WASTE CONTROL SPECIALISTS LLC

July 11, 2011

VIA HAND DELIVERY

Ms. Lorraine C. Council, P.G., Manager
Radioactive Material Licensing Section
Radioactive Materials Division, MC-233
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

References: (1) Radioactive Material License (RML) No. R04100, Amendment 07 CN600616890, RN101702439

(2) Letter from J. Scott Kirk, CHP (WCS), to Lorraine C. Council, P.G. (TCEQ), re: "Report of Completion of Modified Natural Radiation Monitoring Program and Pre-Operational Environmental Monitoring Program for RML No. R04100," dated May 12, 2011

Subject: Radioactive Material License No. R04100, License Condition 171.E: Report Presenting and Analyzing Data Collected in Modified Natural Radiation Monitoring Program and Pre-Operational Environmental Monitoring Program

Dear Ms. Council:

Waste Control Specialists LLC (WCS) reported completion of the pre-operational environmental monitoring activities that are required to be completed under Radioactive Material License (RML) No. R04100 in a letter dated May 12, 2011 (Reference 2). RML No. R04100, License Condition (LC) 171.E requires WCS to submit a report on the data collected during the pre-operational environmental monitoring activities as follows:

"The Licensee must submit a report presenting and analyzing all data collected in the Modified Natural Radiation Monitoring Program and the Pre-Operational Monitoring Program within 60 days after the completion of the programs."

The enclosed report and its appendices present data and analysis to satisfy RML No. R04100, LC 171.E. The report also presents Pre-Operational Environmental Monitoring data and analysis specified in the WCS Radiological Environmental Monitoring Plan (REMP) and the Non-Radiological Environmental Monitoring Plan (N-REMP) included in the license application.

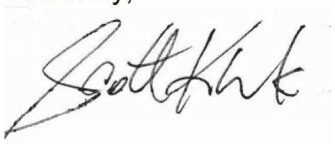
Corporate
5430 LBJ Freeway, Ste. 1700
Three Lincoln Centre
Dallas, TX 75240
Ph. 972.715.9800
Fx. 972.448.1419

Facility
P.O. Box 1129
Andrews, TX 79714
Ph. 888.789.2783
Fx. 505-394-3427

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

WCS requests that a copy of all correspondence regarding this matter be directly emailed to my attention (skirk@valhi.net) as soon as possible after issuance. If you have any questions or need additional information, please call me at 432-525-8500.

Sincerely,



J. Scott Kirk, CHP
Vice President, Licensing, Corporate Compliance and Radiation Safety Officer

Enclosure

cc: Susan Jablonski, P.E., TCEQ
William P. Dornsife, P.E., WCS
Jim Van Vliet, WCS
Jeffrey M. Skov, WCS
Linda J. Beach, WCS
Sheila Parker, WCS
Jane Grimm, WCS
Mike Woodward, Hance Scarborough
Pam Giblin, Baker Botts
WCS Regulatory Compliance
WCS Records Management

ENCLOSURE
PRE-OPERATIONAL MONITORING DATA EVALUATION

Low-Level Radioactive Waste Disposal Facility

Pre-Operational Environmental Monitoring Report

Radioactive Material License No. R04100
License Condition 171.E

Prepared By: _____ 7-11-11
Health Physicist
Travis Matthews
Date

Prepared By: _____ 7/11/11
Environmental Scientist
Mina Kirk
Date

Approved By: _____ 7/11/11
Radiation Safety Officer
J. Scott Kirk, CHP
Date

Table of Contents

1.0 Purpose

Waste Control Specialists LLC (WCS) has prepared this report for the low-level radioactive waste (LLRW) disposal facility to fulfill the requirement of License Condition (LC) 171.E contained in Radioactive Material License (RML) No. R04100 (Amendment 4). LC 171.E states: "The Licensee must submit a report presenting and analyzing all data collected in the Modified Natural Radiation Monitoring Program and the Pre-Operational Monitoring Program within 60 days after the completion of the programs." The Modified Natural Radiation Monitoring Program is specified in Attachment A of RML No. R04100, and the Pre-Operational Monitoring Program is specified in Attachment B of RML No. R04100. These programs were conducted concurrently, consistent with LC 171.A, beginning in fourth quarter 2009 and continuing through first quarter 2011. In this report, this time period is referred to as the pre-operational period.

In addition to the environmental monitoring specified in RML No. R04100, WCS program documents also specify environmental monitoring to be conducted at the LLRW disposal facility. In some cases, the WCS program documents specify environmental monitoring activities that are not detailed under the license. This report also presents the radiological and non-radiological environmental monitoring results collected as specified in the WCS program documents during the pre-operational period. The data summarized in this report documents the results of the completed Pre-Operational Monitoring Program and Modified Natural Radiation Monitoring Program under Attachments A and B of RML No. R04100 and enables a comprehensive review of the additional baseline data collected during the pre-operational period for the LLRW facility and completion of the These data, together with data collected through previous monitoring performed at the site, will be used to establish a modified baseline. A separate Data Quality Objectives document is being prepared to document and provide the results of statistical evaluations of the modified baseline data, in accordance with LC 179.

The WCS LLRW disposal facility is co-located with several other waste management facilities. In addition to the LLRW facility, WCS operates the storage and processing facility (RML No. R04971), the byproduct material disposal facility (RML No. R05807), and the industrial and hazardous waste treatment, storage and disposal facility (Permit No. 50358). With the exception of the LLRW disposal facility that is currently under construction, all of the WCS facilities are active. In addition, the Louisiana Energy Services National Enrichment Facility (LES NEF), a uranium enrichment plant, is located immediately west of WCS-controlled property in New Mexico. The modified baseline data will be used in the future, together with the results of operational monitoring, to detect any significant masking that may occur due to nearby or adjacent facilities or activities.

2.0 Scope

This report covers the environmental monitoring data collected during the pre-operational monitoring period (fourth quarter 2009 through first quarter 2011) for the WCS LLRW facility. These data were collected as specified in RML No. R04100 and in accordance with applicable WCS plans and procedures. Monitoring locations, frequencies, and sample analyses are primarily detailed in Attachments A and B of RML No. R04100. In addition, the following WCS program documents identify the environmental monitoring program elements that are implemented to the extent consistent with the license:

- EV-1.1.0, Radiological Environmental Monitoring Program, Rev. 0, 4/18/2005, as revised by Addendum No. 1, Revision 2 to tis document (Appendix 2.10.1-2 of the application for RML No. R04100); and
- Non-Radiological Environmental Monitoring Plan (Appendix 2.10.2-2 of the application for RML No. R04100).

These monitoring programs and plans are collectively referred to herein as the pre-operational monitoring program, and the data obtained under these programs and plans are collectively referred to herein as the pre-operational monitoring data. pre-operational monitoring data have been collected for the following media: radon, fauna, soil, sediment, vegetation, ambient radiation, air particulate, air cartridge, air tritium, aquatic eco-receptors, groundwater and surface water. All samples[1] were analyzed by commercial laboratories that are certified under the National Environmental Laboratory Accreditation Program (NELAP).

[1] Not including the dosimeters used to record ambient radiation; no NELAP-recognized field of accreditation is available for these measurements.

Table 2-1 provides a list of radiological constituents analyzed as part of the pre-operational monitoring period. The appendices in this report contain all the results of all radiological measurements, including results for the complete list of constituents reported by gamma spectroscopy. For clarity in presentation, the summary tables and graphs are limited to the following radiological parameters: Gross Alpha, Americium-241, Gross Beta, Carbon-14, Cesium-137, Chromium-51, Cobalt-60, Curium-242, Curium-243/244, Iodine-129, Manganese-54, Neptunium-237, Lead-210, Plutonium-238, Plutonium-239/240, Plutonium-241, Plutonium-242, Radium-226, Radium-228, Strontium-90, Technetium-99, Thorium-228, Thorium-230, Thorium-232, Tritium, Uranium-233/234, Uranium-235/236 and Uranium-238. When a parameter is analyzed by more than one method, the summary tables and graphs report the superior method. Time series graphs contain Investigation Levels (ILs) from EV-1.1.0, Radiological Environmental Monitoring Program where applicable. These ILs are not the approved ILs under RML No. R04100 and are provided for informational purposes only.

Tables 2-2 and 2-3 provide lists of the non-radiological constituents[2] that were analyzed during the pre-operational monitoring period. Table 2-2 lists the non-radiological constituents required by RML No. R04100; and Table 2-3 summarizes the analytes required by WCS's Non-Radiological Environmental Monitoring Program (N-REMP). Tables 2-2 and 2-3 also provide the type of each analyte (metal, volatile organic compound [VOC], or semi-volatile organic compound [SVOC]).

[2] As requested by the TCEQ in a letter to WCS dated October 11, 2010, this report uses the term "non-radiological constituents" in lieu of the term used in RML No. R04100 ("chemical constituents").

Table 2-1 : Radionuclides Analyzed for the LLRW Pre-Operational Monitoring.

Radionuclide	Symbol	Radionuclide	Symbol	Radionuclide	Symbol
Actinium-228	^{228}Ac	Cerium-141	^{141}Ce	Curium-243/244	$^{243/234}$Cm
Americium-241	^{241}Am	Cerium-144	^{144}Ce	Europium-152	^{152}Eu
Americium-243	^{243}Am	Cesium-134	^{134}Cs	Europium-154	^{154}Eu
Antimony-124	^{124}Sb	Cesium-136	^{136}Cs	Europium-155	^{155}Eu
Antimony-125	^{125}Sb	Cesium-137	^{137}Cs	Iodine-129	^{129}I
Barium-133	^{133}Ba	Chromium-51	^{51}Cr	Iridium-192	^{192}Ir
Barium-140	^{140}Ba	Cobalt-56	^{56}Co	Iron-59	^{59}Fe
Beryllium-7	^{7}Be	Cobalt-57	^{56}Co	Krypton-85	^{85}Kr
Bismuth-212	^{212}Bi	Cobalt-58	^{58}Co	Lead-210	^{210}Pb
Bismuth-214	^{214}Bi	Cobalt-60	^{60}Co	Lead-212	^{212}Pb
Carbon-14	^{14}C	Curium-242	^{242}Cm	Lead-214	^{214}Pb
Manganese-54	^{54}Mn	Plutonium-242	^{242}Pu	Thallium-208	^{208}Tl
Mercury-203	^{203}Hg	Potassium-40	^{40}K	Thorium-228	^{228}Th
Neodymium-147	^{147}Nd	Promethium-144	^{144}Pm	Thorium-230	^{230}Th
Neptunium-237	^{237}Np	Promethium-146	^{146}Pm	Thorium-232	^{232}Th
Neptunium-239	^{239}Np	Radium-226	^{226}Ra	Thorium-234	^{234}Th
Nickel-59	^{59}Ni	Radium-228	^{228}Ra	Tritium (Hydrogen-3)	^{3}H
Nickel-63	^{63}Ni	Radon-222	^{222}Rn	Uranium-233/234	$^{233/234}$U
Niobium-94	^{94}Nb	Ruthenium-106	^{106}Ru	Uranium-235/236	$^{235/236}$U
Niobium-95	^{95}Nb	Silver-110m	^{110m}Ag	Uranium-238	^{238}U
Plutonium-238	^{238}Pu	Sodium-22	^{22}Na	Yttrium-88	^{88}Yt
Plutonium-239/240	$^{239/240}$Pu	Strontium-90	^{90}Sr	Zinc-65	^{65}Zn
Plutonium-241	^{241}Pu	Technetium-99	^{99}Tc	Zirconium-95	^{95}Zr

Table 2-2 : R04100 Non-Radiological Constituents Analyzed for the LLRW Pre-Operational Monitoring.

Analyte	**Type**	**Analyte**	**Type**	**Analyte**	**Type**
Arsenic	Metal	Chlorobenzene	VOC	Ethylbenzene	VOC
Cadmium	Metal	Chlorodibromomethane	VOC	Methyl Bromide	VOC
Nickel	Metal	Chloroethane	VOC	Methyl Chloride	VOC
Selenium	Metal	Chloroform	VOC	1,1,2,2-Tetrachloroethane	VOC
Phenol	SVOC	Dichlorobromomethane	VOC	Tetrachloroethylene	VOC
1,4-Dioxane	SVOC	1,1-Dichloroethane	VOC	Toluene	VOC
Acetone	VOC	1,2-Dichloroethane	VOC	Trans-1,2-Dichloroethylene	VOC
Benzene	VOC	1,1-Dichloroethylene	VOC	1,1,1-Trichloroethane	VOC
Bromoform	VOC	1,2-Dichloropropane	VOC	1,1,2-Trichloroethane	VOC
Carbon Disulfide	VOC	Cis-1,3-Dichloropropylene	VOC	Trichloroethylene	VOC
Carbon Tetrachloride	VOC	Trans-1,3- Dichloropropylene	VOC	Vinyl Chloride	VOC

Table 2-3 : R04100 Non-Radiological Constituents Analyzed for the LLRW Pre-Operational Monitoring.

Metals/Water Quality Measurements*	SVOCs			VOCs	
Antimony	1,2,4,5-Tetrachlorobenzene	p-Nitroaniline	Hexachlorocyclopentadiene	1,1,1,2-Tetrachloroethane	Carbon disulfide
Arsenic	1,2,4-Trichlorobenzene	4-Nitrophenol	Hexachloroethane	1,1,1-Trichloroethane	Carbon tetrachloride
Barium	1,2-Dichlorobenzene	4-Nitroquinoline-1-oxide	Hexachloropropene	1,1,2,2-Tetrachloroethane	Chlorobenzene
Beryllium	1,3,5-Trinitrobenzene	5-Nitro-o-toluidine	Indeno(1,2,3-cd)pyrene	1,1,2-Trichloroethane	Chloroethane
Cadmium	1,3-Dichlorobenzene	7,12Dimethylbenz(a)anthracene	Isodrin	1,1-Dichloroethane	Chloroform
Chromium	m-Dinitrobenzene	Acenaphthene	Isophorone	1,1-Dichloroethylene	Chloromethane
Cobalt	1,4-Dichlorobenzene	Acenaphthylene	Isosafrole	1,1-Dichloropropene	cis-1,2-Dichloroethylene
Lead	1,4-Dioxane	Acetophenone	m,p-Cresols	1,2,3-Trichlorobenzene	cis-1,3-Dichloropropylene
Mercury	1,4-Naphthoquinone	Aniline	Methapyrilene	1,2,3-Trichloropropane	Dibromochloromethane
Nickel	1-Naphthylamine	Anthracene	Methyl methanesulfonate	1,2,4-Trichlorobenzene	Dibromomethane
Selenium	2,3,4,6-Tetrachlorophenol	Benzo(a)anthracene	Naphthalene	1,2,4-Trimethylbenzene	Dichlorodifluoromethane
Silver	2,4,5-Trichlorophenol	Benzo(a)pyrene	Nitrobenzene	1,2-Dibromo-3-chloropropane	Ethylbenzene
Zinc	2,4,6-Trichlorophenol	Benzo(b)fluoranthene	N-Methyl-N-nitrosomethylamine	1,2-Dibromoethane	Hexachlorobutadiene
	2,4-Dichlorophenol	Benzo(ghi)perylene	N-Nitrosodiethylamine	1,2-Dichlorobenzene	Iodomethane
Alkalinity, Total	2,4-Dimethylphenol	Benzo(k)fluoranthene	N-Nitrosodi-n-butylamine	1,2-Dichloroethane	Isopropylbenzene
Biological Oxygen Demand (BOD_5)	2,4-Dinitrophenol	Benzyl alcohol	N-Nitrosodipropylamine	1,2-Dichloroethylene (total)	Methylene chloride
Dissolved Oxygen (DO)	2,4-Dinitrotoluene	bis(2-Chloroethoxy)methane	N-Nitrosomethylethylamine	1,2-Dichloropropane	Naphthalene
pH	2,6-Dichlorophenol	bis(2-Chloroethyl) ether	N-Nitrosomorpholine	trans-1,2-Dichloroethylene	n-Butylbenzene
Specific Conductivity	2,6-Dinitrotoluene	bis(2-Chloroisopropyl)ether	N-Nitrosopiperidine	1,3,5-Trimethylbenzene	n-Propylbenzene
Total Dissolved Solids (TDS)	2-Acetylaminofluorene	bis(2-Ethylhexyl)phthalate	N-Nitrosopyrrolidine	1,3-Dichlorobenzene	sec-Butylbenzene
Total Suspended Solids (TSS)	2-Chloronaphthalene	Butylbenzylphthalate	Triethylphosphorothioate	1,3-Dichloropropane	Styrene

Metals/Water Quality Meas-urements*	SVOCs			VOCs	
Turbidity	2-Chlorophenol	Chlorobenzilate	o-Cresol	1,4-Dichlorobenzene	tert-Butyl methyl ether
	2-Methyl-4,6-dinitrophenol	Chrysene	o-Toluidine	2,2-Dichloropropane	tert-Butylbenzene
	2-Methylnaphthalene	Diallate	p-(Dimethylamino)azobenzene	2-Butanone	Tetrachloroethylene
	2-Naphthylamine	Dibenzo(a,h)anthracene	Pentachlorobenzene	2-Chloroethylvinyl ether	Toluene
	o-Nitroaniline	Dibenzofuran	Pentachloronitrobenzene	2-Chlorotoluene	trans-1,3-Dichloropropylene
	2-Nitrophenol	Diethylphthalate	Pentachlorophenol	2-Hexanone	Trichloroethylene
	2-Picoline	Dimethoate	Phenacetin	4-Chlorotoluene	Trichlorofluoromethane
	3,3'-Dichlorobenzidine	Dimethylphthalate	Phenanthrene	4-Isopropyltoluene	Vinyl acetate
	3,3-Dimethylbenzidine	Di-n-butylphthalate	Phenol	4-Methyl-2-pentanone	Vinyl chloride
	3-Methylcholanthrene	Di-n-octylphthalate	p-Phenylenediamine	Acetone	Xylenes (total)
	m-Nitroaniline	Diphenylamine	Pronamide	Benzene	
	4-Aminobiphenyl	Ethyl Methanesulfonate	Pyrene	Bromobenzene	
	4-Bromophenylphenylether	Fluoranthene	Pyridine	Bromochloromethane	
	4-Chloro-3-methylphenol	Fluorene	Safrole	Bromodichloromethane	
	4-Chloroaniline	Hexachlorobenzene	Sulfotepp	Bromoform	
	4-Chlorophenylphenylether	Hexachlorobutadiene	Thionazin	Bromomethane	

Notes: * = Only half of the water quality measurements are determined by the analytical laboratory. Those measurements (total alkalinity, BOD_5, TDS, and TSS) are not provided in the appendices of this report. They are, however, available on-line in WCS's Environmental Monitoring Database. The other water quality parameters (DO, pH, specific conductivity, and turbidity), are measured in the field by WCS personnel using calibrated water quality meters. Those data are recorded and maintained in WCS's field books and are available to the TCEQ upon request (but are not provided in this report).

In the following sections, summary tables are provided for each "set" of analytical results. For each media having both radiological and non-radiological data, there are at least two data sets – the radiological data set and the non-radiological data set. For certain media, there are additional data sets due to the fact that discrete populations within the general media description are being sampled (e.g., routine soil sample data is separated into two depth intervals, 0 to 6" below ground and 6 to 12" below ground, each with a radiological and a non-radiological data set). The summary tables provide basic statistical characteristics such as the number of total observations, the number of non-detect observations, the sample mean, and standard deviation of the sample measurements.

For radionuclides, a measurement result is considered to be a non-detect if the measured value is less than the critical level, in accordance with the guidance in the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)[3]. The critical level (L_c) is defined in MARLAP as "the minimum measured value to give confidence that a positive (nonzero) amount of the analyte is present in the material analyzed." WCS has requested that future radiochemical analytical reports include the critical level for each analytical result. However, during the pre-operational monitoring period, the analytical laboratory reported the minimum detectable concentration (MDC) for each analytical result[4], and did not report the critical level. The analytical laboratory confirmed that the MDCs reported for WCS' environmental monitoring samples represent a significance level of $\alpha = 0.05$. Therefore, for the purpose of characterizing the number of non-detects in the radiological data obtained during the pre-operational monitoring period, WCS has estimated the critical level for each radiochemical result to be equal to one-half the MDC reported by the laboratory for that result. This approximation can be mathematically demonstrated to be a reasonable estimate of the critical level when the background count is not extremely low.

For non-radionuclides, measurements that are less than the Method Detection Limits (MDL) are reported by the analytical laboratory as "<MDL", and measurements that are greater than the MDL but less than the Practical Quantitation Limit (PQL) are reported as the measured value flagged with a qualifier (typically, a "J" qualifier) that indicates the reported value is an estimated result, in accordance with standard analytical protocol. The summary tables include the number of measurements that were less than the PQL and the number of measurements that are estimated. The number of measurements that were reported by the laboratory as "<MDL" can be derived by subtracting the number of estimated values from the number of values less than the PQL.

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[3] NUREG-1576 and EPA 402-B-04-001A, July 2004

[4] During the pre-operational monitoring period, the laboratory reports, including the electronic data files, used the term 'MDL' as a generic term for the reporting limits shown in the laboratory reports. For radiochemical analyses, the laboratory has confirmed that the values shown as "MDLs" are actually MDC's, consistent with the terminology in MARLAP. For non-radiological analyses, the values shown as "MDLs" are method detection limits as defined in 40 CFR Part 136, Appendix B. Since the appendices of pre-operational monitoring data in this report are directly exported from the WCS REMP database and the electronic data are imported directly as supplied by the laboratory into the WCS REMP database, the appendices also use the term 'MDL' as a generic term with the meanings as described in this footnote.

3.0 Precipitation Data

Attachments A and B of RML No. R04100 specify the collection of metrological and radiological precipitation data from the ranch house draw weather station (Weatherhawk East). Ranch house draw is a drainage feature located south of the LLRW facility. Figure 3-1 depicts the location of the Weatherhawk East weather station, as well as other metrological stations on WCS-controlled property in relation to the LLRW facility.

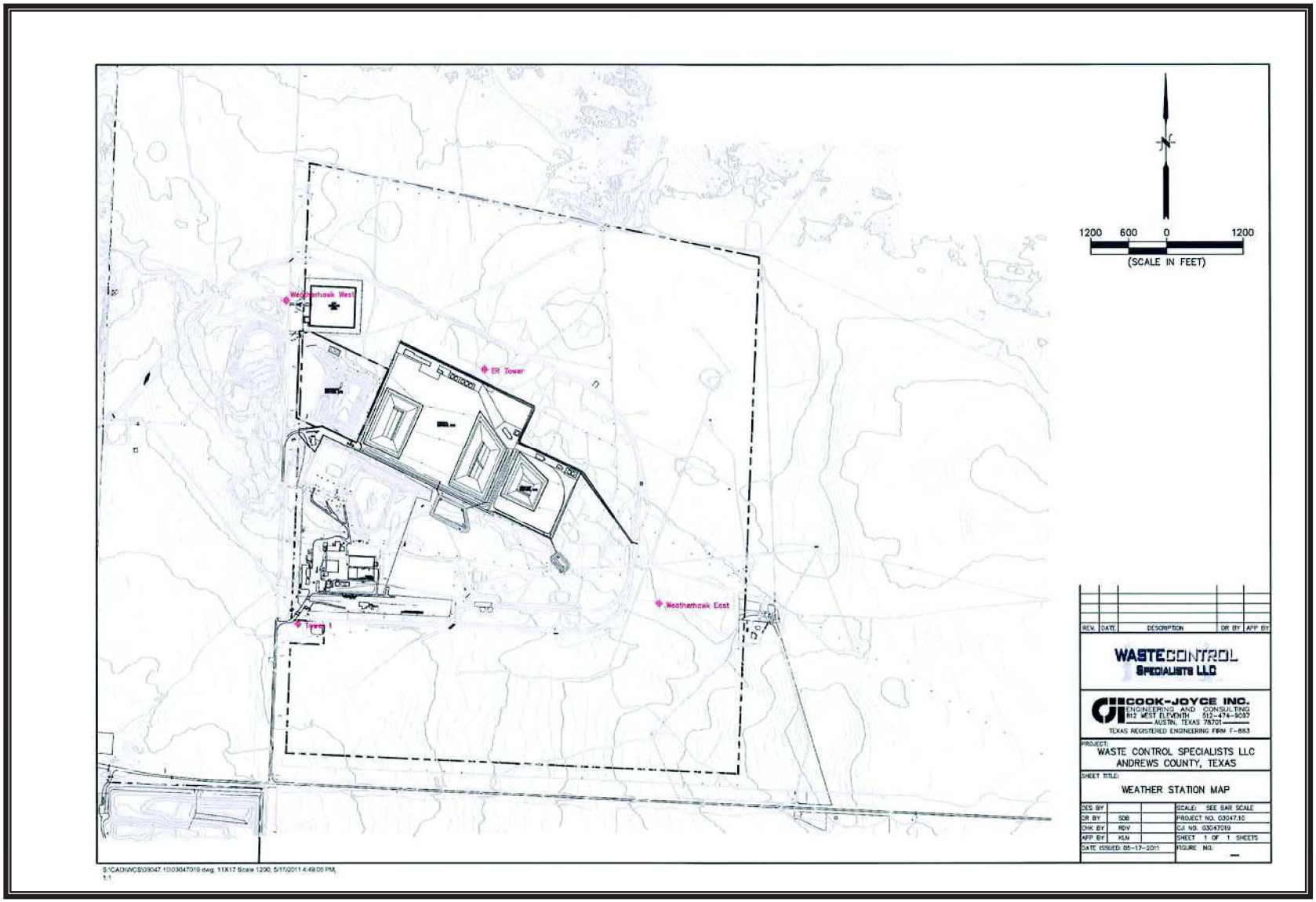

Figure 3-1 : Weather Station Locations.

Metrological data

Attachments A and B of RML No. R04100 require continuous collection of precipitation amounts. During the pre-operational monitoring period 21.4 inches of precipitation were recorded at the Weatherhawk East station. Table 3-1 provides a summary of the cumulative rainfall totals recorded at all of the WCS weather stations during the pre-operational monitoring period. Figure 3-1, Figure 3-2, Figure 3-3, and Figure 3-4 display the daily precipitation totals at the WCS weather stations over the pre-operational monitoring period.

Table 3-1 : Cumulative Rainfall.

Station	Cumulative Rainfall (in)
Weatherhawk East	21.4
ER Tower	17.8
Tower 1	18.0
Weatherhawk West	23.6

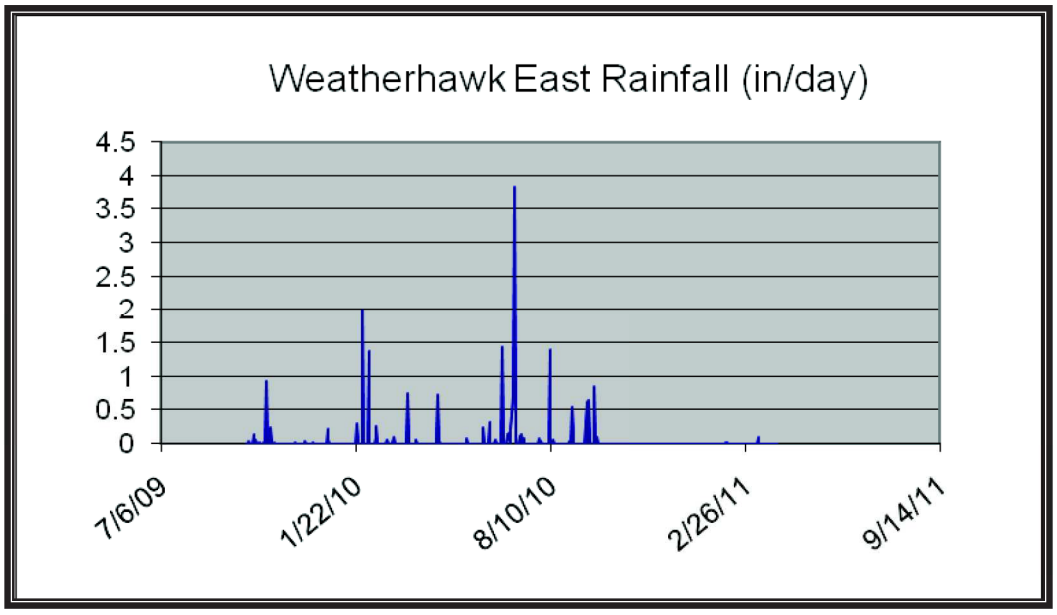

Figure 3-1 : Weatherhawk East daily totals over the Pre-Operational Monitoring Period.

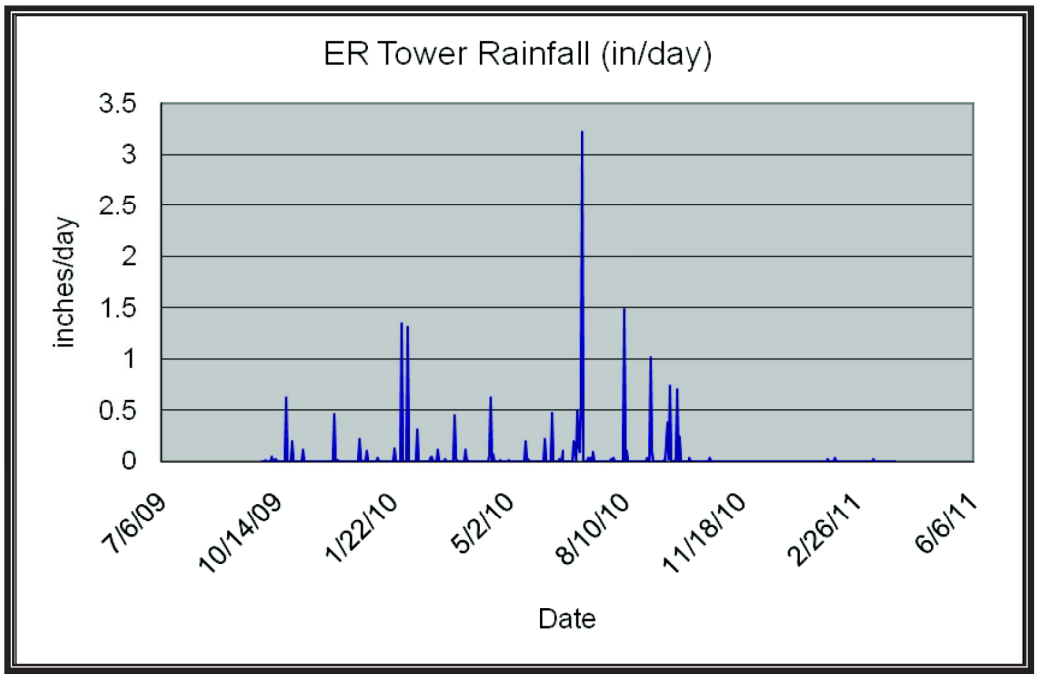

Figure 3-2 : ER Tower daily totals over the Pre-Operational Monitoring Period.

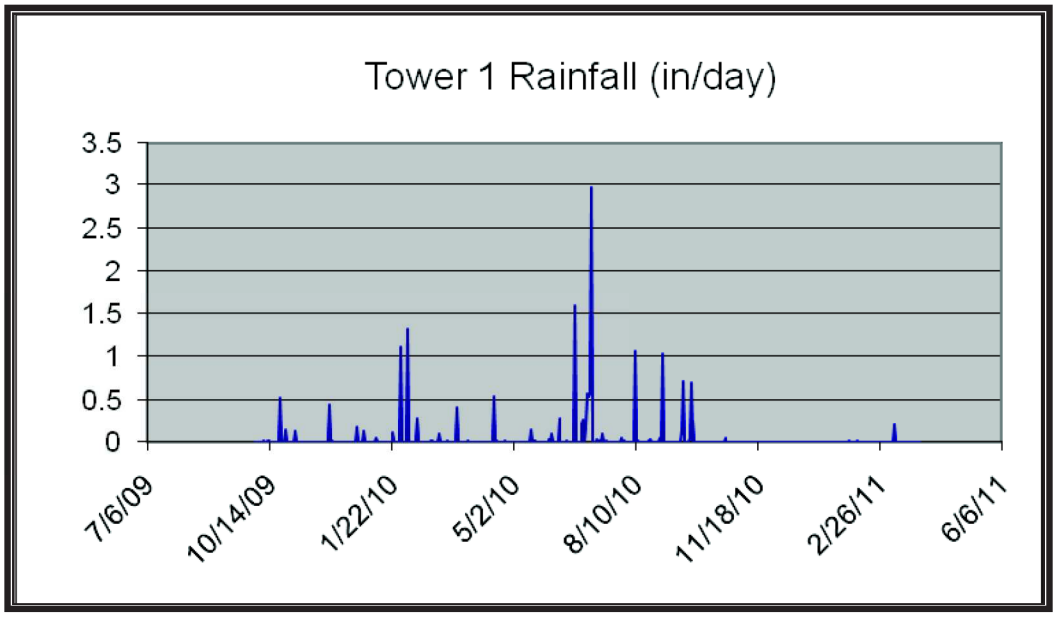

Figure 3-3 : Tower 1 daily totals over the Pre-Operational Monitoring Period.

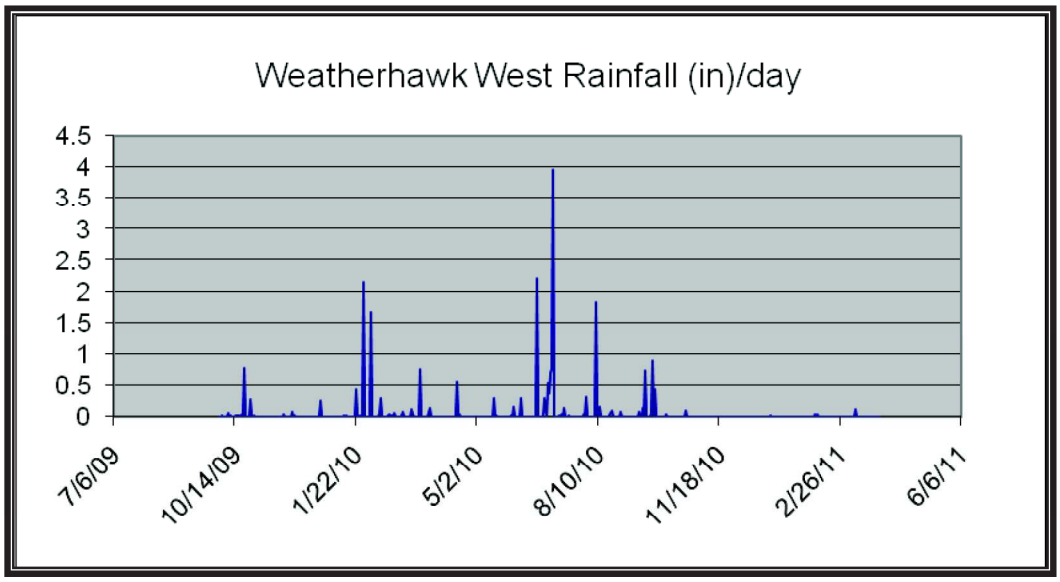

Figure 3-4 : Weatherhawk West daily totals over the Pre-Operational Monitoring Period.

Radiological data

Attachments A and B of RML No. R04100 require monthly collection of precipitation samples at the Weatherhawk East weather station when the quantity is sufficient for analysis of radionuclides by gamma spectroscopy. Although rain was recorded on multiple days during the pre-operational monitoring period, either the quantity was insufficient for analysis or the rainfall event occurred outside of normal operating hours.

4.0 Water

Groundwater

As part of the pre-operational monitoring program, 204 wells are sampled if there is sufficient water in the well. Groundwater is monitored in several different transmissive zones. The primary transmissive zones that are monitored for groundwater are described below.

The Ogallala-Antlers-Gatuña (OAG) unit. This is the uppermost groundwater-bearing stratum that is sampled at the site. It is intermittently saturated at WCS. WCS sampled (or attempted to sample) 106 monitoring wells completed in the OAG during the pre-operational period. Sixty-two (63) of those 106 wells did not contain sufficient water for WCS to collect a sample. In addition, 16 of the 106 OAG wells did not yield a sufficient quantity of groundwater to allow analysis of all monitoring parameters during one or more monitoring events. When this occurred, WCS collected the available sample volume and prioritized analyses in accordance with RML R04100 (Attachment A Footnote 6 and Attachment B Footnote 11).

The 125 foot (') zone. The 125'-zone is a discontinuous sand- and silt-stone stratum found in the Dockum Formation (the red beds), which underlies the OAG. It is mostly unsaturated beneath WCS. WCS sampled (or attempted to sample) 29 monitoring wells completed in the 125'-zone during the pre-operational period. Only one of those wells, PM-02, contained sufficient water for WCS to collect a sample. However, as discussed below, WCS suspects that the groundwater in PM-02 is actually OAG groundwater that has been leaking through a faulty seal in PM-02.

The 225'-zone. This continuous sand- and siltstone stratum is found in the Dockum Formation. It is the uppermost continuously saturated stratum at WCS. WCS sampled 66 monitoring wells completed in the 225'-zone during the pre-operational period. WCS was able to collect full samples from all of the 225'-zone wells.

In addition, WCS has monitored groundwater in a few wells completed in other transmissive zones, as part of the pre-operational monitoring program, as follows:

The 180'-zone. This discontinuous sand- and silt-stone stratum is found in the Dockum Formation. It is mostly unsaturated beneath WCS. Monitor well 6B1 is the only 180'-zone well in the pre-operational monitoring program.

The Trujillo sandstone. This saturated stratum is located in the Dockum Formation at an approximate depth of 600 to 700 feet below the ground surface. The South Well (also known as Station 9) is completed in this formation.

The Santa Rosa sandstone. This saturated stratum is located in the Dockum Formation at an approximate depth of 1,140 to 1,400 feet below the ground surface. The Central Well, which has now been plugged and abandoned, produced groundwater from this formation.

Because each transmissive zone is discrete and hydrologically unconnected from one another, the data from each zone represent separate data populations, each of which are described separately below. Figure 4-1, Figure 4-2, Figure 4-3 and Figure 4-4 display the locations of wells completed in the 225'-zone, 125'-zone, OAG, and other transmissive zones, respectively.

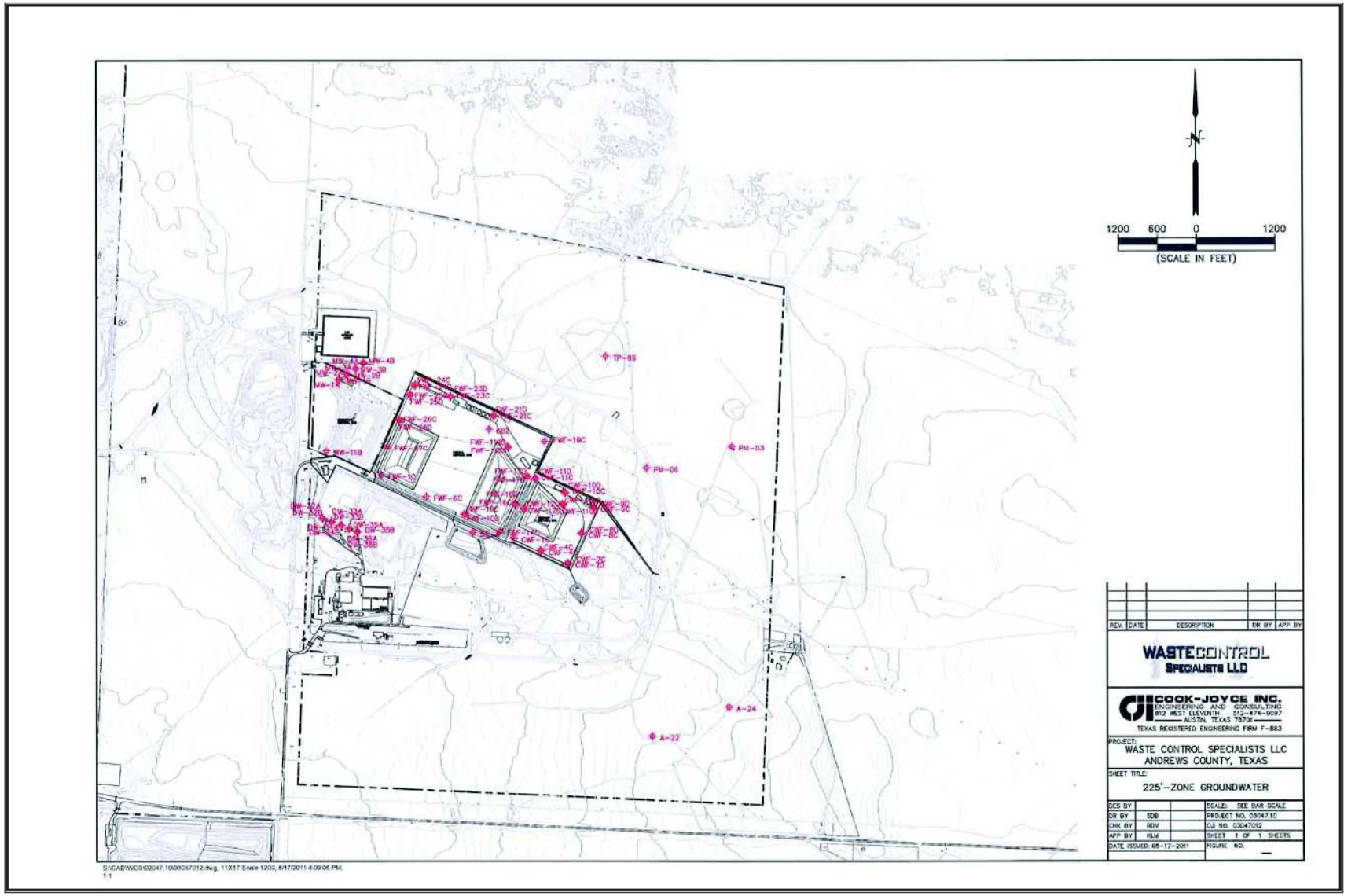

Figure 4-1 : 225' Zone Groundwater Monitoring Locations.

Figure 4-2 : 125' Zone Groundwater Monitoring Locations.

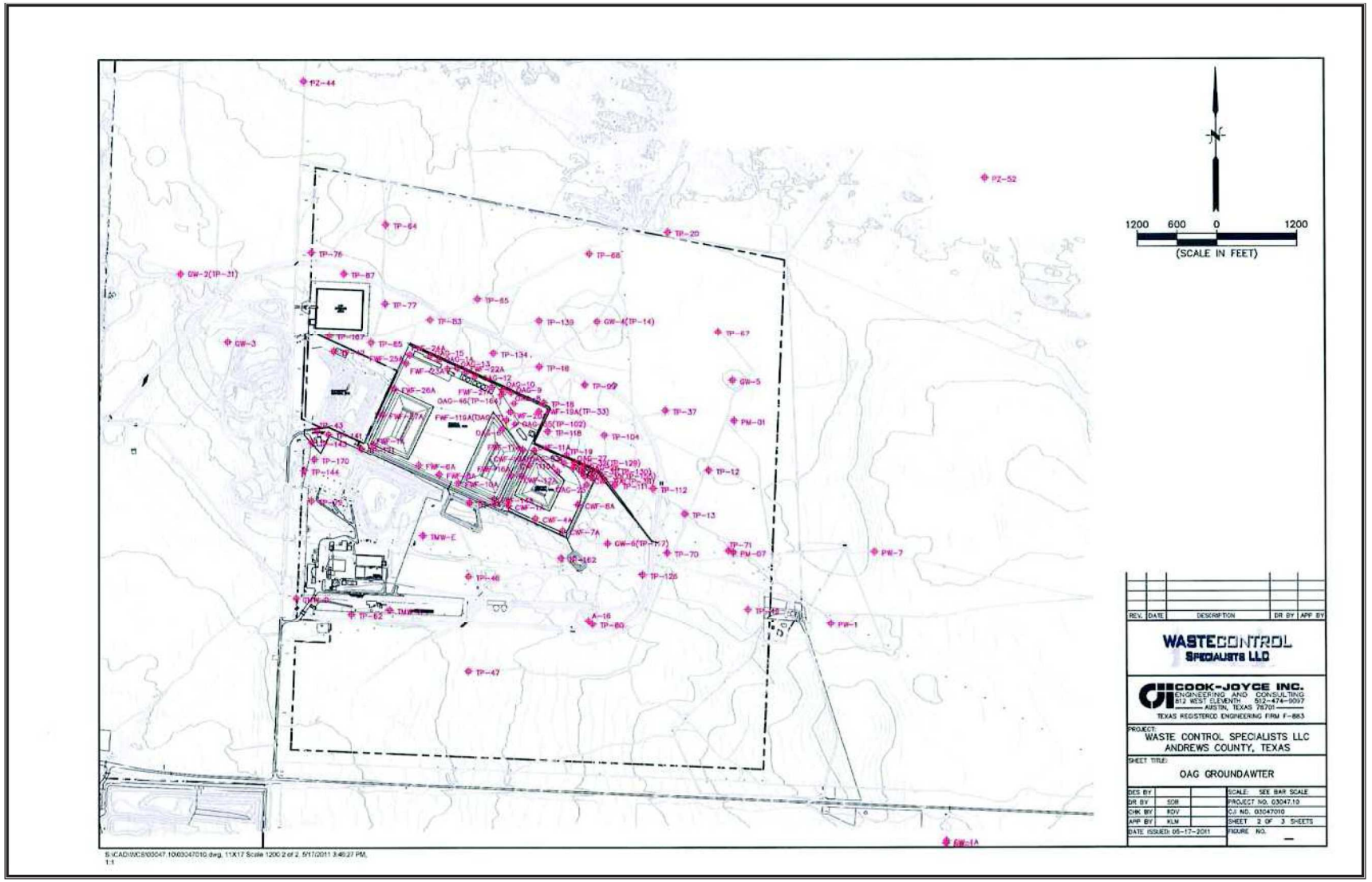

Figure 4-3 : OAG Groundwater Monitoring Locations.

Figure 4-4 : Other Groundwater Monitoring Locations.

OAG Groundwater Data

Table 4-1 indicates whether the monitored OAG wells had sufficient water to sample as part of the pre-operational monitoring program.

Table 4-1: OAG Wells in Low Level Pre-Operational Monitoring Program.

Well	Saturation?	Well	Saturation?	Well	Saturation?	Well	Saturation?
A-16	Partial	GW-1	Dry*	PW-7	Sufficient	TP-69	Sufficient
CWF-1A	Dry	GW-1A	Sufficient	PZ-1	Sufficient	TP-71	Variable-SP
CWF-4A	Dry	GW-2 (TP-31)	Sufficient	PZ-10	Sufficient	TP-76	Dry
CWF-7A	Dry	GW-3 (PZ-68)	Variable-SP	PZ-32	Sufficient	TP-77	Sufficient
CWF-8A	Dry	GW-4 (TP-14)	Sufficient	PZ-44	Sufficient	TP-79	Dry
CWF-9A (TP-38)	Dry	GW-5	Sufficient	PZ-52	Sufficient	TP-80	Variable-SP
OAG 33 (CWF 10A)	Dry	GW 6 (TP 117)	Sufficient	TMW D	Sufficient	TP 83	Dry
CWF-11A	Dry	OAG-6	Dry	TMW-E	Dry	TP-85	Dry
CWF-12A	Dry	OAG-7	Dry	TMW-K	Sufficient	TP-87	Dry
CWF-110A	Dry	OAG-8	Dry	TP-12	Variable-PD	TP-99	Variable-SP
FWF-1A	Variable-SP	OAG-9	Dry	TP-13	Dry	TP-104	Dry
FWF-6A	Variable-SP	OAG-10	Dry	TP-16	Dry	TP-111	Sufficient
FWF-8A	Dry	OAG-12	Dry	TP-18	Variable-SP	TP-112	Dry
FWF-10A	Dry	OAG-13	Dry	TP-19	Dry	TP-118	Sufficient
FWF 14A	Dry	OAG-14	Dry	TP-20	Partial	TP-126,	Dry
FWF-16A	Dry	OAG-15	Dry	TP-37	Dry	TP-134	Dry
FWF-17A	Dry	OAG-25	Dry	TP-42	Sufficient	TP-139	Variable-PD
FWF-19A (TP-33)	Dry	OAG-26	Dry	TP-43	Sufficient	TP-141	Sufficient
OAG-44 (FWF-20A)	Dry	OAG-27	Dry	TP-44	Dry	TP-143	Sufficient
FWF-21A	Dry	OAG-30 (TP-155)	Dry	TP-46	Dry	TP-144	Dry
FWF-22A	Dry	OAG-31 (TP-130)	Dry	TP-47	Dry	TP-162	Dry
FWF-23A	Dry	OAG-32 (TP-129)	Dry	TP-49	Sufficient	TP-163	Dry
FWF-24A	Dry	OAG-46 (TP-164)	Dry	TP-62	Sufficient	TP-167	Sufficient
FWF-25A	Dry	OAG-55 (TP-102)	Dry	TP-64	Dry	TP-170	Partial
FWF-26A	Dry	PM-01	Variable-SP	TP-65	Dry	TP-171	Sufficient
FWF-27A	Variable-SP	PM-07	Sufficient	TP-67	Variable-SP		
FWF-119A (OAG-7)	Dry	PW-1	Sufficient	TP-68	Variable-SP		

NOTES: Values in Saturation Columns are:

Sufficient = Sufficient Groundwater is present in the well to collect a full sample.
Partial = Enough Groundwater is present to collect a sample for some, but not all, of the required analyses.
Dry = Insufficient groundwater to collect a sample.
Variable = Amounts of groundwater in the well are variable, causing it to move between sufficient and partial (Variable-SP), or partial and dry (Variable-PD).

* = Water sampled from GW-1 appears to be surface water that filled the normally dry stock pond that GW-1 is installed in. The water overtopped the well's surface casing and infiltrated the underlying well bore.

Summary statistics for the pre-operational radiological OAG groundwater results are presented in Table 4-2. Figure 4-5 through Figure 4-5 graphically depict the pre-operational soil results. All pre-operational OAG groundwater sample results are given in Appendix A.

Table 4-2: Summary Statistics for OAG Wells (pCi/L).

Analyte	Observations	Number of Stations	Below L_c*	Maximum	Minimum	Mean	Standard Deviation
Alpha	253	42	5	1.98E+01	6.35E 01	5.76E+00	3.29E+00
Beta	253	42	4	4.06E+01	-1.26E+00	6.66E+00	3.67E+00
Am-241	249	42	241	1.94E+01	-4.51E+01	-3.19E+00	1.06E+01
Cs-137	249	42	241	5.30E+00	-8.28E+00	-6.38E-02	1.69E+00
Cr-51	249	42	242	8.56E+02	-1.42E+03	-1.03E+01	2.09E+02
C-14	221	39	205	1.51E+01	-1.42E+01	-1.30E+00	5.98E+00
Co 60	249	42	239	4.11E+00	3.46E+00	2.12E 02	1.56E+00
Cu-243	249	42	235	1.50E+01	-1.35E+01	-3.97E-01	4.97E+00
Cu-243/244	234	42	221	7.08E-02	-2.29E-02	1.49E-03	1.21E-02
I-129	209	39	194	1.05E+00	-7.93E-01	4.81E-02	2.88E-01
Pb-210	210	39	95	8.86E+00	-3.25E+00	2.17E+00	1.84E+00
Mn-54	249	42	244	4.50E+00	-6.13E+00	-1.65E-01	1.53E+00
Np-237	234	42	214	6.62E-02	-4.60E-02	2.69E-03	1.73E-02
Pu-238	234	42	180	9.81E-02	-2.85E-02	1.42E-02	1.92E-02
Pu-239/240	234	42	221	1.26E-01	-3.37E-02	5.16E-03	1.71E-02
Pu-241	221	39	206	5.30E+00	-4.67E+00	-2.26E-01	1.67E+00
Pu-242	234	42	224	8.35E-02	-2.31E-02	3.98E-03	1.50E-02
Ra-226	216	39	17	2.49E+00	-7.85E-02	4.25E-01	4.06E-01
Ra-228	211	39	12	3.36E+00	-2.32E-01	1.09E+00	6.40E-01
Sr-90	202	39	165	1.84E+00	-1.28E+00	2.00E-01	6.77E-01
Tc-99	220	39	214	3.12E+01	-3.65E+01	-1.72E+00	1.00E+01
Th-228	239	42	130	4.66E-01	-3.80E-02	4.38E-02	6.64E-02
Th-230	239	42	131	1.92E-01	-3.18E-02	2.56E-02	3.72E-02
Th-232	239	42	182	4.68E-02	-2.92E-02	7.52E-03	1.15E-02
H-3	221	39	213	1.68E+02	-2.15E+02	-1.33E+01	7.61E+01
U-234	239	42	0	1.46E+01	4.26E-01	3.40E+00	2.27E+00
U-235	239	42	63	6.08E-01	-2.00E-02	9.30E-02	8.43E-02
U-238	239	42	0	6.68E+00	2.18E-01	1.36E+00	9.61E-01

*Values of Critical Level (Lc) were estimated as one-half of the Minimum Detectable Concentration (MDC).

As summarized in Appendix A and in the table below, a number of naturally occurring metals were also reported in OAG groundwater. Collectively, the concentrations of these radionuclides and non-radiological metals are representative of background conditions at WCS.

Table 4-3: OAG Groundwater Monitoring Results for Low Level Pre-Operational Monitoring Program.

Analyte	Units	Observations	No. of Stations	< PQL	Max. Value	Min. Value	Mean Value*	Standard Dev.*
Antimony	µg/L	44	29	26 (7 J Flags)	30.3 J	<3.0	9.01	8.09
Arsenic	µg/L	205	41	164 (108 J Flags)	324	<5.0	20.86	35.10
Barium	µg/L	68	29	68	915	23.2	230.0	201.2
Beryllium	µg/L	44	29	43 (5 J flags)	6.65	<1	0.80	1.02
Boron	µg/L	19	12	0	1160	82.2	380.1	327.2
Cadmium	µg/L	205	41	204 (27 J flags)	8.42	<1	0.66	0.65
Calcium	µg/L	12	12	0	326000	71100	159775	86045
Chromium	µg/L	68	29	20 (20 J flags)	280	1.31 J	23.7	41.5
Cobalt	µg/L	39	29	33 (10 J flags)	49	<1	3.72	8.68
Copper	µg/L	31	24	21 (9 J flags)	117	<3	12.5	23.0
Iron	µg/L	12	12	0	113000	1690	22386	30940
Lead	µg/L	68	29	59 (13 J flags)	64.3	<3.3	6.09	10.1
Magnesium	µg/L	12	12	0	62900	11600	27625	16402
Manganese	µg/L	12	12	0	1420	24.2	384.5	430.3
Mercury	µg/L	63	24	63 (2 J flags)	0.099 J	<0.066	N/A	N/A
Molybdenum	µg/L	19	12	16 (14 J flags)	24.3	<2	6.16	5.41
Nickel	µg/L	200	41	69 (43 J flags)	475	<1.5	19.2	39.1
Potassium	µg/L	12	12	0	23200	2720	8405.8	5598.3
Selenium	µg/L	212	41	181 (70 flags)	178	<1.5	14.5	24.5
Sodium	µg/L	12	12	0	196000	18800	99375	53830
Thallium	µg/L	31	24	14 (3 J flags)	35.6	<5	17.0	12.5
Uranium	µg/L	19	12	14 (6 J flags)	191	<10	31.2	45.3
Vanadium	µg/L	31	24	0	350	24.9	68.6	67.3
Zinc	µg/L	44	29	3 (3 J flags)	433	5.54 J	53.5	69.7
1,4-Dioxane	µg/L	193	42	193	<2.44	<1.74	N/A	N/A
Phenol	µg/L	193	42	193	<1.22	<0.87	N/A	N/A
1,1,1-Trichloroethane	µg/L	199	42	199	<0.325	<0.325	N/A	N/A
1,1,2,2-Tetrachloroethane	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
1,1,2-Trichloroethane	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
1,1-Dichloroethane	µg/L	199	42	199	<0.3	<0.3	N/A	N/A
1,1-Dichloroethylene	µg/L	199	42	199	<0.3	<0.3	N/A	N/A
1,2-Dichloroethane	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
1,2-Dichloropropane	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
2-Butanone	µg/L	34	24	33	37.1	<1.25	N/A	N/A
Acetone	µg/L	199	42	199 (21 J-flags, 9 BJ flags)	18.4 J	<1.5	N/A	N/A
Benzene	µg/L	199	42	199	<0.3	<0.3	N/A	N/A
Bromodichloromethane	µg/L	199	42	199 (1 J-flag)	0.34 J	<0.25	N/A	N/A
Bromoform	µg/L	199	42	199 (4 J-flags)	1.63 J	<0.25	N/A	N/A
Bromomethane	µg/L	199	42	199	<0.3	<0.3	N/A	N/A
Carbon disulfide	µg/L	199	42	199	<1.25	<1.25	N/A	N/A
Carbon tetrachloride	µg/L	199	42	199	<0.3	<0.3	N/A	N/A
Chlorobenzene	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
Chloroethane	µg/L	199	42	199 (2 J-flags)	0.59 J	<0.3	N/A	N/A
Chloroform	µg/L	199	42	199 (1 J-flag)	0.5 J	<0.25	N/A	N/A
Chloromethane	µg/L	199	42	199 (8 J-flags)	0.862 J	<0.3	N/A	N/A
cis-1,3-Dichloropropylene	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
Dibromochloromethane	µg/L	199	42	199	<0.3	<0.3	N/A	N/A
Ethylbenzene	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
Tetrachloroethylene	µg/L	199	42	199	<0.3	<0.3	N/A	N/A

Analyte	Units	Observations	No. of Stations	< PQL	Max. Value	Min. Value	Mean Value*	Standard Dev.*
Toluene	µg/L	199	42	199 (1 J-flag; 2 BJ-flags)	0.57 J	<0.25	N/A	N/A
trans-1,2-Dichloroethylene	µg/L	199	42	199	<0.3	<0.3	N/A	N/A
trans-1,3-Dichloropropylene	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
Trichloroethylene	µg/L	199	42	199	<0.25	<0.25	N/A	N/A
Vinyl chloride	µg/L	199	42	199	<0.5	<0.5	N/A	N/A

NOTES: * Non-detect values were replaced with one half of the MDL for summary statistics.

In addition to the naturally occurring analytes, a number of false positives were reported during the pre-operational period as well. False positives were identified during the data validation process WCS implements to verify and validate analytical data. All of the VOCs reported as being detected in the table above are considered false positives. They appear to be artifacts of either the sampling or analytical procedures and do not represent contaminants present at WCS's facility.

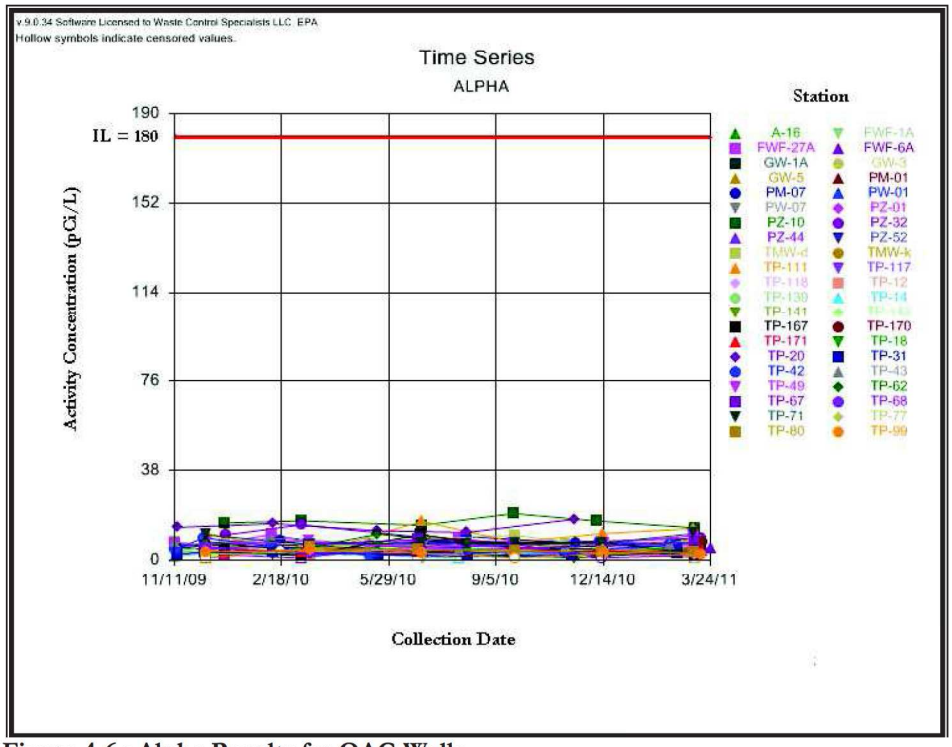

Figure 4-6 : Alpha Results for OAG Wells.

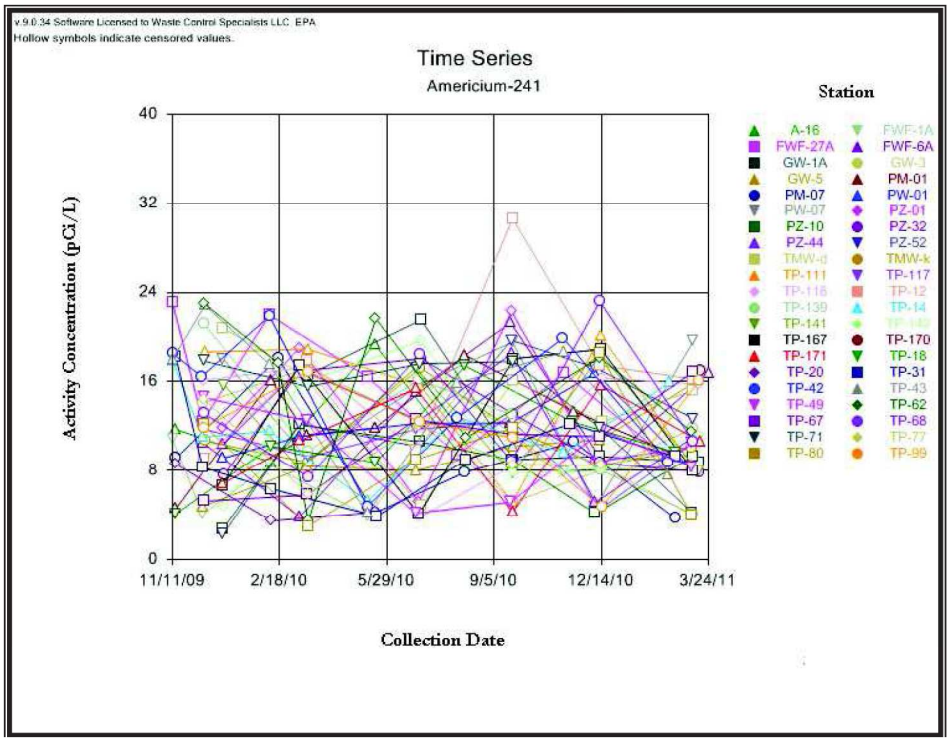

Figure 4-7 : Americum-241 Results for OAG Wells.

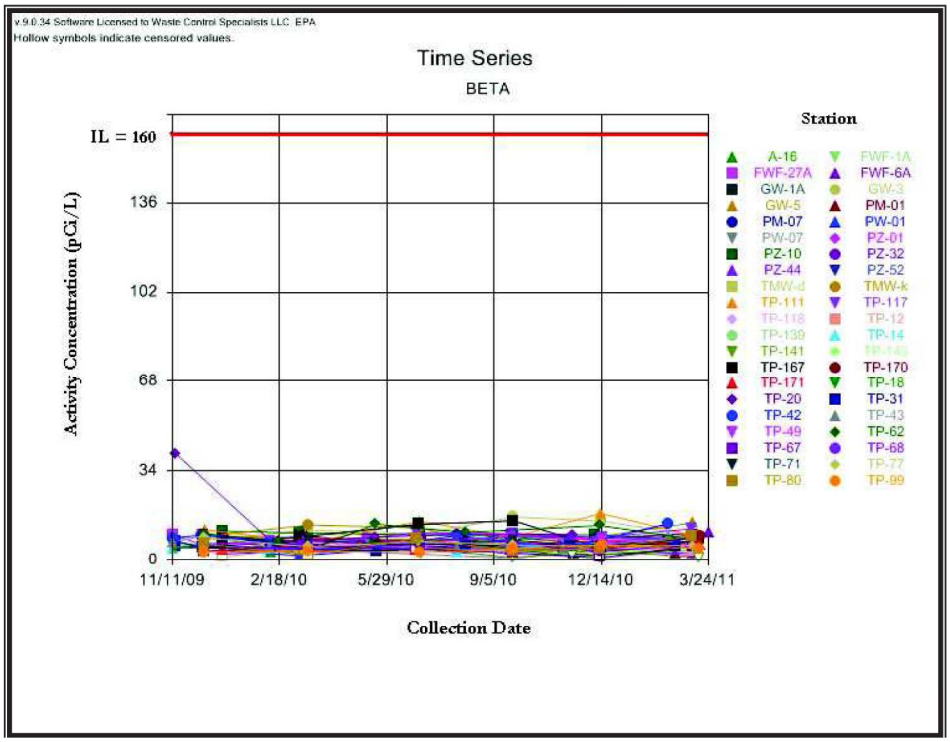

Figure 4-8 : Beta Results for OAG Wells.

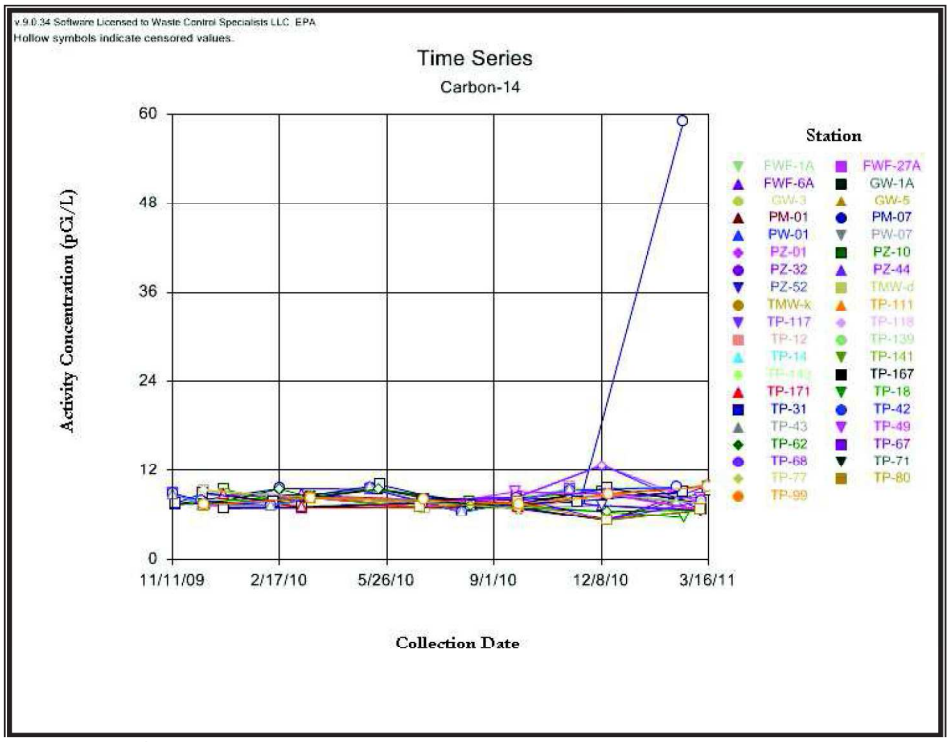

Figure 4-9 : Carbon-14 Results for OAG Wells.

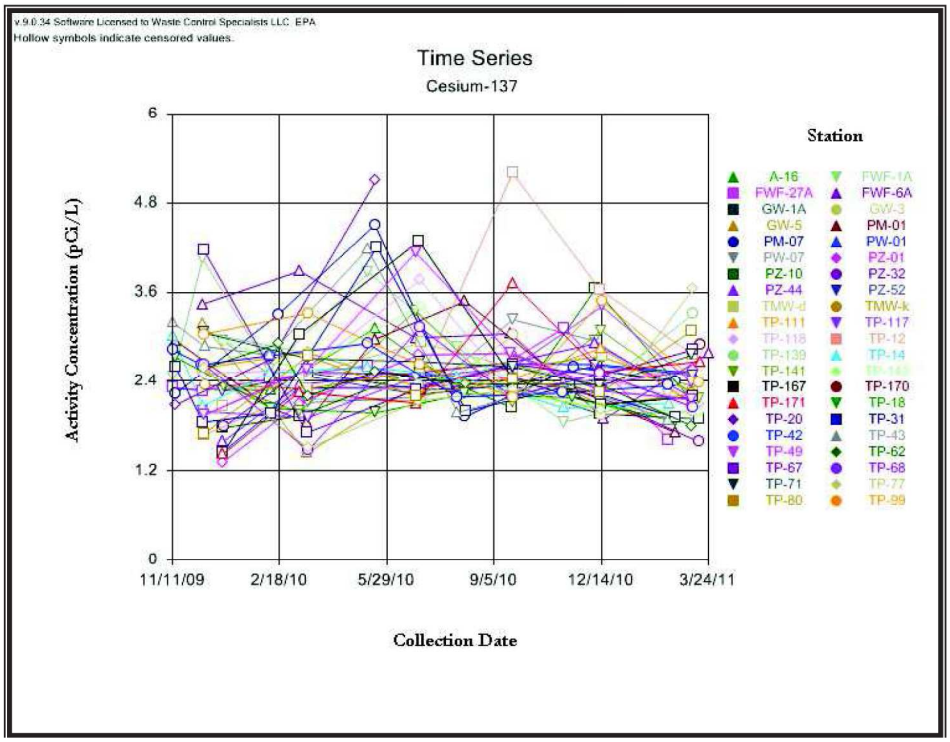

Figure 4-10 : Cesium-137 Results for OAG Wells.

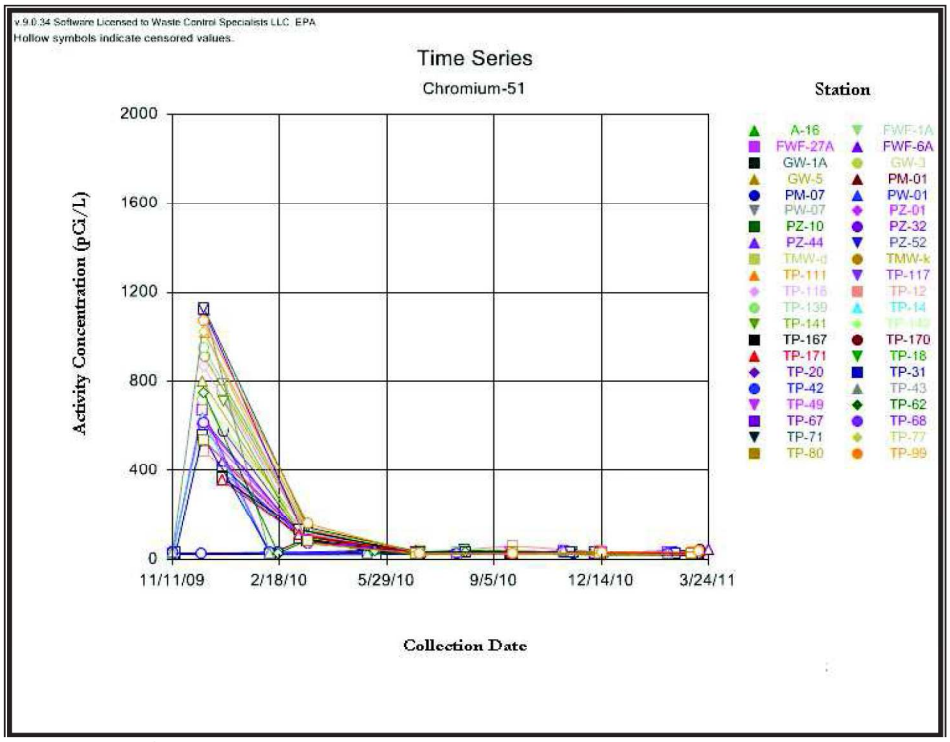

Figure 4-11 : Chromium-51 Results for OAG Wells.

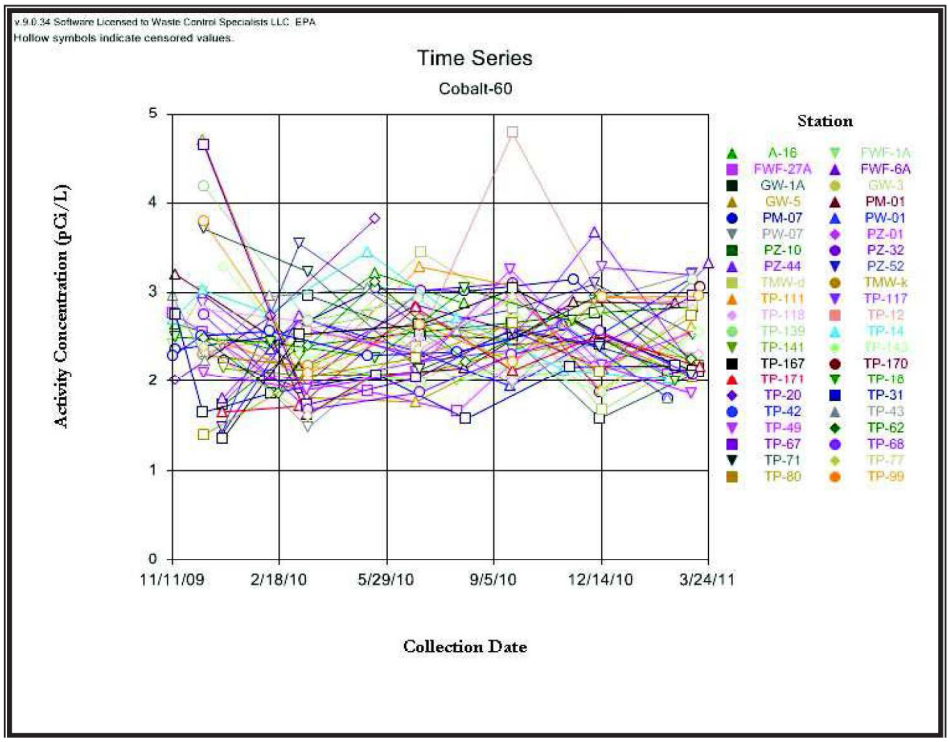

Figure 4-12 : Cobalt-60 Results for OAG Wells.

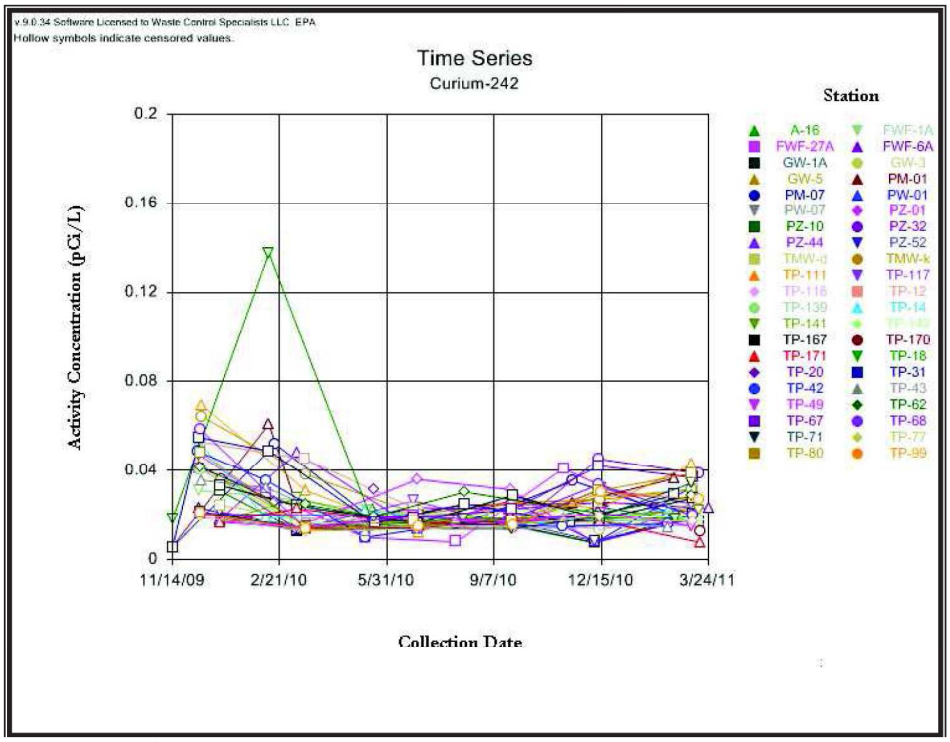

Figure 4-13 : Curium-242 Results for OAG Wells.

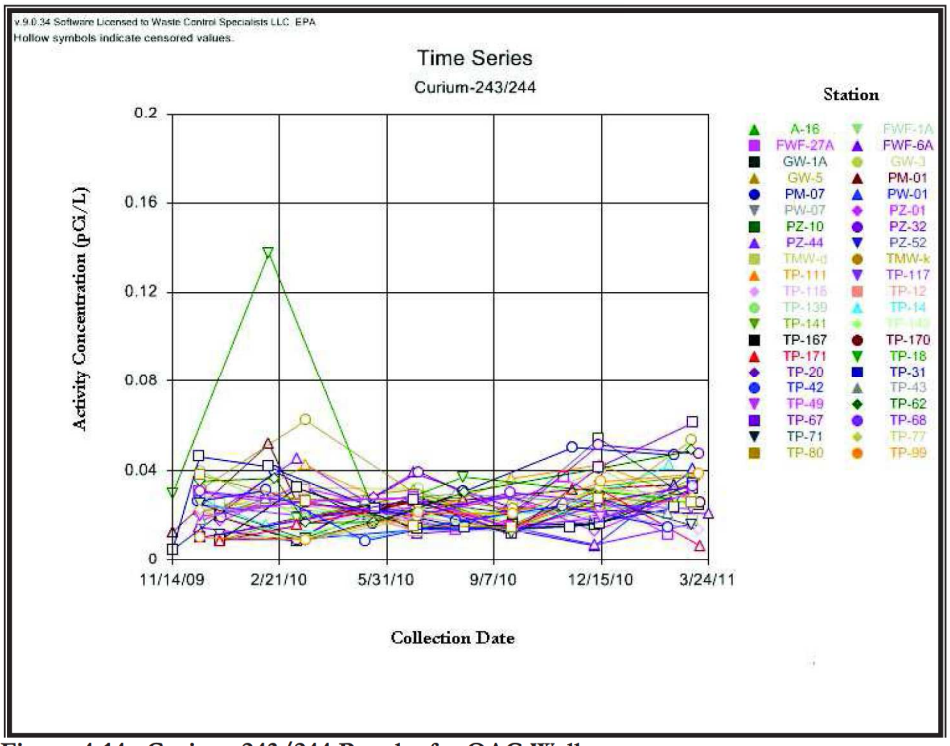

Figure 4-14 : Curium-243/244 Results for OAG Wells.

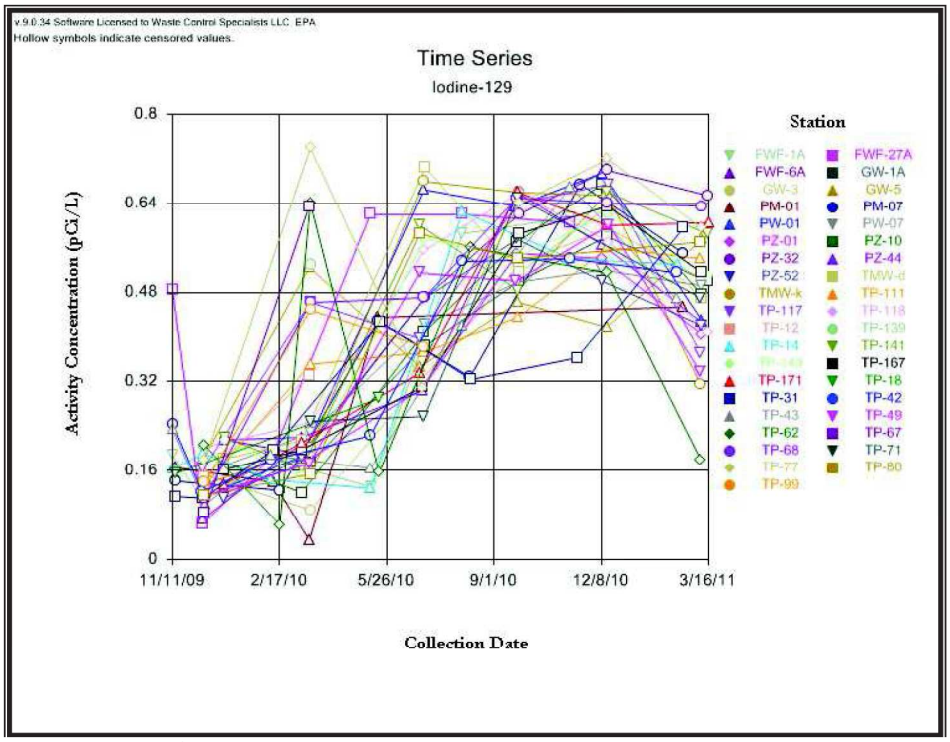

Figure 4-15 : Iodine-129 Results for OAG Wells.

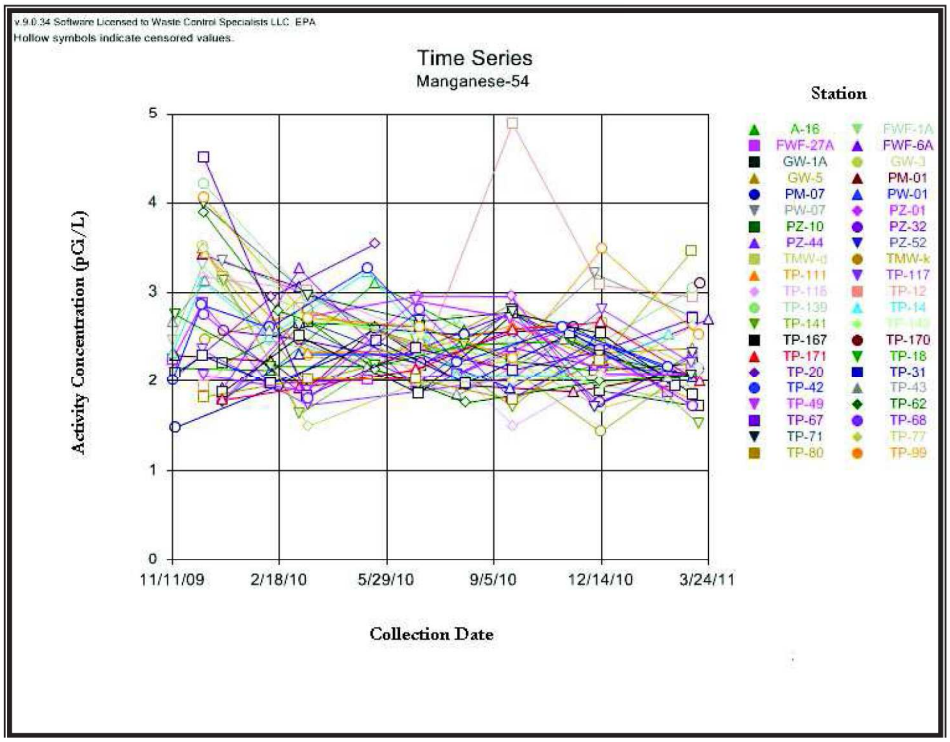

Figure 4-16 : Manganese-54 Results for OAG Wells.

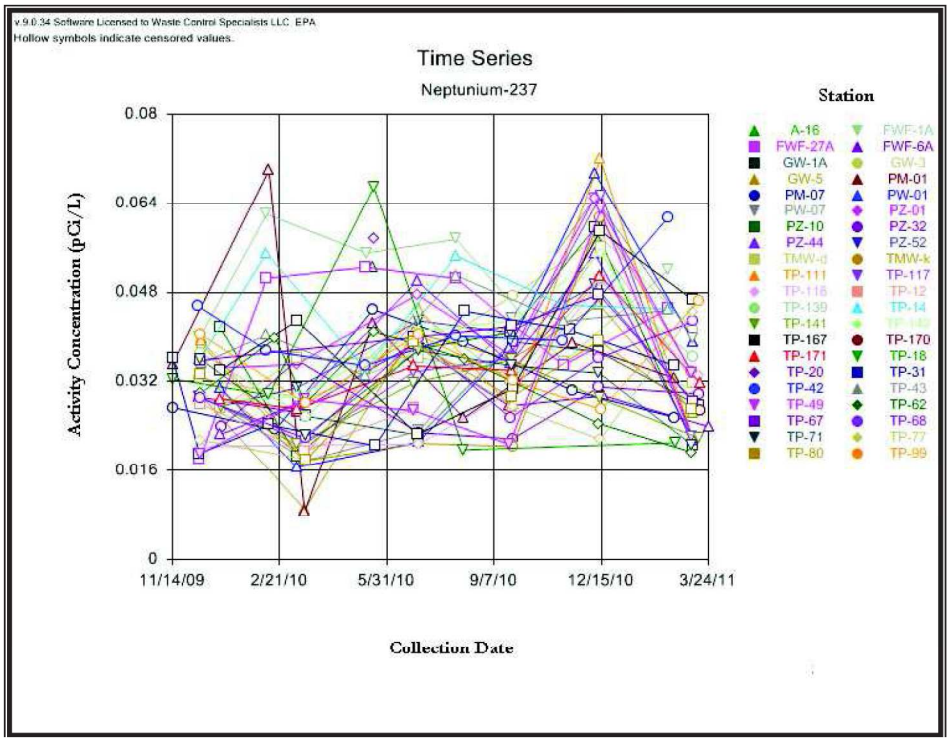

Figure 4-17 : Neptunium-237 Results for OAG Wells.

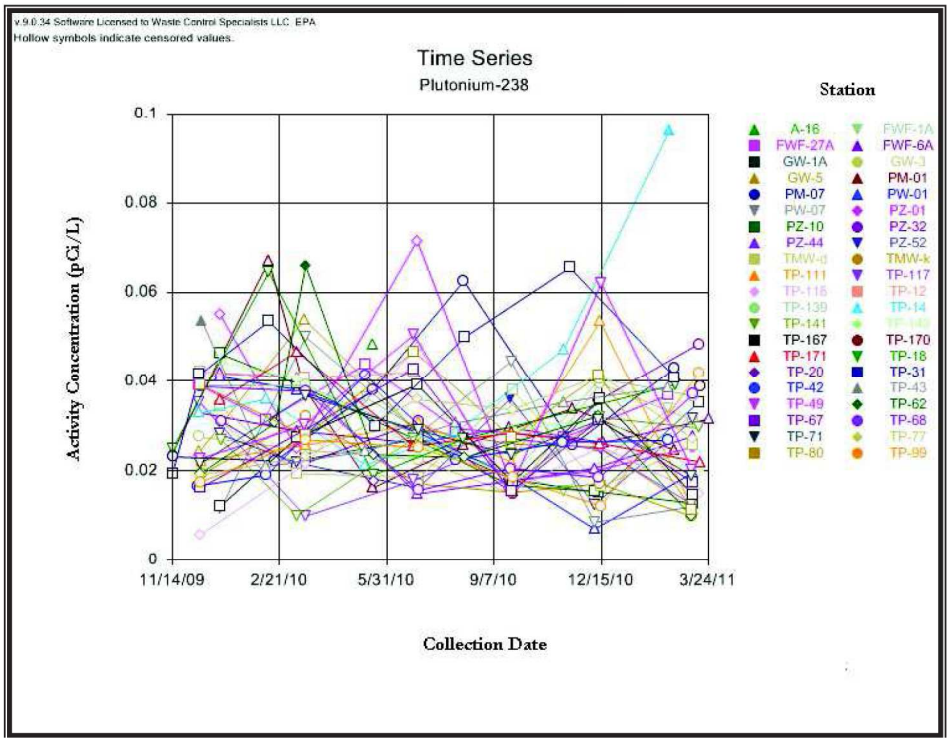

Figure 4-18 : Plutonium-238 Results for OAG Wells.

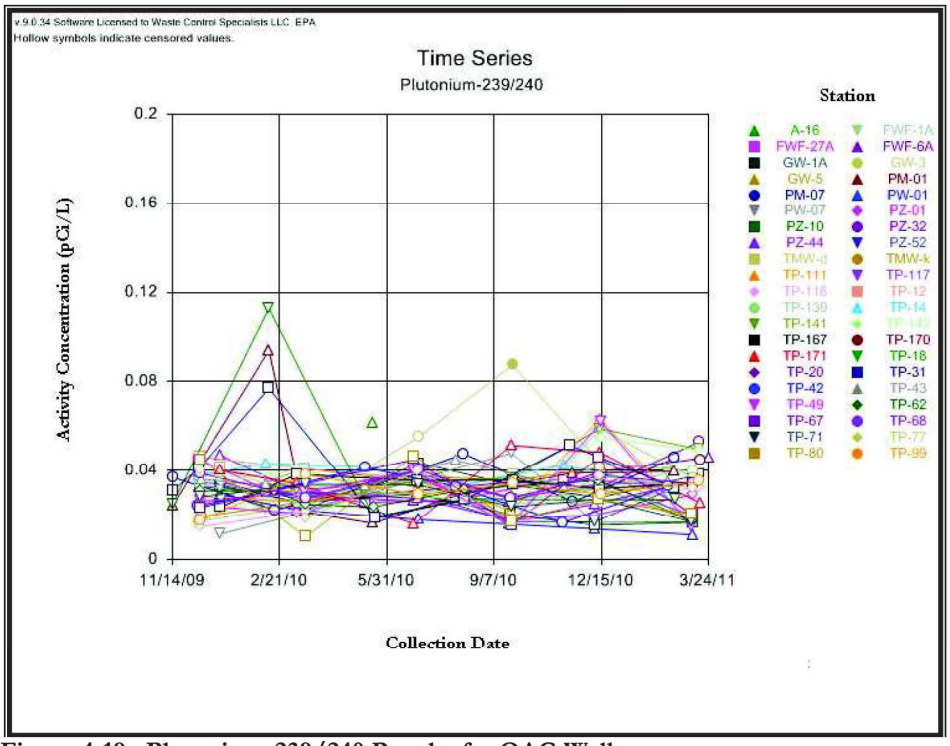

Figure 4-19 : Plutonium-239/240 Results for OAG Wells.

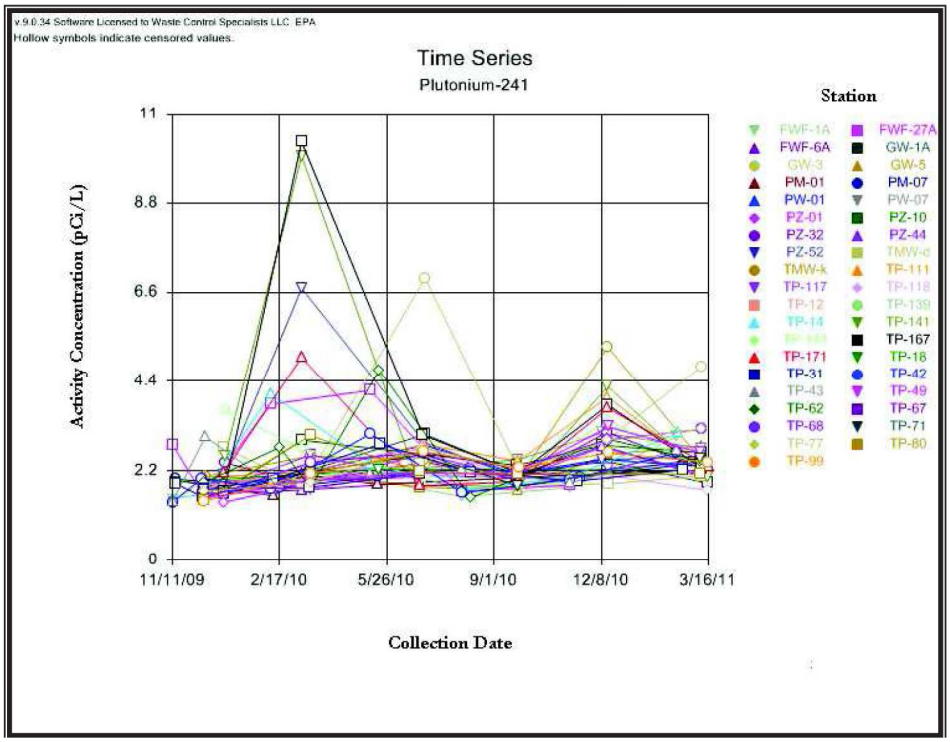

Figure 4-20 : Plutonium-241 Results for OAG Wells.

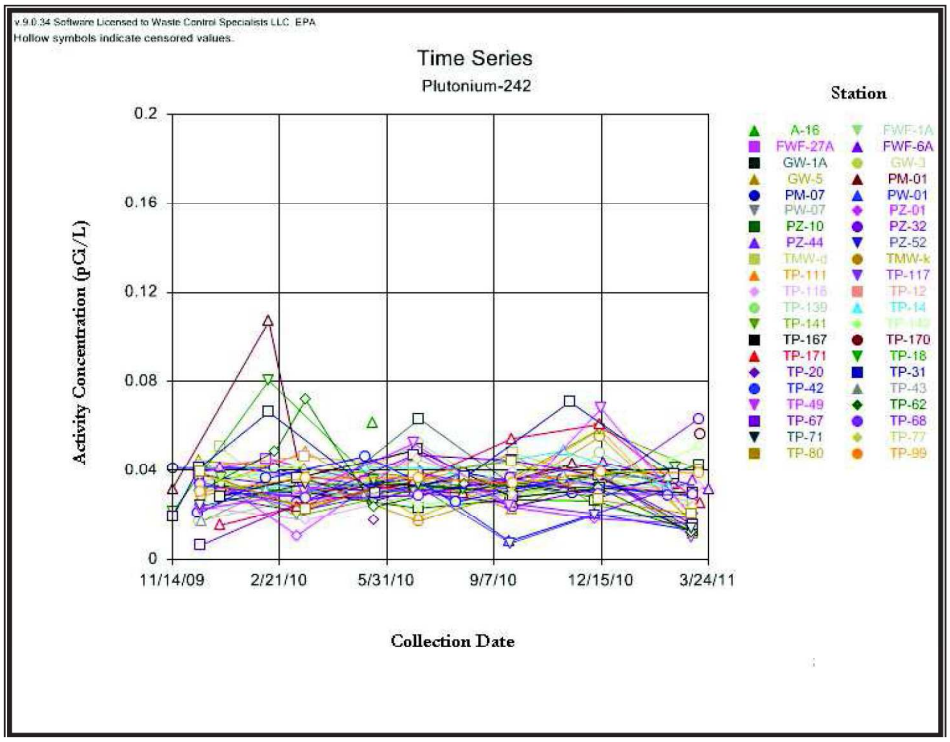

Figure 4-21 : Plutonium-242 Results for OAG Wells.

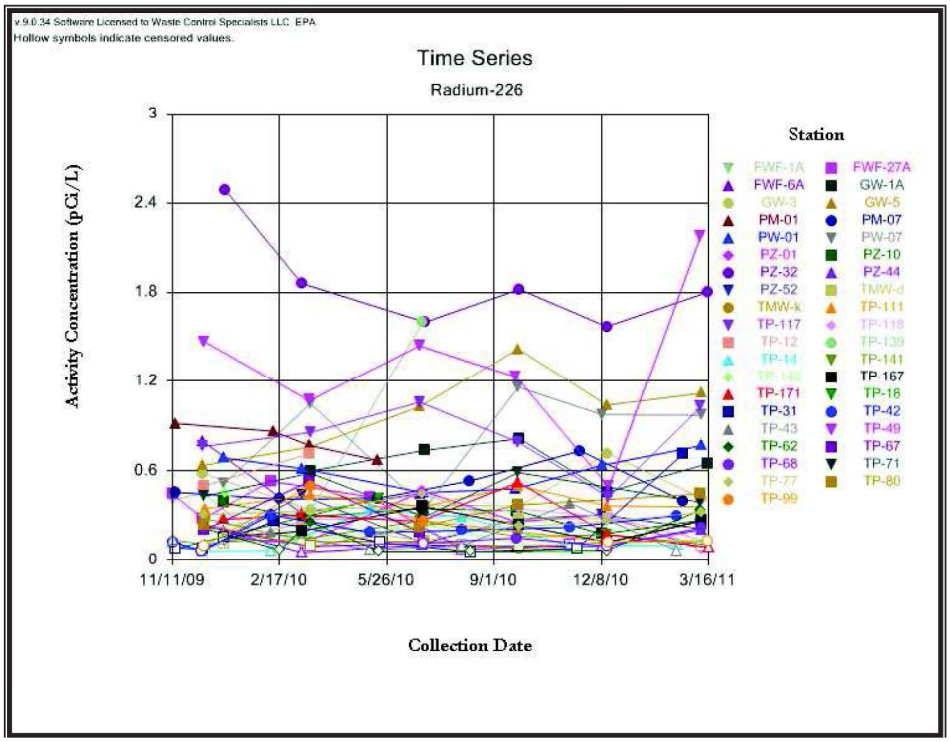

Figure 4-22 : Radium-226 Results for OAG Wells.

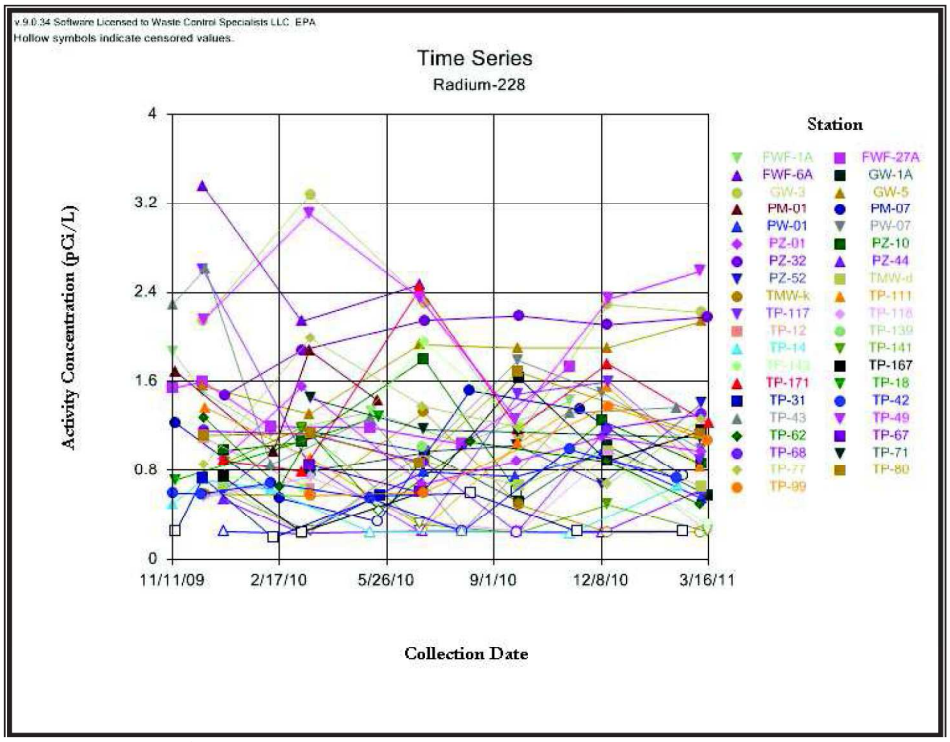

Figure 4-23 : Radium-228 Results for OAG Wells.

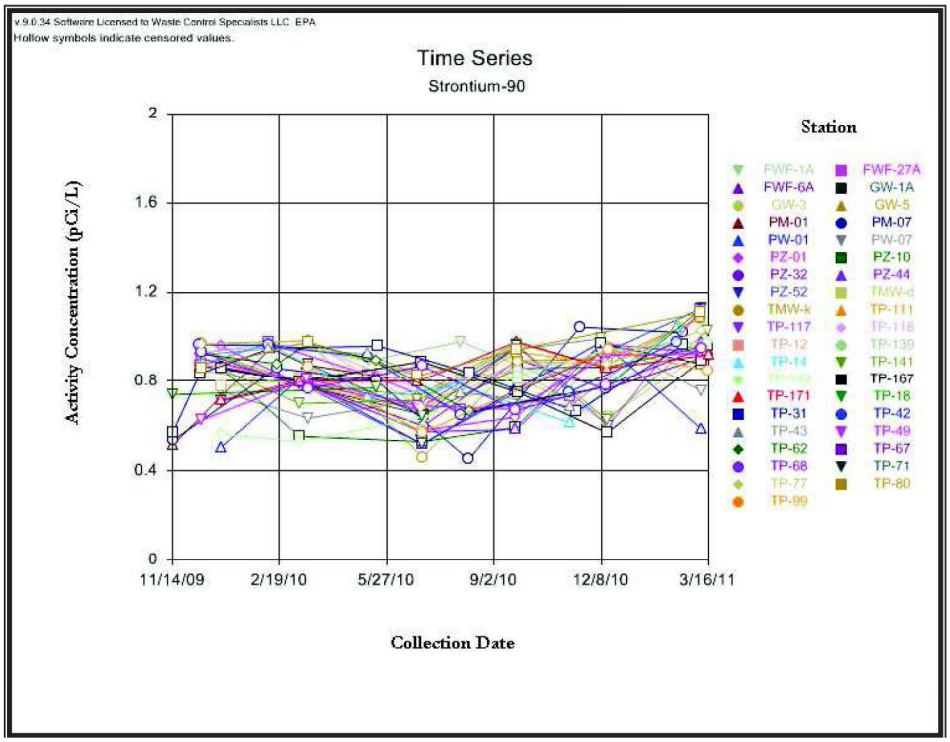

Figure 4-24 : Strontium-90 Results for OAG Wells.

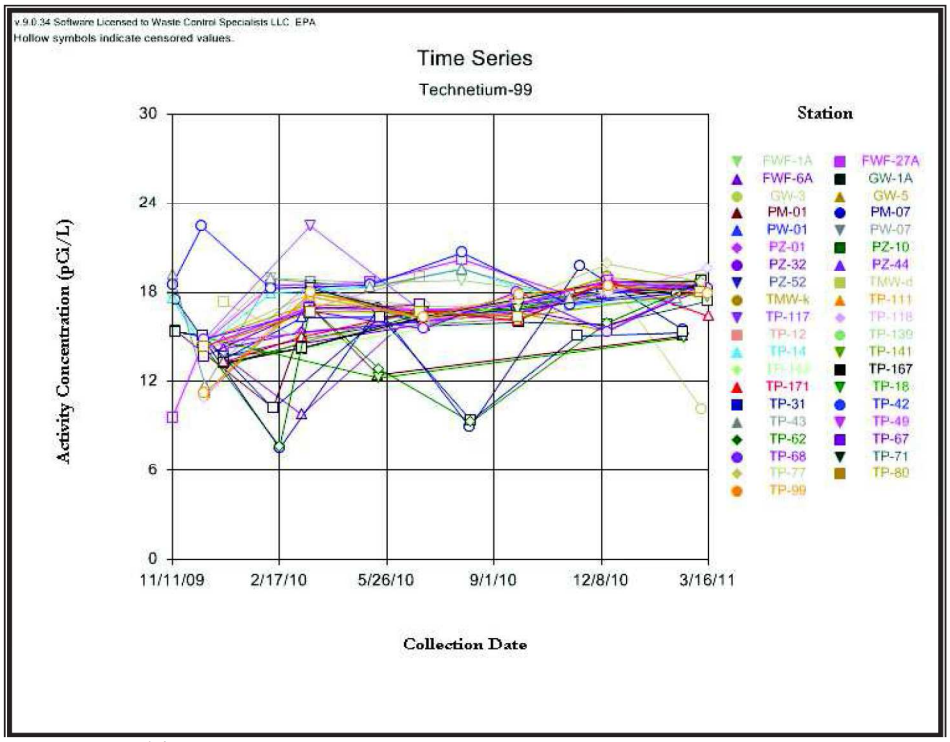

Figure 4-25 : Technetium-99 Results for OAG Wells.

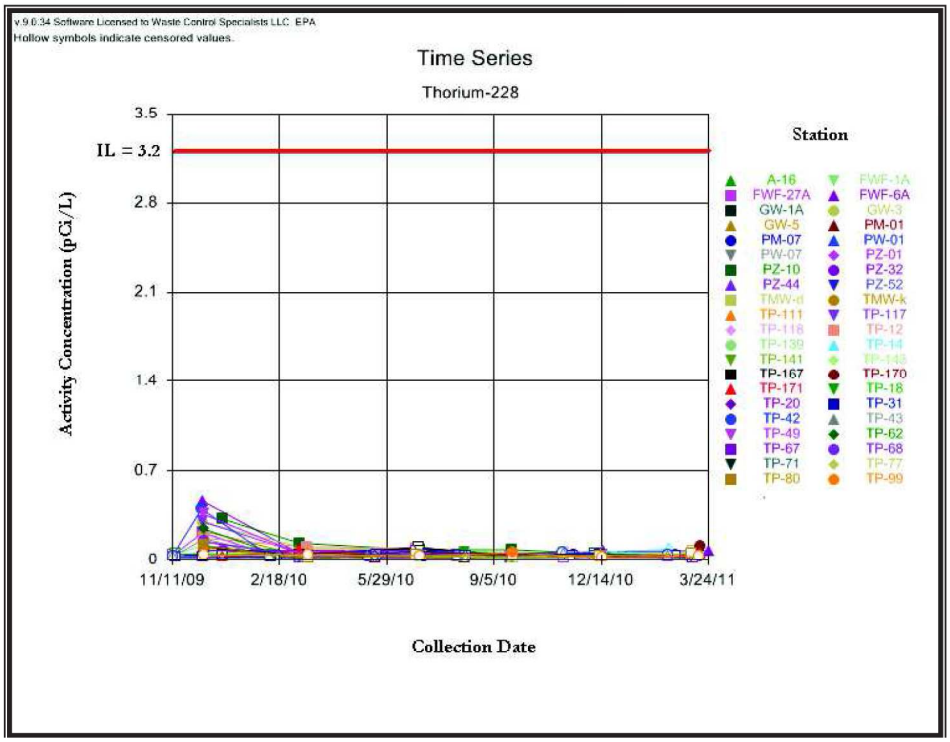

Figure 4-26 : Thorium-228 Results for OAG Wells.

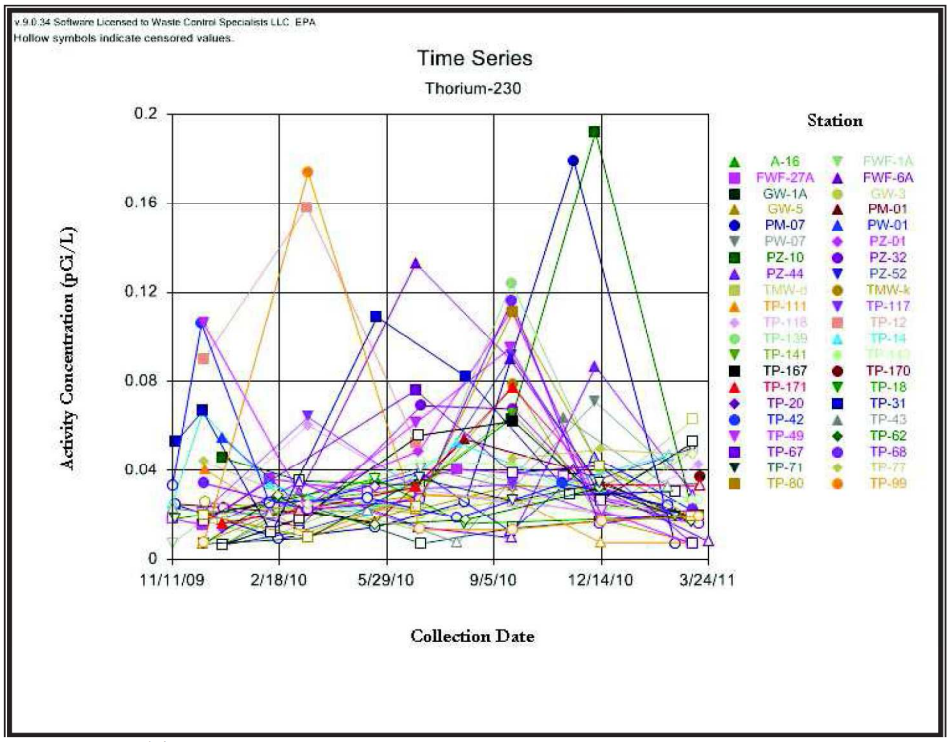

Figure 4-27 : Thorium-230 Results for OAG Wells.

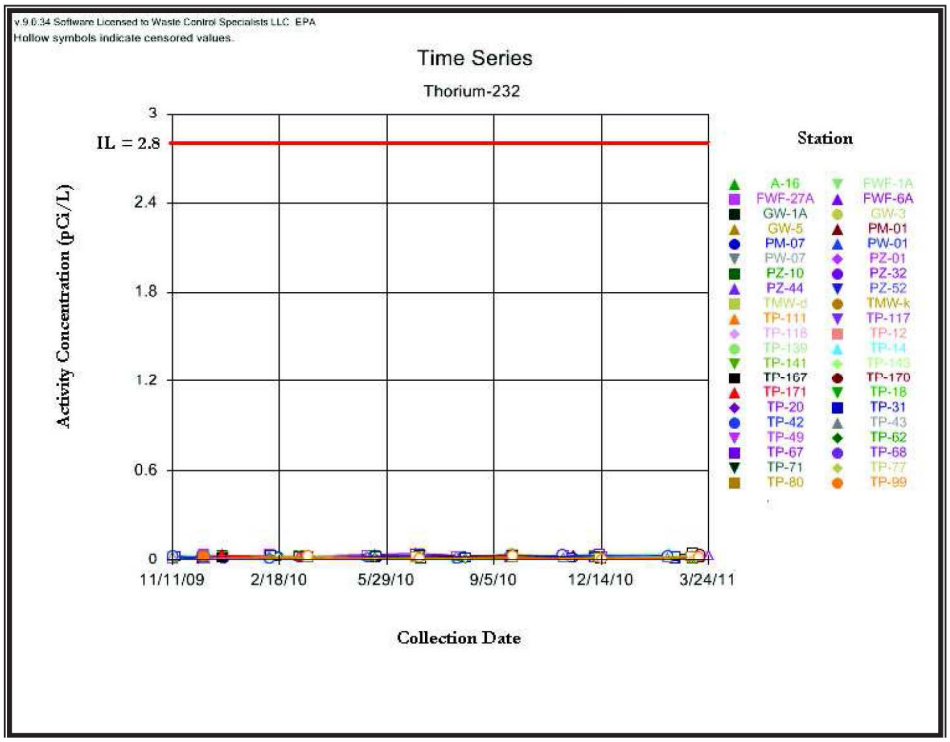

Figure 4-28 : Thorium-232 Results for OAG Wells.

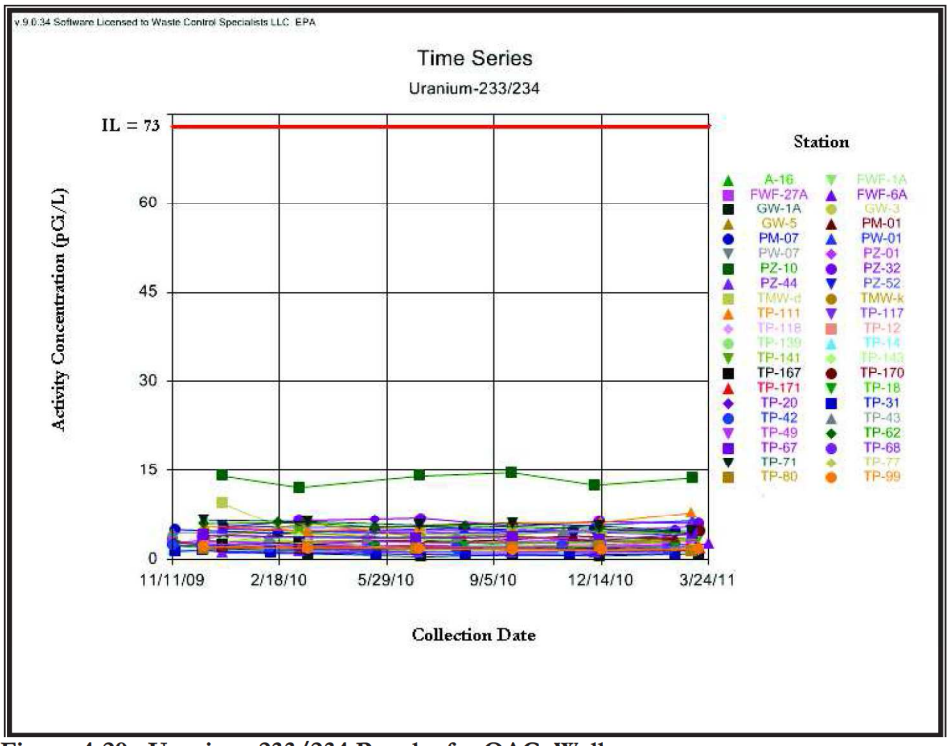

Figure 4-29 : Uranium-233/234 Results for OAG Wells.

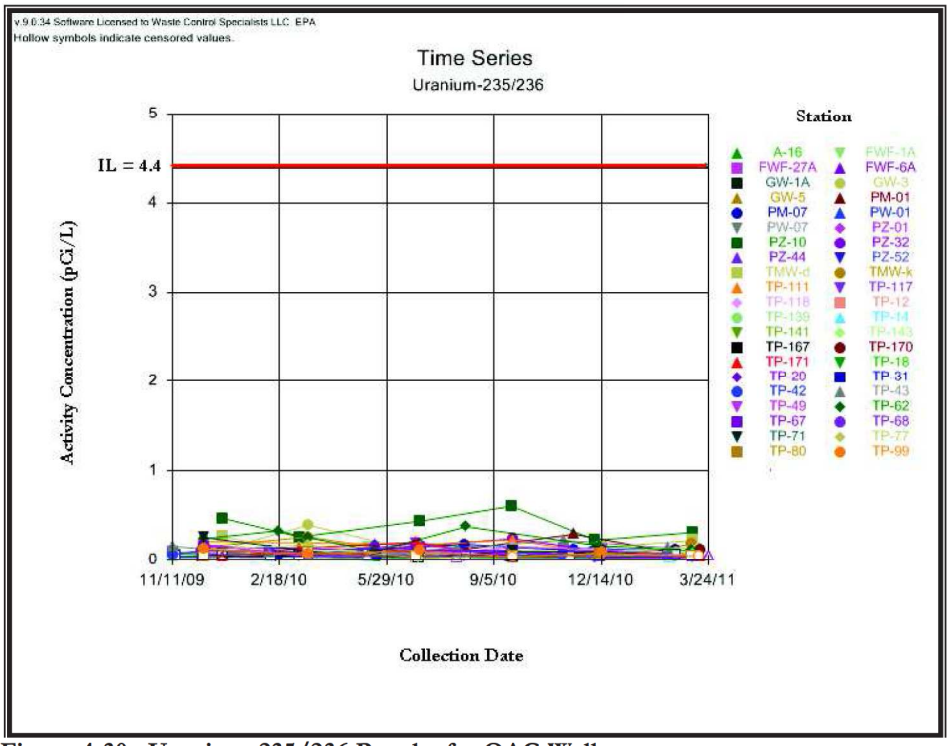

Figure 4-30 : Uranium-235/236 Results for OAG Wells.

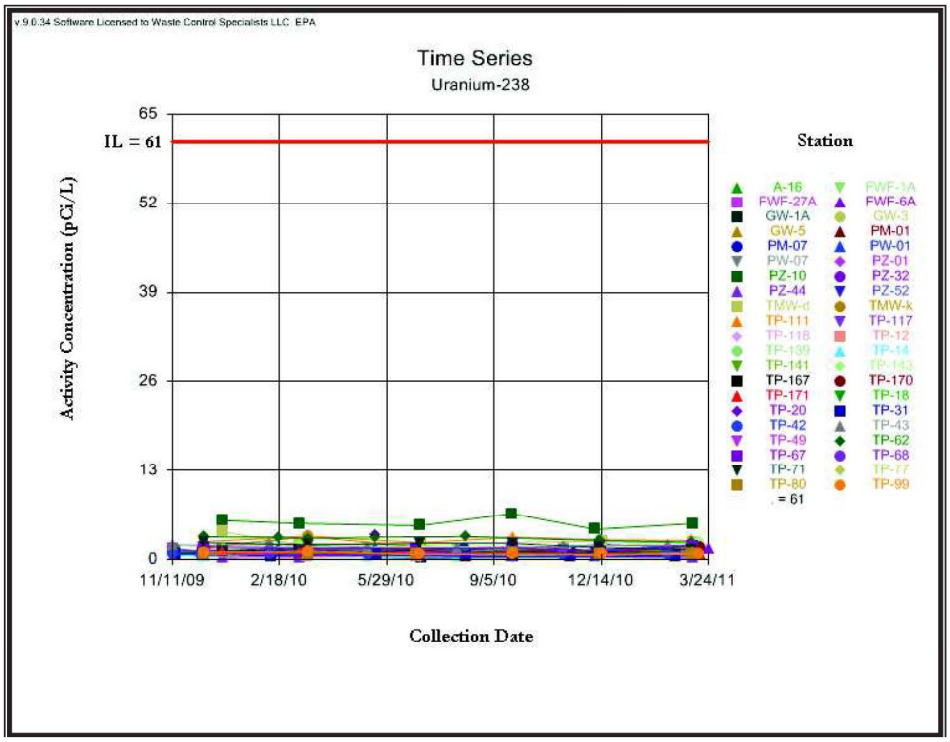

Figure 4-31 : Uranium-238 Results for OAG Wells.

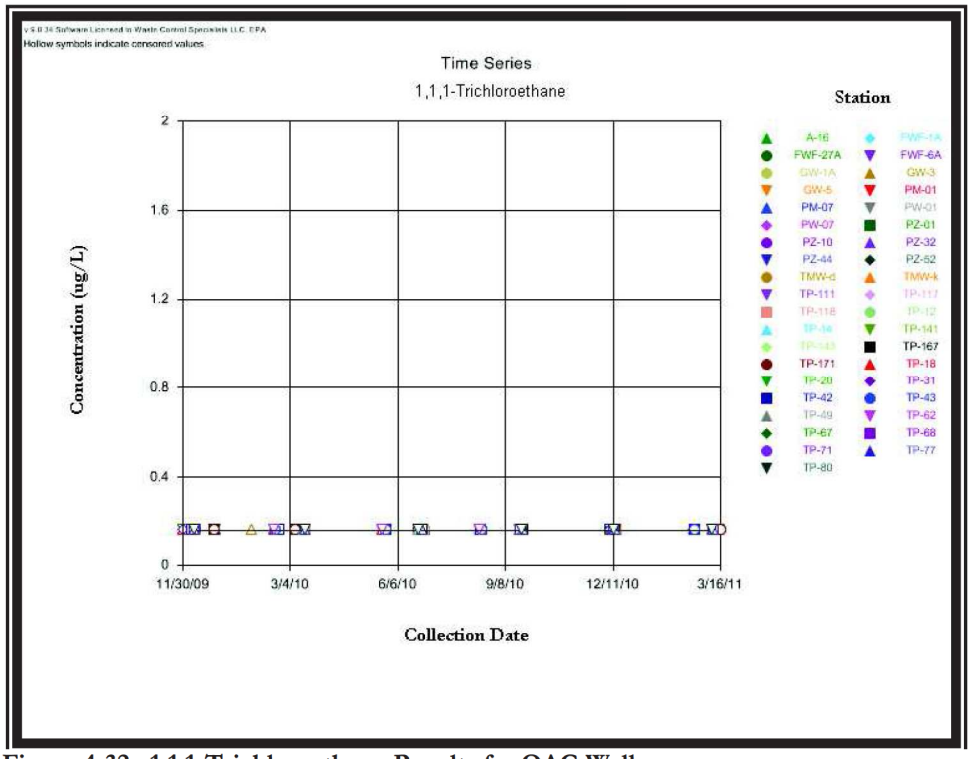

Figure 4-32 : 1,1,1-Trichloroethane Results for OAG Wells.

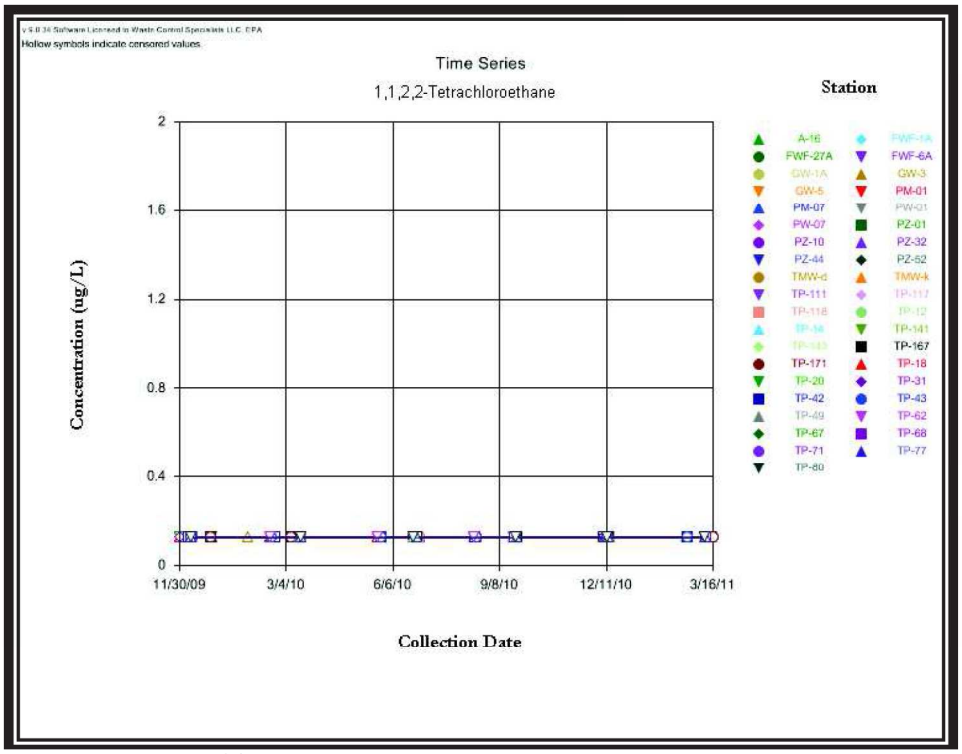

Figure 4-33 : 1,1,2,2-Tetrachloroethane Results for OAG Wells.

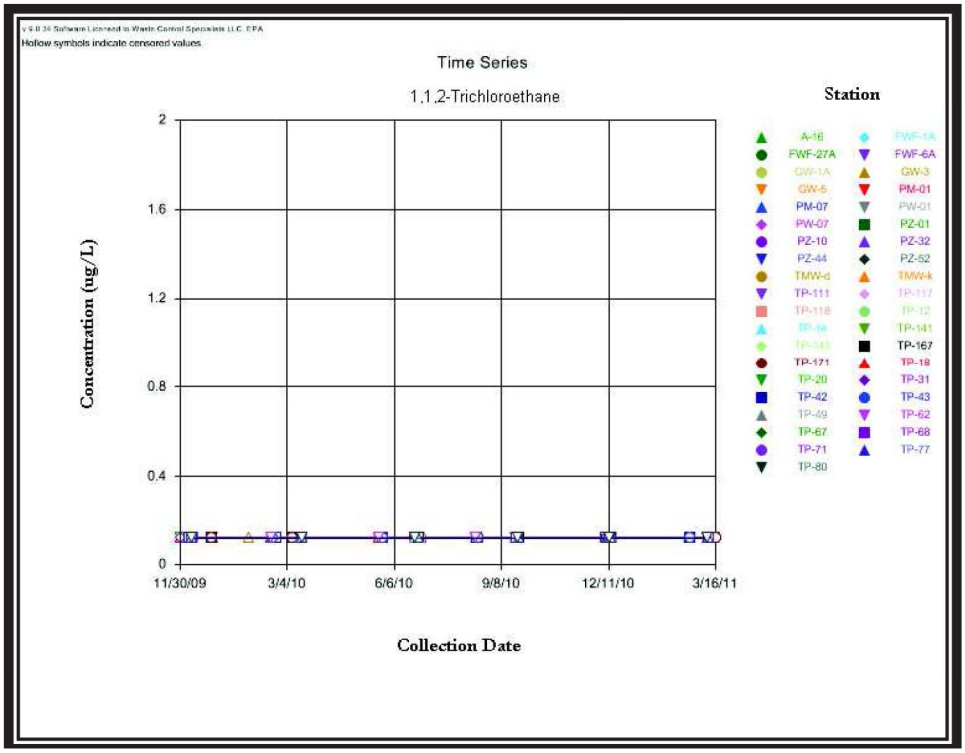

Figure 4-34 : 1,1,2-Trichloroethane Results for OAG Wells.

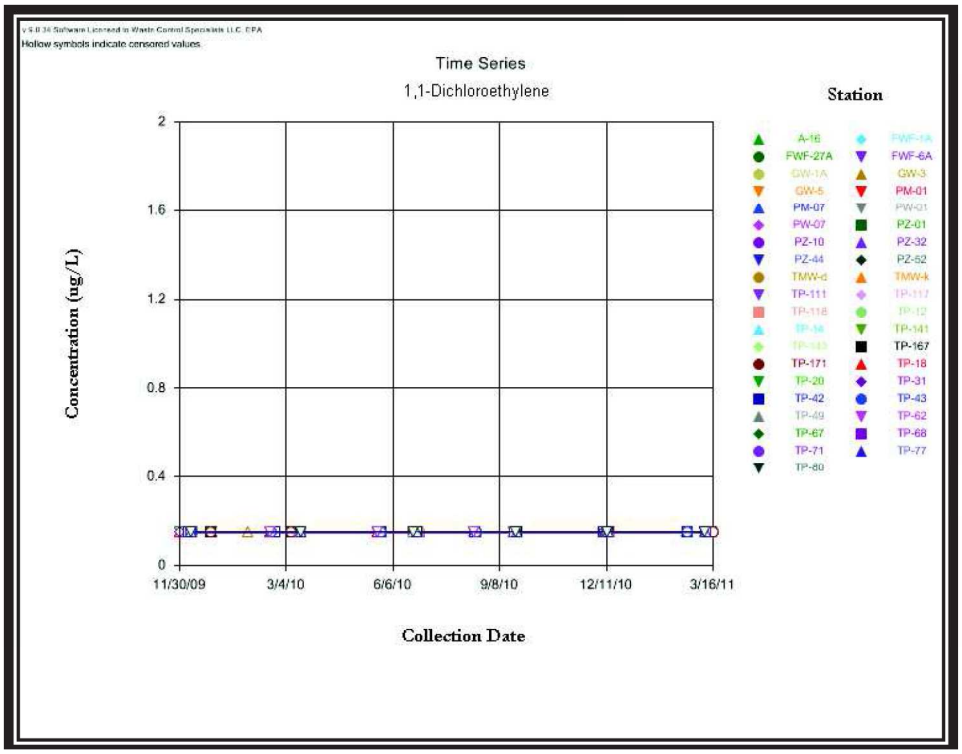

Figure 4-35 : 1,1-Dichloroethylene Results for OAG Wells.

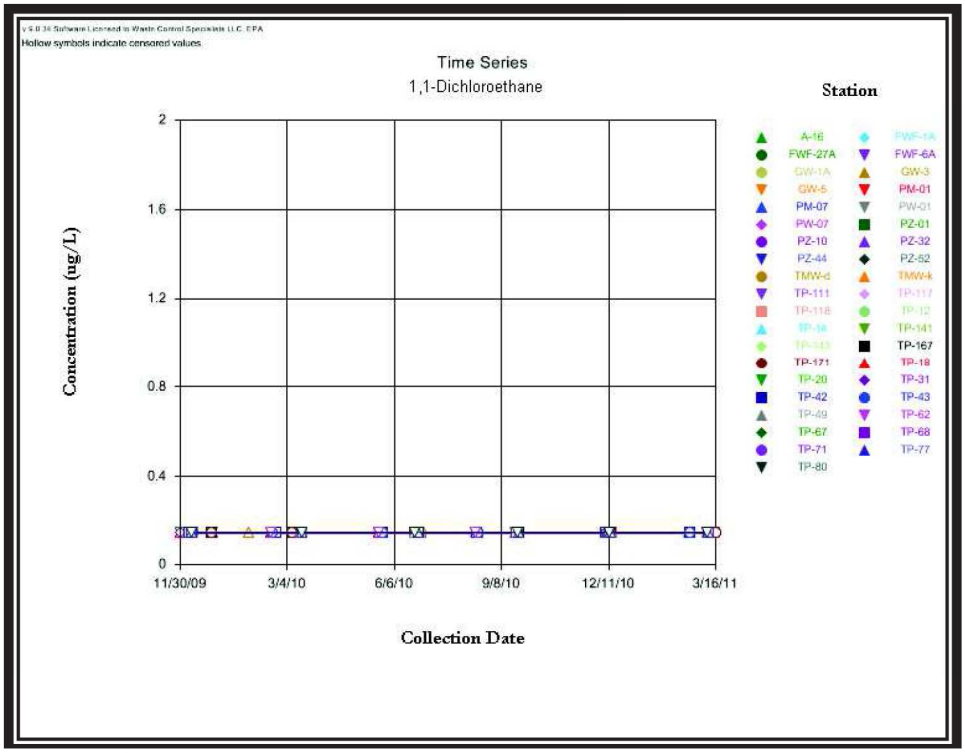

Figure 4-36 : 1,1-Dichloroethane Results for OAG Wells.

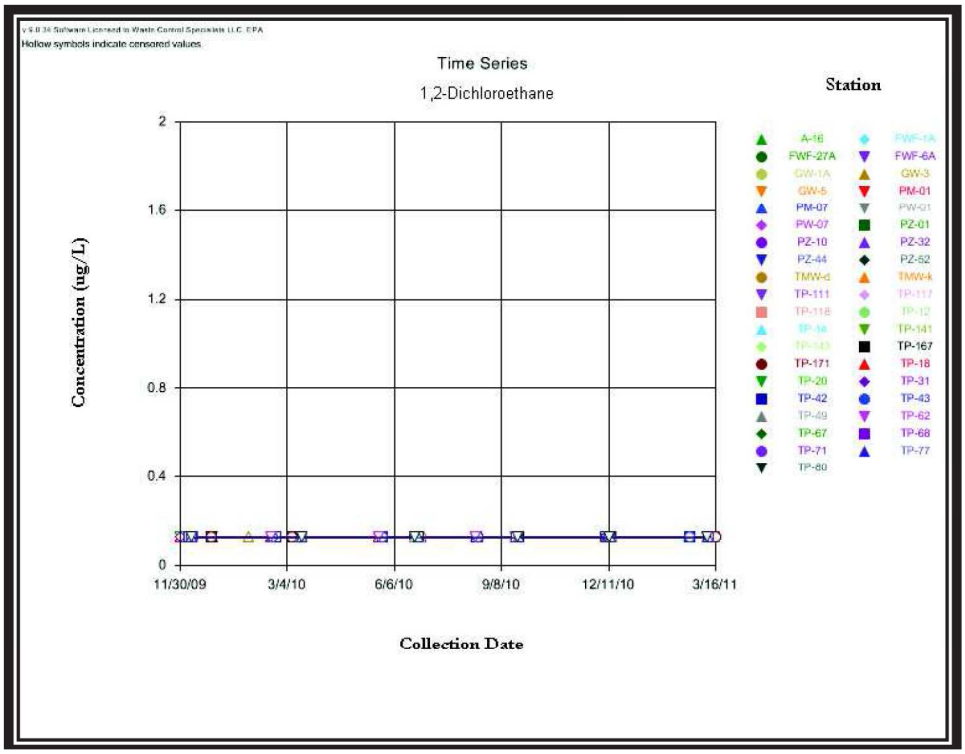

Figure 4-37 : 1,2-Dichloroethane Results for OAG Wells.

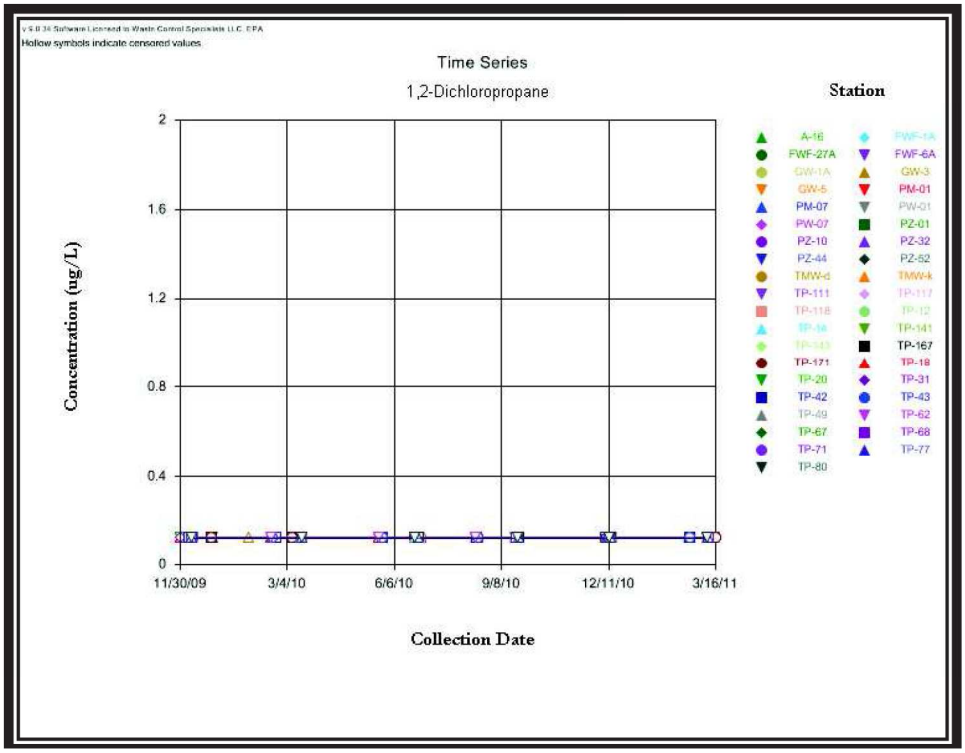

Figure 4-38 : 1,2-Dichloropropane Results for OAG Wells.

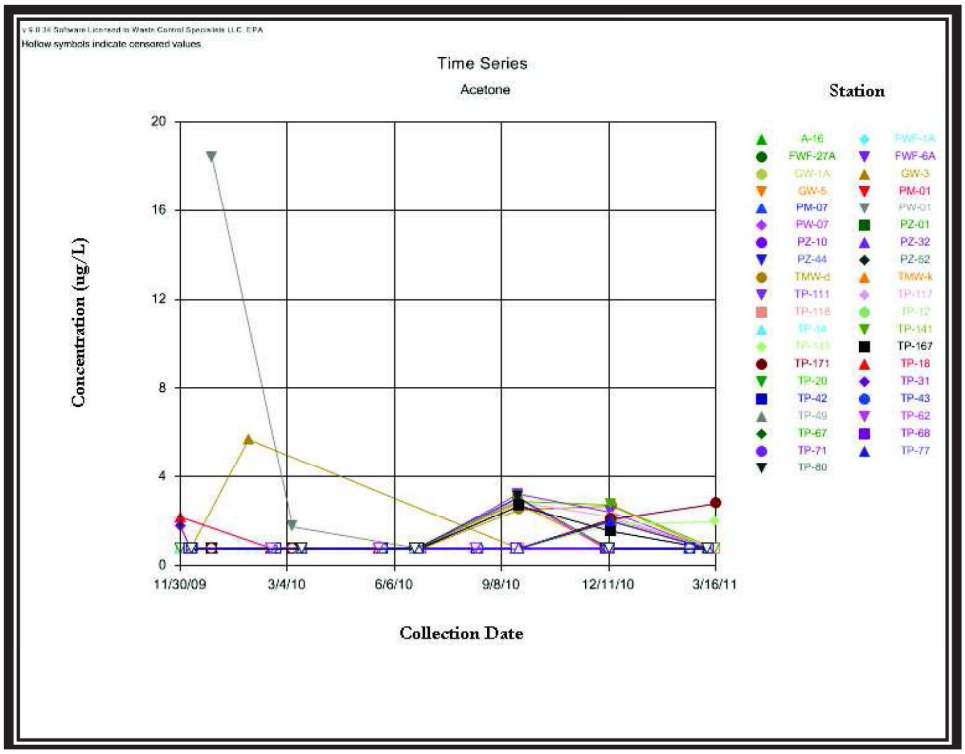

Figure 4-39 : Acetone Results for OAG Wells.

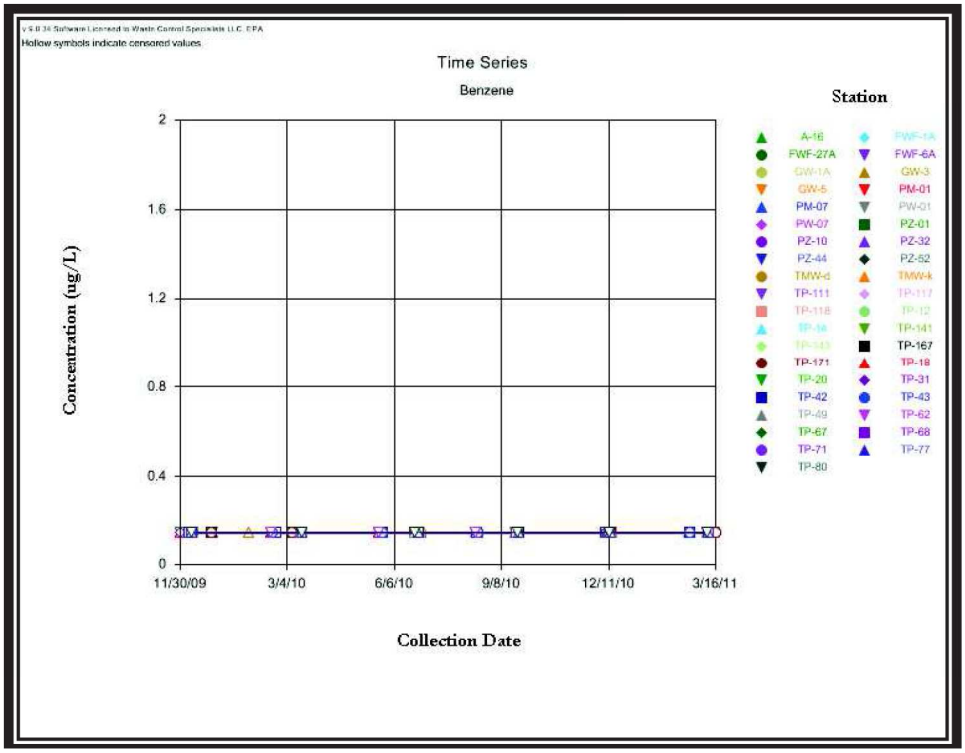

Figure 4-40 : Benzene Results for OAG Wells.

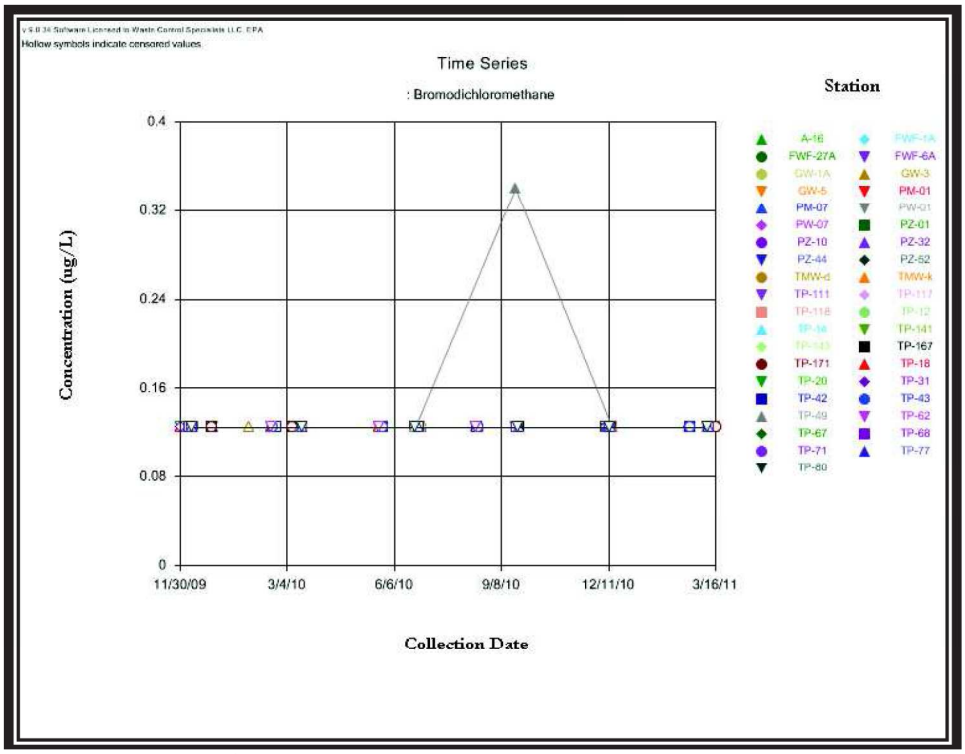

Figure 4-41 : Bromodichloromethane Results for OAG Wells.

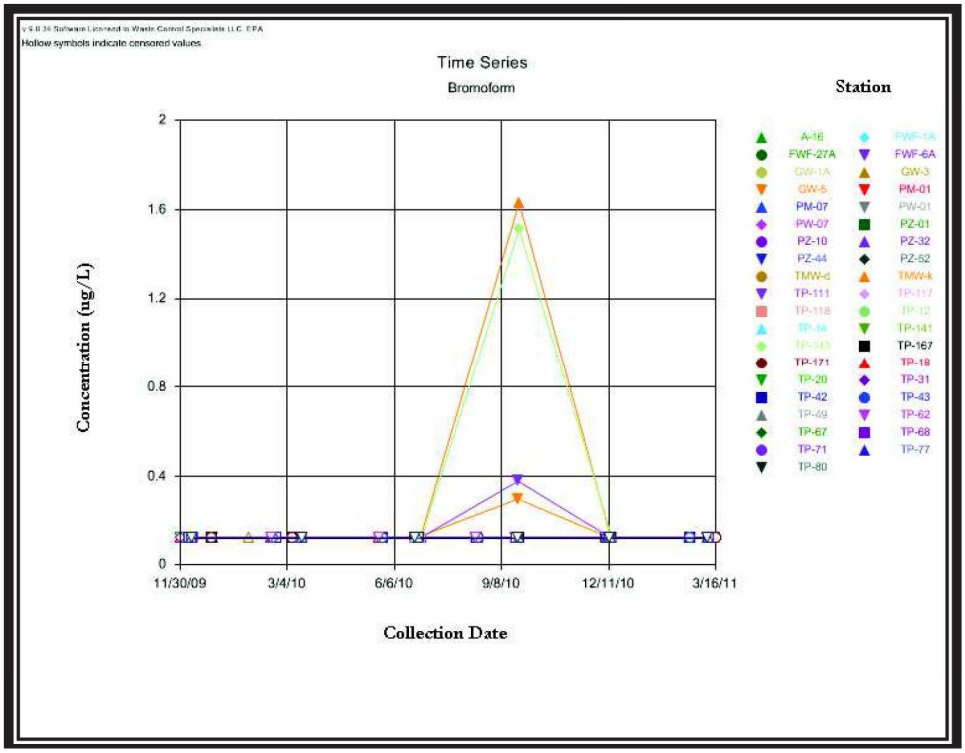

Figure 4-42 : Bromoform Results for OAG Wells.

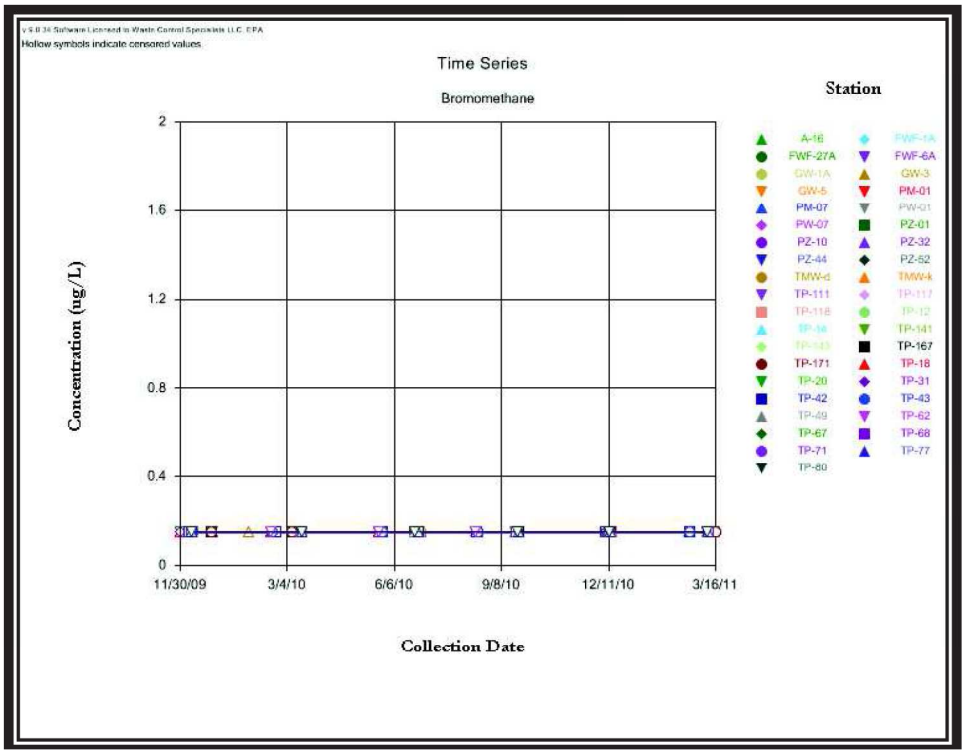

Figure 4-43 : Bromomethane Results for OAG Wells.

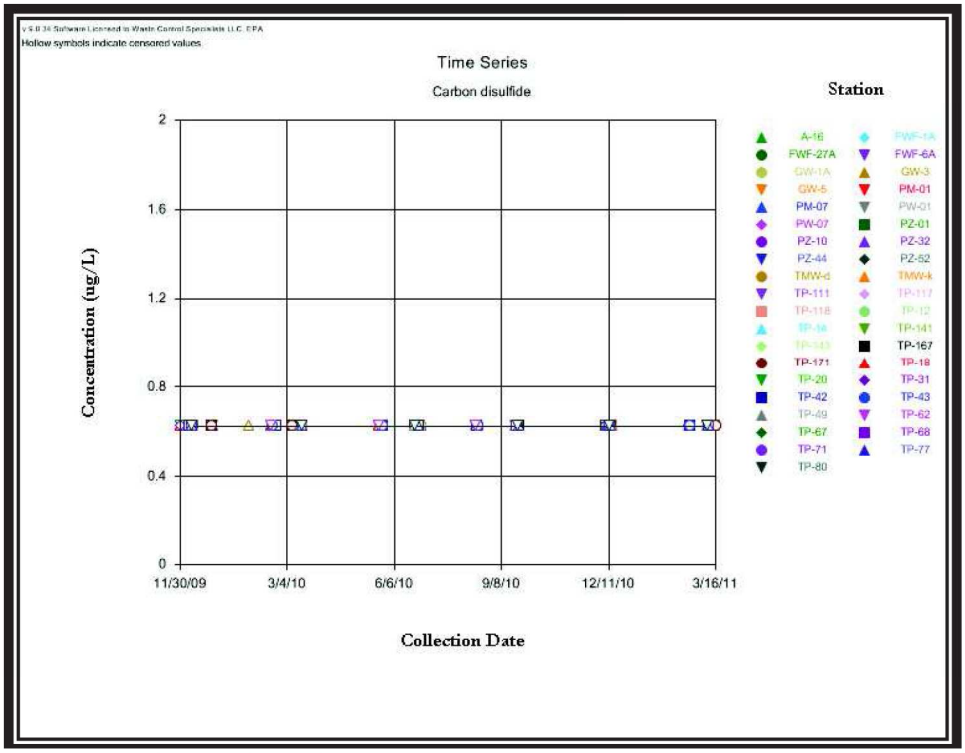

Figure 4-44 : Carbon disulfide Results for OAG Wells.

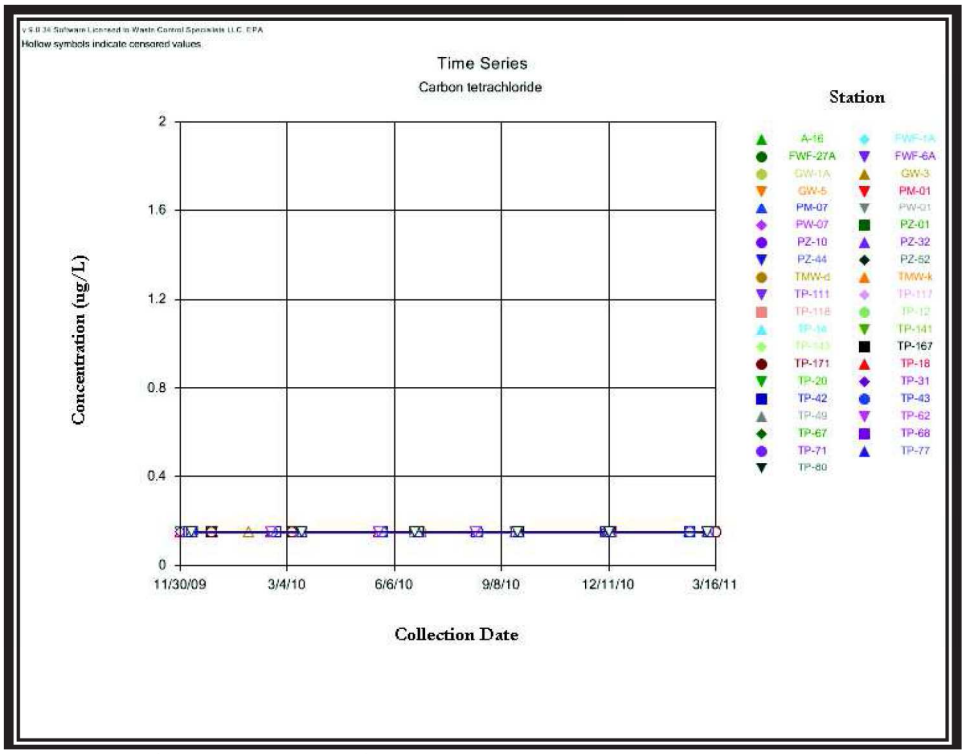

Figure 4-45 : Carbon tetrachloride Results for OAG Wells.

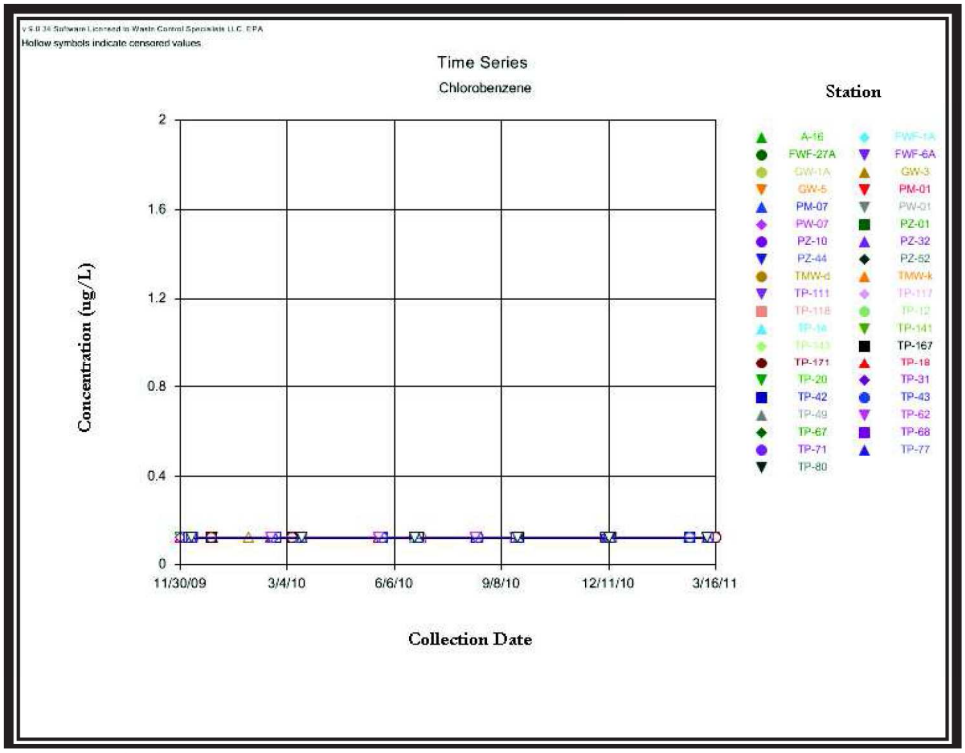

Figure 4-46 : Chlorobenzene Results for OAG Wells.

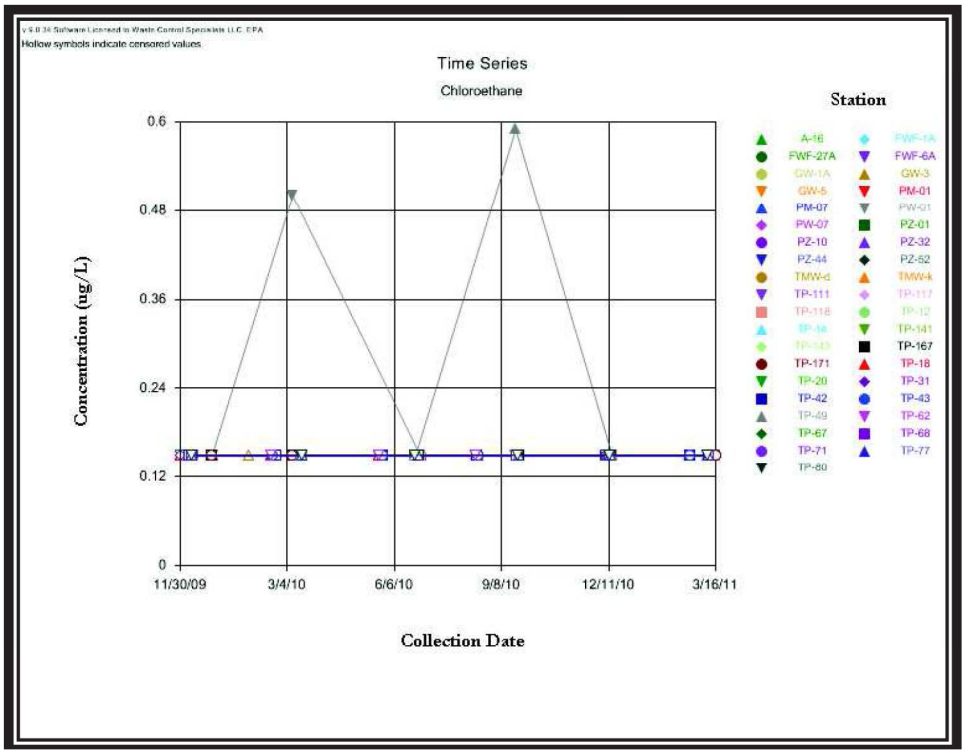

Figure 4-47 : Chloroethane Results for OAG Wells.

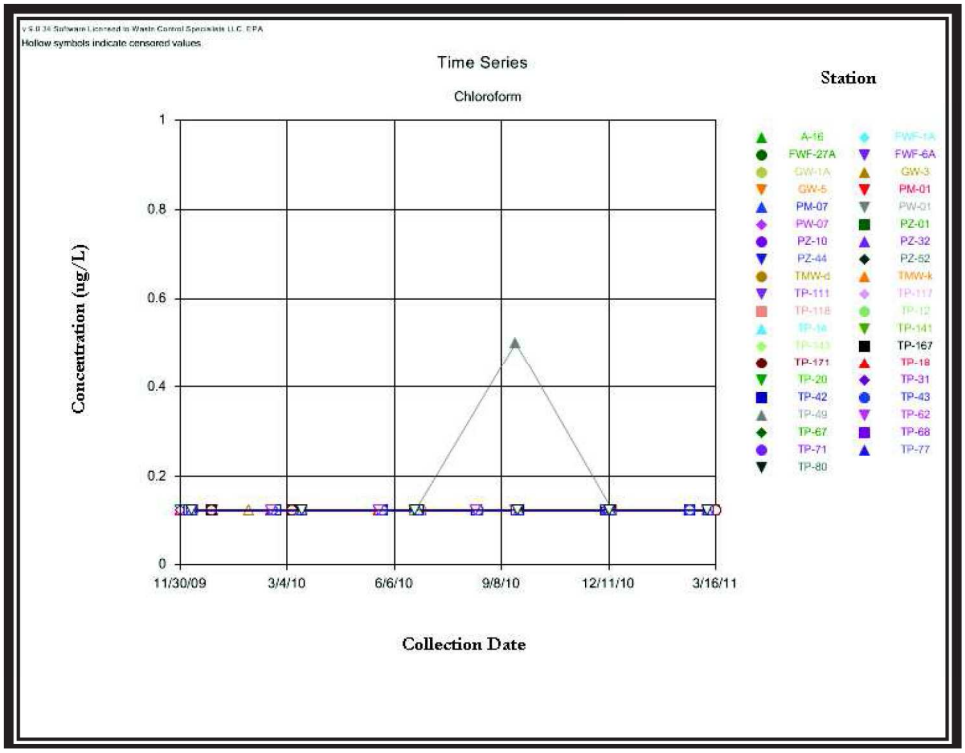

Figure 4-48 : Chloroform Results for OAG Wells.

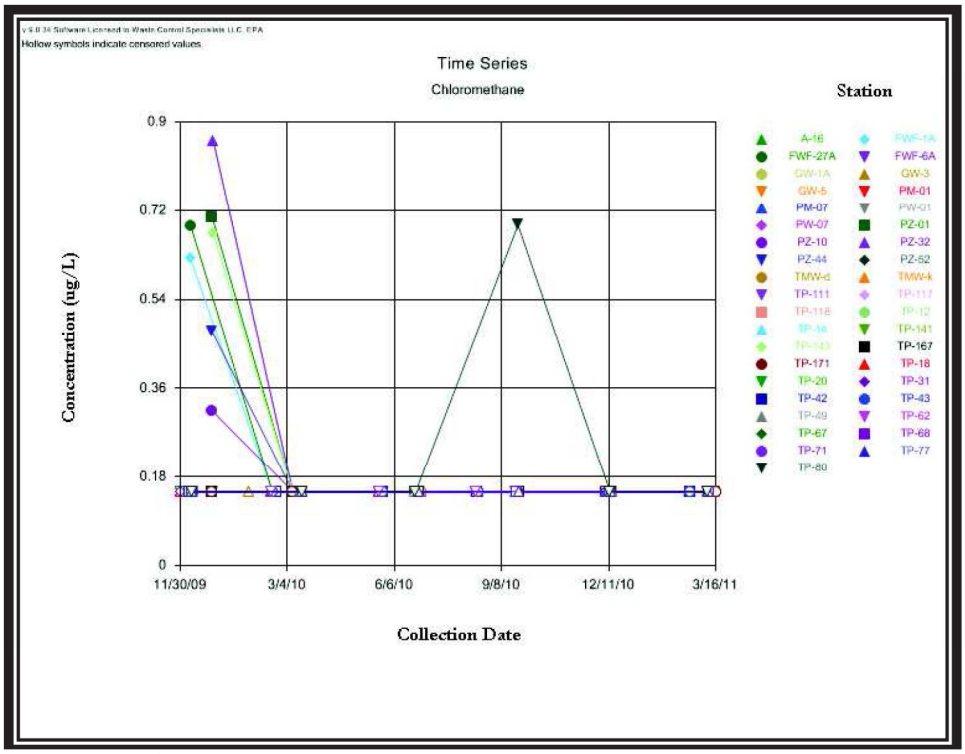

Figure 4-49 : Chloromethane Results for OAG Wells.

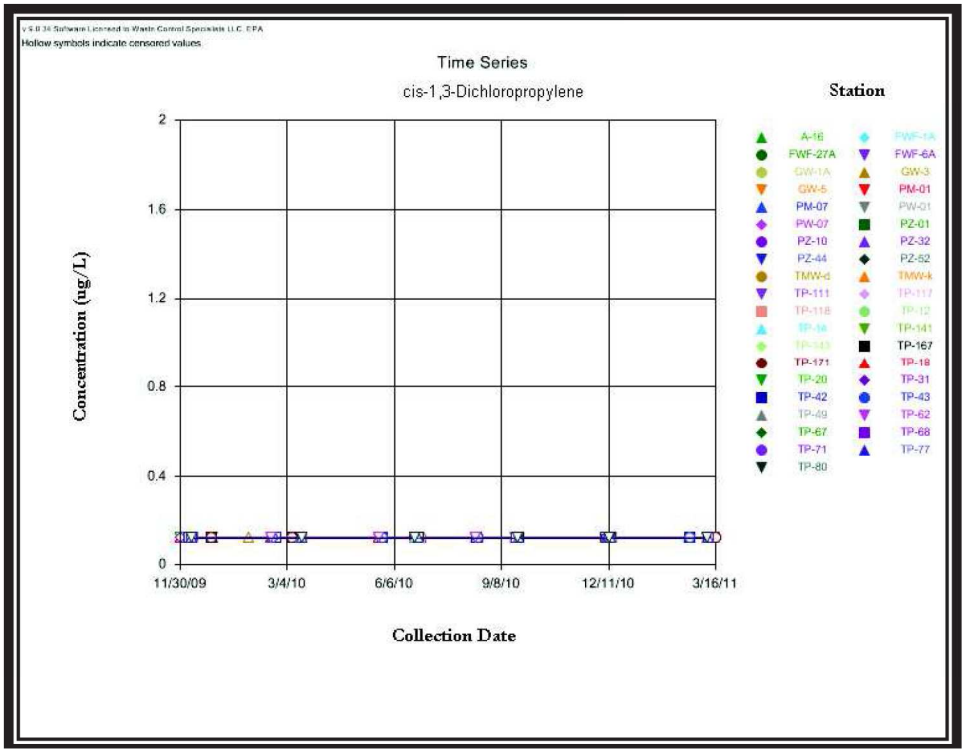

Figure 4-50 : cis-1,3-Dichloropropylene Results for OAG Wells.

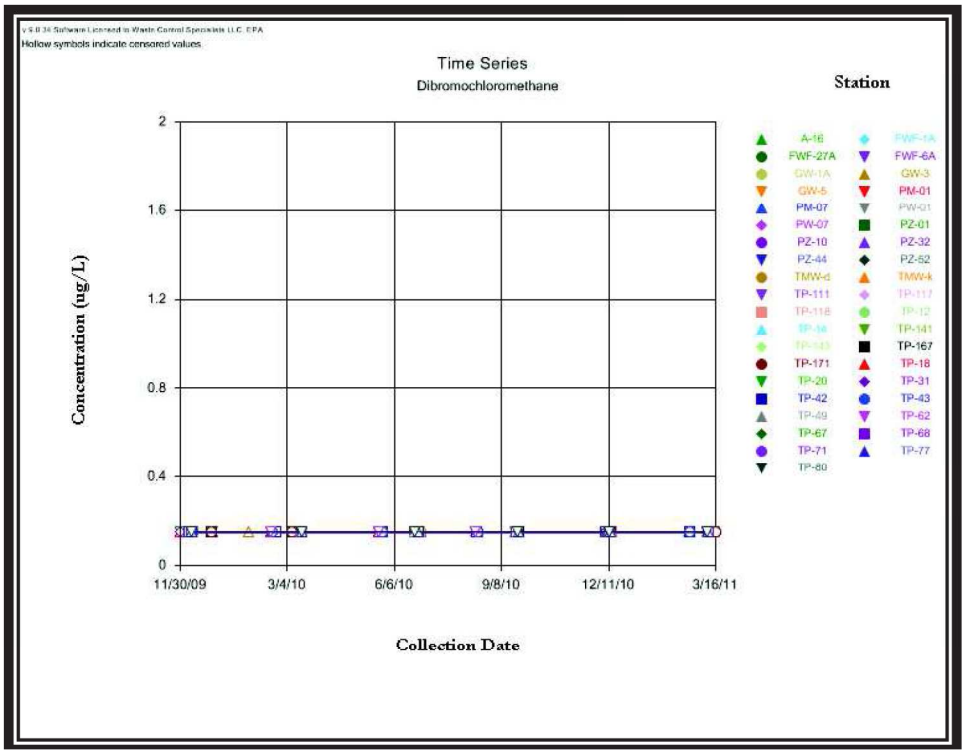

Figure 4-51 : Dibromochloromethane Results for OAG Wells.

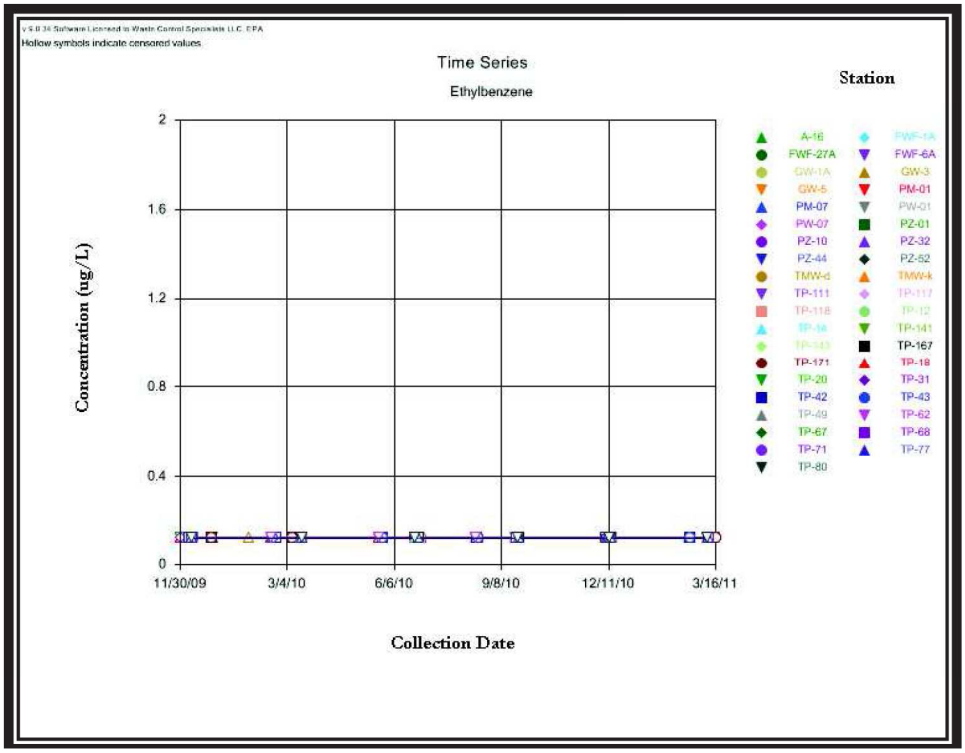

Figure 4-52 : Ethylbenzene Results for OAG Wells.

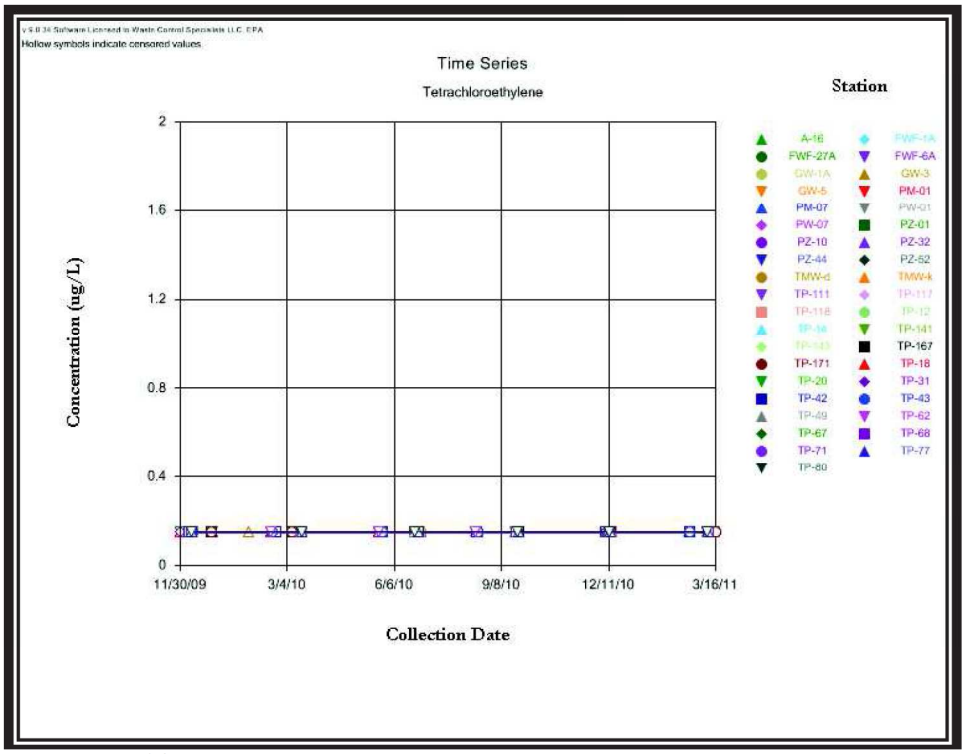

Figure 4-53 : Tetrachloroethylene Results for OAG Wells.

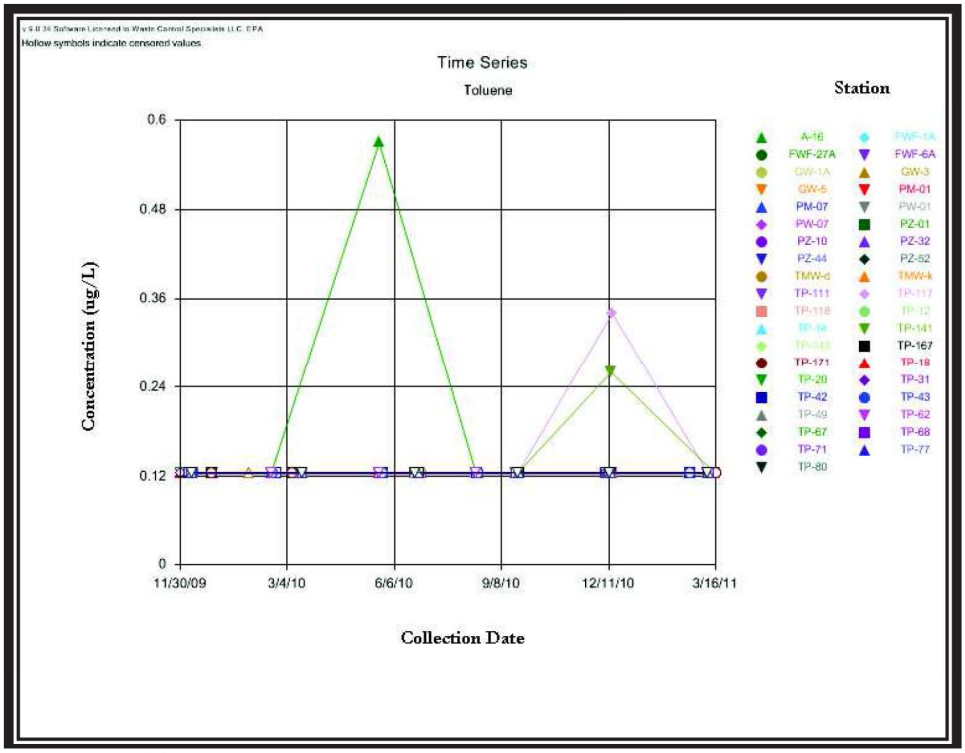

Figure 4-54 : Toluene Results for OAG Wells.

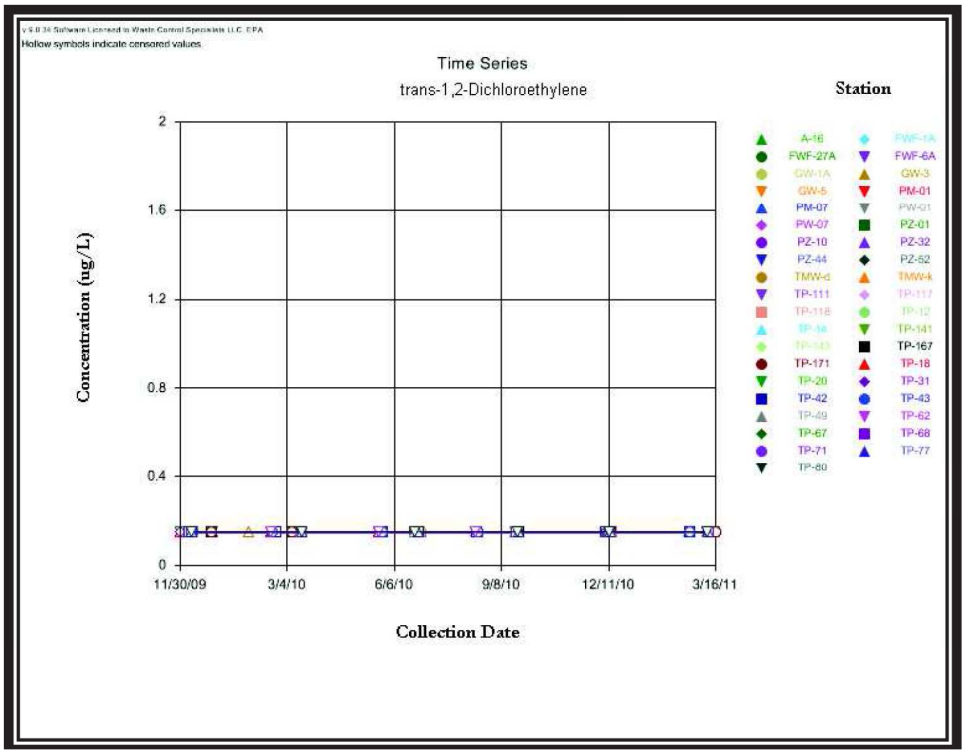

Figure 4-55 : trans-1,2-Dichloroethylene Results for OAG Wells.

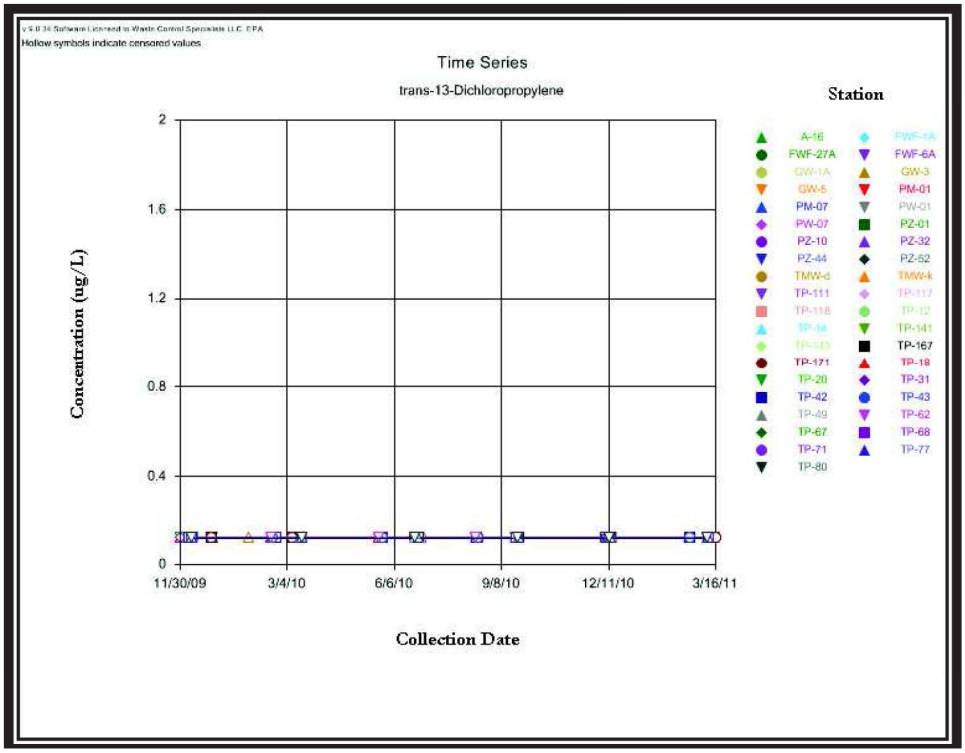

Figure 4-56 : trans-1,3-Dichloropropylene Results for OAG Wells.

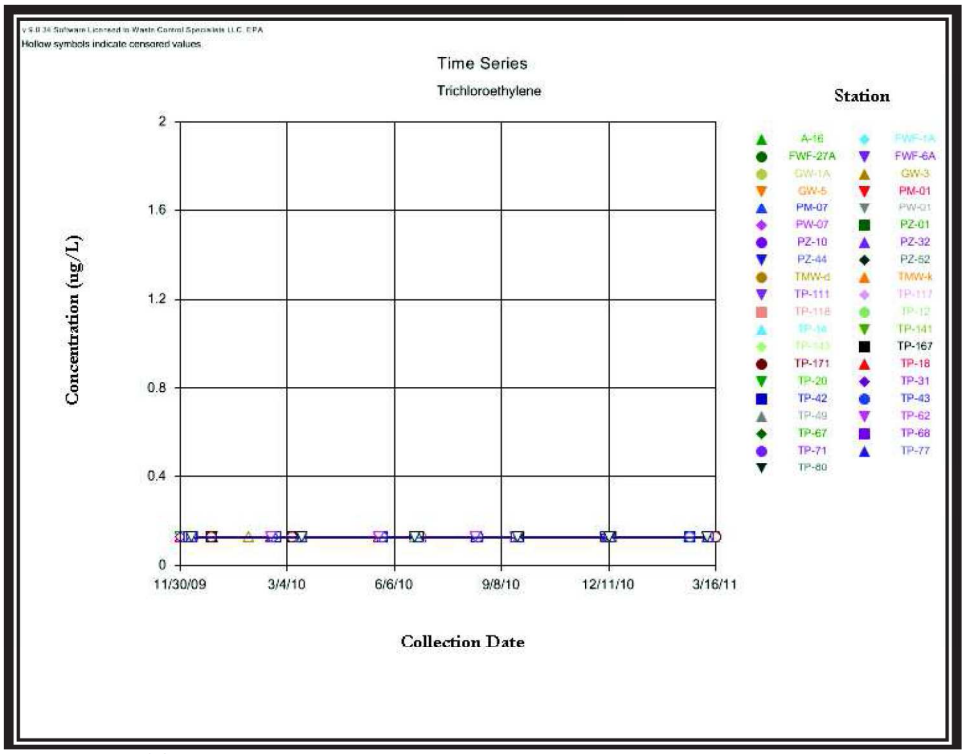

Figure 4-57 : Trichloroethylene Results for OAG Wells.

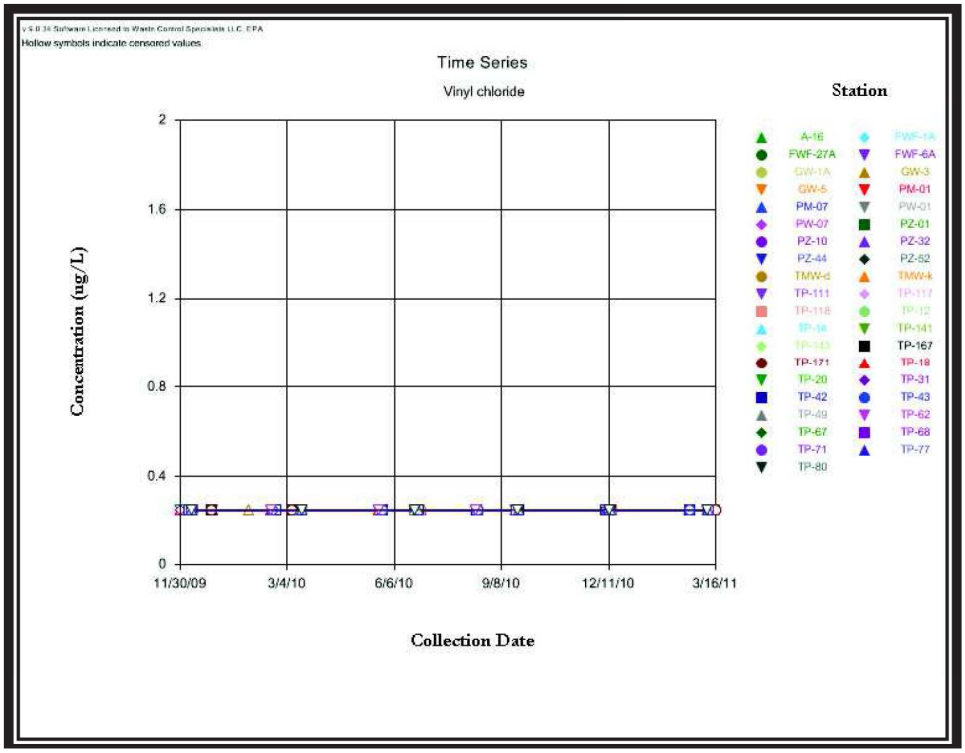

Figure 4-58 : Vinyl chloride Results for OAG Wells.

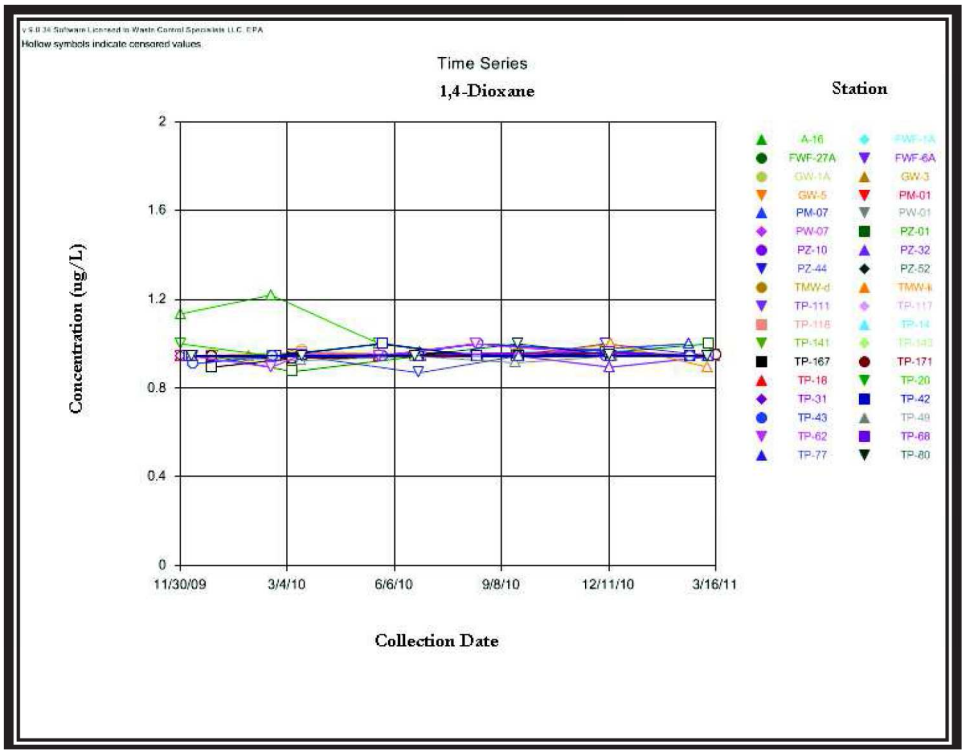

Figure 4-59 : 1,4-Dioxane Results for OAG Wells.

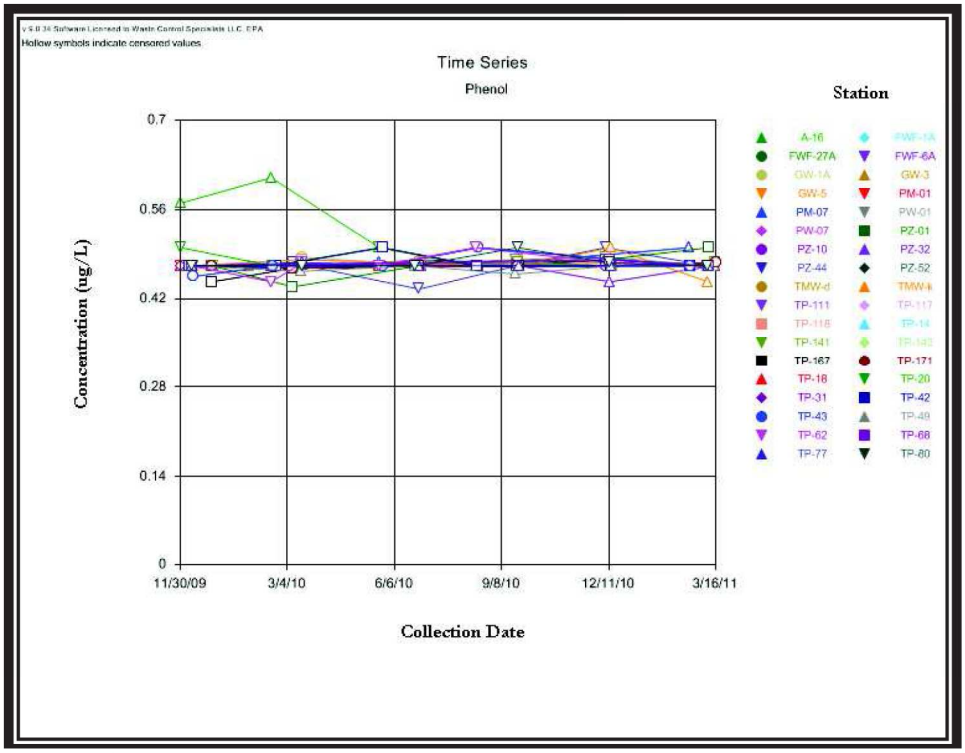

Figure 4-60 : Phenol Results for OAG Wells.

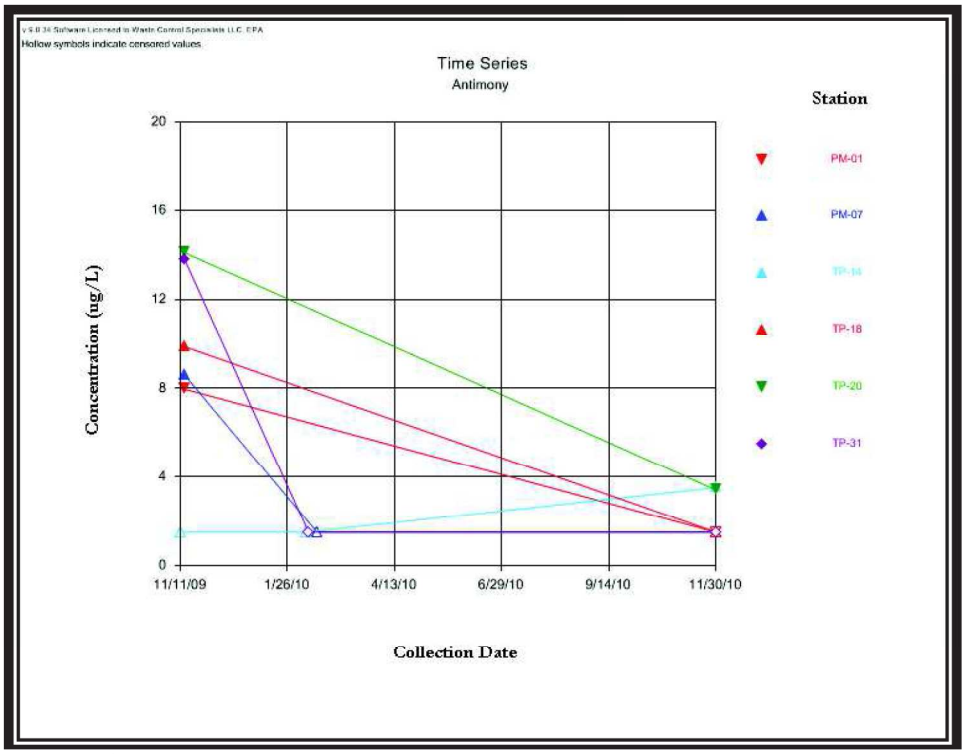

Figure 4-61 : Antimony Results for OAG Wells.

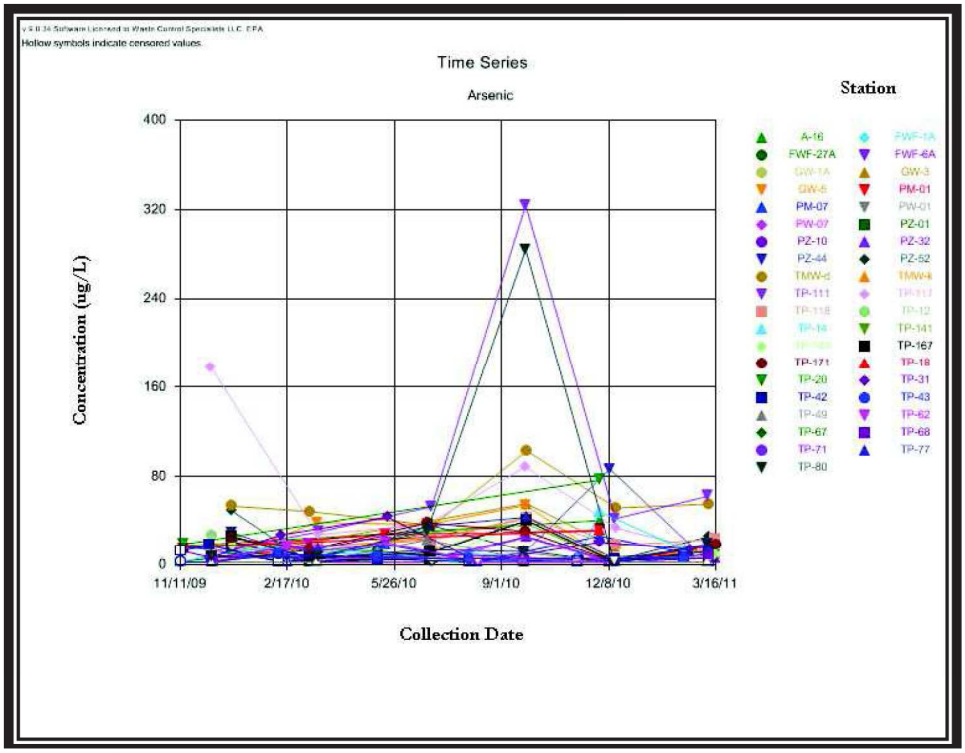

Figure 4-62 : Arsenic Results for OAG Wells.

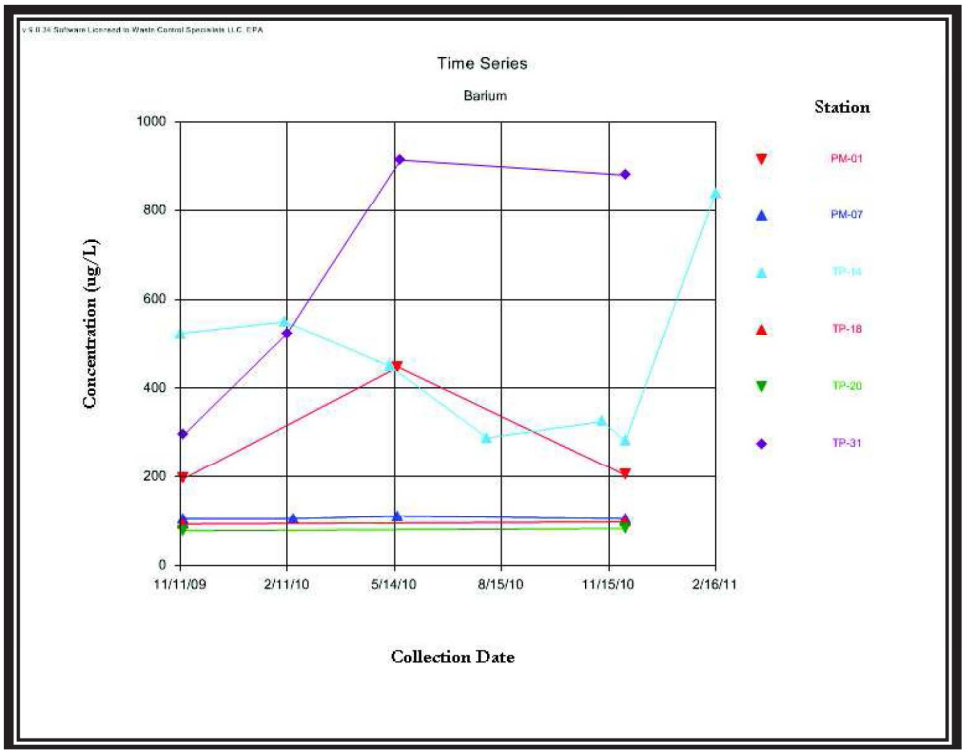

Figure 4-63 : Barium Results for OAG Wells.

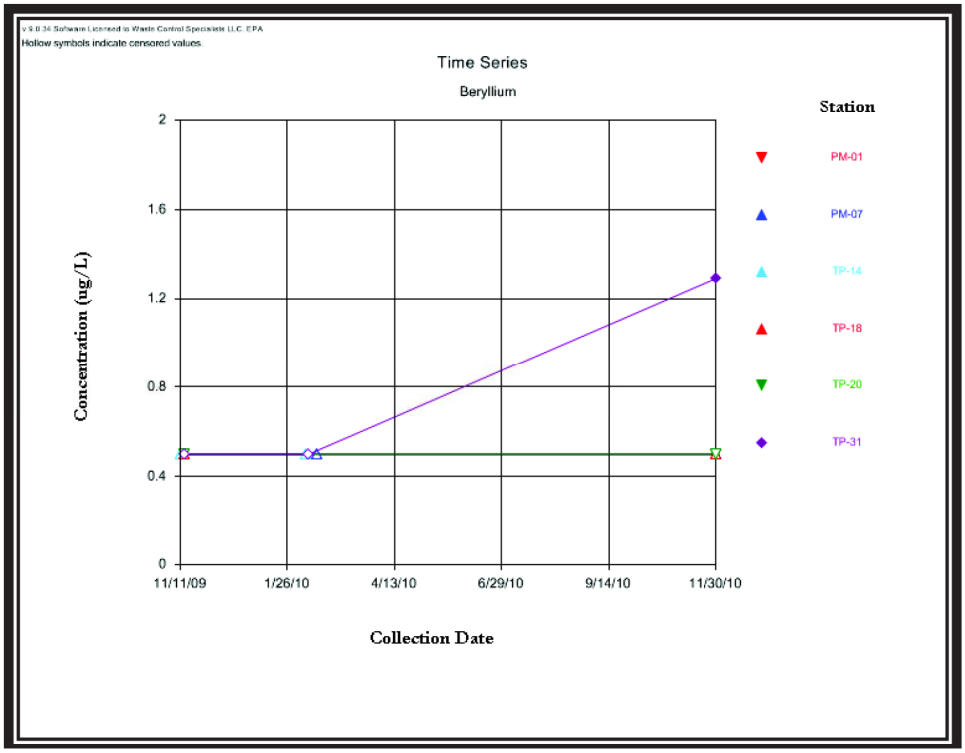

Figure 4-64 : Beryllium Results for OAG Wells.

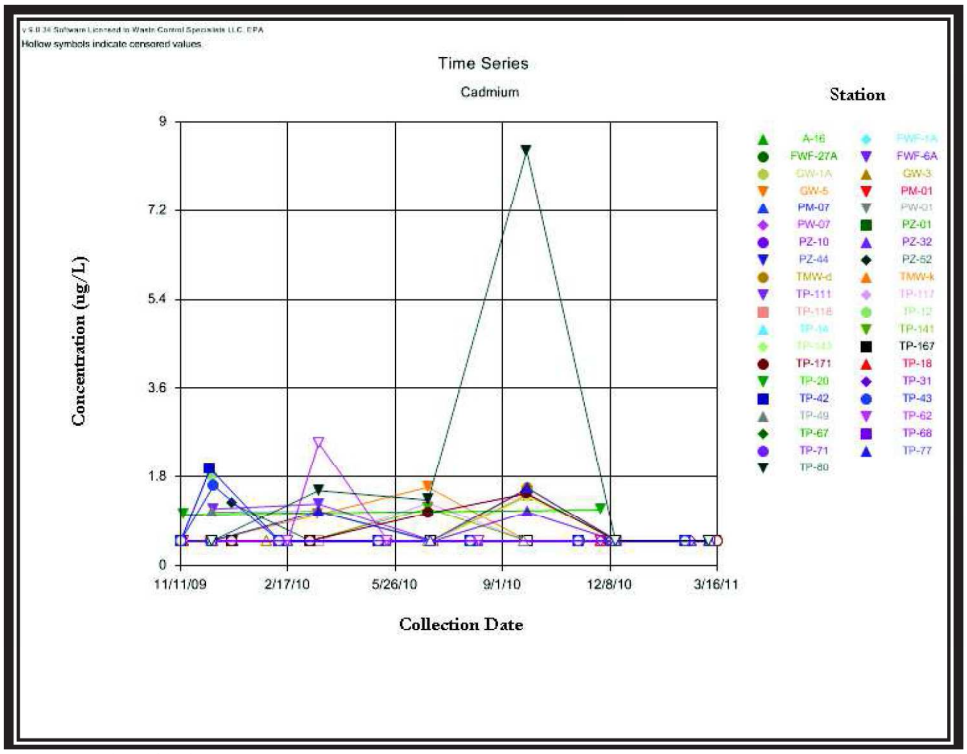

Figure 4-65 : Cadmium Results for OAG Wells.

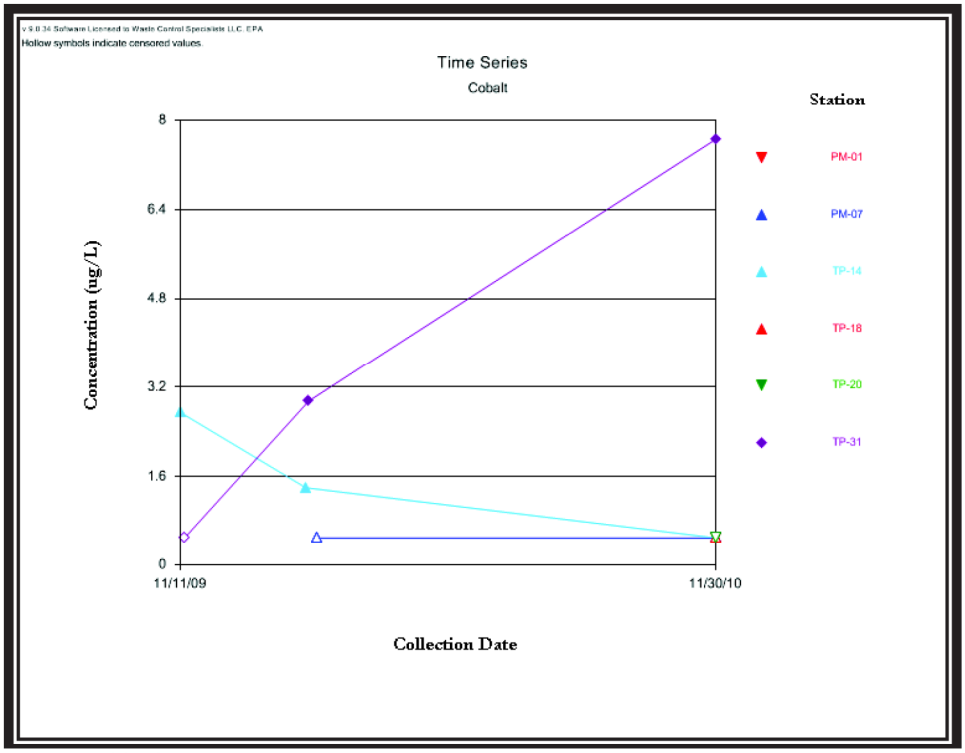

Figure 4-66 : Cobalt Results for OAG Wells.

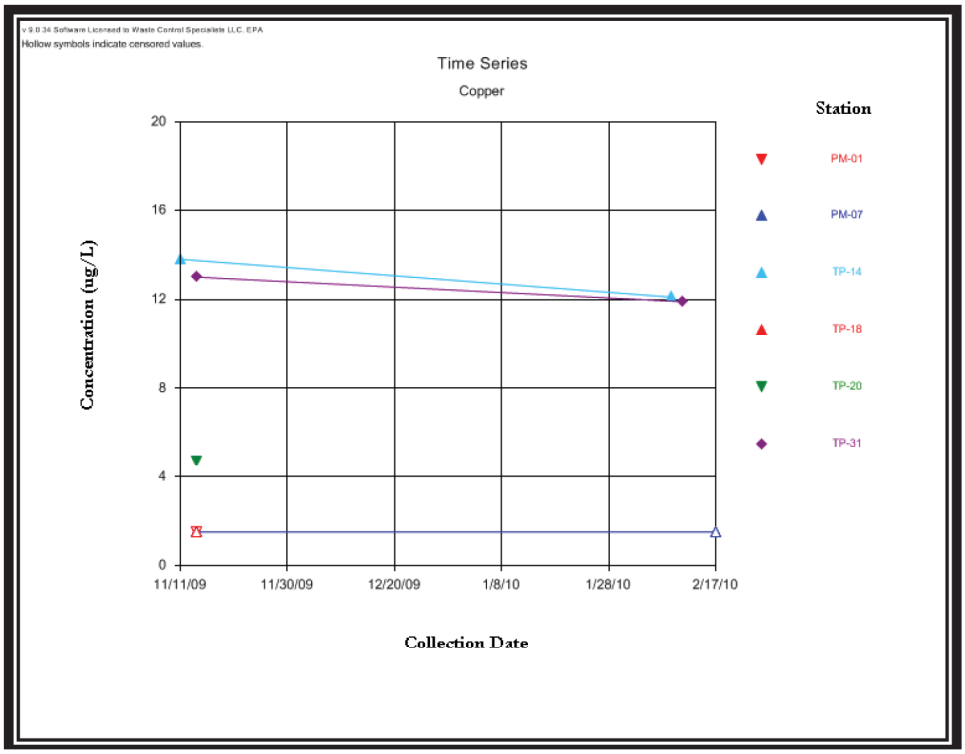

Figure 4-67 : Copper Results for OAG Wells.

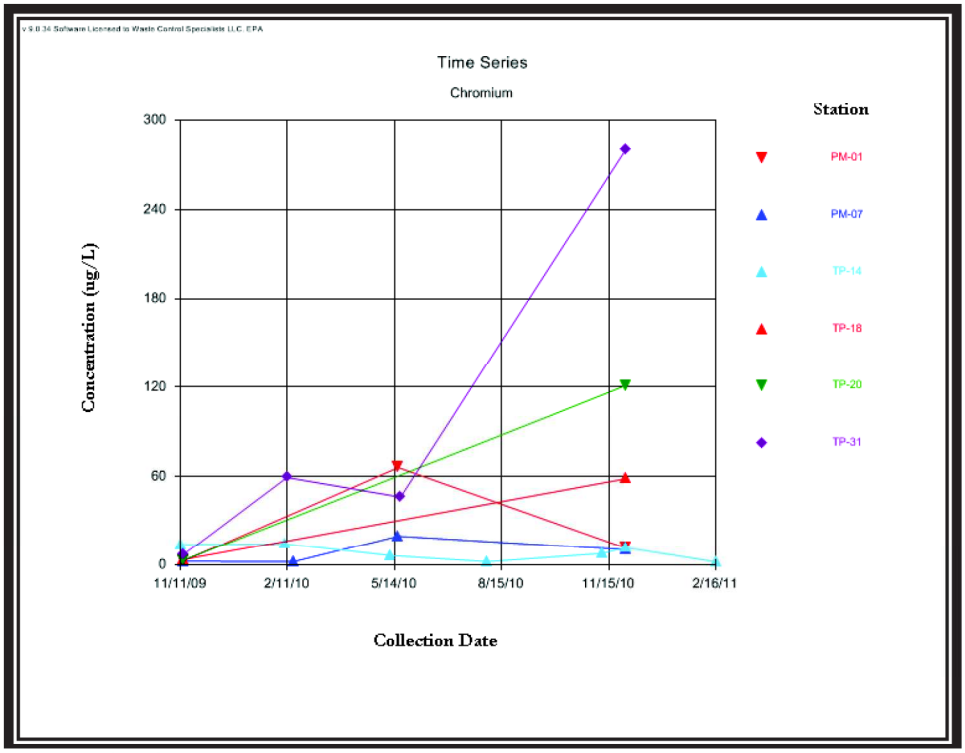

Figure 4-68 : Chromium Results for OAG Wells.

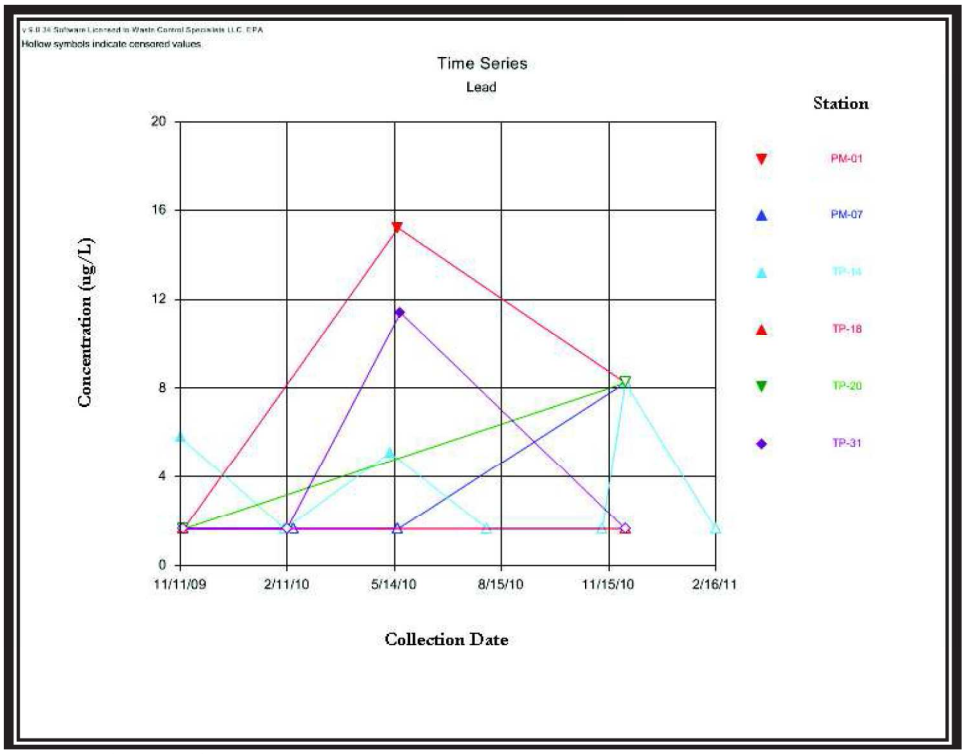

Figure 4-69 : Lead Results for OAG Wells.

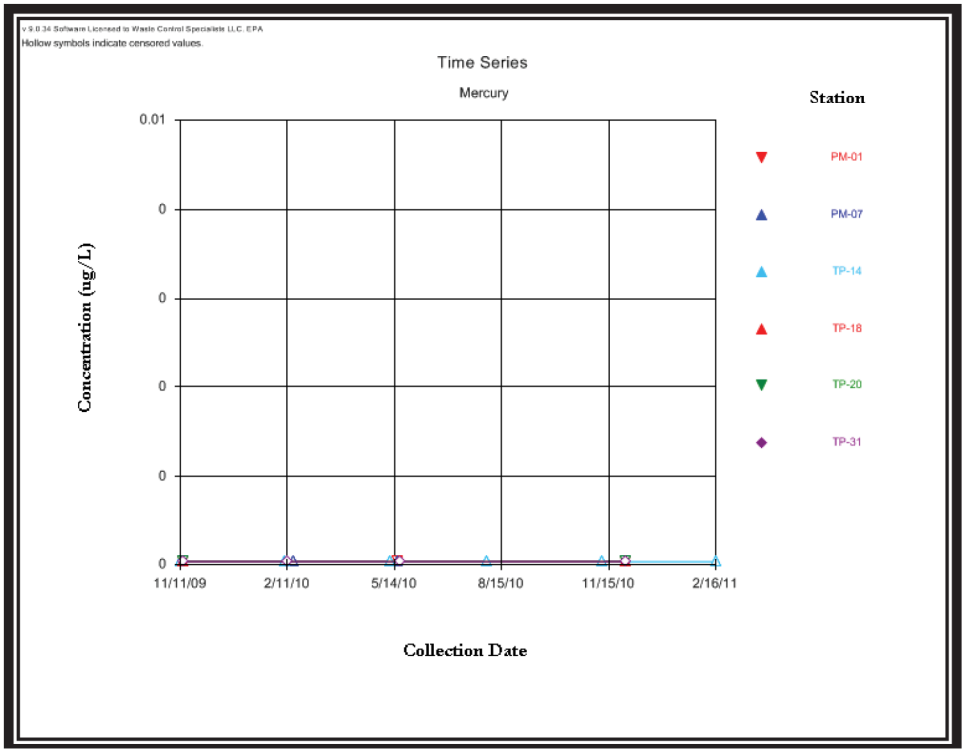

Figure 4-70 : Mercury Results for OAG Wells.

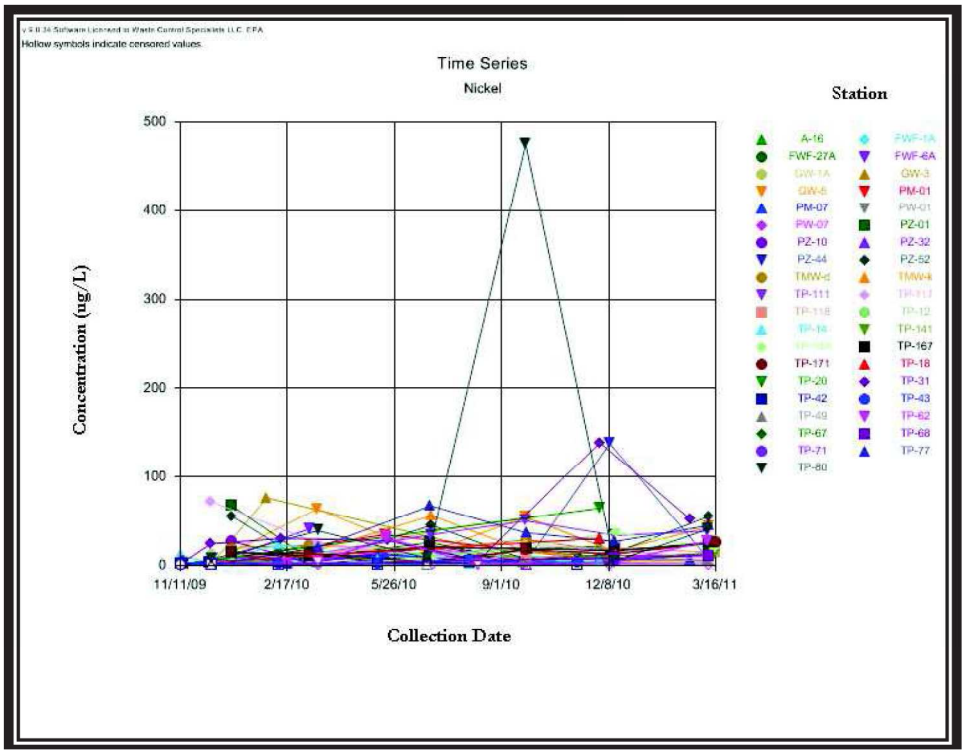

Figure 4-71 : Nickel Results for OAG Wells.

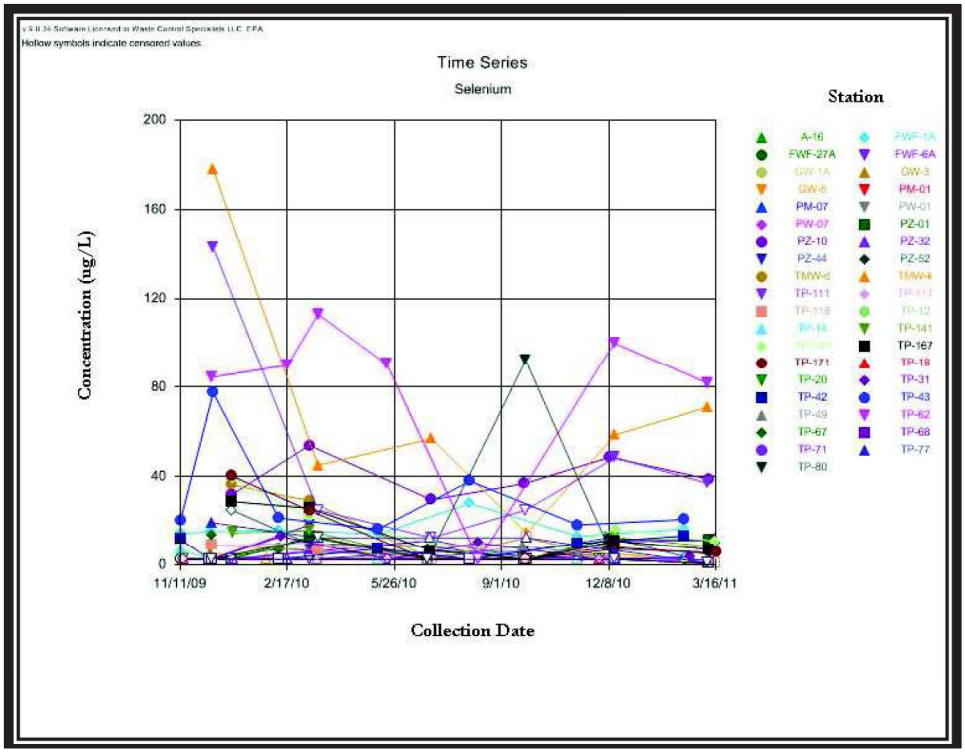

Figure 4-72 : Selenium Results for OAG Wells.

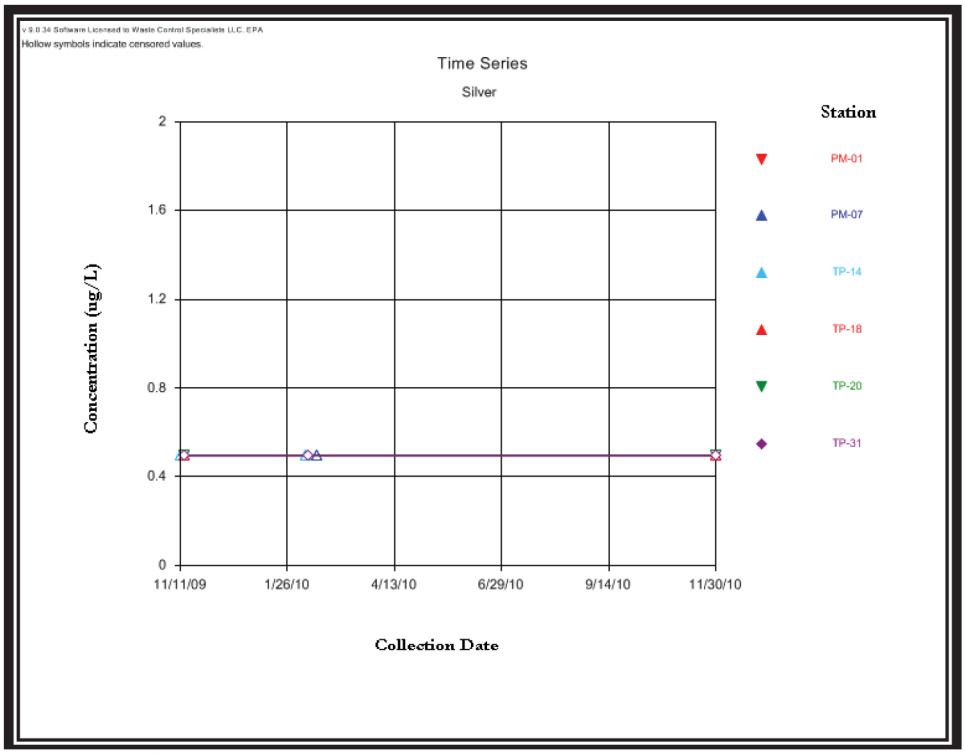

Figure 4-73 : Silver Results for OAG Wells.

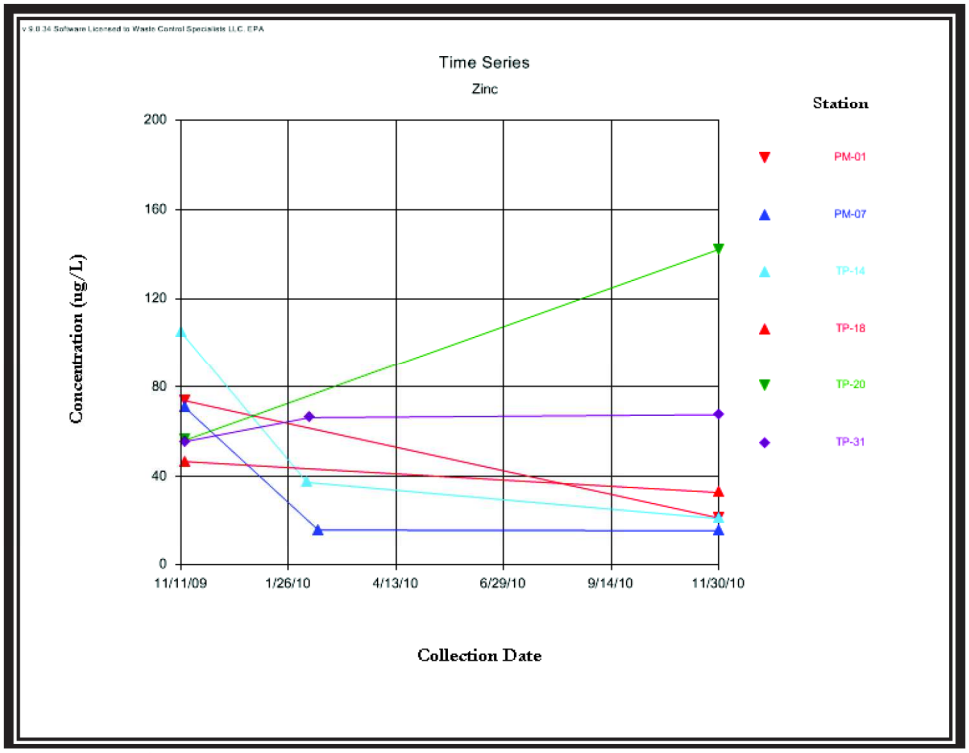

Figure 4-74 : Zinc Results for OAG Wells.

125'-Zone Groundwater Data

The following 125'-zone wells are currently in the pre-operational monitoring program.

Table 4-4 : 125'-Zone Wells in Low Level Pre-Operational Monitoring Program

Well	Saturation?	Well	Saturation?	Well	Saturation?	Well	Saturation?
CWF-1B	Dry	CWF-110B	Dry	FWF-19B	Dry	FWF-27B	Dry
CWF-4B	Dry	FWF-1B	Dry	FWF-20B	Dry	FWF-119B	Dry
CWF-7B	Dry	FWF-6B	Dry	FWF-21B	Dry	PM-02	Dry*
CWF-8B	Dry	FWF-8B	Dry	FWF-22B	Dry	SW-32	Dry
CWF-9B	Dry	FWF-10B	Dry	FWF-23B	Dry	SW-33	Dry
CWF-10B	Dry	FWF 14B	Dry	FWF-24B	Dry	SW-34	Dry
CWF-11B	Dry	FWF-16B	Dry	FWF-25B	Dry	SW-35	Dry
CWF-12B	Dry	FWF-17B	Dry	FWF-26B	Dry	SW-36	Dry

NOTES: Values in Saturation Columns are:
Dry = Insufficient groundwater to collect a sample.
*** = As discussed below, water sampled from PM-02 appears to be OAG water that has leaked down the PM-02 well bore versus being saturation native to the 125'-zone.**

As indicated in the table above, all of the 125'-zone wells being monitored are dry, with one apparent exception, PM-02. As represented in the license application, the 125'- zone is relatively continuous across the 1338-acre facilities area, although it is absent along the western edge of the byproduct landfill. There are 50 wells screened in the 125'- zone, all within the facilities area. The 125'- zone is dry at every location, with two exceptions located near the eastern perimeter of the facilities area. One of these locations is PM-02; the other is TP-08. Both of these wells were installed in 2001 as part of a hydraulic conductivity testing program. The wells had insufficient water for their intended purpose. At both these locations there is currently about 2.5 feet of saturation in the OAG unit. WCS believes that both wells are improperly completed, with inadequate isolation of the 125'- zone screened interval from the water in the overlying OAG unit. WCS believes that the only reason for the presence of water in the 125'- zone in this area is most likely leakage of OAG water down the grouted annulus, and therefore no true 125'- zone groundwater exists in this area. The annulus of these two wells was sealed with a 4:1 cement:bentonite mixture. Such a mixture was found to be an unsatisfactory seal which did not set-up properly when the unsaturated instrument arrays were installed in 2008 in borings B-130, B-131, B-132 and B-133.

PM-02 water levels were not monitored until it was added to the site water level monitoring program in 2004. During the pre-operational monitoring program (2010 – 2011) it was noted that water levels in PM-02 were similar to those in the adjacent OAG well (PM-01) and that water levels in TP-08 were also similar to OAG water levels on the eastern edge of the facilities area. PM-02 was investigated in detail as it is part of the pre-operational monitoring program. After evacuating the well and visually inspecting the integrity of the interior of the well, it was suspected that the well may have been compromised during installation. To determine the likely source of the water in PM-02 (as well as in TP-08), a major ion study was initiated to characterize groundwater type(s) at the WCS facility.

Twenty-one (21) wells containing sufficient groundwater for analysis and representing the various monitored units were sampled for major ion characterization and comparisons. The table below lists the wells and monitored units included in the characterization study.

Well	Zone	Well	Zone	Well	Zone
FWF-27A	OAG	TP-06	Red Bed	TP-58	180
PM-01	OAG	PM-08	80	FWF-19C	225
PM-07	OAG	PM-02 (1)	OAG/125?	FWF-27C	225
TP-100	OAG	PM-02 (2)	OAG/125?	MW-3A	225
TP-14	OAG	TP-08	125	PM-03	225
TP-15	OAG	PM-09	180	TP-69	225
TP-42	OAG	TP-24	180		
TP-10	Red Bed	TP-57	180		

(1) Sample Collection Date: 4/21/2011 (2) Sample Collection Date: 5/17/2011

The major ion study showed a clear distinction between the groundwater types in the monitored units. The Stiff plots in Figure 4-74 graphically show a proportional reduction in calcium and bicarbonate concentrations with depth below the OAG/Red Bed contact, and a marked increase in sodium, sulfate, and chloride concentrations with increasing depth in the Dockum Group. Groundwater in the OAG is characterized as calcium-bicarbonate water, while groundwater in the deeper zones (the 180'- and 225'- zones) in the Dockum Group are characteristically sodium-sulfate water type.

PM-02 was sampled for major ions on April 21, 2011 and May 17, 2011. The April analysis shows a definite calcium-bicarbonate (OAG) water type. The well was then evacuated and allowed to recharge for about one month. The water type in PM-02 appeared to change between the April and May samples, with the May analysis showing a sodium-bicarbonate water type. The May sample could represent OAG water that has migrated into the 125'- zone over time and was drawn back to the PM-02 well following evacuation. Through the process of cation exchange and over a period of years, calcium in the infiltrating OAG water would exchange with sodium due to the difference in geochemistry of the 125' zone. Alternatively, the water in the second PM-02 sample could have been a mixture of water from the artificially saturated 125'- zone and infiltrating OAG water in the compromised annulus between the well casing and the borehole wall. Nonetheless, the resulting water type appears to have characteristics of mixed OAG/Dockum Group groundwater types.

The water in TP-08 is not as obviously derived from the OAG as that in PM-02, however it is also most likely derived by leakage down the annulus between the borehole wall and the casing. The Stiff diagram for TP-08 indicates relatively high calcium compared to other Dockum Group waters in the 180- and 225-foot zones, and the sodium and sulfate concentrations are also lower.

Based on the major ion comparisons and the fact that all other wells in the 125'- zone in the facilities area are dry, WCS believes that 125'- zone wells PM-02 and TP-08 are not representative of the 125'- zone and that they should be properly plugged.

Although the groundwater in PM-02 appears to originate from the OAG versus the 125'-zone, it is currently being monitored by WCS. As summarized in Appendix A, the primary radionuclides reported in groundwater collected from PM-02 are naturally occurring radionuclides. In addition to naturally occurring radionuclides, a number of naturally occurring metals were also reported in groundwater from PM-02. Those metal results, along with the VOC and SVOC analytical results, are summarized in Table 4-5.

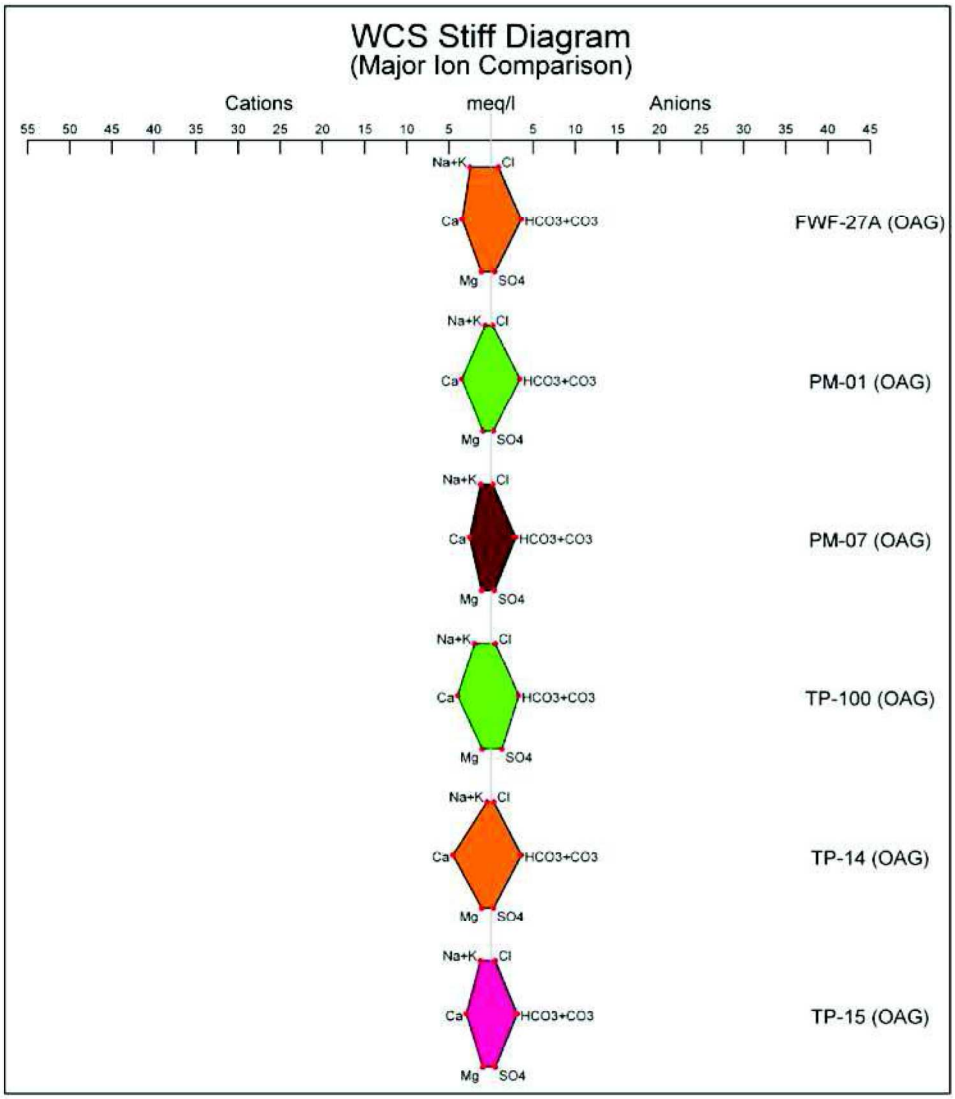

Figure 4-75 : Stiff Diagram Depicting Geochemical Water Types. Sheet 1 of 4.

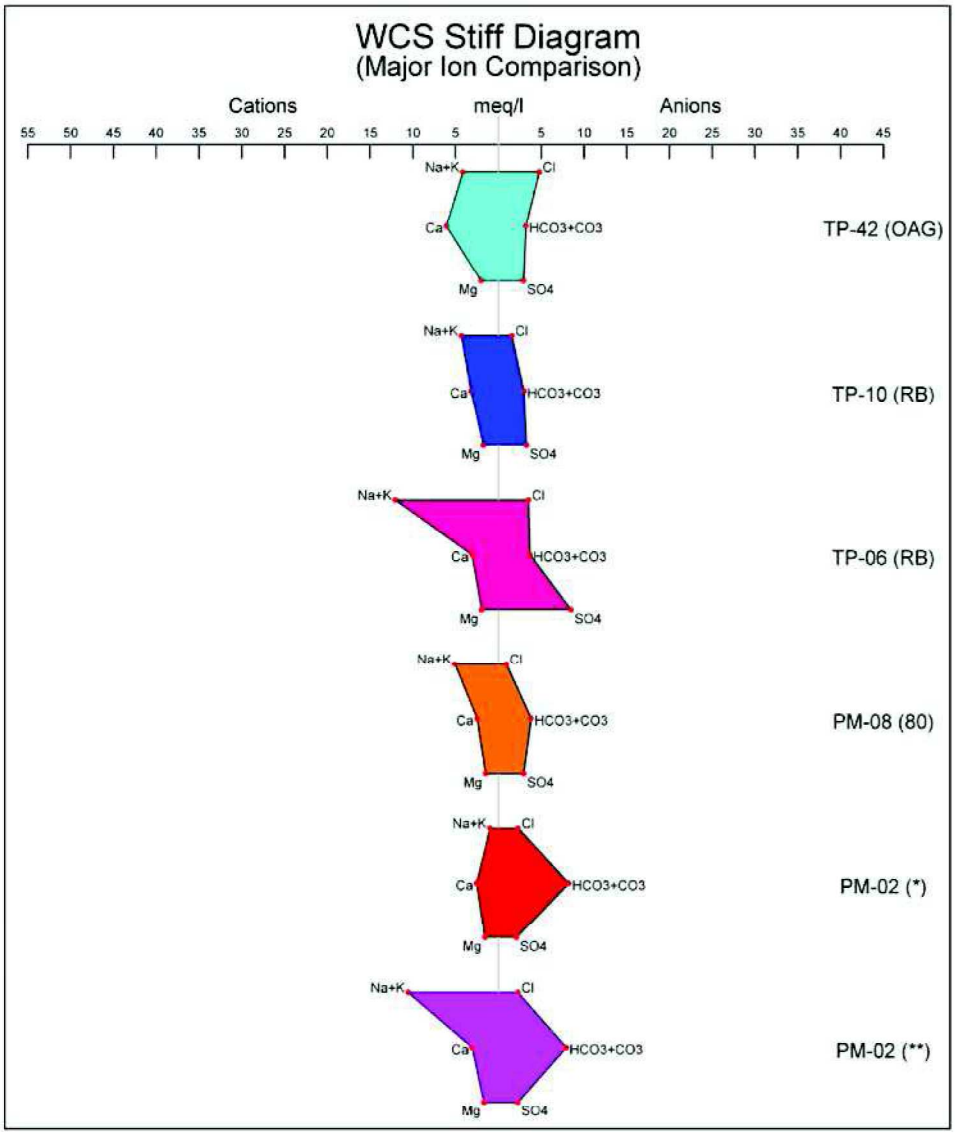

Figure 4-76 : Stiff Diagram Depicting Geochemical Water Types. Sheet 2 of 4.

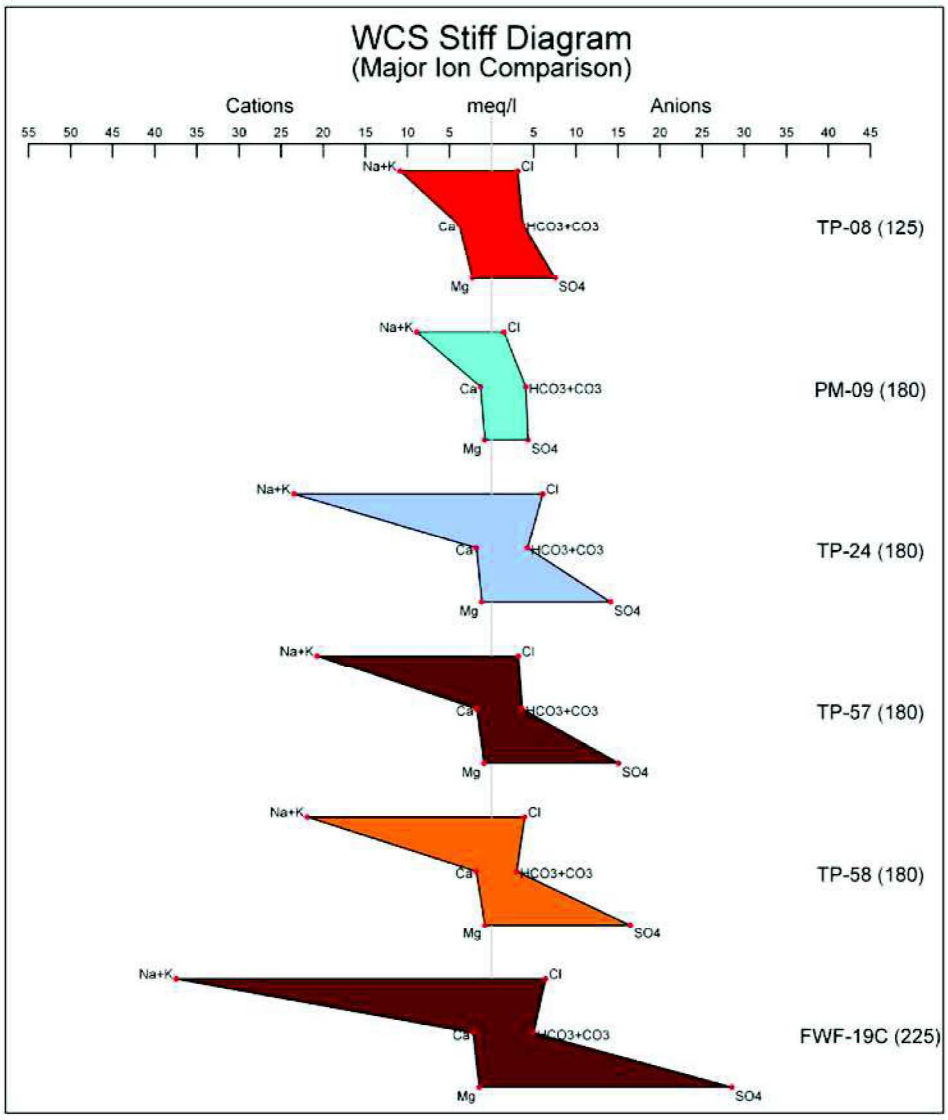

Figure 4-77 : Stiff Diagram Depicting Geochemical Water Types. Sheet 3 of 4.

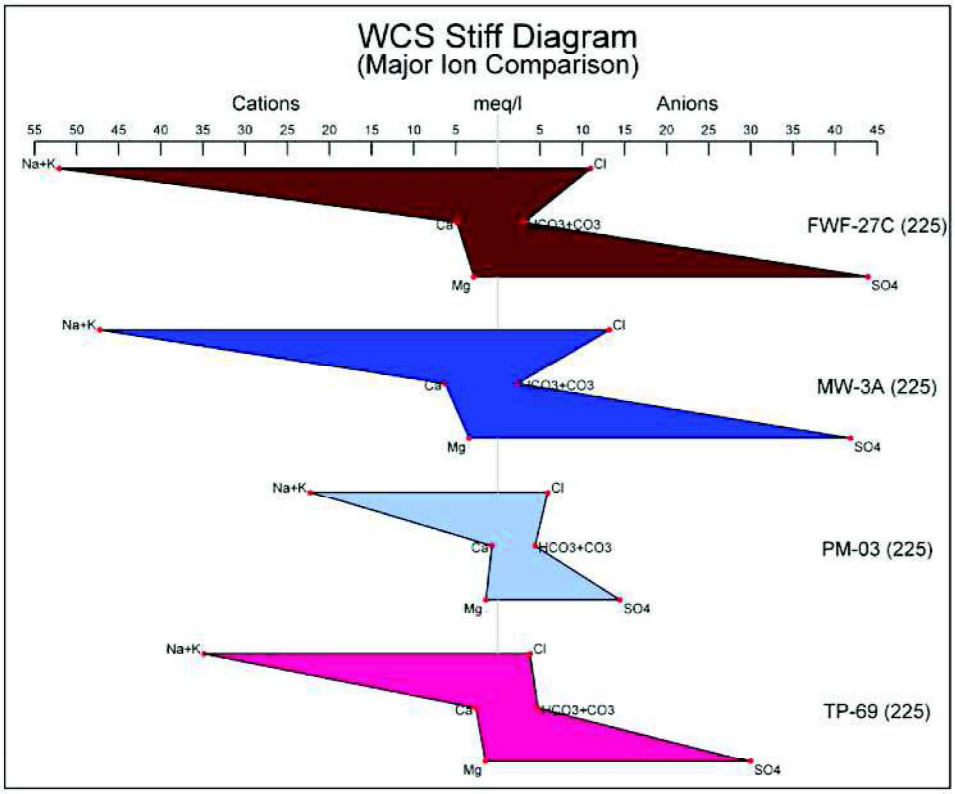

Figure 4-78 : Stiff Diagram Depicting Geochemical Water Types. Sheet 4 of 4.

Table 4-5 :PM-02 Groundwater Monitoring Results for Low Level Pre-Operational Monitoring Program.

Analyte	Units	Observations	No. of Stations	< PQL	Max. Value	Min. Value	Mean Value*	Standard Dev.*
Arsenic	µg/L	1	1	1	<5	<5	N/A	N/A
Cadmium	µg/L	1	1	1 (1 J flag)	1.07 J	1.07 J	N/A	N/A
Nickel	µg/L	1	1	0	13.3	13.3	N/A	N/A
Selenium	µg/L	1	1	1	<5	<5	N/A	N/A
1,4-Dioxane	µg/L	1	1	1	<2.0	<2.0	N/A	N/A
Phenol	µg/L	1	1	1	<1.0	<1.0	N/A	N/A
1,1,1-Trichloroethane	µg/L	1	1	1	<0.325	<0.325	N/A	N/A
1,1,2,2-Tetrachloroethane	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
1,1,2-Trichloroethane	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
1,1-Dichloroethane	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
1,1-Dichloroethylene	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
1,2-Dichloroethane	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
1,2-Dichloropropane	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Acetone	µg/L	1	1	1	<1.5	<1.5	N/A	N/A
Benzene	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
Bromodichloromethane	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Bromoform	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Bromomethane	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
Carbon disulfide	µg/L	1	1	1	<1.25	<1.25	N/A	N/A
Carbon tetrachloride	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
Chlorobenzene	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Chloroethane	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
Chloroform	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Chloromethane	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
cis-1,3-Dichloropropylene	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Dibromochloromethane	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
Ethylbenzene	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Tetrachloroethylene	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
Toluene	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
trans-1,2-Dichloroethylene	µg/L	1	1	1	<0.3	<0.3	N/A	N/A
trans-1,3-Dichloropropylene	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Trichloroethylene	µg/L	1	1	1	<0.25	<0.25	N/A	N/A
Vinyl chloride	µg/L	1	1	1	<0.5	<0.5	N/A	N/A

NOTES: * Summary statistics not calculated due to insufficient data.

Because there is only one data point, WCS cannot draw conclusions regarding the metal concentrations reported in the PM-02 groundwater samples other than that they appear to be within the range of naturally occurring concentrations at the site.

225' Zone Groundwater Data

The following 225'-zone wells are currently in the pre-operational monitoring program. Because all of these wells contain sufficient groundwater for routine sampling the "Saturation" column has been omitted from this table.

225'-Zone Wells in Low Level Pre-Operational Monitoring Program

Well	Well	Well	Well	Well	Well	Well	Well
5E-A	CWF-8C	CWF-12D	DW-35A	FWF 16C	FWF-24C	MW-1A	PM-03
6B2	CWF-8D	CWF-110C	DW-35B	FWF-16D	FWF-24D	MW-1B	PM-06
A-22	CWF-9C	CWF-110D	DW-36A	FWF-17C	FWF-25C	MW-2A	TP-69
A-24	CWF-9D	DW-32A	DW-36B	FWF-17D	FWF-25D	MW-2B	
CWF-1C	CWF-10C	DW-32B	FWF-1C	FWF-19C	FWF-26C	MW-3A	
CWF-4C	CWF-10D	DW-33A	FWF-6C	FWF-21C	FWF-26D	MW-3B	
CWF-4D	CWF-11C	DW-33B	FWF-10C	FWF-21D	FWF-27C	MW-4A	
CWF-7C	CWF-11D	DW-34A	FWF-10D	FWF-23C	FWF-119C	MW-4B	
CWF-7D	CWF-12C	DW-34B	FWF-14C	FWF-23D	FWF-119D	MW11B	

Radiological summary statistics for radiological analytes in the 225' zone are presented in Table 4-6. Figure 4-75 through Figure 4-142 graphically depict the pre-operational groundwater results. All pre-operational sample results for 225'-zone groundwater are given in Appendix A.

As summarized in the following table, naturally occurring radionuclides were reported in 225'-zone groundwater at expected concentrations and detection rates. False positive rates for radionuclides that are not expected to be present were consistently between 3 and 6%.

Table 4-6: Summary Statistics for 225' Zone Groundwater data (pCi/L).

Analyte	Observations	Number of Stations	Below L_c*	Maximum	Minimum	Mean	Standard Deviation
Alpha	412	66	57	9.53E+01	-6.65E+00	1.17E+01	9.65E+00
Am-241	412	66	391	5.57E-02	-3.37E-02	-1.79E-03	1.08E-02
Beta	412	66	52	6.85E+01	-5.32E+00	1.01E+01	8.13E+00
C-14	411	66	396	1.41E+01	-1.55E+01	-1.49E+00	4.90E+00
Cs-137	412	66	397	4.85E+00	-8.42E+00	-5.25E-02	1.71E+00
Cr-51	412	66	393	9.81E+02	-1.28E+03	-1.38E+01	1.59E+02
Co-60	412	66	398	5.03E+00	-5.03E+00	1.37E-01	1.54E+00
Cu-242	404	66	392	6.11E-02	-2.64E-02	1.44E-03	8.08E-03
Cu-243/244	404	66	384	8.14E-02	-2.45E-02	6.50E-04	1.02E-02
I-129	411	66	388	1.21E+00	-8.37E-01	5.63E-02	2.74E-01
Mn-54	412	66	405	3.98E+00	-5.58E+00	-2.18E-01	1.52E+00
Np-237	404	66	374	6.24E-02	-4.26E-02	2.47E-03	1.53E-02
Pb-210	409	66	194	1.11E+01	-2.65E+00	2.30E+00	1.86E+00
Pu-238	404	66	310	9.30E-02	-3.80E-02	1.35E-02	1.83E-02
Pu239/240	404	66	378	6.06E-02	-5.19E-02	4.38E-03	1.43E-02
Pu-241	412	66	387	4.62E+00	-5.98E+00	-1.46E-01	1.61E+00

Analyte	Observations	Number of Stations	Below L_c*	Maximum	Minimum	Mean	Standard Deviation
Pu-242	395	66	368	1.06E-01	-3.14E-02	5.07E-03	1.62E-02
Ra-226	413	66	19	7.71E+00	-6.55E-02	5.37E-01	6.16E-01
Ra-228	412	66	19	4.08E+00	-2.77E-01	1.10E+00	6.41E-01
Sr-90	404	66	339	1.87E+00	-1.13E+00	1.97E-01	5.94E-01
Tc-99	412	66	396	2.66E+01	-3.54E+01	-3.02E+00	9.47E+00
Th-228	412	66	207	2.13E-01	-4.38E-02	4.07E-02	3.82E-02
Th-230	412	66	183	3.07E-01	-4.95E-02	3.26E-02	4.29E-02
Th-232	412	66	316	1.36E-01	-1.84E-02	7.16E-03	1.49E-02
H-3	412	66	390	2.76E+02	-1.92E+02	-1.75E+01	7.64E+01
U-233/234	412	66	1	3.62E+01	4.08E-03	1.18E+01	6.67E+00
U-235/236	412	66	46	1.79E+00	-1.63E-02	2.69E-01	2.63E-01
U-238	412	66	4	1.56E+01	-5.98E-03	3.35E+00	3.30E+00
U-238	412	66	4	1.56E+01	-5.98E-03	3.35E+00	3.30E+00

*Values of Critical Level (Lc) were estimated as one-half of the Minimum Detectable Concentration (MDC).

As discussed above in relation to PM-02, dissolved constituents in Dockum groundwater, including 225'-zone groundwater, differ from those in OAG groundwater. That includes the prevalence (or lack) of certain dissolved metals. As shown in Table 4-7 below, some naturally occurring metals also follow this pattern. Specifically, arsenic, chromium, and vanadium concentrations appear to be either more widely distributed, more ubiquitous, and/or to have higher concentrations in OAG groundwater versus 225'-zone groundwater.

Table 4-7: 225'-Zone Groundwater Monitoring Results for Low Level Pre-Operational Monitoring Program.

Analyte	Units	Observations	No. of Stations	< PQL	Max. Value	Min. Value	Mean Value*	Standard Dev.*
Antimony	µg/L	87	52	67 (19 J flags)	42.7	<3	5.81	6.86
Arsenic	µg/L	409	65	405 (175 J flags)	63.5	<5	7.16	7.31
Barium	µg/L	109	52	0	4710	6.5	88.67	459.8
Beryllium	µg/L	87	52	87 (8 J flags)	4.39 J	<1	0.63	0.50
Boron	µg/L	25	11	0	1670	1080	1476.8	137.1
Cadmium	µg/L	1	1	1 (1 J flag)	1.07 J	1.07 J	N/A	N/A
Chromium	µg/L	109	52	41 (35 J flags)	101	<1	11.22	14.14
Cobalt	µg/L	72	52	65 (8 J flags)	18.3	<1	1.89	3.86
Copper	µg/L	25	11	24 (8 J flags)	17.5	<3	3.39	3.66
Lead	µg/L	109	52	105 (5 J flags)	54.2	<3.3	2.91	5.77
Molybdenum	µg/L	25	11	0	58.9	29.4	45.82	7.88
Nickel	µg/L	404	65	288 (181 J flags)	620	<1.5	6.89	31.87
Selenium	µg/L	417	65	404 (118 J flags)	143	<1.5	6.32	10.44
Silver	µg/L	87	52	87 (4 J flags)	3.65 J	<1	0.64	0.57
Thallium	µg/L	25	11	25 (5 J flags)	15.7 J	<5	3.96	3.34
Uranium	µg/L	25	11	17 (12 J flags)	139	<10	44.78	43.72
Vanadium	µg/L	25	11	17 (12 J flags)	11.7	<1	3.98	2.96
Zinc	µg/L	87	52	2 (2 J flags)	996	7.63 J	97.62	153.5
1,4-Dioxane	µg/L	380	65	380	<2.0	<1.79	N/A	N/A
Phenol	µg/L	380	65	380	<1.0	<0.893	N/A	N/A
1,1,1-Trichloroethane	µg/L	386	65	386	<0.325	<0.325	N/A	N/A
1,1,2,2-Tetrachloroethane	µg/L	387	65	387	<0.25	<0.25	N/A	N/A

Analyte	Units	Observations	No. of Stations	< PQL	Max. Value	Min. Value	Mean Value*	Standard Dev.*
1,1,2-Trichloroethane	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
1,1-Dichloroethane	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
1,1-Dichloroethylene	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
1,2-Dichloroethane	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
1,2-Dichloropropane	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
Acetone	µg/L	386	65	386	<1.5	<1.5	N/A	N/A
Benzene	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
Benzoic acid	µg/L	33	11	33 (1 J flag)	14.6 J	<5.36	N/A	N/A
Bromodichloromethane	µg/L	386	65	386	0.47 J	<0.25	N/A	N/A
Bromoform	µg/L	386	65	386 (4 J flags)	4.53 J	<0.25	N/A	N/A
Bromomethane	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
Carbon disulfide	µg/L	386	65	386 (2 J flags)	2.04 J	<1.25	N/A	N/A
Carbon tetrachloride	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
Chlorobenzene	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
Chloroethane	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
Chloroform	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
Chloromethane	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
cis-1,3-Dichloropropylene	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
Dibromochloromethane	µg/L	386	65	386 (1 J flag)	0.89 J	<0.3	N/A	N/A
Ethylbenzene	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
Tetrachloroethylene	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
Toluene	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
trans-1,2-Dichloroethylene	µg/L	386	65	386	<0.3	<0.3	N/A	N/A
trans-1,3-Dichloropropylene	µg/L	386	65	386	<0.25	<0.25	N/A	N/A
Trichloroethylene	µg/L	386	65	386 (2 J flags)	1.09 J	<0.25	N/A	N/A
Vinyl chloride	µg/L	386	65	386	<0.5	<0.5	N/A	N/A

NOTES: * Non-detect values were replaced with one half of the MDL for summary statistics.

As with the other groundwater bearing zones at WCS, the radionuclides and non-radioactive metals reported in 225'-zone groundwater are naturally occurring and are representative of background conditions at WCS.

In addition to the naturally occurring analytes, a number of false positives were reported during the pre-operational period as well. False positives were identified during the data validation process WCS implements to verify and validate analytical data.

The primary chemical false positives were acetone, chloromethane, and toluene. Estimated (J-flag) concentrations make up the vast majority of these detections (113 out of 114 detections). In addition to these three chemicals, between one and four estimated concentrations of benzoic acid, bromodichloromethane, bromoform, carbon disulfide, dibromochloromethane, and trichloroethene were reported in 225'-zone groundwater samples. All of these VOCs are considered false positives.

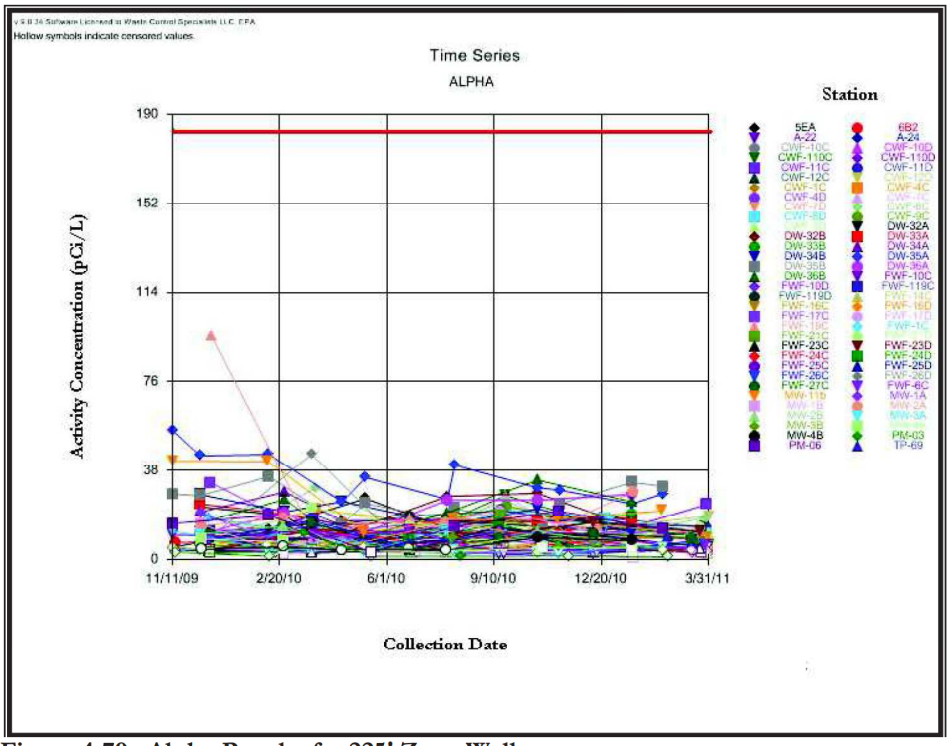

Figure 4-79 : Alpha Results for 225' Zone Wells.

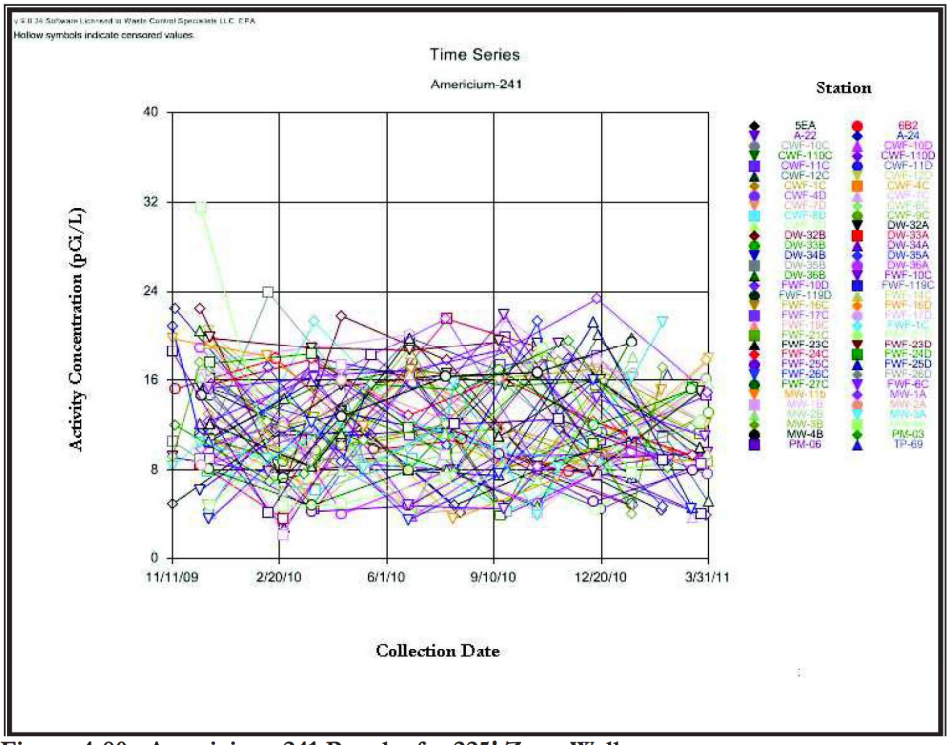

Figure 4-80 : Americium-241 Results for 225' Zone Wells.

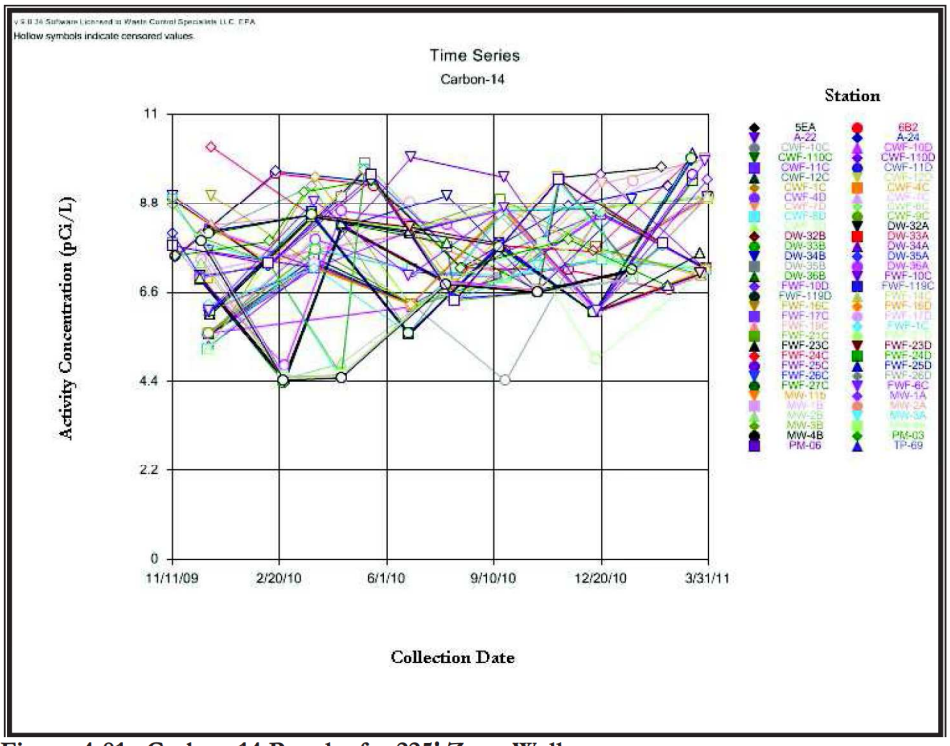

Figure 4-81 : Carbon-14 Results for 225' Zone Wells.

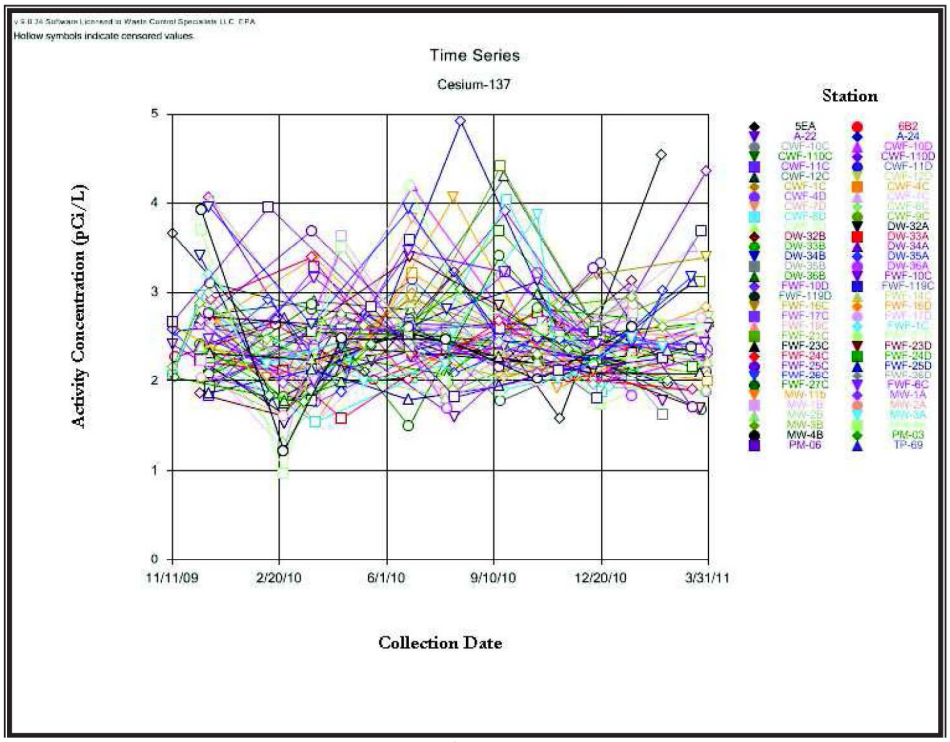

Figure 4-82 : Cesium-137 Results for 225' Zone Wells.

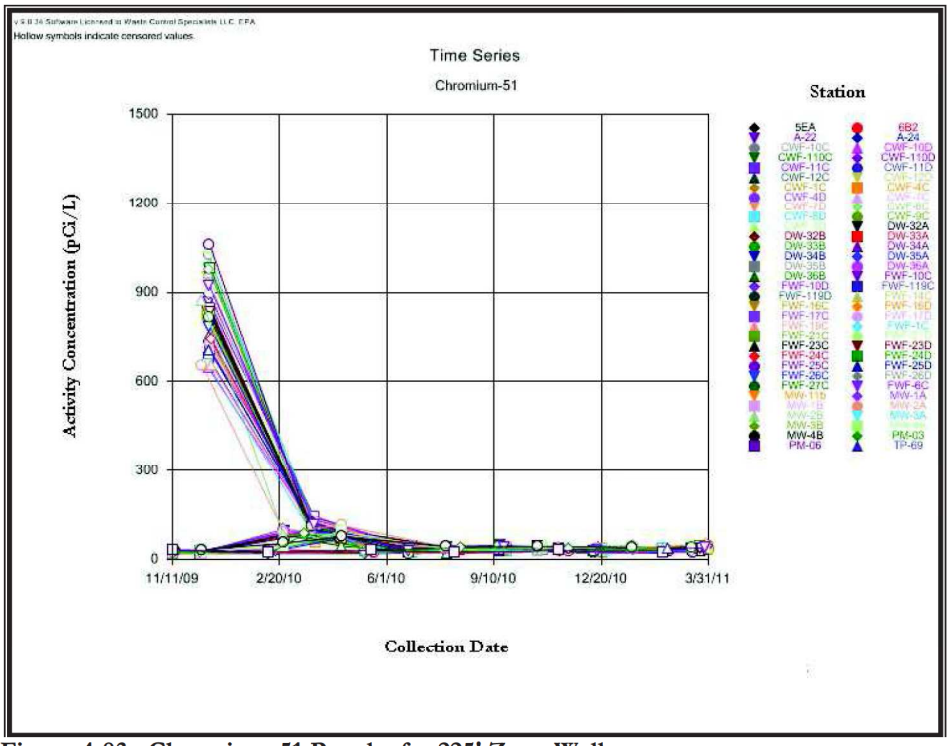

Figure 4-83 : Chromium-51 Results for 225' Zone Wells.

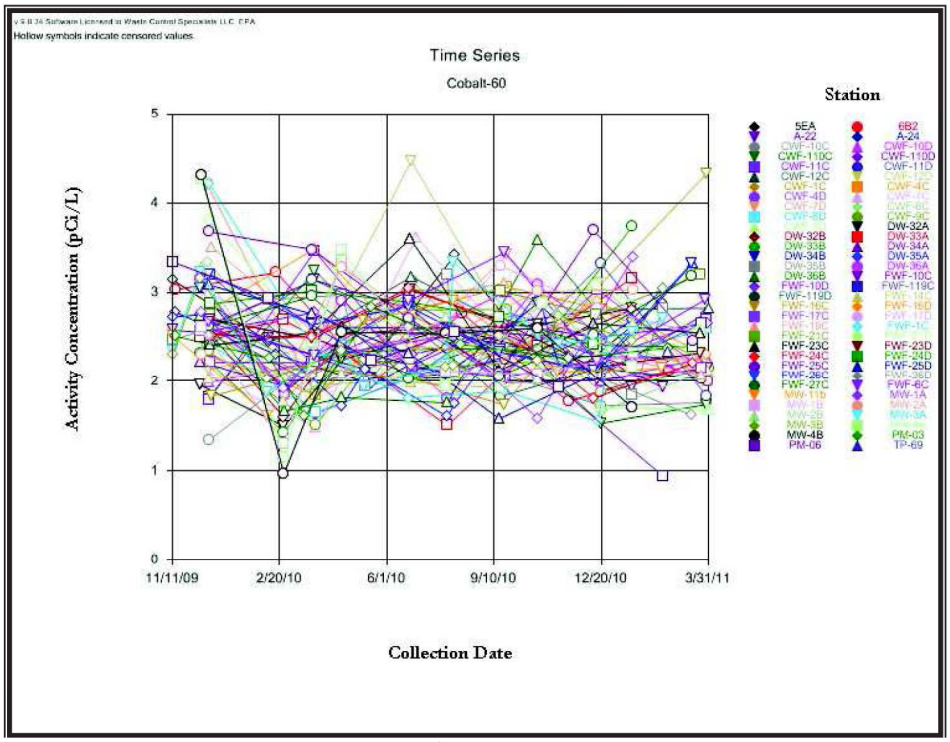

Figure 4-84 : Colbalt-60 Results for 225' Zone Wells.

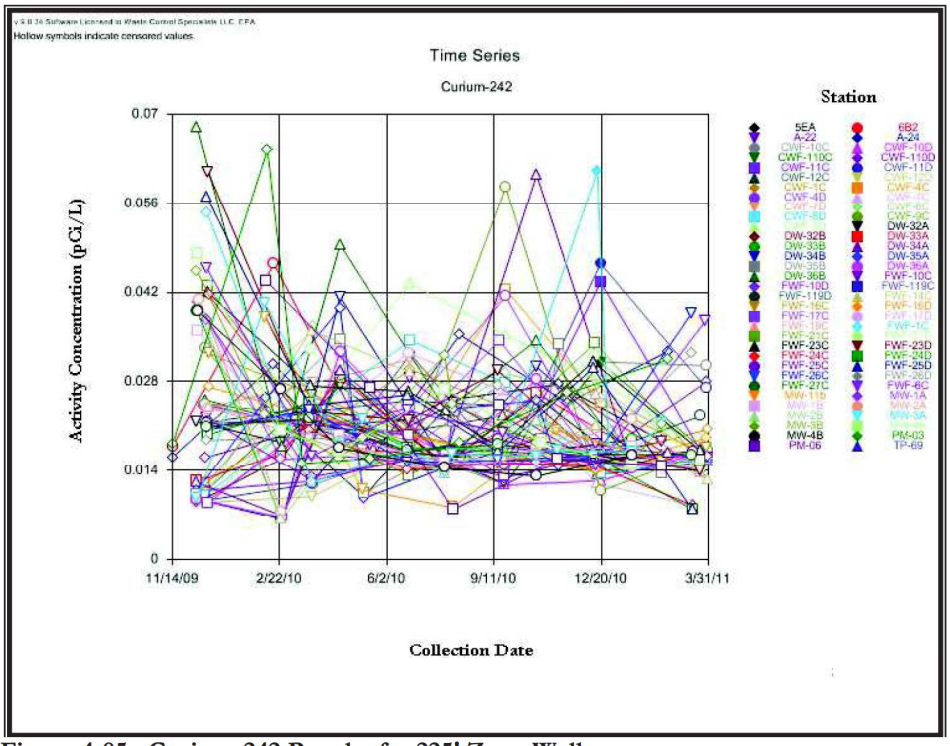

Figure 4-85 : Curium-242 Results for 225' Zone Wells.

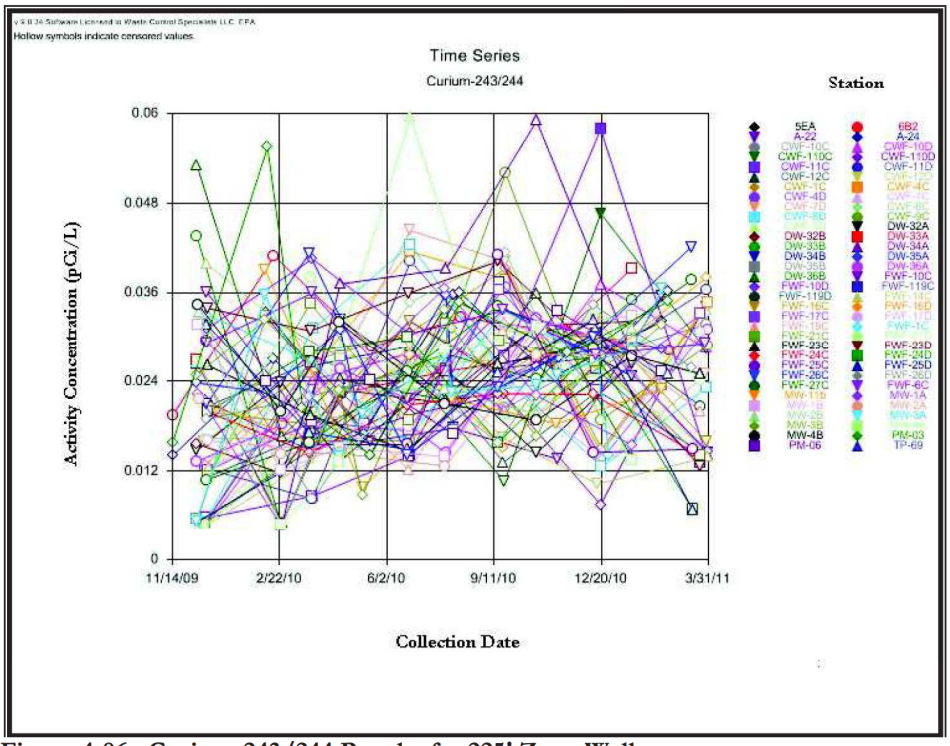

Figure 4-86 : Curium-243/244 Results for 225' Zone Wells.

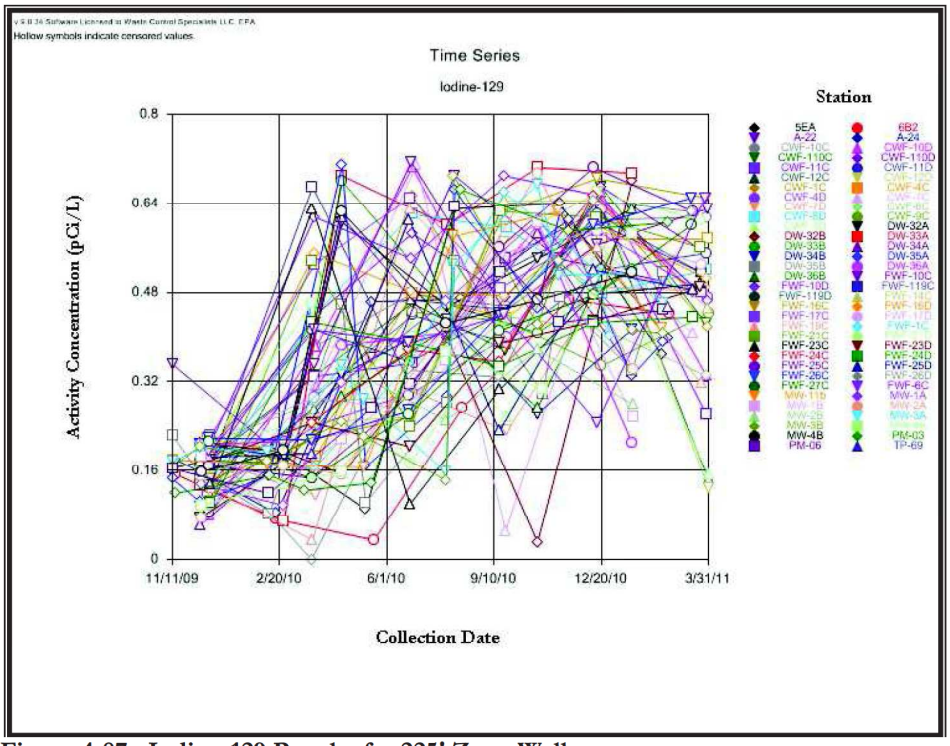

Figure 4-87 : Iodine-129 Results for 225' Zone Wells.

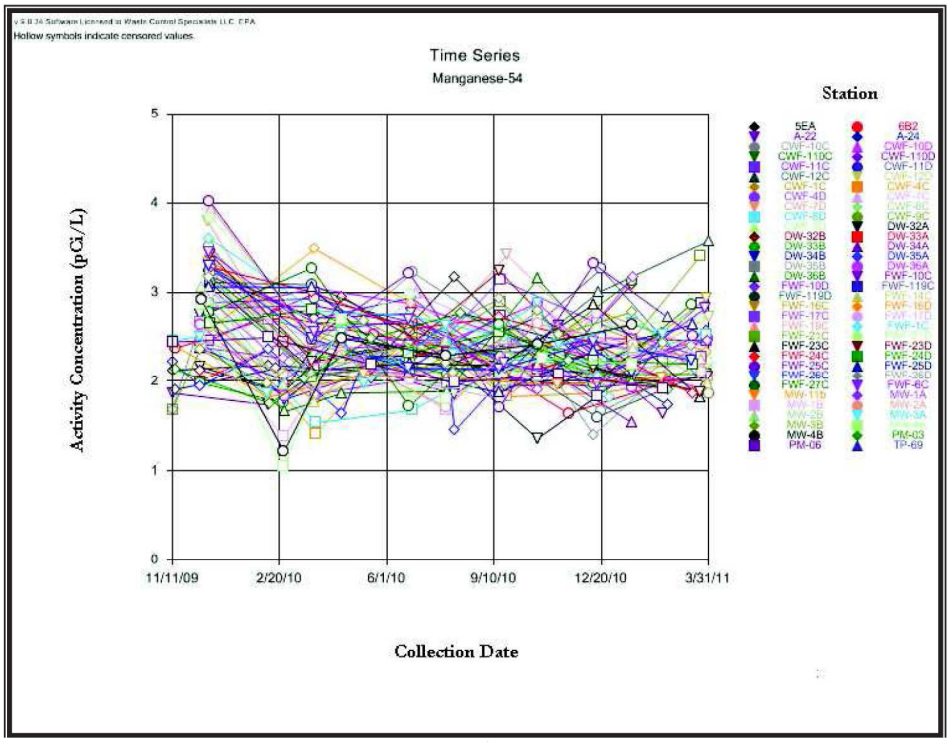

Figure 4-88 : Manganese-54 Results for 225' Zone Wells.

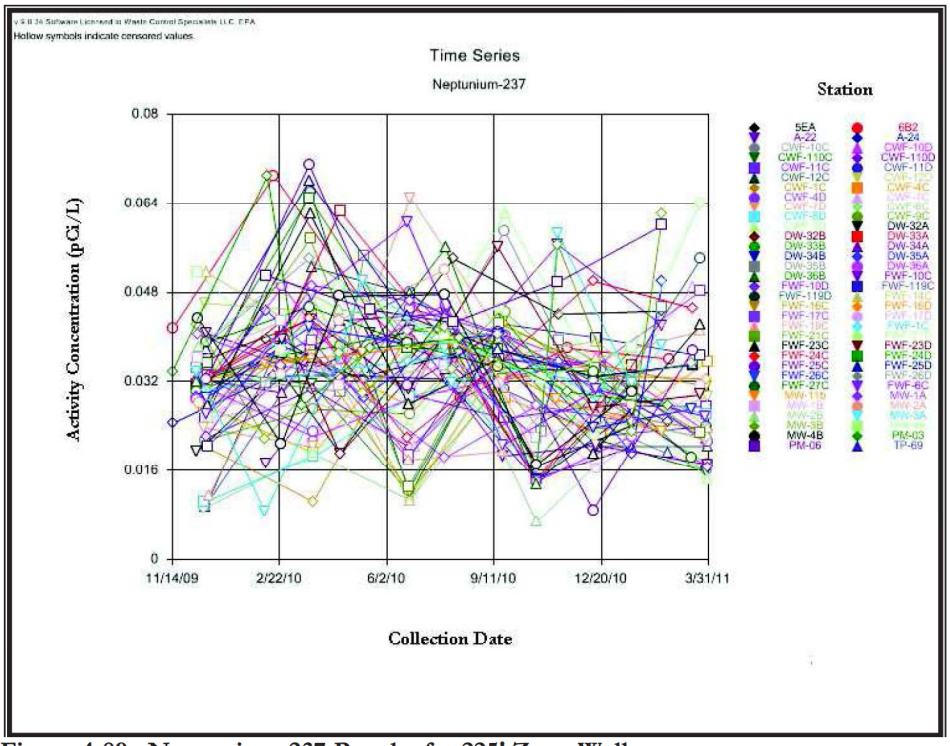

Figure 4-89 : Neptunium-237 Results for 225' Zone Wells.

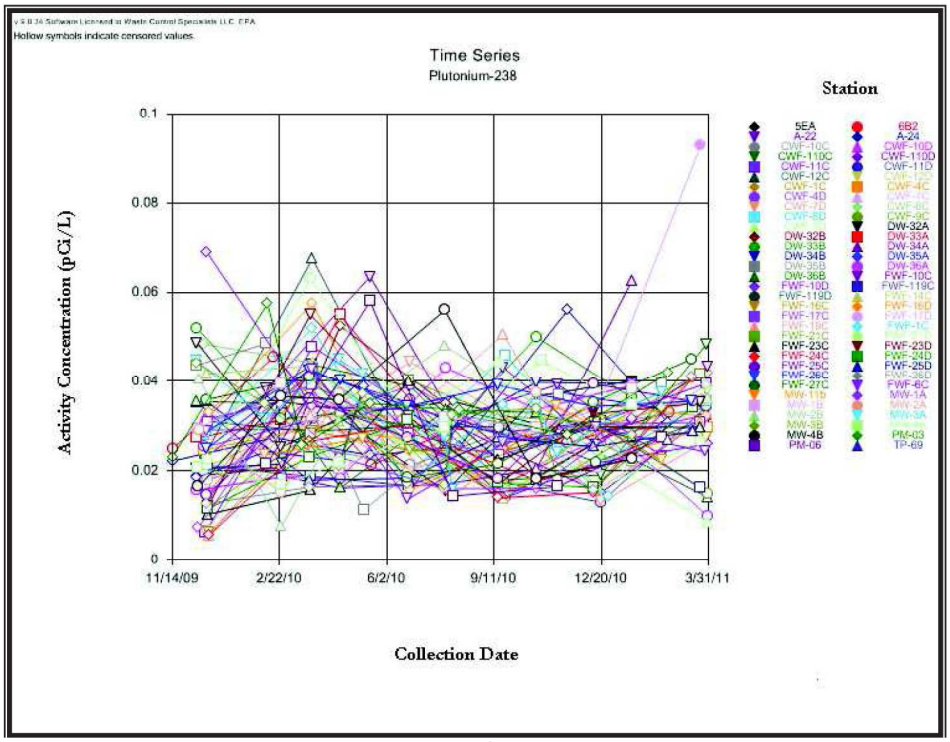

Figure 4-90 : Plutonium-238 Results for 225' Zone Wells.

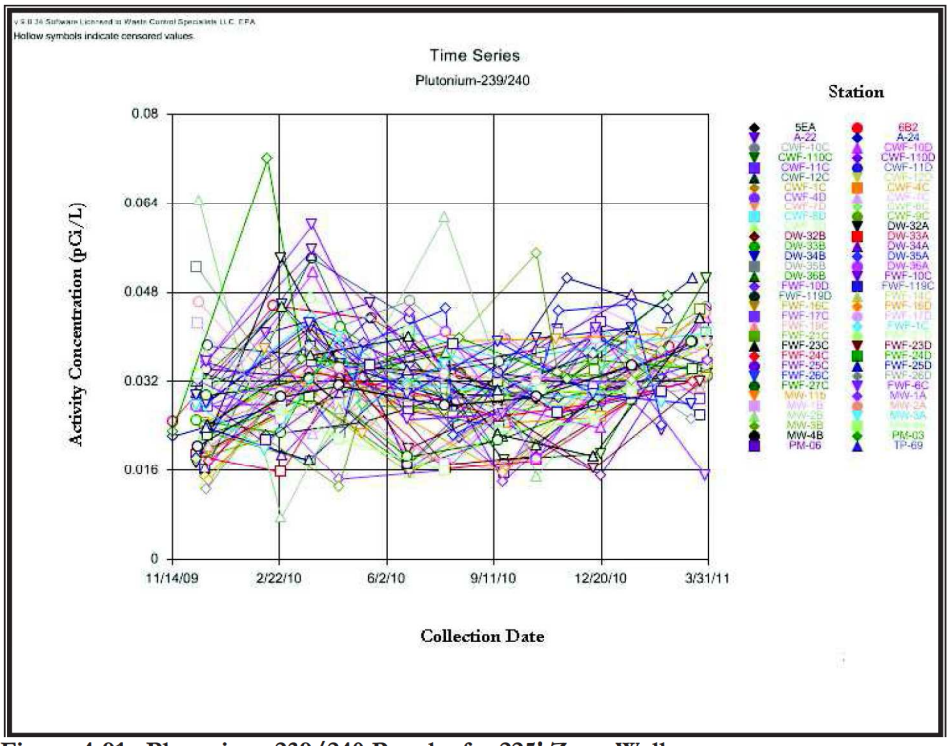

Figure 4-91 : Plutonium-239/240 Results for 225' Zone Wells.

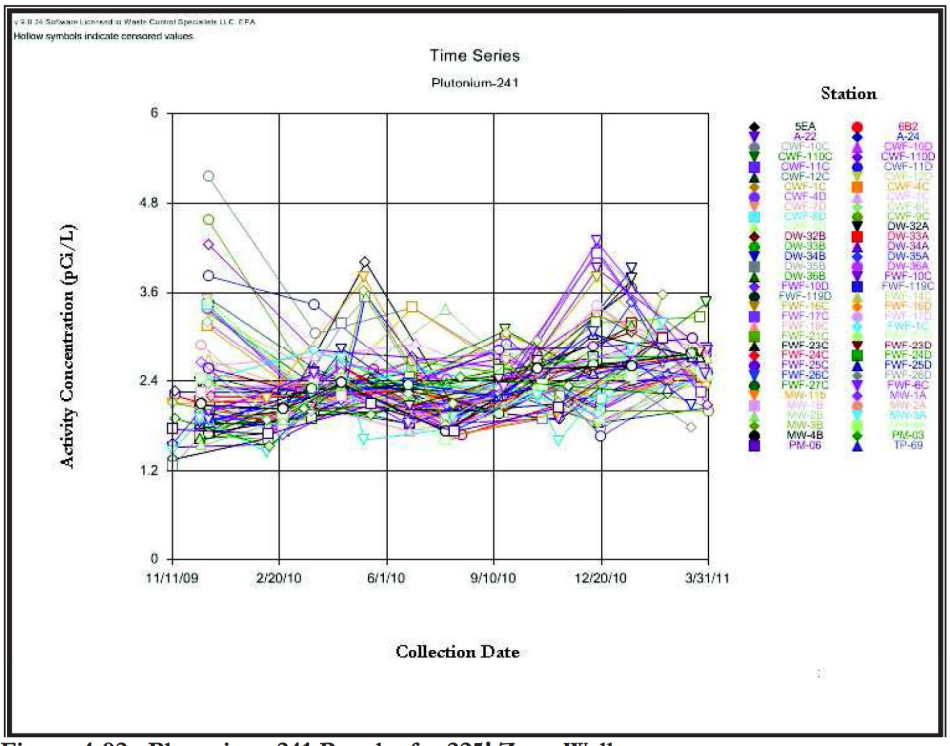

Figure 4-92 : Plutonium-241 Results for 225' Zone Wells.

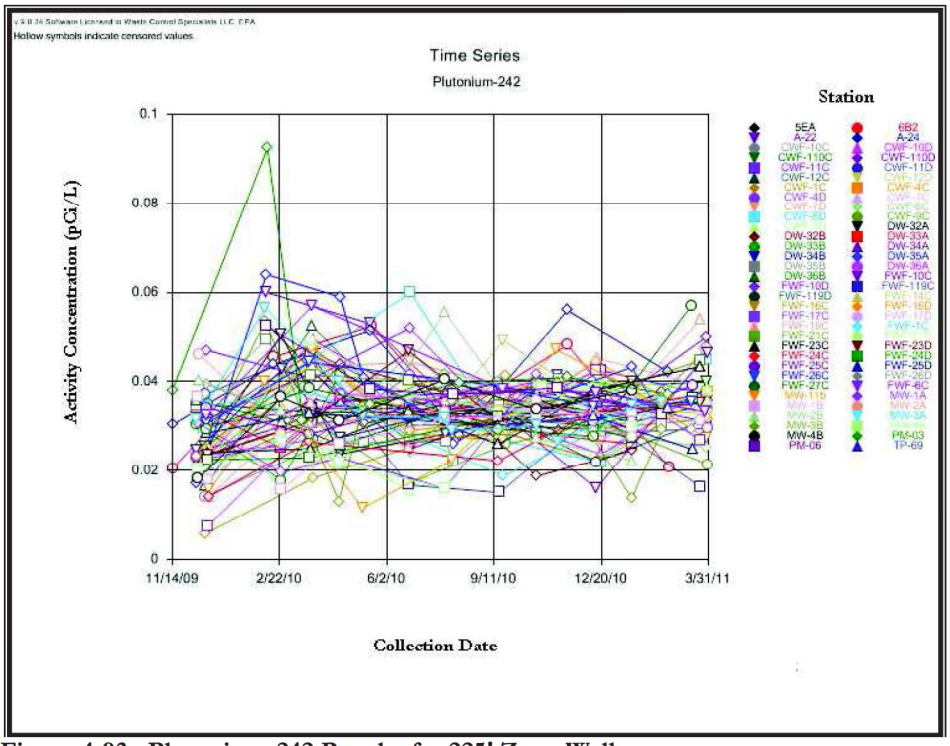

Figure 4-93 : Plutonium-242 Results for 225' Zone Wells.

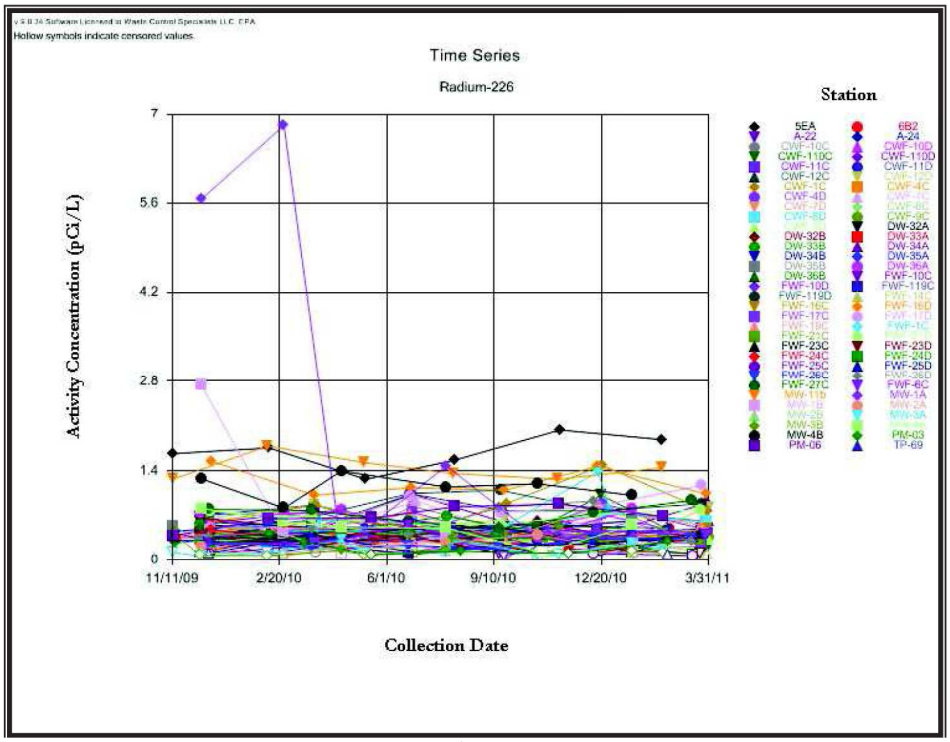

Figure 4-94 : Radium-226 Results for 225' Zone Wells.

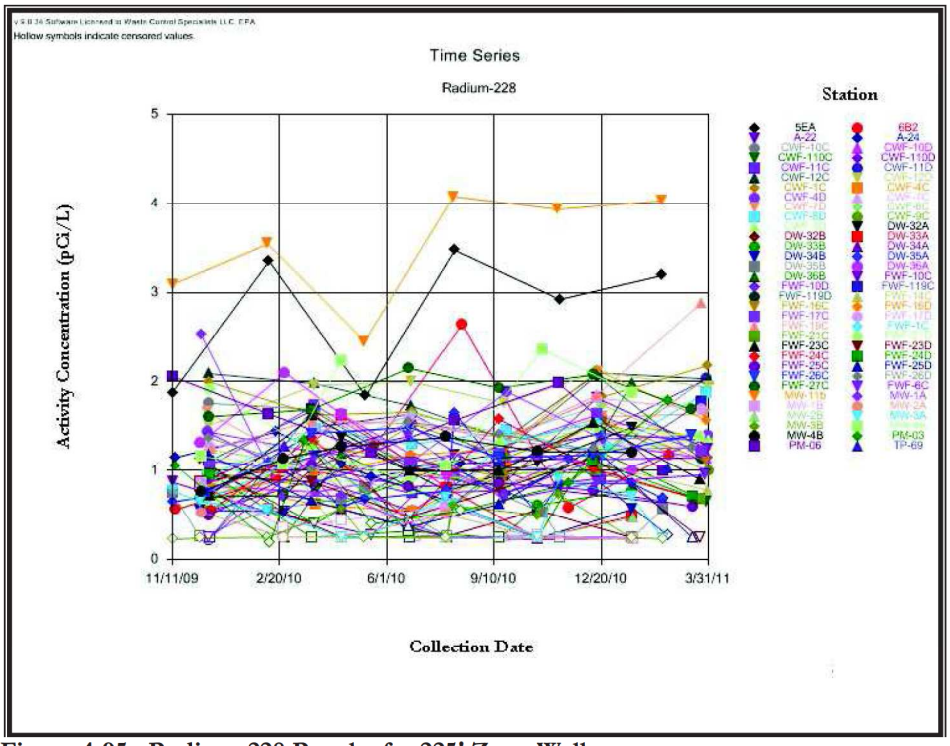

Figure 4-95 : Radium-228 Results for 225' Zone Wells.

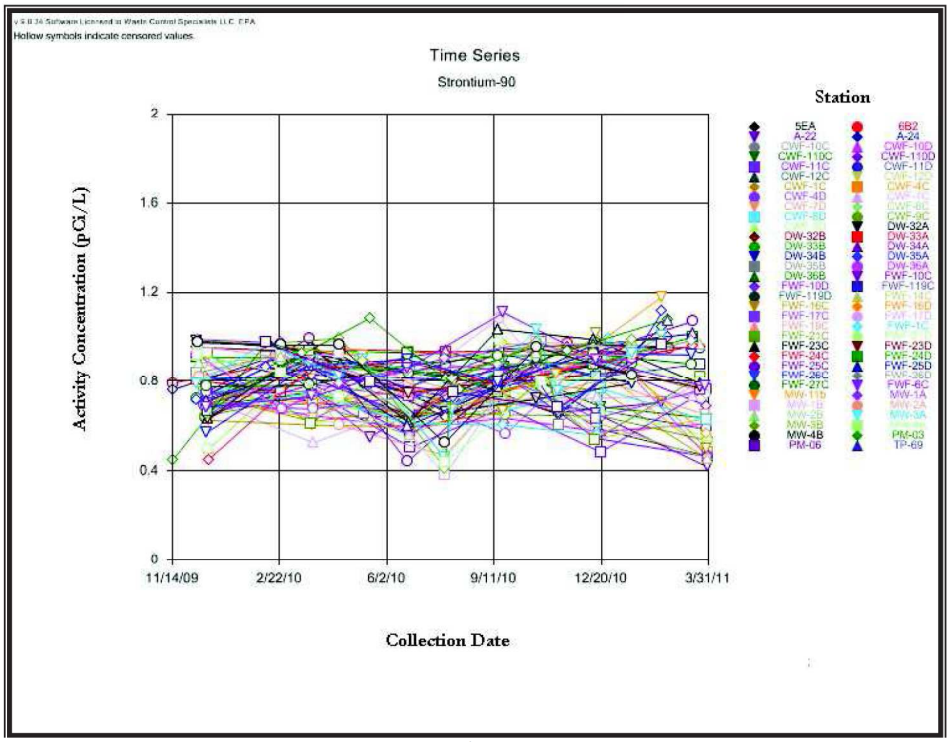

Figure 4-96 : Strontium-90 Results for 225' Zone Wells.

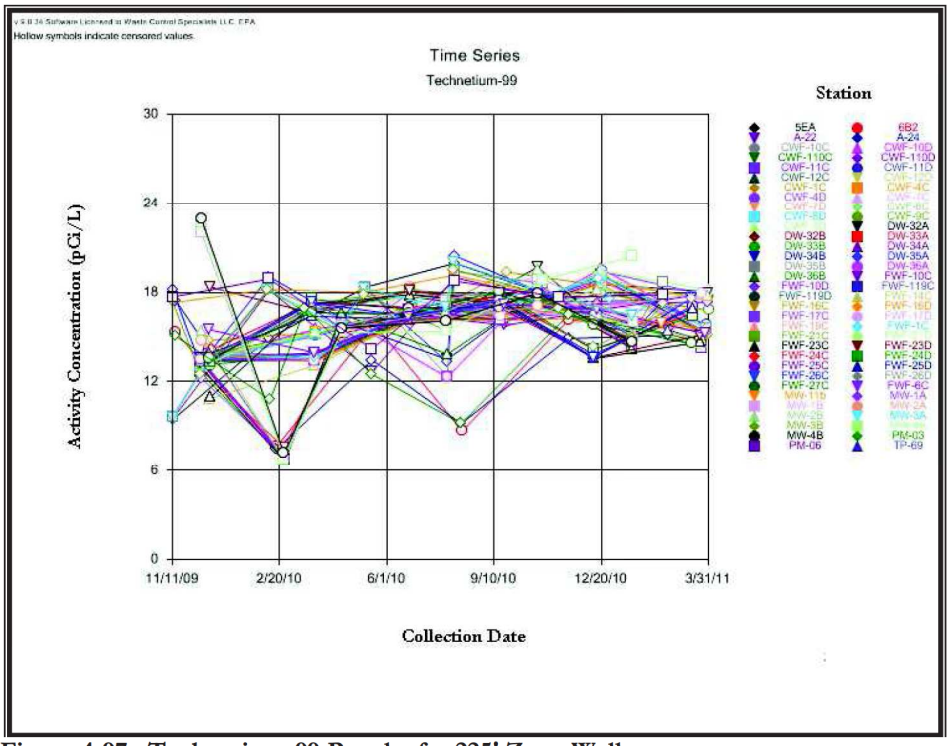

Figure 4-97 : Technetium-99 Results for 225' Zone Wells.

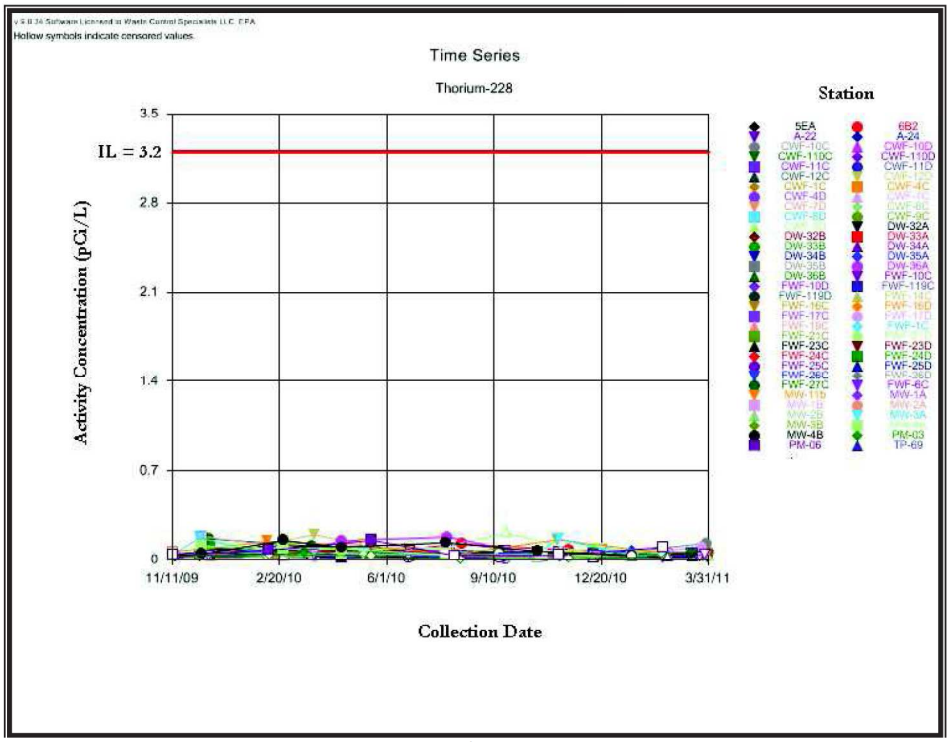

Figure 4-98 : Thorium-228 Results for 225' Zone Wells.

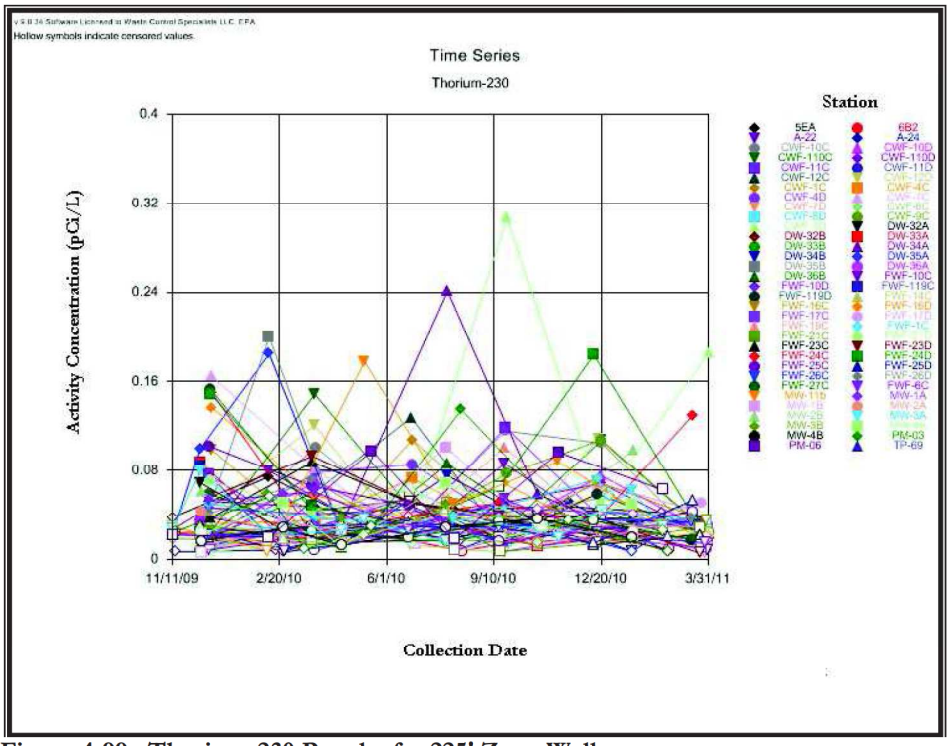

Figure 4-99 : Thorium-230 Results for 225' Zone Wells.

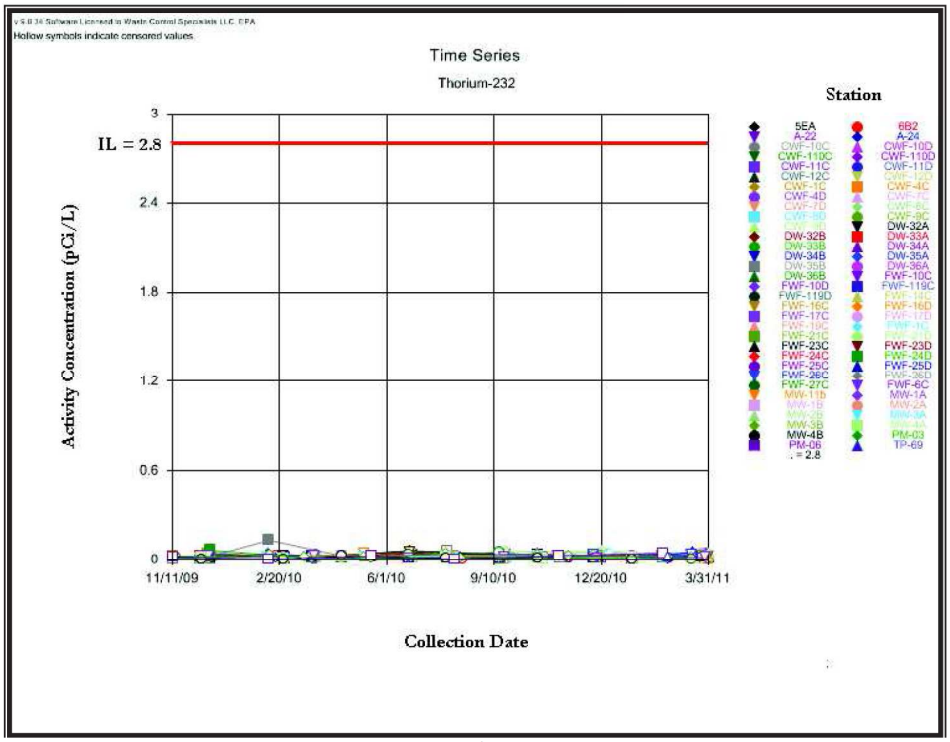

Figure 4-100 : Thorium-232 Results for 225' Zone Wells.

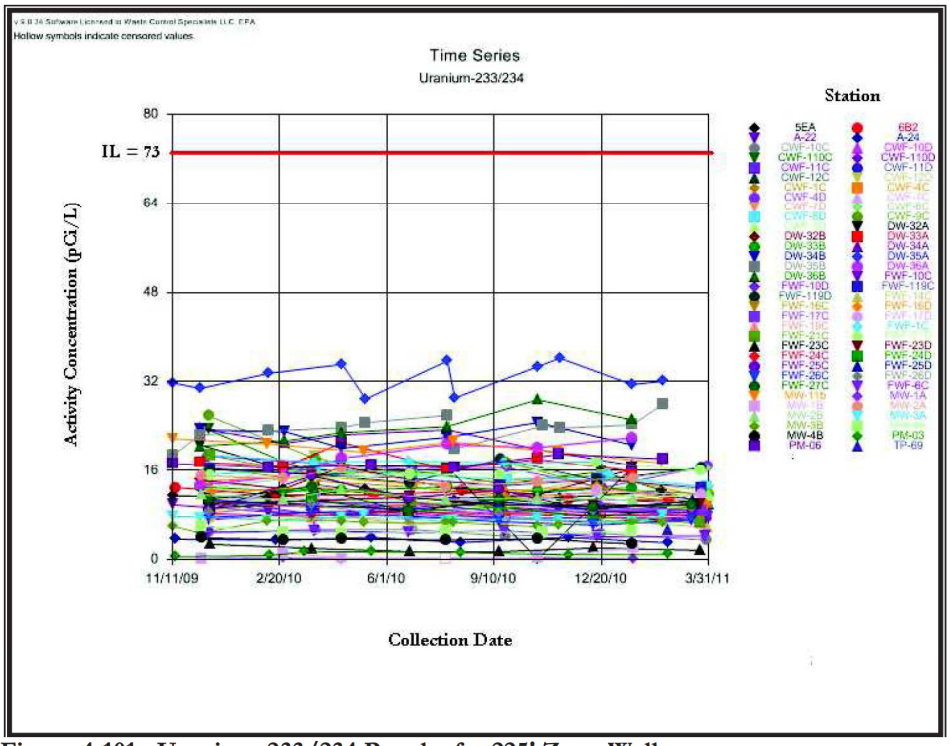

Figure 4-101 : Uranium-233/234 Results for 225' Zone Wells.

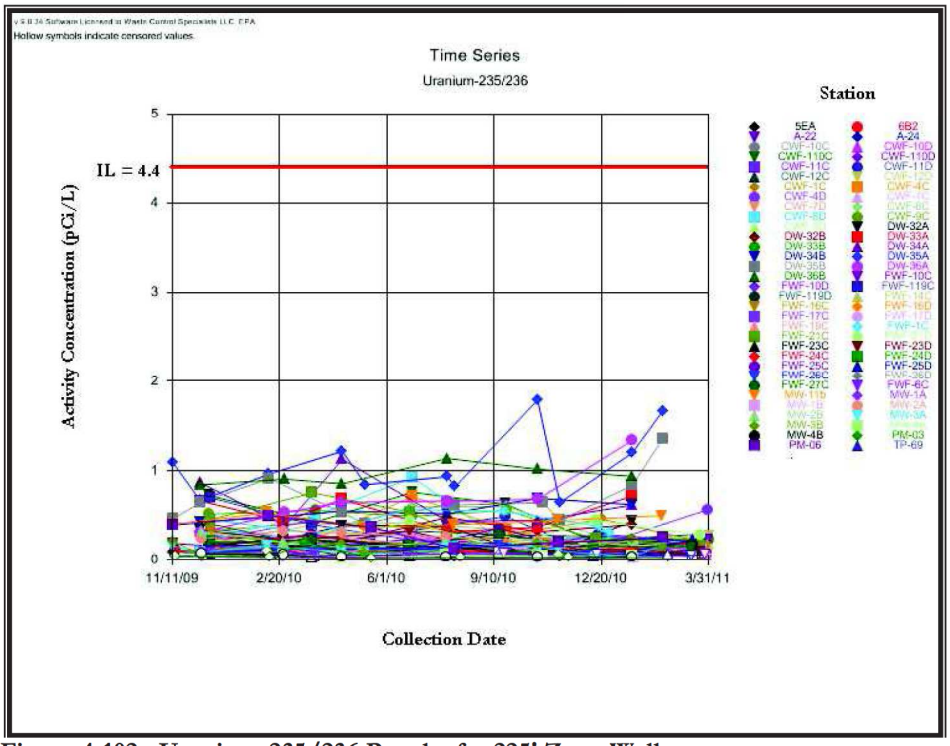

Figure 4-102 : Uranium-235/236 Results for 225' Zone Wells.

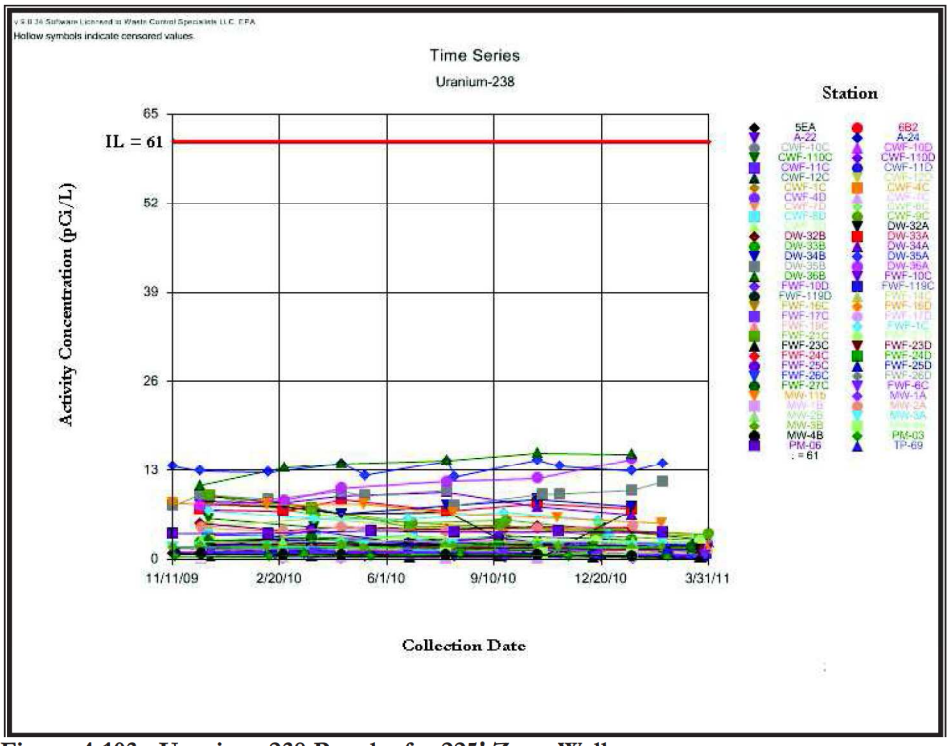

Figure 4-103 : Uranium-238 Results for 225' Zone Wells.

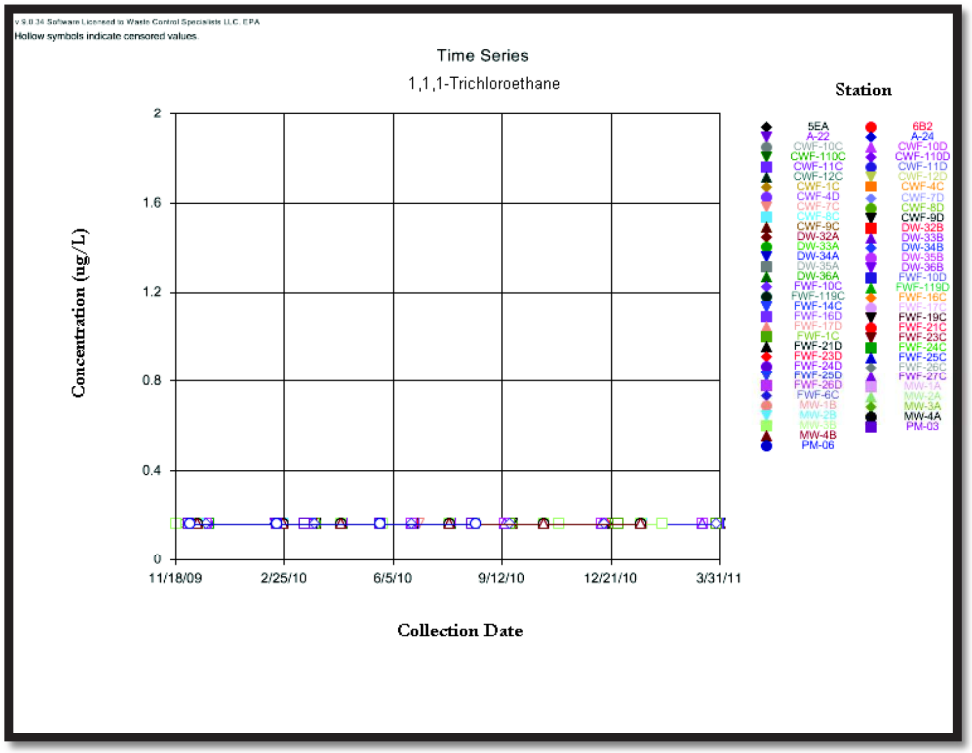

Figure 4-104 : 1,1,1-Trichloroethane Results for 225' Zone Wells.

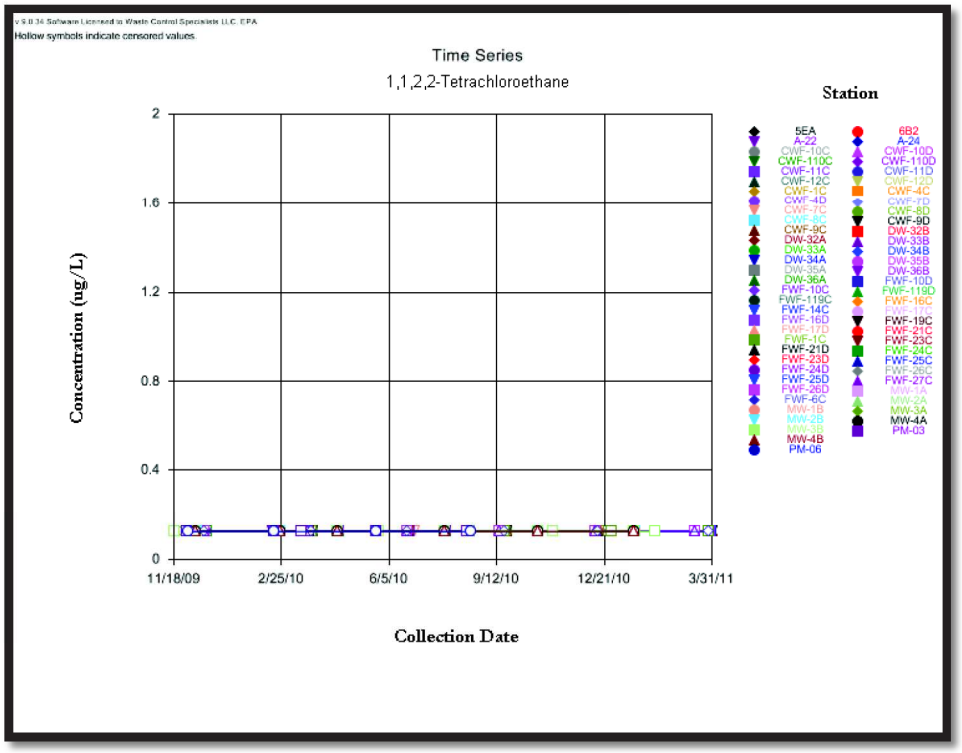

Figure 4-105 : 1,1,2,2-Tetrachloroethane Results for 225' Zone Wells.

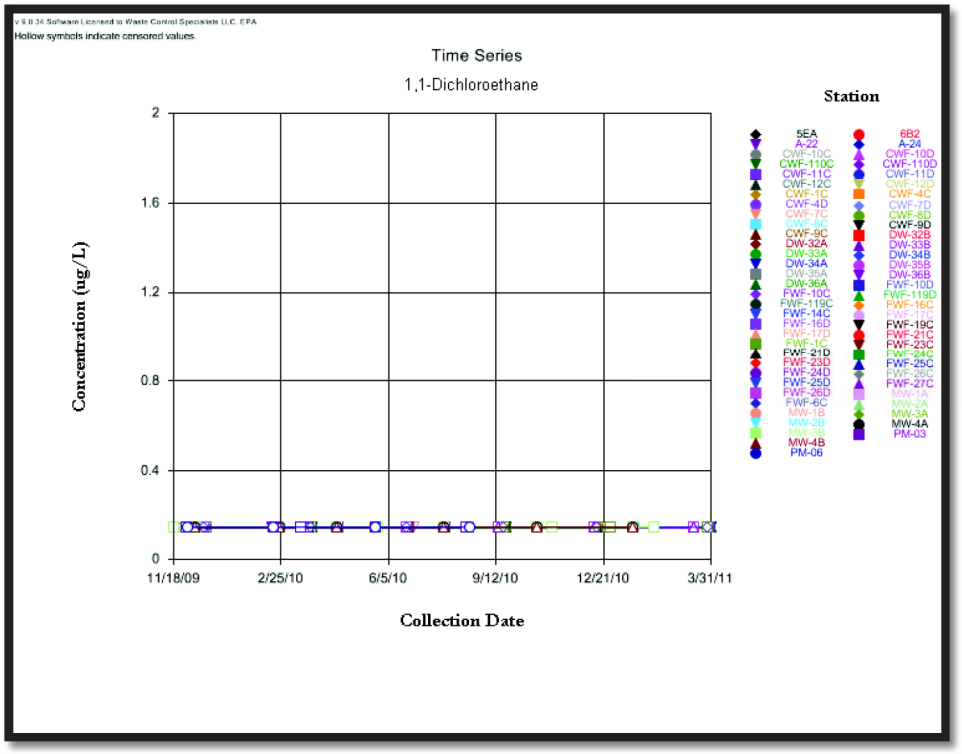

Figure 4-106 : 1,1-Dichloroethane Results for 225' Zone Wells.

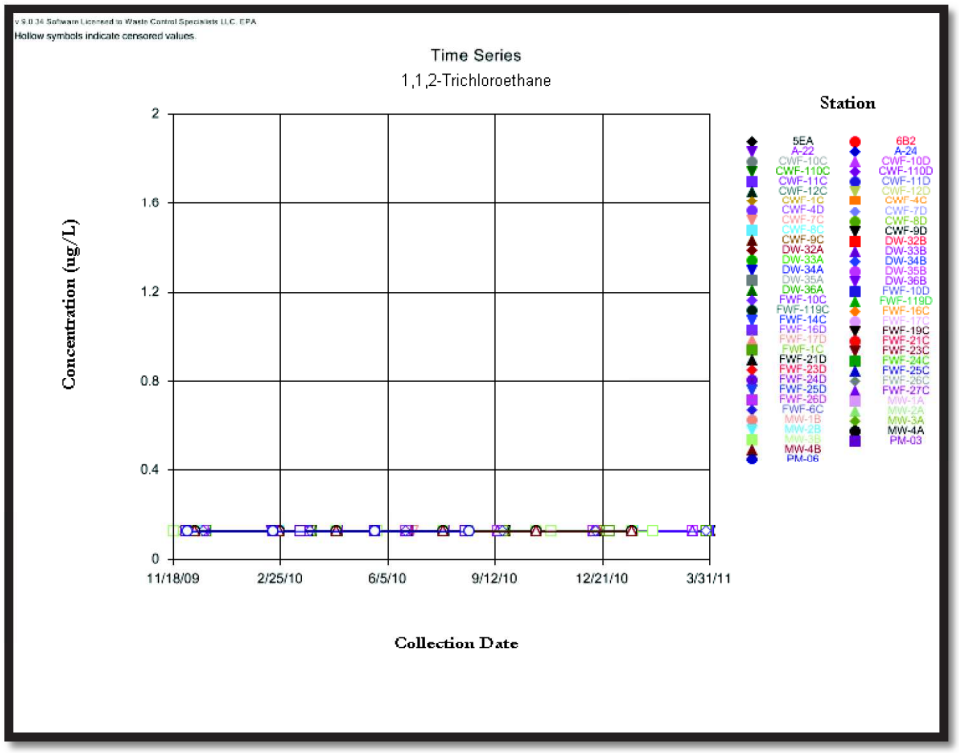

Figure 4-107 : 1,1,2-Trichloroethane Results for 225' Zone Wells.

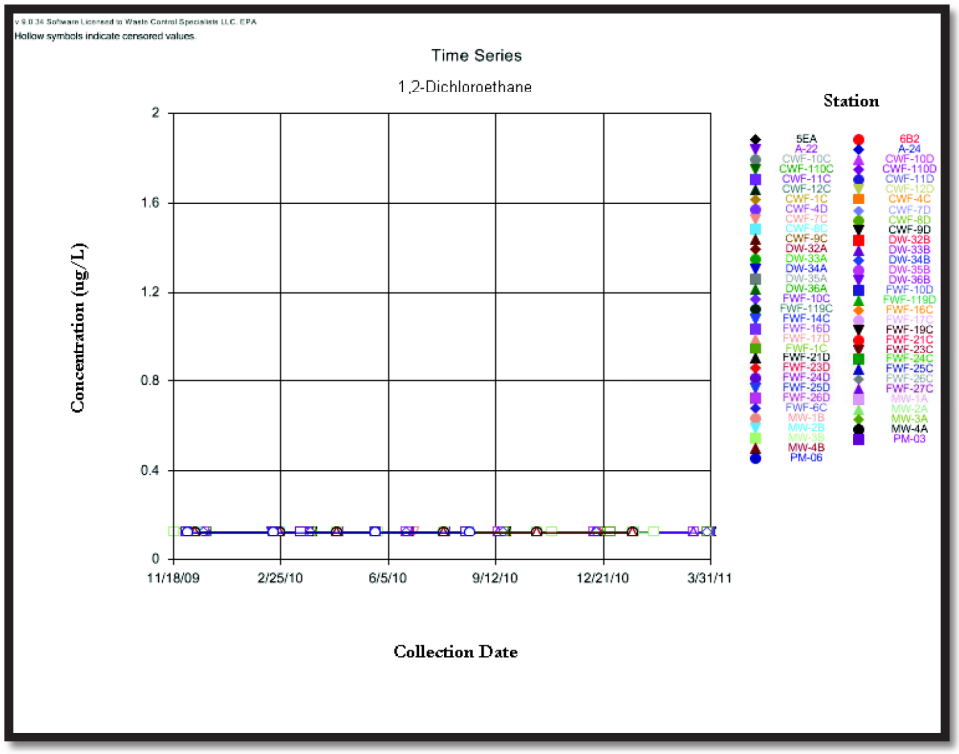

Figure 4-108 : 1,2-Dichloroethane Results for 225' Zone Wells.

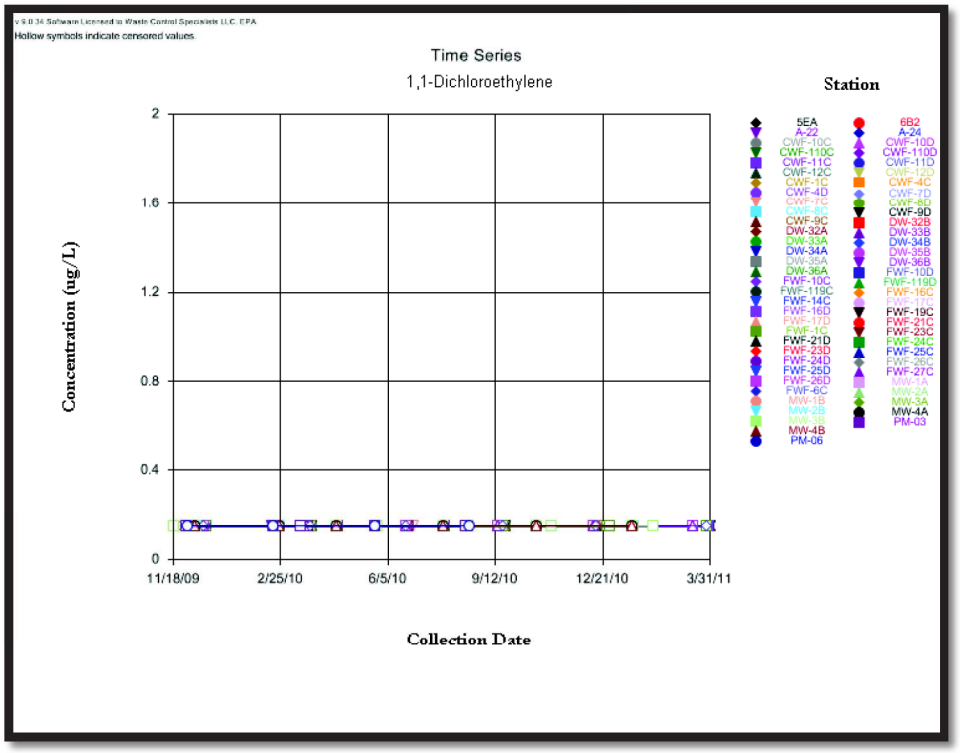

Figure 4-109 : 1,1-Dichloroethylene Results for 225' Zone Wells.

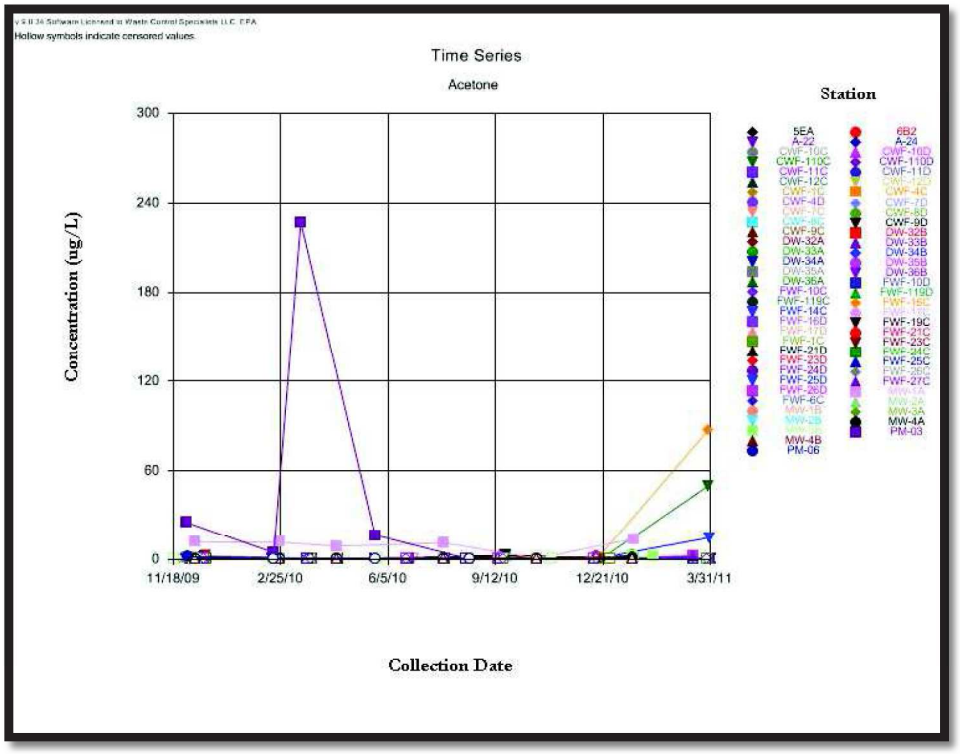

Figure 4-110 : Acetone Results for 225' Zone Wells.

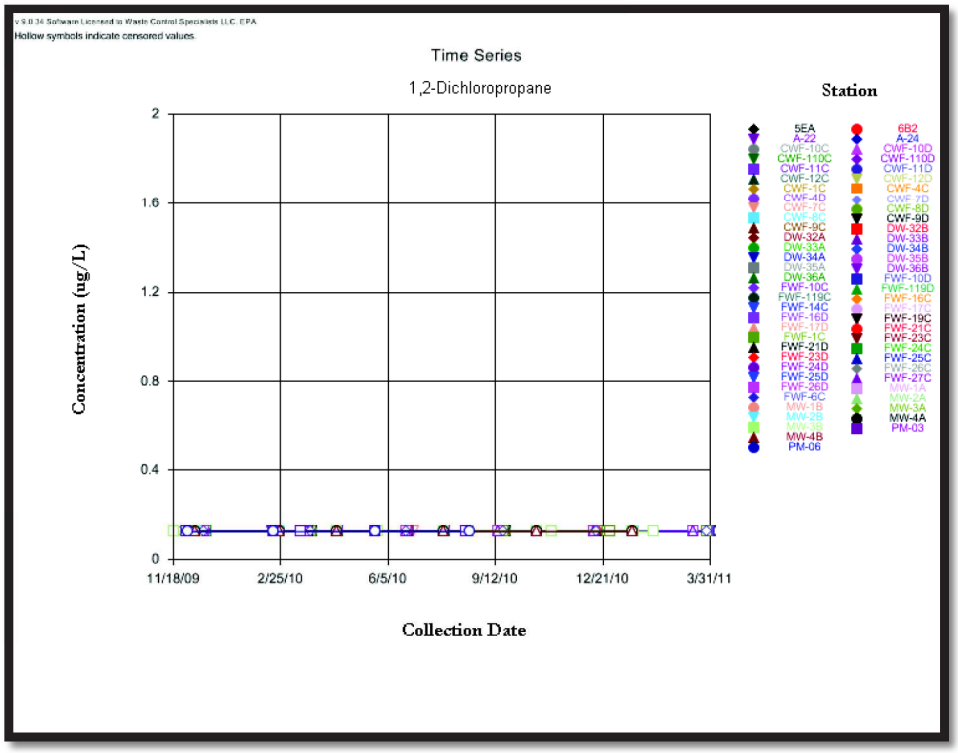

Figure 4-111 : 1,2-Dichloropropane Results for 225' Zone Wells.

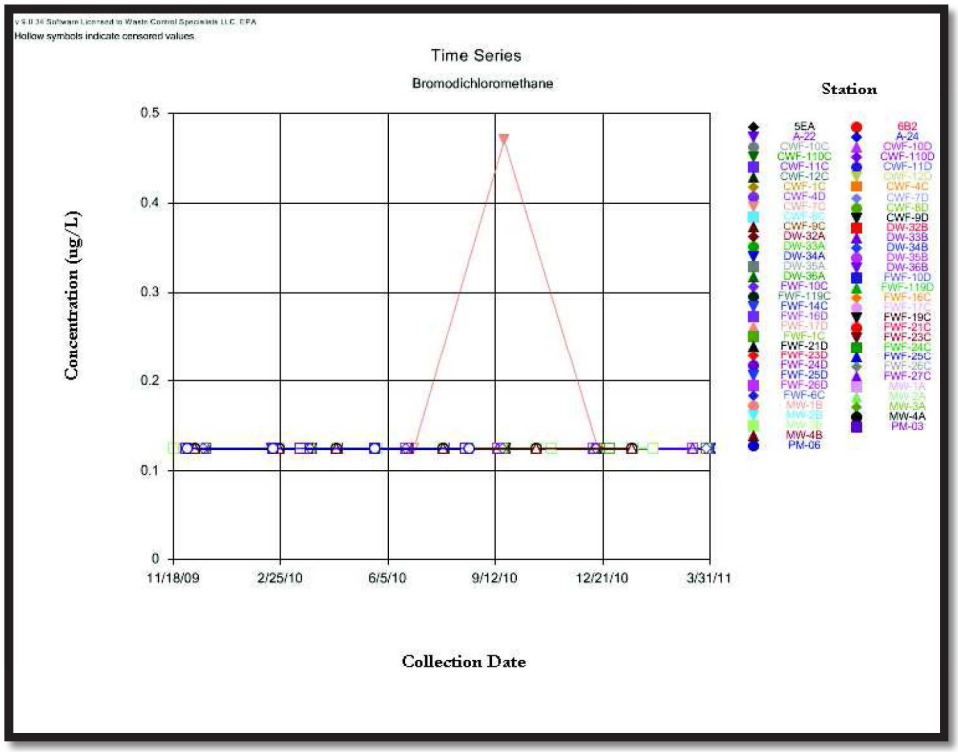

Figure 4-112 : Bromodichloromethane Results for 225' Zone Wells.

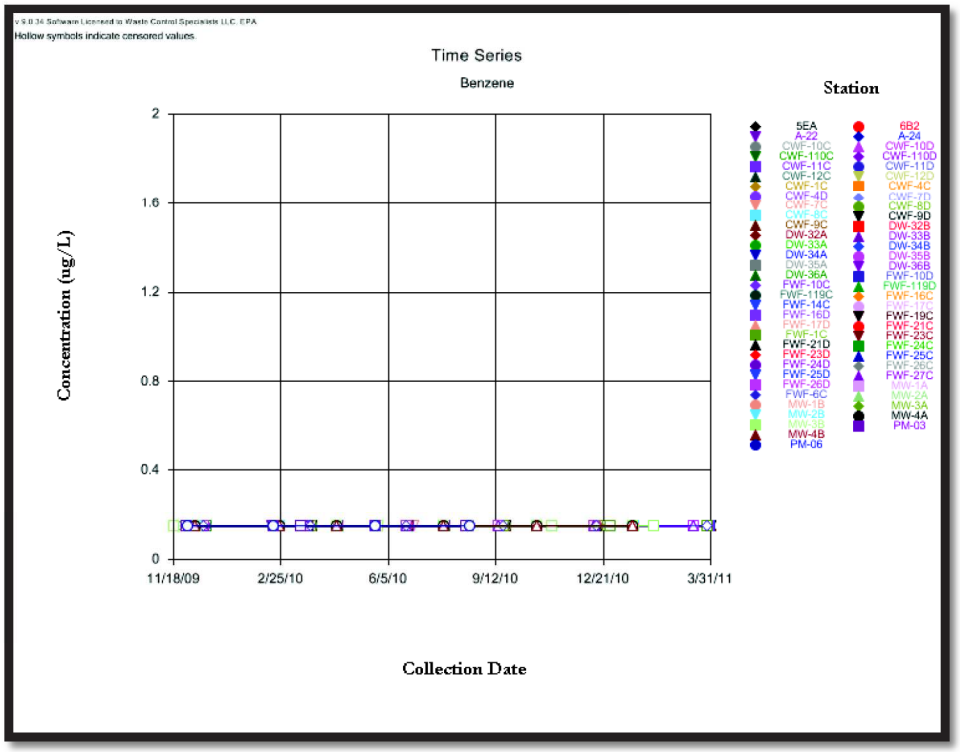

Figure 4-113 : Benzene Results for 225' Zone Wells.

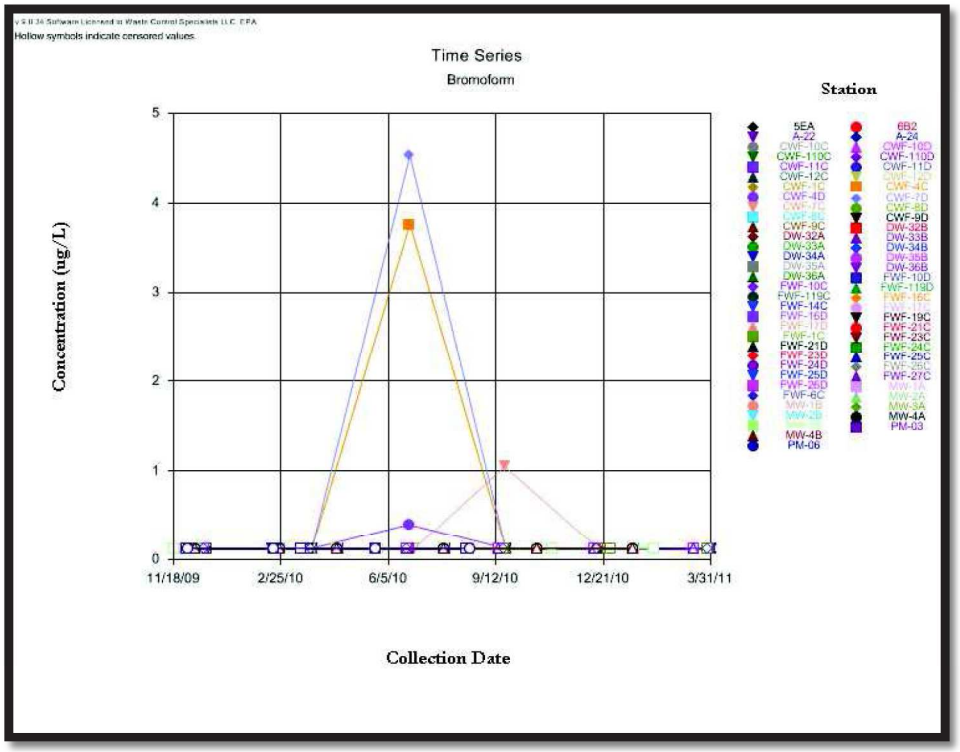

Figure 4-114 : Bromoform Results for 225' Zone Wells.

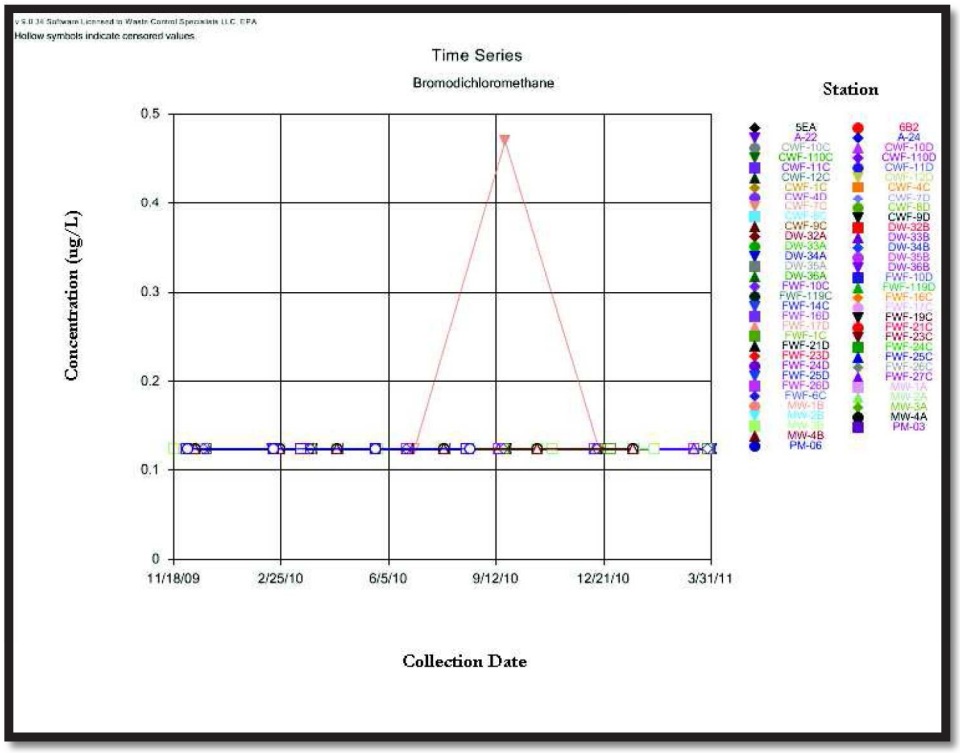

Figure 4-115 : Bromodichloromethane Results for 225' Zone Wells.

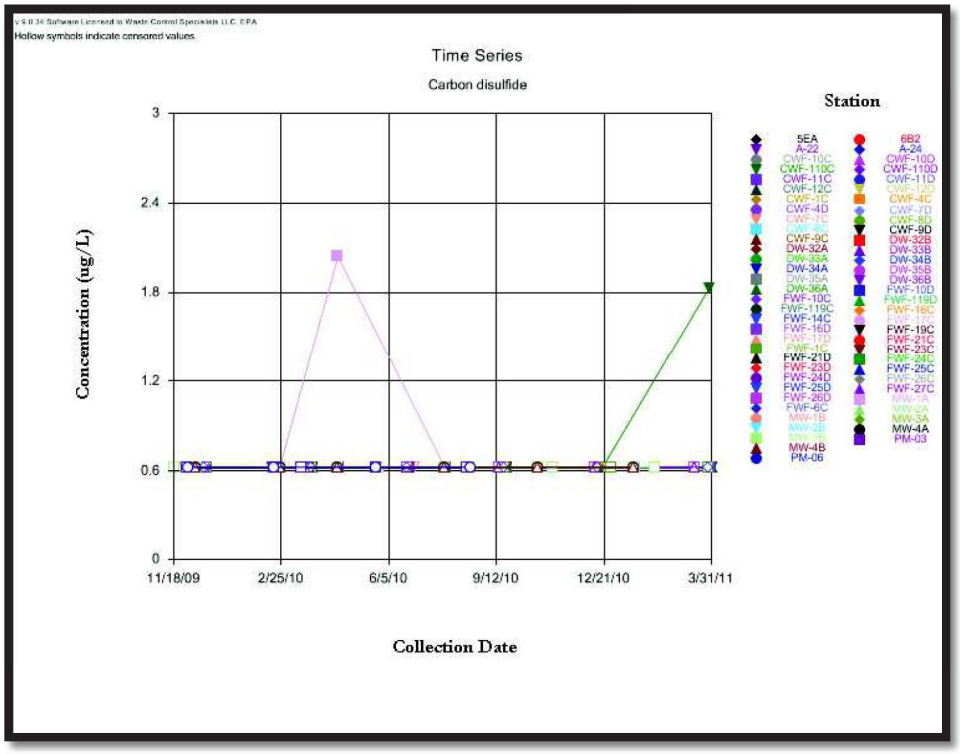

Figure 4-116 : Carbon disulfide Results for 225' Zone Wells.

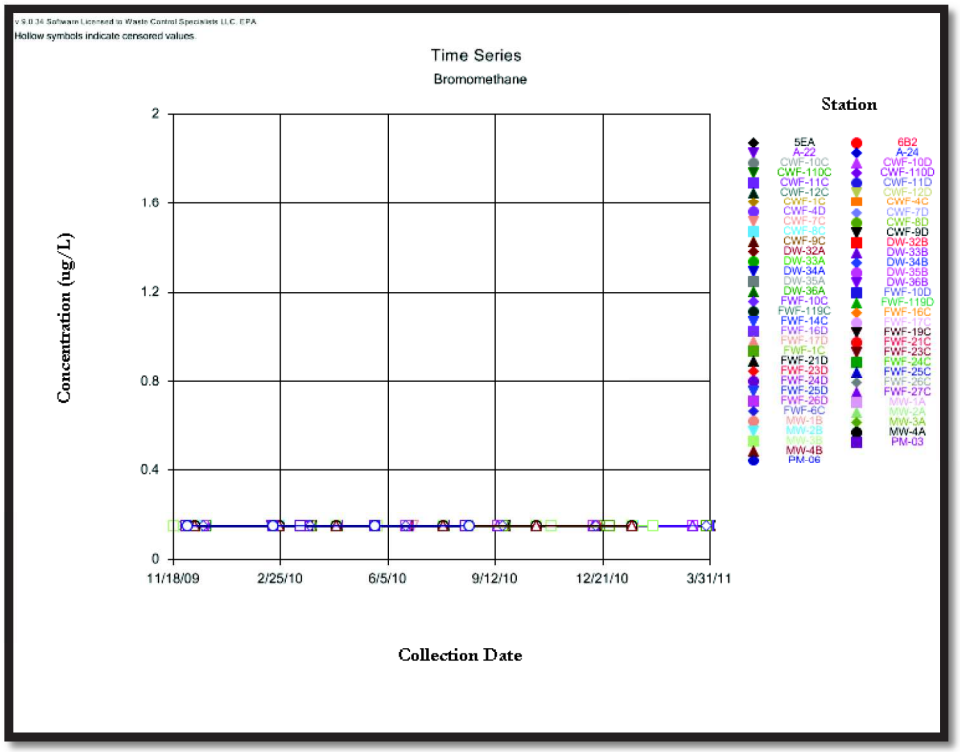

Figure 4-117 : Bromomethane Results for 225' Zone Wells.

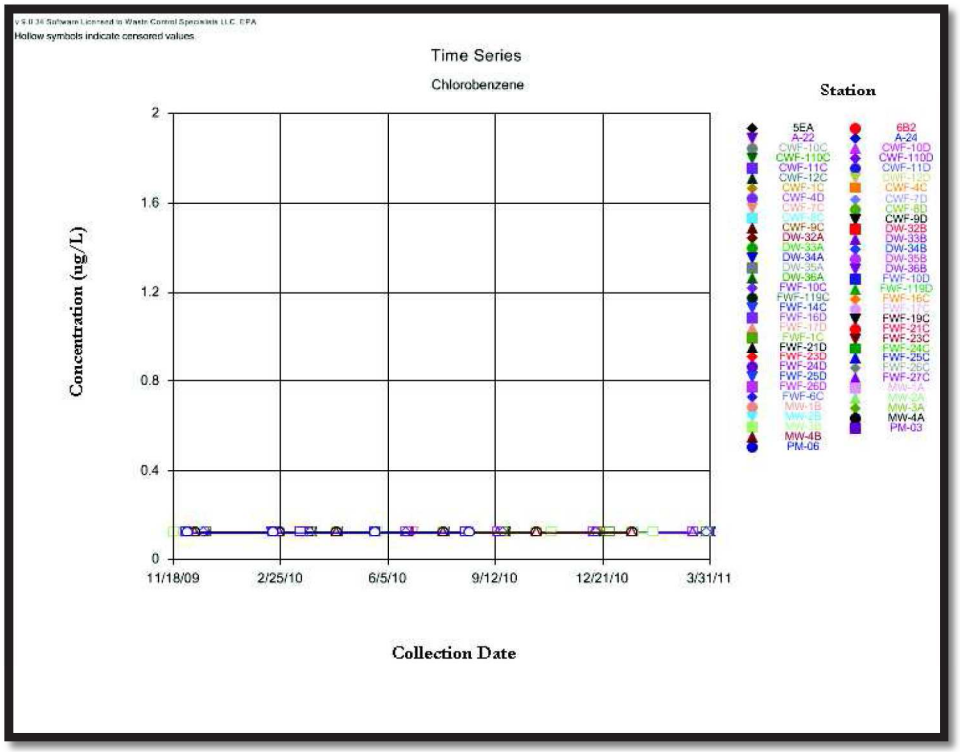

Figure 4-118 : Chlorobenzene Results for 225' Zone Wells.

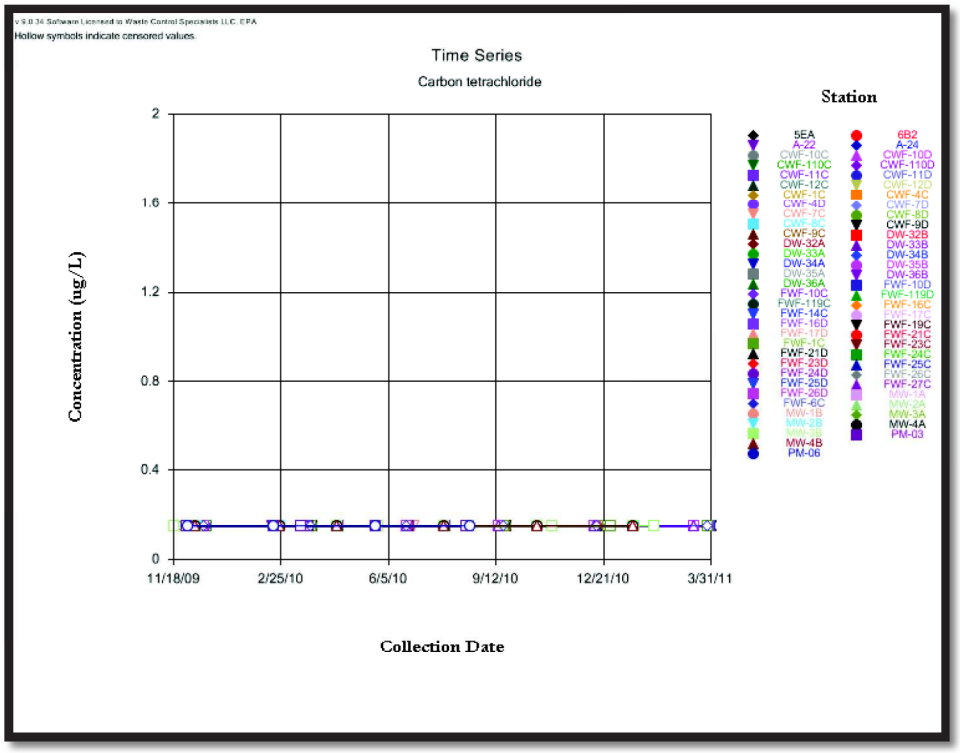

Figure 4-119 : Carbon tetrachloride Results for 225' Zone Wells.

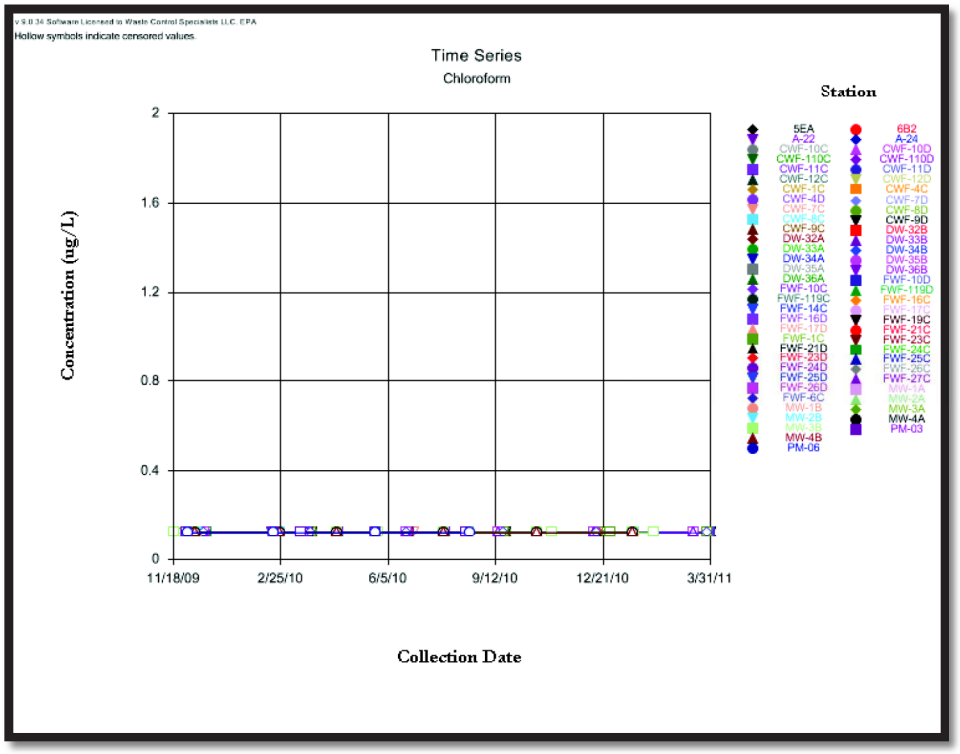

Figure 4-120 : Chloroform Results for 225' Zone Wells.

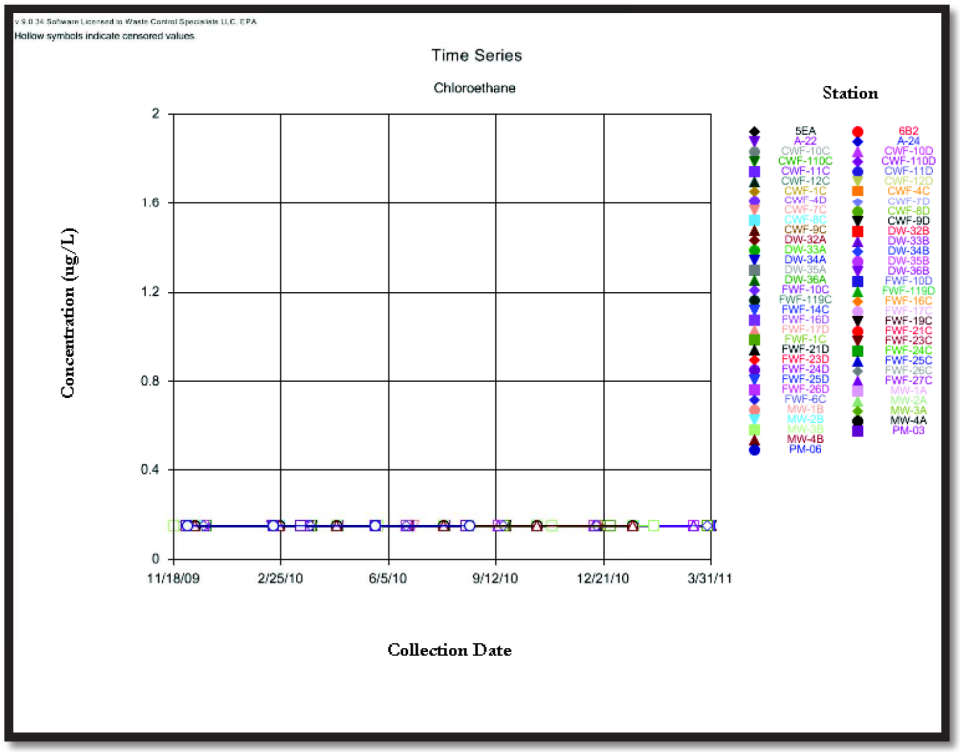

Figure 4-121 : Chloroethane Results for 225' Zone Wells.

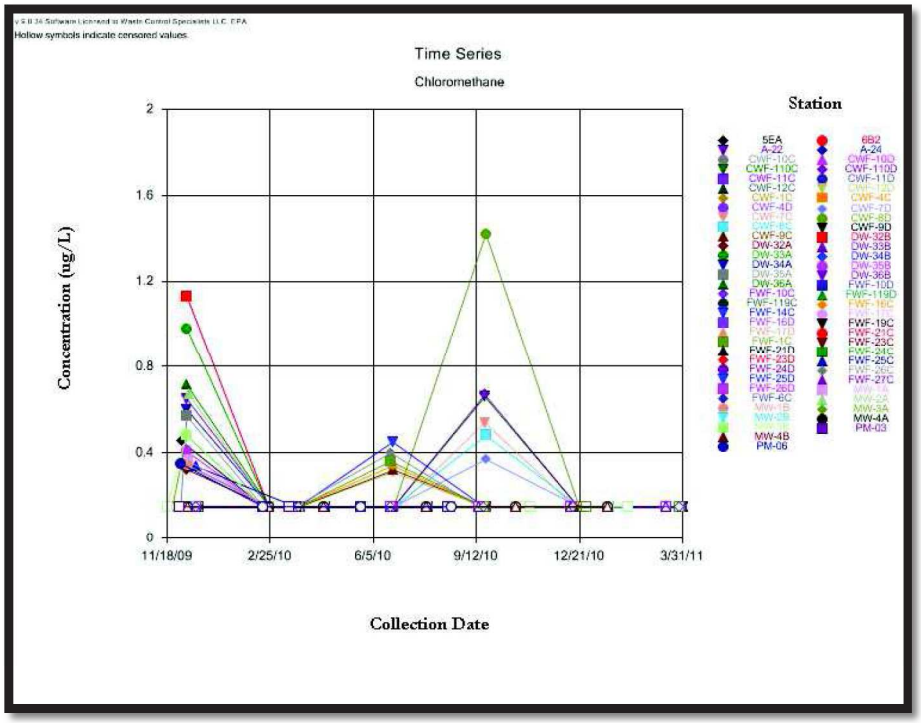

Figure 4-122 : Chloromethane Results for 225' Zone Wells.

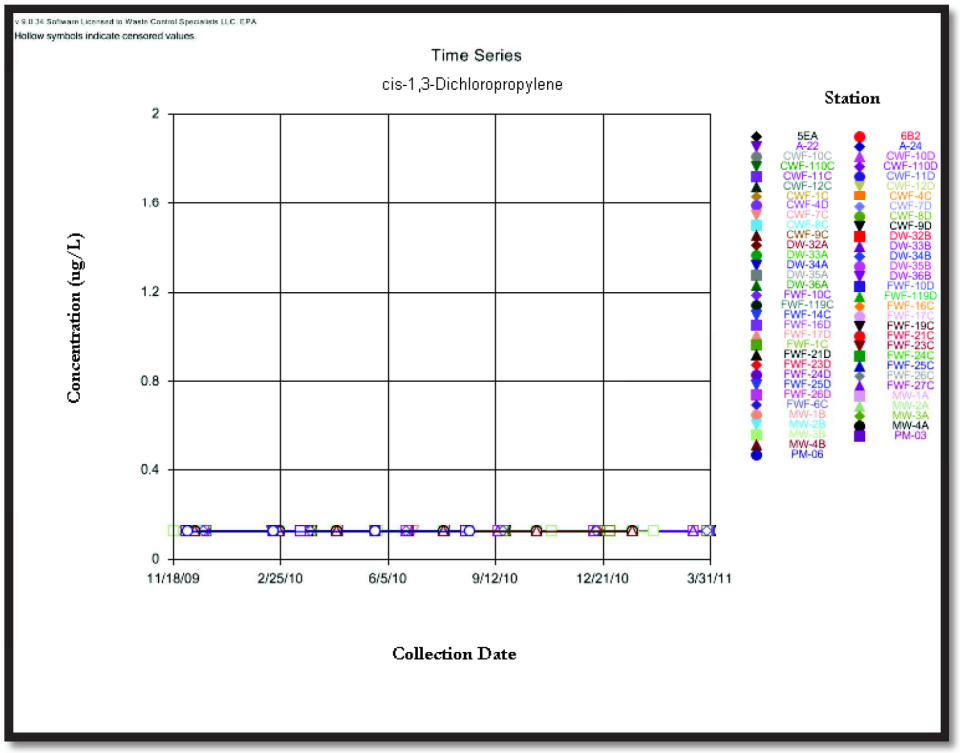

Figure 4-123 : cis-1,3-Dichloropropylene Results for 225' Zone Wells.

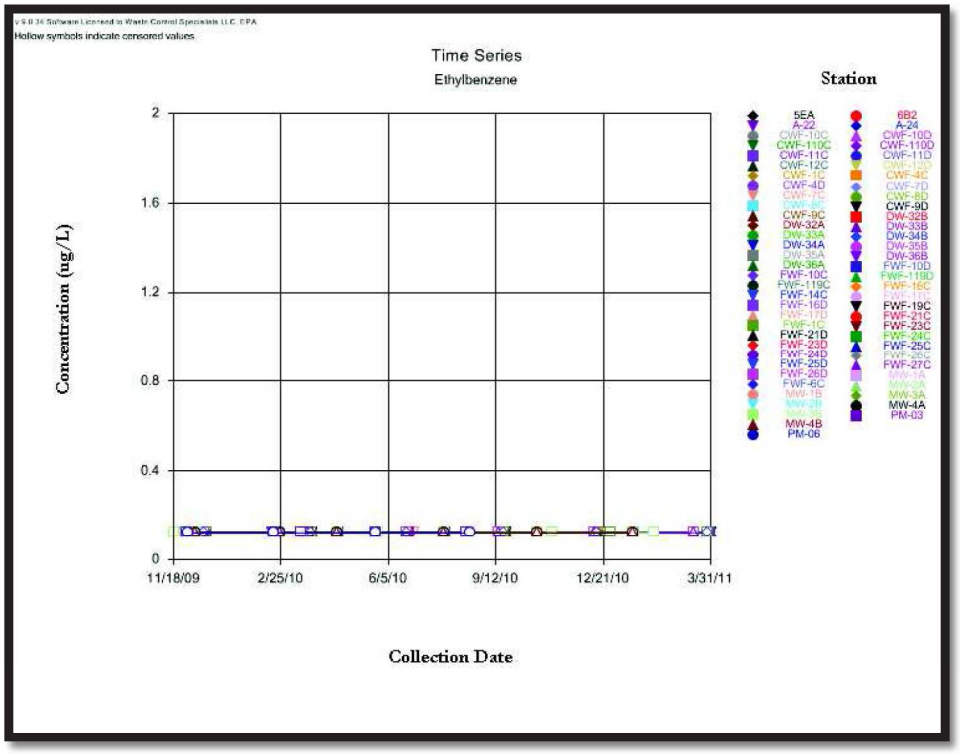

Figure 4-124 : Ethylbenzene Results for 225' Zone Wells.

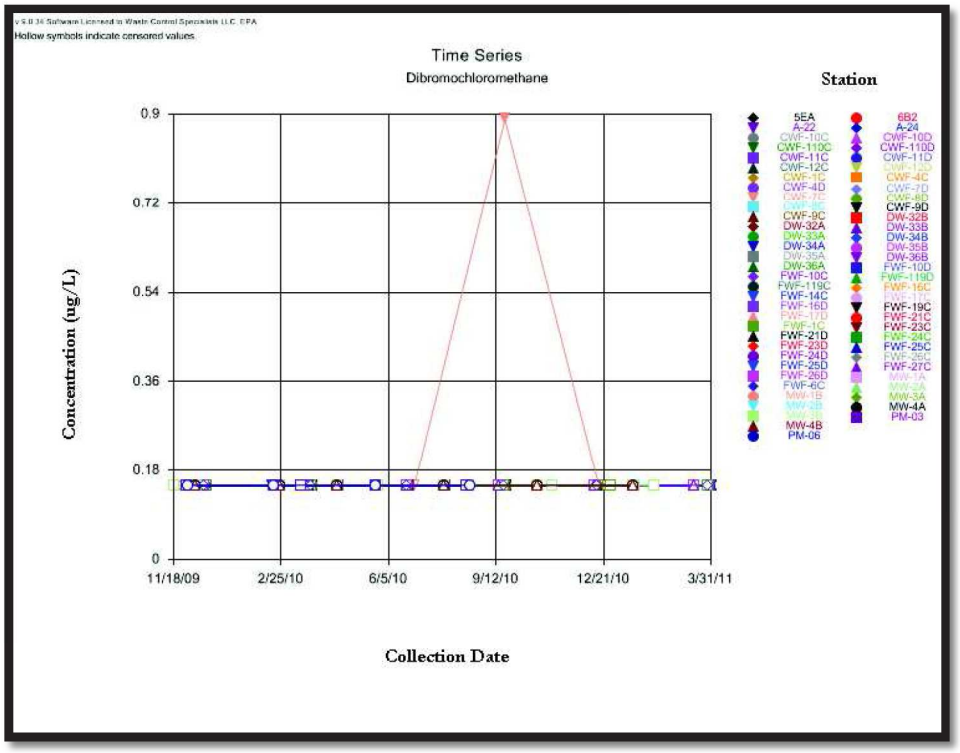

Figure 4-125 : Dibromochloromethane Results for 225' Zone Wells.

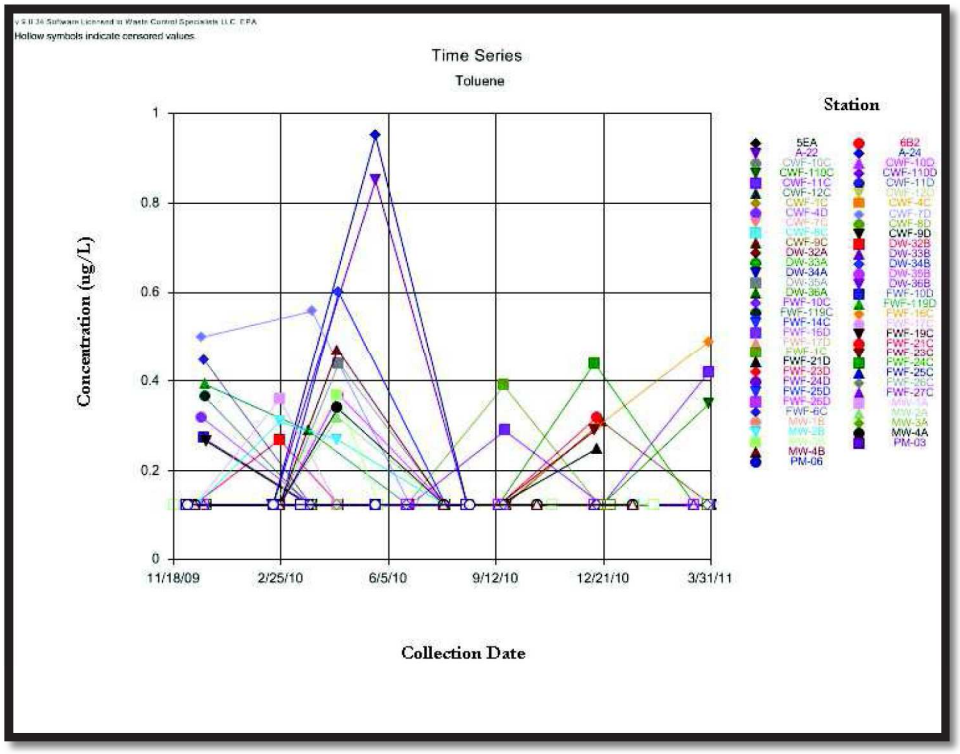

Figure 4-126 : Toluene Results for 225' Zone Wells.

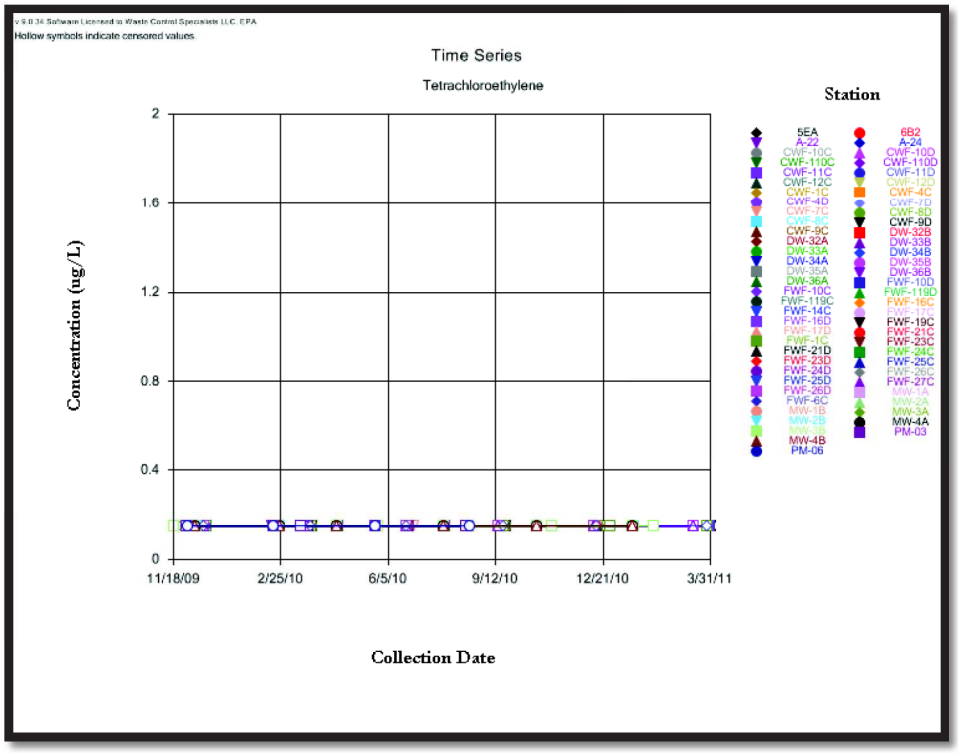

Figure 4-127 : Tetrachloroethylene Results for 225' Zone Wells.

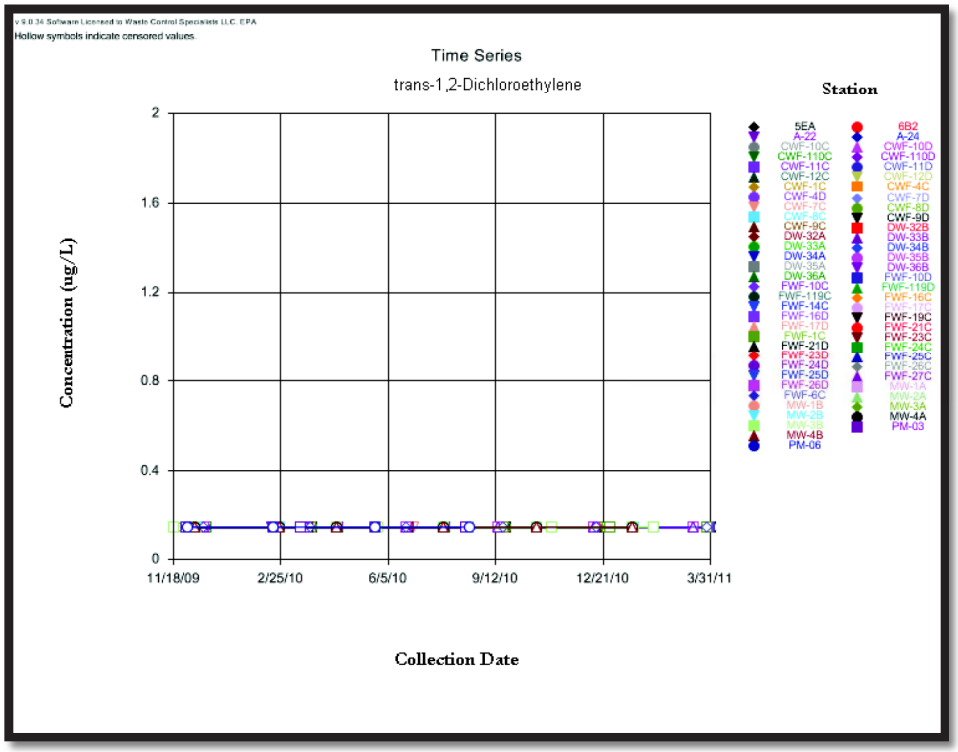

Figure 4-128 : trans-1,2-Dichloroethylene Results for 225' Zone Wells.

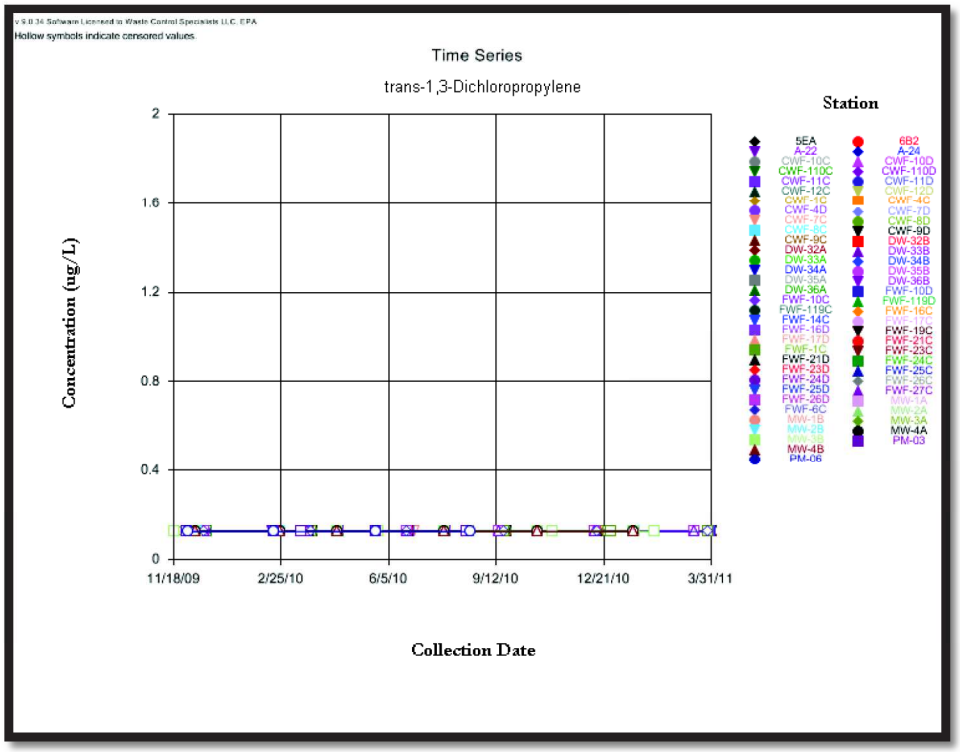

Figure 4-129 : trans-1,3-Dichloropropylene Results for 225' Zone Wells.

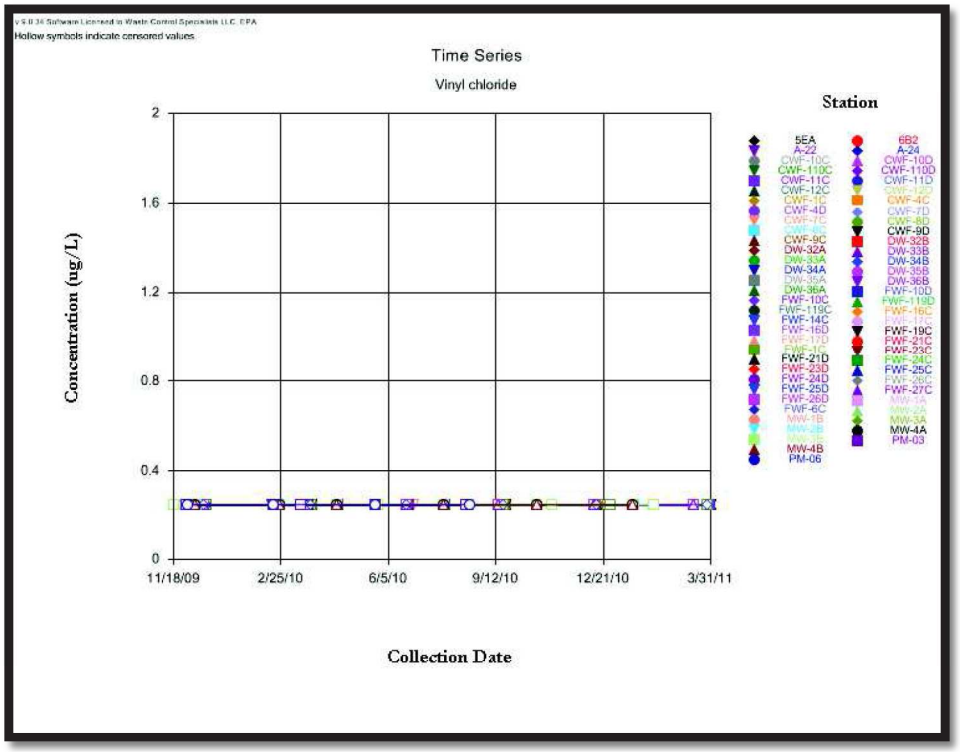

Figure 4-130 : Vinyl Chloride Results for 225' Zone Wells.

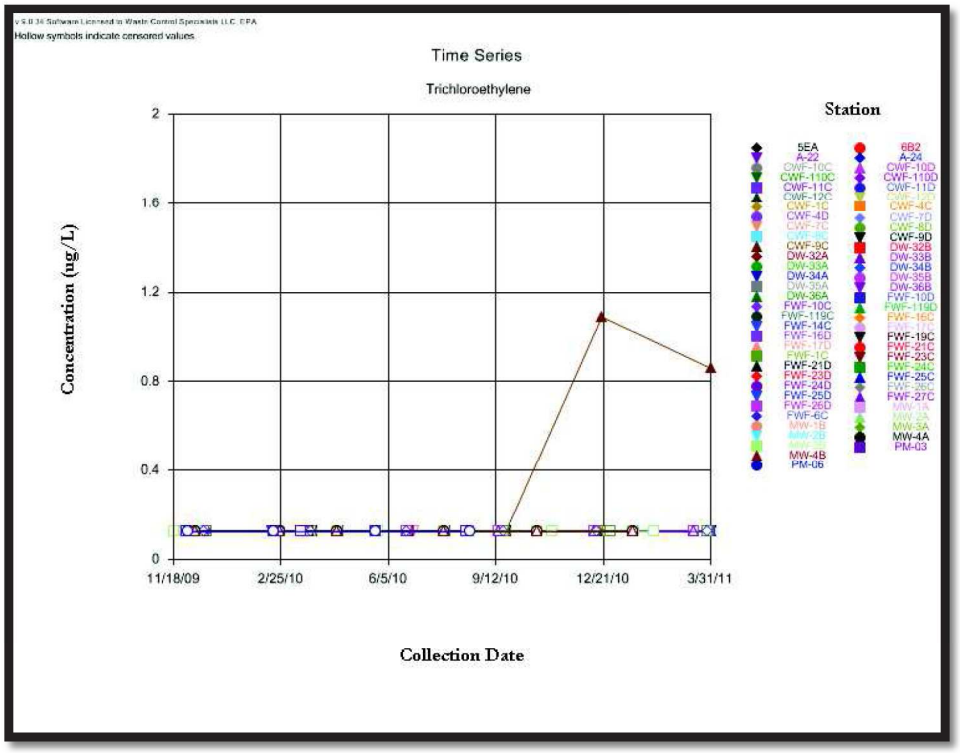

Figure 4-131 : Trichloroethylene Results for 225' Zone Wells.

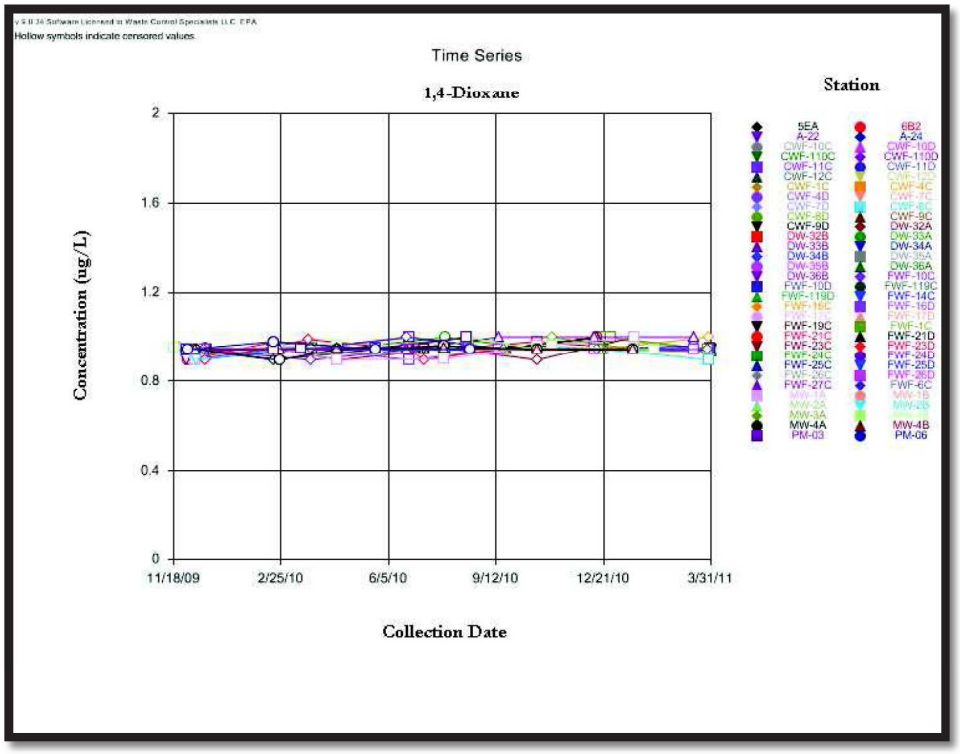

Figure 4-132 : 1,4-Dioxane Results for 225' Zone Wells.

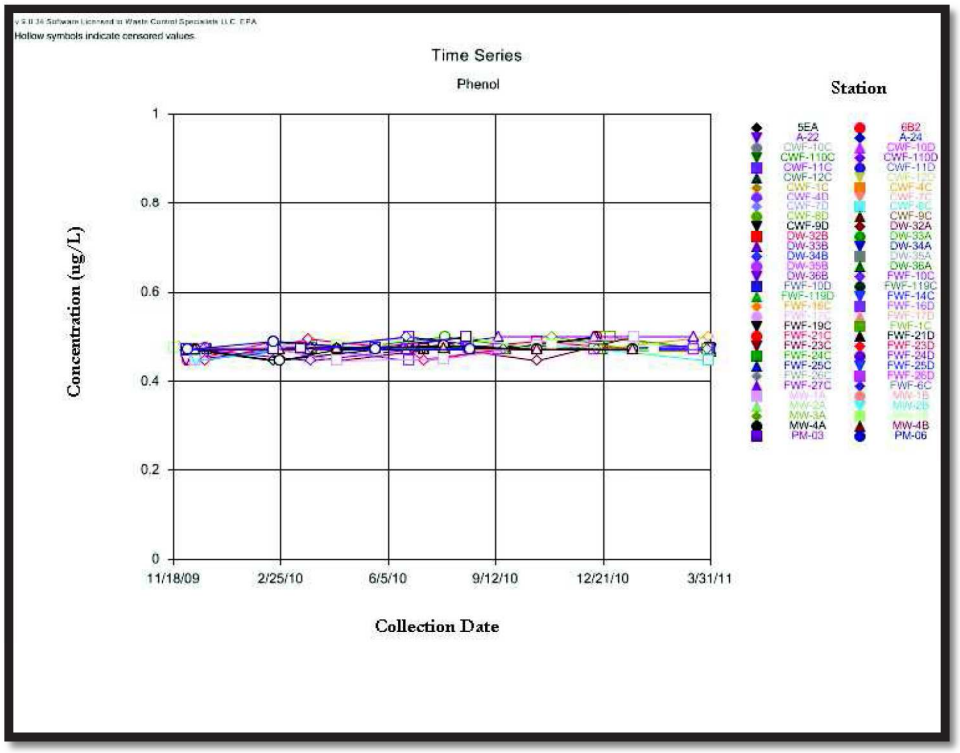

Figure 4-133 : Phenol Results for 225' Zone Wells.

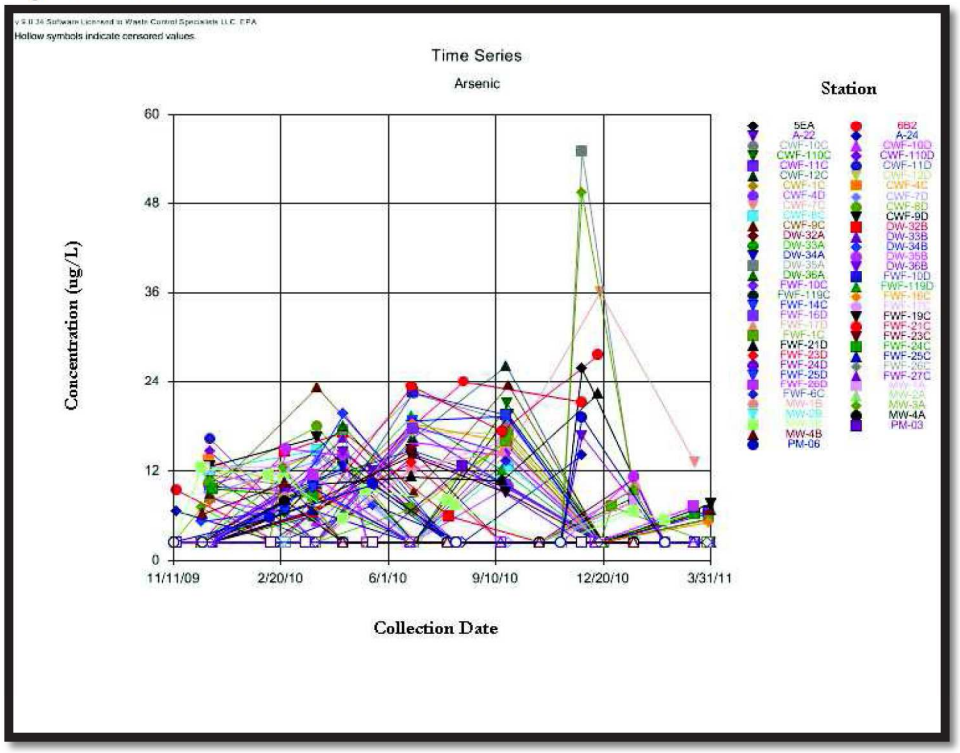

Figure 4-134 : Arsenic Results for 225' Zone Wells.

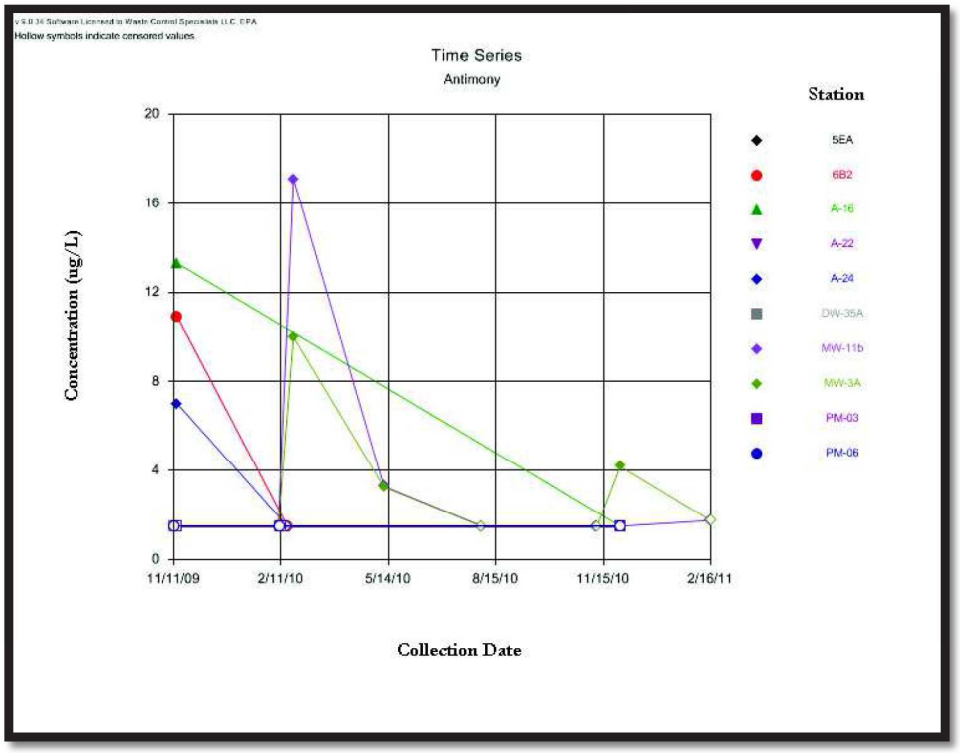

Figure 4-135 : Antimony Results for 225' Zone Wells.

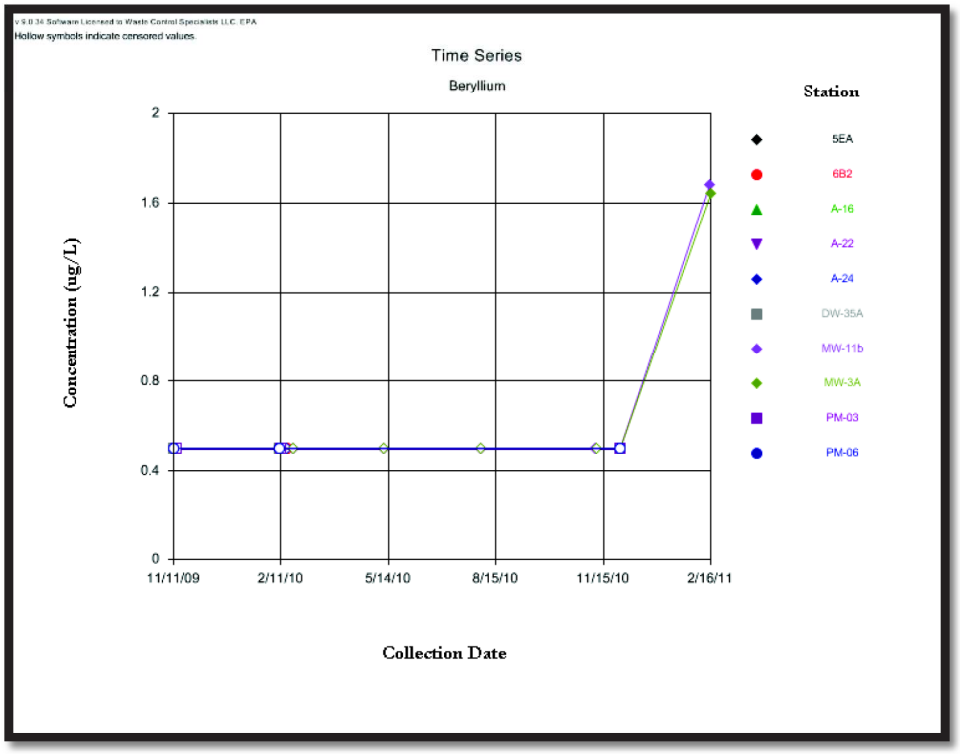

Figure 4-136 : Beryllium Results for 225' Zone Wells.

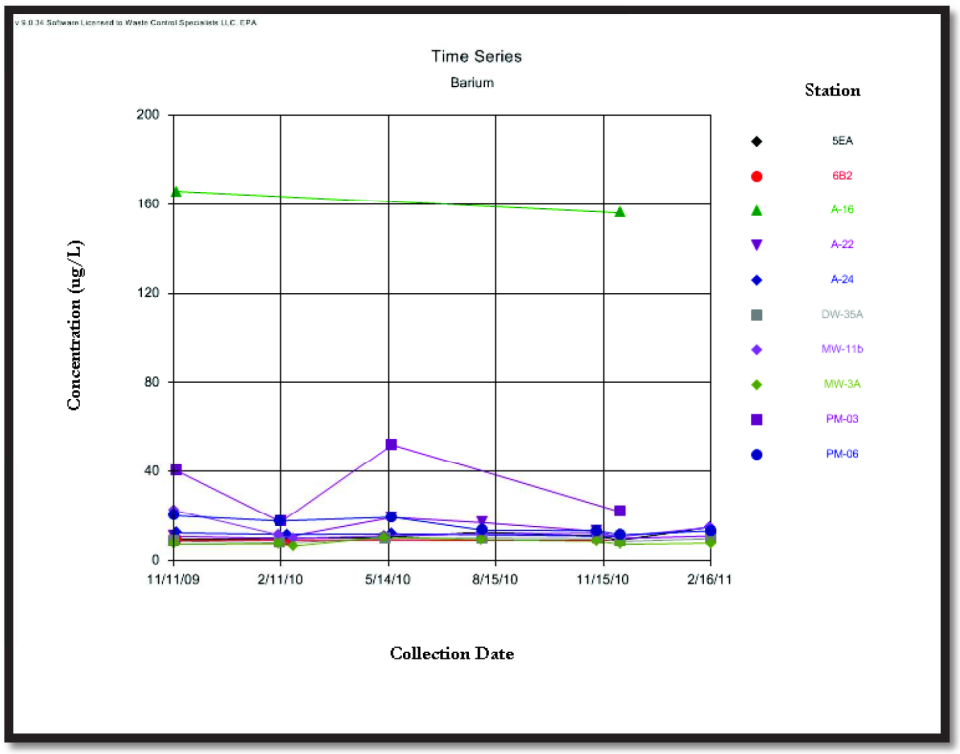

Figure 4-137 : Barium Results for 225' Zone Wells.

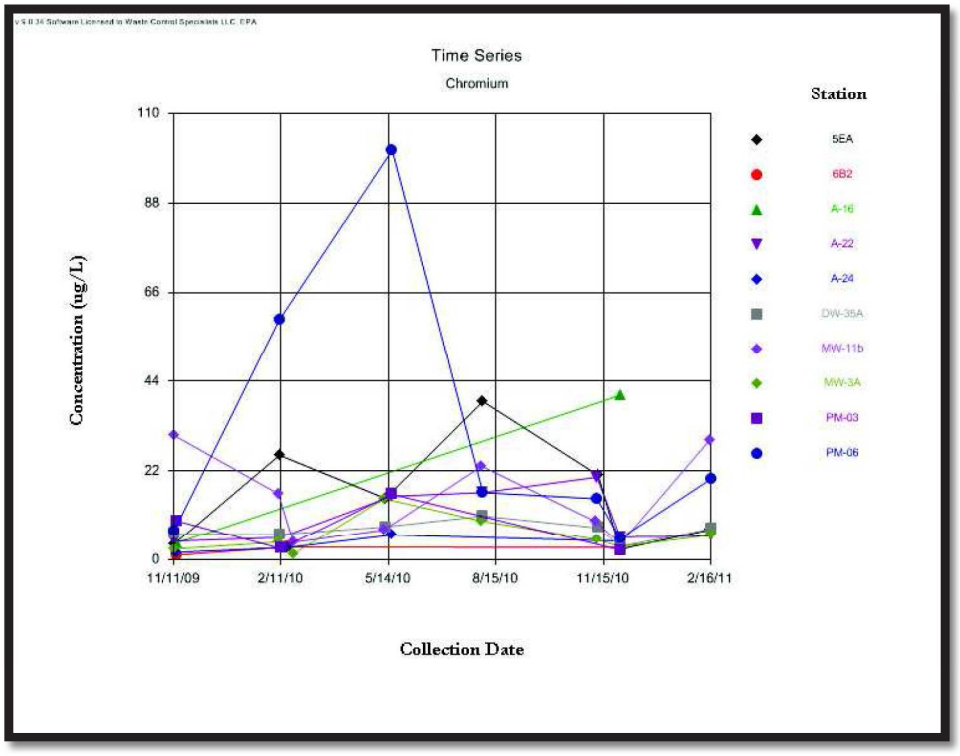

Figure 4-138 : Chromium Results for 225' Zone Wells.

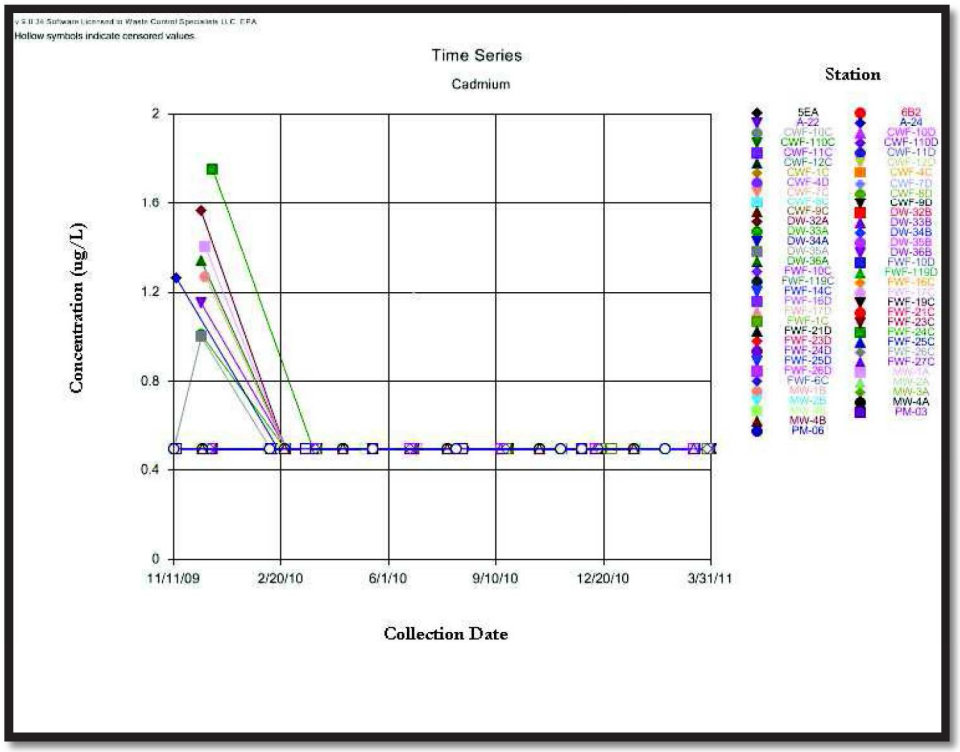

Figure 4-139 : Cadmium Results for 225' Zone Wells.

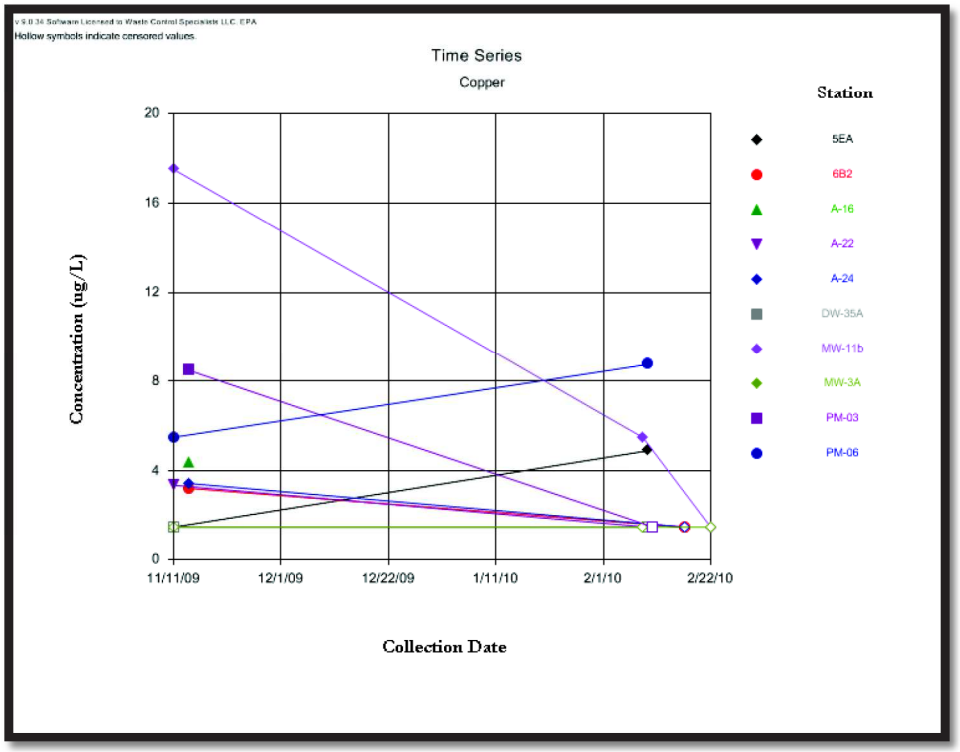

Figure 4-140 : Copper Results for 225' Zone Wells.

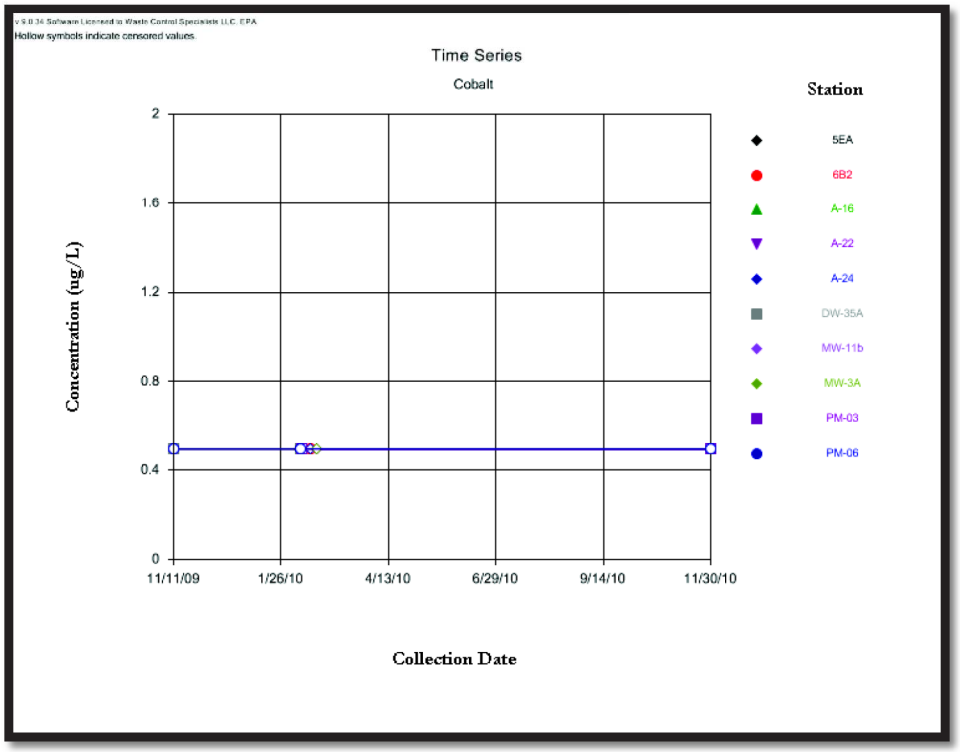

Figure 4-141 : Cobalt Results for 225' Zone Wells.

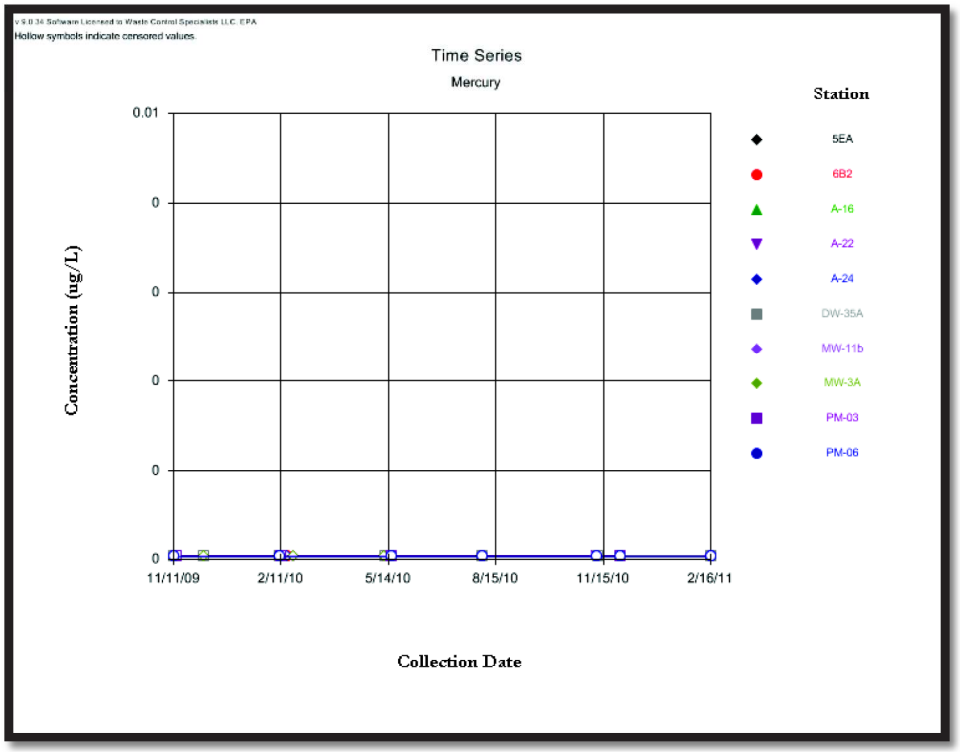

Figure 4-142 : Mercury Results for 225' Zone Wells.

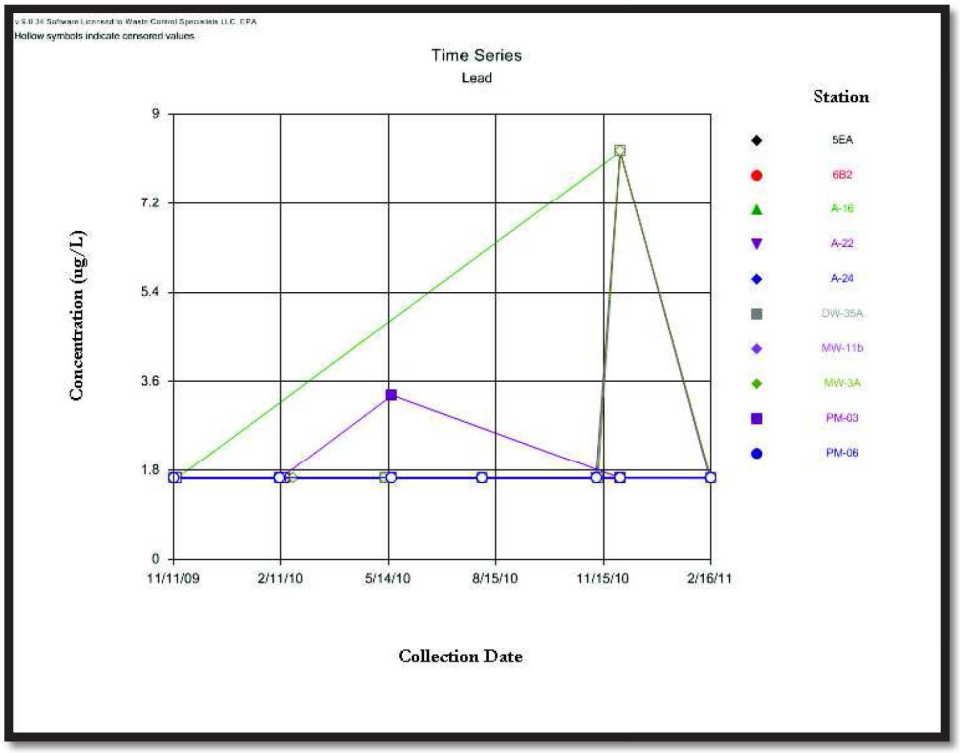

Figure 4-143 : Lead Results for 225' Zone Wells.

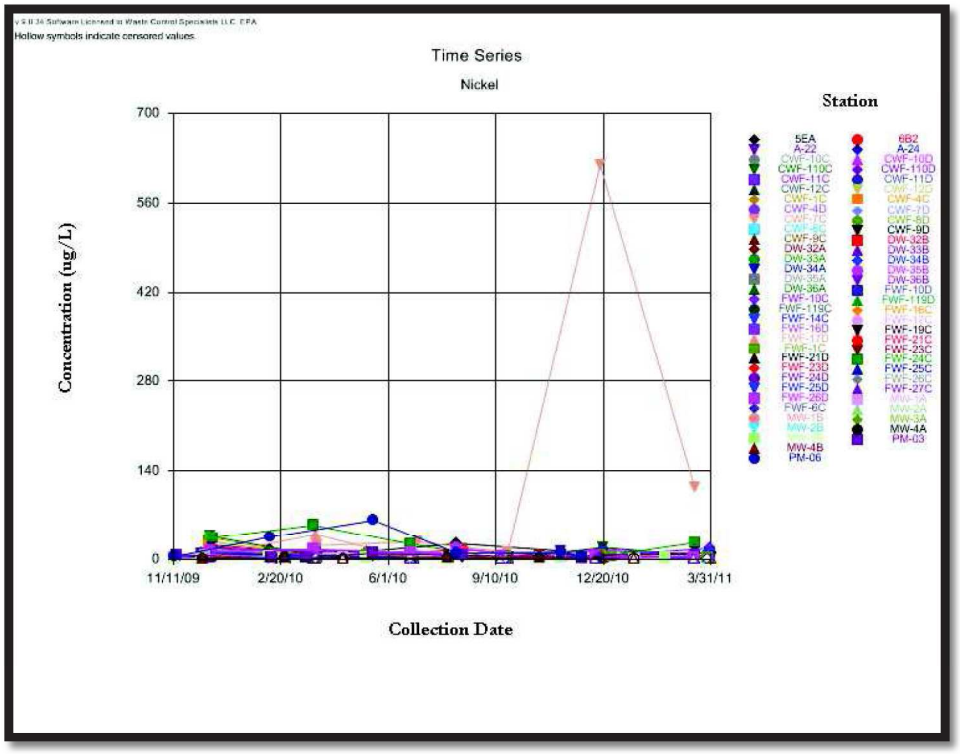

Figure 4-144 : Nickel Results for 225' Zone Wells.

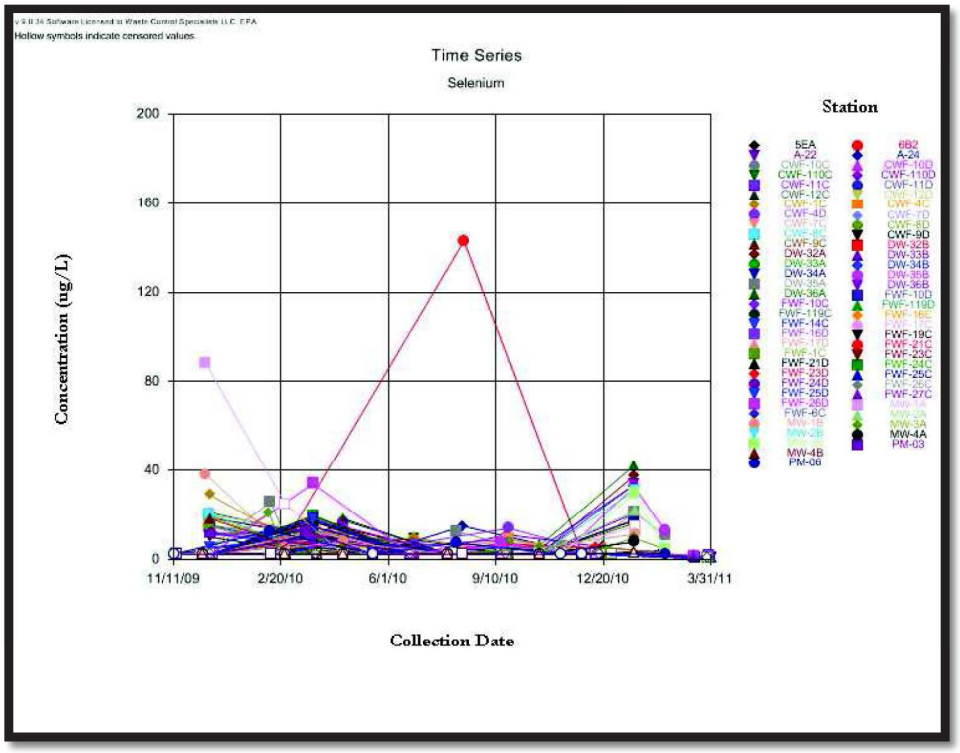

Figure 4-145 : Selenium Results for 225' Zone Wells.

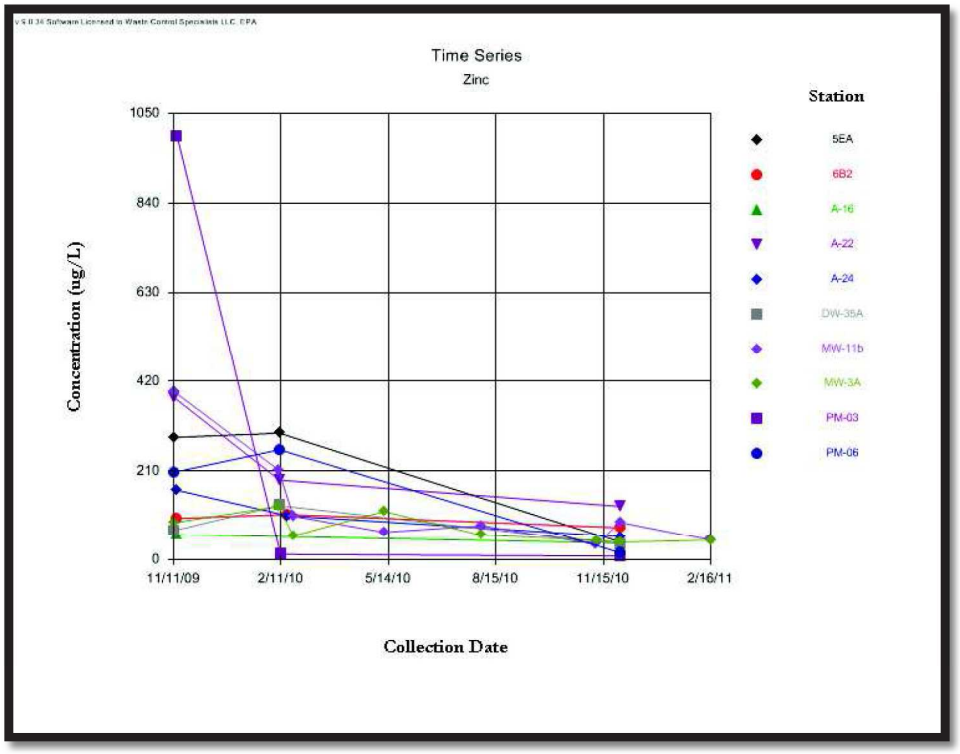

Figure 4-146 : Zinc Results for 225' Zone Wells.

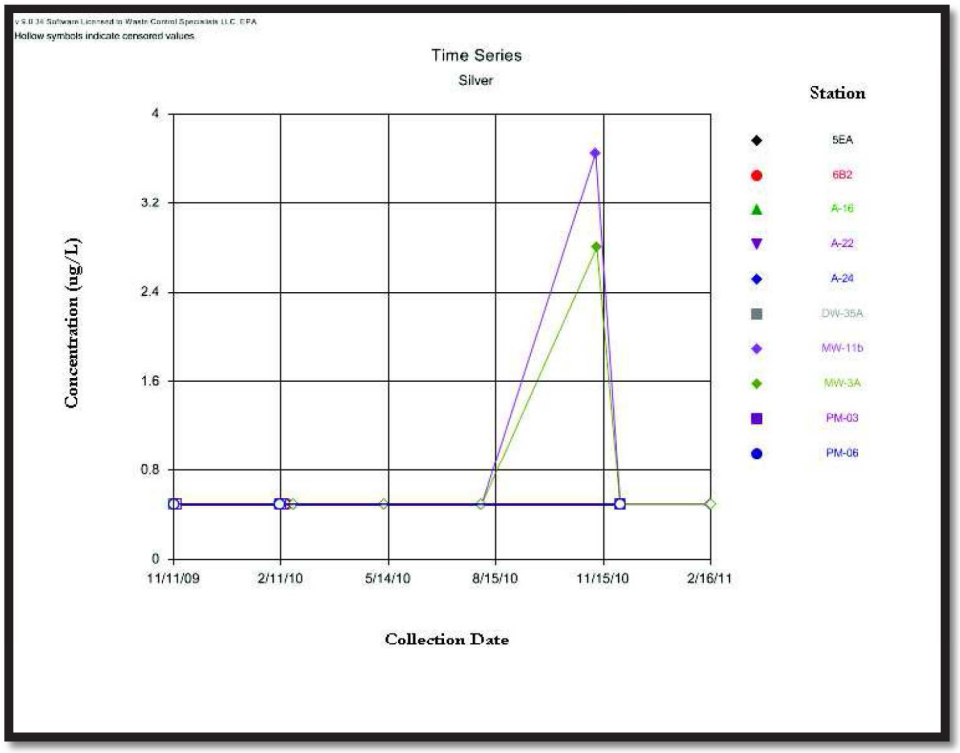

Figure 4-147 : Silver Results for 225' Zone Wells.

Other Groundwater Data

The following wells are currently in the pre-operational monitoring program and are completed in transmissive zones other than the OAG, the 125'-zone or the 225'-zone. Because all of these wells contain sufficient groundwater for routine sampling the Saturation column has been omitted from this table.

Table 4-8 :Wells in Other Strata, Low Level Pre-Operational Monitoring Program

Well	Producing Zone	Saturation?
6B1	180'-Zone	Sufficient
South Well	Trujillo	Sufficient
Central Well	Santa Rosa	Sufficient

NOTES: Values in Saturation Columns are:
Sufficient = Sufficient Groundwater is present in the well to collect a full sample.

Radiological summary statistics for radiological analytes in the 225' zone are presented in Table 4-8. Figure 4-143 through Figure 4-170 graphically depict the pre-operational groundwater results. All pre-operational sample results for 225'-zone groundwater are given in Appendix A.

Summary statistics for were not computed for analytes in other groundwater zones due to the small number of samples collected from those zones. However, several qualitative conclusions can be drawn from these data. All three groundwater producing strata are in the Dockum formation, and the number, types, and concentrations of the metals reported in these strata are similar to those from the 225'-Zone.

In addition to those metal concentrations, a number of VOCs and one SVOC were reported in these data. All are estimated concentrations. Chloromethane was reported in one of the samples from the Central Well and Diethylphthalate was reported in one sample from the South Well. Both are considered false positives. It is unknown if the other organic constituents are false positives or are actually present in the South Well. Estimated concentrations of benzene have been repeatedly detected in samples from the South Well. An estimated concentration of ethylbenzene has also been reported in a sample from the South Well. The South Well is a "control well" located approximately 3.5 miles away from WCS's facility.

Benzene and ethylbenzene are unusual laboratory contaminants. They may have originated from the well's original use (it is a converted oil well). Alternatively, due to their extremely low concentrations these detections could be the result of "carryover" (when a residual concentration of a chemical affects the measurements of subsequent samples). Due to the distance of this well from WCS's facilities, and the depth to which it is completed, the contaminants do not appear to originate from WCS. Regardless of their source, these trace concentrations are below regulatory standards for groundwater and as such are not considered to be a concern by WCS.

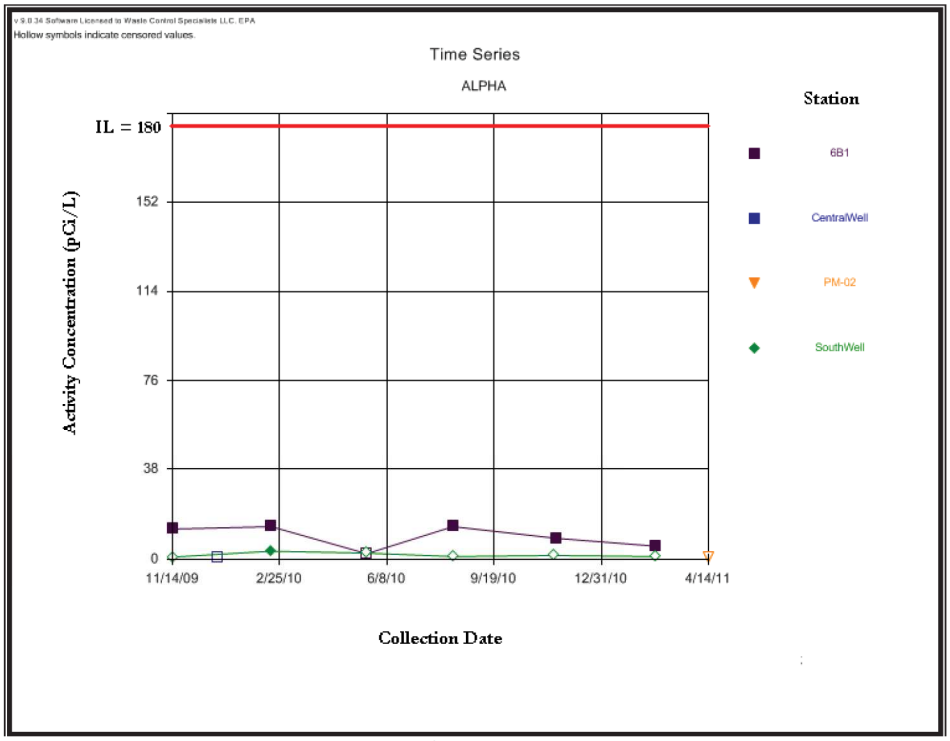

Figure 4-148 : Alpha Results for Other Zone Wells.

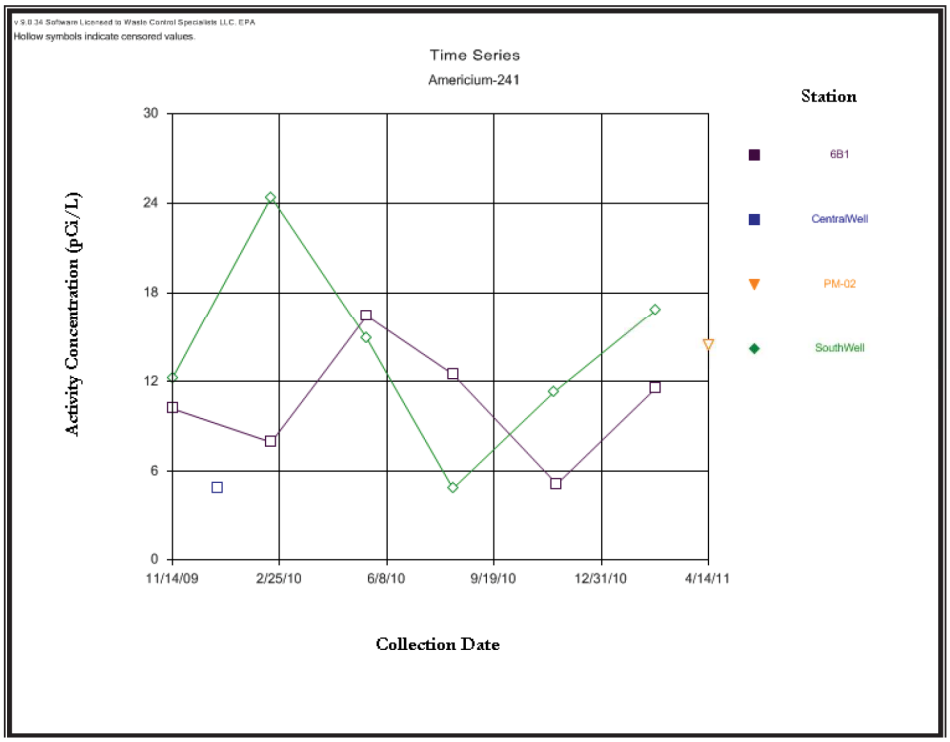

Figure 4-149 : Americum-241 Results for Other Zone Wells.

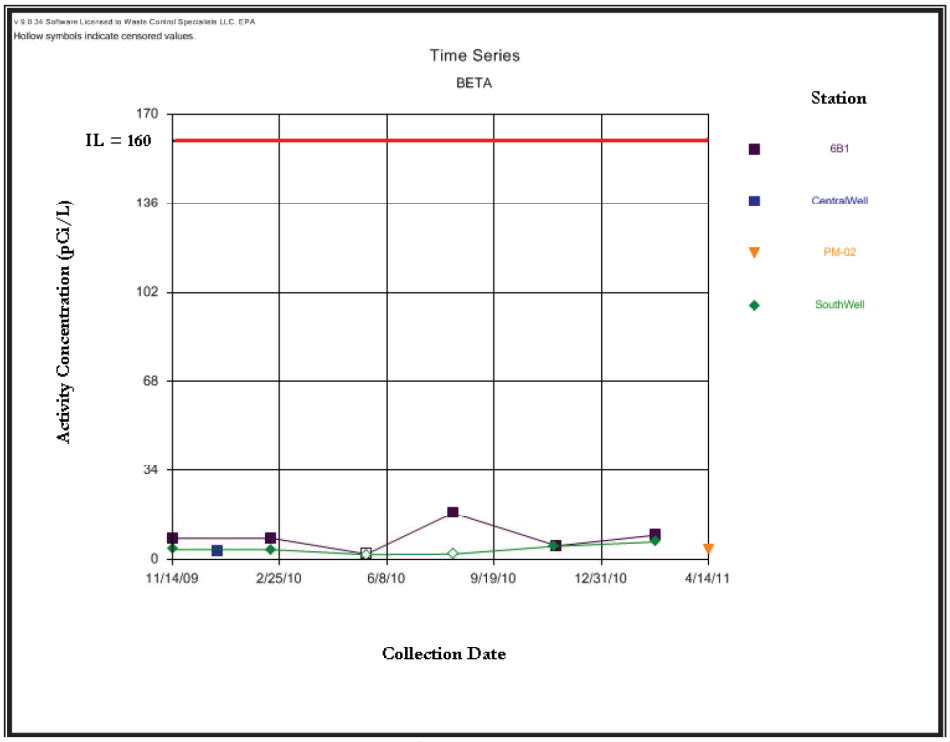

Figure 4-150 : Beta Results for Other Zone Wells.

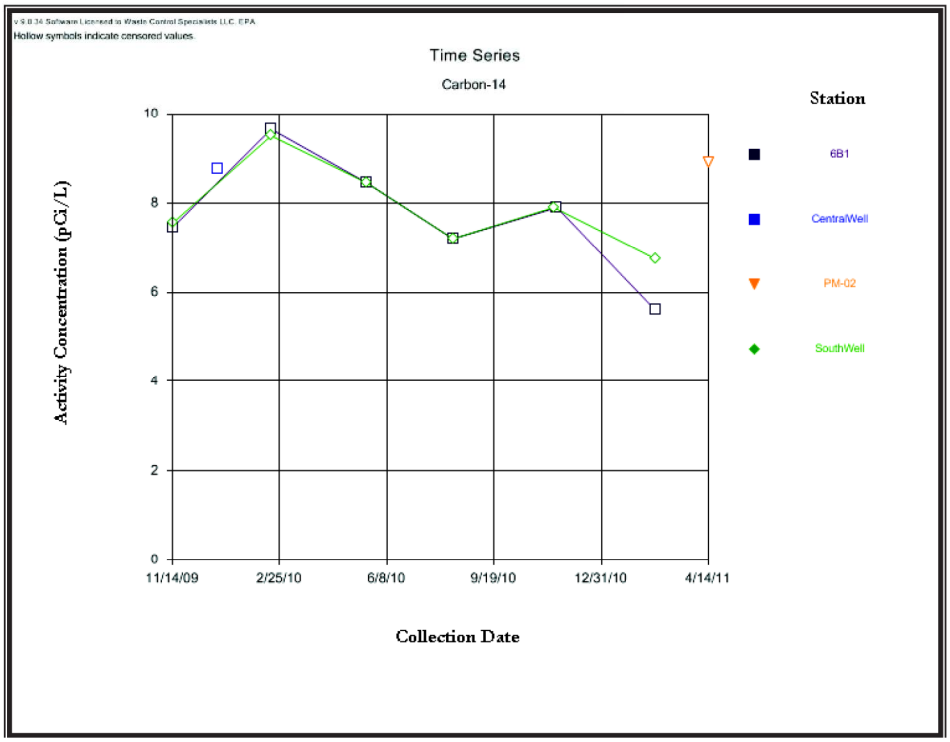

Figure 4-151 : Carbon-14 Results for Other Zone Wells.

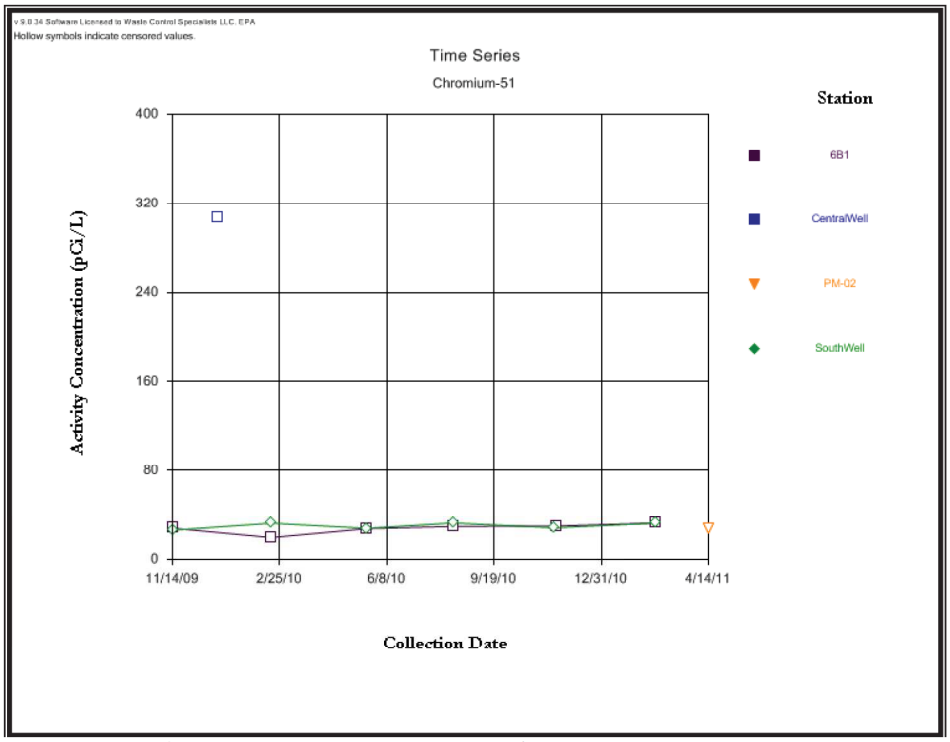

Figure 4-152 : Chromium-51 Results for Other Zone Wells.

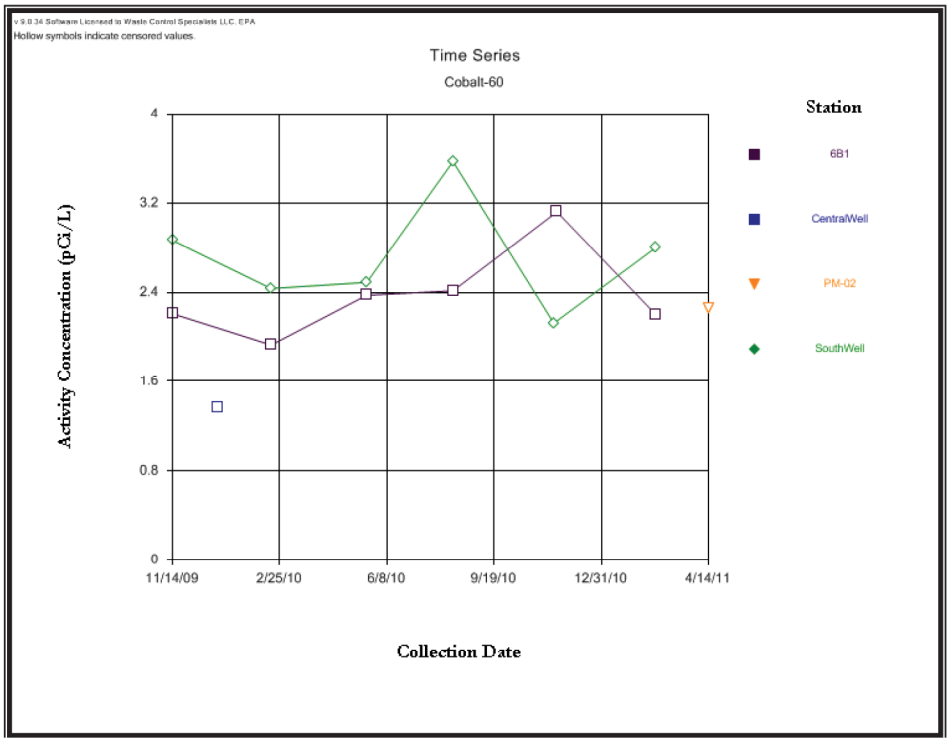

Figure 4-153 : Cobalt-60 Results for Other Zone Wells.

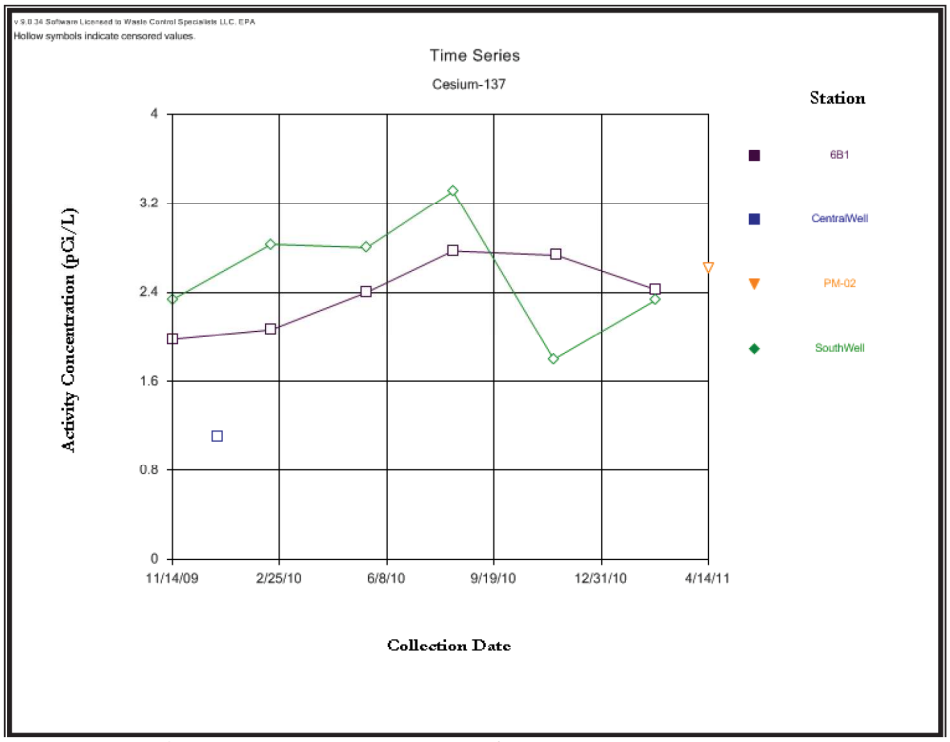

Figure 4-154 : Cesium-137 Results for Other Zone Wells.

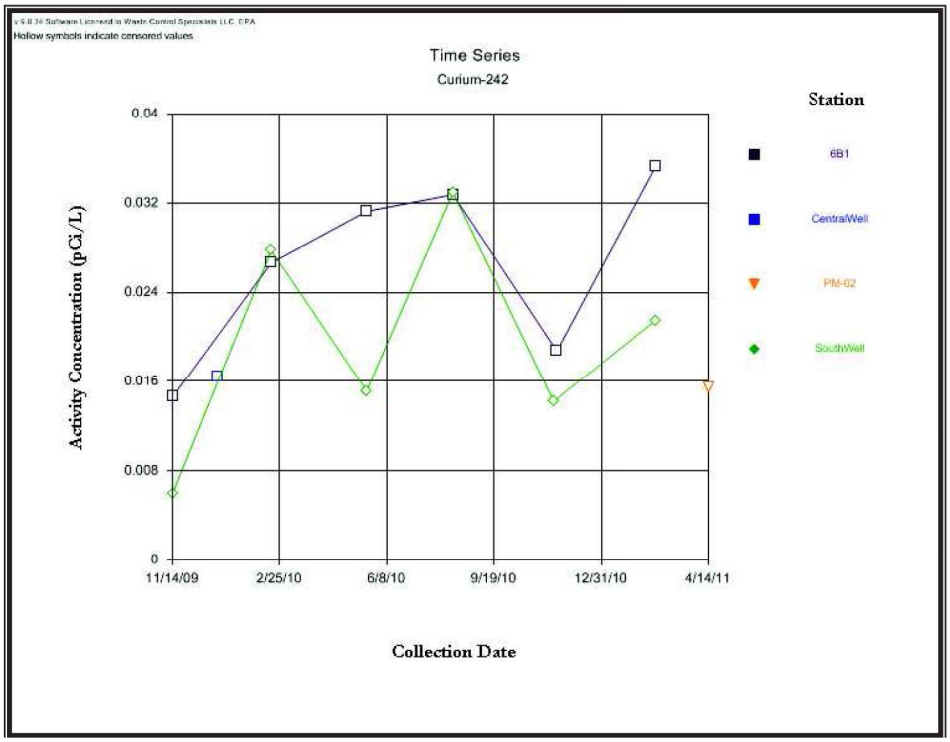

Figure 4-155 : Curium-242 Results for Other Zone Wells.

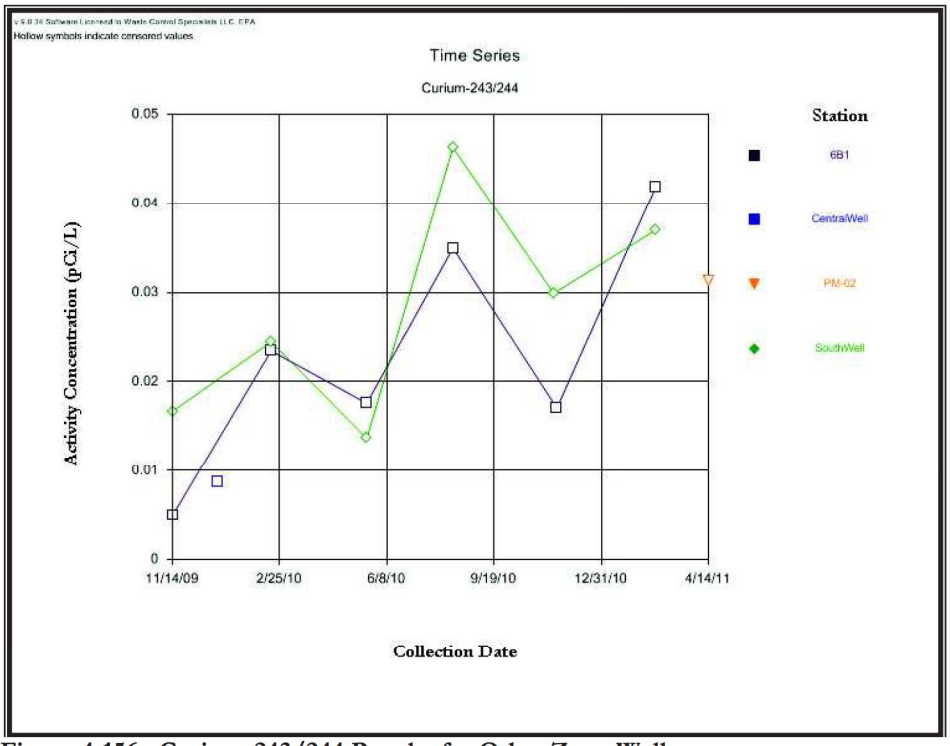

Figure 4-156 : Curium-243/244 Results for Other Zone Wells.

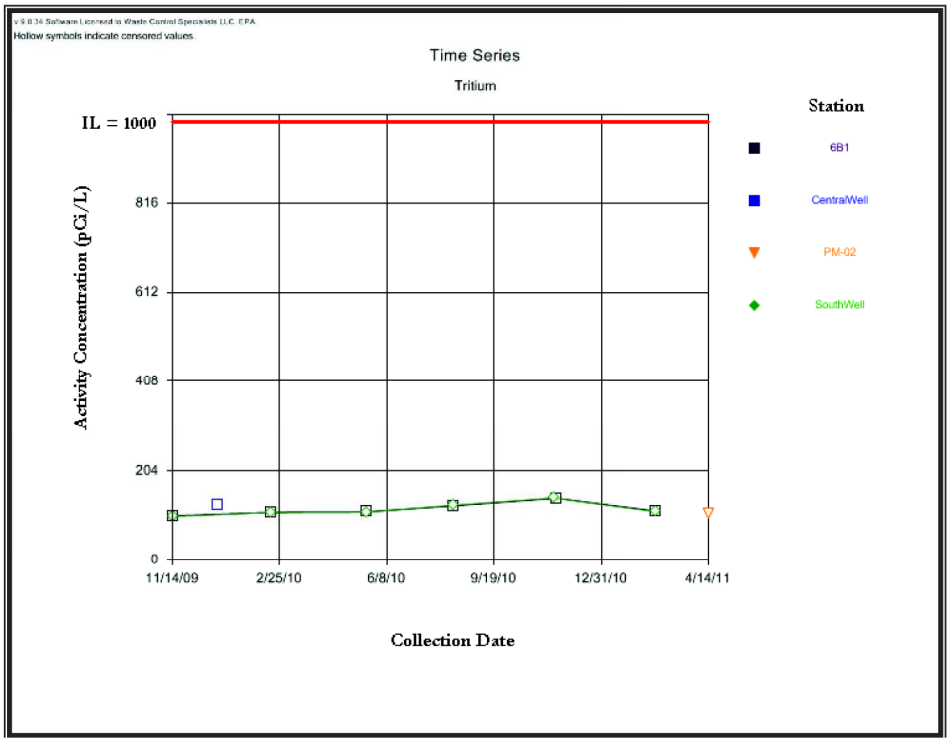

Figure 4-157 : Tritium Results for Other Zone Wells.

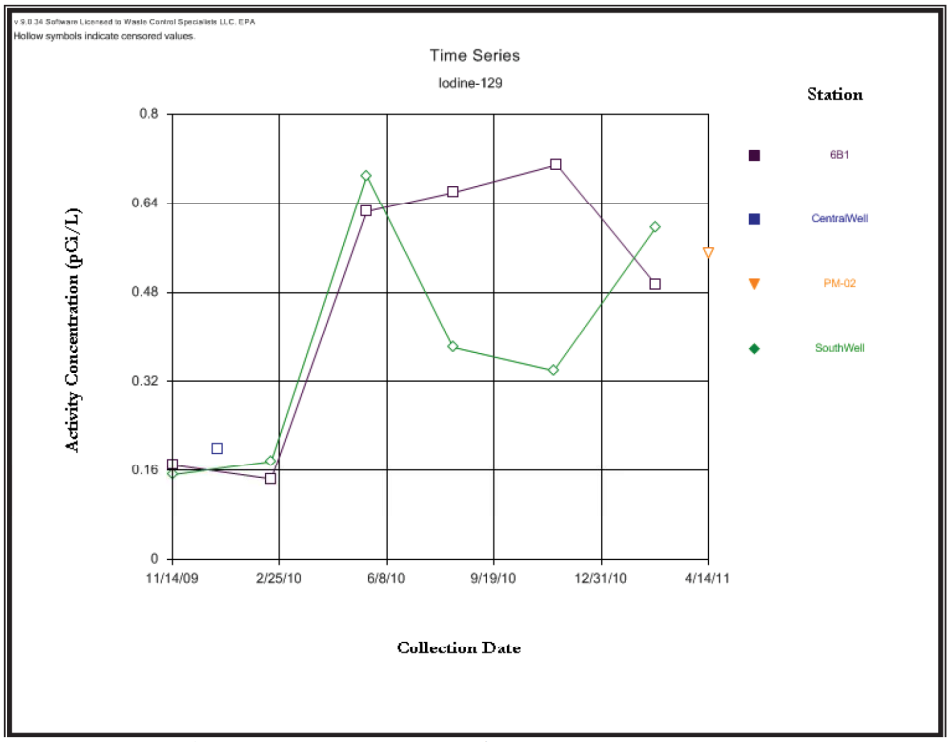

Figure 4-158 : Iodine-129 Results for Other Zone Wells.

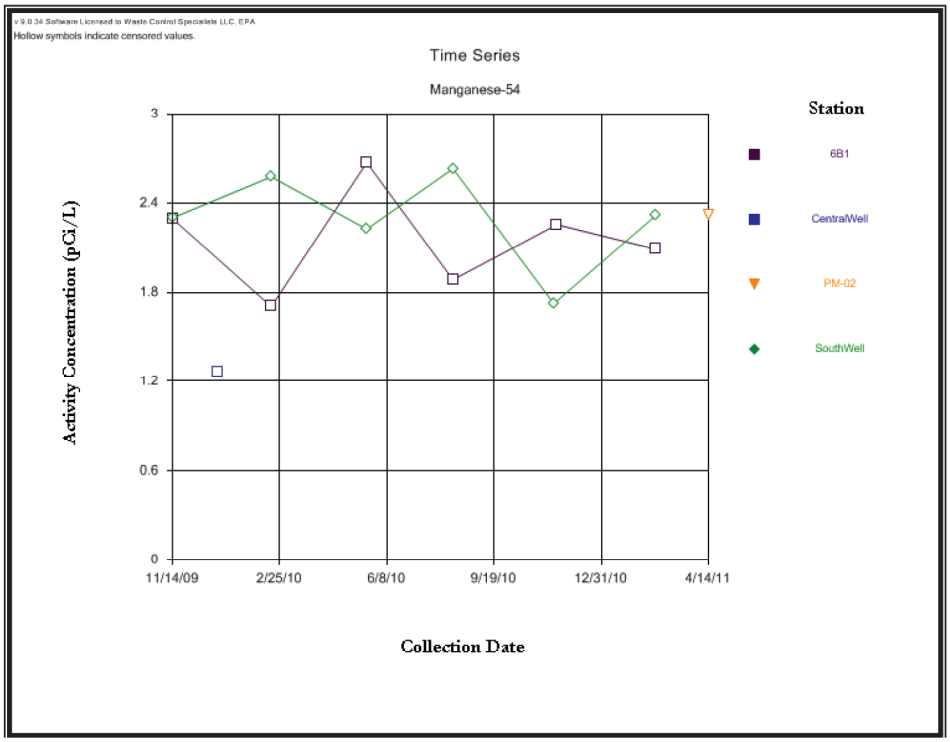

Figure 4-159 : Manganese-54 Results for Other Zone Wells.

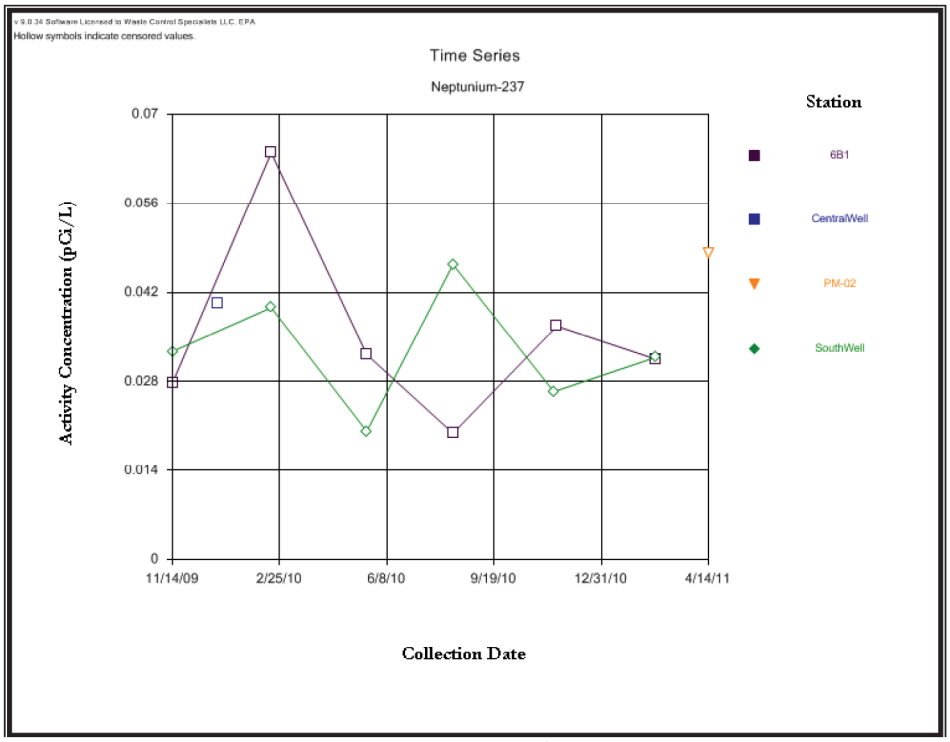

Figure 4-160 : Neptunium-237 Results for Other Zone Wells.

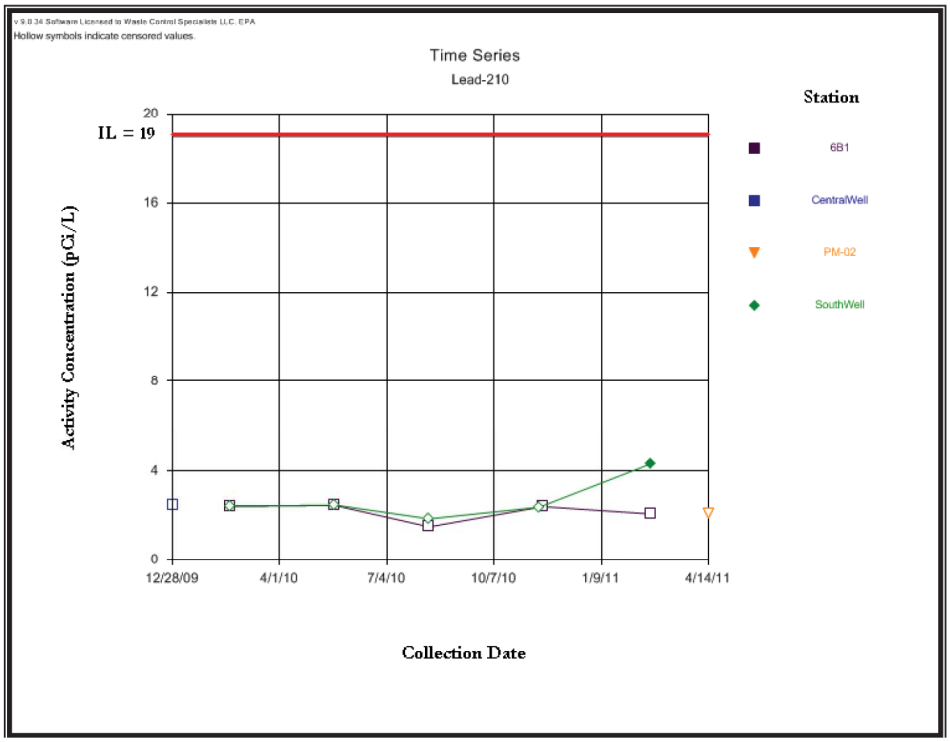

Figure 4-161 : Lead-210 Results for Other Zone Wells.

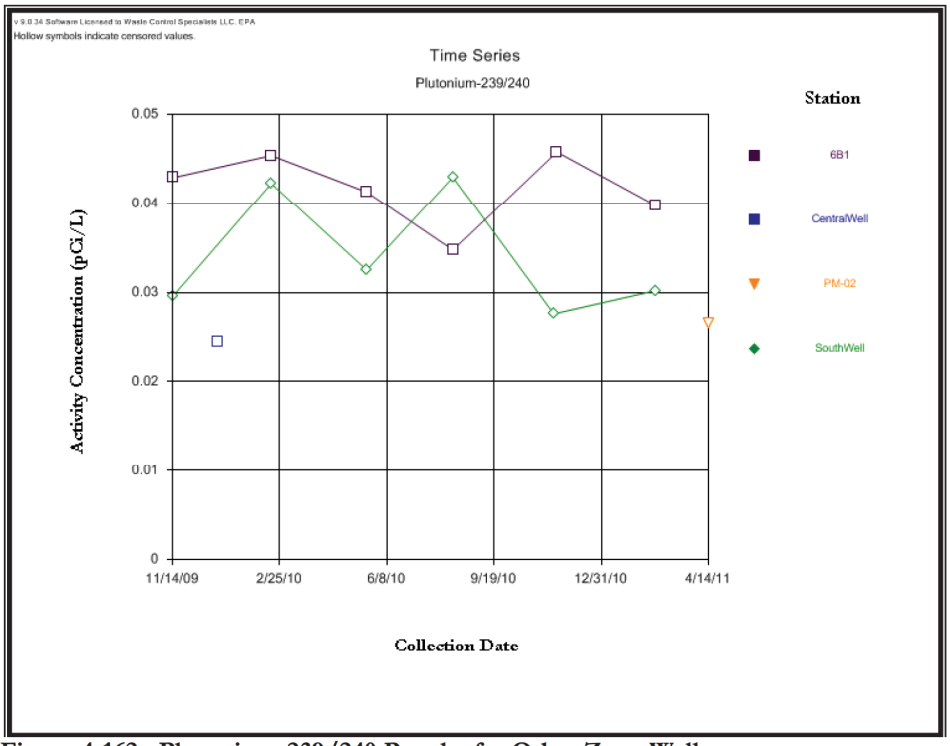

Figure 4-162 : Plutonium-239/240 Results for Other Zone Wells.

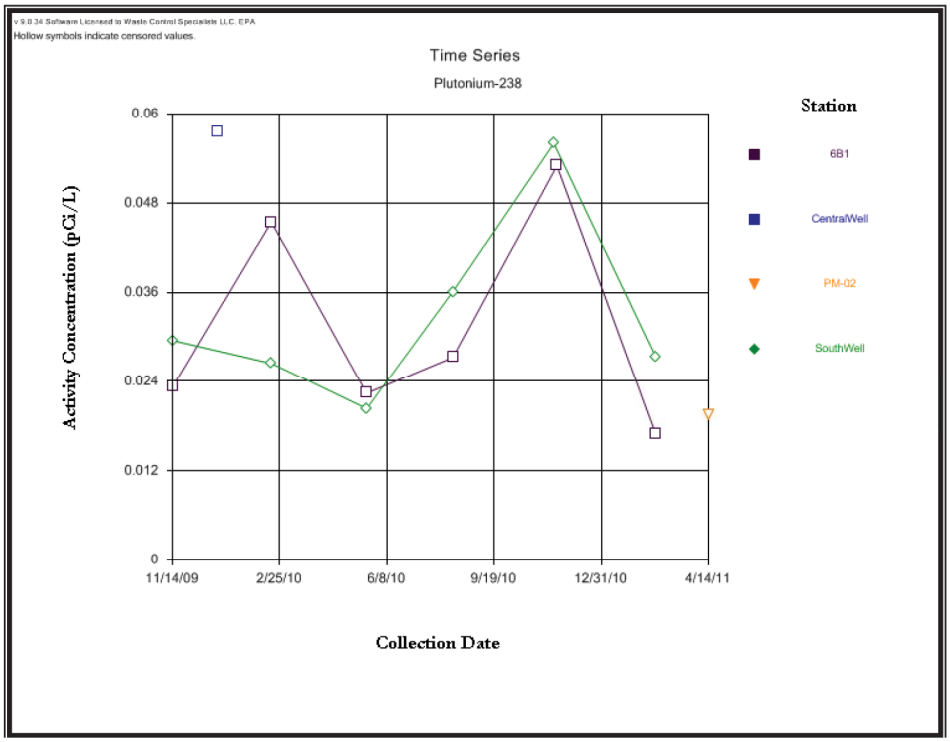

Figure 4-163 : Plutonium-238 Results for Other Zone Wells.

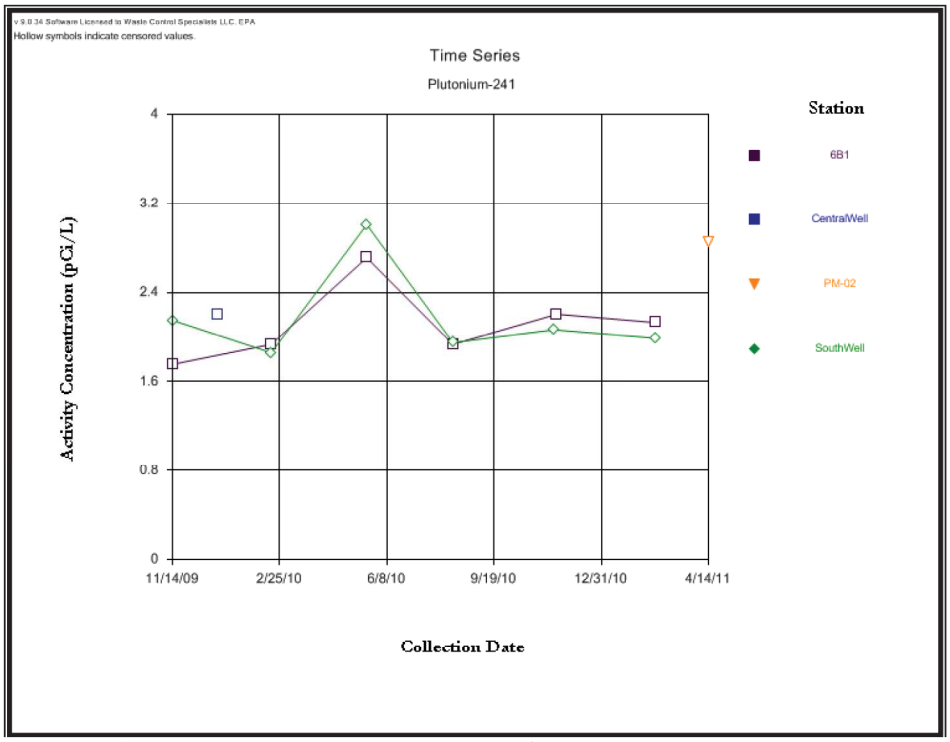

Figure 4-164 : Plutonium-241 Results for Other Zone Wells.

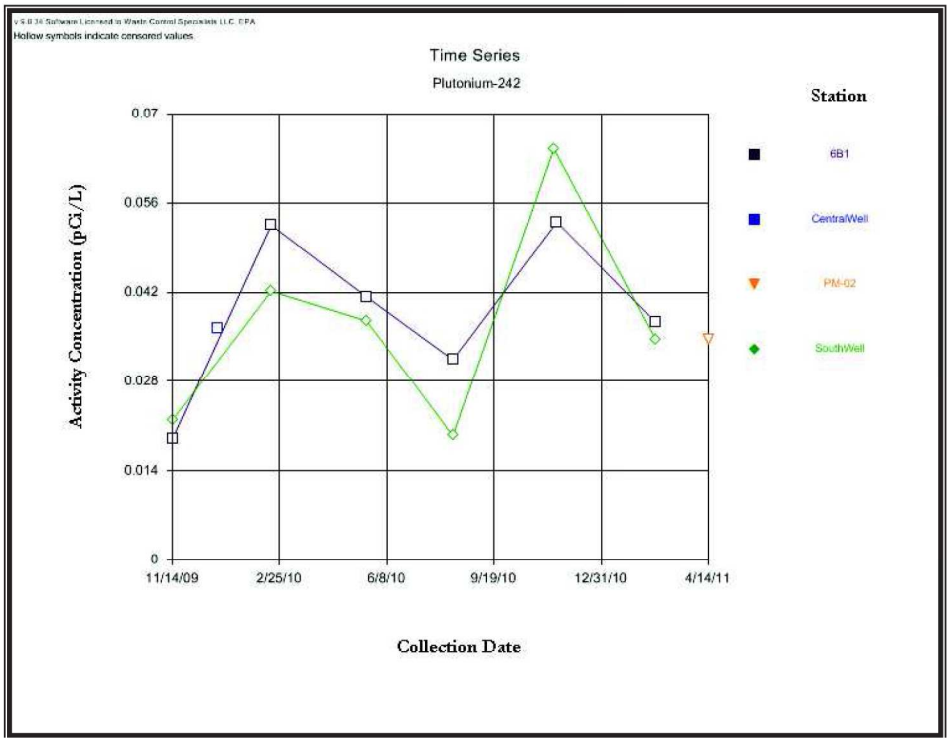

Figure 4-165 : Plutonium-242 Results for Other Zone Wells.

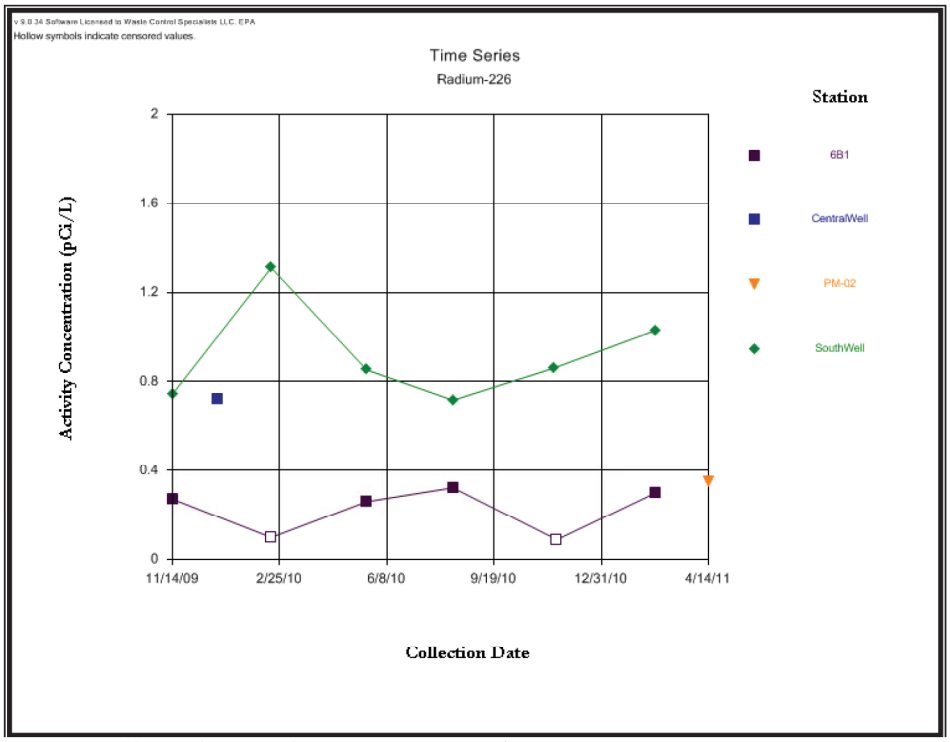

Figure 4-166 : Radium-226 Results for Other Zone Wells.

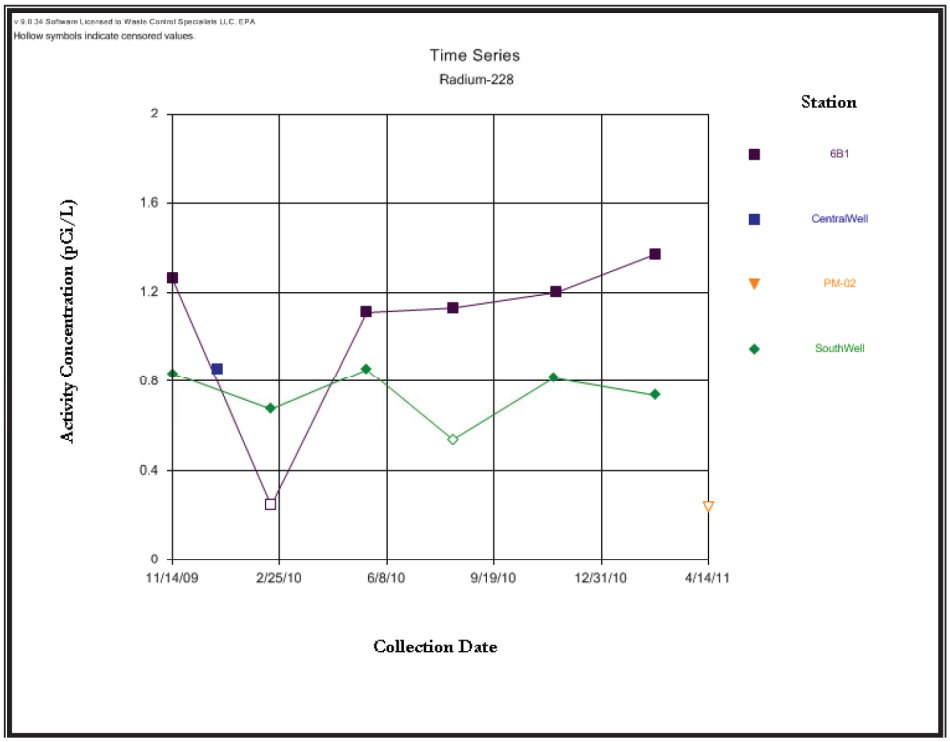

Figure 4-167 : Radium-228 Results for Other Zone Wells.

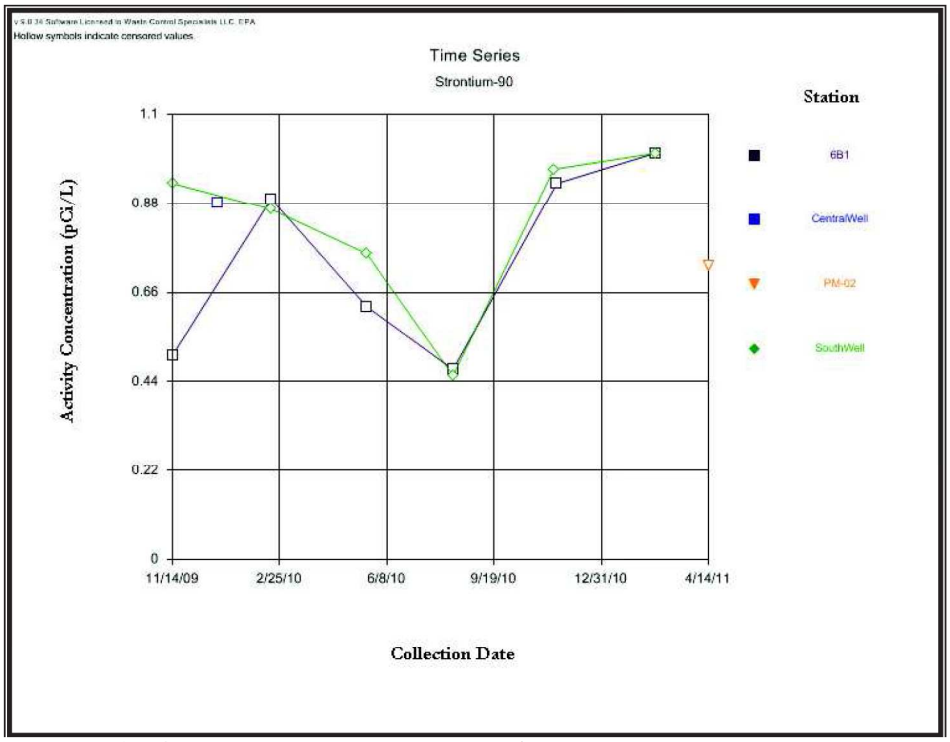

Figure 4-168 : Stronitium-90 Results for Other Zone Wells.

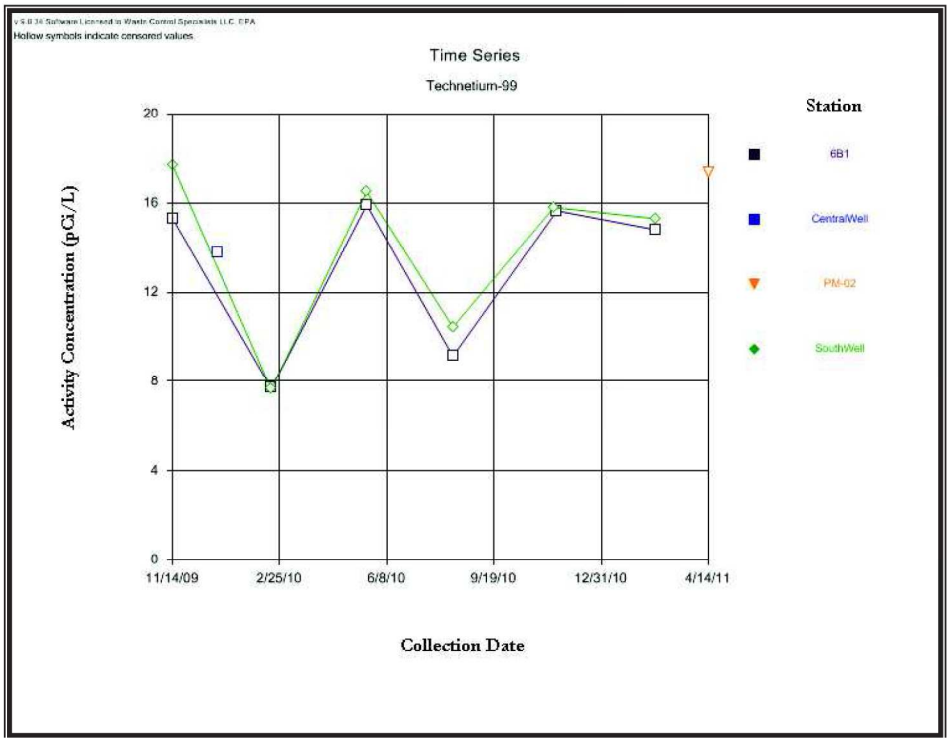

Figure 4-169 : Technetium-99 Results for Other Zone Wells.

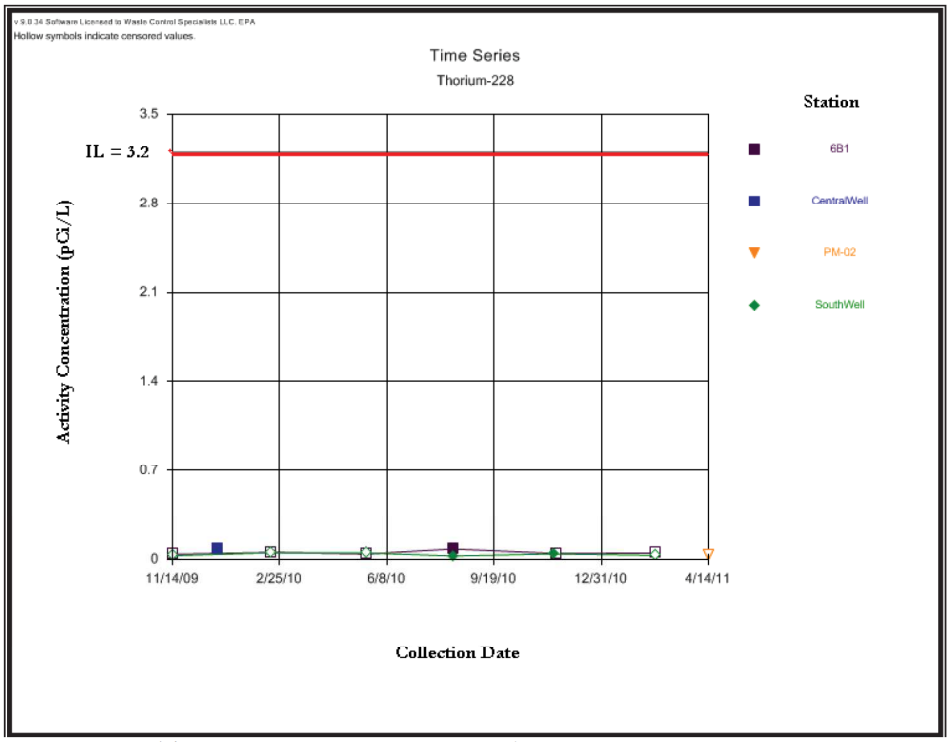

Figure 4-170 : Thorium-228 Results for Other Zone Wells.

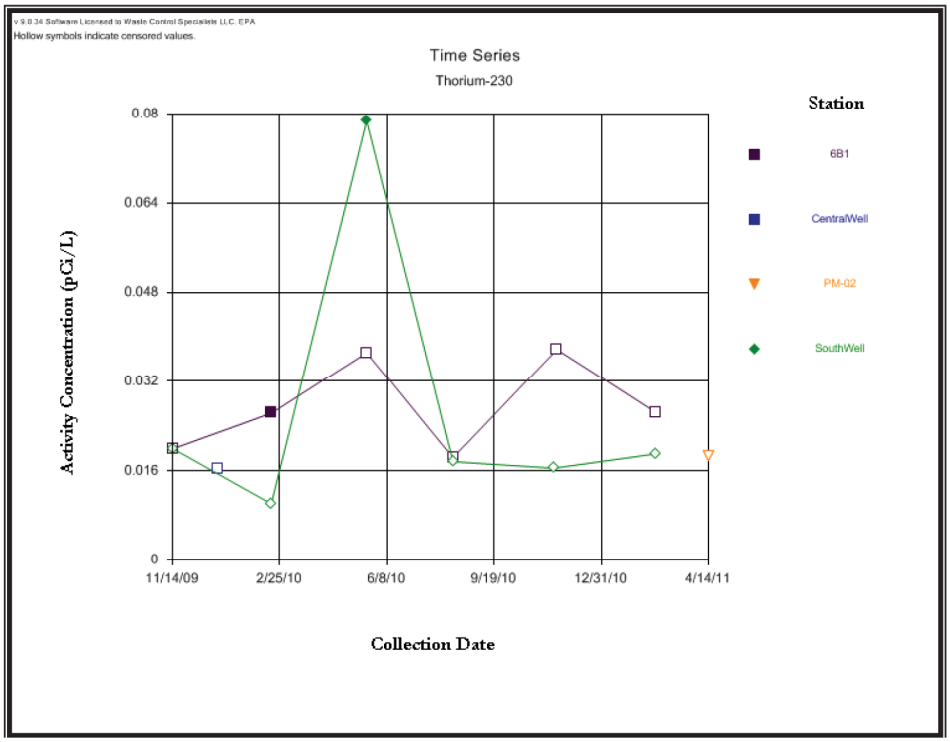

Figure 4-171 : Thorium-230 Results for Other Zone Wells.

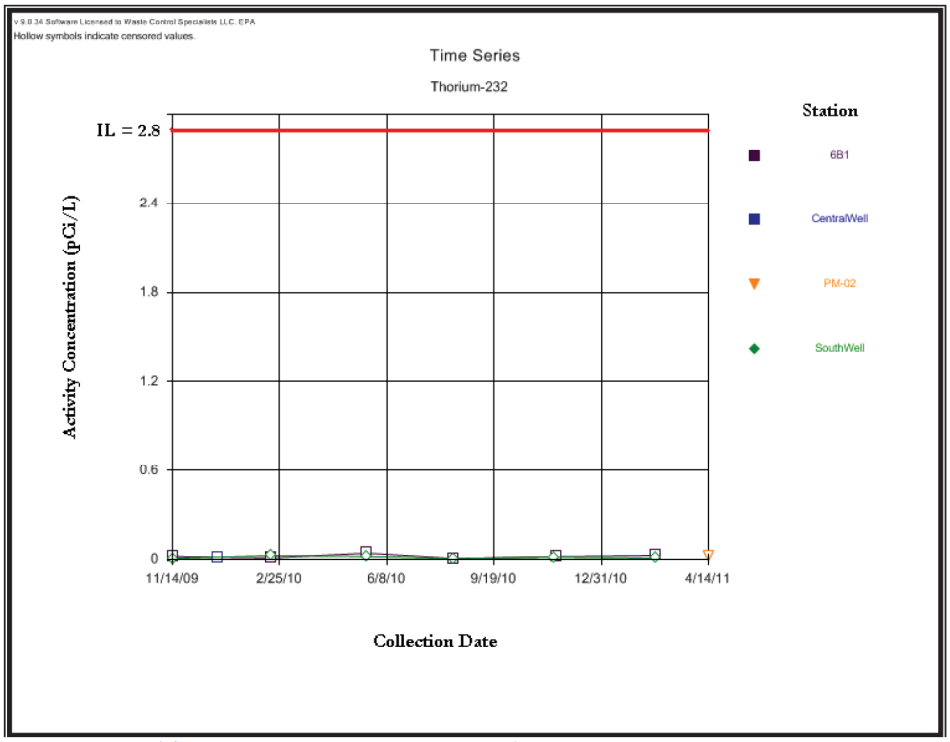

Figure 4-172 : Thorium-232 Results for Other Zone Wells.

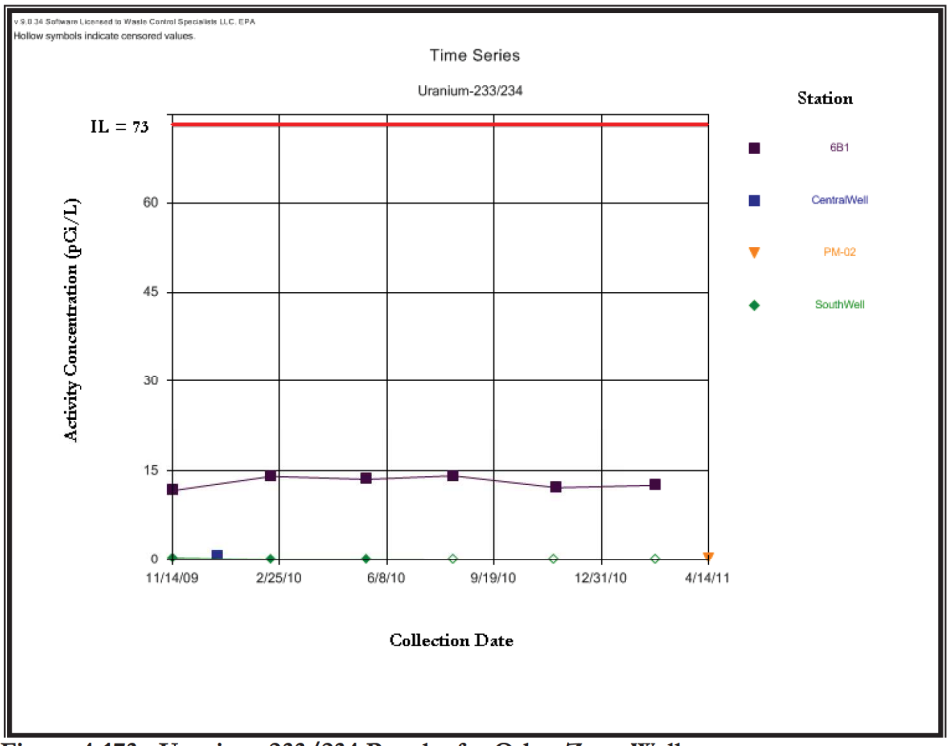

Figure 4-173 : Uranium-233/234 Results for Other Zone Wells.

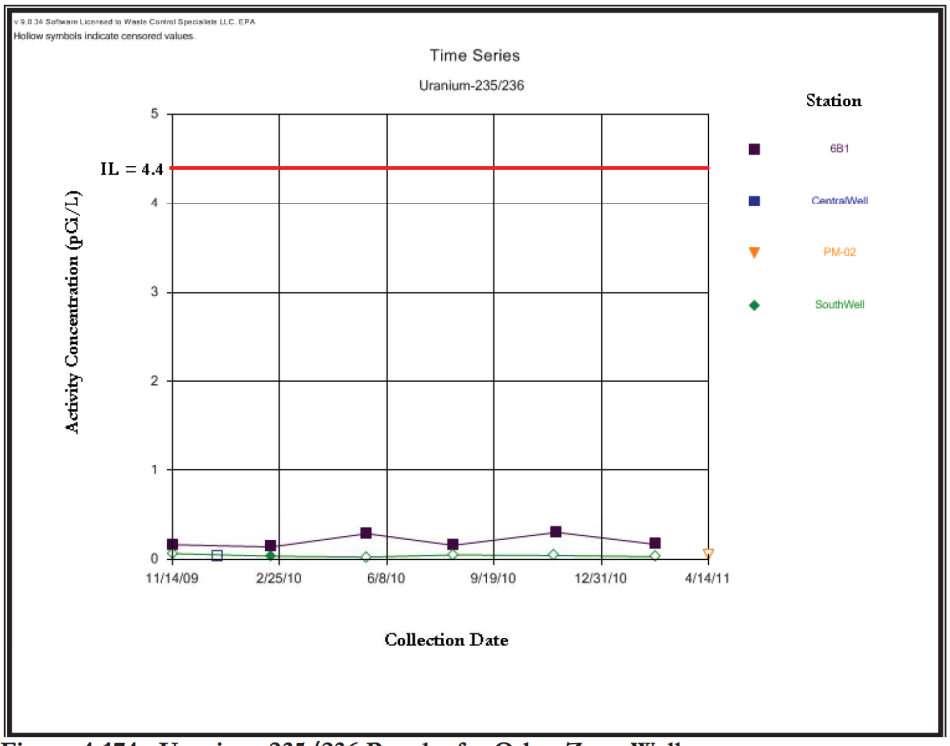

Figure 4-174 : Uranium-235/236 Results for Other Zone Wells.

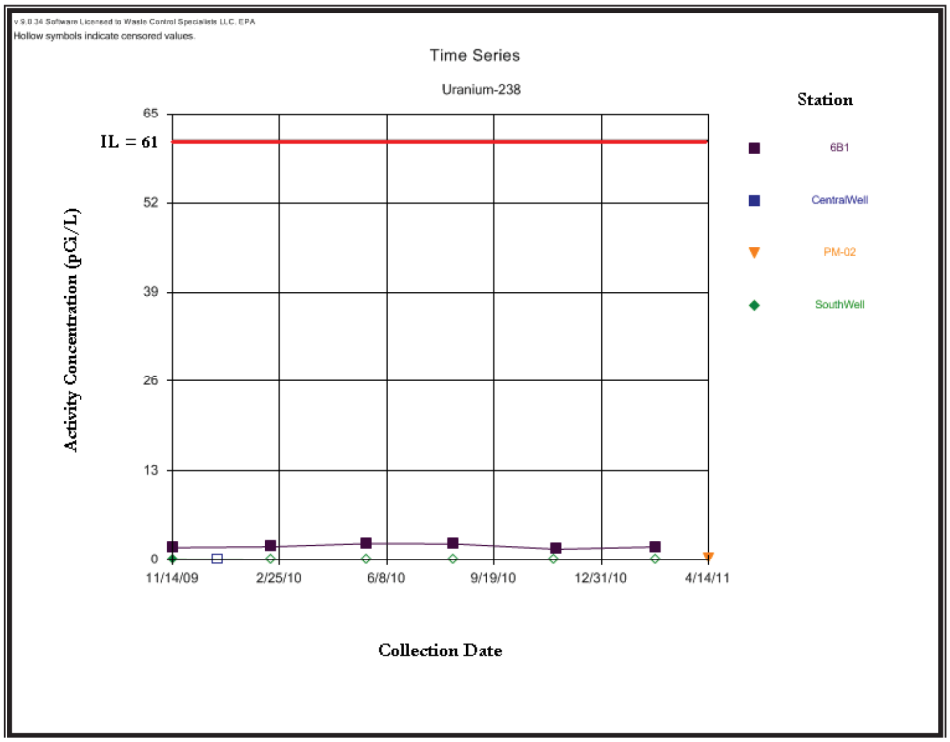

Figure 4-175 : Uranium-238 Results for Other Zone Wells.

Surface Water

As part of the Modified Natural Radiation Monitoring Program Attachment A and Pre-Operational, Construction, and Operational Environmental Monitoring Attachment B of RML R04100, EV-1.1.0, Radiological Environmental Monitoring Program and Non-Radiological Environmental Program surface water is sampled quarterly at 6 locations when there is sufficient water. Figure 4-171 displays the surface water locations.

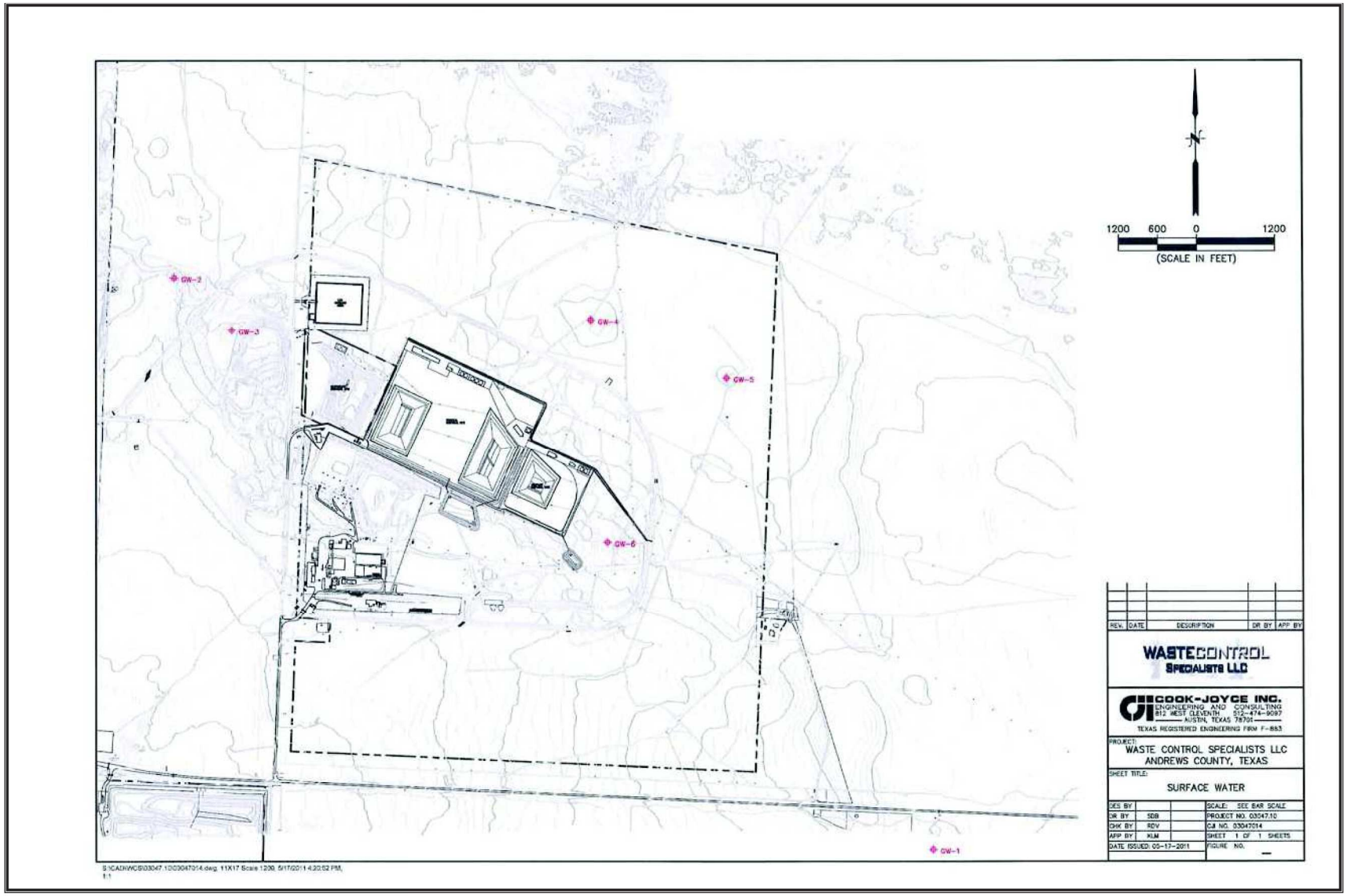

Figure 4-176 : Surface Water Locations

Surface Water Monitoring

As part of the pre-operational monitoring program, surface water is sampled quarterly at six locations specified in Attachments A and B of RML No. R04100 if water sufficient for sampling is present. Since these locations are topographic lows that collect precipitation, the presence of any water during a given monitoring event is uncommon. Surface water was sampled on January 29, 2010, June 22, 2010 and July 6, 2010 at Station GW-1, Station GW-2, Station GW-3, Station GW-5 and Station GW-6. Station GW-4 did not contain sufficient surface water to collect a sample during the pre-operational monitoring period.

Summary statistics for the pre-operational groundwater analytical results are presented in the Table 4-9 and Table 4-10. Figure 4-172 through Figure 4-229 graphically depict the pre-operational groundwater results. All pre-operational groundwater samples results for are given in Appendix B.

Table 4-6 : Summary Statistics for Radiological Surface Water (pCi/L).

Analyte	Observations	Number of Stations	Below L_c*	Maximum	Minimum	Mean	Standard Deviation
Alpha	10	5	1	5.68E+00	3.17E-01	2.59E+00	1.72E+00
Am-241	10	5	9	5.05E-02	-1.34E-02	1.48E-03	1.89E-02
Beta	10	5	0	5.56E+01	6.56E+00	2.56E+01	1.52E+01
C-14	10	5	10	7.28E+00	-1.05E+01	-3.86E+00	5.01E+00
Cs-137	10	5	10	1.94E+00	-2.25E+00	-2.18E-01	1.35E+00
Cr-51	10	5	10	2.93E+01	-3.13E+01	-8.81E-01	1.84E+01
Co-60	10	5	10	1.51E+00	-3.04E+00	-2.21E-01	1.32E+00
Cu-242	10	5	10	2.55E-02	0.00E+00	4.35E-03	9.34E-03
Cu-243/244	10	5	10	9.63E-03	-7.79E-03	-2.64E-03	5.52E-03
I-129	10	5	10	1.69E-01	-3.58E-01	-5.27E-02	1.69E-01
Mn-54	10	5	9	2.27E+00	-1.54E+00	2.80E-01	1.27E+00
Np-237	10	5	8	6.11E-02	-1.07E-02	2.15E-02	2.58E-02
Pb-210	10	5	1	7.35E+00	-4.53E-01	3.74E+00	2.03E+00
Pu-238	10	5	8	3.20E-02	-1.36E-02	5.60E-03	1.34E-02
Pu239/240	10	5	8	3.01E-02	-7.63E-03	1.04E-02	1.25E-02
Pu-241	10	5	10	1.76E+00	-2.61E+00	-6.69E-01	1.23E+00
Pu-242	7	5	7	3.40E-02	-1.47E-02	1.44E-03	1.86E-02
Ra-226	10	5	3	2.02E-01	4.47E-02	1.18E-01	5.59E-02
Ra-228	10	5	4	1.20E+00	-1.43E+00	2.77E-01	7.63E-01
Sr-90	10	5	10	4.73E-01	-1.13E+00	-6.10E-02	4.41E-01
Tc-99	10	5	10	6.85E+00	-8.15E+00	-1.40E+00	5.08E+00
Th-228	10	5	6	8.85E-02	-9.48E-04	2.80E-02	3.17E-02
Th-230	10	5	3	1.11E-01	9.69E-03	4.23E-02	3.23E-02
Th-232	10	5	5	5.08E-02	-9.75E-04	2.06E-02	1.64E-02
H-3	10	5	10	9.65E+01	-1.47E+02	1.46E+01	7.38E+01

Analyte	Observations	Number of Stations	Below L_c*	Maximum	Minimum	Mean	Standard Deviation
U-233/234	10	5	2	3.04E-01	-2.44E-02	9.35E-02	9.07E-02
U-235/236	10	5	10	2.77E-02	-4.29E-02	1.43E-03	2.06E-02
U-238	10	5	4	2.21E-01	-6.92E-03	7.53E-02	7.30E-02

*Values of Critical Level (Lc) were estimated by one-half of the Minimum Detectable Concentration (MDC).

Table 4-7 : Surface Water Monitoring Results for Low Level Pre-Operational Monitoring Program.

Analyte	Units	Observations	No. of Stations	< PQL	Max. Value	Min. Value	Mean Value*	Standard Dev.*
Arsenic	µg/L	10	5	10 (5 J flags)	28.1 J	<5	11.67	10.24
Cadmium	µg/L	10	5	10 (3 J flags)	3.46 J	<1	0.91	0.93
Nickel	µg/L	10	5	5 (4 J flags)	133	<1.5	24.35	44.49
Selenium	µg/L	10	5	10 (2 J flags)	10.7 J	<5	3.79	2.85
1,4-Dioxane	µg/L	10	5	10	<2.0	<2.0	N/A	N/A
Phenol	µg/L	10	5	10 (1 J flag)	1.06 J	<1.0	N/A	N/A
1,1,1-Trichloroethane	µg/L	10	5	10	<0.325	<0.325	N/A	N/A
1,1,2,2-Tetrachloroethane	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
1,1,2-Trichloroethane	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
1,1-Dichloroethane	µg/L	10	5	10	<0.3	<0.3	N/A	N/A
1,1-Dichloroethylene	µg/L	10	5	10	<0.3	<0.3	N/A	N/A
1,2-Dichloroethane	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
1,2-Dichloropropane	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Acetone	µg/L	10	5	10 (8 J flags)	35.9 J	<1.5	N/A	N/A
Benzene	µg/L	10	5	10	<0.3	<0.3	N/A	N/A
Bromodichloromethane	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Bromoform	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Bromomethane	µg/L	10	5	10	<0.3	<0.3	N/A	N/A
Carbon disulfide	µg/L	10	5	10	<1.25	<1.25	N/A	N/A
Carbon tetrachloride	µg/L	10	5	10	<0.3	<0.3	N/A	N/A
Chlorobenzene	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Chloroethane	µg/L	10	5	10	<0.3	<0.3	N/A	N/A
Chloroform	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Chloromethane	µg/L	10	5	10 (1 J flag)	0.42 J	<0.3	N/A	N/A
cis-1,3-Dichloropropylene	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Dibromochloromethane	µg/L	10	5	10	<0.3	<0.3	N/A	N/A
Ethylbenzene	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Tetrachloroethylene	µg/L	10	5	10 (1 J flag)	0.88 J	<0.3	N/A	N/A
Toluene	µg/L	10	5	9 (3 J flags)	9.61	<0.25	1.16	2.97
trans-1,2-Dichloroethylene	µg/L	10	5	10	<0.3	<0.3	N/A	N/A
trans-1,3-Dichloropropylene	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Trichloroethylene	µg/L	10	5	10	<0.25	<0.25	N/A	N/A
Vinyl chloride	µg/L	10	5	10	<0.5	<0.5	N/A	N/A

NOTES: * Non-detect values were replaced with one half of the MDL for summary statistics

No significant trends were observed with radionuclides or with non-radioactive metals in the surface water sample locations.

There were a number of chemical false positives. The primary false positives were acetone, chloromethane, and toluene. Estimated (J-flag) concentrations make up the vast majority of these detections (12 out of 13 detections). In addition to these three chemicals, between one estimated concentration of tetrachloroethene and phenol were reported in surface water samples. All of these chemicals are considered false positives.

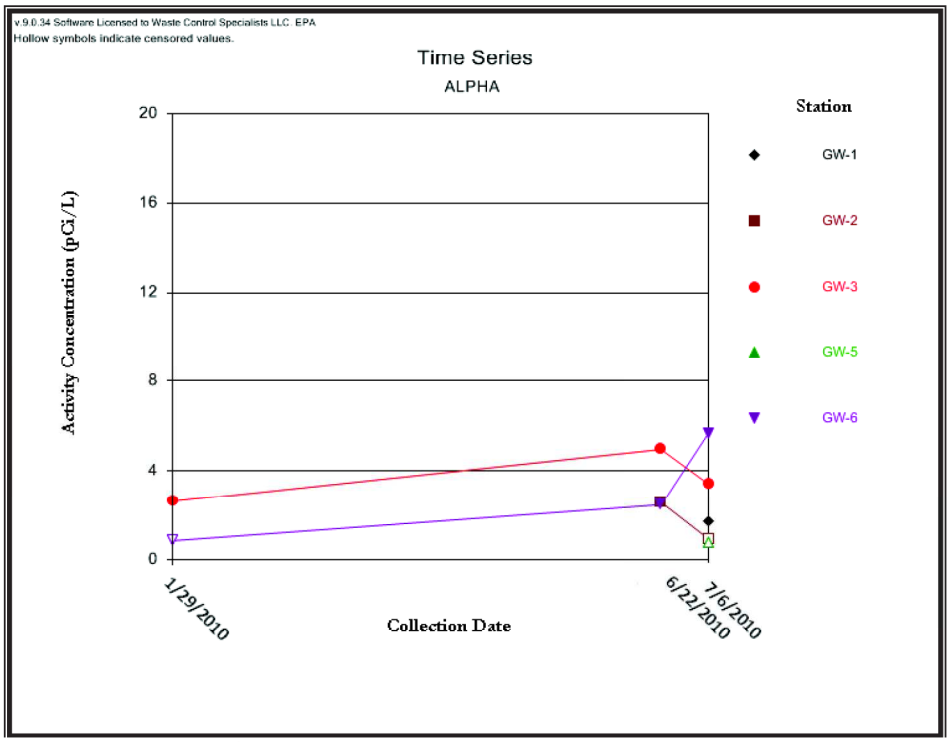

Figure 4-177 : Alpha Surface Water Results.

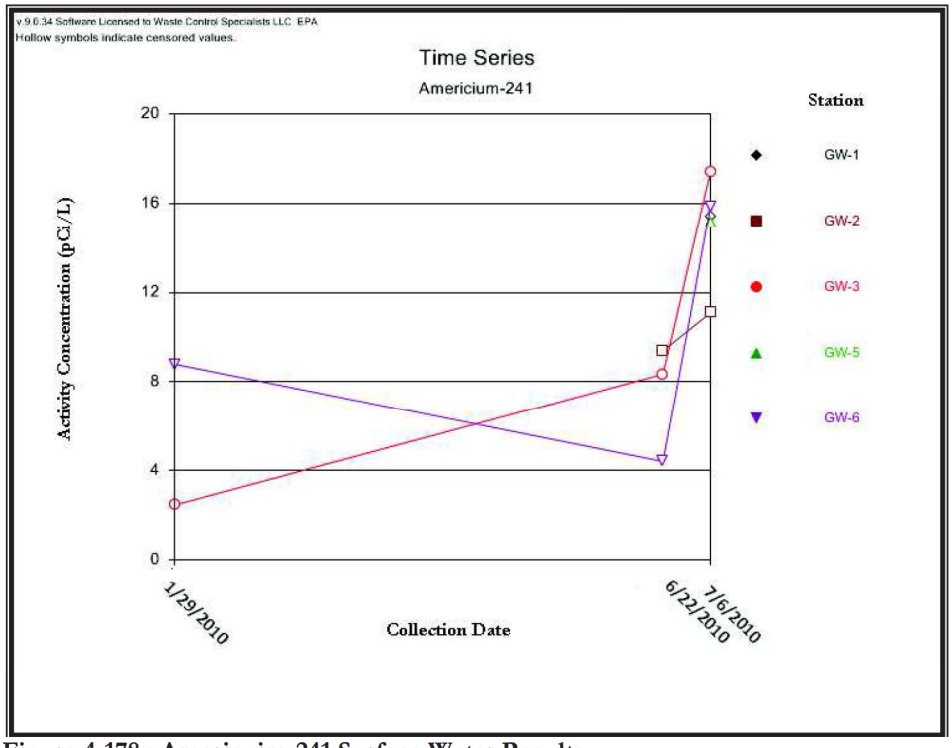

Figure 4-178 : Americuim-241 Surface Water Results.