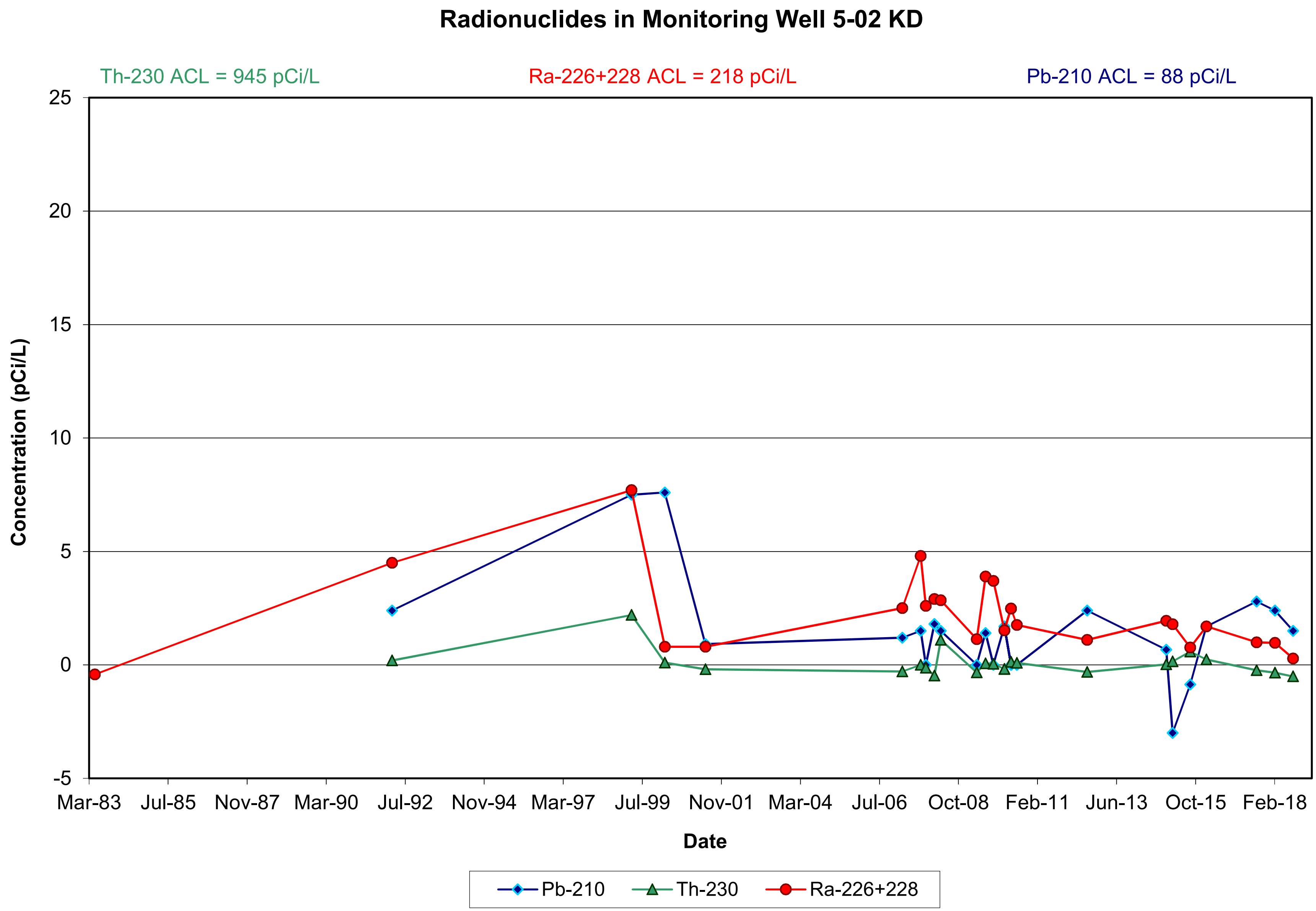

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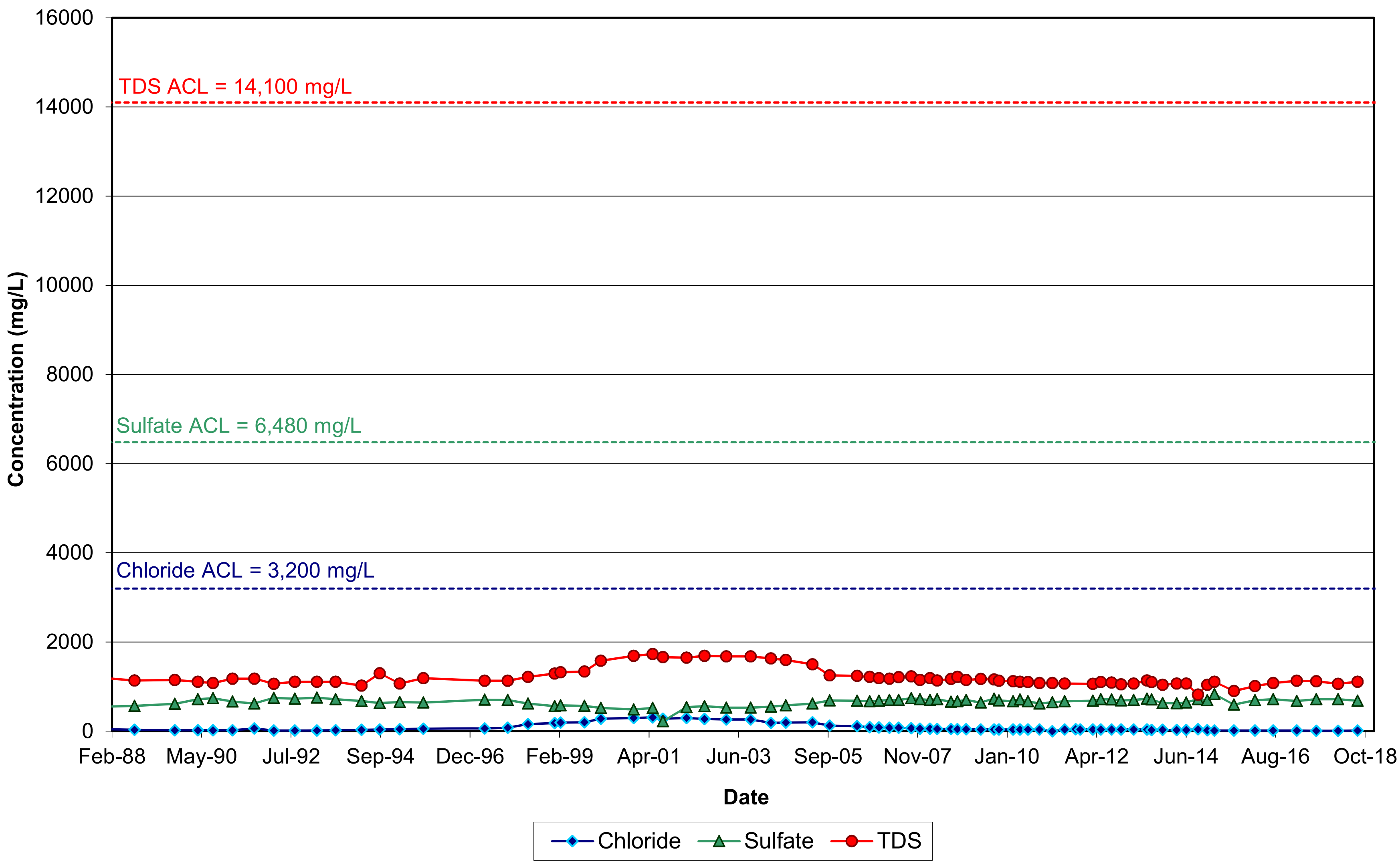
Anions and TDS in Monitoring Well 17-01 KD



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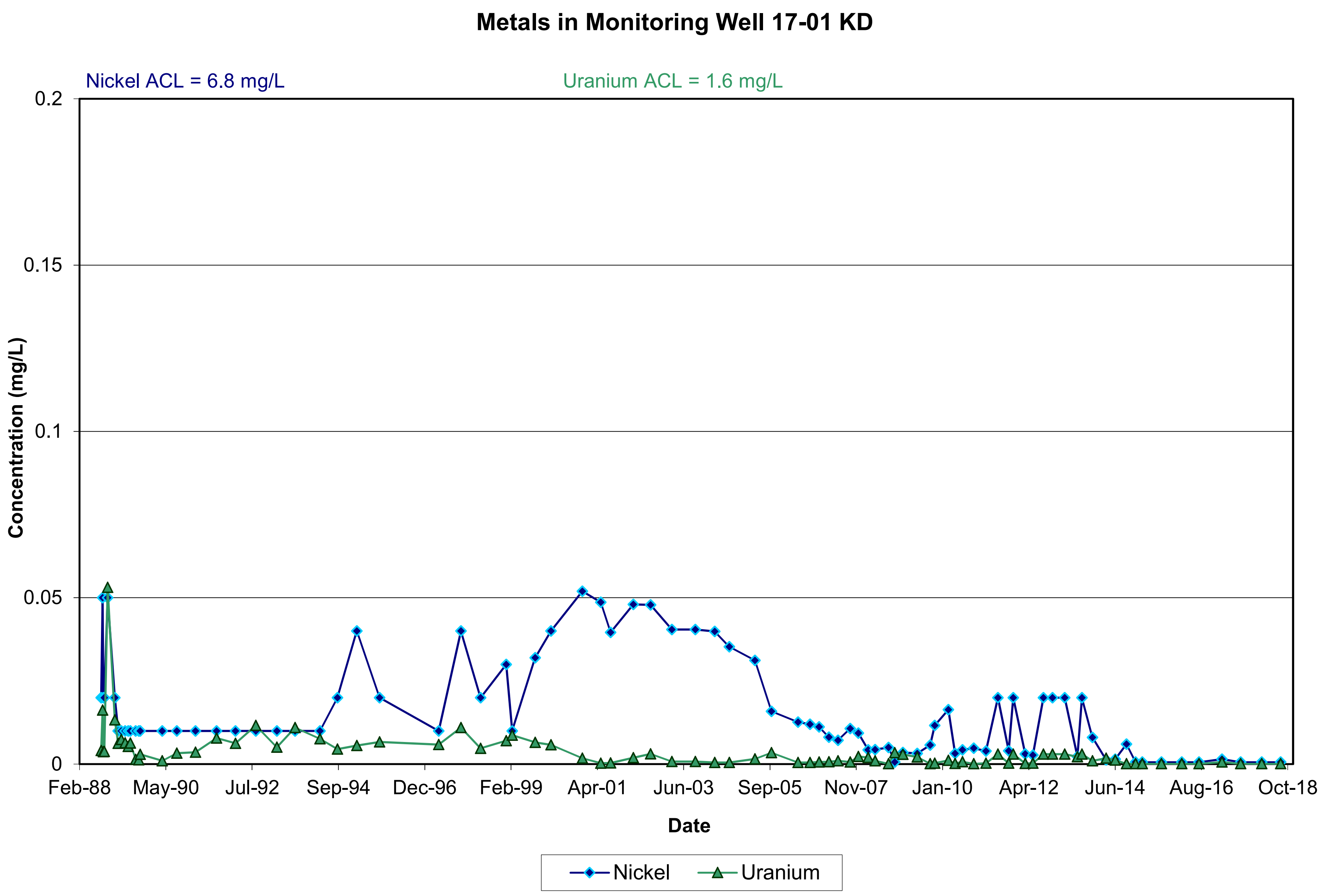

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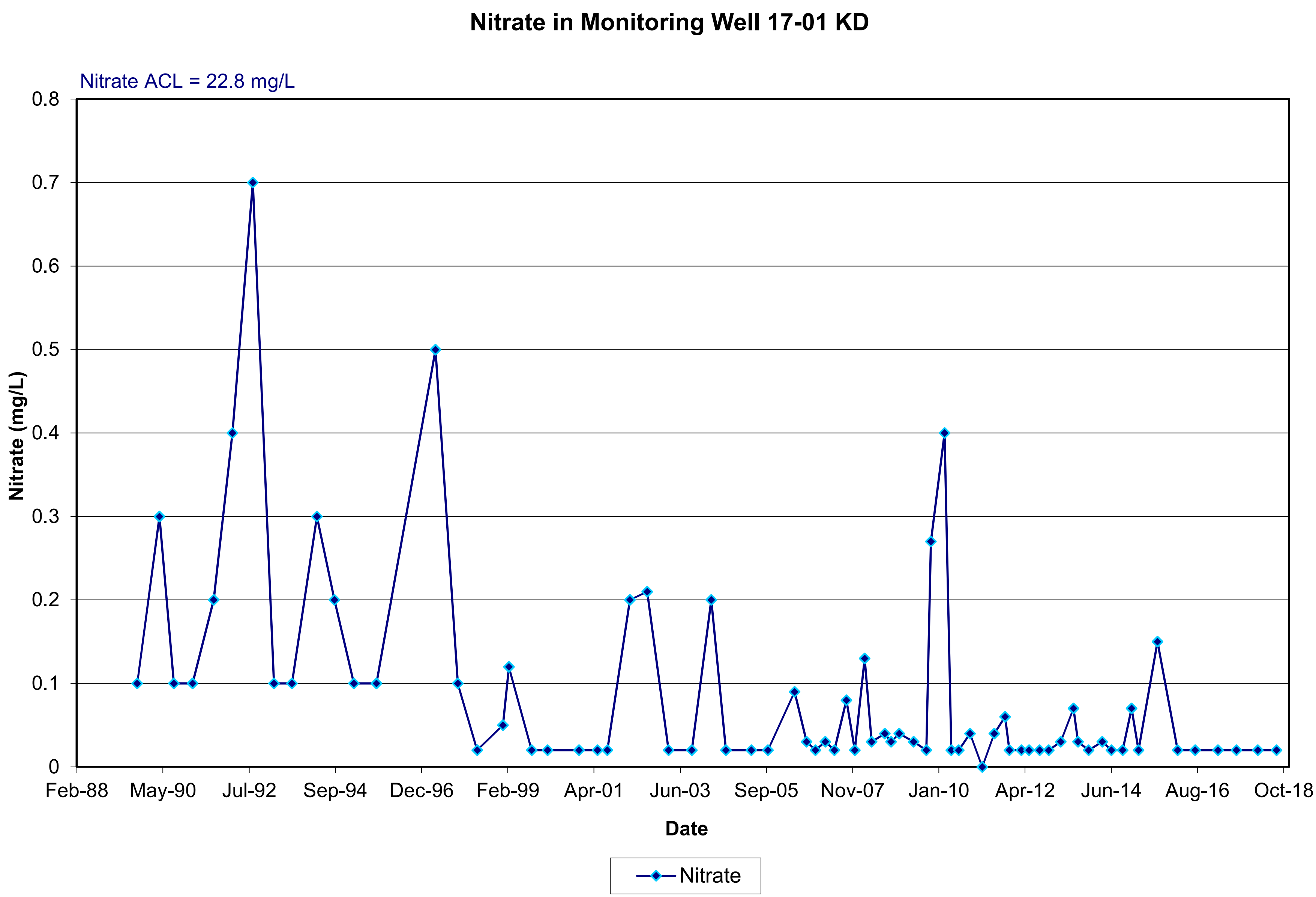

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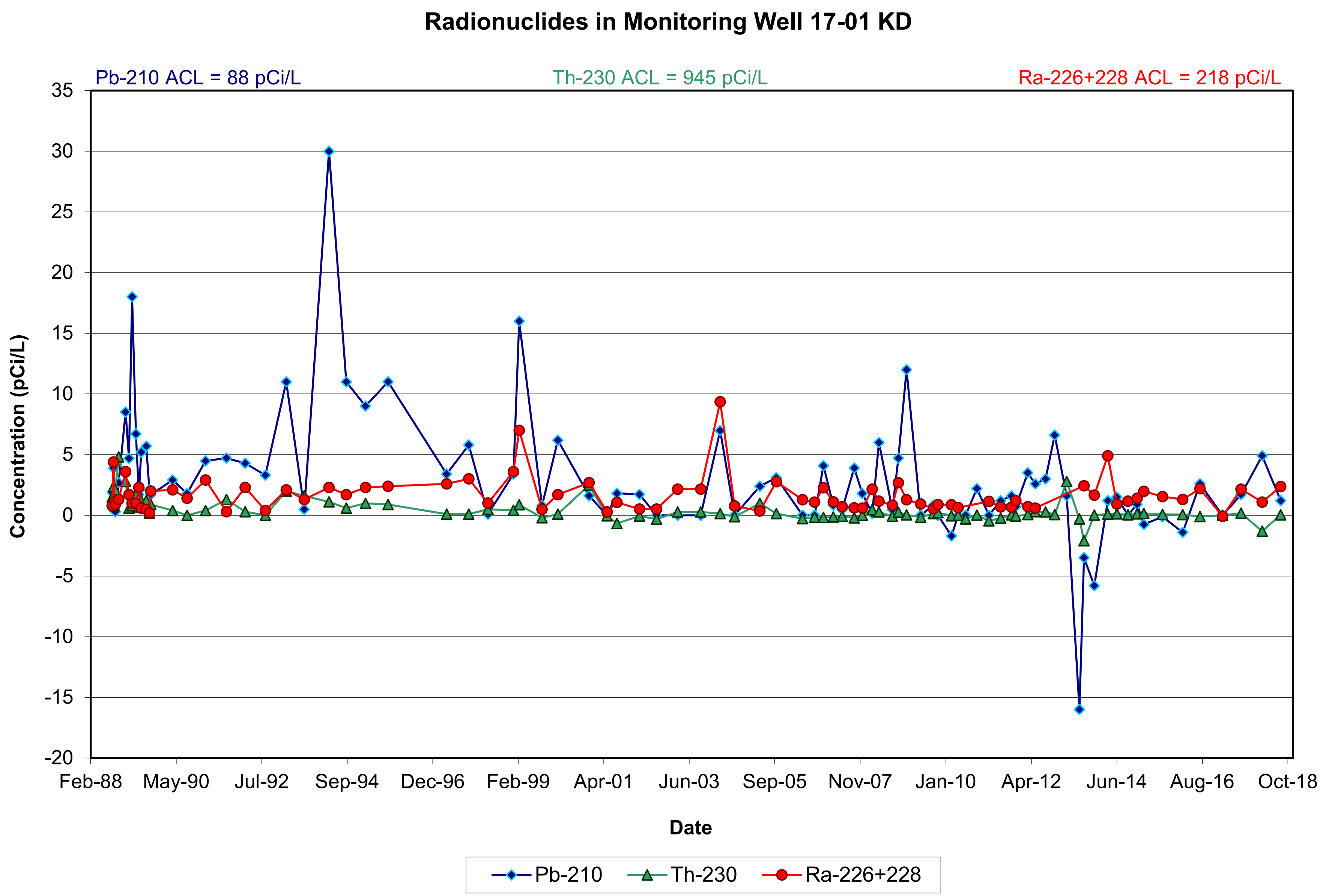

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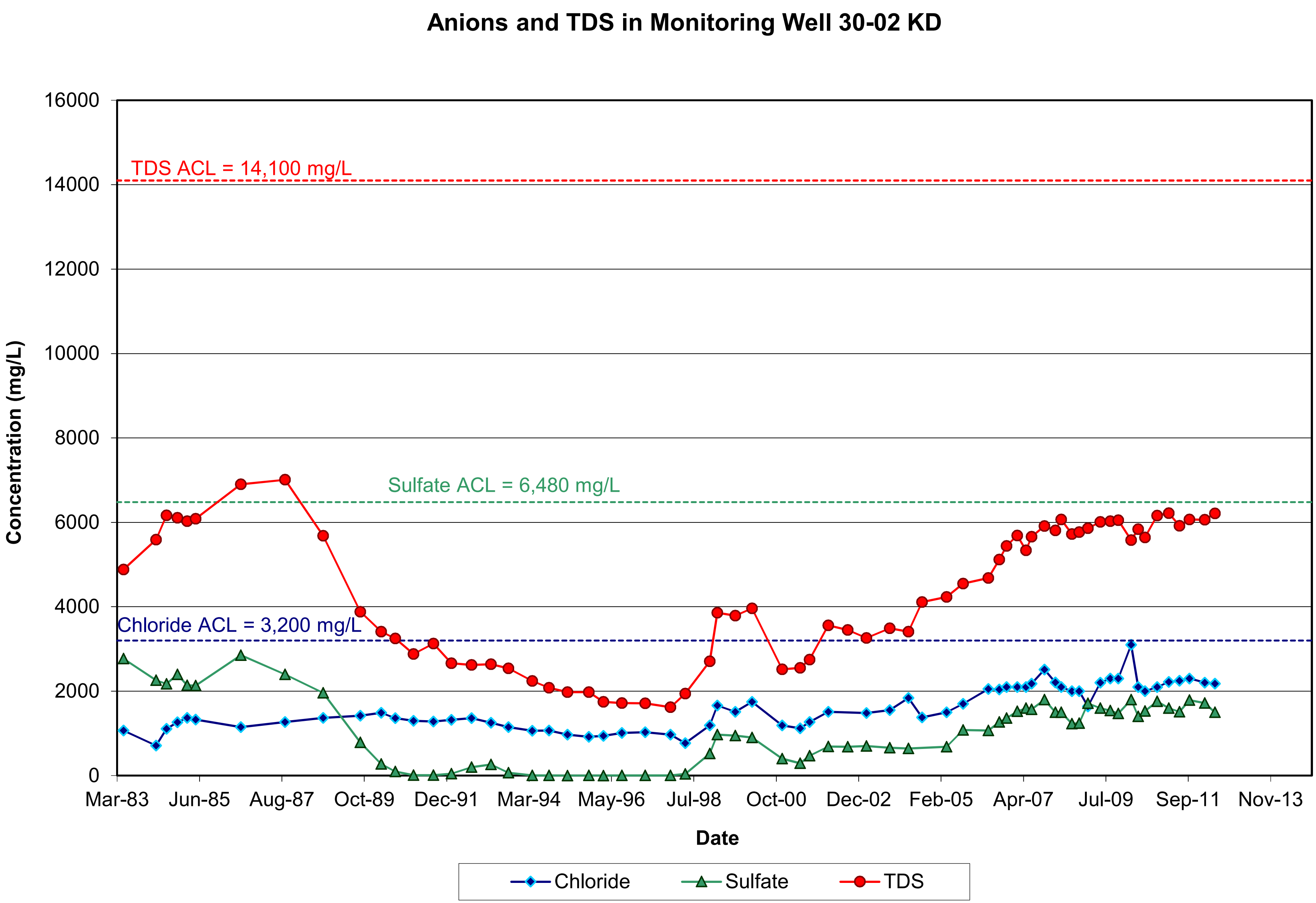

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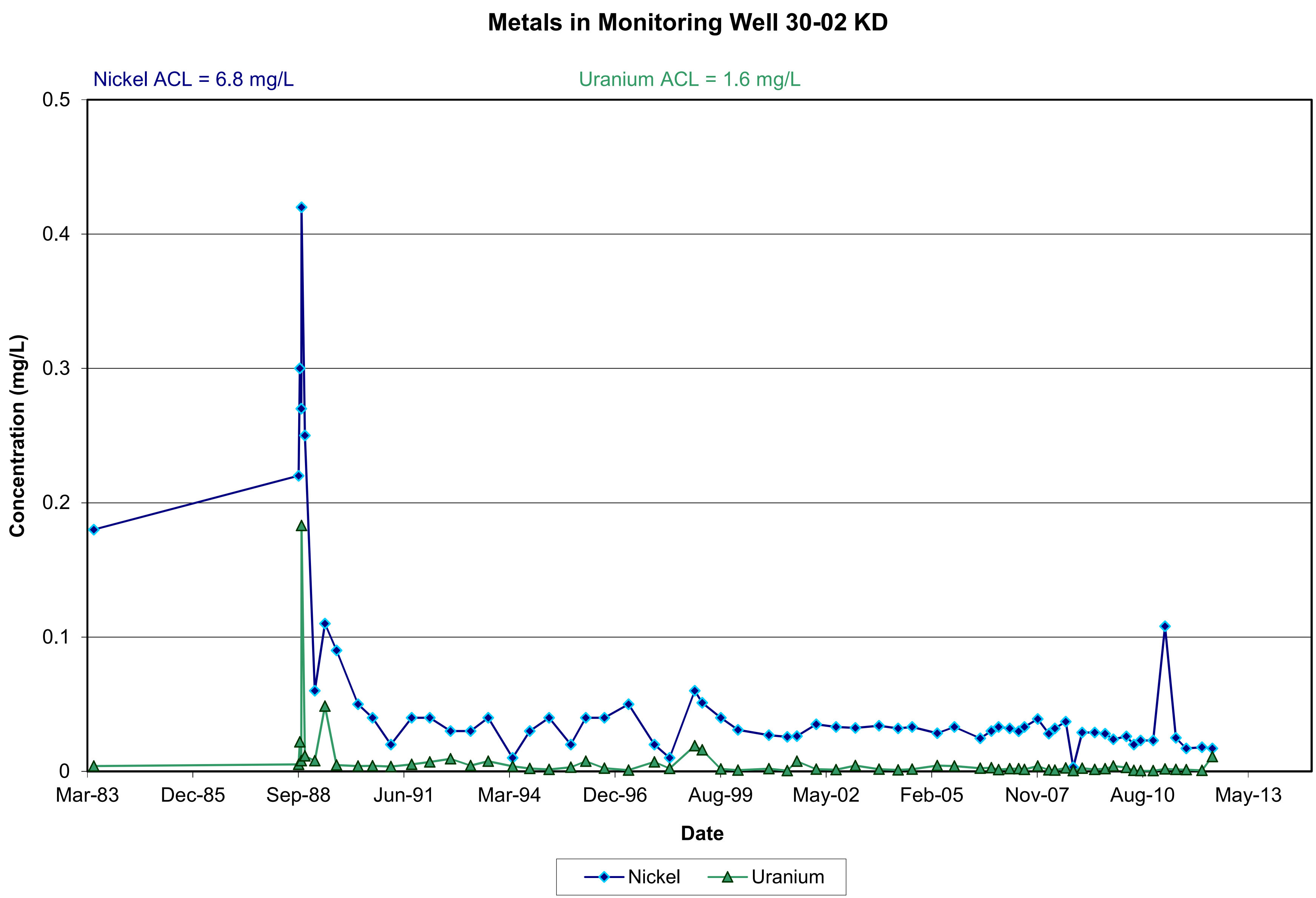
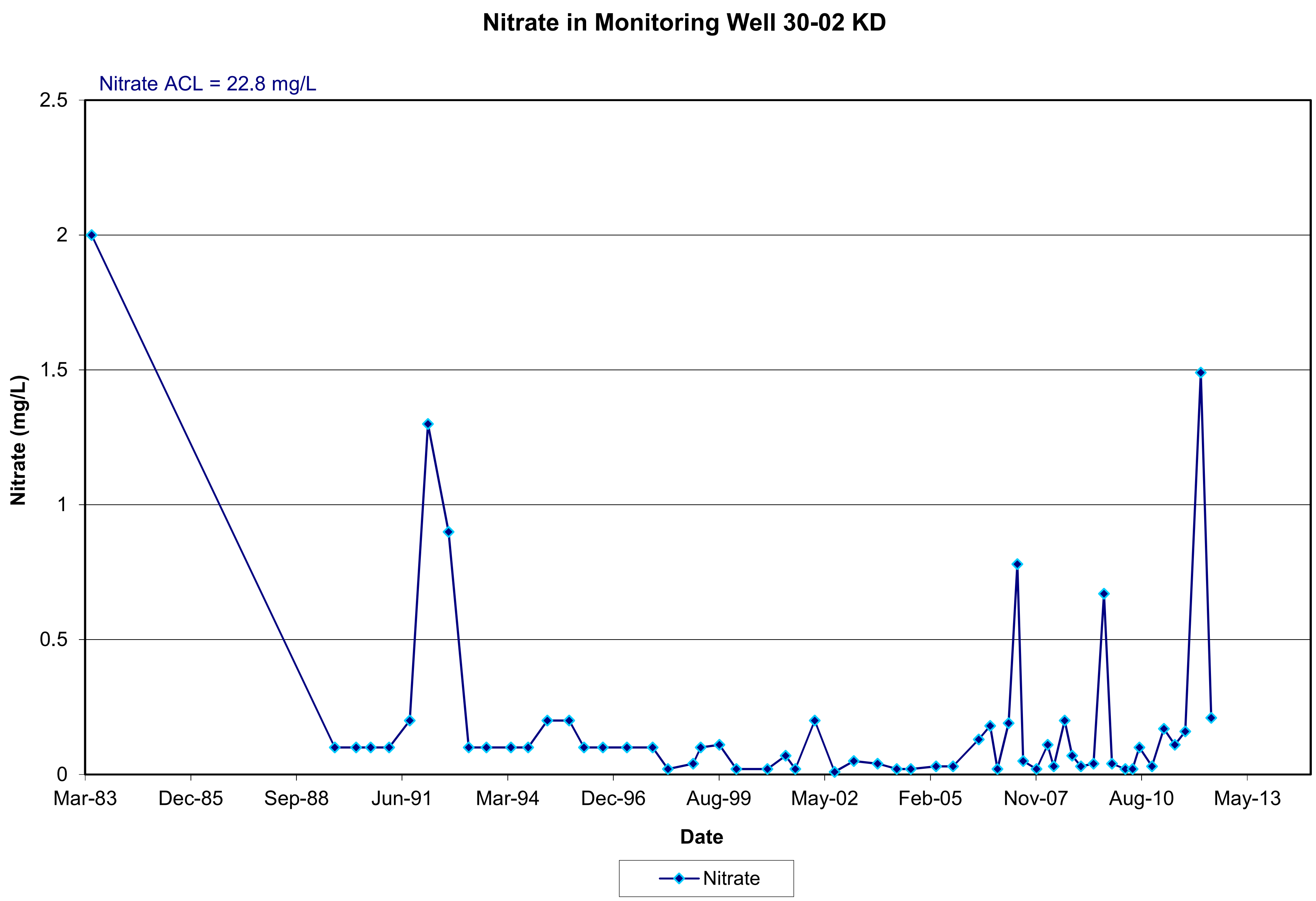


Metals in Monitoring Well 30-02 KD
Nickel ACL = 6.8 mg/L
Uranium ACL = 1.6 mg/L
Concentration (mg/L)
0
0.1
0.2
0.3
0.4
0.5
Mar-83
Dec-85
Sep-88
Jun-91
Mar-94
Dec-96
Aug-99
May-02
Feb-05
Nov-07
Aug-10
May-13
Date
Nickel
Uranium



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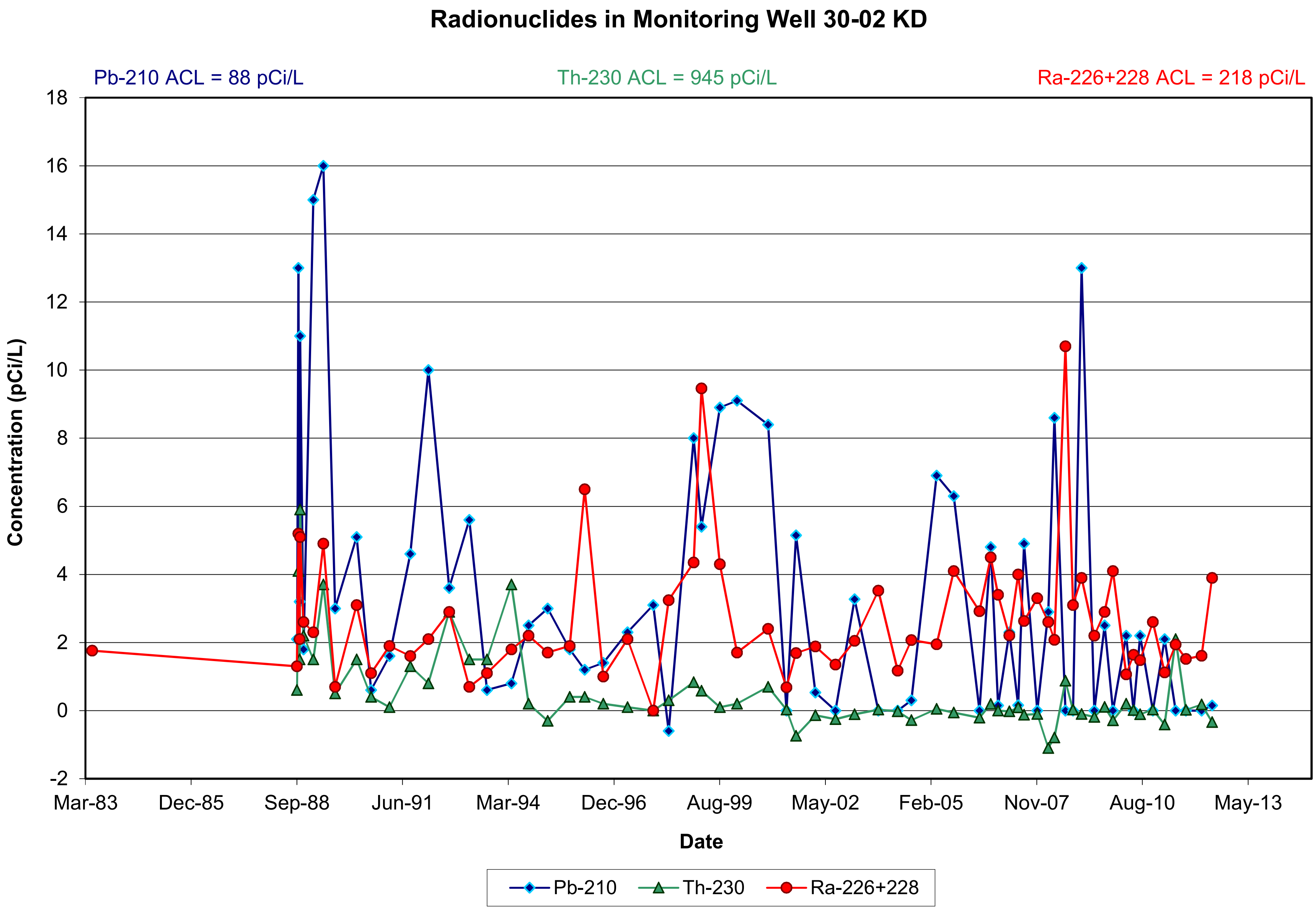
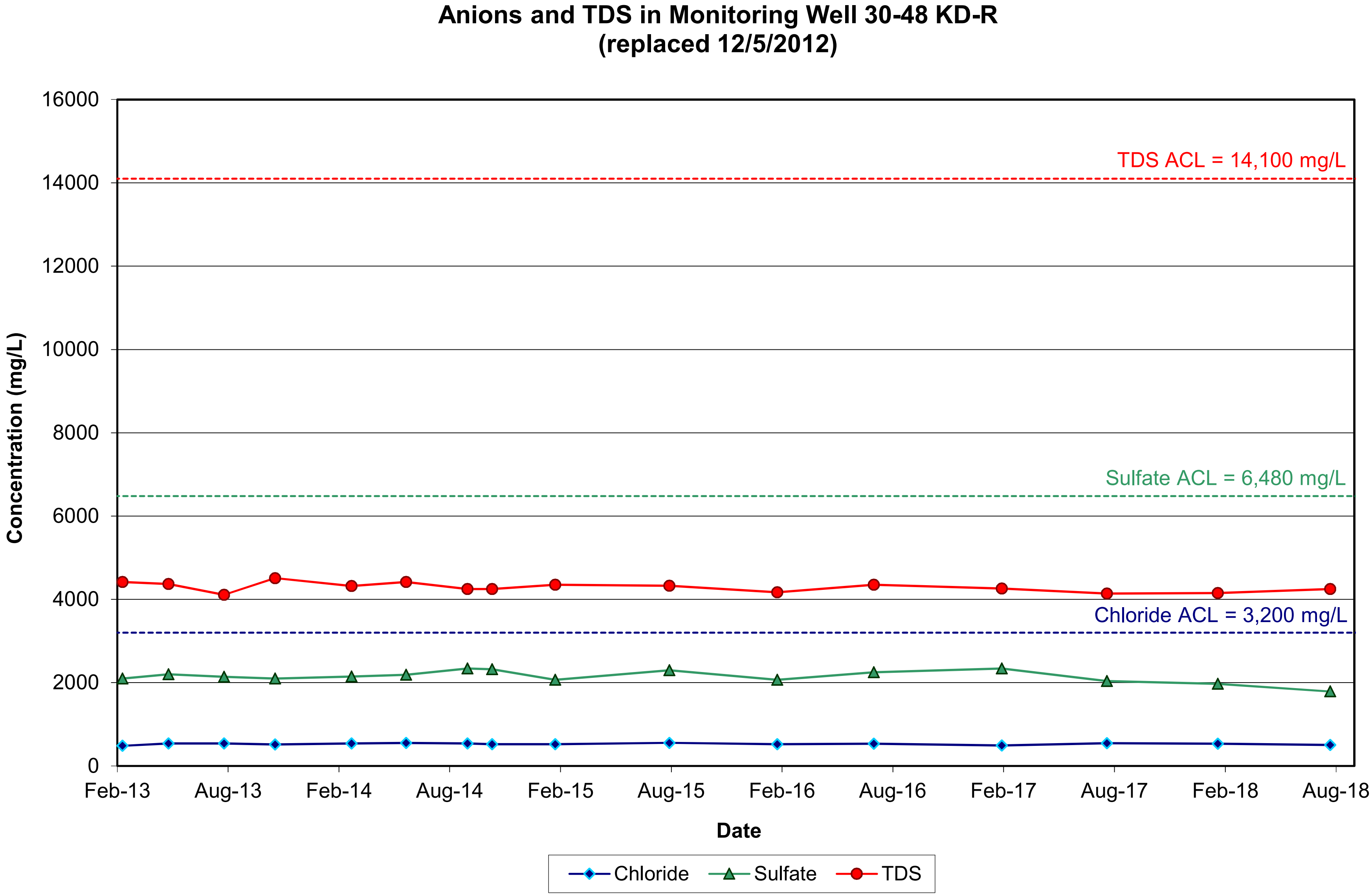

Radionuclides in Monitoring Well 30-02 KD
Pb-210 ACL = 88 pCi/L
Th-230 ACL = 945 pCi/L
Ra-226+228 ACL = 218 pCi/L
Concentration (pCi/L)
18
16
14
12
10
8
6
4
2
0
-2
Mar-83
Dec-85
Sep-88
Jun-91
Mar-94
Dec-96
Aug-99
May-02
Feb-05
Nov-07
Aug-10
May-13
Date
Pb-210
Th-230
Ra-226+228



Anions and TDS in Monitoring Well 30-48 KD-R
(replaced 12/5/2012)
16000
14000
12000
10000
8000
6000
4000
2000
0
Concentration (mg/L)
TDS ACL = 14,100 mg/L
Sulfate ACL = 6,480 mg/L
Chloride ACL = 3,200 mg/L
Feb-13
Aug-13
Feb-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
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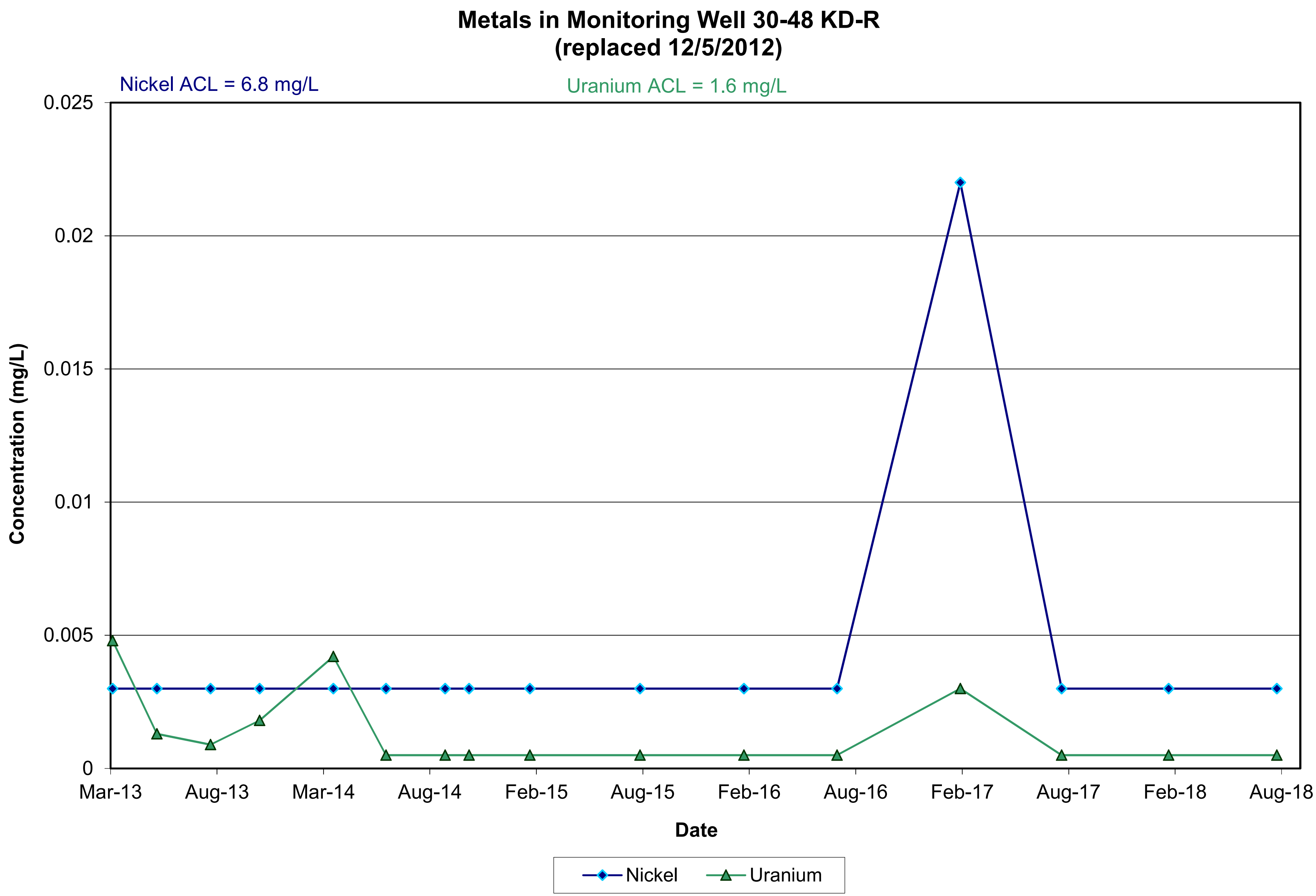
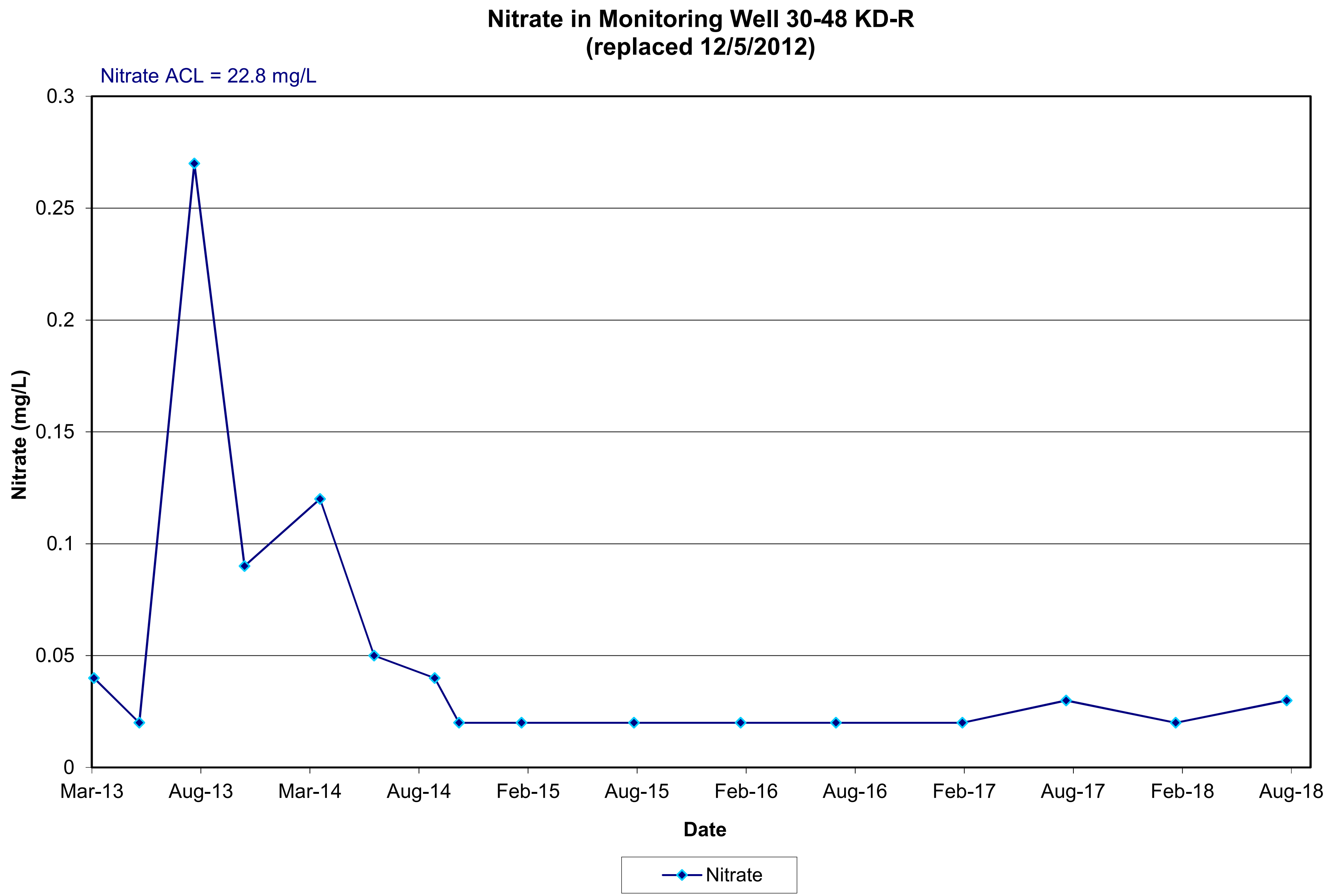
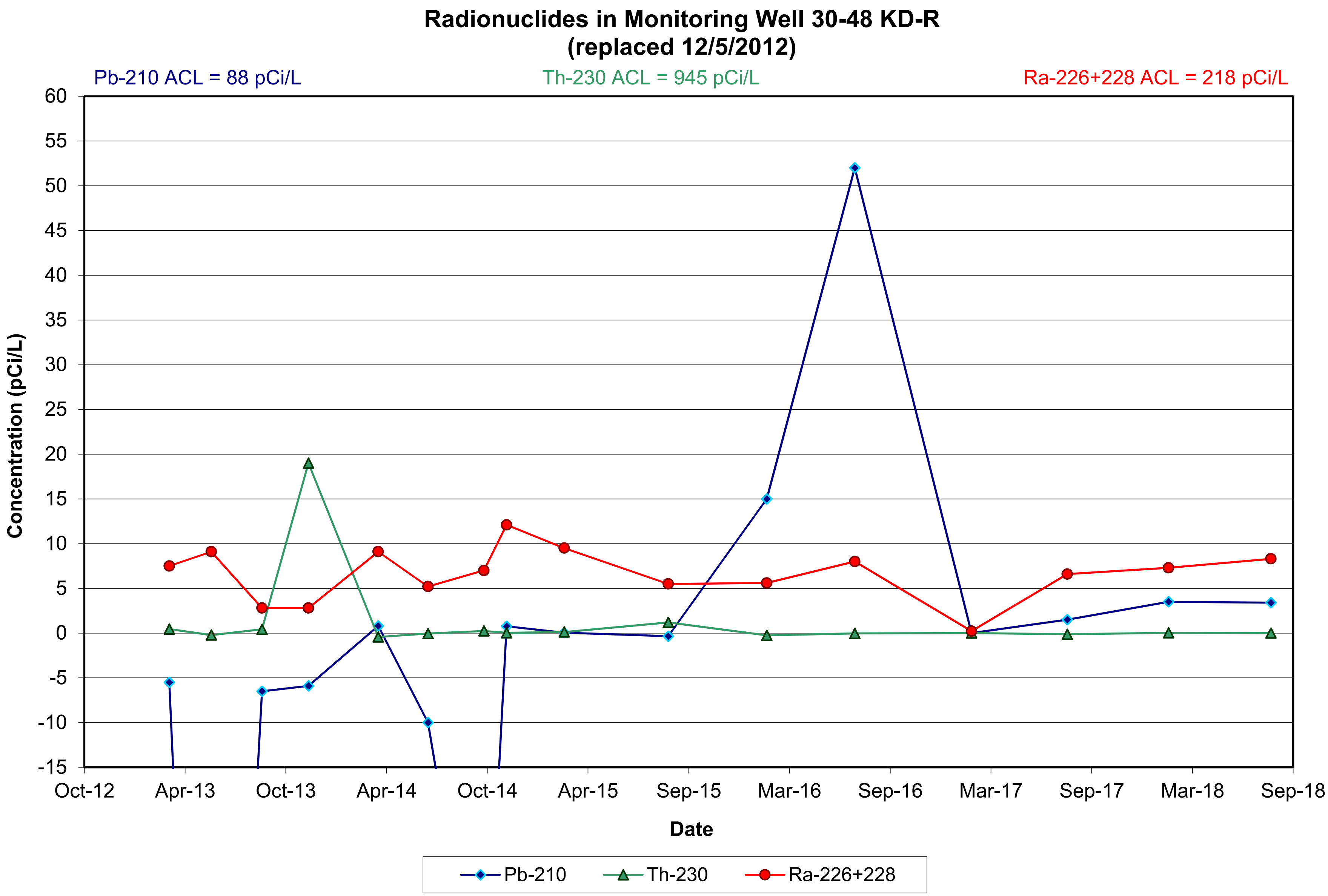
Aug-17
Feb-18
Aug-18
Date
Chloride
Sulfate
TDS



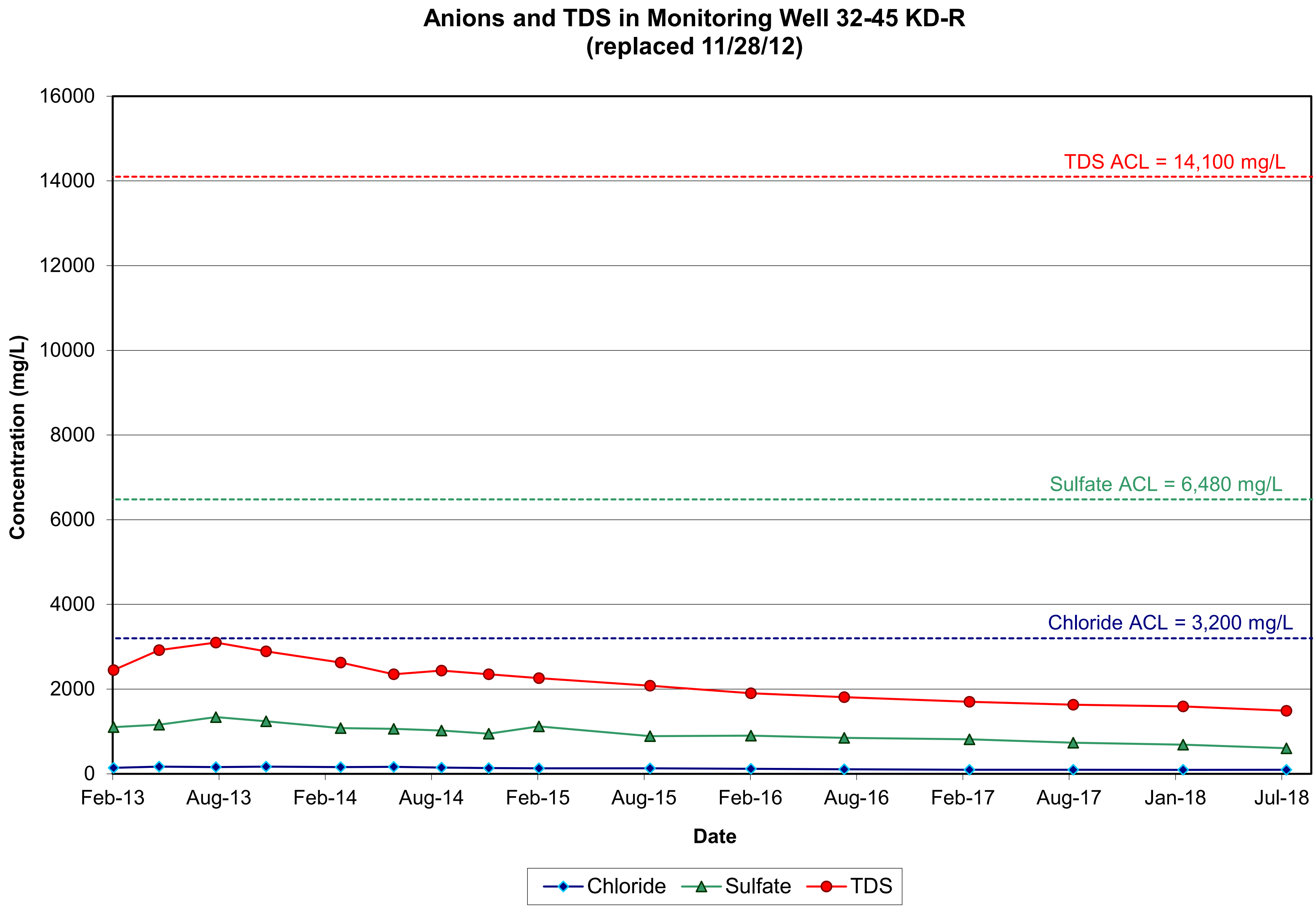
Metals in Monitoring Well 30-48 KD-R
(replaced 12/5/2012)
Nickel ACL = 6.8 mg/L
Uranium ACL = 1.6 mg/L
Concentration (mg/L)
0.025
0.02
0.015
0.01
0.005
0
Mar-13
Aug-13
Mar-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
Feb-17
Aug-17
Feb-18
Aug-18
Date
Nickel
Uranium



Nitrate in Monitoring Well 30-48 KD-R
(replaced 12/5/2012)
Nitrate ACL = 22.8 mg/L
Nitrate (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
Mar-13
Aug-13
Mar-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
Feb-17
Aug-17
Feb-18
Aug-18
Date
Nitrate


Radionuclides in Monitoring Well 30-48 KD-R
(replaced 12/5/2012)
Pb-210 ACL = 88 pCi/L
Th-230 ACL = 945 pCi/L
Ra-226+228 ACL = 218 pCi/L
Concentration (pCi/L)
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Sep-15
Mar-16
Sep-16
Mar-17
Sep-17
Mar-18
Sep-18
Date
Pb-210
Th-230
Ra-226+228

INTERA



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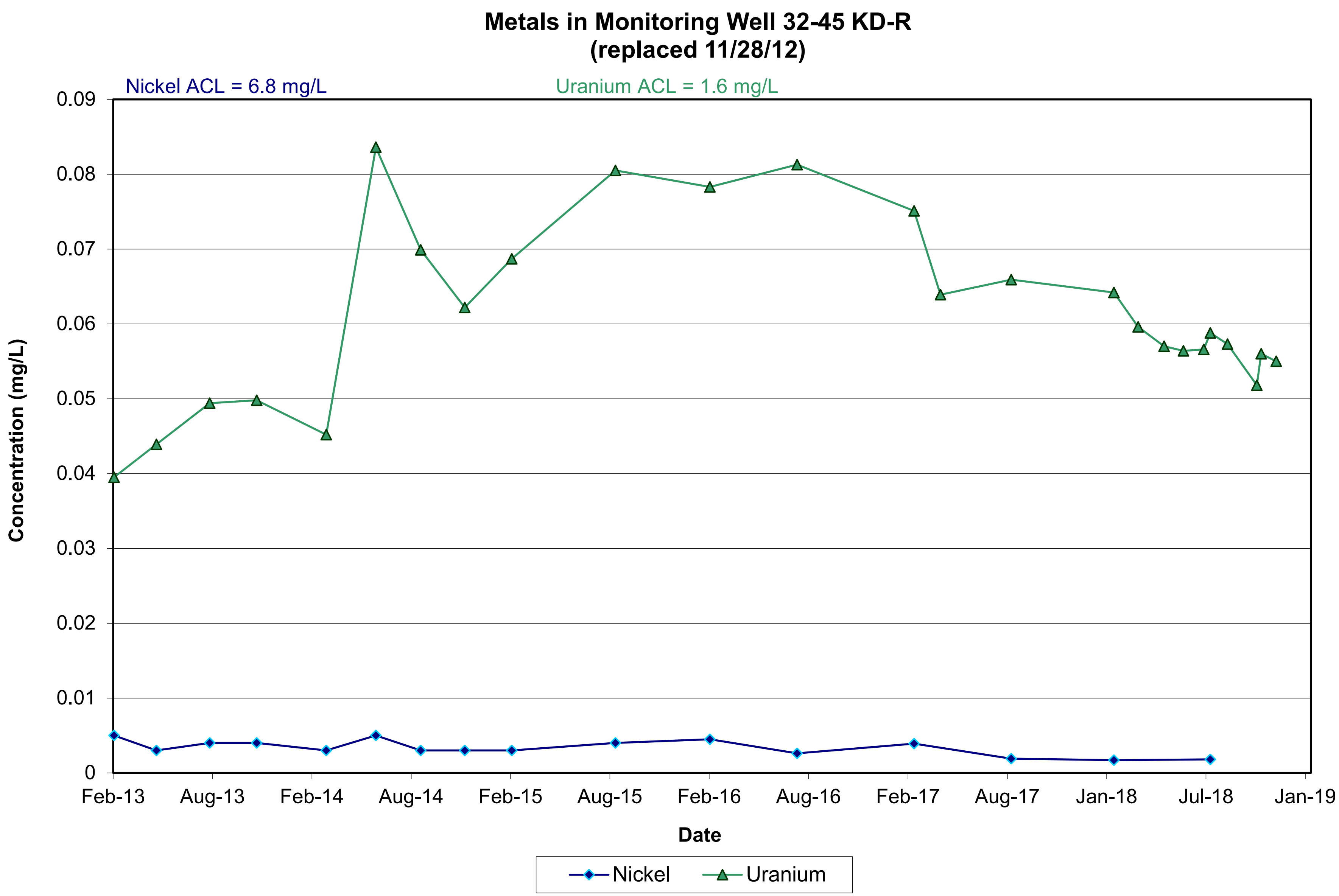

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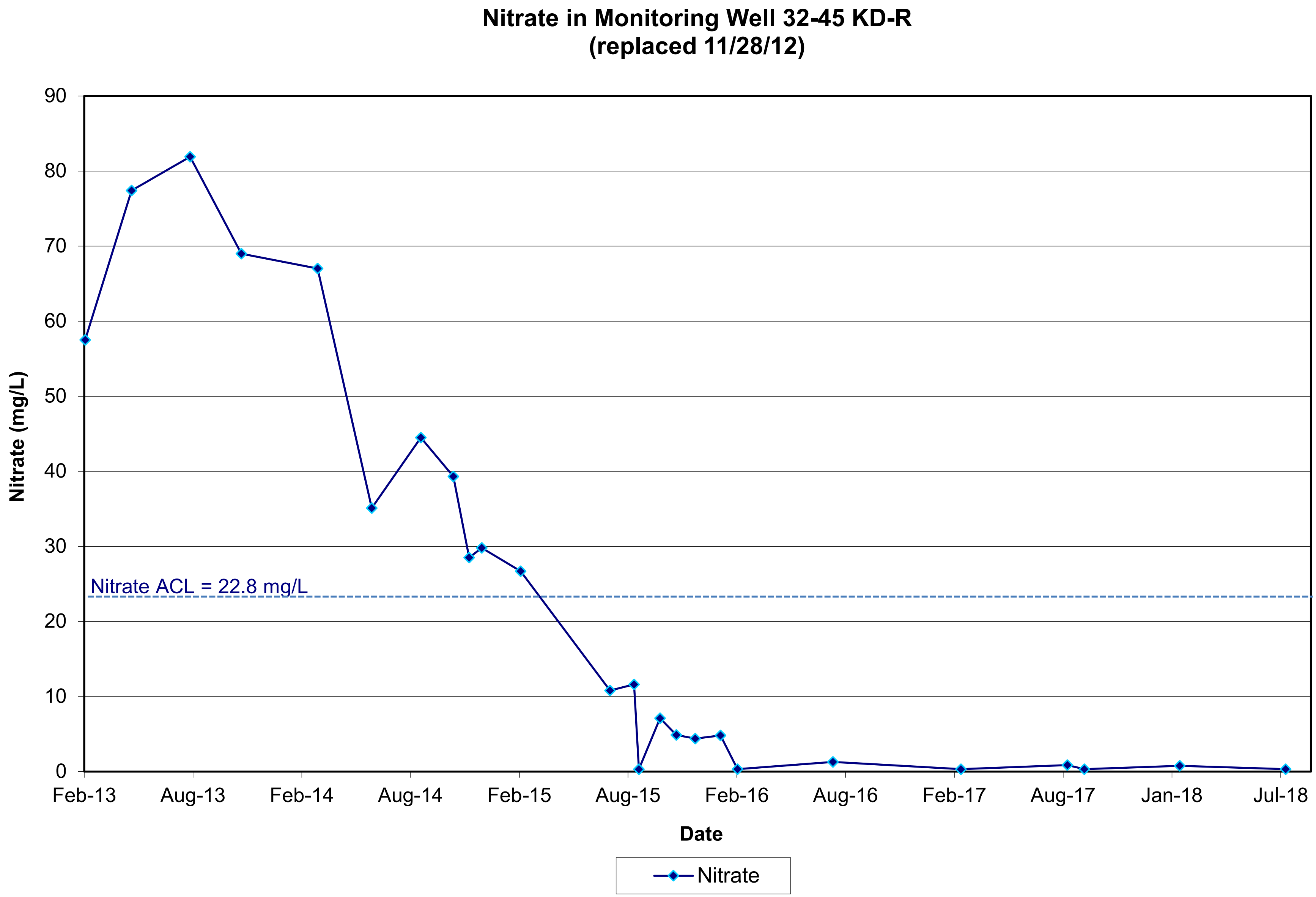

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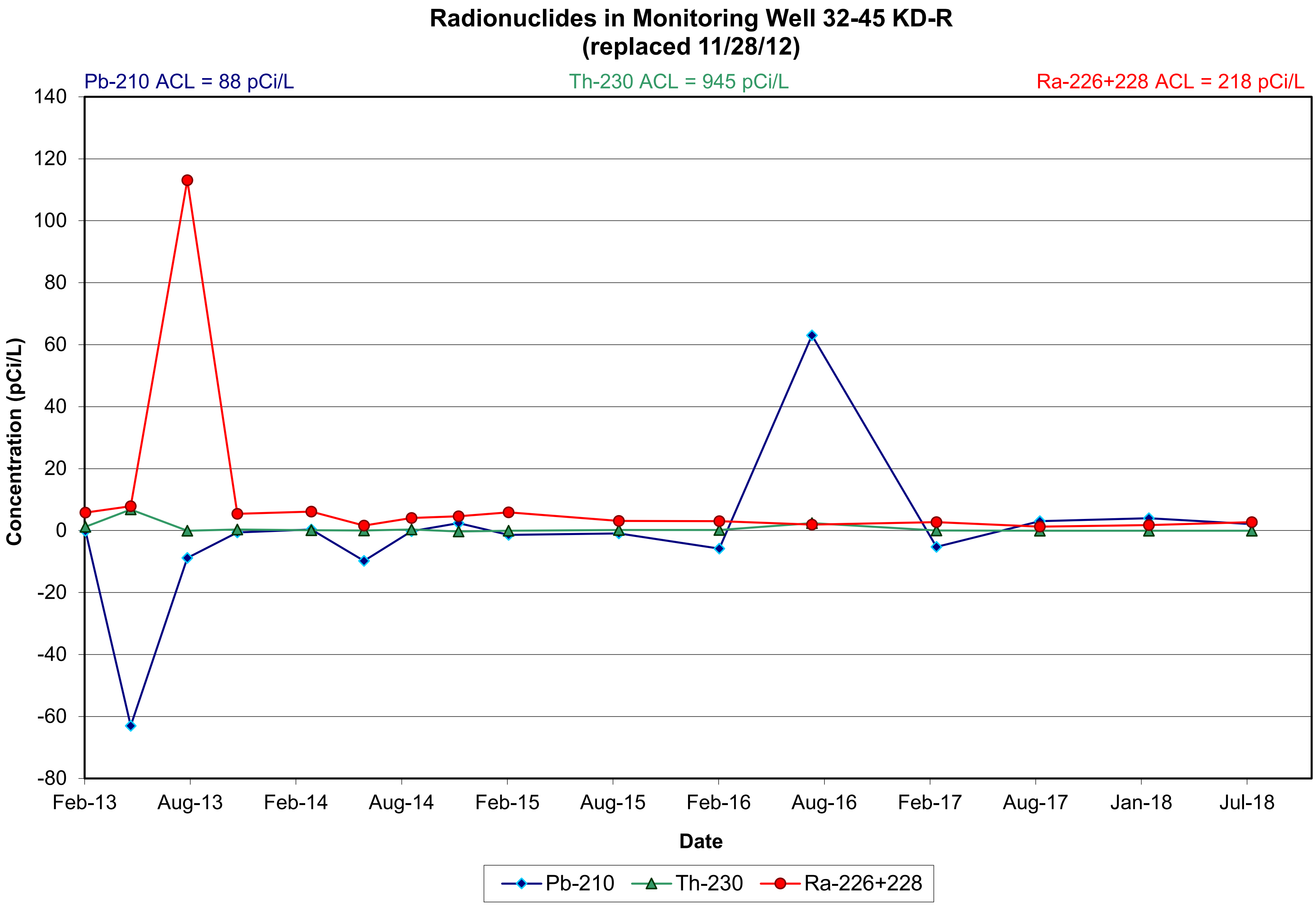

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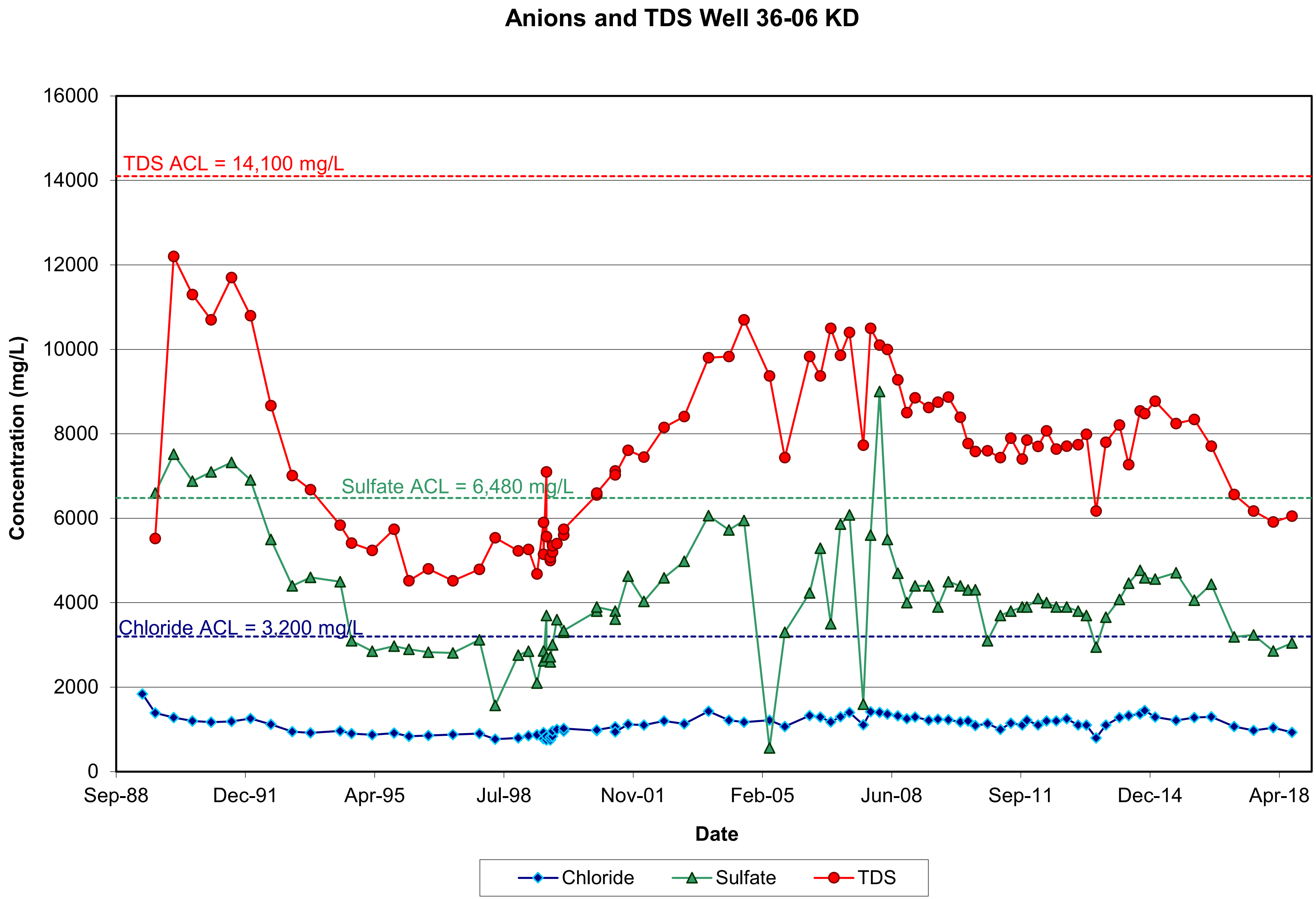
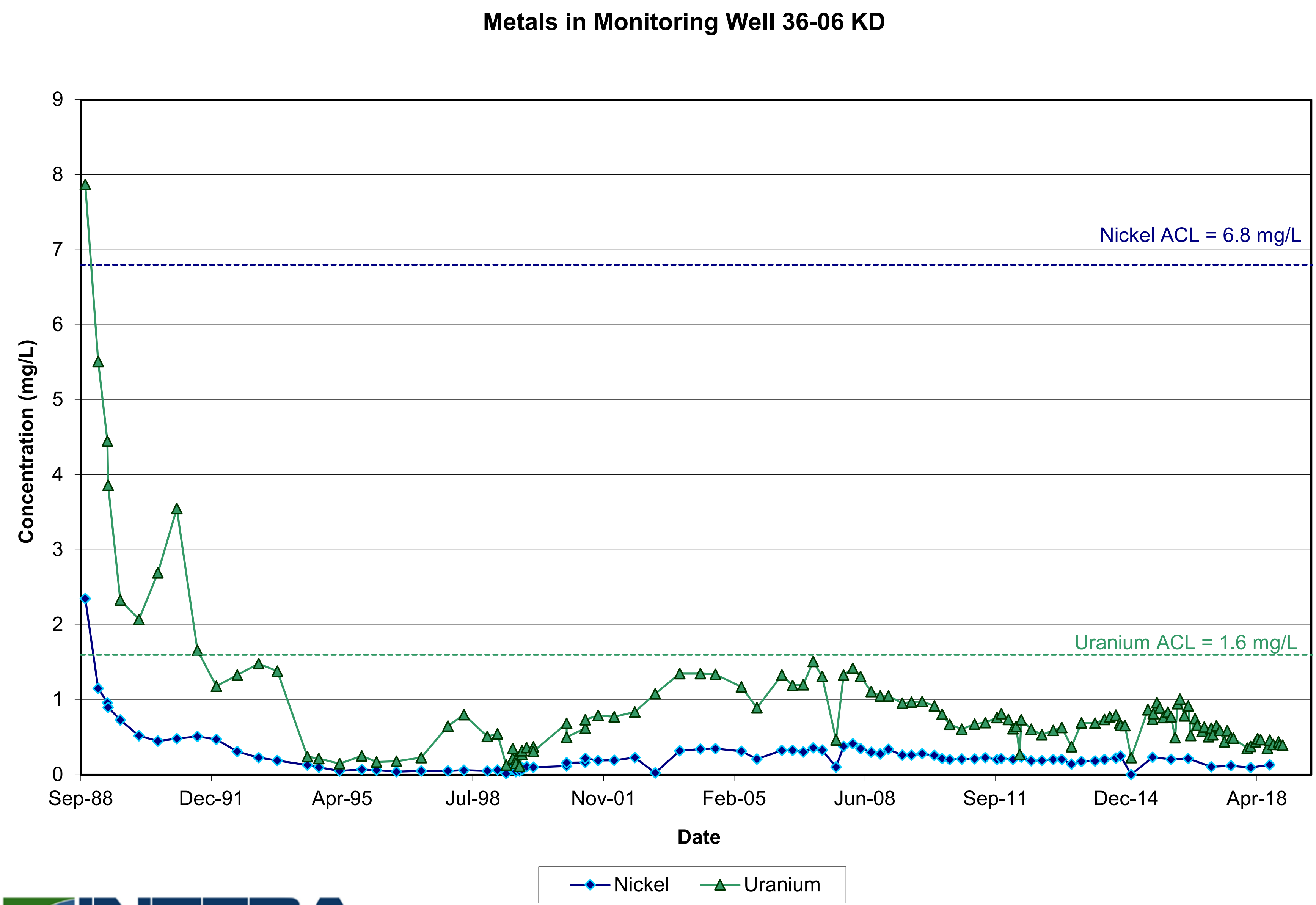


Anions and TDS Well 36-06 KD
Concentration (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
TDS ACL = 14,100 mg/L
Sulfate ACL = 6,480 mg/L
Chloride ACL = 3,200 mg/L
Sep-88
Dec-91
Apr-95
Jul-98
Nov-01
Feb-05
Jun-08
Sep-11
Dec-14
Apr-18
Date
Chloride
Sulfate
TDS

INTERA



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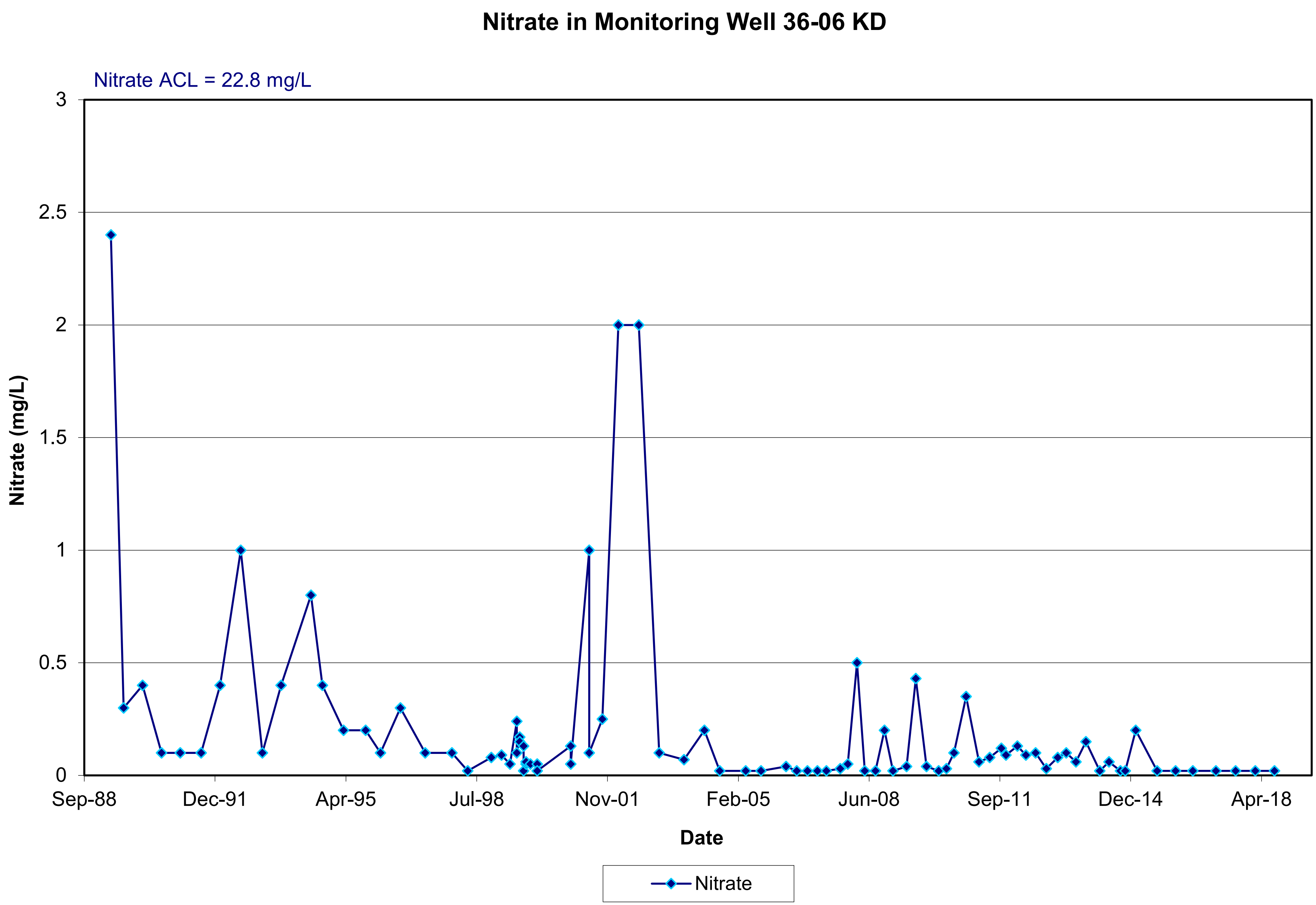

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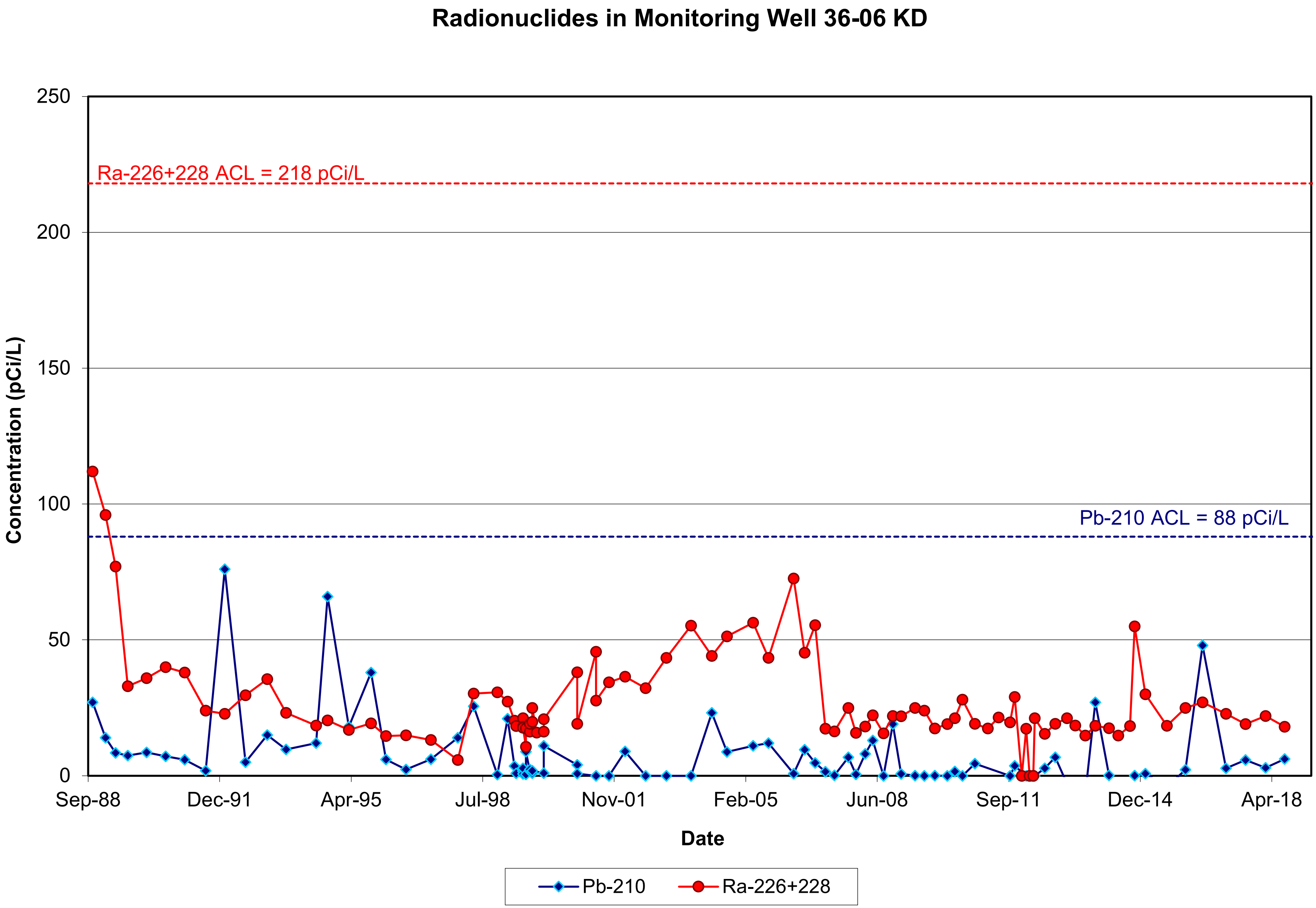

Radionuclides in Monitoring Well 36-06 KD
Ra-226+228 ACL = 218 pCi/L
Pb-210 ACL = 88 pCi/L
Concentration (pCi/L)
250
200
150
100
50
0
Sep-88
Dec-91
Apr-95
Jul-98
Nov-01
Feb-05
Jun-08
Sep-11
Dec-14
Apr-18
Date
Pb-210
Ra-226+228

Stability Monitoring Plan
Time Versus Concentration Plots

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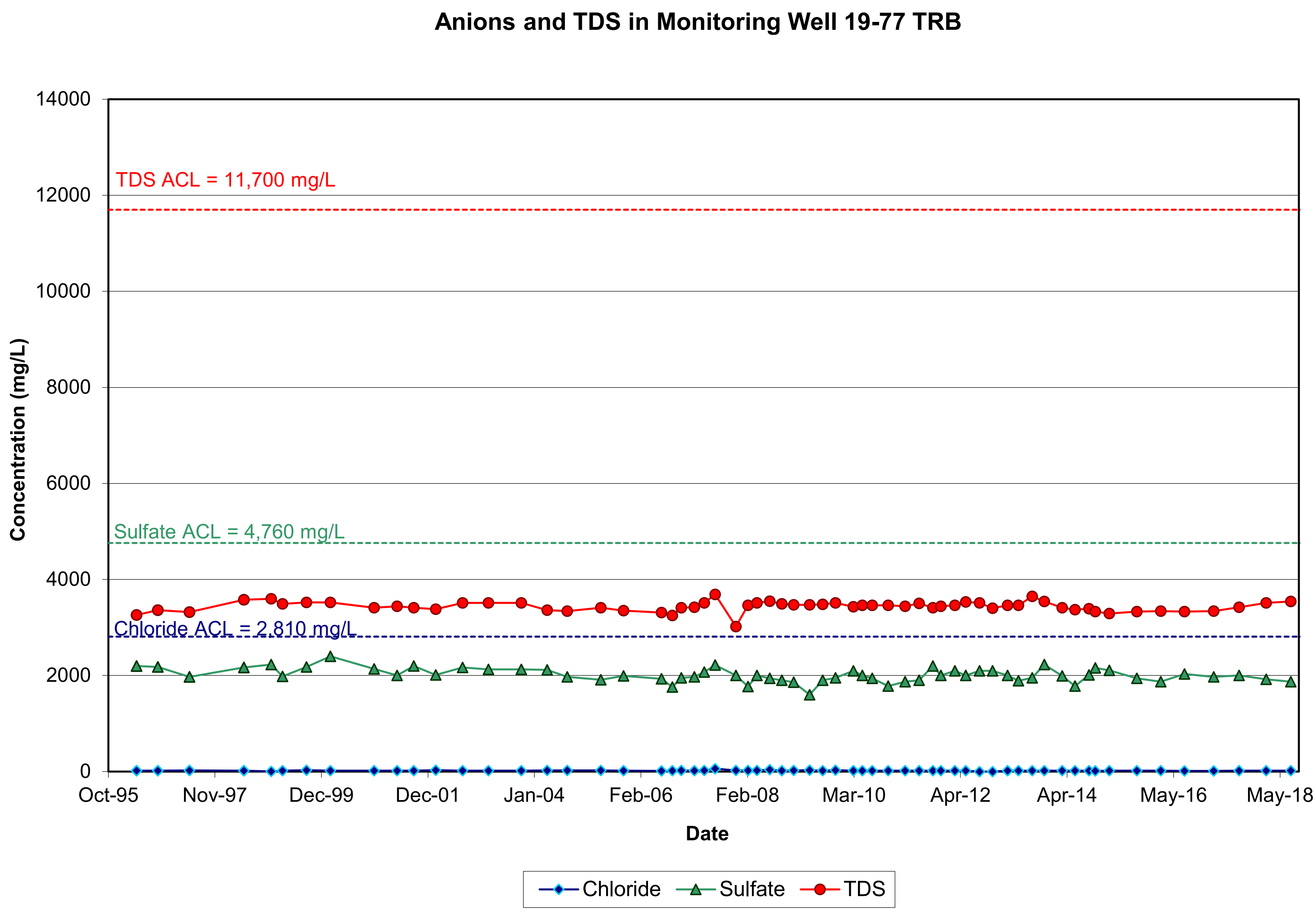

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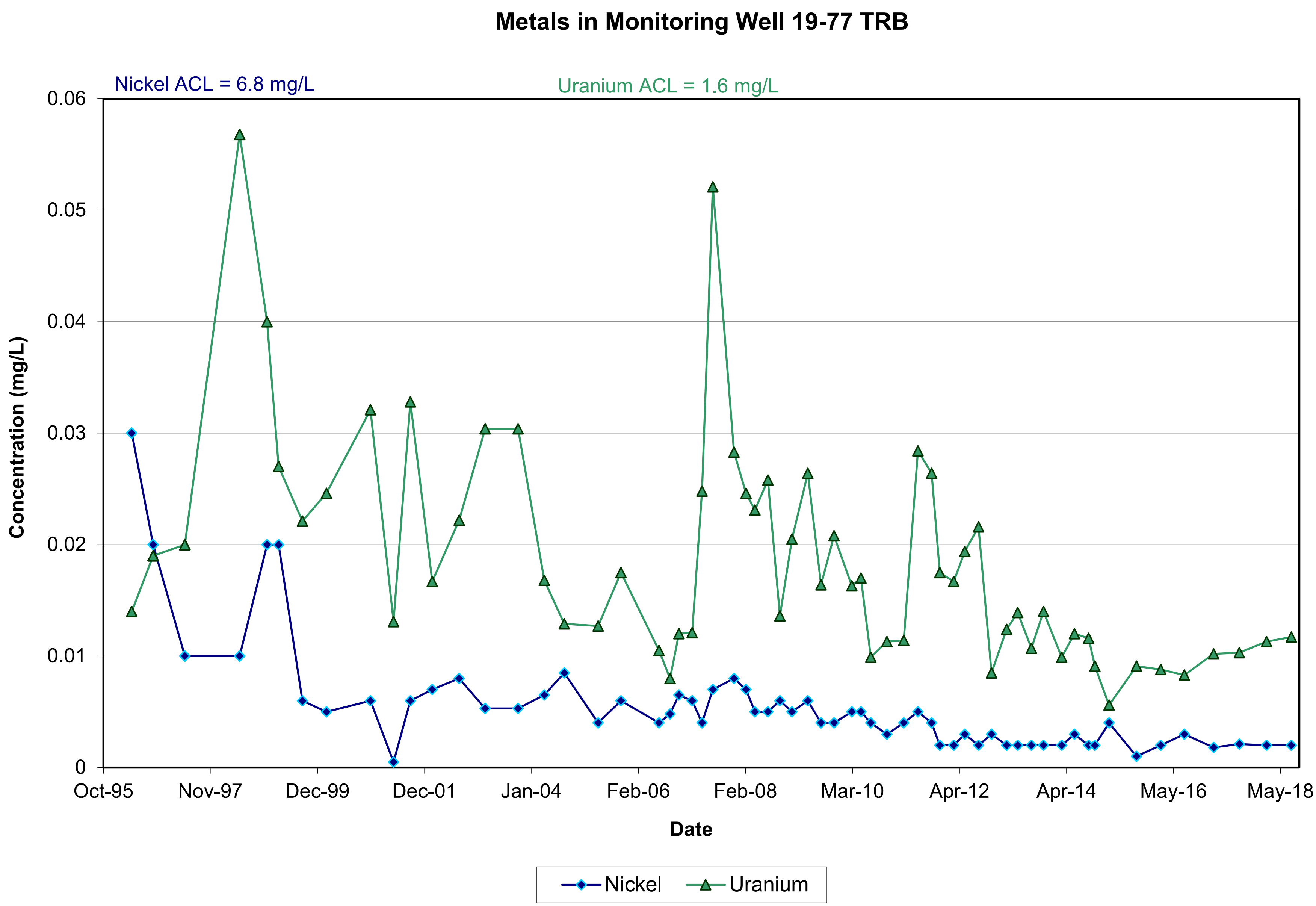

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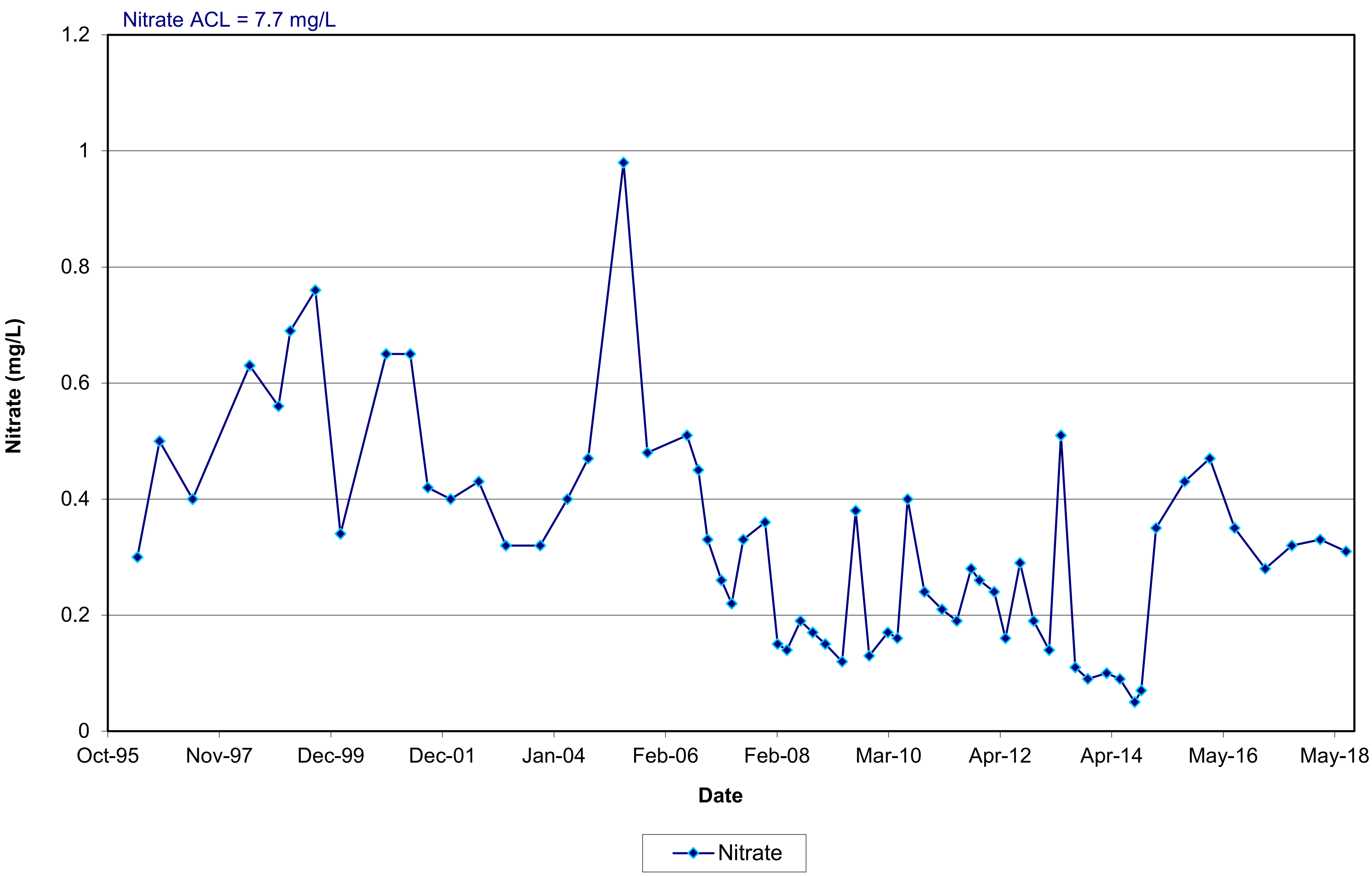
Nitrate in Monitoring Well 19-77 TRB



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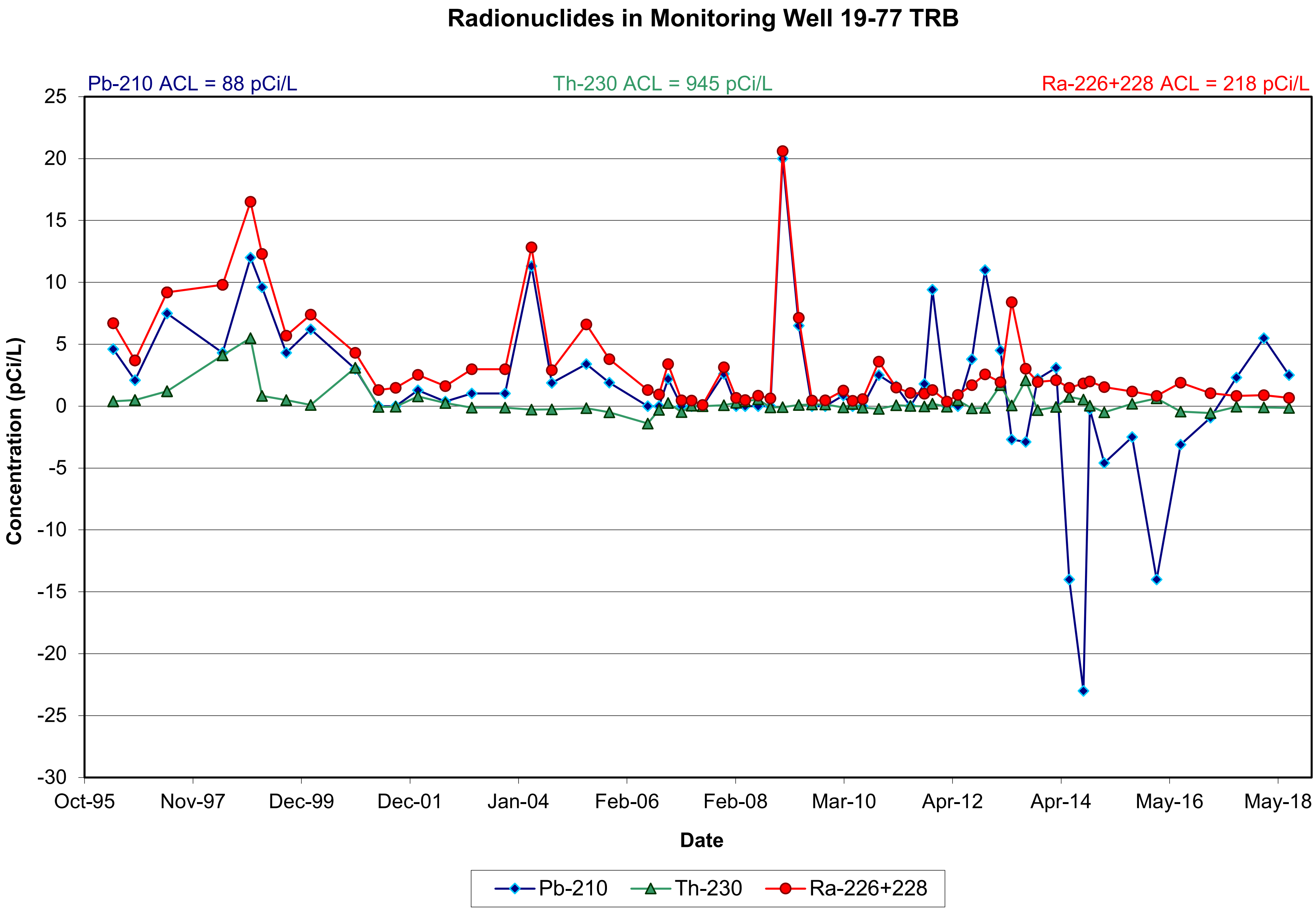

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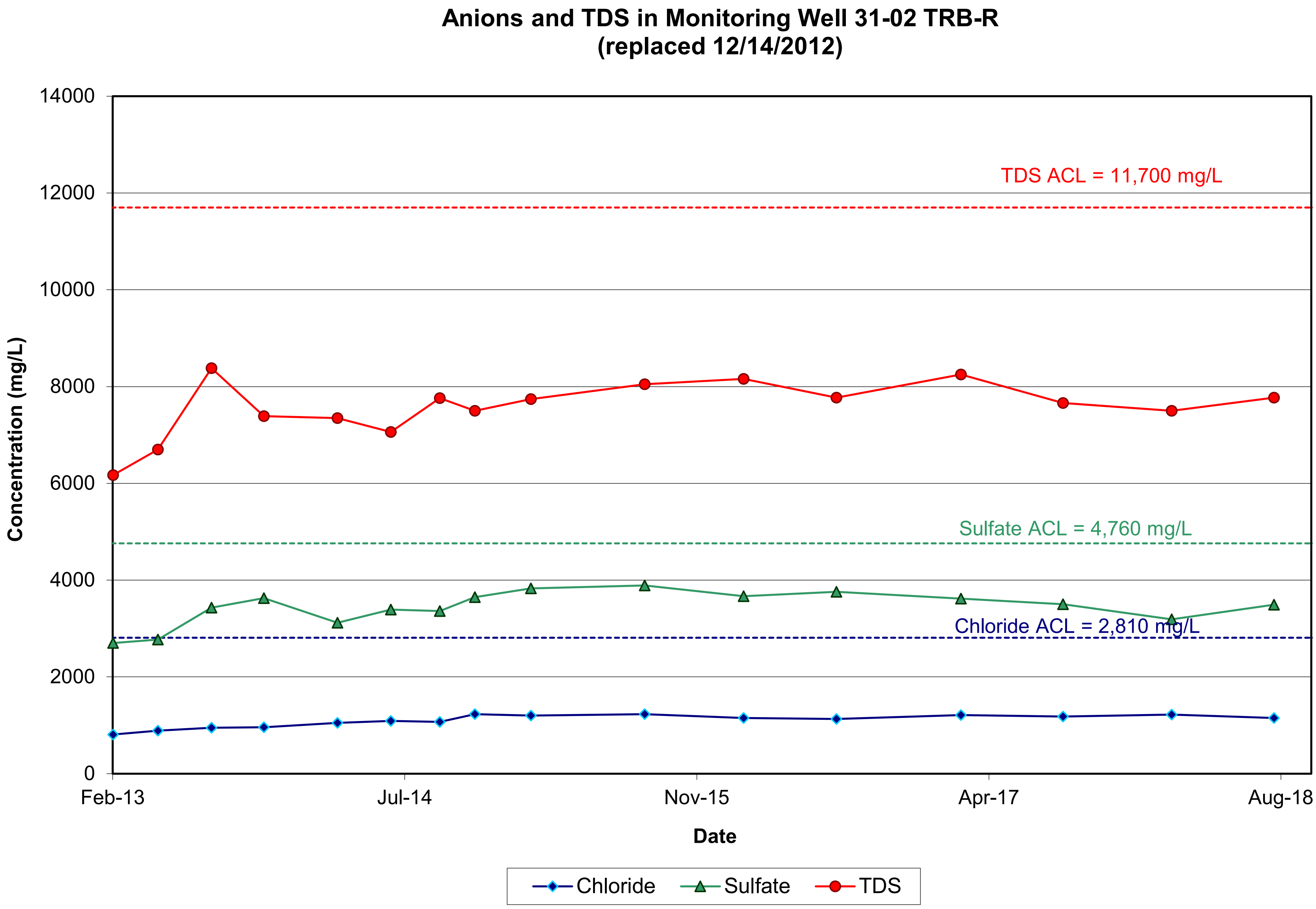

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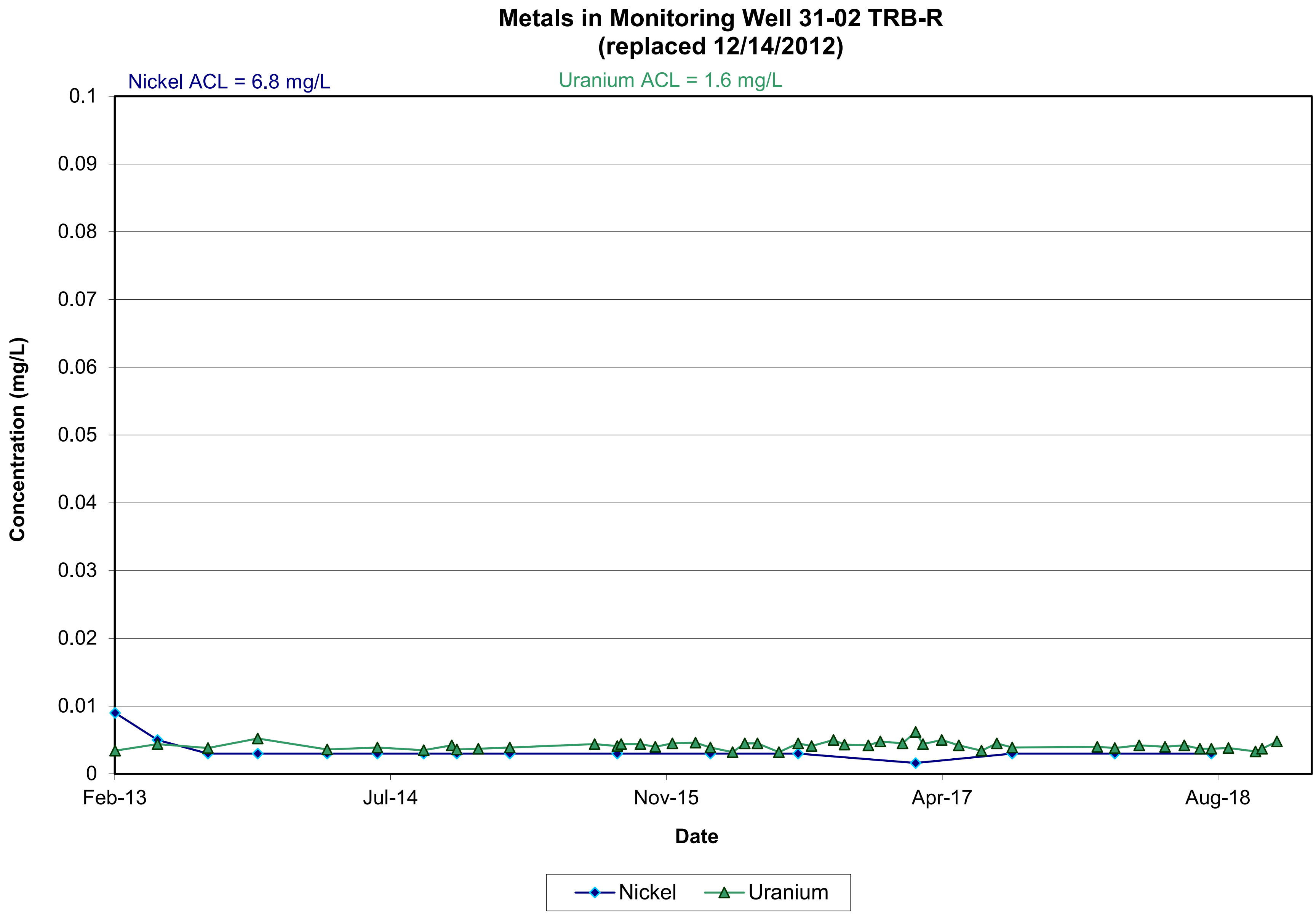
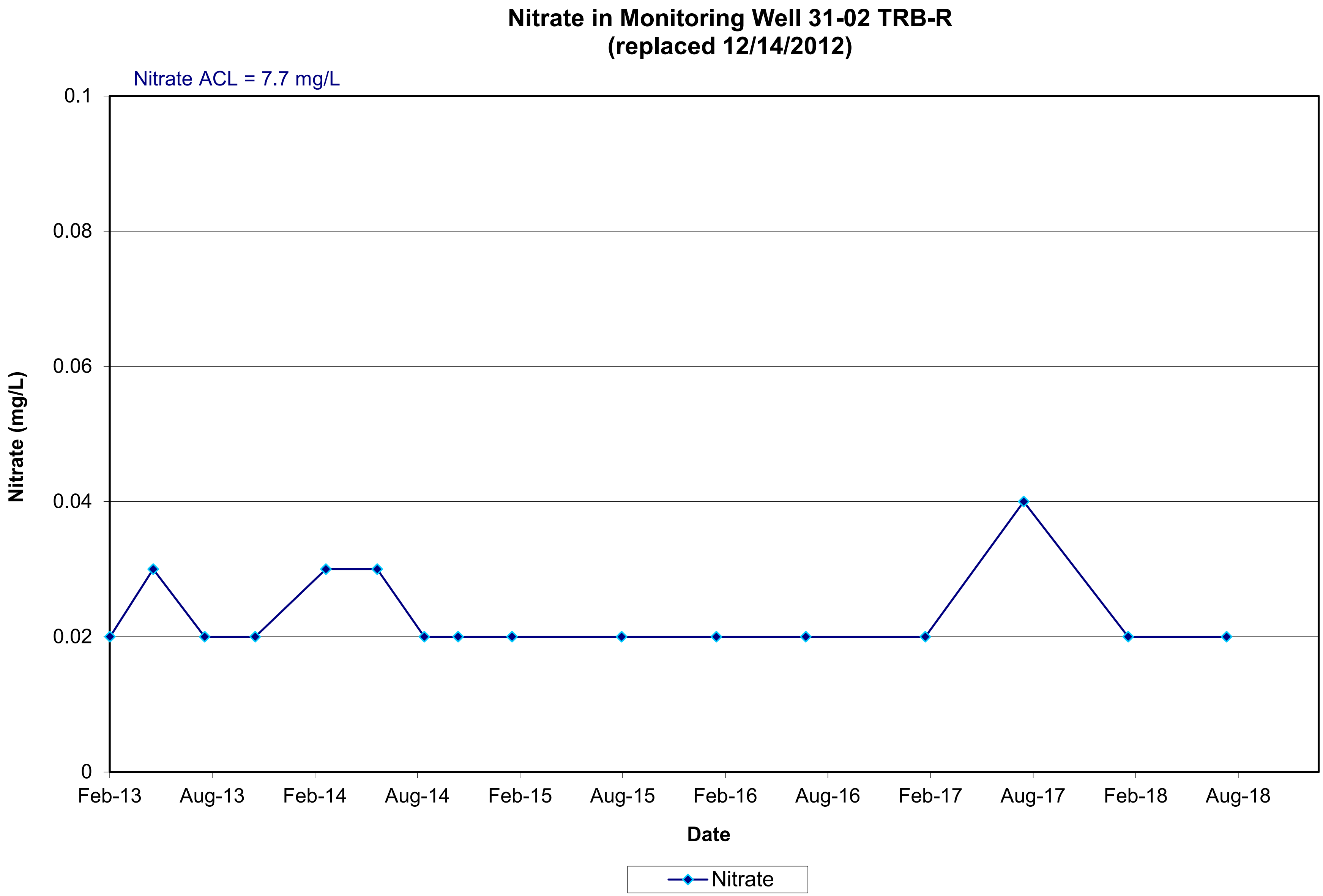
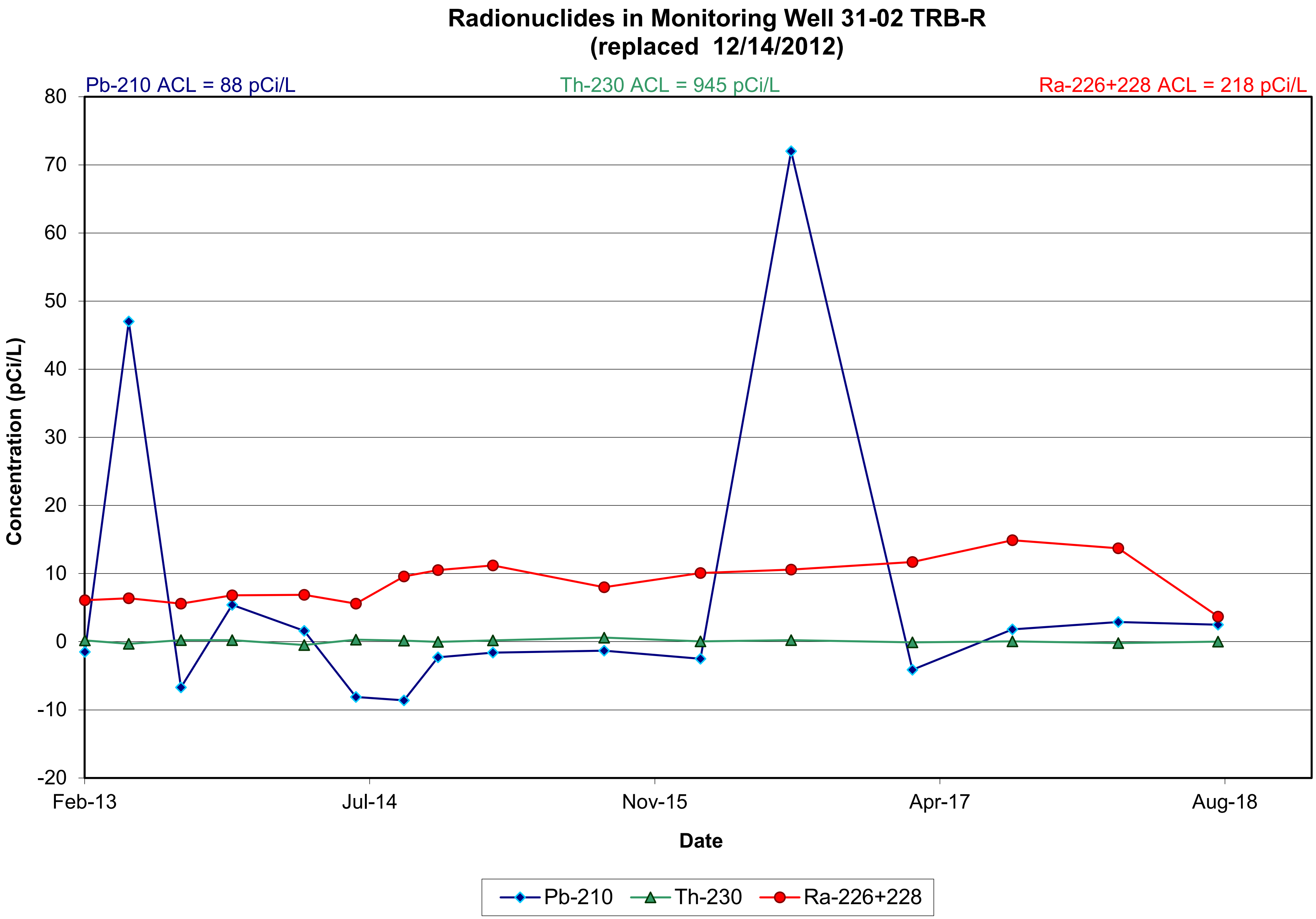


Metals in Monitoring Well 31-02 TRB-R
(replaced 12/14/2012)
Nickel ACL = 6.8 mg/L
Uranium ACL = 1.6 mg/L
Concentration (mg/L)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Feb-13
Jul-14
Nov-15
Apr-17
Aug-18
Date
Nickel
Uranium



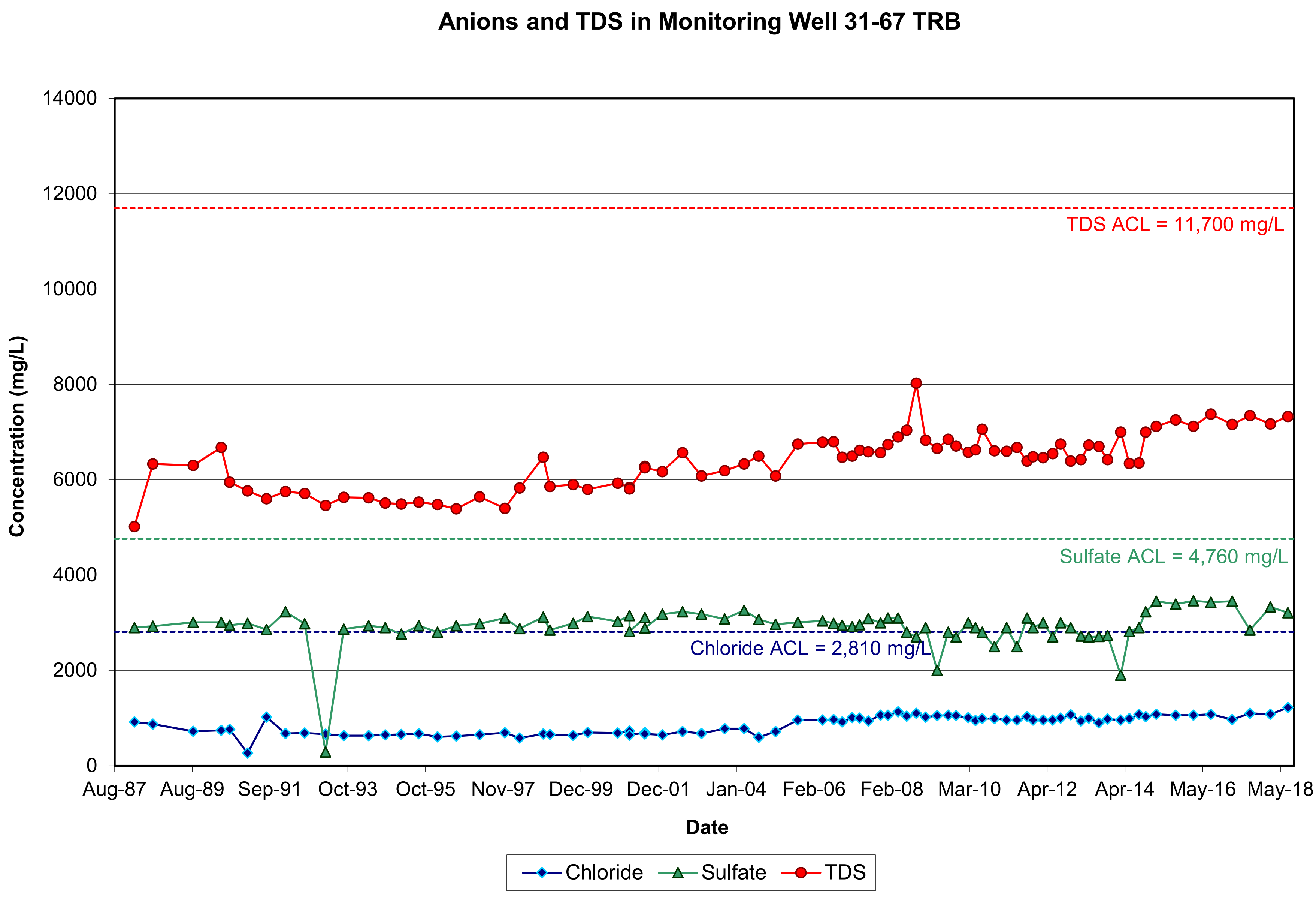
Nitrate in Monitoring Well 31-02 TRB-R
(replaced 12/14/2012)
Nitrate ACL = 7.7 mg/L
Nitrate (mg/L)
0.1
0.08
0.06
0.04
0.02
0
Feb-13
Aug-13
Feb-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
Feb-17
Aug-17
Feb-18
Aug-18
Date
Nitrate

INTERA

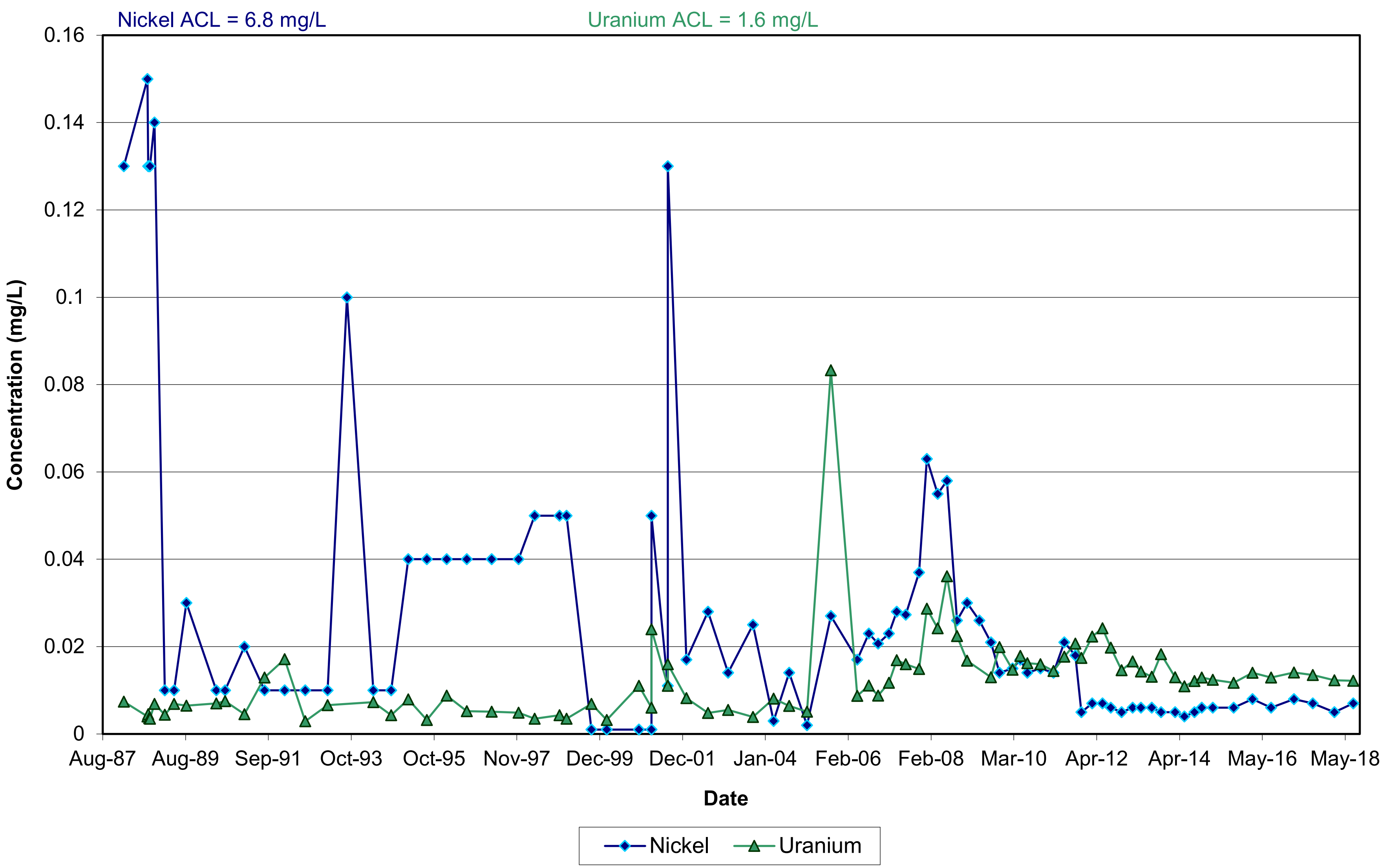


Radionuclides in Monitoring Well 31-02 TRB-R
(replaced 12/14/2012)
Pb-210 ACL = 88 pCi/L
Th-230 ACL = 945 pCi/L
Ra-226+228 ACL = 218 pCi/L
Concentration (pCi/L)
80
70
60
50
40
30
20
10
0
-10
-20
Feb-13
Jul-14
Nov-15
Apr-17
Aug-18
Date
Pb-210
Th-230
Ra-226+228

INTERA


Anions and TDS in Monitoring Well 31-67 TRB
14000
12000
10000
8000
6000
4000
2000
0
Concentration (mg/L)
TDS ACL = 11,700 mg/L
Sulfate ACL = 4,760 mg/L
Chloride ACL = 2,810 mg/L
Aug-87
Aug-89
Sep-91
Oct-93
Oct-95
Nov-97
Dec-99
Dec-01
Jan-04
Feb-06
Feb-08
Mar-10
Apr-12
Apr-14
May-16
May-18
Date
Chloride
Sulfate
TDS

Metals in Monitoring Well 31-67 TRB



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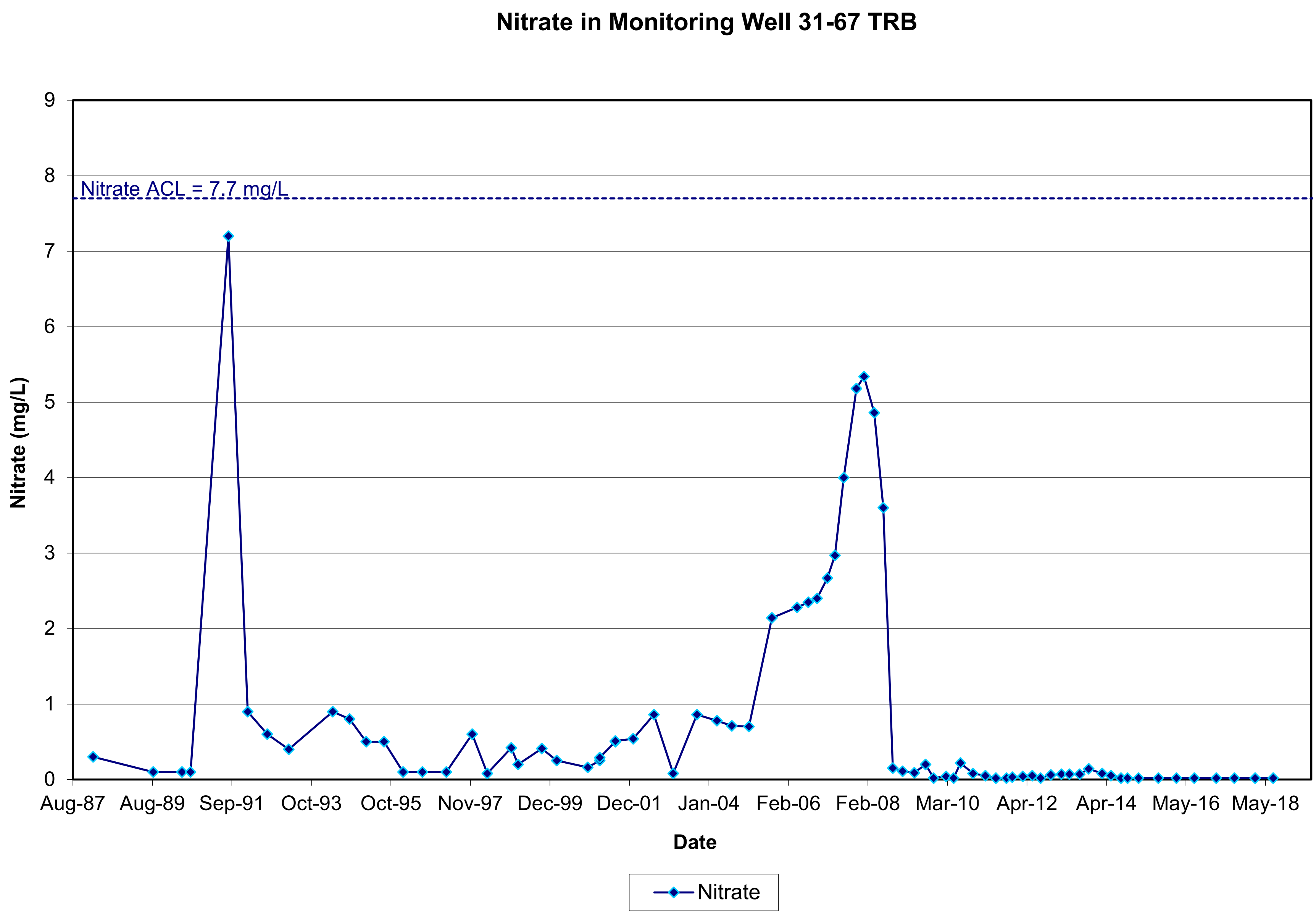
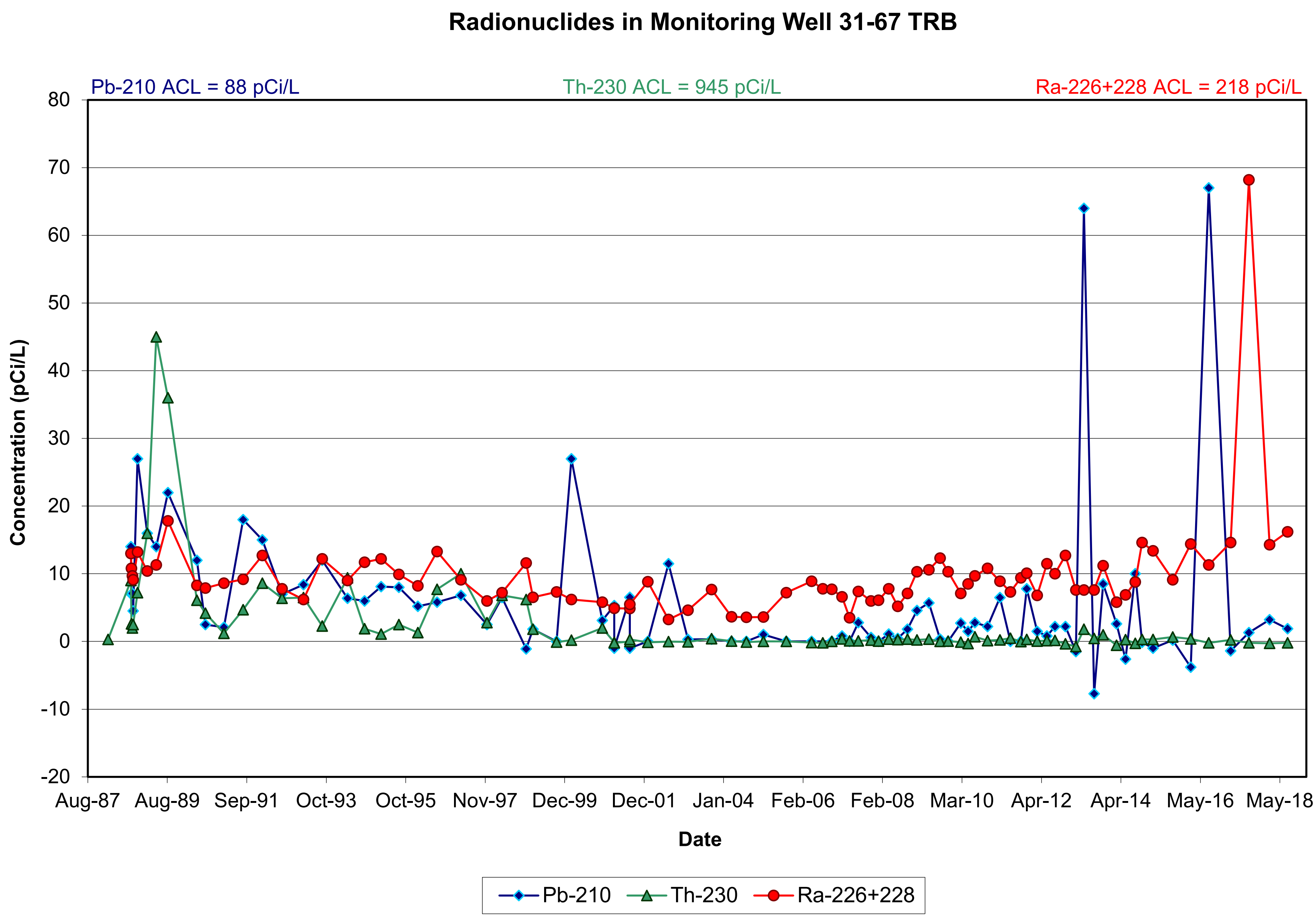
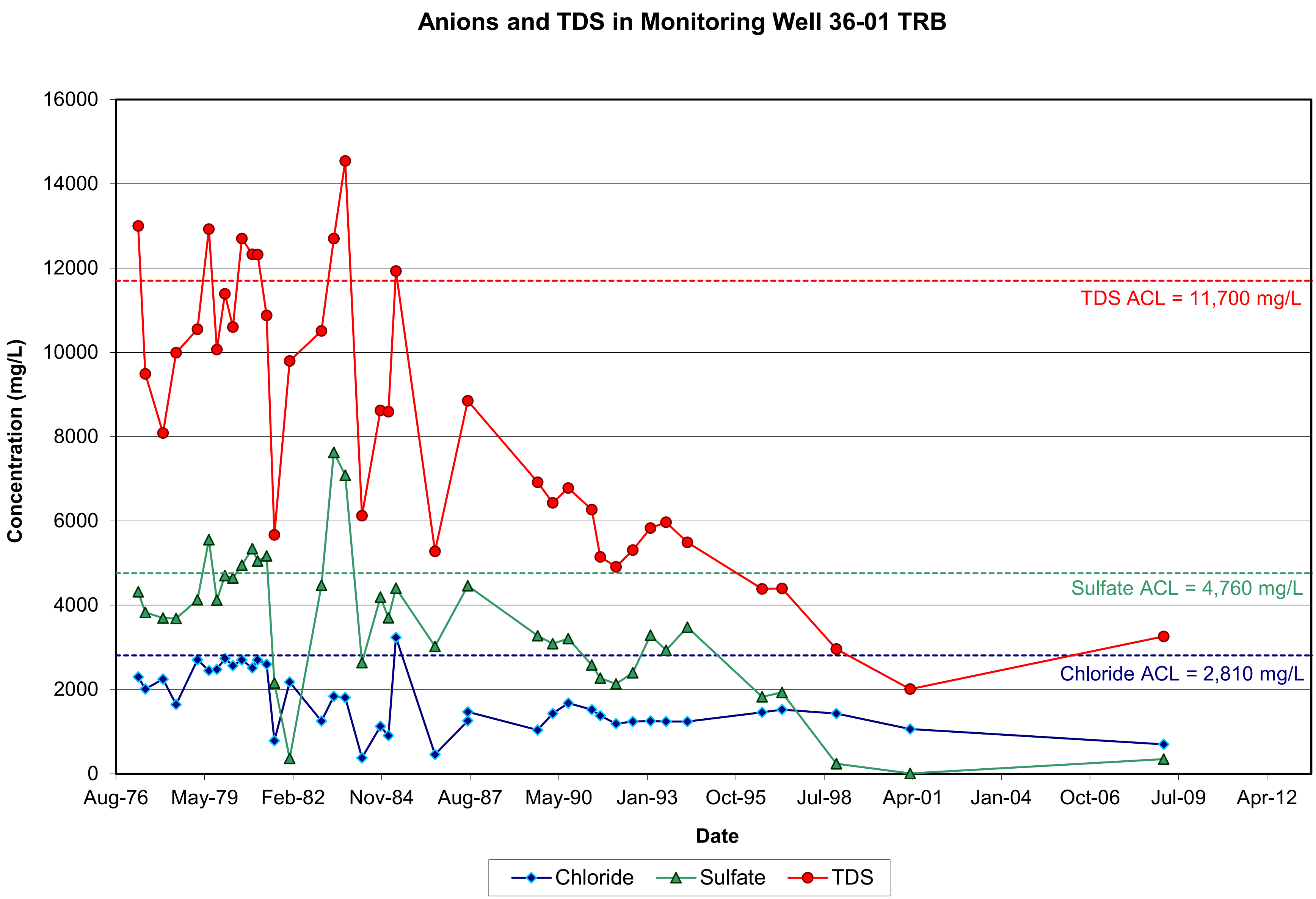


Nitrate in Monitoring Well 31-67 TRB
Nitrate ACL = 7.7 mg/L
Nitrate (mg/L)
0
1
2
3
4
5
6
7
8
9
Aug-87
Aug-89
Sep-91
Oct-93
Oct-95
Nov-97
Dec-99
Dec-01
Jan-04
Feb-06
Feb-08
Mar-10
Apr-12
Apr-14
May-16
May-18
Date
Nitrate



Radionuclides in Monitoring Well 31-67 TRB
Pb-210 ACL = 88 pCi/L
Th-230 ACL = 945 pCi/L
Ra-226+228 ACL = 218 pCi/L
Concentration (pCi/L)
80
70
60
50
40
30
20
10
0
-10
-20
Aug-87
Aug-89
Sep-91
Oct-93
Oct-95
Nov-97
Dec-99
Dec-01
Jan-04
Feb-06
Feb-08
Mar-10
Apr-12
Apr-14
May-16
May-18
Date
Pb-210
Th-230
Ra-226+228



Anions and TDS in Monitoring Well 36-01 TRB
Concentration (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
TDS ACL = 11,700 mg/L
Sulfate ACL = 4,760 mg/L
Chloride ACL = 2,810 mg/L
Aug-76
May-79
Feb-82
Nov-84
Aug-87
May-90
Jan-93
Oct-95
Jul-98
Apr-01
Jan-04
Oct-06
Jul-09
Apr-12
Date
Chloride
Sulfate
TDS

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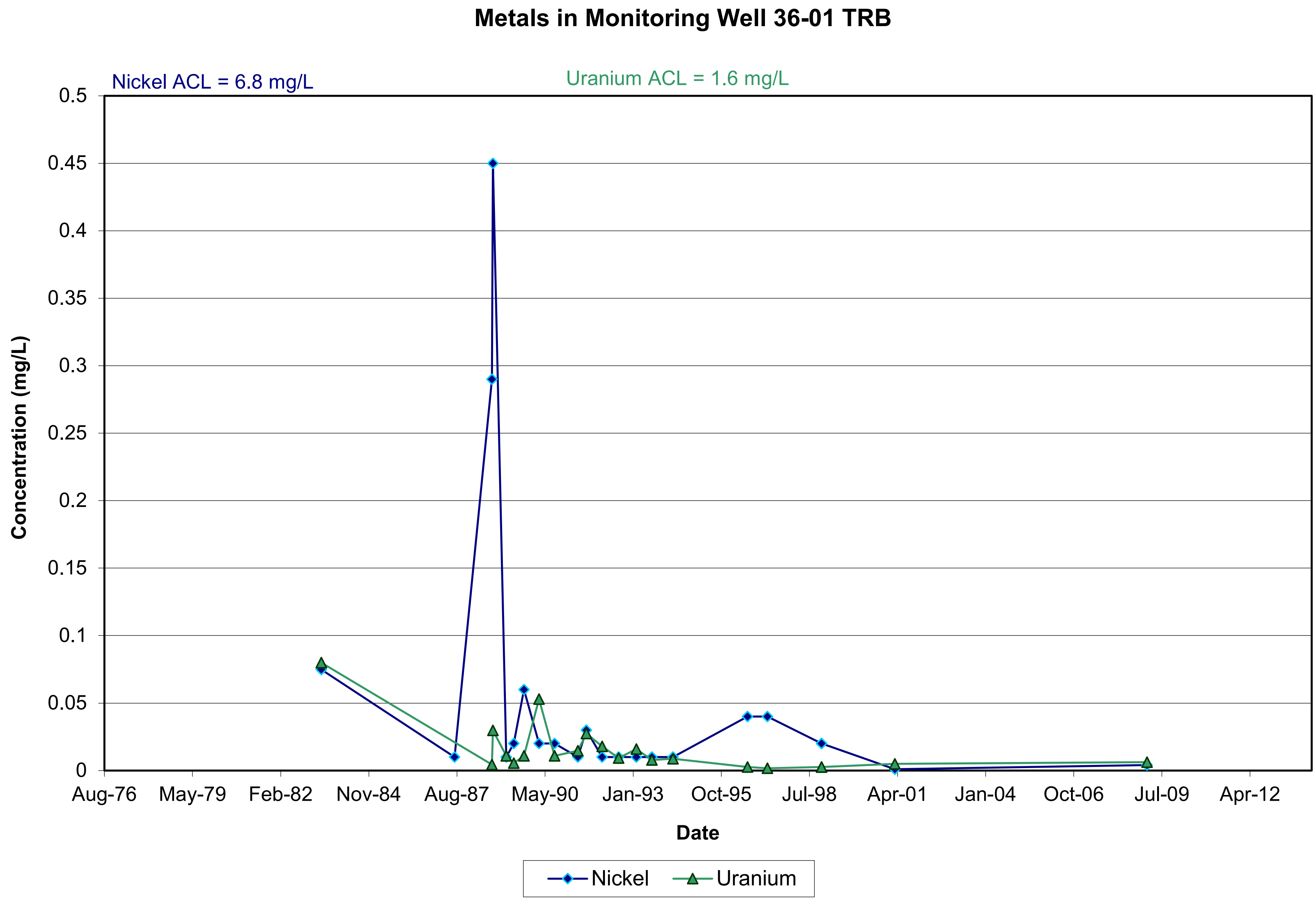

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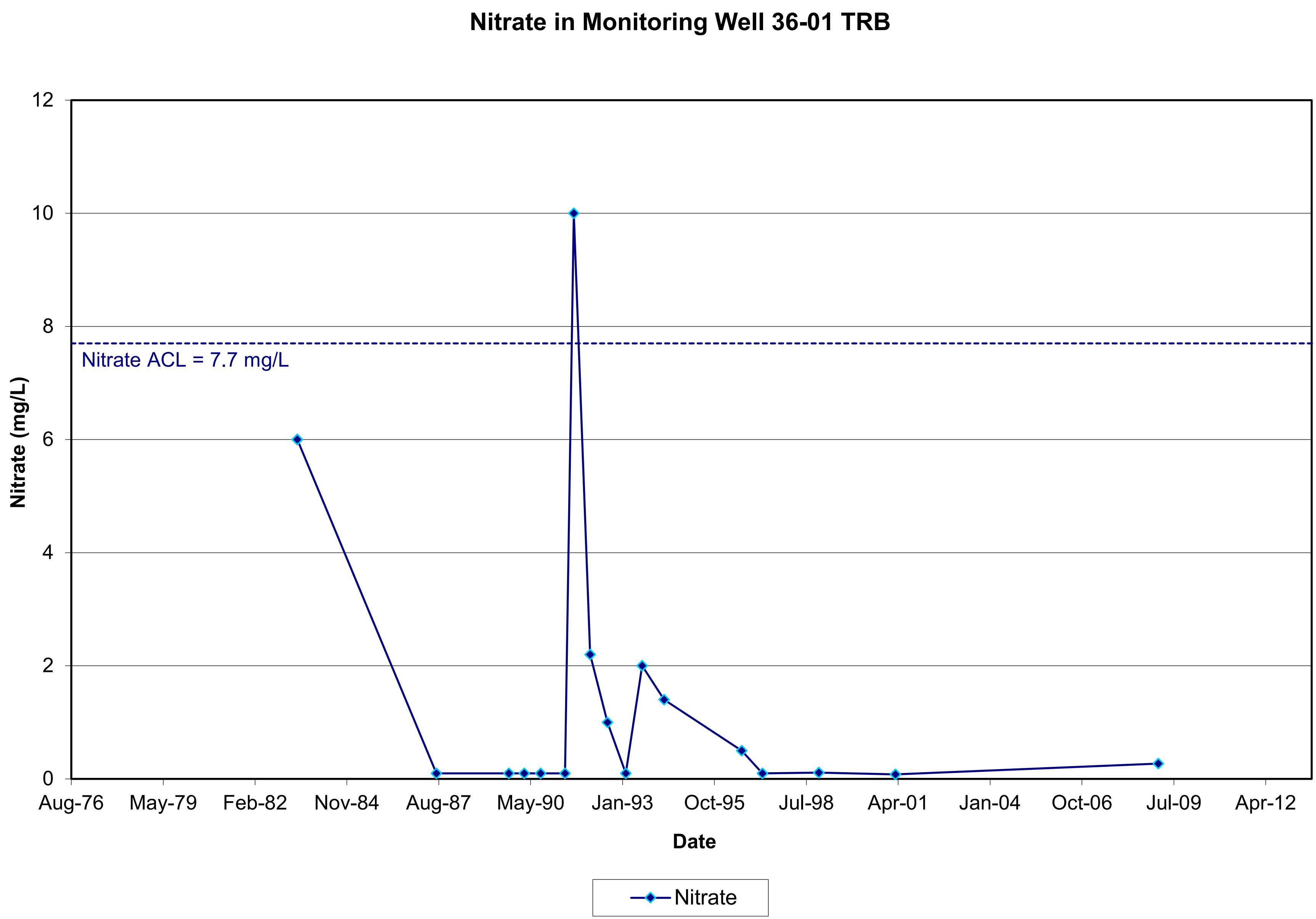

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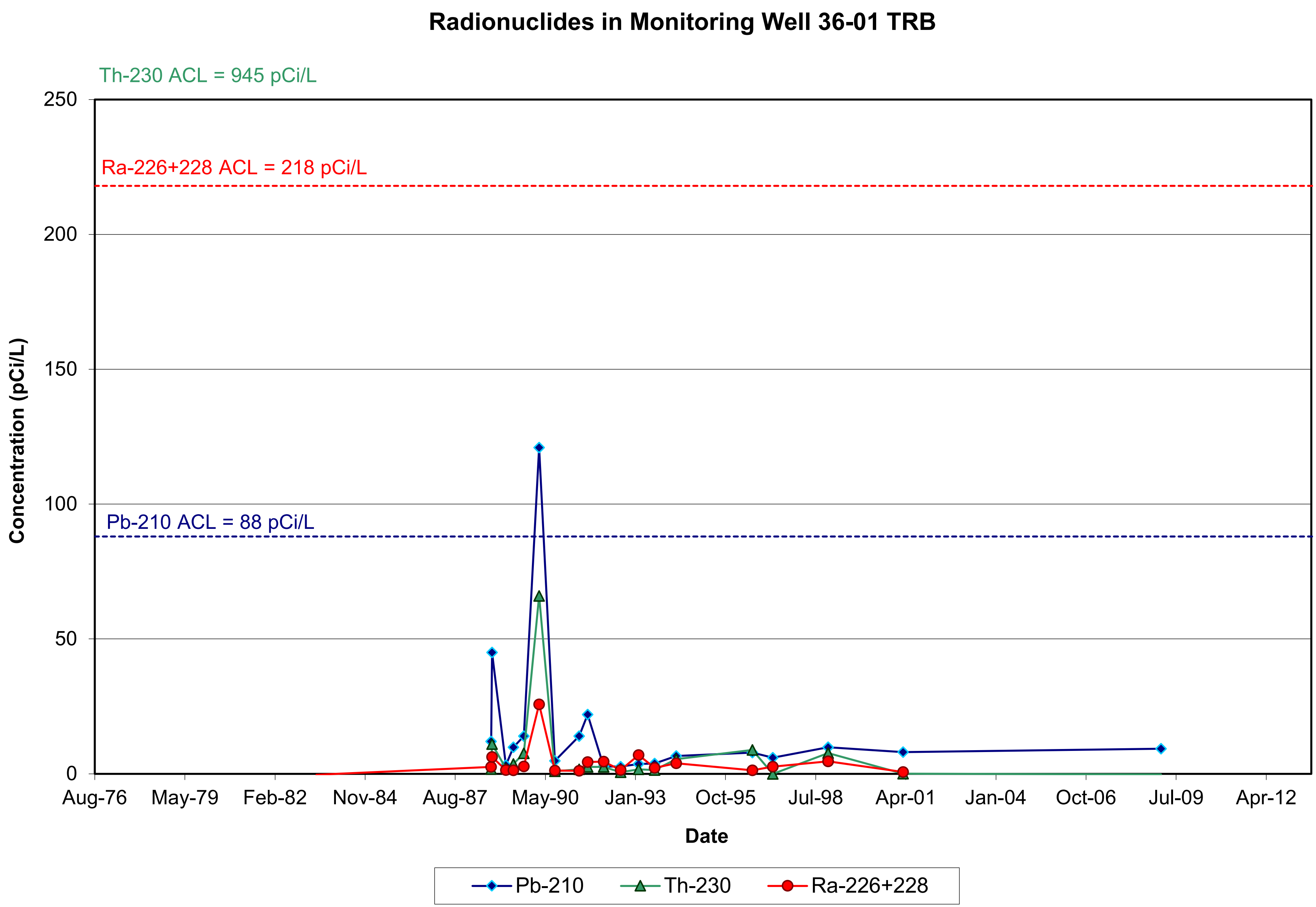

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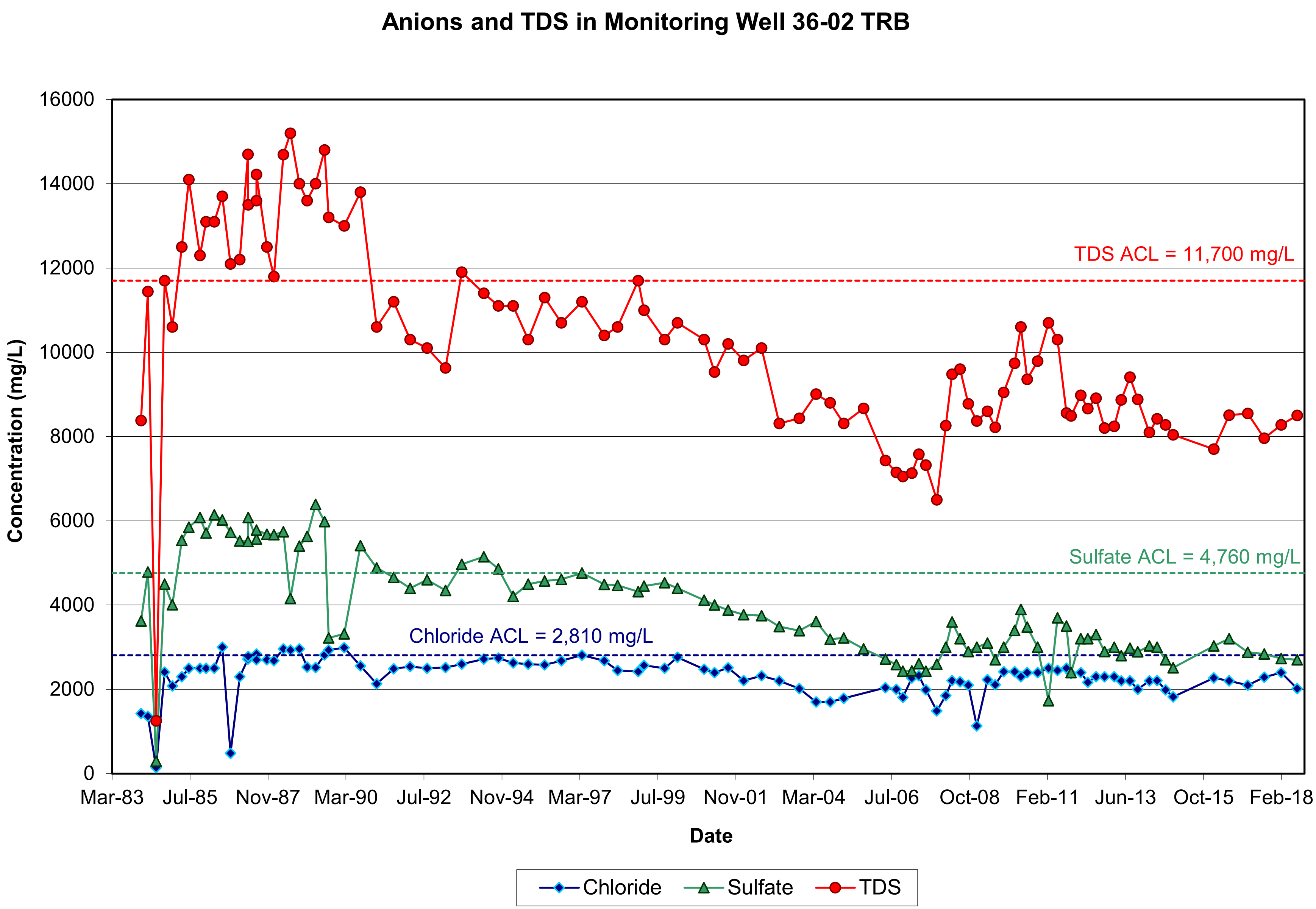
Anions and TDS in Monitoring Well 36-02 TRB
Concentration (mg/L)
16000
14000
12000
10000
8000
6000
4000
2000
0
TDS ACL = 11,700 mg/L
Sulfate ACL = 4,760 mg/L
Chloride ACL = 2,810 mg/L
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Chloride
Sulfate
TDS

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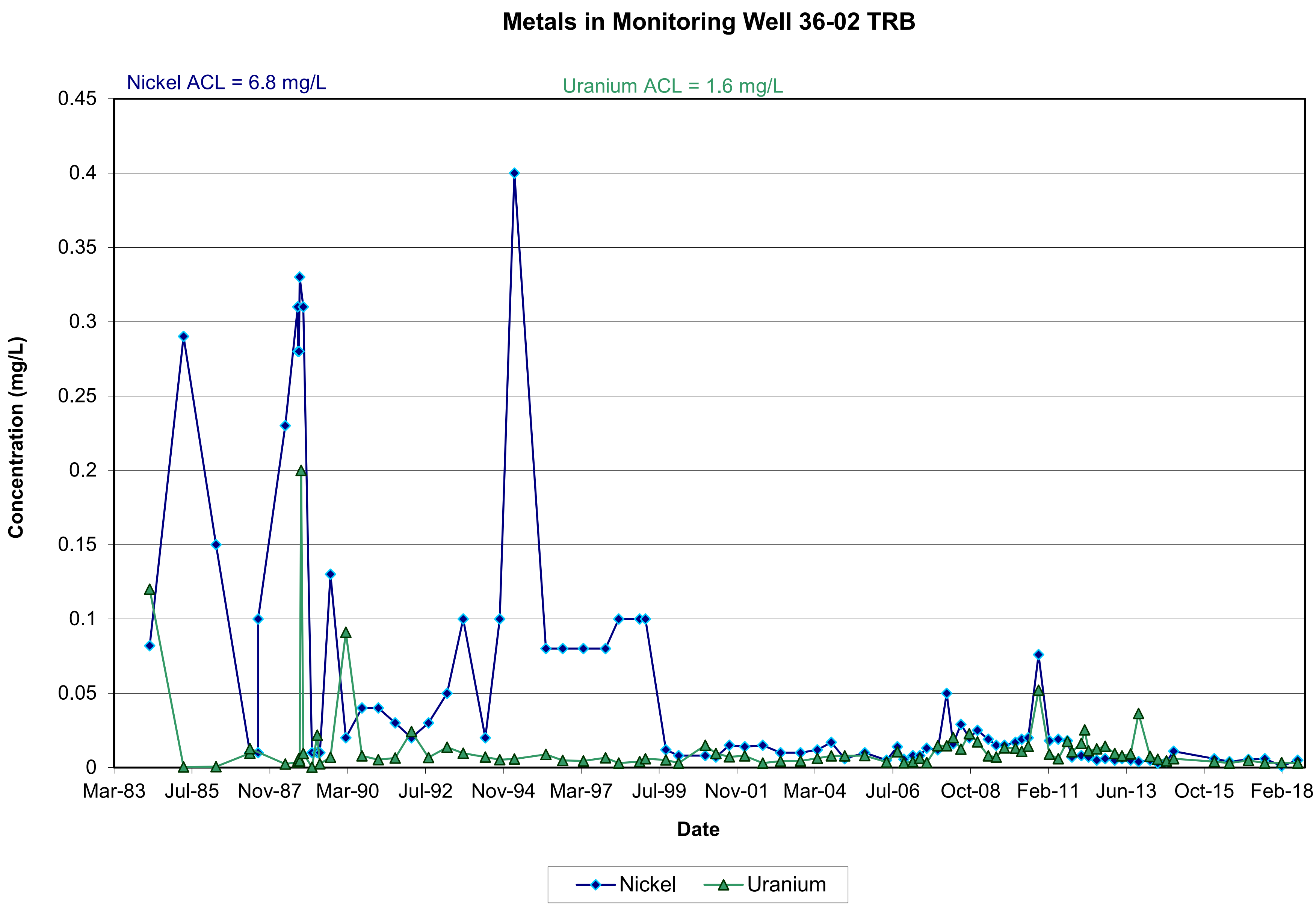

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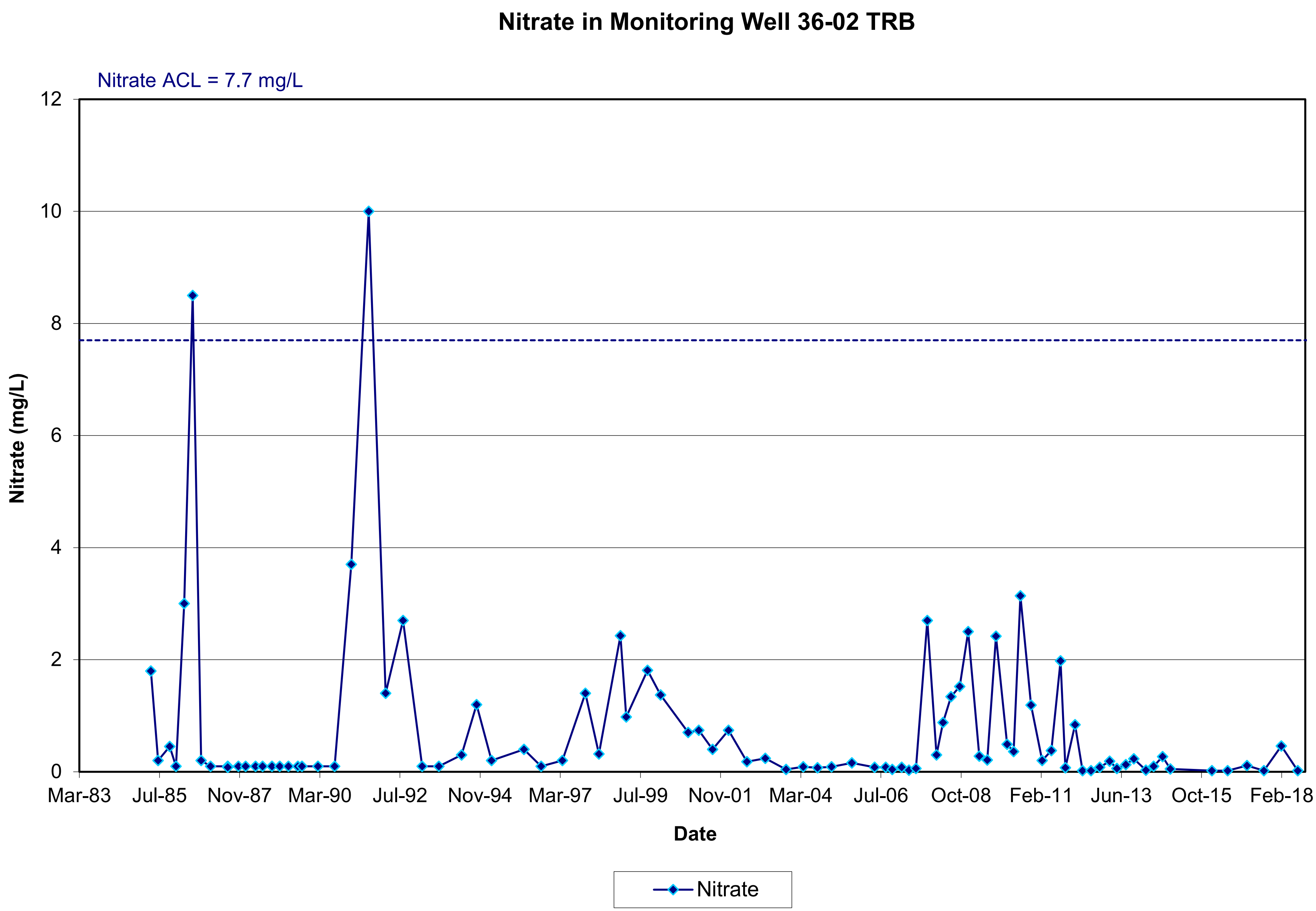

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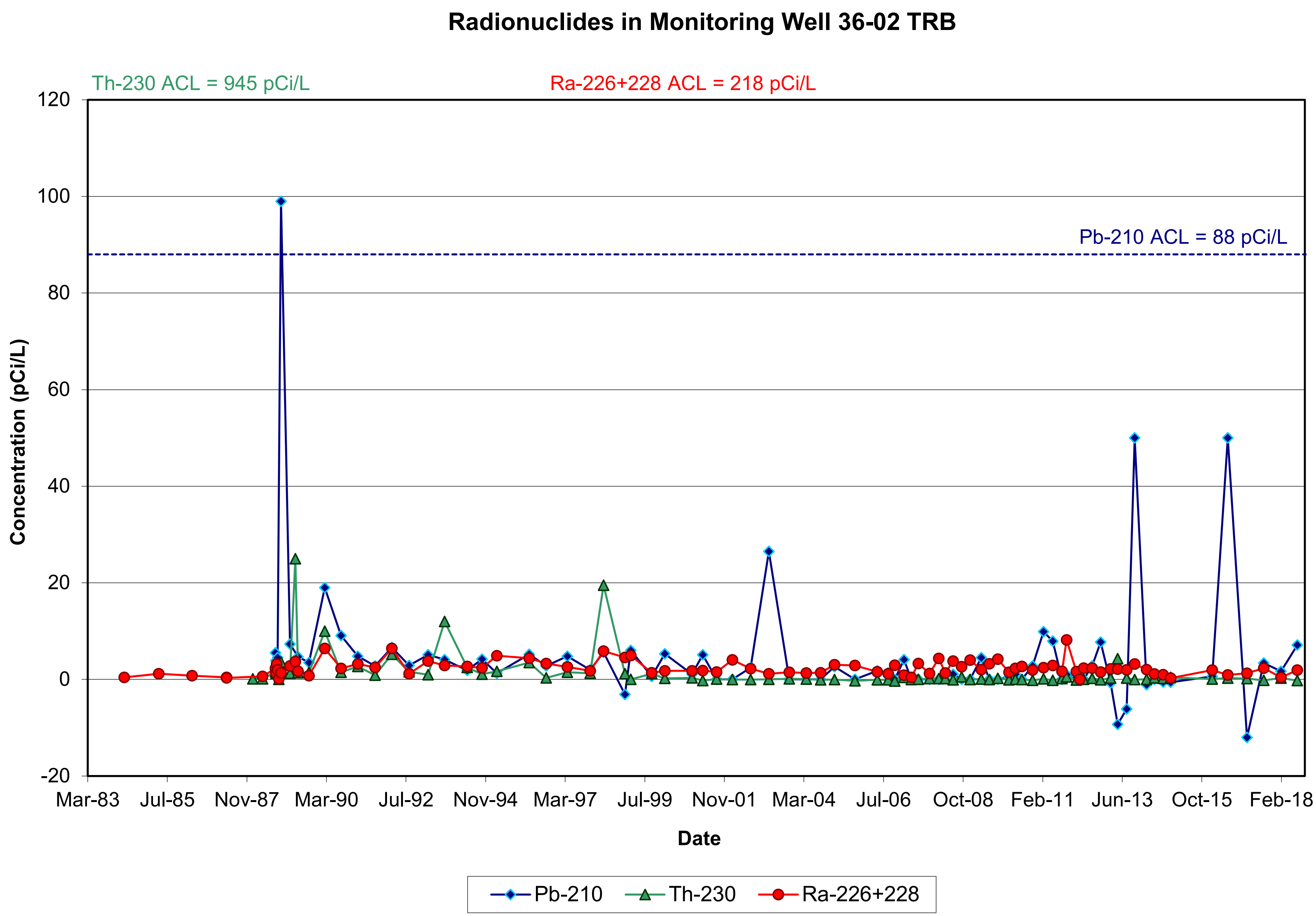

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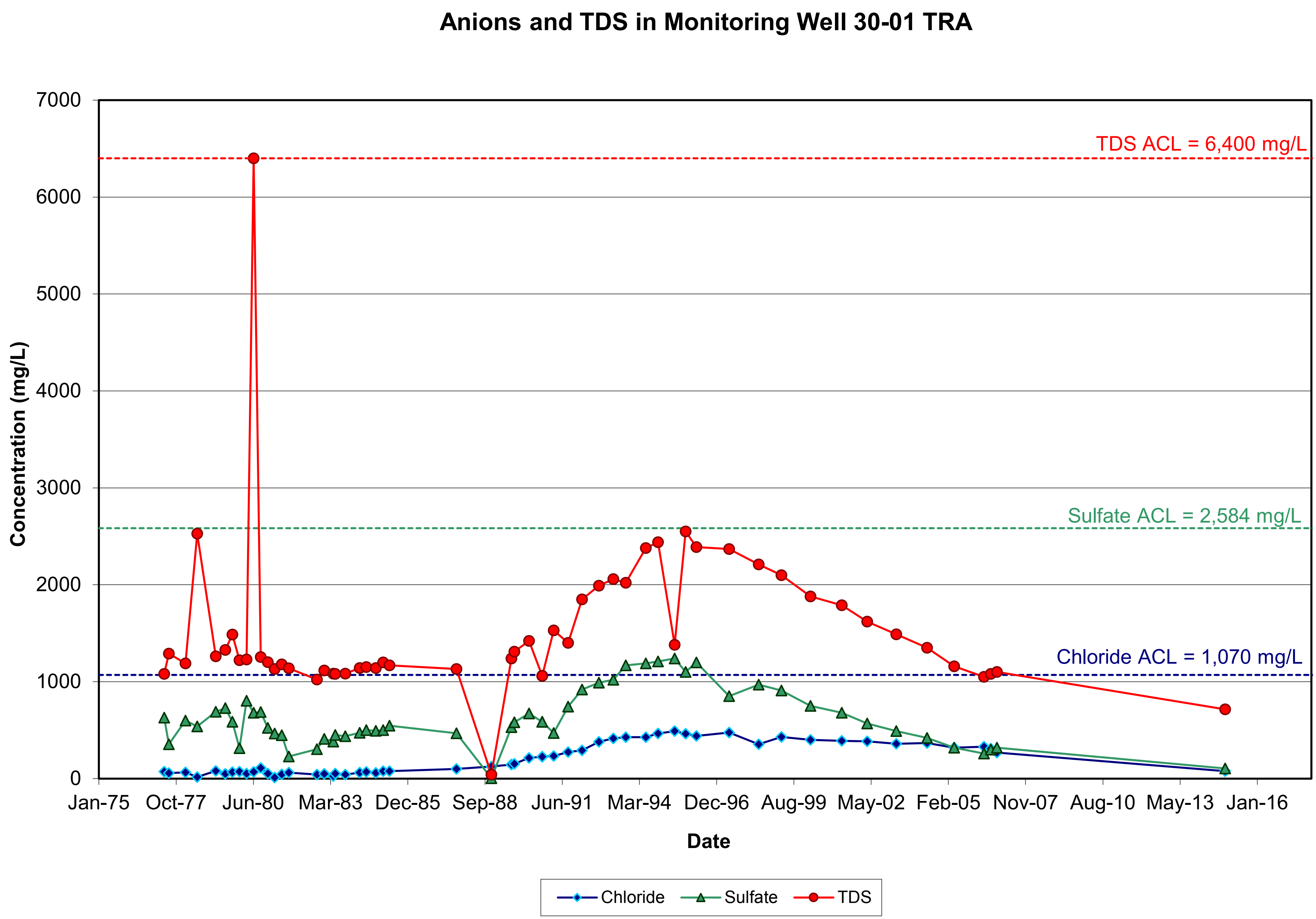
Stability Monitoring Plan
Time Versus Concentration Plots

Tres Hermanos A



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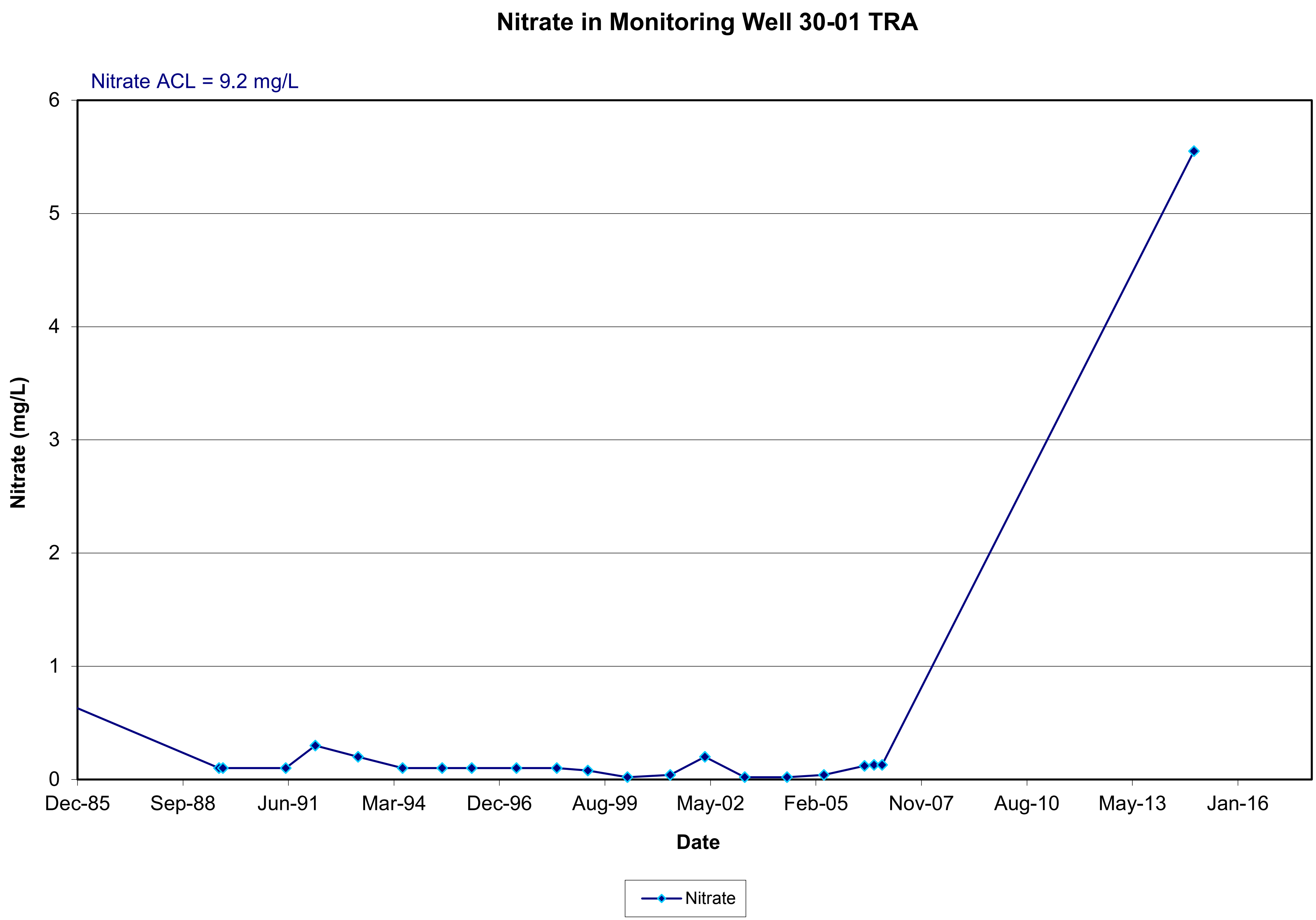

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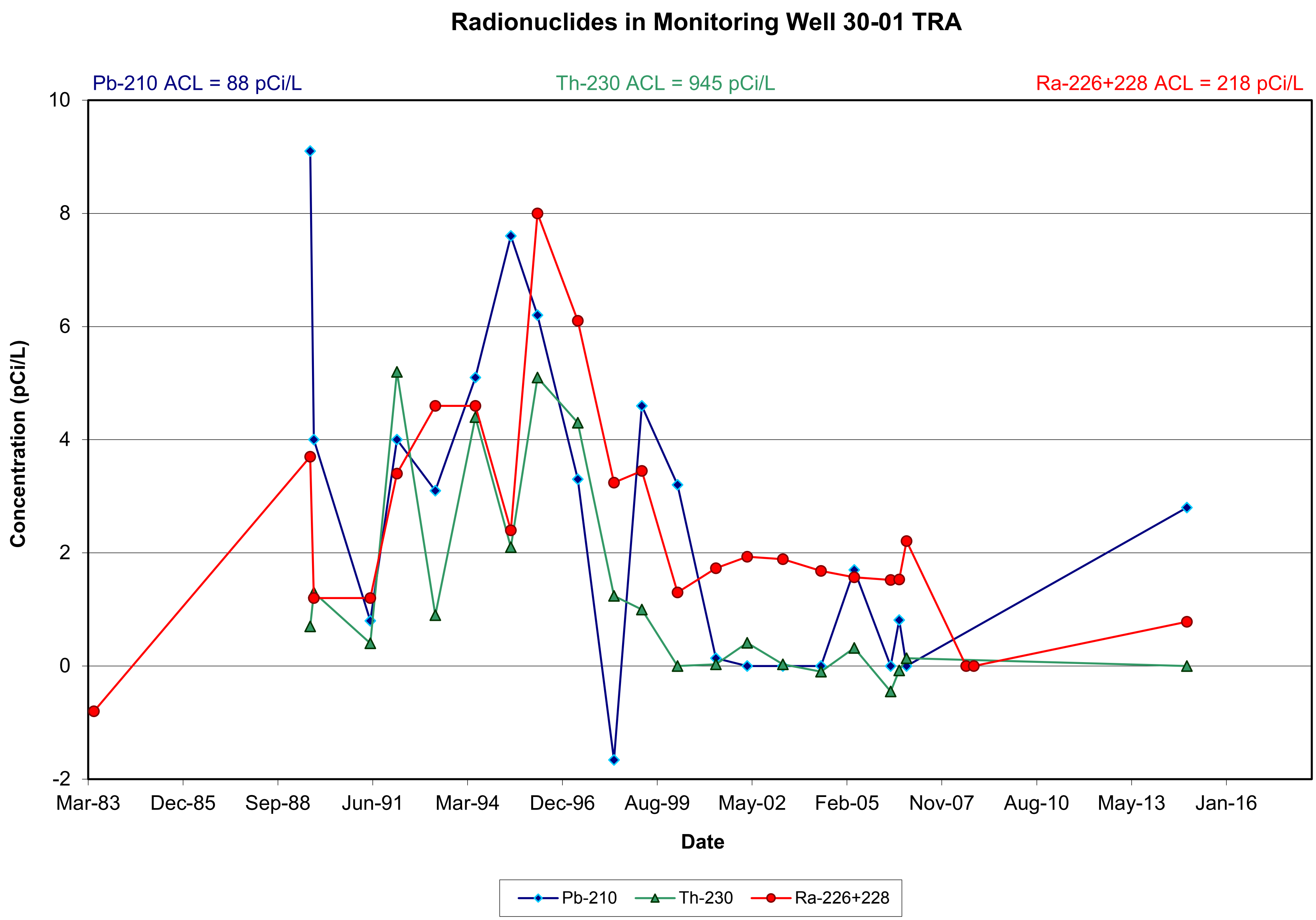

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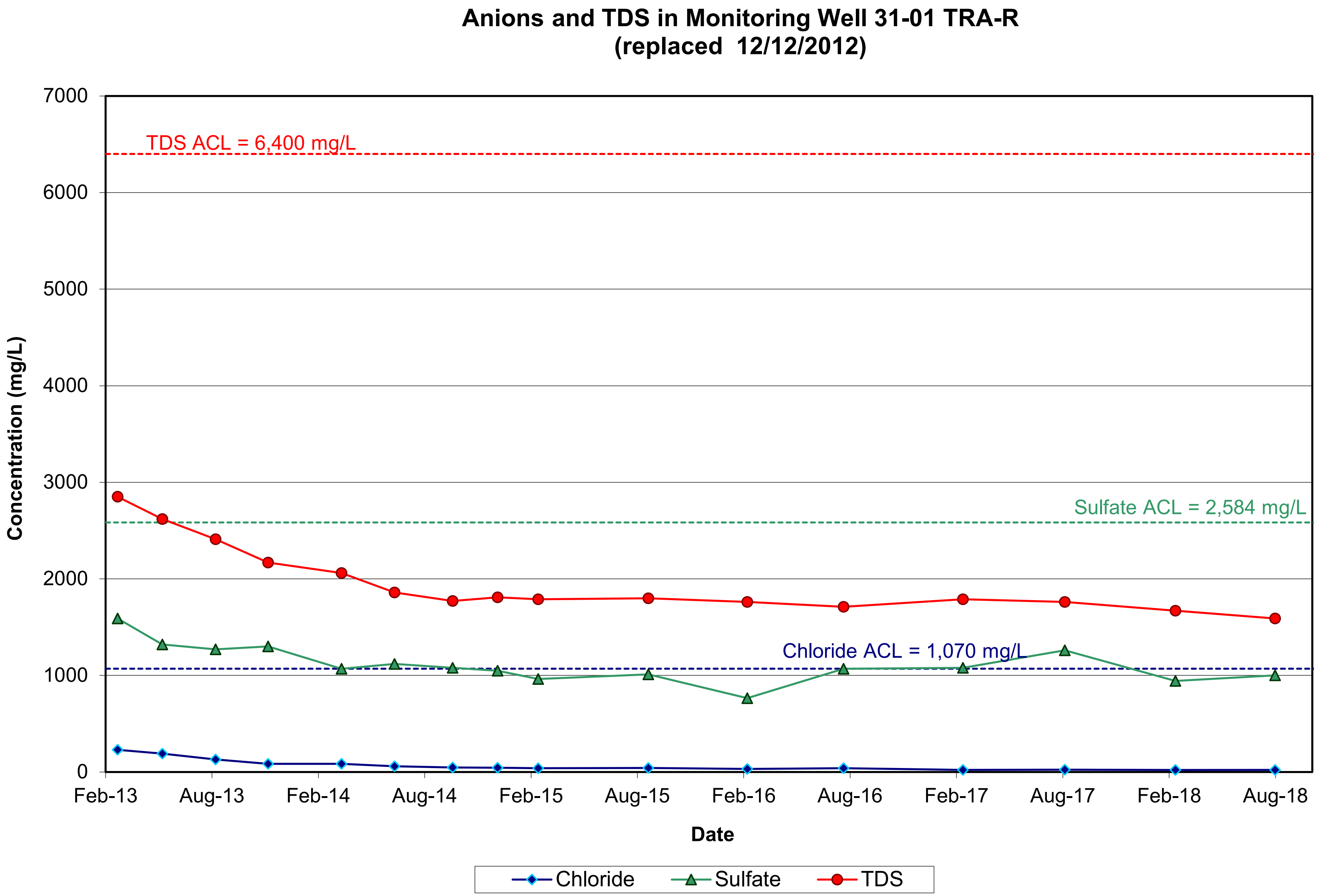
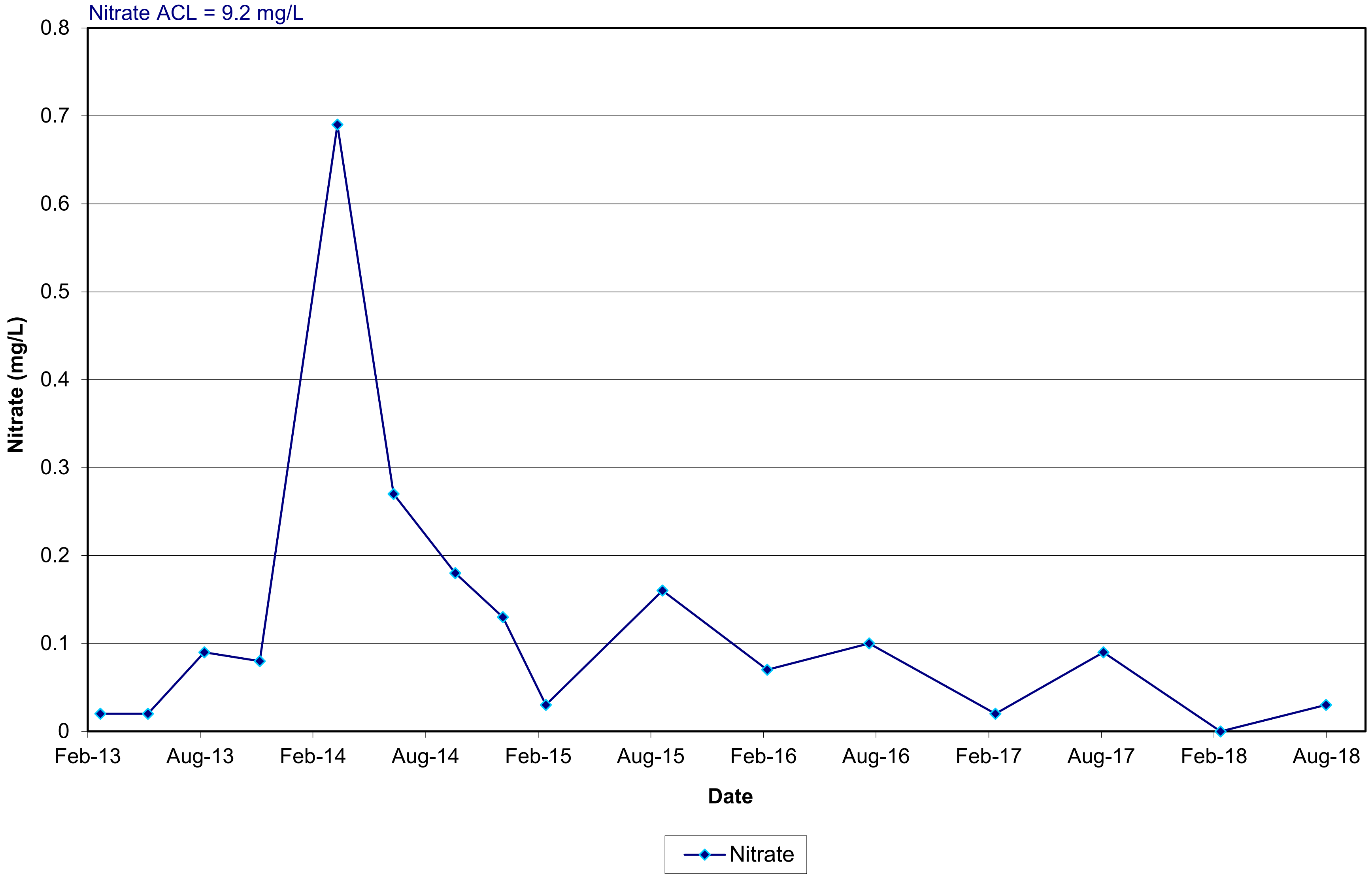

Anions and TDS in Monitoring Well 31-01 TRA-R
(replaced 12/12/2012)
TDS ACL = 6,400 mg/L
Sulfate ACL = 2,584 mg/L
Chloride ACL = 1,070 mg/L
Concentration (mg/L)
0
1000
2000
3000
4000
5000
6000
7000
Feb-13
Aug-13
Feb-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
Feb-17
Aug-17
Feb-18
Aug-18
Date
Chloride
Sulfate
TDS

Nitrate in Monitoring Well 31-01 TRA-R
(replaced 12/12/2012)



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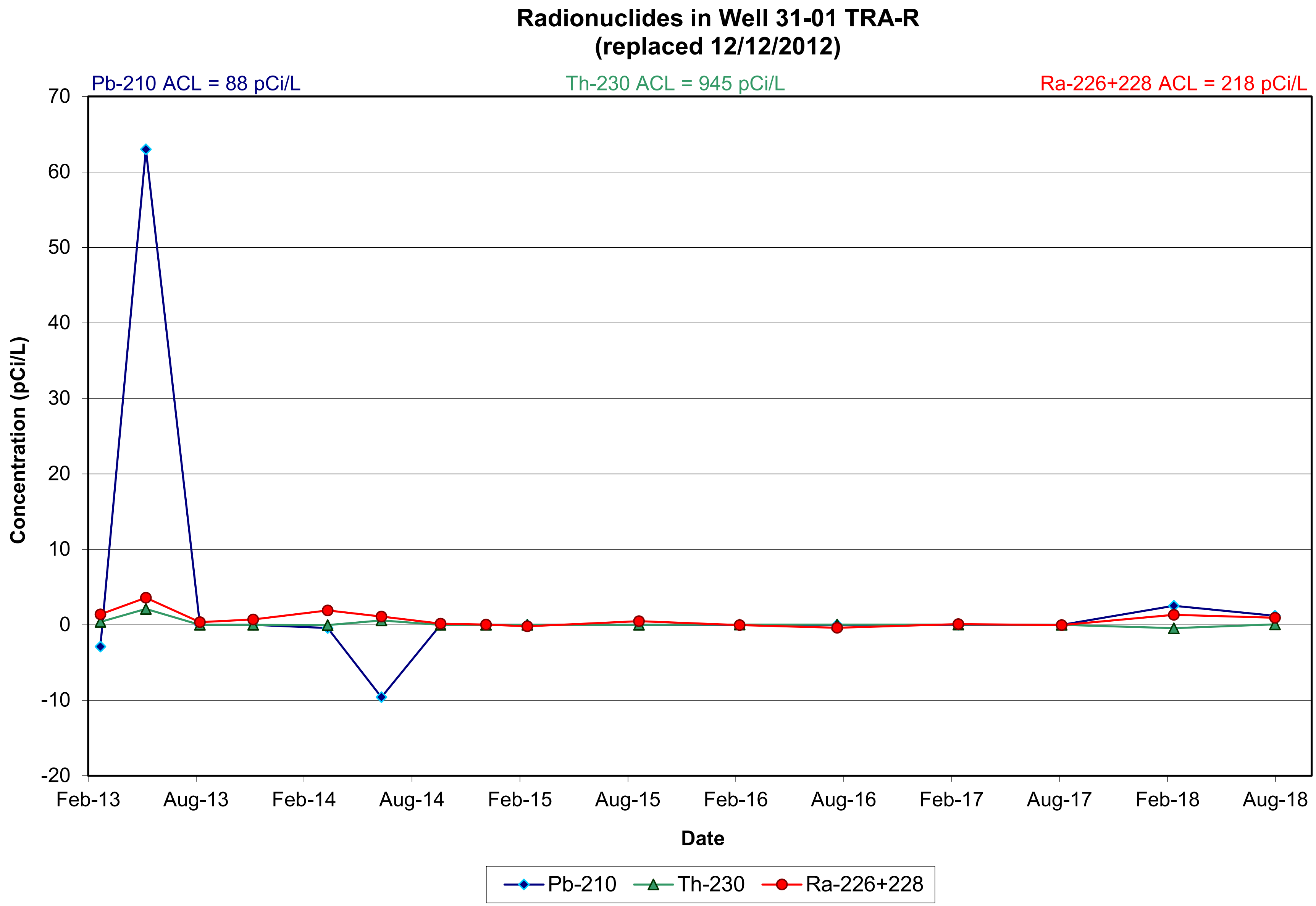

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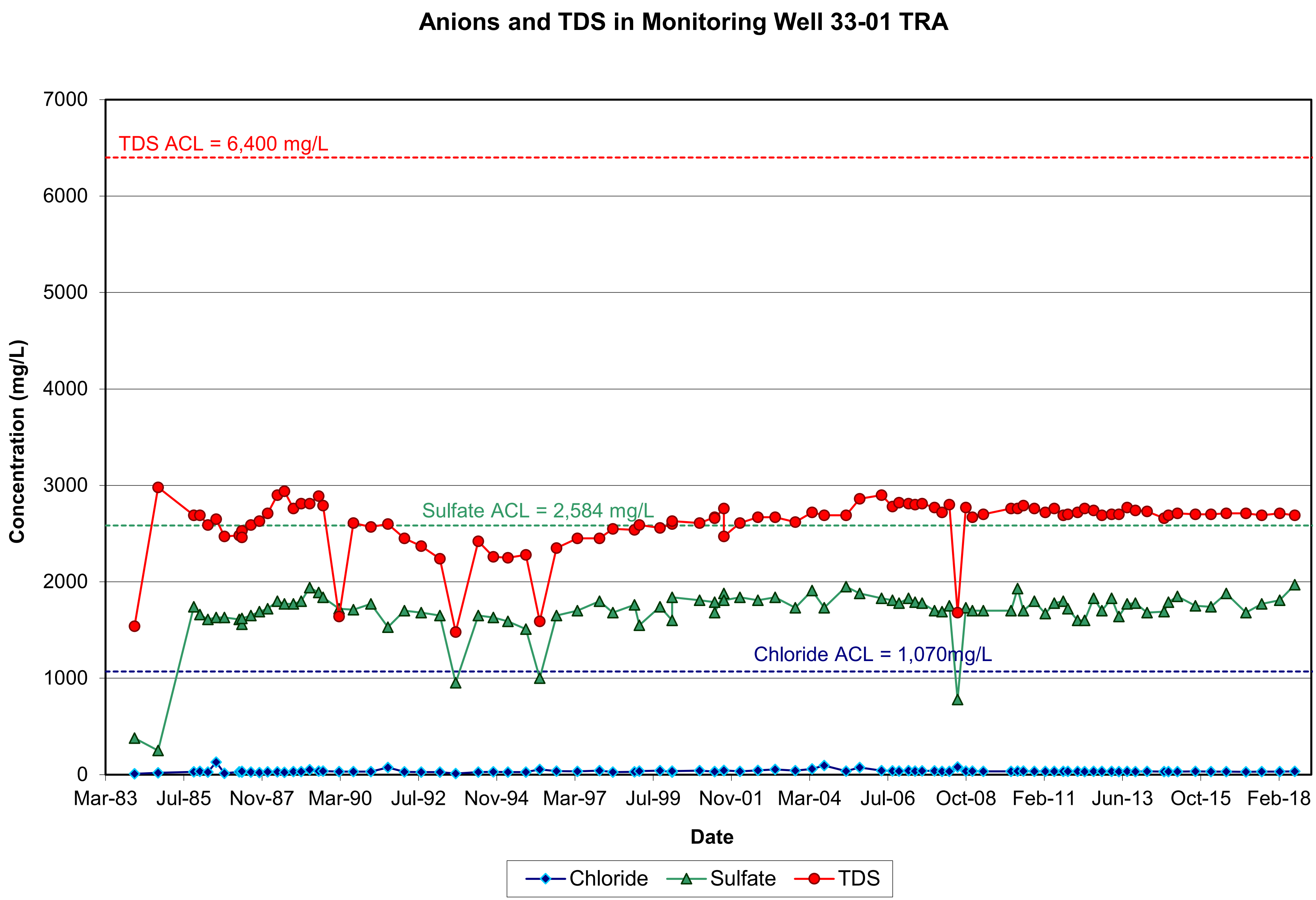

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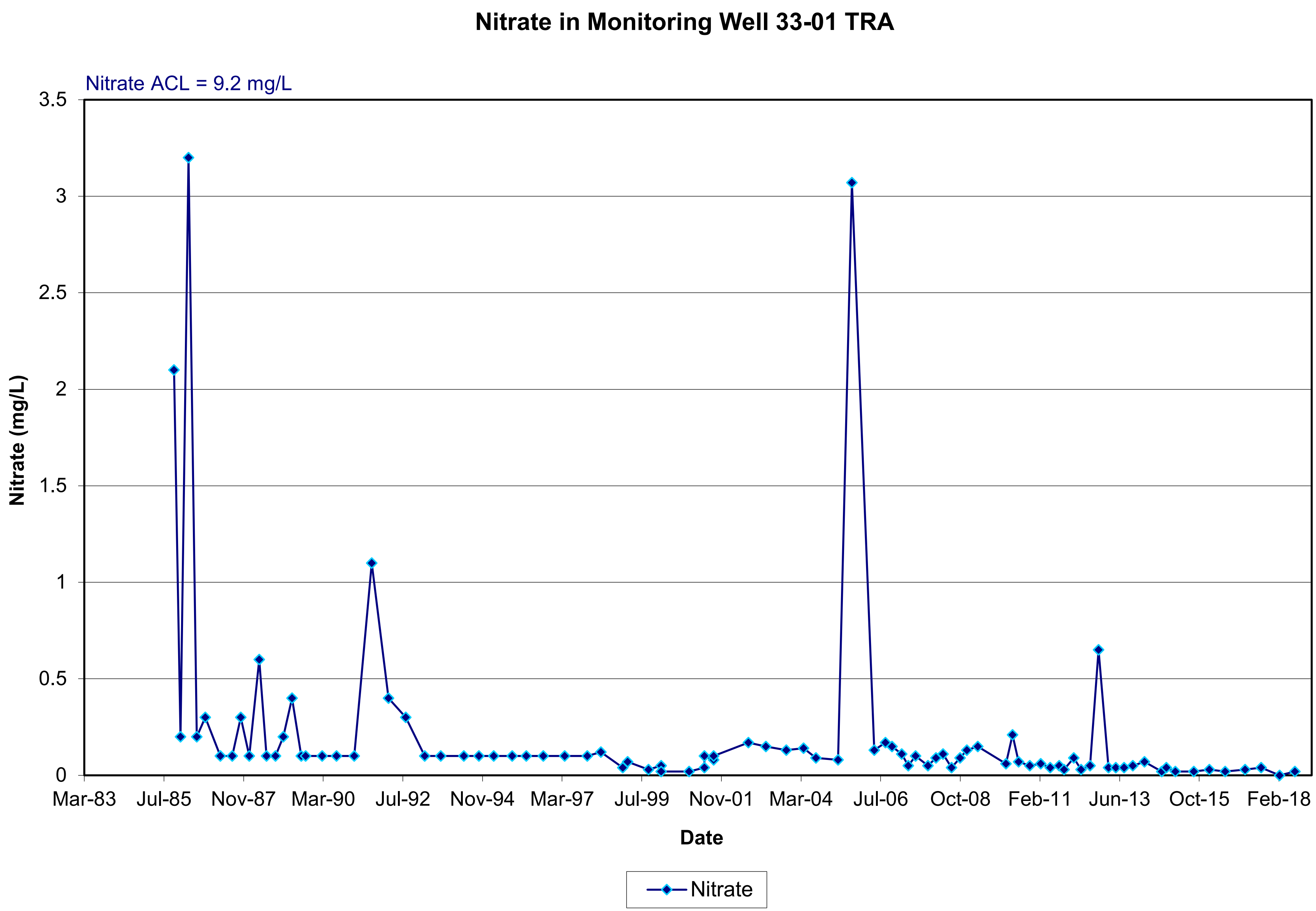
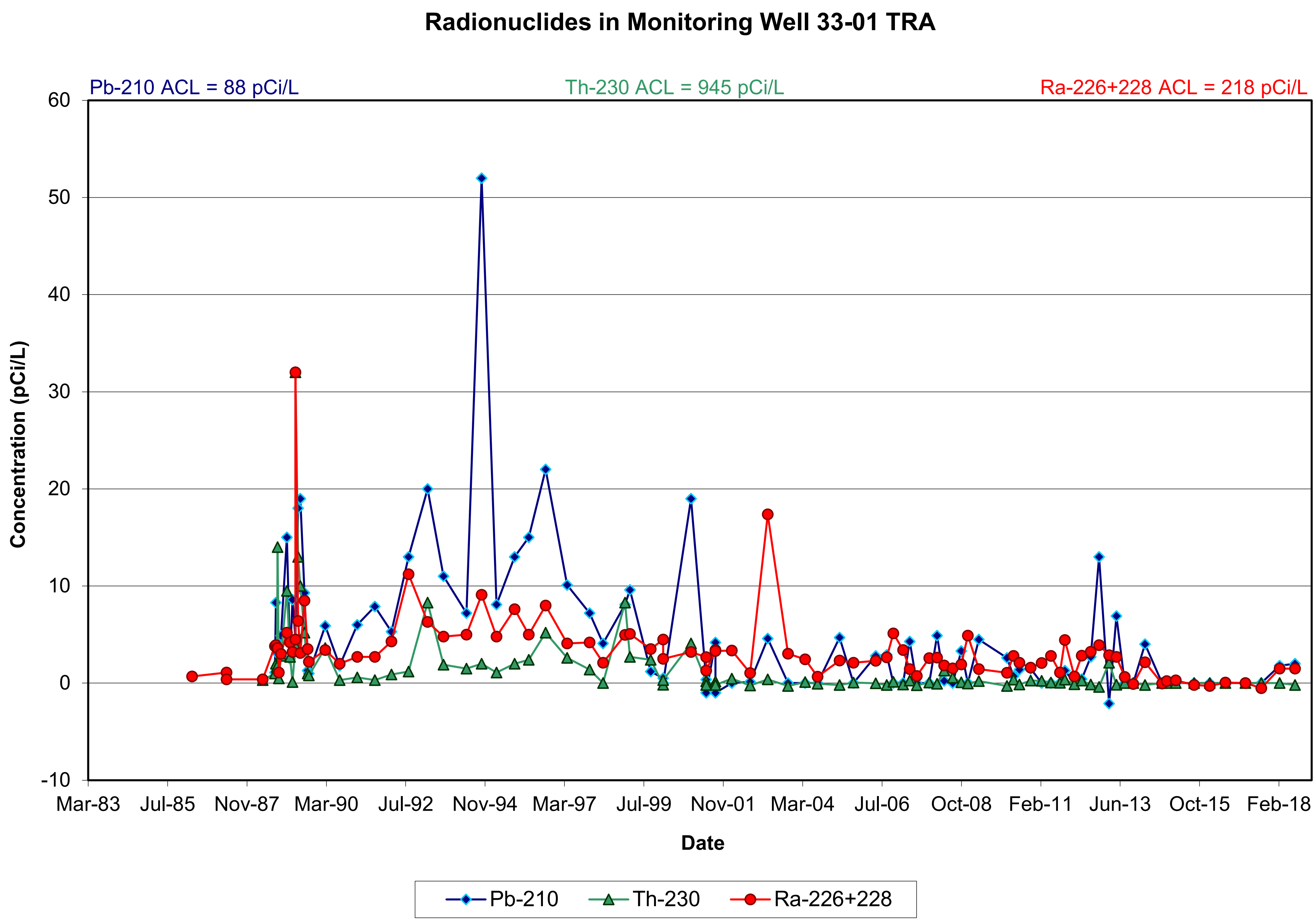


Nitrate in Monitoring Well 33-01 TRA
Nitrate ACL = 9.2 mg/L
Nitrate (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Nitrate


Radionuclides in Monitoring Well 33-01 TRA
Pb-210 ACL = 88 pCi/L
Th-230 ACL = 945 pCi/L
Ra-226+228 ACL = 218 pCi/L
Concentration (pCi/L)
60
50
40
30
20
10
0
-10
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Pb-210
Th-230
Ra-226+228

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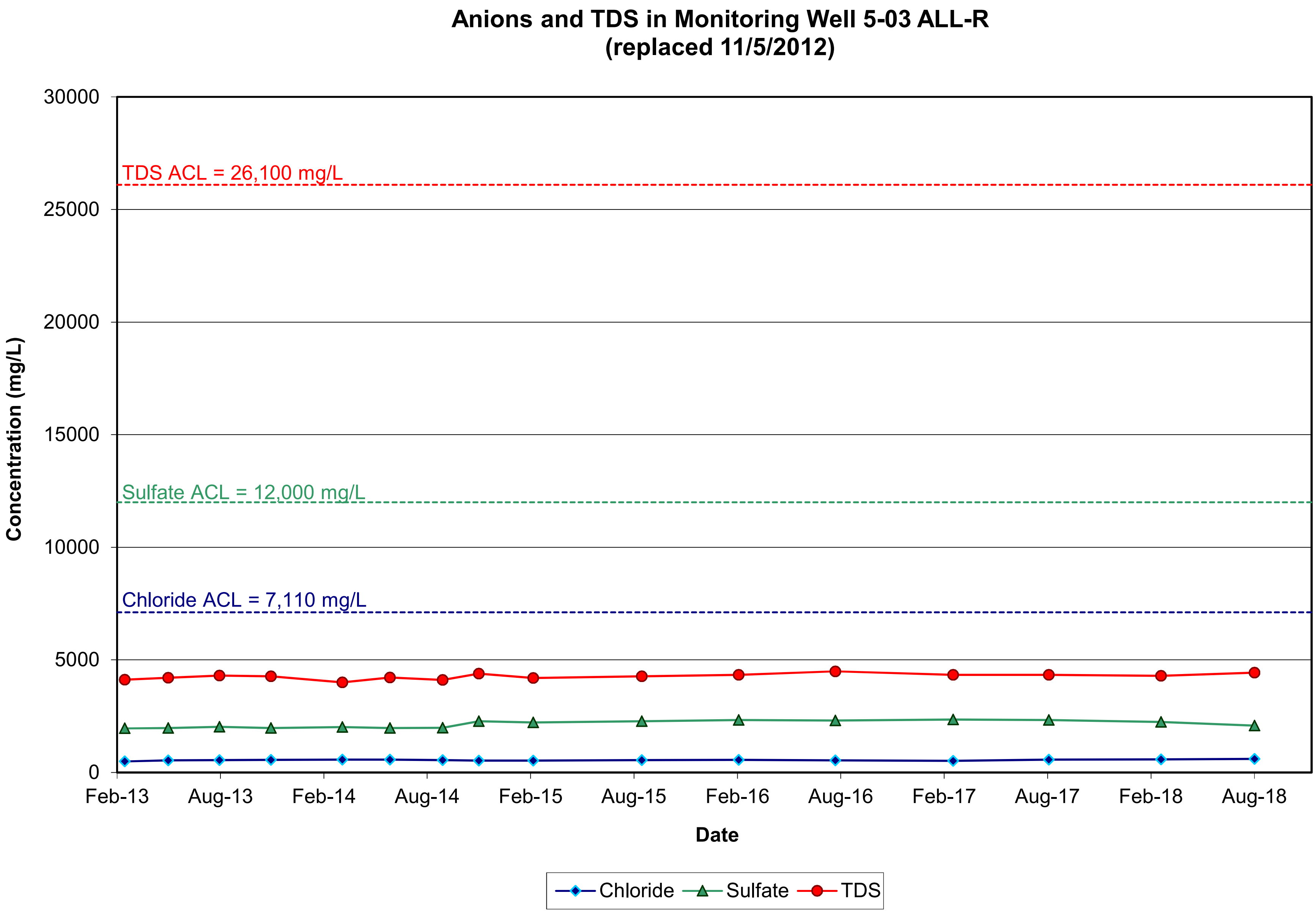
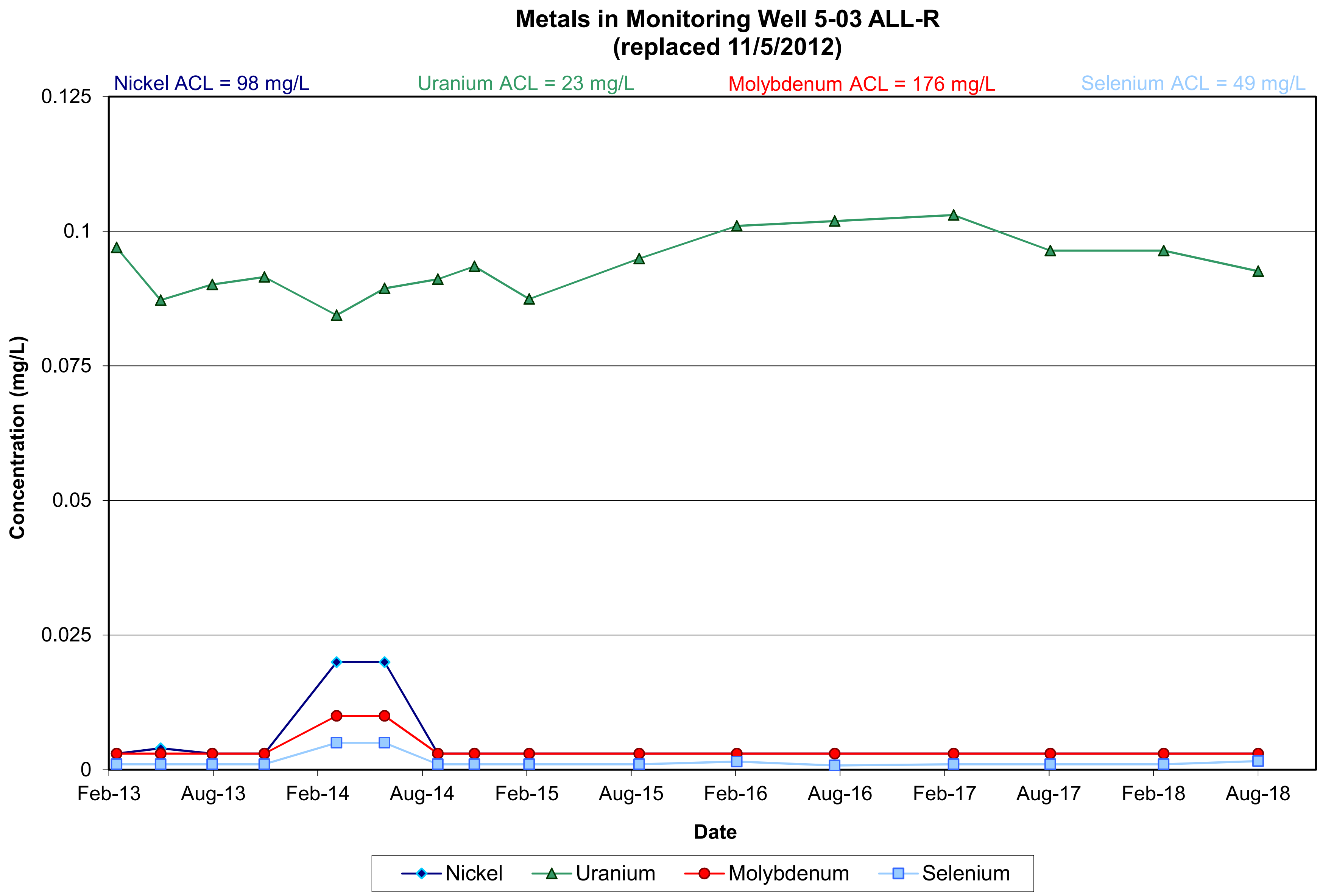
Stability Monitoring Plan
Time Versus Concentration Plots

Alluvium


Anions and TDS in Monitoring Well 5-03 ALL-R
(replaced 11/5/2012)
TDS ACL = 26,100 mg/L
Sulfate ACL = 12,000 mg/L
Chloride ACL = 7,110 mg/L
Concentration (mg/L)
30000
25000
20000
15000
10000
5000
0
Feb-13
Aug-13
Feb-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
Feb-17
Aug-17
Feb-18
Aug-18
Date
Chloride
Sulfate
TDS

INTERA



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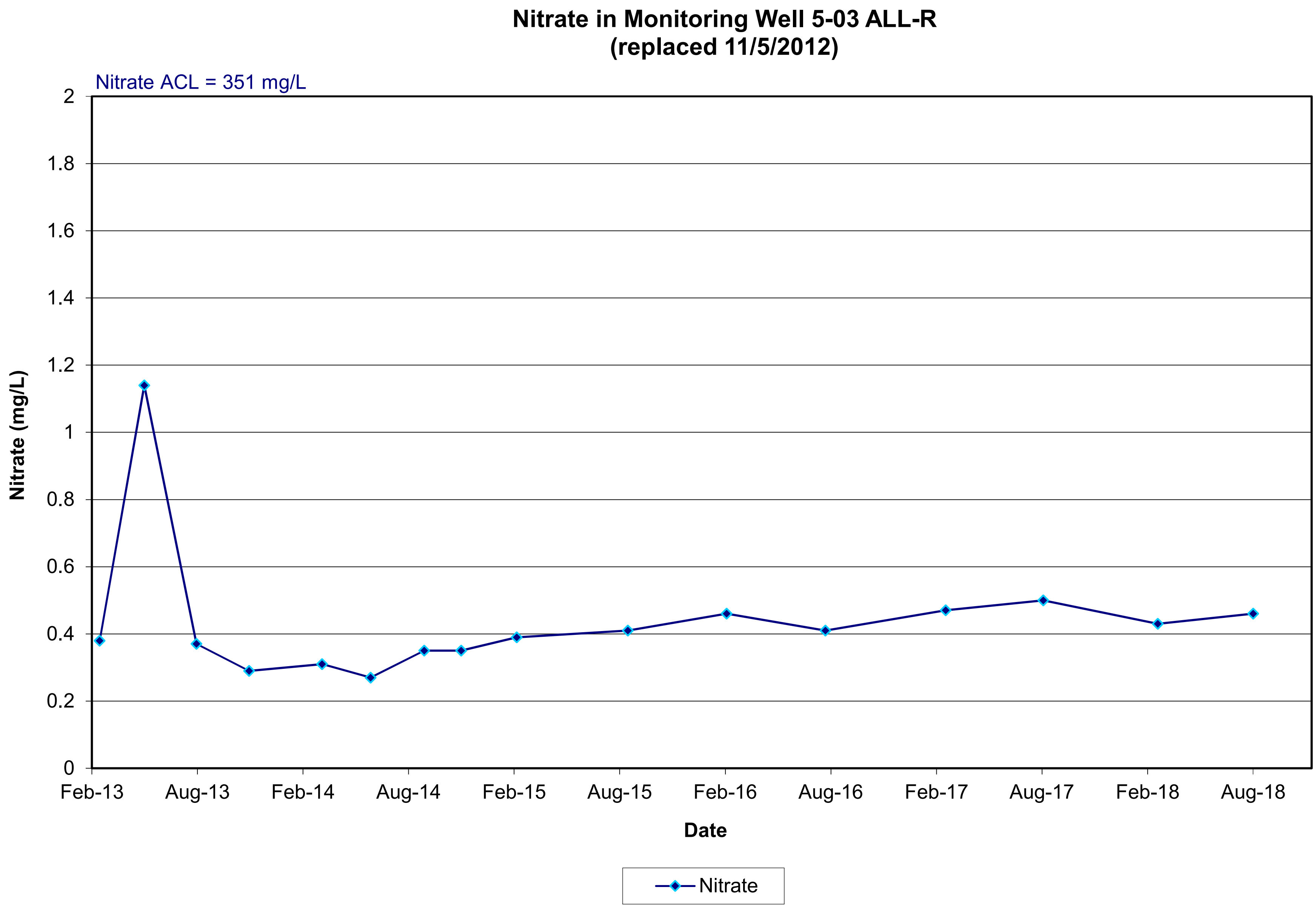
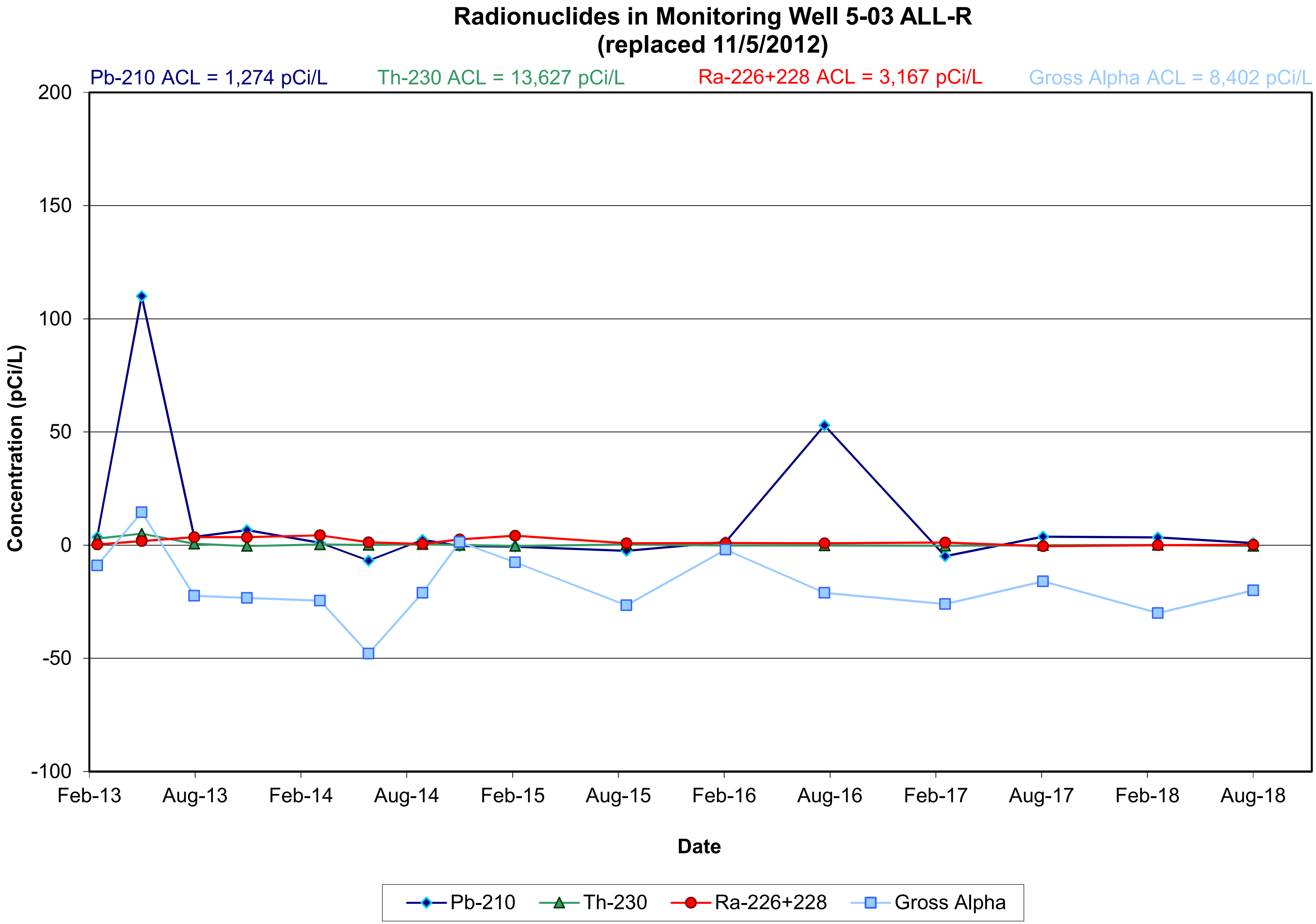


Nitrate in Monitoring Well 5-03 ALL-R
(replaced 11/5/2012)
Nitrate ACL = 351 mg/L
Nitrate (mg/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Feb-13
Aug-13
Feb-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
Feb-17
Aug-17
Feb-18
Aug-18
Date
Nitrate

INTERA



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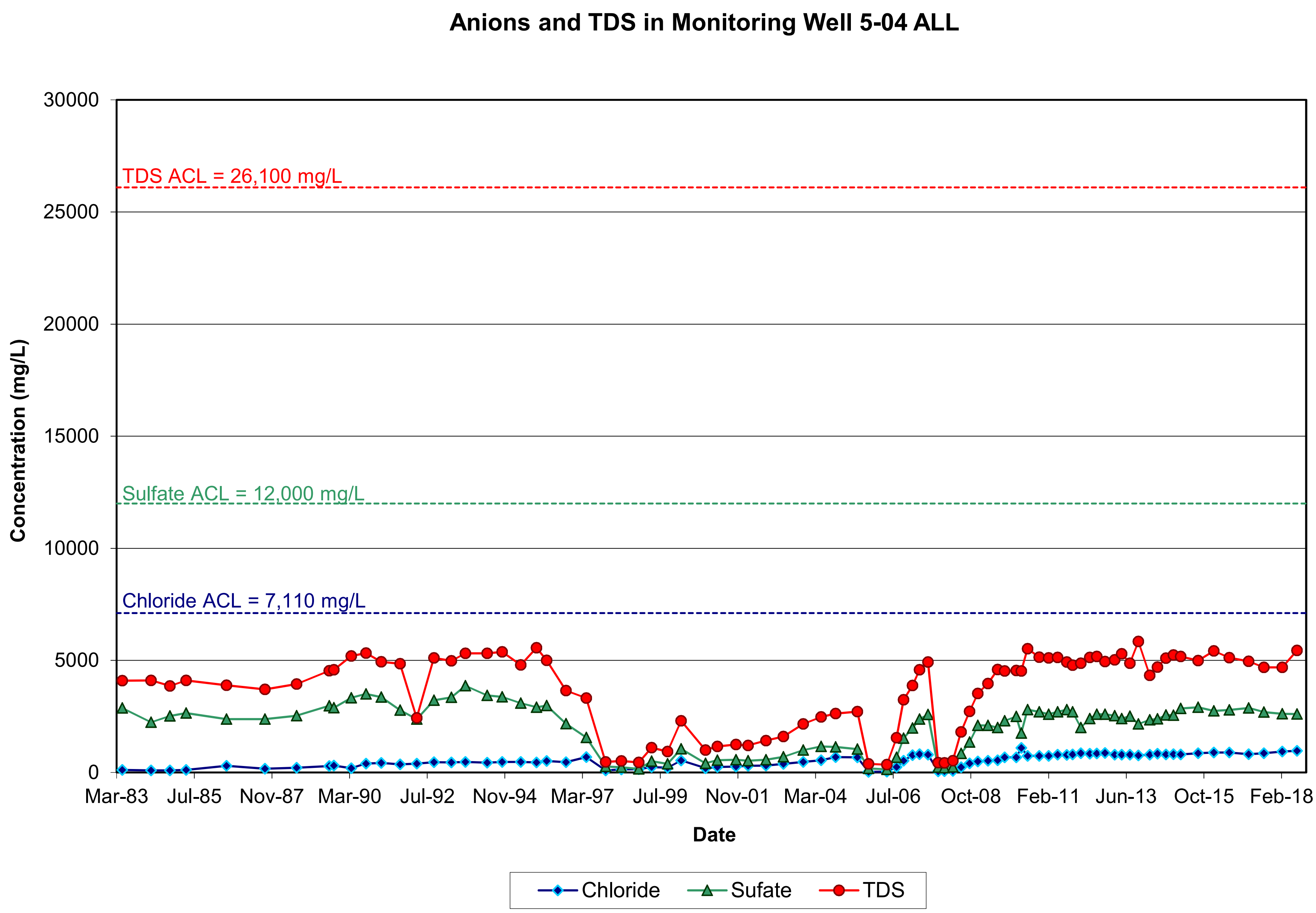
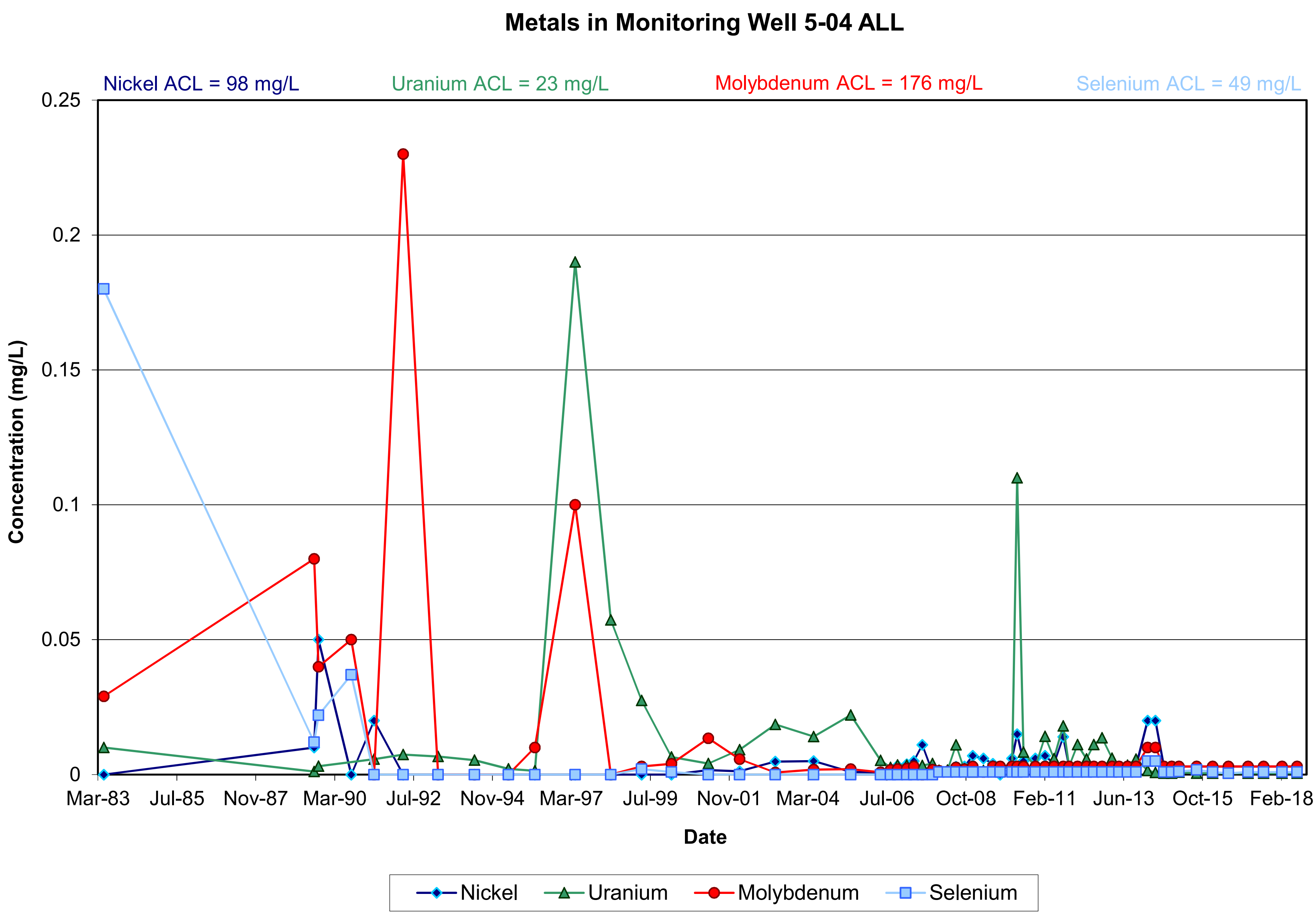


Anions and TDS in Monitoring Well 5-04 ALL
30000
25000
20000
15000
10000
5000
0
TDS ACL = 26,100 mg/L
Sulfate ACL = 12,000 mg/L
Chloride ACL = 7,110 mg/L
Concentration (mg/L)
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Chloride
Sufate
TDS



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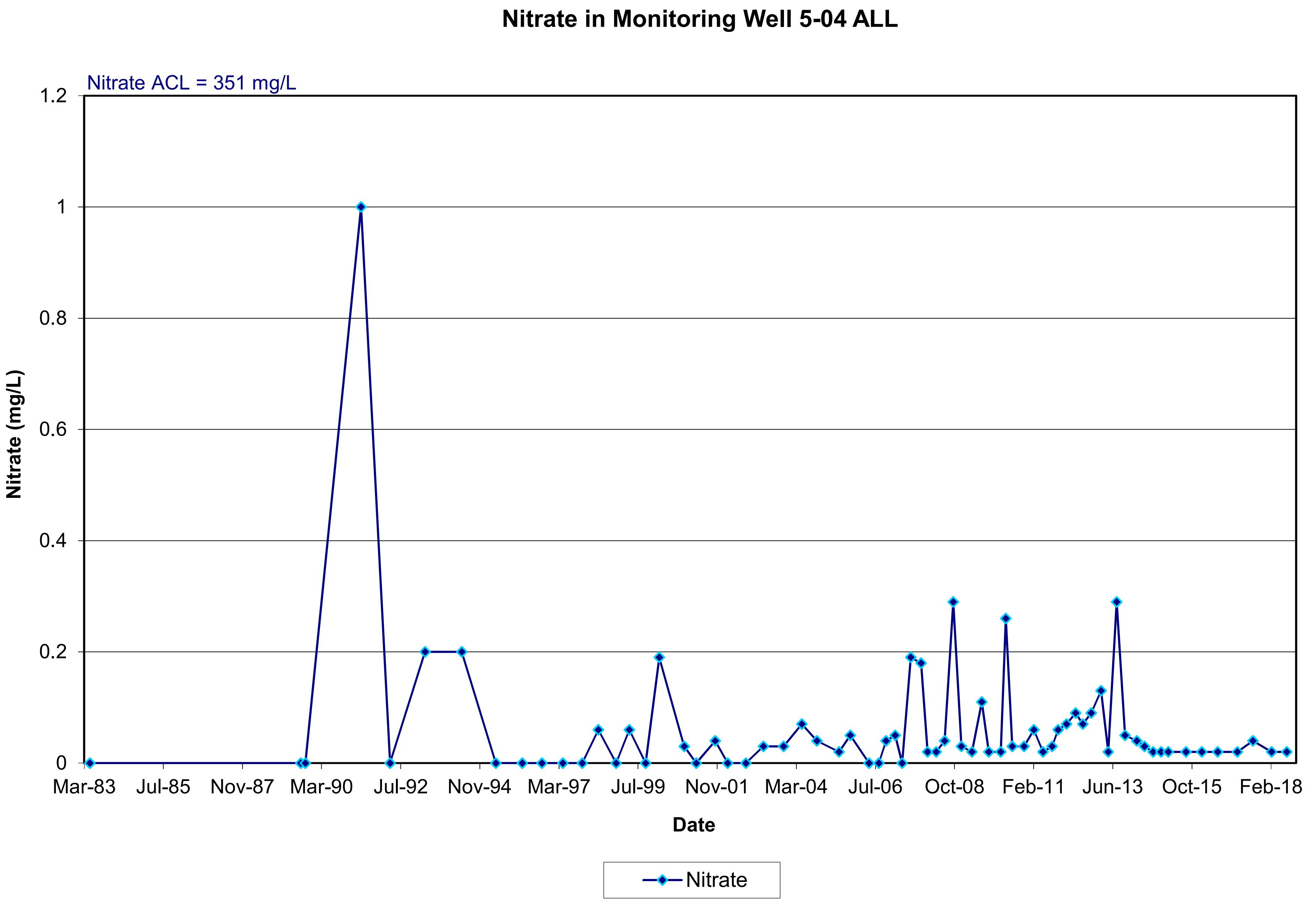
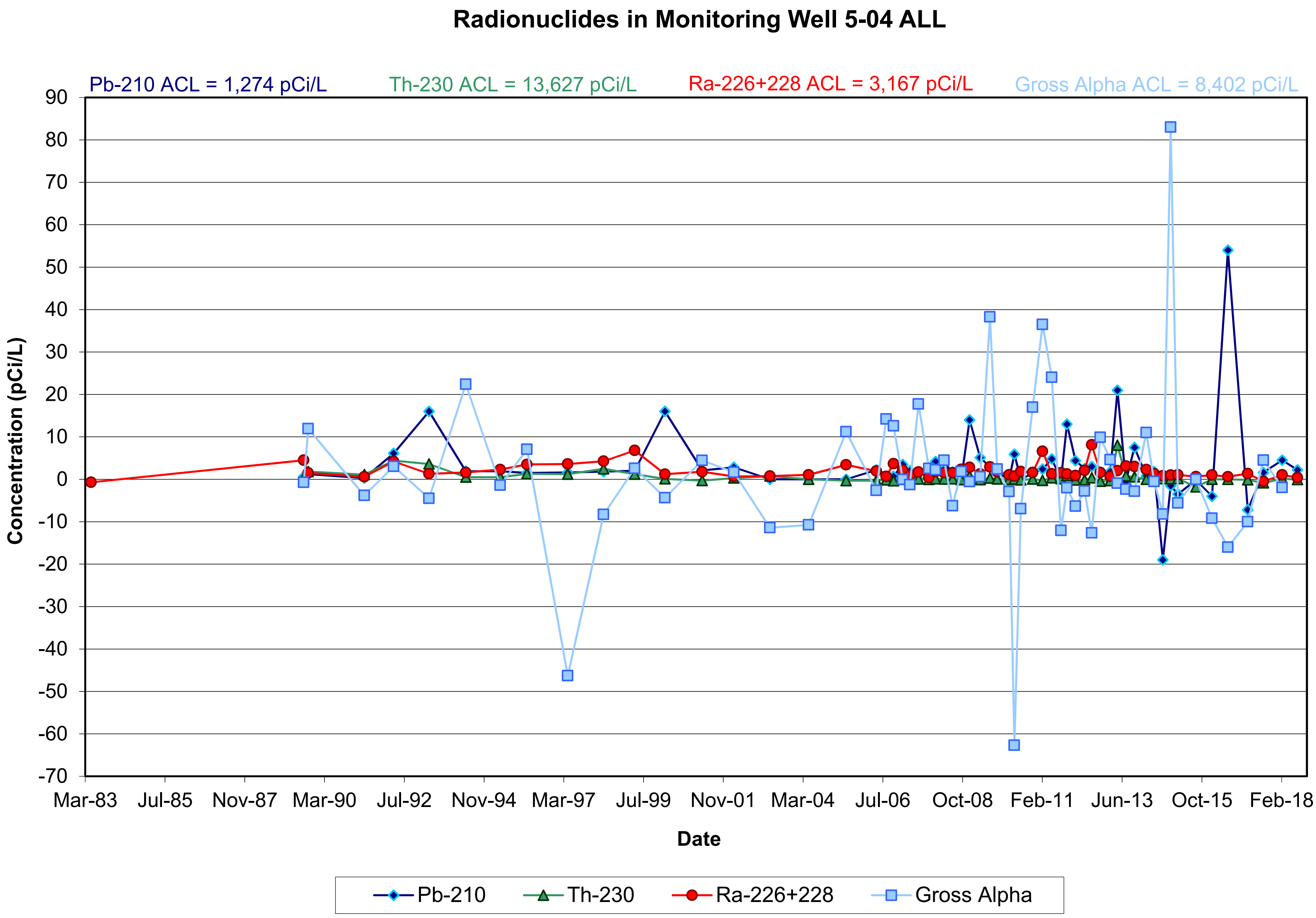
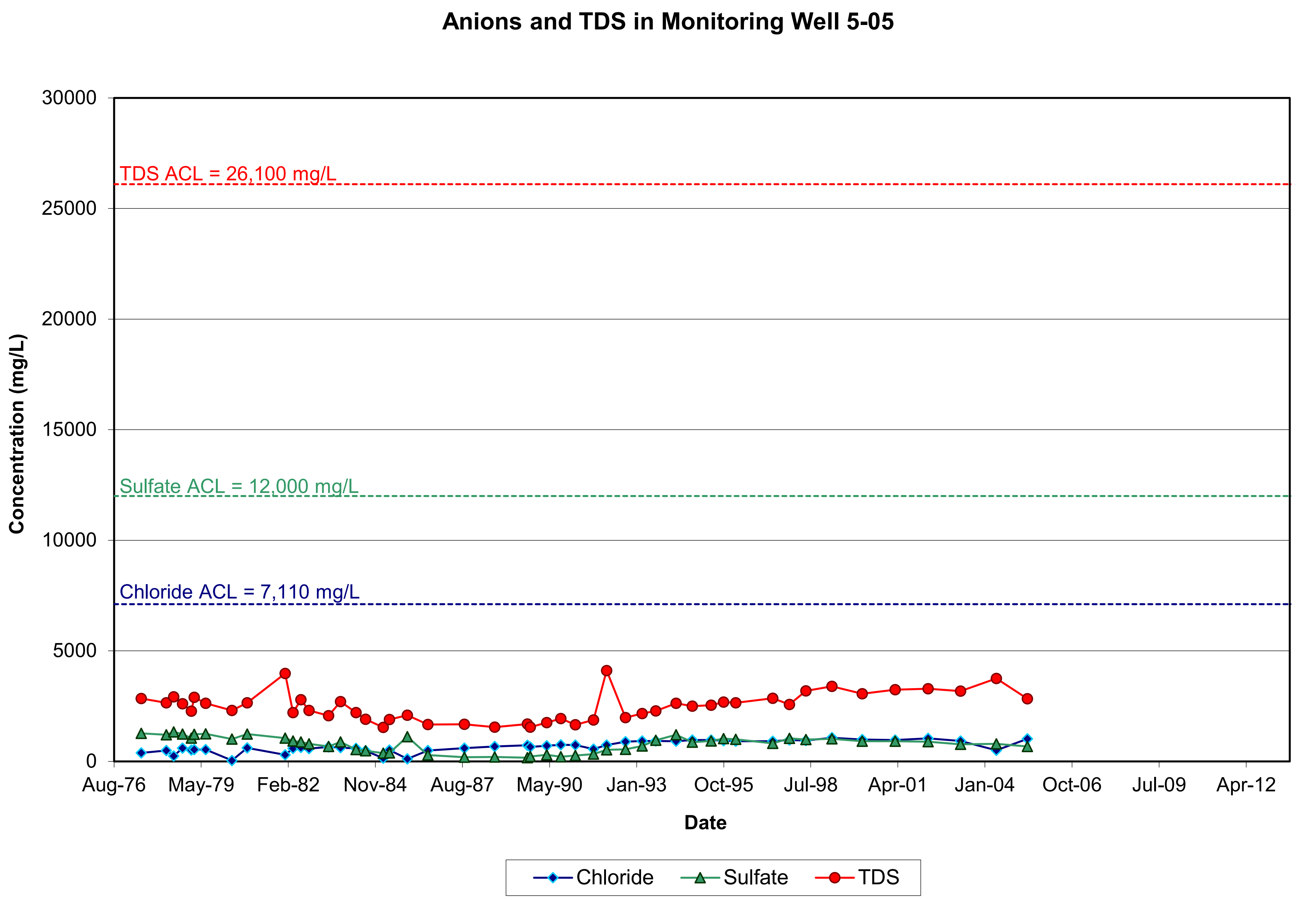


Nitrate in Monitoring Well 5-04 ALL
Nitrate ACL = 351 mg/L
Nitrate (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Nitrate

INTERA


Radionuclides in Monitoring Well 5-04 ALL
Pb-210 ACL = 1,274 pCi/L
Th-230 ACL = 13,627 pCi/L
Ra-226+228 ACL = 3,167 pCi/L
Gross Alpha ACL = 8,402 pCi/L
Concentration (pCi/L)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Pb-210
Th-230
Ra-226+228
Gross Alpha



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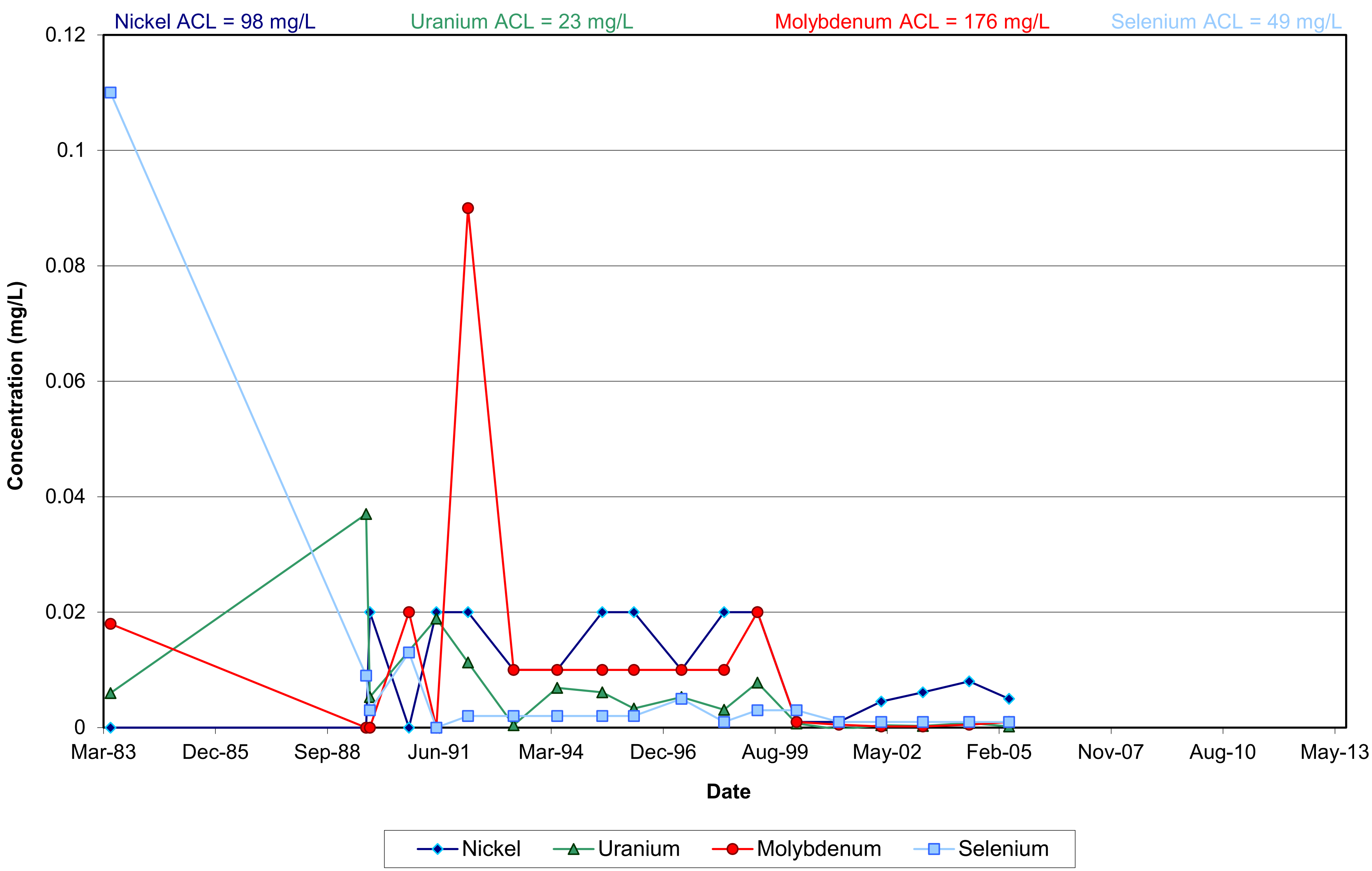
Metals in Monitoring Well 5-05



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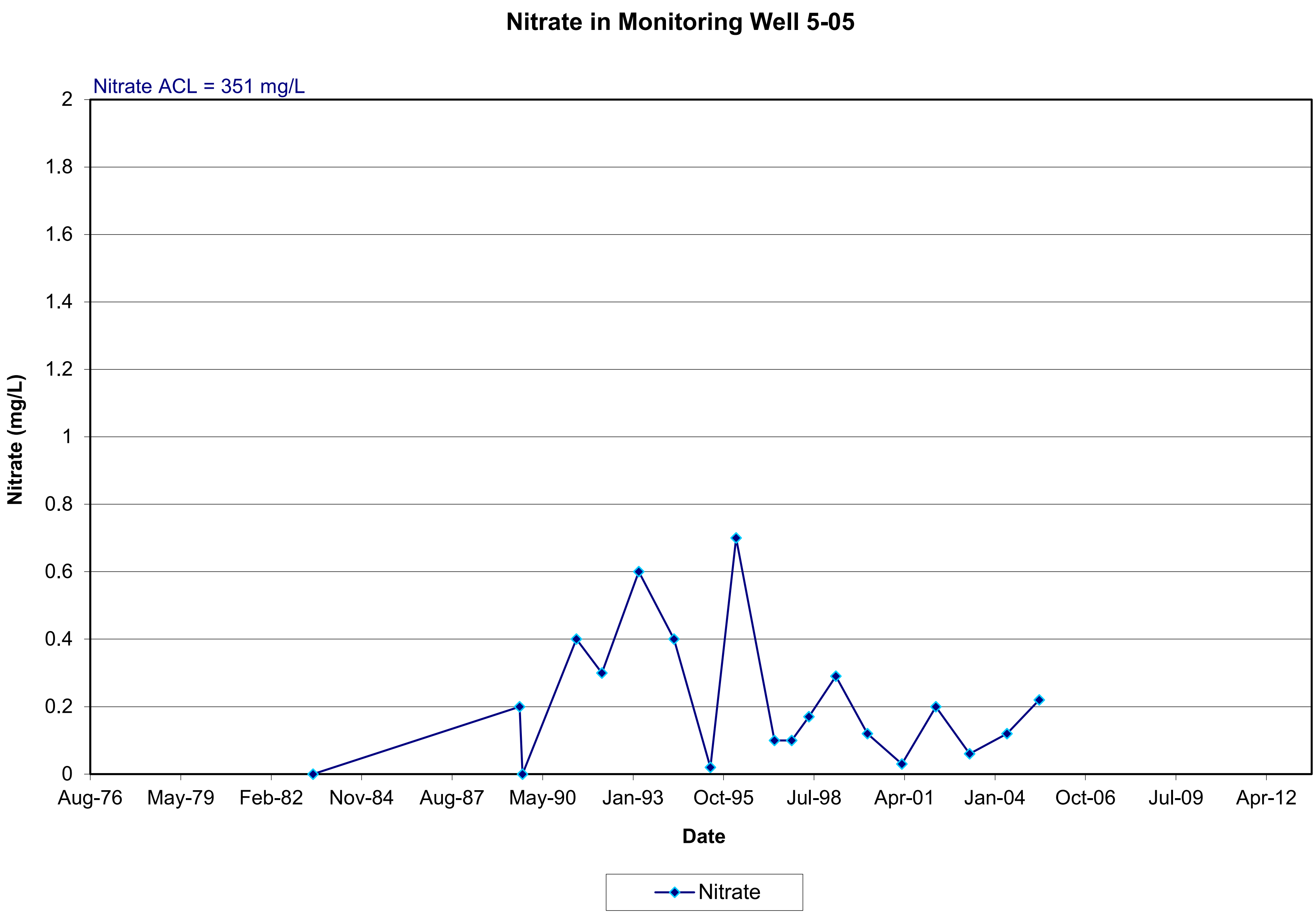

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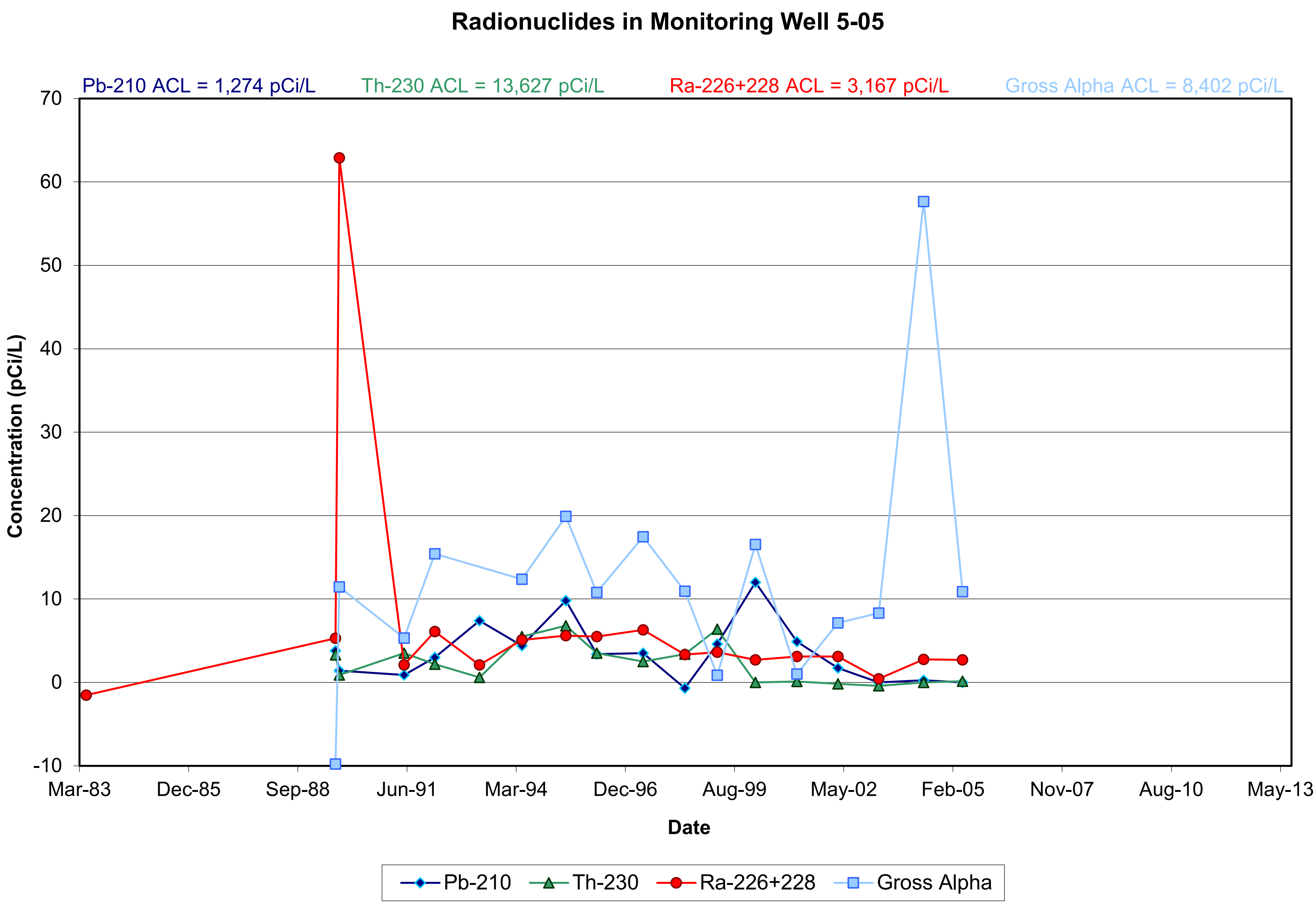
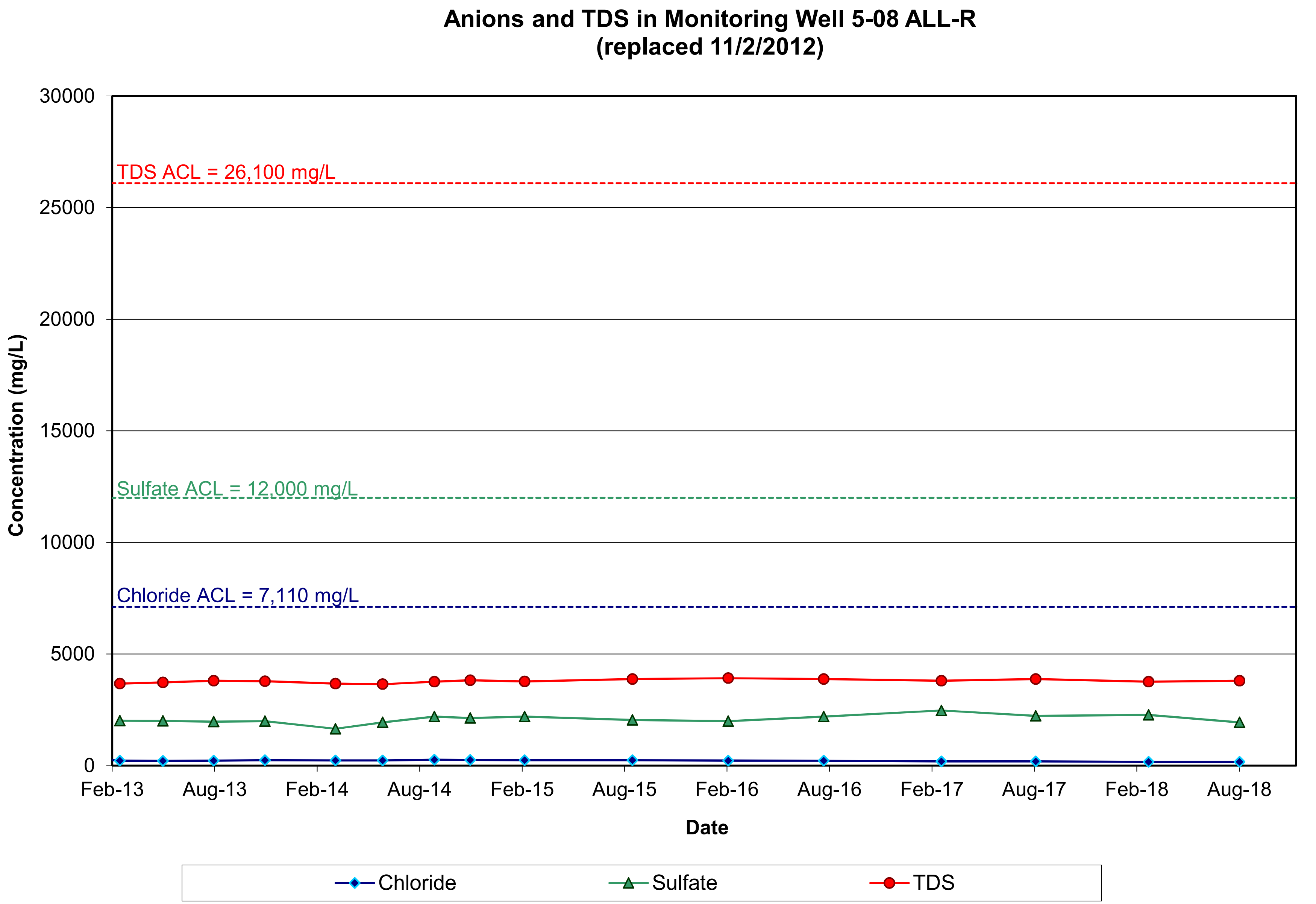


Radionuclides in Monitoring Well 5-05
Pb-210 ACL = 1,274 pCi/L
Th-230 ACL = 13,627 pCi/L
Ra-226+228 ACL = 3,167 pCi/L
Gross Alpha ACL = 8,402 pCi/L
Concentration (pCi/L)
70
60
50
40
30
20
10
0
-10
Mar-83
Dec-85
Sep-88
Jun-91
Mar-94
Dec-96
Aug-99
May-02
Feb-05
Nov-07
Aug-10
May-13
Date
Pb-210
Th-230
Ra-226+228
Gross Alpha



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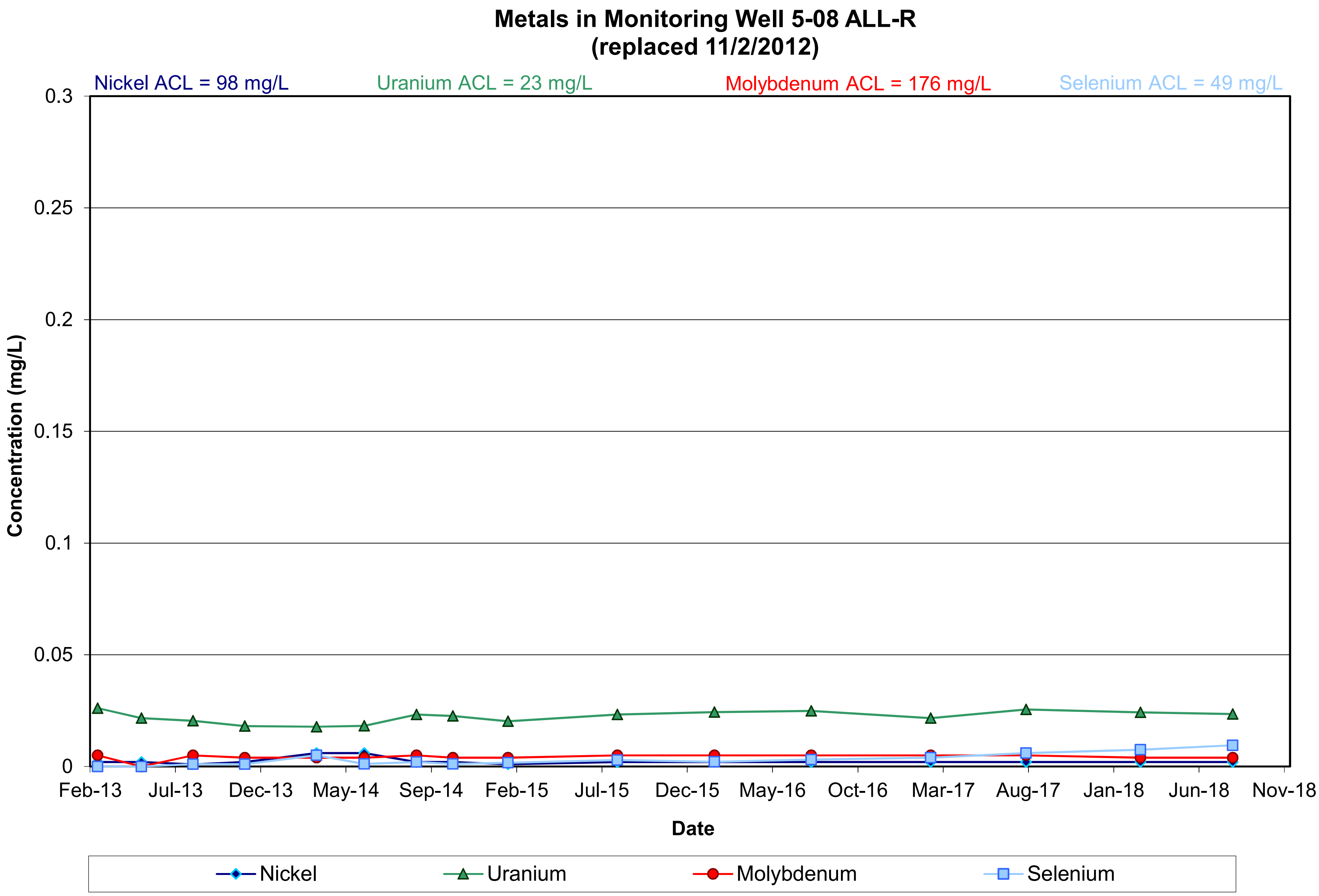
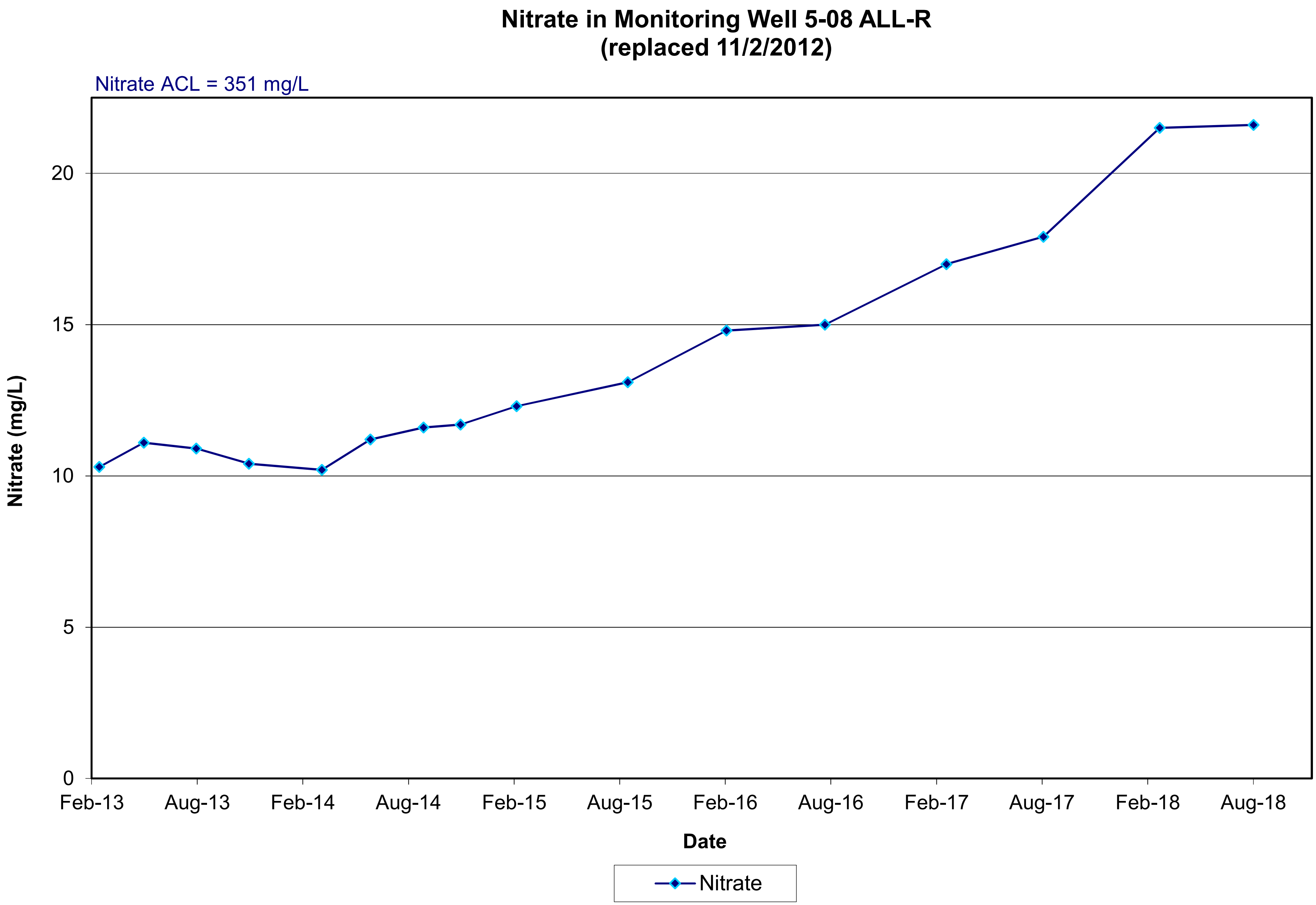

Metals in Monitoring Well 5-08 ALL-R
(replaced 11/2/2012)
Nickel ACL = 98 mg/L
Uranium ACL = 23 mg/L
Molybdenum ACL = 176 mg/L
Selenium ACL = 49 mg/L
Concentration (mg/L)
0.3
0.25
0.2
0.15
0.1
0.05
0
Feb-13
Jul-13
Dec-13
May-14
Sep-14
Feb-15
Jul-15
Dec-15
May-16
Oct-16
Mar-17
Aug-17
Jan-18
Jun-18
Nov-18
Date
Nickel
Uranium
Molybdenum
Selenium



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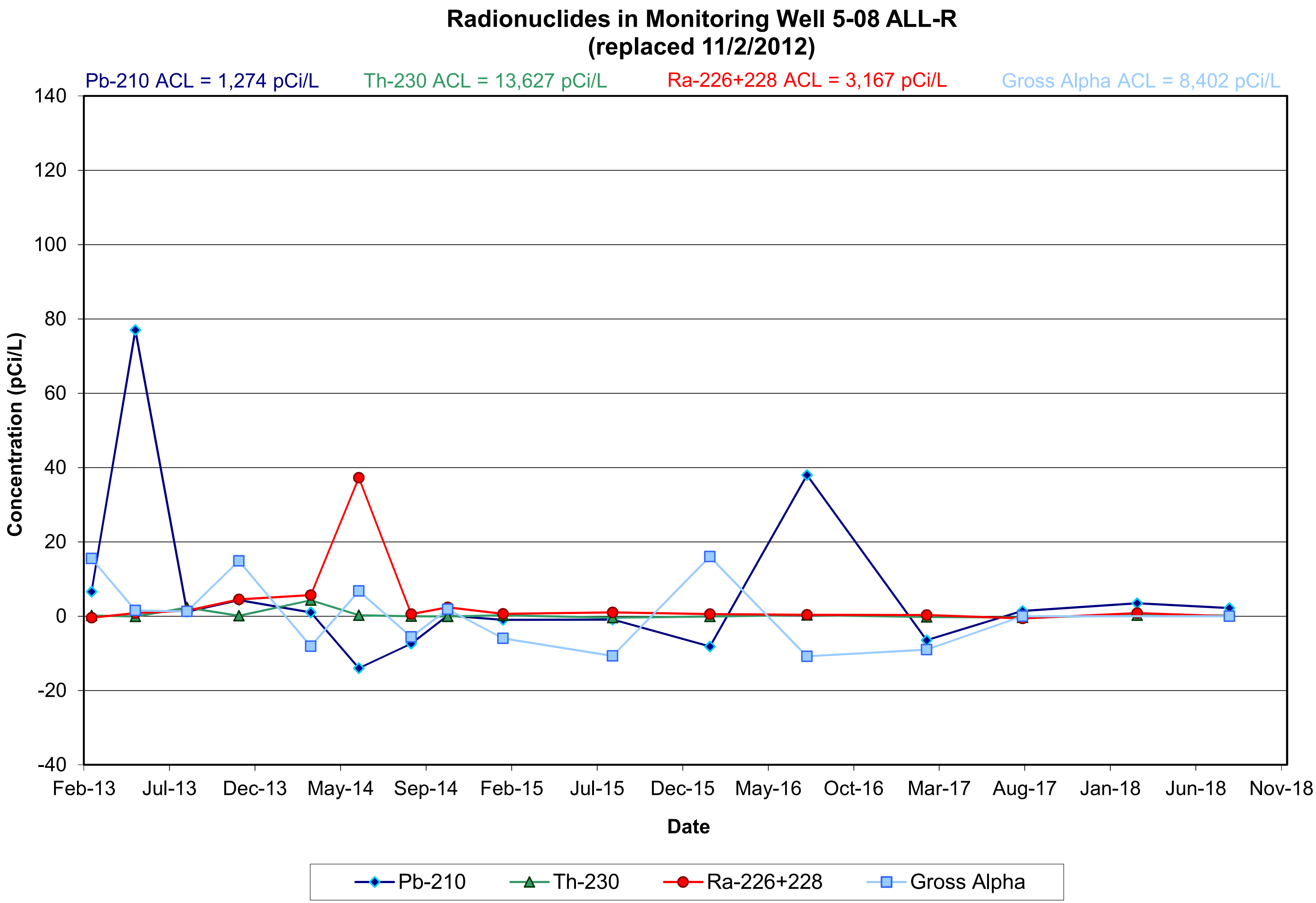

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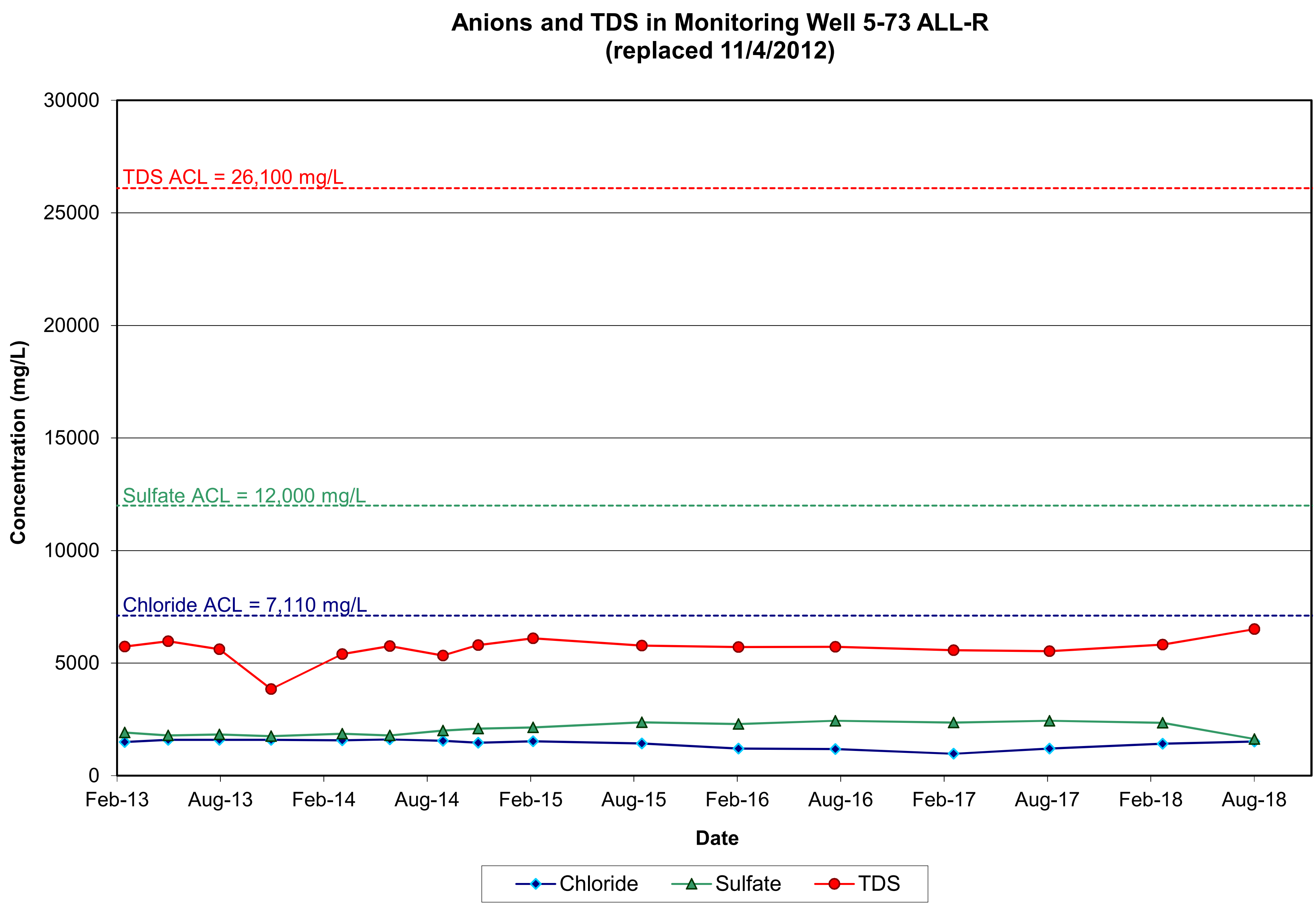
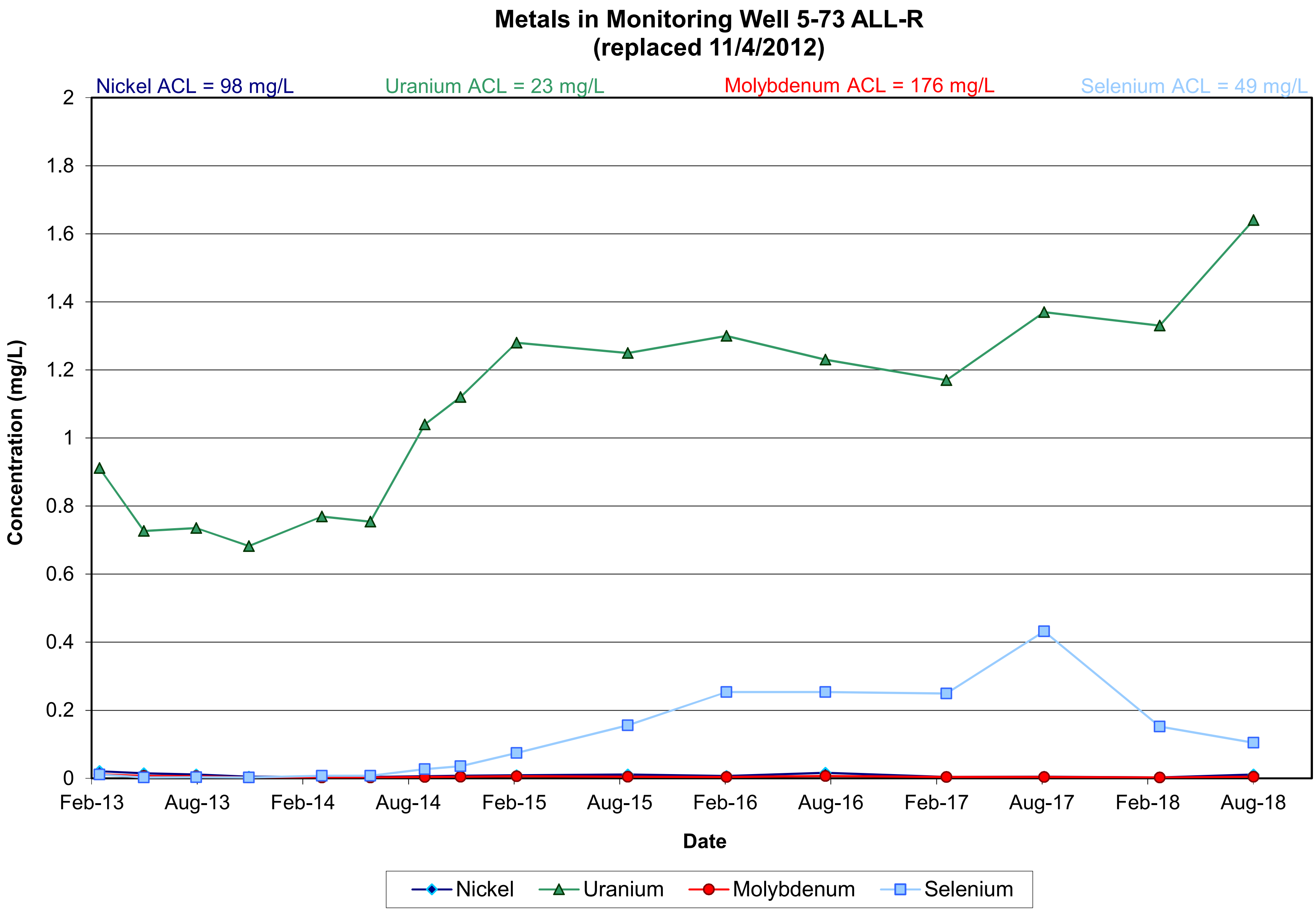
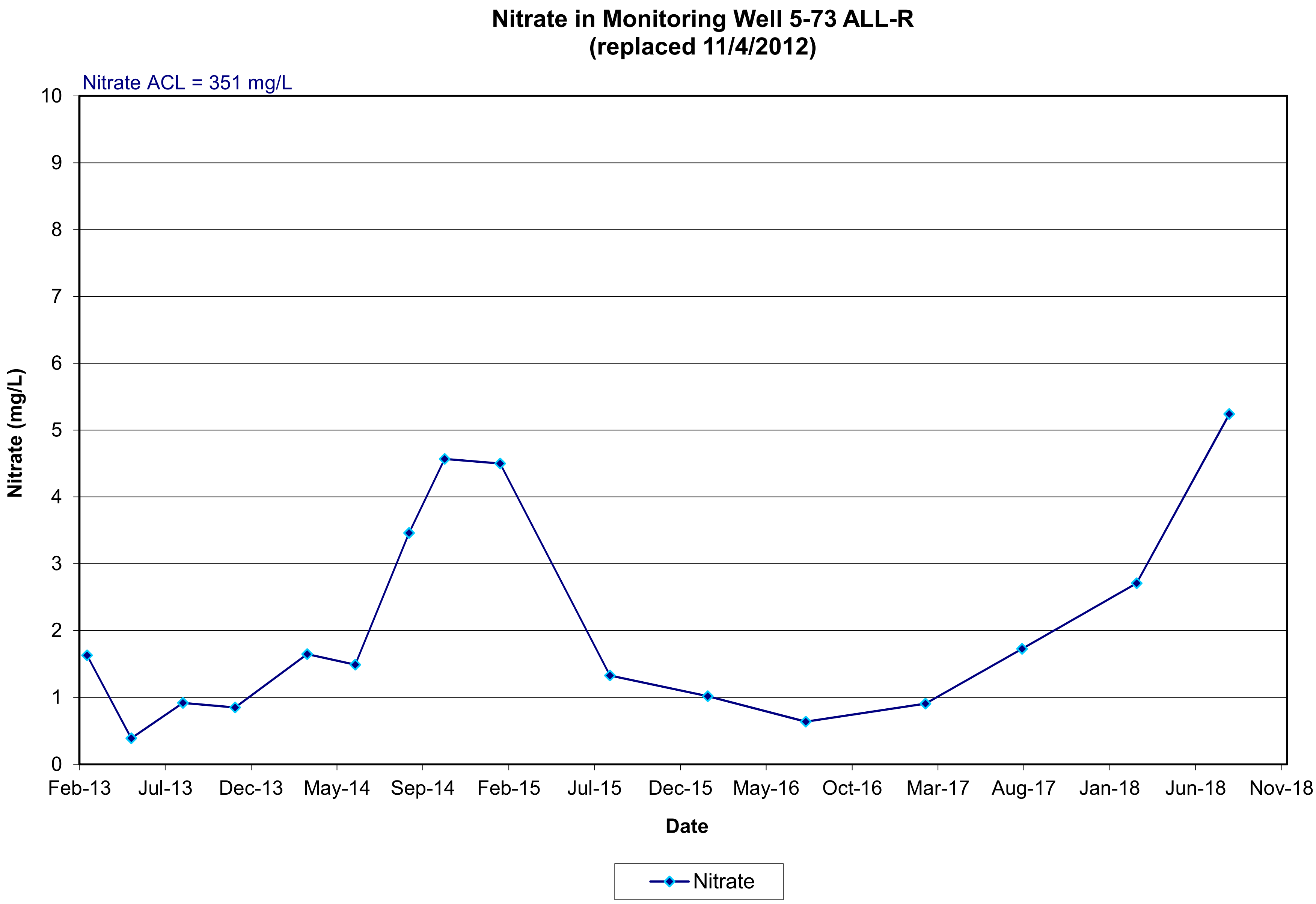

Anions and TDS in Monitoring Well 5-73 ALL-R
(replaced 11/4/2012)
TDS ACL = 26,100 mg/L
Sulfate ACL = 12,000 mg/L
Chloride ACL = 7,110 mg/L
Concentration (mg/L)
30000
25000
20000
15000
10000
5000
0
Feb-13
Aug-13
Feb-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
Feb-17
Aug-17
Feb-18
Aug-18
Date
Chloride
Sulfate
TDS

INTERA


Metals in Monitoring Well 5-73 ALL-R
(replaced 11/4/2012)
Nickel ACL = 98 mg/L
Uranium ACL = 23 mg/L
Molybdenum ACL = 176 mg/L
Selenium ACL = 49 mg/L
Concentration (mg/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Feb-13
Aug-13
Feb-14
Aug-14
Feb-15
Aug-15
Feb-16
Aug-16
Feb-17
Aug-17
Feb-18
Aug-18
Date
Nickel
Uranium
Molybdenum
Selenium



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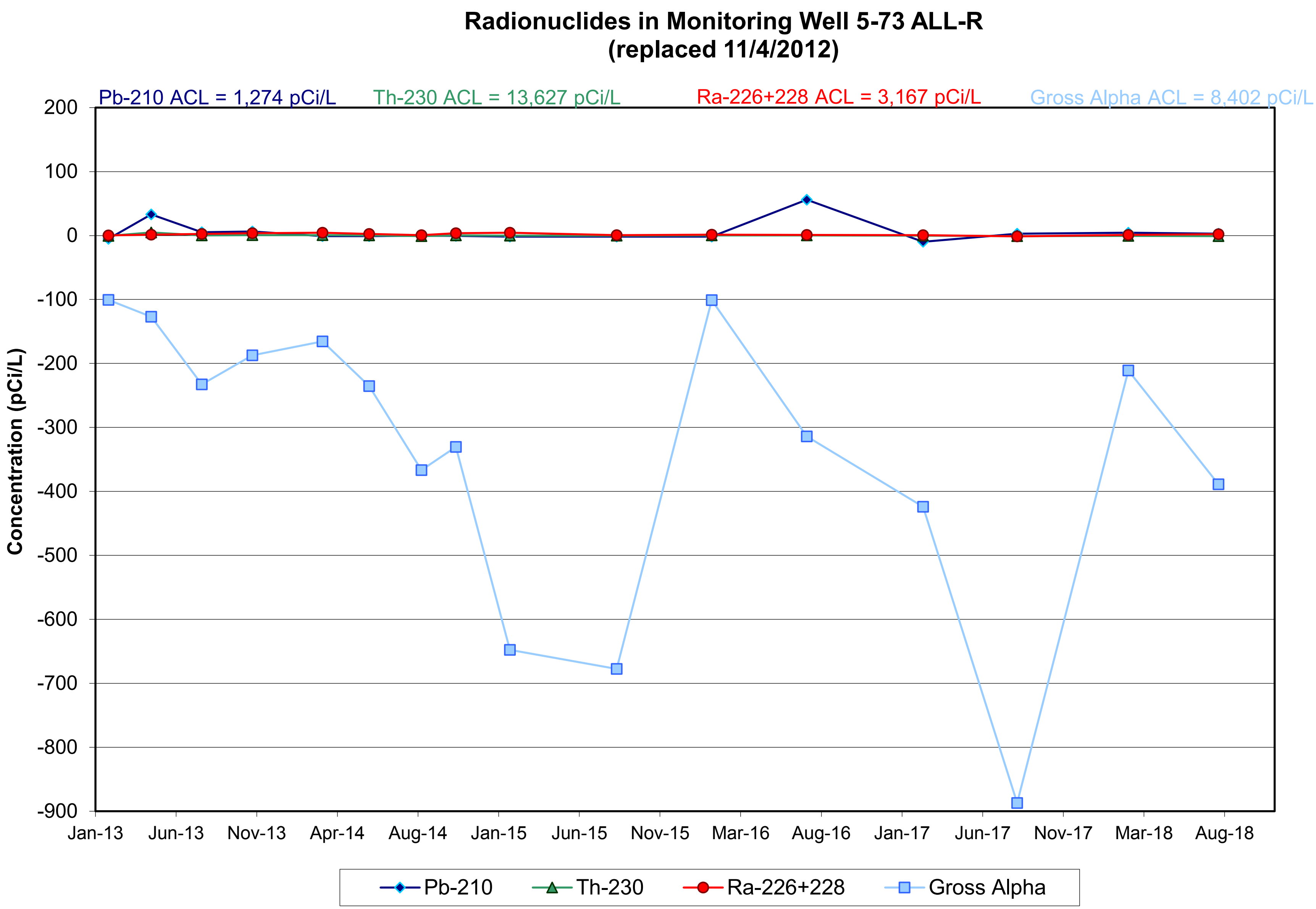
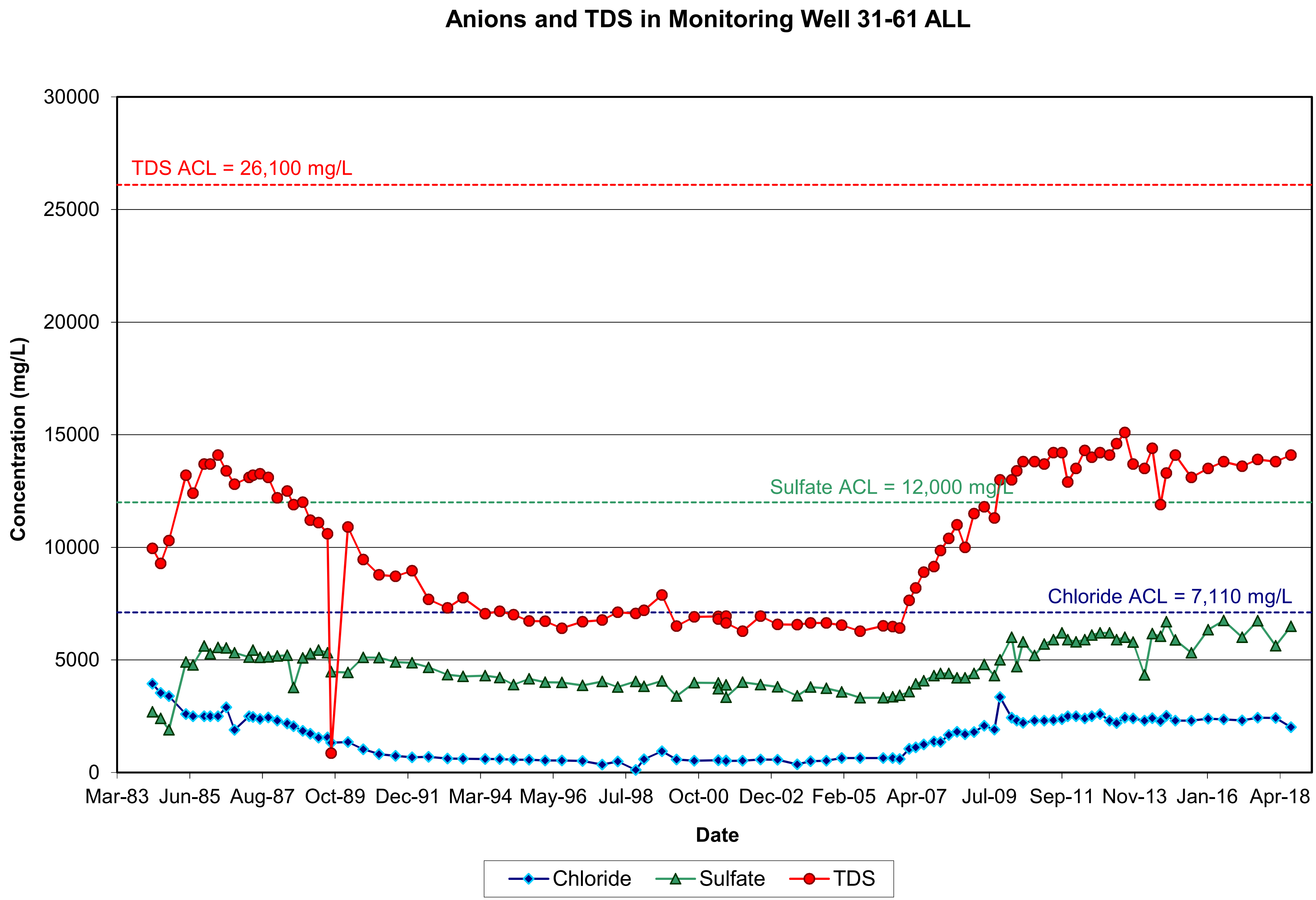
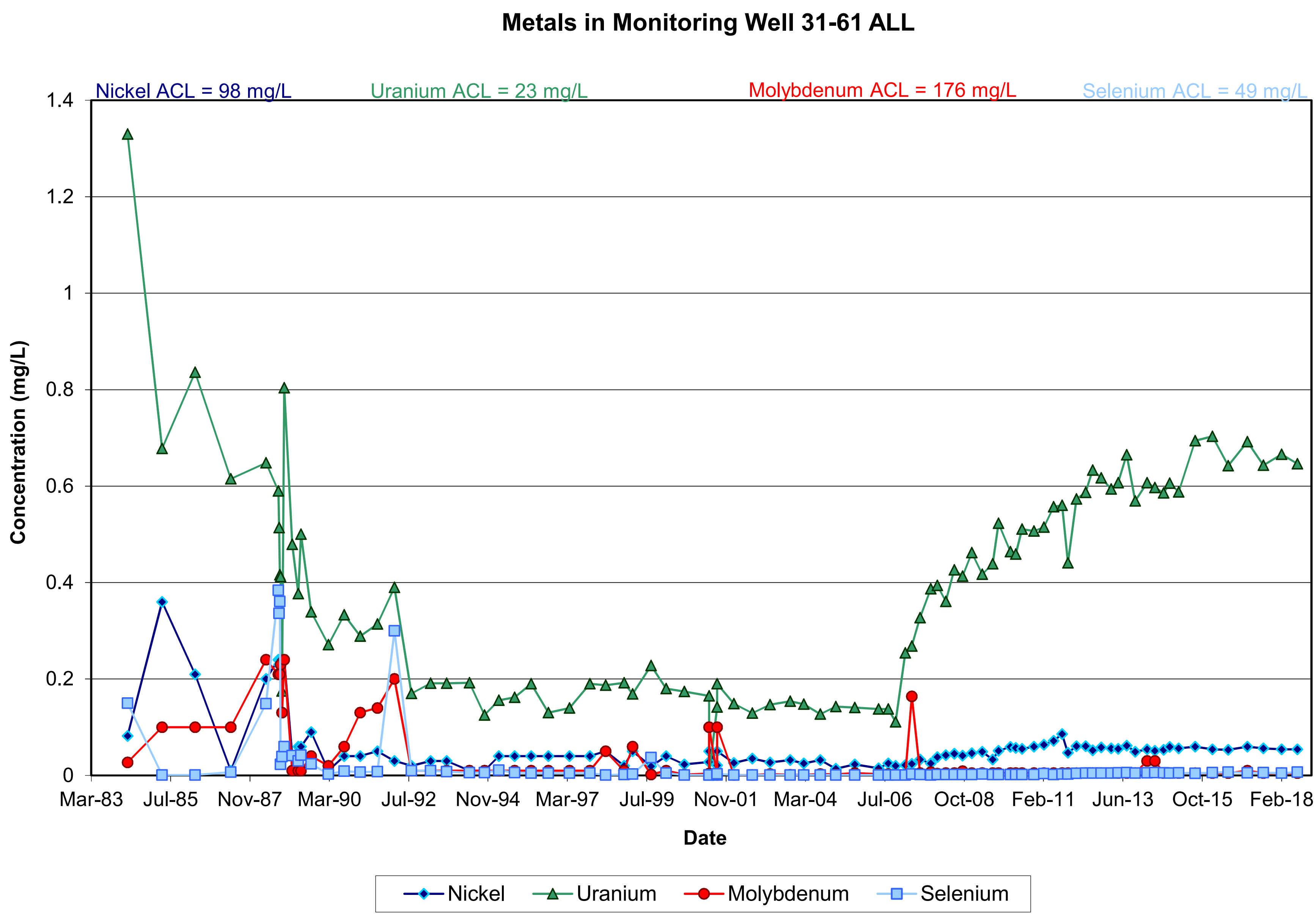


Radionuclides in Monitoring Well 5-73 ALL-R
(replaced 11/4/2012)
Pb-210 ACL = 1,274 pCi/L
Th-230 ACL = 13,627 pCi/L
Ra-226+228 ACL = 3,167 pCi/L
Gross Alpha ACL = 8,402 pCi/L
Concentration (pCi/L)
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
Jan-13
Jun-13
Nov-13
Apr-14
Aug-14
Jan-15
Jun-15
Nov-15
Mar-16
Aug-16
Jan-17
Jun-17
Nov-17
Mar-18
Aug-18
Pb-210
Th-230
Ra-226+228
Gross Alpha

INTERA



Anions and TDS in Monitoring Well 31-61 ALL
30000
25000
20000
15000
10000
5000
0
Concentration (mg/L)
TDS ACL = 26,100 mg/L
Sulfate ACL = 12,000 mg/L
Chloride ACL = 7,110 mg/L
Mar-83
Jun-85
Aug-87
Oct-89
Dec-91
Mar-94
May-96
Jul-98
Oct-00
Dec-02
Feb-05
Apr-07
Jul-09
Sep-11
Nov-13
Jan-16
Apr-18
Date
Chloride
Sulfate
TDS



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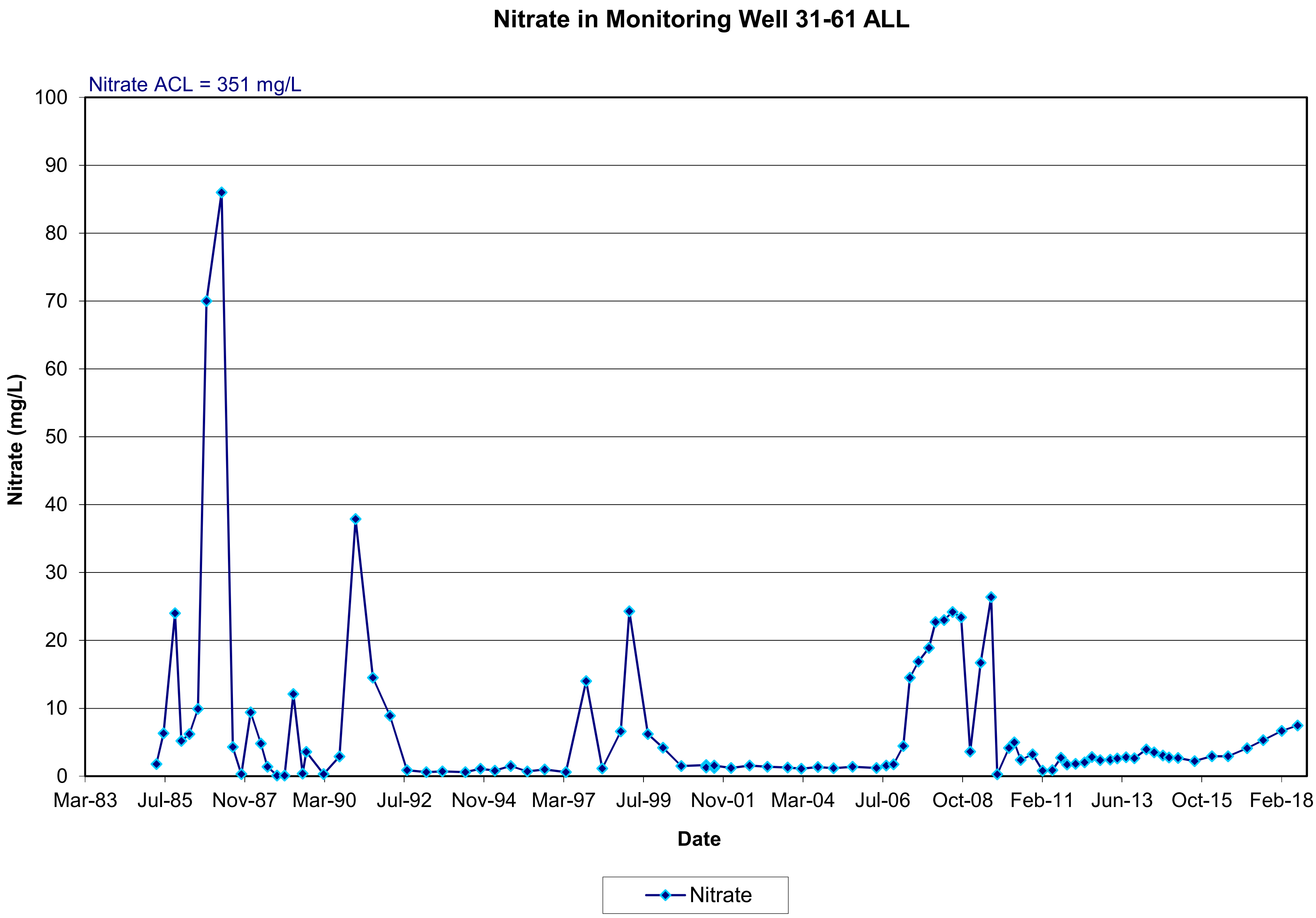

INTERA

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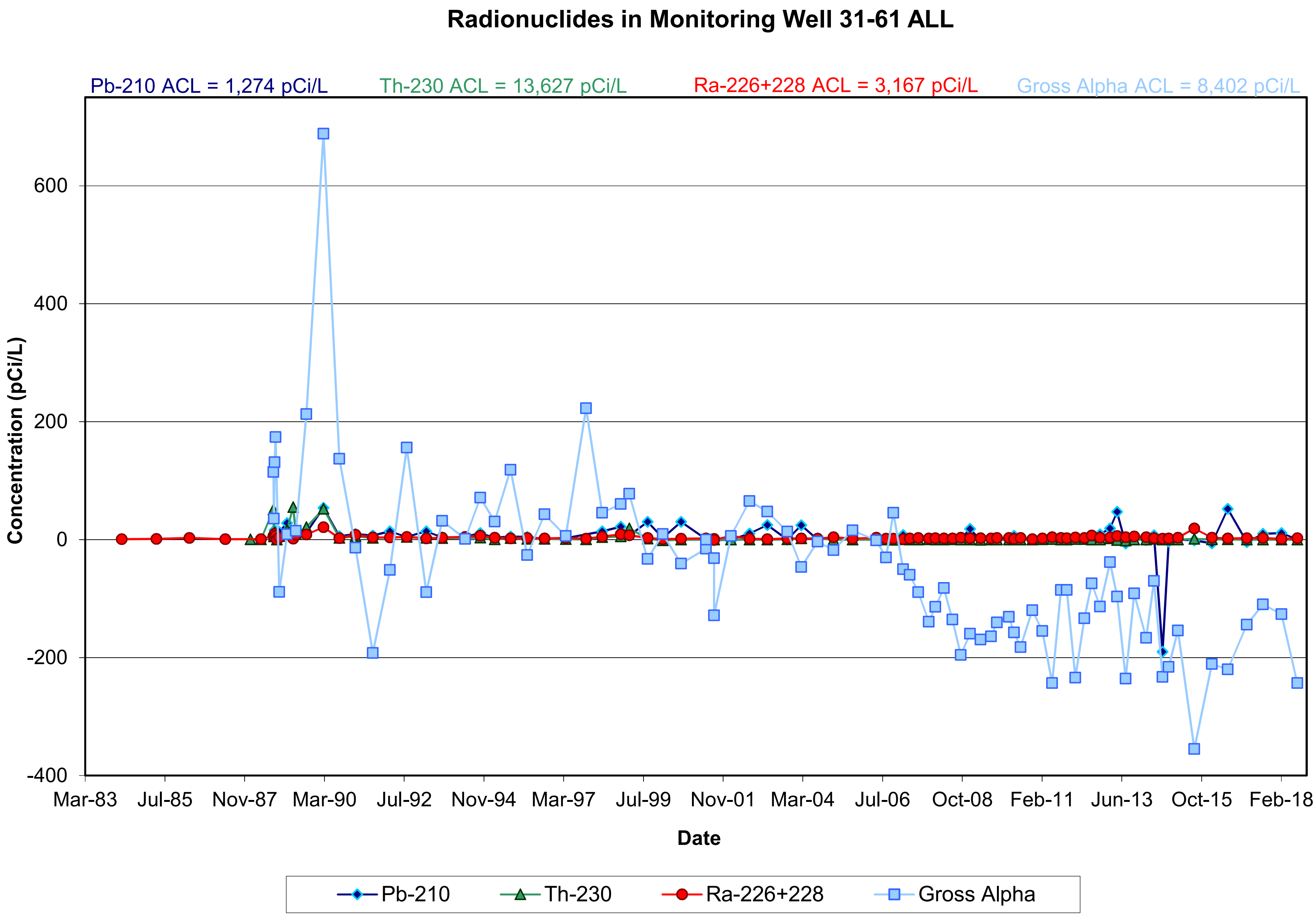
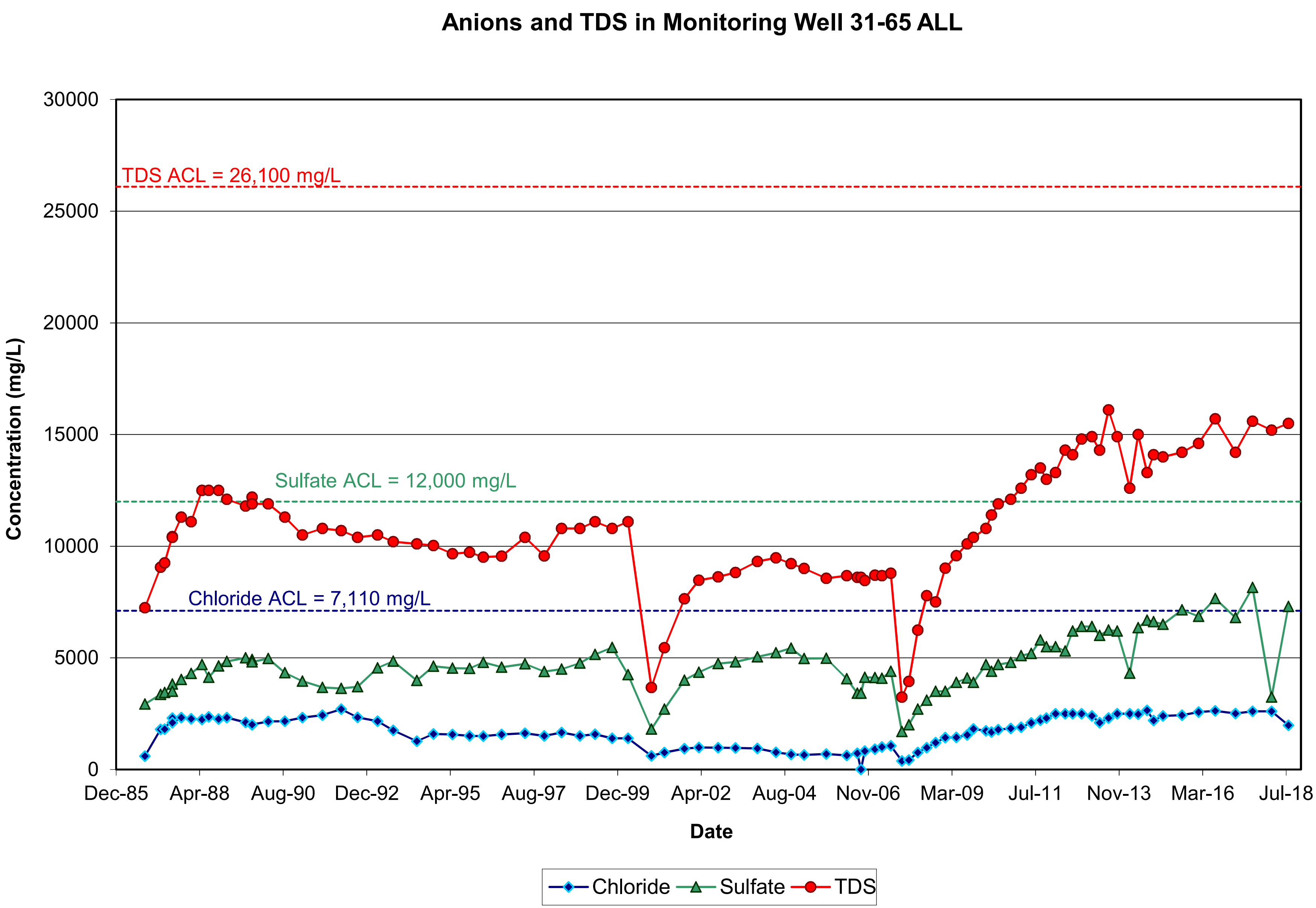

Radionuclides in Monitoring Well 31-61 ALL
Pb-210 ACL = 1,274 pCi/L
Th-230 ACL = 13,627 pCi/L
Ra-226+228 ACL = 3,167 pCi/L
Gross Alpha ACL = 8,402 pCi/L
Concentration (pCi/L)
600
400
200
0
-200
-400
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Pb-210
Th-230
Ra-226+228
Gross Alpha

INTERA



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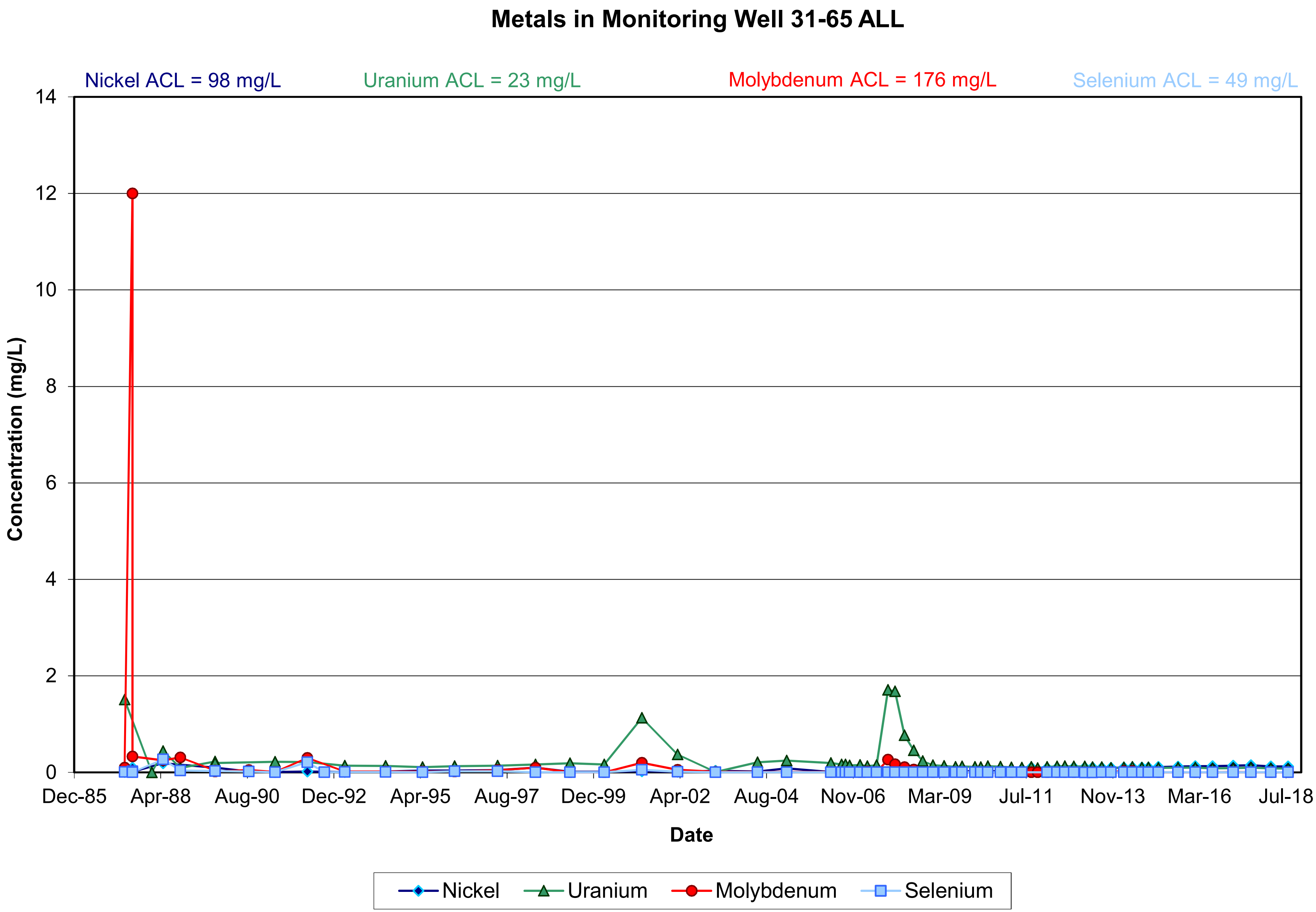
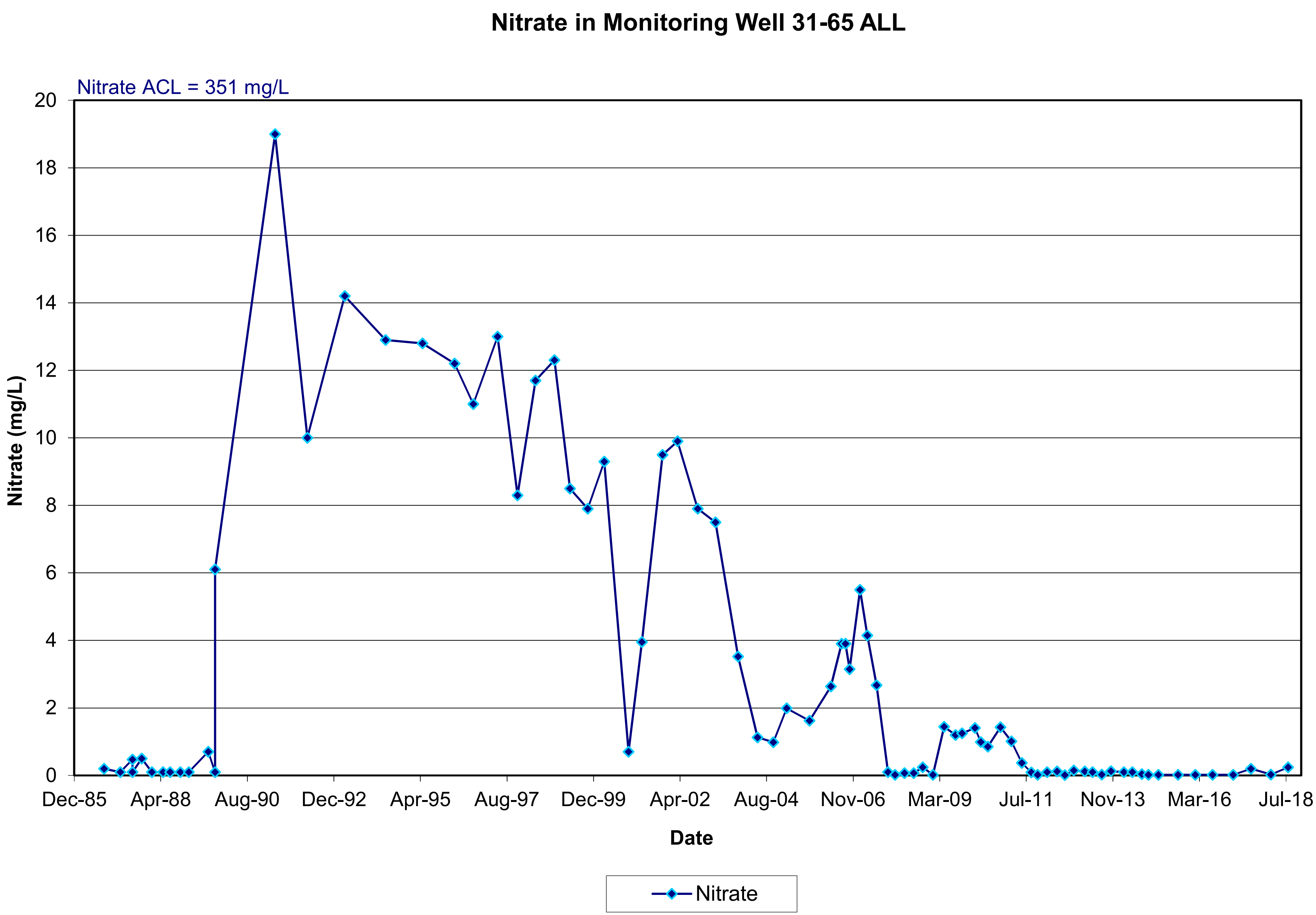


Metals in Monitoring Well 31-65 ALL
Nickel ACL = 98 mg/L
Uranium ACL = 23 mg/L
Molybdenum ACL = 176 mg/L
Selenium ACL = 49 mg/L
Concentration (mg/L)
14
12
10
8
6
4
2
0
Dec-85
Apr-88
Aug-90
Dec-92
Apr-95
Aug-97
Dec-99
Apr-02
Aug-04
Nov-06
Mar-09
Jul-11
Nov-13
Mar-16
Jul-18
Date
Nickel
Uranium
Molybdenum
Selenium

INTERA



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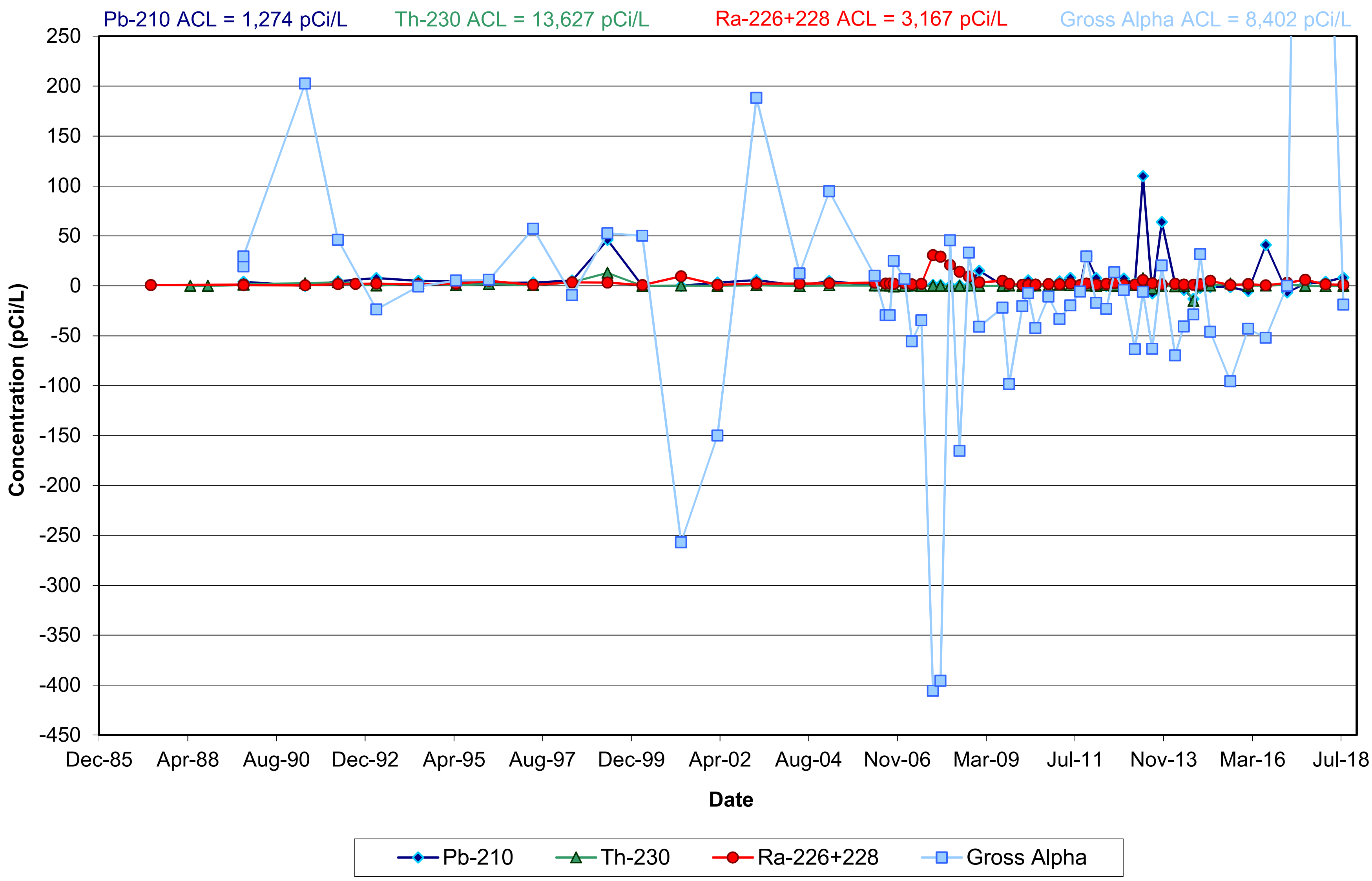
Radionuclides in Monitoring Well 31-65 ALL



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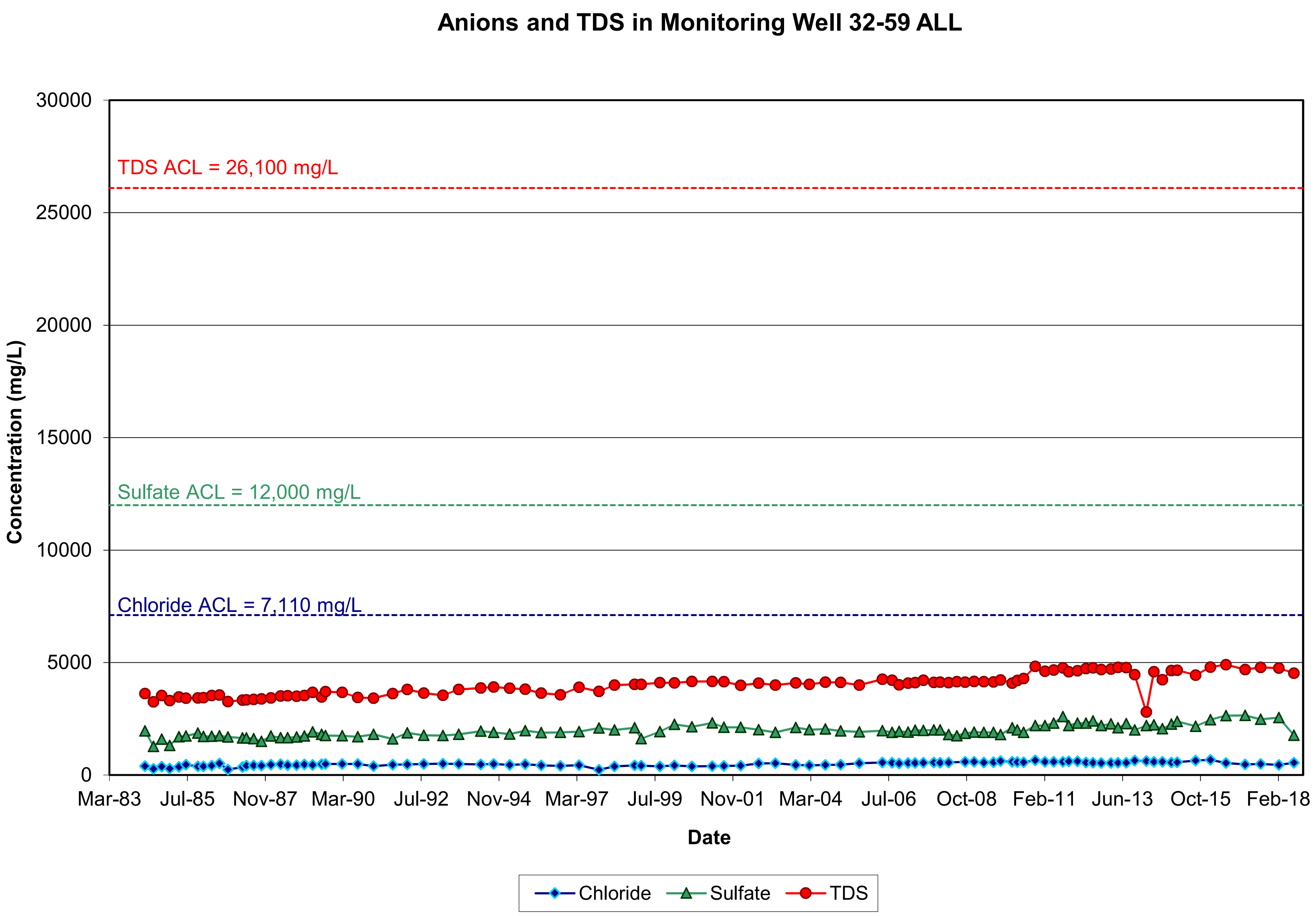

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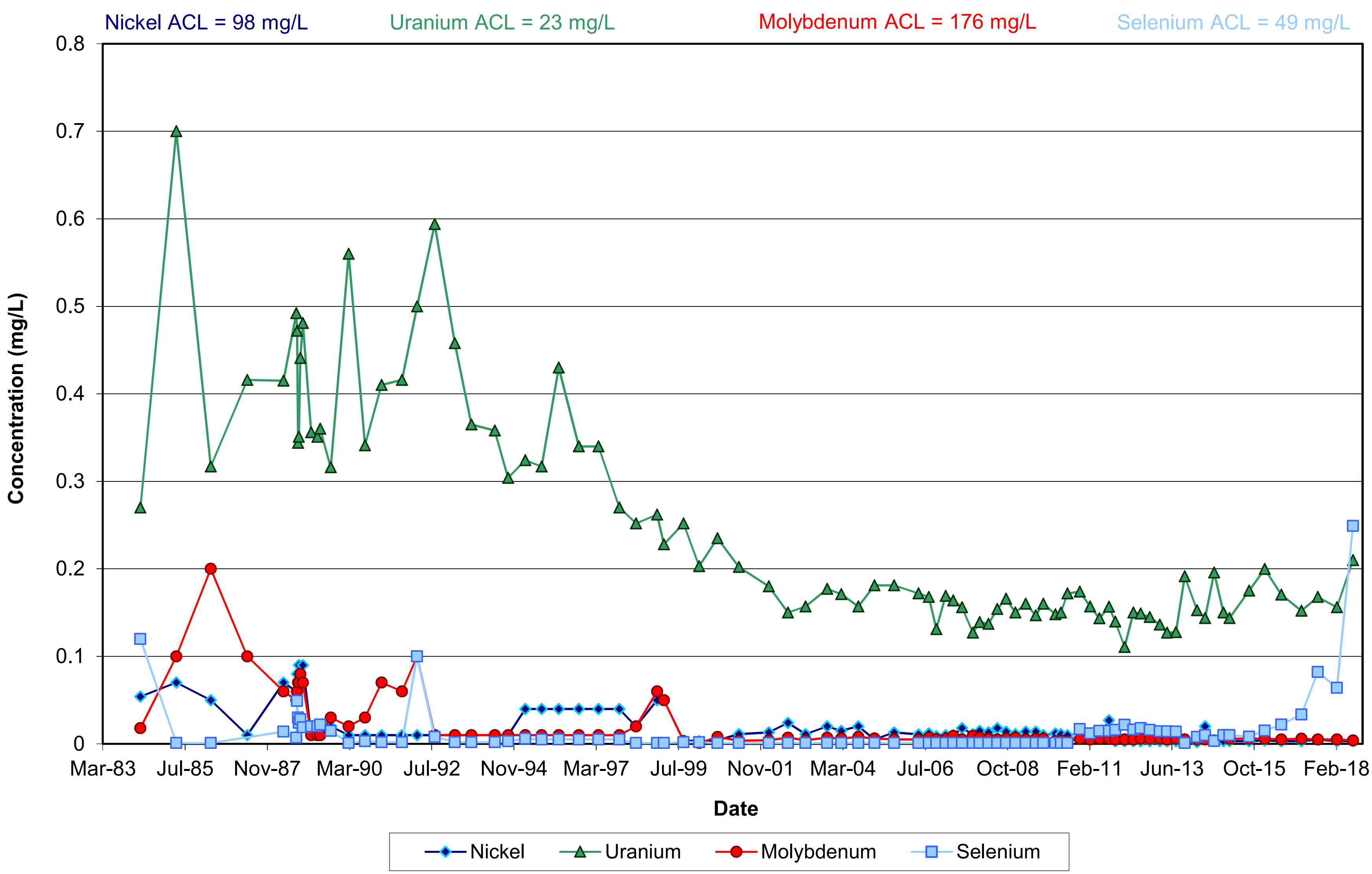
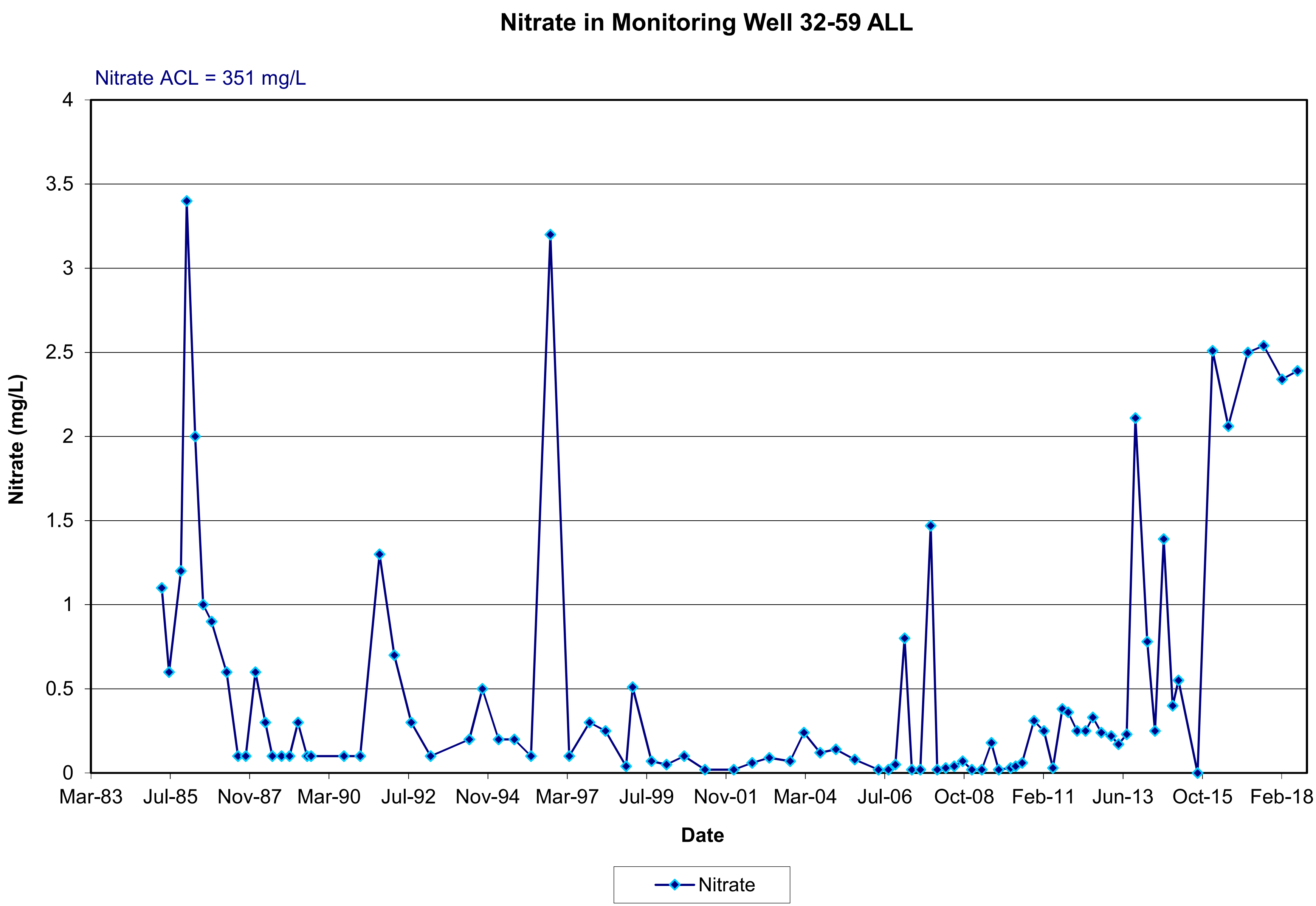
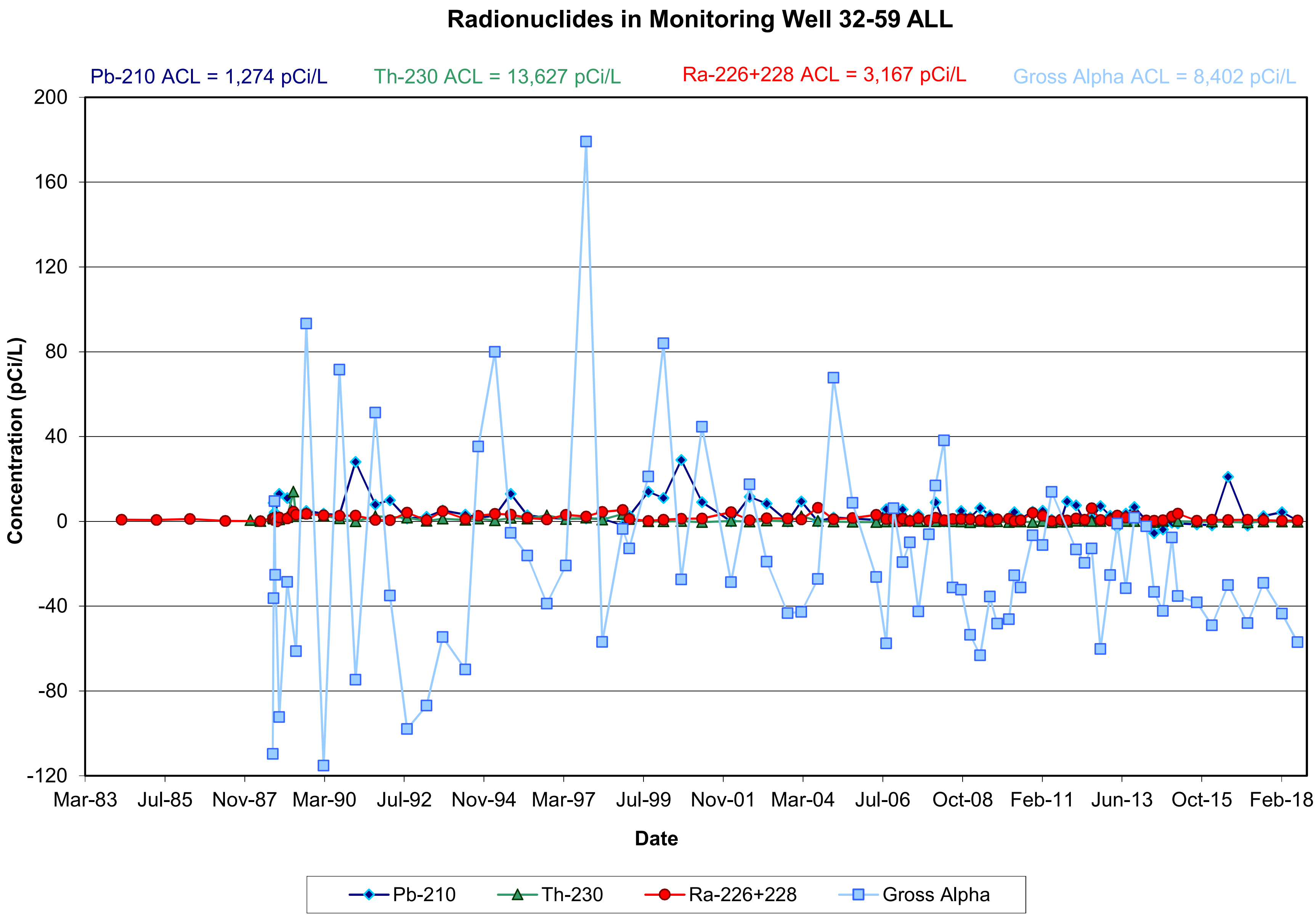
Metals in Monitoring Well 32-59 ALL

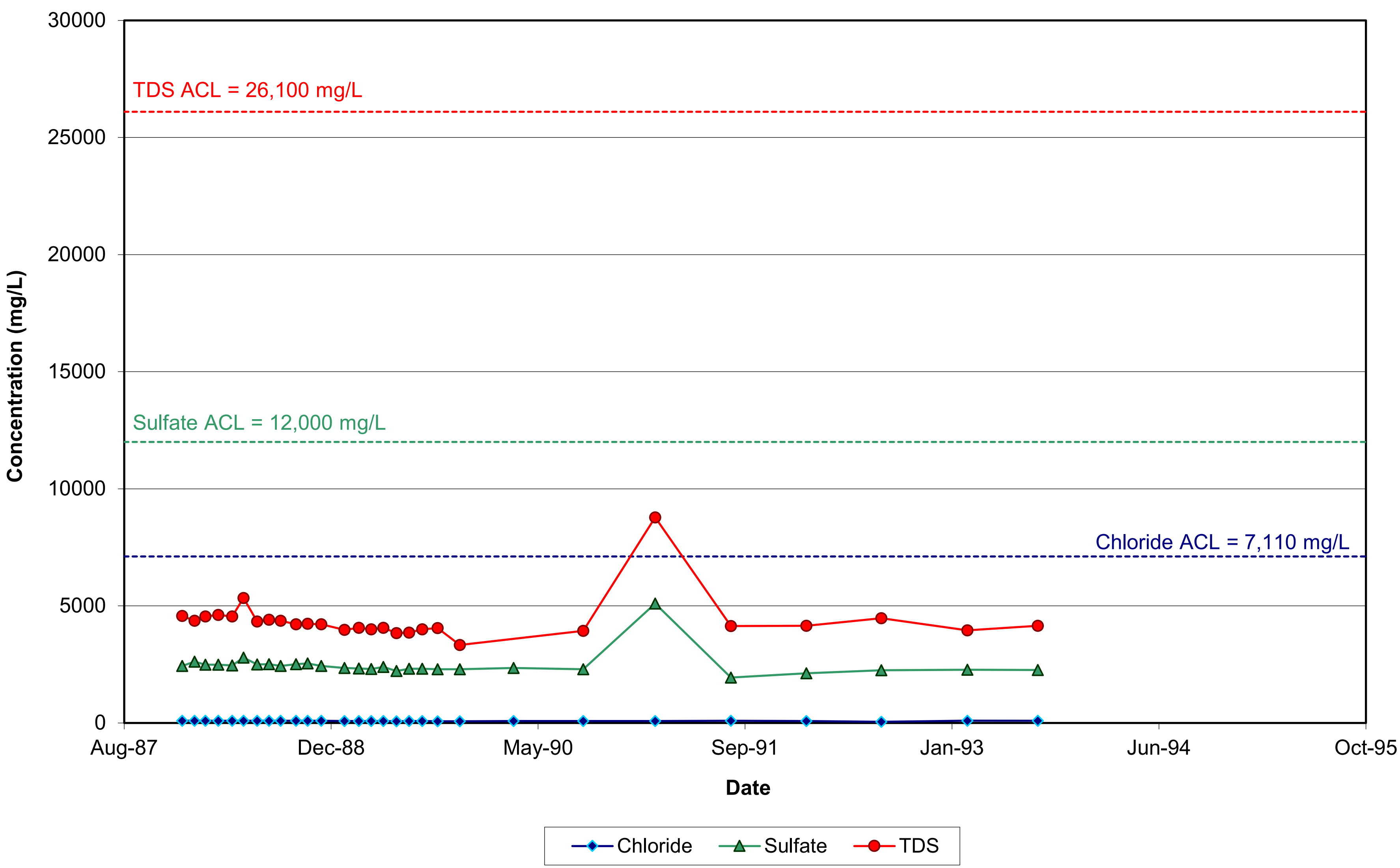



Nitrate in Monitoring Well 32-59 ALL
Nitrate ACL = 351 mg/L
Nitrate (mg/L)
0
0.5
1
1.5
2
2.5
3
3.5
4
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Nitrate


Radionuclides in Monitoring Well 32-59 ALL
Pb-210 ACL = 1,274 pCi/L
Th-230 ACL = 13,627 pCi/L
Ra-226+228 ACL = 3,167 pCi/L
Gross Alpha ACL = 8,402 pCi/L
Concentration (pCi/L)
200
160
120
80
40
0
-40
-80
-120
Mar-83
Jul-85
Nov-87
Mar-90
Jul-92
Nov-94
Mar-97
Jul-99
Nov-01
Mar-04
Jul-06
Oct-08
Feb-11
Jun-13
Oct-15
Feb-18
Date
Pb-210
Th-230
Ra-226+228
Gross Alpha

INTERA

Anions and TDS in Monitoring Well MW-24 ALL



INTERA

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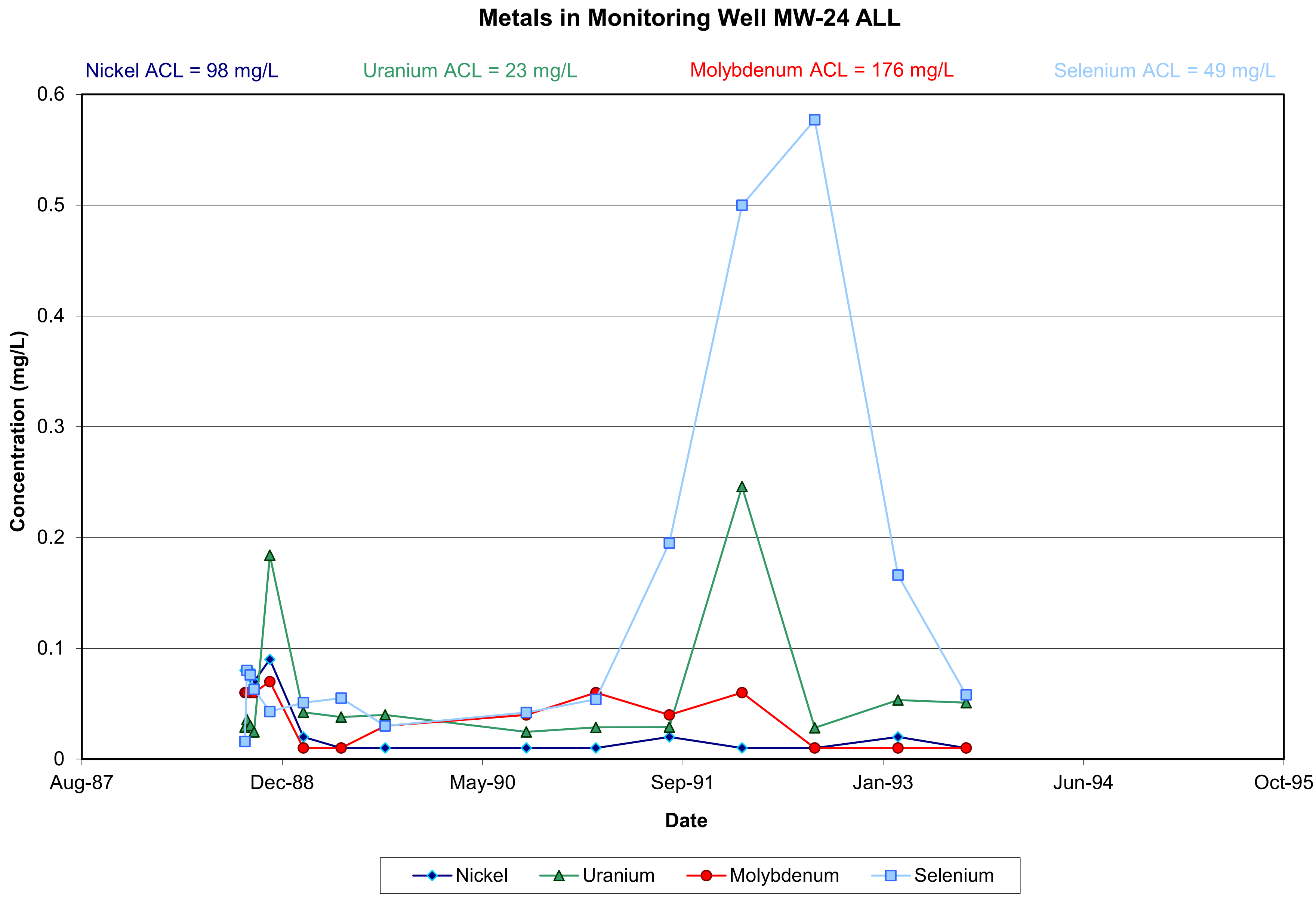

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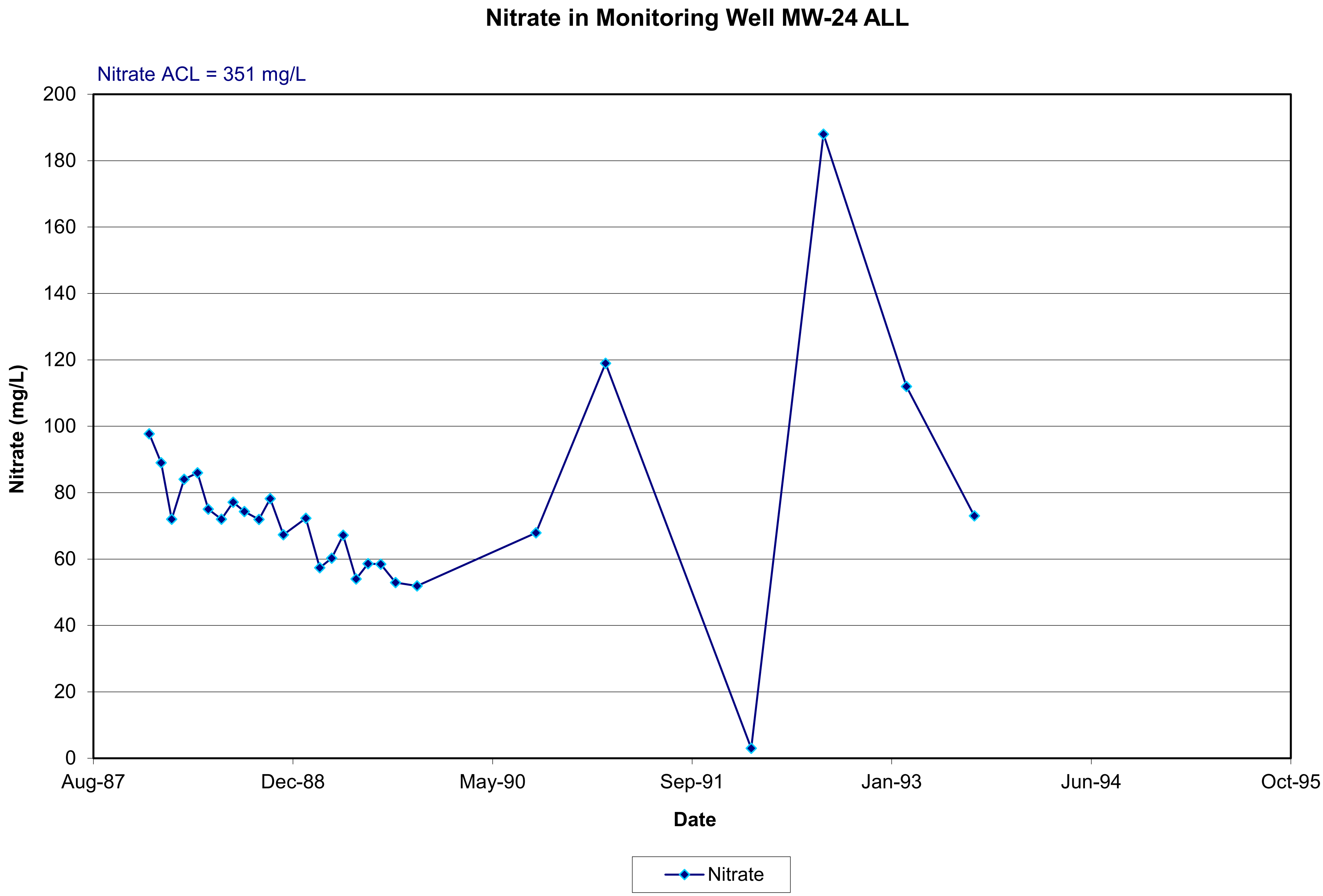
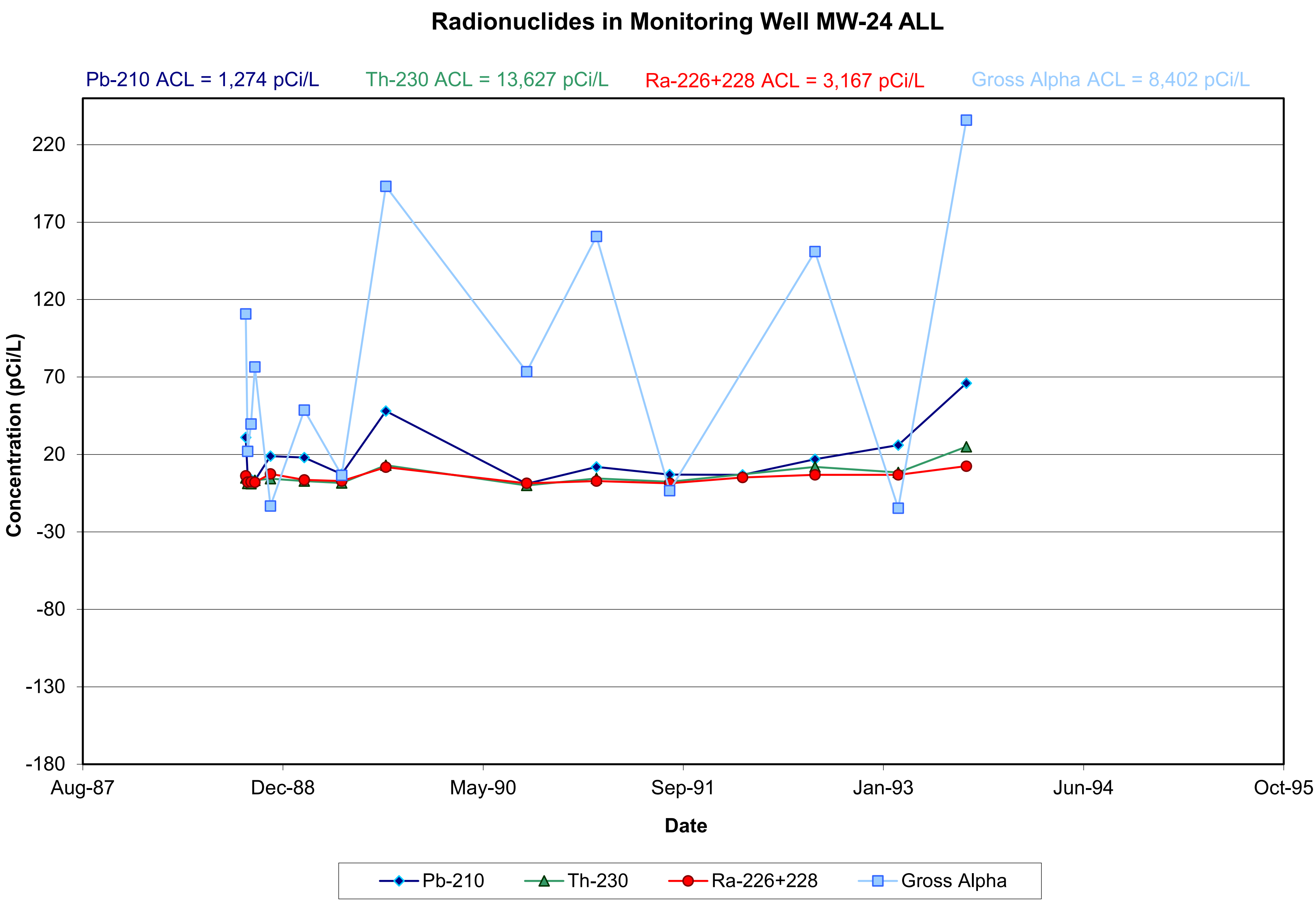

Nitrate in Monitoring Well MW-24 ALL
Nitrate ACL = 351 mg/L
Nitrate (mg/L)
200
180
160
140
120
100
80
60
40
20
0
Aug-87
Dec-88
May-90
Sep-91
Jan-93
Jun-94
Oct-95
Date
Nitrate

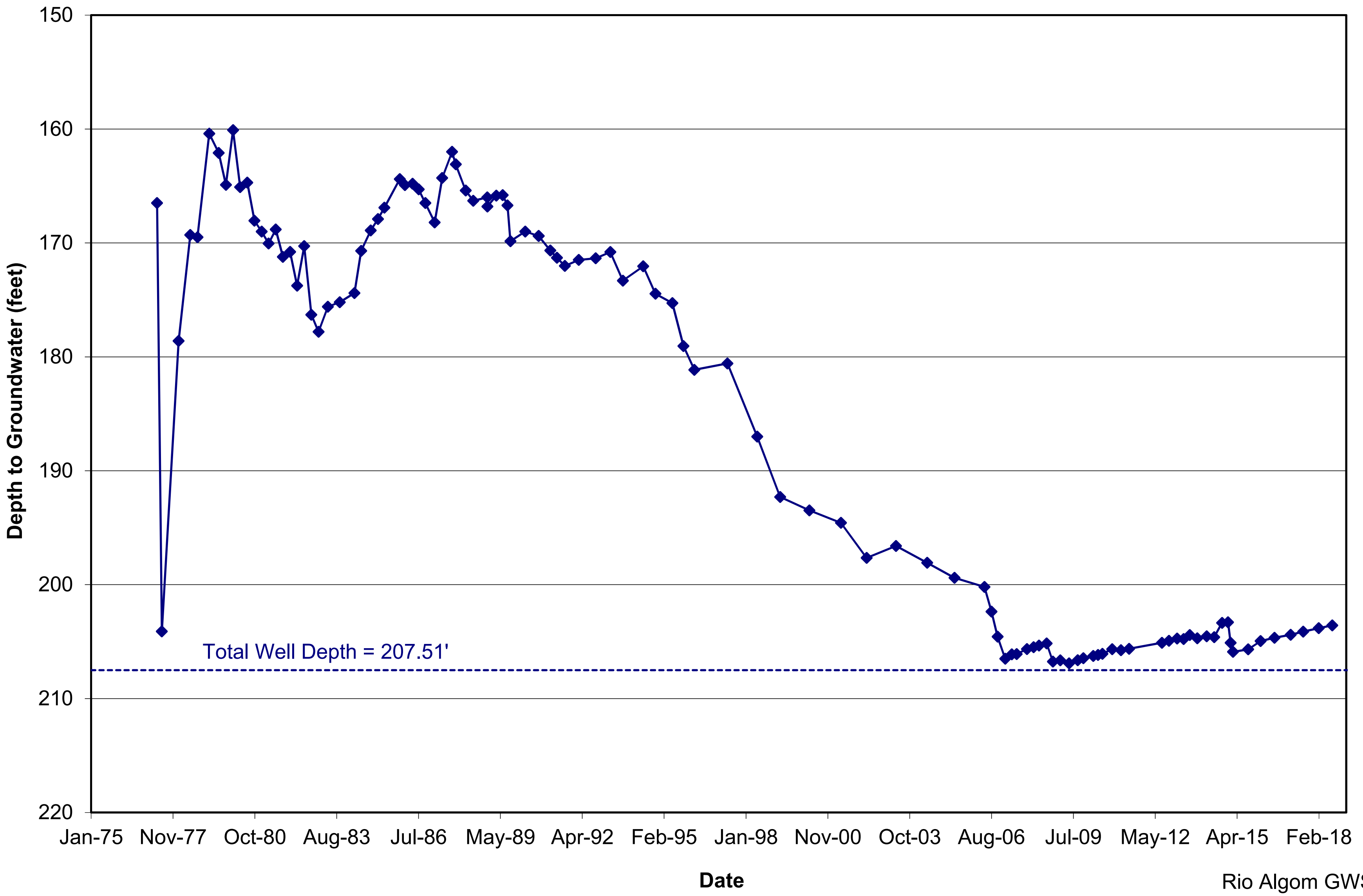

Radionuclides in Monitoring Well MW-24 ALL
Pb-210 ACL = 1,274 pCi/L
Th-230 ACL = 13,627 pCi/L
Ra-226+228 ACL = 3,167 pCi/L
Gross Alpha ACL = 8,402 pCi/L
Concentration (pCi/L)
220
170
120
70
20
-30
-80
-130
-180
Aug-87
Dec-88
May-90
Sep-91
Jan-93
Jun-94
Oct-95
Date
Pb-210
Th-230
Ra-226+228
Gross Alpha

INTERA

APPENDIX 3

Stability Monitoring Plan
Hydrographs

Hydrograph for TRA Monitoring Well 30-01 TRA



INTERA

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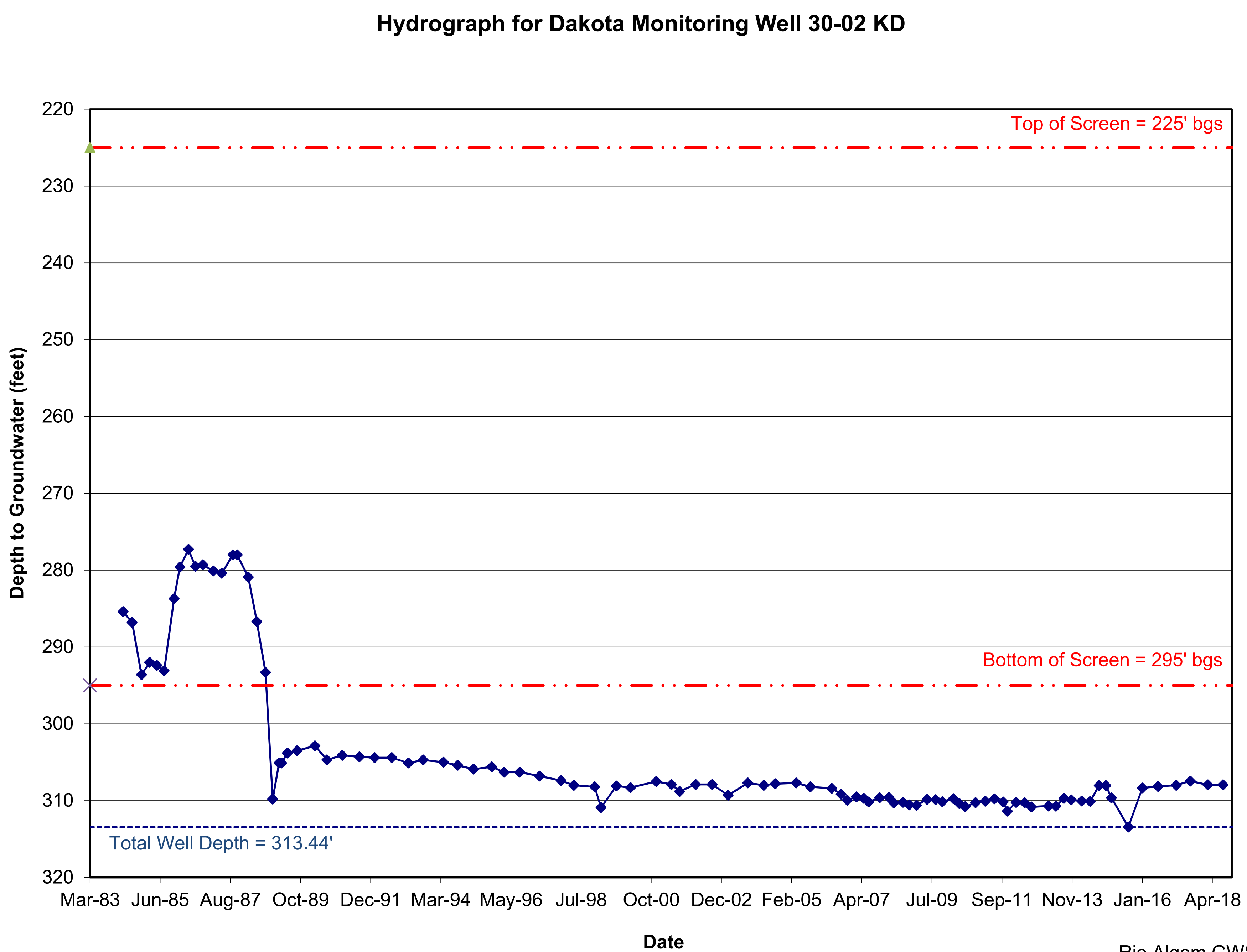

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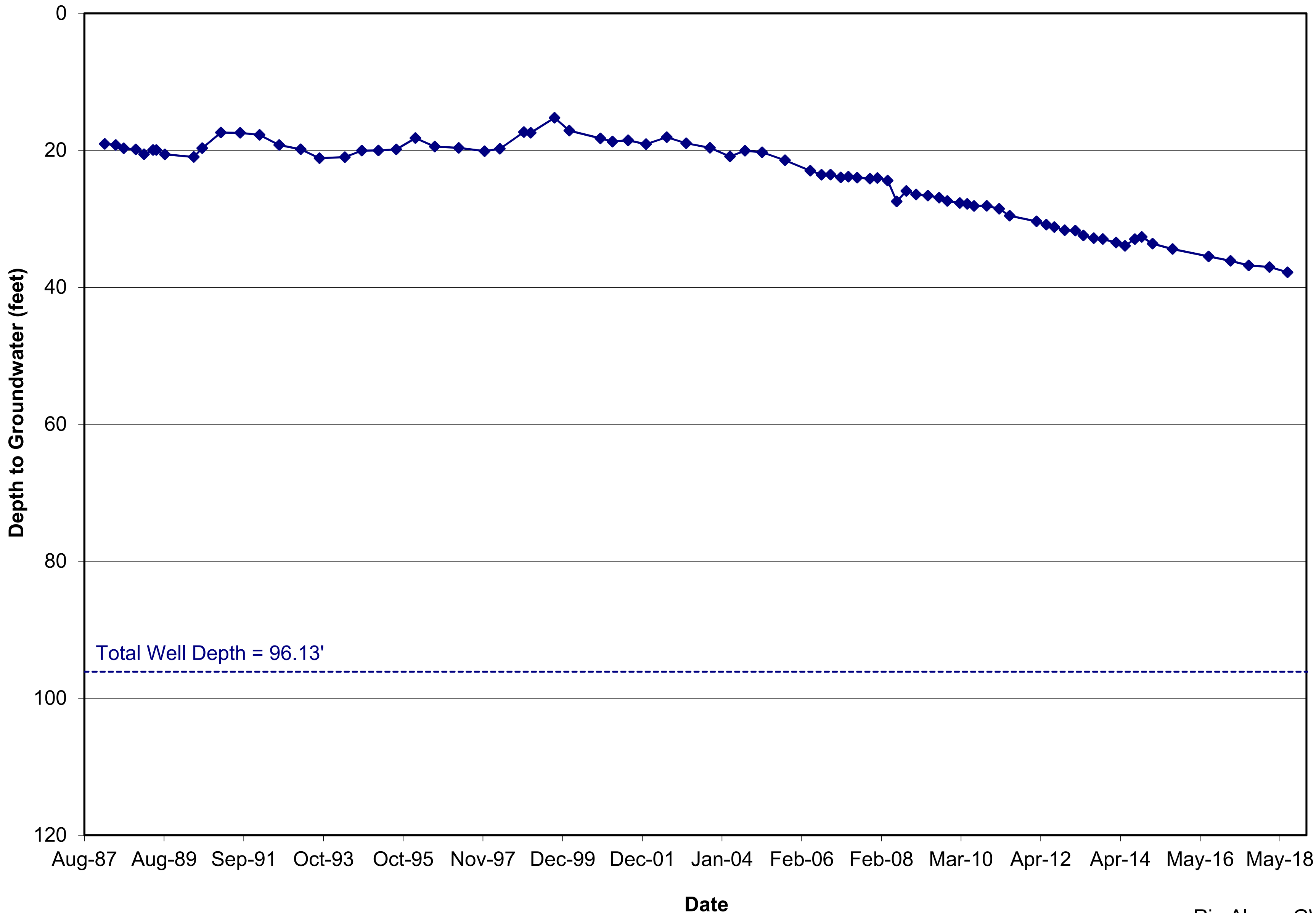
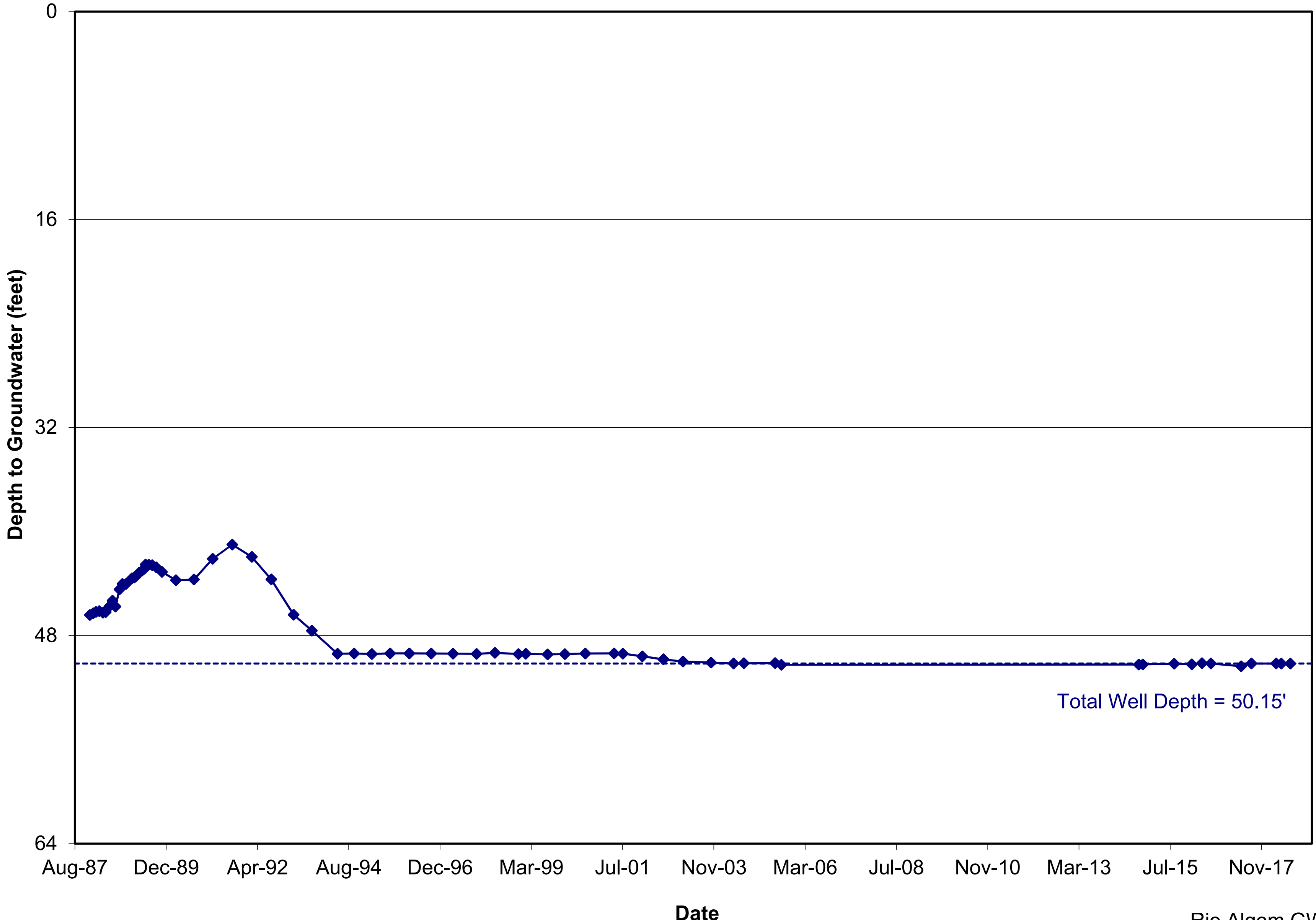
Hydrograph for TRB Monitoring Well 31-67 TRB



Hydrograph for Alluvial Monitoring Well MW-24 ALL



INTERA

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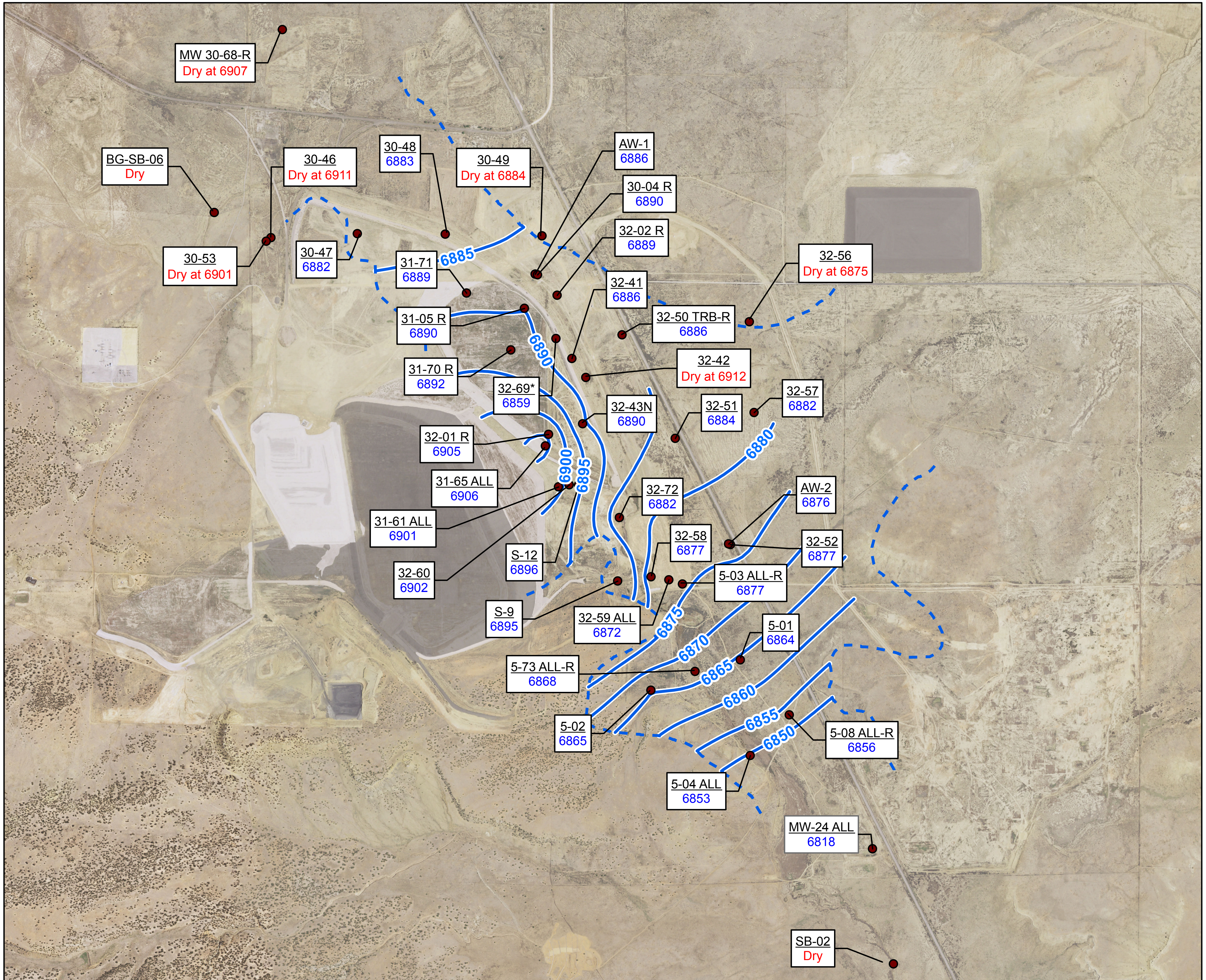
APPENDIX 4

Stability Monitoring Plan
Potentiometric Surface Maps



INTERA

N

0 1,800 3,600

Feet

Aerial – NAIP imagery, dated 2016

Legend

- Alluvial Monitoring Well Location
- Alluvial Groundwater Surface Elevation (ft amsl)
- Estimated Boundary of Saturated Alluvium

Well ID
Groundwater Surface Elevation (ft amsl)

Notes:
1) All data collected 2nd half, 2018;
2) Elevations at DRY wells are at the base of the screened interval or most recent Total Depth, whichever is greater.
* = Water level at well not used for contouring due to inaccurate TOC survey.

Gradient calculation:
(Difference in Groundwater Elevation Between Point of Compliance Well 31-61 ALL and Trend Well 5-08 ALL-R = 6,901 - 6,856 = 45 feet) Divided by (Distance Along a Flow Path Between Point of Compliance Well 31-61 and Trend Well 5-08 = 5802 feet)

= 0.008 feet per foot

2nd Half 2018 Alluvial Potentiometric Surface Elevation Iso-Contours ACL
Rio Algom Mining LLC
Groundwater Stability Monitoring Report

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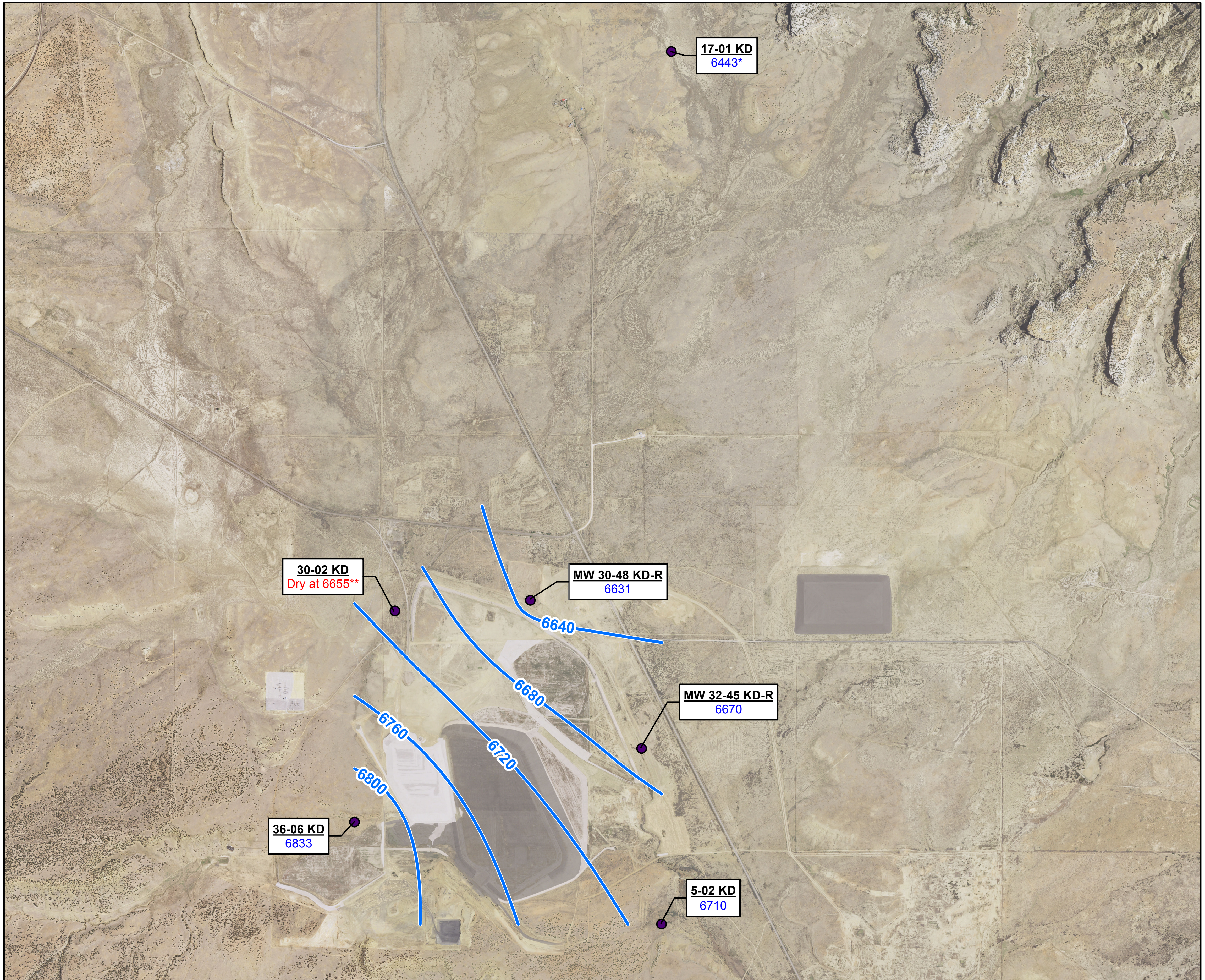

INTERA

N

0 1,250 2,500 5,000

Feet

Aerial – NAIP imagery, dated 2016

Legend

- Dakota Monitoring Well
- KD Potentiometric Surface Elevations (ft amsl)

Well ID
Groundwater Surface Elevation (ft amsl)

* indicates well 17-01 KD reading was taken 9/23/14, prior to pump install

** Elevation at bottom of screen since water level is below the bottom of the screened interval in the 30-02 KD well casing (sump)

Note: All data collected 2nd half, 2018 except 17-01 KD

Gradient calculation:
(Difference in Groundwater Elevation Between Point of Compliance Well 36-06 KD and Trend Well 30-48 KD-R = 6,833 - 6,631 = 202 feet) Divided by (Distance Along a Flow Path Between Point of Compliance Well 36-06 KD and Trend Well 30-48 KD-R = 7277 feet)

= 0.028 feet per foot

2nd Half 2018 Dakota Potentiometric Surface Elevation Iso-Contours
Rio Algom Mining LLC
Groundwater Stability Monitoring Report

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INTERA

N

0 750 1,500 3,000

Feet

Aerial – NAIP imagery, dated 2016

Legend

● TRA Monitoring Well Location

Well ID
Groundwater Surface Elevation (ft amsl)

* Elevation at bottom of screen since water level is below the bottom of the screened interval in the 30-01 TRA well casing (sump)

Notes:
a) Insufficient data to estimate potentiometric surface elevation contours.
b) All data collected 2nd half, 2018

Gradient calculation:
Due to lack of Groundwater Elevation data, hydraulic gradients were not calculated.

2nd Half 2018 TRA Potentiometric Surface Elevation
Rio Algom Mining LLC
Groundwater Stability Monitoring Report

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INTERA

N

0 750 1,500 3,000
Feet

Aerial – NAIP imagery, dated 2016

Legend

- TRB Monitoring Well Location
- TRB Potentiometric Surface Elevations (ft amsl)

Well ID
Groundwater Surface Elevation (ft amsl)

Notes:
1) All data collected 2nd half, 2018;
2) Elevations at DRY wells are at the base of the screened interval or most recent Total Depth, whichever is greater.

Gradient calculation:
(Difference in Groundwater Elevation
Between Point of Compliance
Well 31-02 TRB-R and far downgradient
Well 19-77 = 6,889 - 6,739 = 150 feet)
Divided by
(Distance Along a Flow Path
Between Point of Compliance
Well 31-02 TRB-R and far downgradient
Well 19-77 = 9,665 feet)

= 0.016 feet per foot

2nd Half 2018 TRB Potentiometric Surface Elevation Iso-Contours ACL

Rio Algom Mining LLC
Groundwater Stability Monitoring Report

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