



United States Department of Energy

Savannah River Site

**Effectiveness Monitoring Report for the
Monitored Natural Attenuation (MNA) at
the Chemicals, Metals, and Pesticides (CMP) Pits
Operable Unit (OU) (U)**

April 2021 through March 2022

SEMS Number: 24

SRNS-RP-2022-00342

Revision 0

June 2022

DISCLAIMER

This report was prepared by Savannah River Nuclear Solutions, LLC (SRNS) for the United States Department of Energy under Contract No. DE-AC09-08SR22470 and is an account of work performed under that contract. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees assumes any legal liability or responsibility for any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process or services by trademark, name, manufacturer or otherwise does not necessarily constitute or imply endorsement recommendation, or favoring of same by SRNS or the United States Government or any agency thereof.

**Printed in the United States of America
Prepared for
U. S. Department of Energy
and
Savannah River Site Nuclear Solutions, LLC
Aiken, South Carolina**

TABLE OF CONTENTS

Section	Page
LIST OF FIGURES.....	iv
LIST OF TABLES.....	v
LIST OF APPENDICES.....	v
LIST OF ACRONYMS AND ABBREVIATIONS.....	vi
1.0 INTRODUCTION.....	1
1.1 OPERABLE UNIT BACKGROUND	1
1.2 NATURE AND EXTENT OF CONTAMINATION.....	2
1.3 OBSERVED HYDROSTRATIGRAPHY AT THE CMP PITS OU.....	4
1.4 OBSERVED HYDROLOGY AT THE CMP PITS OU.....	5
2.0 REMEDIAL ACTIONS.....	8
2.1 CMP PITS VADOSE ZONE REMEDIAL ACTION.....	8
2.2 GROUNDWATER MONITORED NATURAL ATTENUATION REMEDY.....	9
<i>2.2.1 Groundwater Aquifers</i>	<i>9</i>
<i>2.2.2 Groundwater Sampling Results.....</i>	<i>10</i>
2.2.2.1 PCE and TCE.....	10
2.2.2.2 Cis-1,2-Dichloroethylene (c-1,2-DCE).....	17
2.2.2.3 Trans-1,2-Dichloroethylene (t-1,2-DCE).....	18
2.2.2.4 1,1-Dichloroethylene (1,1-DCE).....	18
2.2.2.5 Vinyl Chloride (VC).....	18
2.2.2.6 1,4-Dioxane.....	18
2.2.2.7 Carbon Tetrachloride (CCl ₄).....	19
2.2.2.8 Chloroform.....	19
2.2.2.9 Dichloromethane (DCM).....	20
2.2.2.10 Bromodichloromethane.....	20
2.2.2.11 1,1,2-Trichloroethane (1,1,2-TCA).....	20
2.2.2.12 Lindane.....	20
<i>2.2.3 Surface Water Sampling Results.....</i>	<i>22</i>
<i>2.2.4 Additional Data from Independent Analysis.....</i>	<i>23</i>
3.0 ADDITIONAL SAMPLING EFFORTS.....	24
4.0 SUMMARY.....	25
5.0 REFERENCES.....	28

LIST OF FIGURES

Item	Page
Figure 1.	Location of the CMP Pits OU within the Savannah River Site..... 31
Figure 2.	CMP Pits OU Subunits 33
Figure 3.	CMP Pits Groundwater OU Conceptual Site Model (CSM)..... 35
Figure 4.	Stratigraphic Surfaces of the TCCZ and TCLC with 4Q2021 Dry Zones of the TZ and MAZ..... 37
Figure 5.	CMP Pits OU Monitoring Network, and Cross Section Lines..... 39
Figure 6.	Regional Water Table Potentiometric Surface 41
Figure 7.	2021 Potentiometric Surface for the TZ and MAZ..... 43
Figure 8.	2021 Potentiometric Surface for the LAZ and GA 45
Figure 9.	Monthly Rainfall Measurements in L-Area for 2021, 2020, 2019, 2018, and the 20-Year Average..... 47
Figure 10.	2021 PCE Plume and Groundwater and Surface Water Results for the TZ and MAZ..... 49
Figure 11.	2021 PCE Plume and Groundwater Results for the LAZ and GA 51
Figure 12.	Cross Section A - A' at the CMP Pits OU Area with 2021 PCE Plume and Results..... 53
Figure 13.	Cross Section B - B' at the CMP Pits OU Area with 2021 PCE Plume and Results..... 55
Figure 14.	Cross Section C - C' at the CMP Pits OU Area with 2021 PCE Plume and Results..... 57
Figure 15.	PCE Plume Comparison from 2008 and 2021 in the TZ and MAZ..... 59
Figure 16.	PCE Plume Comparison from 2008 and 2021 in the LAZ and GA 61
Figure 17.	2021 TCE Plume and Groundwater and Surface Water Results in the TZ and MAZ..... 63
Figure 18.	2021 TCE Plume and Groundwater Results for the LAZ and GA..... 65
Figure 19.	2021 1,4-Dioxane Plume and Groundwater Results for the TZ and MAZ 67
Figure 20.	2021 1,4-Dioxane Plume and Groundwater Results for the LAZ and GA.... 69
Figure 21.	Cross Section A - A' at the CMP Pits OU Area with 2021 1,4-Dioxane Plume and Results..... 71
Figure 22.	Cross Section B - B' at the CMP Pits OU Area with 2021 1,4-Dioxane Plume and Results..... 73
Figure 23.	Cross Section C - C' at the CMP Pits OU Area with 2021 1,4-Dioxane Plume and Results..... 75
Figure 24.	2021 Lindane Plume and Groundwater Results for the TZ and MAZ..... 77
Figure 25.	2021 Lindane Plume and Groundwater Results for the LAZ and GA 79

Figure 26.	Cross Section A - A' at the CMP Pits OU Area with 2021 Lindane Plume and Results.....	81
Figure 27.	Cross Section B - B' at the CMP Pits OU Area with 2021 Lindane Plume and Results.....	83
Figure 28.	Cross Section C - C' at the CMP Pits OU Area with 2021 Lindane Plume and Results.....	85
Figure 29.	Lindane Plume Comparison from 2008 and 2021 in the TZ and MAZ.....	87
Figure 30.	Lindane Plume Comparison from 2008 and 2021 in the LAZ and GA.....	89
Figure 31.	Comparison of PCE and Lindane Trends in CMP 10D and CMP 35D.....	91
Figure 32.	Contaminant Concentration Well Trends and Well Trends by Aquifer	93
Figure 33.	SCSU 2021 PCE Groundwater and Surface Water Results	95
Figure 34.	SRS Additional Sampling Locations in 2021.....	97

LIST OF TABLES

Item	Page
Table 1.	CMP Pits OU MNA Monitoring Network 98
Table 2.	CMP Pits OU Horizontal Groundwater Flow Velocities (4Q21) 100
Table 3.	CMP Pits OU Annual MNA Results, April 2021 through March 2022 101
Table 4.	CMP Pits OU PCE Max Results from 2008 and 2021 ($\mu\text{g/L}$)..... 103
Table 5.	CMP Pits OU Lindane Max Results from 2008 and 2021 ($\mu\text{g/L}$)..... 104
Table 6.	SCSU Groundwater Water Results from 2021..... 105

LIST OF APPENDICES

Appendix A	Hydrographs	A-1
Appendix B	Time-Series Plots.....	B-1
Appendix C	Additional Sampling Efforts	C-1

LIST OF ACRONYMS AND ABBREVIATIONS

1,1,2-TCA	1,1,2-trichloroethane
1,1-DCE	1,1-dichloroethylene
bgs	below ground surface
c-1,2-DCE	cis-1,2-dichloroethylene
CCl ₄	carbon tetrachloride
CMCOC	contaminant migration constituent of concern
CMP	chemicals, metals, and pesticides
COC	constituent of concern
CSM	conceptual site model
CY	calendar year
DCM	dichloromethane (methylene chloride)
DEHP	bis-(2-ethylhexyl) phthalate
DNAPL	dense non-aqueous phase liquid
EMP	Effectiveness Monitoring Plan
EMR	Effectiveness Monitoring Report
ERH	electrical resistance heating
ft	feet
GA	Gordon aquifer
GCCZ	Green Clay Confining Zone
GWPS	groundwater protection standard
HDPE	high-density polyethylene
LAZ	lower aquifer zone
m	meters
µg/L	microgram per liter
MAZ	middle aquifer zone
MCL	maximum contaminant level
mg/kg	milligram per kilogram
MNA	monitored natural attenuation
OU	operable unit
PCE	tetrachloroethylene
PDB	passive diffusion bag
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RG	remedial goal
ROD	Record of Decision
RSL	Regional Screening Level
SCDHEC	South Carolina Department of Health and Environmental Control
SCSU	South Carolina State University
SRNS	Savannah River Nuclear Solutions LLC
SRS	Savannah River Site
SVE	soil vapor extraction
TCCZ	Tan Clay Confining Zone

LIST OF ACRONYMS AND ABBREVIATIONS (*continued, end*)

TCLC	Tan Clay Lower Clay
TCE	trichloroethylene
t-1,2-DCE	trans-1,2-dichloroethylene
TZ	transmissive zone
USEPA	U.S. Environmental Protection Agency
UTRA	Upper Three Runs aquifer
VC	vinyl chloride
VOC	volatile organic compound
WSRC	Westinghouse Savannah River Company LLC (before October 2005)
WSRC	Washington Savannah River Company LLC (October 2005- July 2008)

This page is intentionally left blank.

1.0 INTRODUCTION

This Effectiveness Monitoring Report (EMR) addresses the Monitored Natural Attenuation (MNA) groundwater remedy at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU) for the period from April 2021 to March 2022. The monitoring requirements for the CMP Pits OU are identified in the Effectiveness Monitoring Plan (EMP) (WSRC 2006b).

1.1 Operable Unit Background

The CMP Pits OU is located in the central portion of the Savannah River Site (SRS) approximately one mile north of L Area (Figure 1). The subunits of the CMP Pits OU were evaluated in the *RCRA Facility Investigation/Remedial Investigation Addendum with Baseline Risk Assessment for the CMP Pits (U)* (WSRC 2003). The CMP Pits OU is comprised of the following subunits: Ballast Area soils; CMP Pits and associated vadose zone (Field A); vadose zone (Field B); groundwater; and surface water and sediment (Figure 2).

The CMP Pits consist of seven former, unlined pits placed in two rows that were designed to receive non-radioactive wastes (chemicals, metals, and pesticides) and operated from August 1971 until February 1979. Once the pits stopped receiving waste, all the open pits were covered with clay and graded. Contaminated soil and debris at the CMP Pits posed a contaminant migration and human health risk and were partially excavated in 1984. A second phase of excavation was performed at Pit 080-183G to remove a portion of significantly contaminated soil that also contained dense non-aqueous phase liquid (DNAPL). The excavation was followed by backfilling of the pit area with clean soil and then capped across the whole pits area with a black plastic HDPE (high-density polyethylene) cover and overlying soil cover. However, some contaminated soils were left in place. The previous waste in the pits and associated contaminated soils located in the CMP Pits vadose zone (Field A) were determined to be the source of groundwater contamination.

Electrical Resistance Heating (ERH) with Soil Vapor Extraction (SVE) was selected as the final remedial action (RA) for the CMP Pits vadose zone in and around Field A (Figure 2). This remedy targeted the deeper contaminated soil at Pit 080-183G that was underneath the previous soil excavations. This remedy also addressed the remaining DNAPL that was present in the clay horizons beneath the pits. The contaminant migration constituents of concern (CMCOCs) that

were identified in the Resource Conservation Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Addendum (WSRC 2003) are tetrachloroethylene (PCE) and dichloromethane (DCM).

Groundwater contamination has occurred as a result of contaminants leaching from the source area soils. Following remediation of the CMP Pits vadose zone (Field A) source area, MNA was selected as the RA for the contaminated groundwater.

Surface soil contamination in the Ballast Area and vadose zone contamination in Field B have been successfully remediated via interim RAs. There is no problem warranting action and no RA objective for the surface water and sediment; however, surface water sampling is included as part of the MNA sampling.

1.2 Nature and Extent of Contamination

PCE and DCM (or methylene chloride) were identified as CMCOCs and as principal threat source material for mobility (i.e., transport from the source zone to the aquifer in less than 10 years) in the vadose zone beneath the CMP Pits. The volatile organic compound (VOC) contamination was highest in the northwest pit (Pit 080-183G) at depths between 20 and 60 feet (ft) (6.10 and 18.29 meters [m]) below ground surface (bgs). PCE was the most abundant contaminant at CMP Pits. No constituents of concern (COCs) were identified in the surface soils in the CMP Pits subunit.

In accordance with the Record of Decision (ROD) (WSRC 2004), an ERH/SVE remedy was selected to remove the DNAPL from the vadose zone. Based on the limited lateral and vertical extent of PCE contamination in the vadose zone and the intent of the selected remedy defined in the ROD, the ERH treatment area included the extent of PCE contamination above the DNAPL threshold concentrations (60 mg/kg) and comprised an area of approximately 0.05 acres (0.02 hectares) in Field A (Figure 2). Further details of the DNAPL remediation are available in the 2009 EMR (SRNS 2009).

The following VOCs and pesticides were identified as human health COCs in the groundwater for the future industrial worker and/or resident: alpha-benzene hexachloride, beta-benzene hexachloride, delta-benzene hexachloride, dieldrin, lindane, bis-(2-ethylhexyl) phthalate (DEHP),

bromodichloromethane, carbon tetrachloride, chloroform, DCM, PCE, and trichloroethylene (TCE). Following the EMP for the CMP Pits, both groundwater and surface water have been sampled and analyzed for Target Compound List VOCs and/or lindane (WSRC 2006b). DEHP is a common laboratory artifact and is not believed to be present in the groundwater subunit. As of 2010, the constituent DEHP is no longer required to be sampled and/or reported. In 2013, 1,4-dioxane was added to the list of monitored constituents on an annual sampling basis.

Two VOC groundwater plumes exist at the CMP Pits, designated as the main plume and the northeast distal plume. These plumes are moving northward toward Pen Branch. Groundwater modeling indicated that the CMP Pits were the source for the main plume. Particle tracking toward and from the northeast plume suggested that its source was different from that of the main plume (WSRC 2002). A drainage ditch located approximately 361 ft (110 m) north of CMP Pits is a possible previous source area (Figure 2). It is possible that this ditch was used as a dumping location prior to the use of the actual CMP Pits. Additional characterization for the source of the distal plume using soil gas surveys was presented in the RFI/RI Addendum (WSRC 2003). Results indicated that if a source was previously present in the vadose zone, it has been depleted. It is also plausible, due to the dry zone areas within the transmissive zone (TZ) and to some degree the middle aquifer zone (MAZ), that one plume separated into two distinct plumes due to the groundwater flow paths and discharge to Pen Branch. Upwelling of the MAZ as it discharges to the stream most likely brings some contamination up into the TZ. A combination of the three explanations is probable.

As discussed below, the vertical extent of the VOC plume is mostly within the Upper Three Runs aquifer (UTRA) and includes three distinct horizons: the TZ, the MAZ, and the lower aquifer zone (LAZ). The lateral extent of the initial VOC plume was estimated at 46 acres (18.6 hectares), extending from the pit area to Pen Branch. One new Gordon aquifer (GA) well, CMP010A which was installed in 2019, is located directly to the southeast of CMP Pits has shown that the GA may be contaminated with VOCs above maximum contaminant levels (MCLs). This is the first occurrence of GA contamination above MCLs; however, it is suspected this contamination is not a natural occurrence and further investigations are to be conducted as discussed in section 2.2.2.1, *PCE and TCE* and Appendix C, *Additional Sampling Efforts*.

Although vadose zone remediations have occurred, there has been approximately fifty years for contamination to move through the aquifers, resulting in contaminants likely partitioning onto clay particles and/or diffusing into less permeable layers, not only near the original source area at the CMP Pits, but also throughout the aquifer system acting as a secondary contaminant source to groundwater. Figure 3 shows the CMP Pits Groundwater OU Conceptual Site Model (CSM) and potential sources of contamination.

1.3 Observed Hydrostratigraphy at the CMP Pits OU

In the vicinity of the CMP Pits OU, the aquifers of interest include the UTRA and the underlying GA. Horizontal flow within the UTRA is divided into three discrete horizons that are separated by two semi-continuous confining zones which can be comprised of sandy clays in areas and therefore potentially discontinuous and leaky. The horizons are: 1) the TZ – a thin aquifer feature that lies above the top portion of the tan clay, the tan clay confining zone (TCCZ), 2) the MAZ – a thin aquifer horizon between the TCCZ and the lower portion of the tan clay, the tan clay lower clay (TCLC), and 3) the LAZ - the most substantial portion of the UTRA in the area, which extends to the green clay confining zone (GCCZ) with a thickness up to 100 ft (30.48 m). The GCCZ separates the UTRA from the GA and is comprised of single or multiple layers of dark greenish grey to black clay to sandy clay. Fine to medium grained sands to silty/clayey sands exist in-between the clay layers. The confining zones are hummocky, vary in thickness, and can be almost non-existent or leaky in areas. In general, the TCCZ is thinner in the UTRA than the TCLC.

Using the data collected from lithology pushes done for the 2002 modeling effort and from well installation records, the confining unit surfaces of the TCCZ and TCLC were spatially mapped (Figure 4) and compared to the most current fourth quarter 2021 (4Q2021) water elevation surfaces. Areas where the TZ and MAZ are suspected to be dry were delineated and are shown on Figure 4, as well as on all TZ and MAZ figures, and can be seen in the cross sections (See Section 2.2.2). The top of the TCCZ forms a semi-circular ridge at and north of the CMP Pits (shown as white and light pink shaded elevations in Figure 4), which causes much of the TZ to be dry. This shape is mimicked in the top of the TCLC, but the subsequent dry zone is not as extensive. The dry zones at CMP Pits are not a recent occurrence. Review of water elevation data from the 1980's and 1990's from abandoned wells suggests similar dry zones have existed for decades.

Figure 5 shows the locations of the 76 monitoring wells and eight surface water stations associated with the CMP Pits OU. The map also shows corresponding cross-section lines which depict the local hydrostratigraphic lithology and major contaminant plumes at the CMP Pits OU. The stratigraphy, aquifers and plumes are all, in general, gently sloping towards Pen Branch. However, the confining units appear to slope towards the south in some areas at the main CMP Pits area (Figure 4 and cross-section B-B' [See Section 2.2.2]). Although the TCCZ and the TCLC are depicted as continuous units in the cross-sections, the aquifer behavior in this area shows various elevation heads and contaminant pathways that indicate the confining horizons are discontinuous and/or intermixed with sandy clays in areas. The TZ, TCCZ, MAZ, TCLC, and LAZ units are eventually incised by Pen Branch itself and/or the local topography. In the CMP Pits OU area of interest (extent of the maps), the TZ is incised by Pen Branch on the east side of the stream reach, the MAZ is incised in the central portion of the stream reach, and the LAZ is partially incised by Pen Branch at the western portion of the stream. The horizontal extent of the TZ and MAZ are depicted on all TZ and MAZ maps.

1.4 Observed Hydrology at the CMP Pits OU

Regional groundwater flow for the UTRA, as depicted in Figure 6, is to the northwest towards Pen Branch from CMP Pits. The latest compiled potentiometric surfaces from the calendar year (CY) 4Q2021 are displayed for each of the aquifer zones in Figure 7 and Figure 8. These potentiometric surfaces do not show any unusual pattern of flow from previous measurements. Figure 9 depicts the monthly rainfall levels in nearby L Area for 2018 – 2021 and the 20-year average. Rainfall during 2021 (total of 45.03 inches) measured less than the 2020 measurements and was slightly below the 20-year average (48.12 inches). The months of February, June, July and August experienced the highest rainfall totals in the year. April, October and November were the driest months. In general, monitoring wells showed similar water elevations compared to 2020 measurements. Hydrographs of each well are presented in Appendix A.

A small region of radial flow appears to be superimposed upon the northwestward flow beneath the hill on which the CMP Pits are located and is depicted by the groundwater flow direction arrows in Figure 7. This pattern is due to the locally high topography at CMP Pits (Figure 2) as well as the bowl-like structure of the Tan Clay, especially in the upper TCCZ (Figure 4). Based

on water elevations in the MAZ not being fully saturated, it appears the TZ may consist of perched water tables in many locations. The bowl-like structure of the tan clay as depicted in Figure 4 further supports this conclusion as the lower elevation of the TCCZ in the eastern portion of the CMP Pits may locally funnel groundwater to the south and southeast following the slope of the TCCZ before eventually flowing to the north and northwest. Water may mound up in the bowl-like structure as water is pushed towards the northwest from the overall regional groundwater flow and as water flows downslope, as shown in Figure 7 in the TZ, the wells located directly around CMP Pits (CMP 34D, CMP 13D, CMP 35D, CMP 10D, and CMP 11D) and may exhibit a radial groundwater flow path with an additional south or southwest gradient. Some years display a more pronounced southerly flow gradient than others. With lower rainfall totals in 2021, flow patterns have not changed significantly from 2020 but are displaying a more southerly flow as opposed to the 2020 gradients.

The flow pattern in the MAZ generally resembles that of the TZ. Flow directions in the LAZ and GA are less defined, as the horizontal gradients are less across the area, as discussed below. In the area around the CMP Pits and towards the west and north, the water elevations in the LAZ are generally very similar and vary by up to 2 feet (Figure 8). Measurements show that groundwater in the vicinity of Pen Branch flows toward Pen Branch on both the southern and northern side of the stream, further supporting that contaminants originating south of Pen Branch from CMP Pits are not flowing underneath Pen Branch towards the north. Water elevations in the LAZ on the north side of Pen Branch are higher than elevations on the south side of Pen Branch.

Estimated horizontal groundwater linear velocities have been calculated for the following groundwater flow paths:

- Figure 7 - TZ aquifer flow paths A – A', B – B', and C – C';
- Figure 7 - MAZ flow paths A – A' and B – B';
- Figure 8 – LAZ flow paths A – A', B – B', and C – C'; and
- Figure 8 – GA flow path A – A'.

Estimated horizontal groundwater linear velocities were calculated for each of the above flow paths using the following equation:

$$\text{Linear Velocity} \left(\frac{\text{ft}}{\text{day}} \right) = \frac{\text{Hydraulic Conductivity} \left(\frac{\text{ft}}{\text{day}} \right)}{\text{Porosity (unitless)}} \times \frac{dh \text{ (ft)}}{dl \text{ (ft)}}$$

The hydraulic conductivity constants (8, 50, and 30 ft/day for the TZ, MAZ, and LAZ, respectively) and porosity values (all 30%) used in the calculations are taken from the final calibrated 2017 modeling effort (SRNS 2017). For the GA, the hydraulic conductivity constant of 20 ft/day and porosity value of 30% is used based on investigations in other nearby groundwater/waste sites at SRS. The value dh is the difference in head; dl is the length of the groundwater flow paths shown on Figures 7 and 8. The ratio dh/dl is the horizontal gradient. The gradient, linear velocity per day and average linear velocity per year were each determined and are provided in Table 2 and described below.

Estimated velocities vary within the TZ between 0.13 ft/day on the western side of the CMP Pits and 0.38 ft/day on the eastern side. This variation could be caused by a combination of factors including the large dry zone area and the radial groundwater flow paths at the CMP Pits knoll, as discussed above. The average for the TZ is 0.29 ft/day, or 107.31 ft/year. The MAZ is more uniform in its rates and averages at 1.68 ft/day, or 615.17 ft/year. The LAZ's rate is much less than the MAZ near the CMP Pits with a rate of 0.23 ft/day, or 85.26 ft/year (LAZ A – A' Flow Path). Flow is greater near Pen Branch, especially on the north side of Pen Branch with a flow velocity of 1.14 ft/day, or 416.32 ft/year (LAZ C – C' Flow Path); however, flow rates are still less than the MAZ. The GA potentiometric surface is extremely flat compared to the UTRA aquifer as the water elevations only vary slightly in elevation across the whole CMP Pits monitored area. Horizontal flow velocity for the GA was calculated to be an average of 0.24 ft/day, or 89.39 ft/year. Flow direction is towards the south/southeast and is consistent with the regional GA flow.

There is a significant downward component to groundwater flow throughout the UTRA. Water level measurements collected from well clusters during 2021 show an average head drop of 12.22 ft (3.72 m) across the TCCZ and an average of 13.64 ft (4.16 m) across the TCLC. There is an average of a 13.96 ft (4.26 m) drop in head across the Green Clay from the LAZ to the GA. As groundwater approaches Pen Branch, the downward gradient may decrease or even flow upward near and underneath Pen Branch as water discharges into Pen Branch. Monitoring well clusters

CMP064BU and CMP064B as well as CMP 32C and CMP 32B (all screened in the LAZ) show a higher water elevation in the lower B screen than the upper BU or C screen (Figure 8). Additionally, wells in the wetland area near Pen Branch display water table elevations approximately 1 – 3 ft (0.3 – 0.9 m) above the stream bottom, indicating that Pen Branch is a gaining stream. Other wells, CMP 8 and CMP 8B, located upgradient of the wetland area display a much lower than average downward gradient of approximately 4 ft (1.2 m) across the TCLC. The TCCZ and TCLC are not considered thick competent confining clays, but rather are hummocky, vary in thickness, and can be almost non-existent or leaky in areas allowing some degree of flow between aquifers. The steep topography south of Pen Branch incises the TCCZ and TCLC, the sediment around the stream has been reworked over time as the stream has meandered, and trees and roots have penetrated the clay layers allowing more interchange between aquifers.

2.0 REMEDIAL ACTIONS

This EMR documents the performance of the MNA remedy for the groundwater. Remedial activities for the vadose zone and Ballast Area Soils subunits were performed under an interim RA in 2001 and 2005, respectively (WSRC 1999 and WSRC 2006a). ERH combined with SVE was implemented from 2007 through 2009 to remove DNAPL from the vadose zone (Figure 2). This interim RA mitigated the source within the vadose zone for the groundwater subunit which allows for the MNA remedy.

2.1 CMP Pits Vadose Zone Remedial Action

The ERH/SVE RA performed for the CMP Pits vadose zone was implemented to mitigate the CMCOCs PCE and DCM. Details of system construction are provided in the Post-Construction Report (SRNS 2008). ERH/SVE operation began on March 17, 2008. Heating via ERH continued until November 2008. Two SVE systems provided the VOC removal at the CMP Pits well field. SVE well effluent vapor concentrations and soil temperature data were analyzed to determine when the source/DNAPL had been depleted. Operating data from the ERH system was provided in the EMR submitted in June 2009 (SRNS 2009).

In accordance with the EMP, confirmation samples were collected from three core locations. All sample results were below the remedial goal (RG) for PCE (30.7 mg/kg) and DCM (0.2 mg/kg) (SRNS 2010), meeting the objective of the RA. All remedial equipment and SVE units have been removed. Even though the RA was successful and confirmation samples were below RGs, there is a possibility that residual contamination trapped within clay horizons and/or pore space in the vadose zone, in or out of the ERH/SVE zone, could act as a secondary source for groundwater contamination, albeit much smaller than the original source.

2.2 Groundwater Monitored Natural Attenuation Remedy

2.2.1 Groundwater Aquifers

As described above, groundwater analysis has been performed around the CMP Pits in four distinct aquifer zones of the UTRA and the GA. These zones in descending order are 1) the TZ of the UTRA, 2) the MAZ of the UTRA, 3) the LAZ of the UTRA, and 4) the GA.

Groundwater within these aquifers is currently monitored by the 76 wells which have been sampled on a semi-annual or annual basis (Table 1, Figure 5). This includes two new monitoring wells that were installed in 2021 (CMP035B in the LAZ and CMP011A in the GA) (See Appendix C for details associated with the 2021 well installation and VOC headspace sampling). The TZ includes 13 monitoring wells, the MAZ includes 27 monitoring wells, the LAZ includes 29 monitoring wells, and the GA includes seven monitoring wells. All wells are used for water level measurements and the majority (67) are sampled for VOCs and/or lindane. Eight surface water stations north of the CMP Pits located in the Pen Branch stream were used to monitor any discharge of VOCs to the stream (Figure 5). Table 1 indicates the monitoring network required sampling frequency and the constituents that are monitored.

Based on the evaluation of monitoring data, advection and dispersion are the main MNA processes occurring at the CMP Pits. Based on sampling analysis, some degree of biodegradation is occurring in the wetland area near Pen Branch, although it is not seen in much significance upgradient in the CMP Pits area outside the immediate wetland area. The original 2002 groundwater model only accounted for advection and dispersion and estimated the plumes would remain above MCLs for a minimum of 50 years (~2050) and as long as 130 years (~2130) even if

the vadose zone source was completely remediated (WSRC 2002). An updated model conducted in 2017 added sorption and continuing VOC sources in clays and estimated the plumes will remain above MCLs for approximately 100 years (~2117). The increase in minimum time is mostly attributed to sorption but is within the range of timeframes calculated in the original 2002 model (50 – 130 years [calendar year 2050 – 2130]).

2.2.2 Groundwater Sampling Results

Groundwater samples are required to be collected from a total of 67 monitoring wells as listed in Table 1 (65 VOCs, 64 1,4-dioxane, and 19 lindane). Groundwater samples were collected from 71 monitoring wells at the CMP Pits mostly during CY 2Q2021 and 4Q2021. Nine of the 76 monitoring wells are generally only used for water level measurements; however, four of these wells (CMP 56D, CMP 56B, CMP 57D, and CMP 57B) were additionally sampled for VOCs during 2021. All groundwater results from April 2021 through March 2022 are provided in Table 3. Plume maps were drawn based on the maximum concentration from the data collected between April 2021 through March 2022. Details on specific contaminants are described in the following subsections.

2.2.2.1 PCE and TCE

PCE and TCE contamination has been identified in the TZ, MAZ, and LAZ above MCLs. The PCE plumes comprise approximately 43.6 acres (17.7 hectares) (Figures 10 and 11), and the TCE plumes comprise approximately 41.4 acres (16.8 hectares) (Figures 17 and 18). The majority of the horizontal plume movement occurs in the MAZ, which is consistent with modeling estimates. Vertical movement of the plumes are occurring as shown by an overall trend of decreasing concentrations in the MAZ, and an increasing trend in portions of the LAZ (Appendix B and Figures 15, 16, and 32). This is also consistent with modeling, as concentrations in the LAZ are predicted to increase over time. Additionally, samples collected from newer GA well CMP010A detected PCE and TCE above MCLs. Seventy (70) monitoring wells were sampled in 2021 for VOCs. Although not required as shown in Table 1, sampling/analysis for VOCs also included five extra wells (CMP 34D, CMP 56B, CMP 56D, CMP 57B, and CMP 57D). Thirty-two (32) wells had PCE concentrations above the MCL of 5.0 µg/L and 29 wells had TCE concentrations above the MCL of 5.0 µg/L. Most of the monitoring wells (87%) show a declining or steady (including

consistent non-detects) trend in PCE and TCE over the past 11 years as shown in the time-series plots for all the wells in Appendix B, Figure 32, and summarized below.

The following is a summary of the PCE and TCE contaminant trends by aquifer for the April 2021 through March 2022 reporting period.

Transmissive Zone:

The maximum concentrations of PCE and TCE found in the TZ were 2,470 µg/L for PCE (Figure 10) and 1,390 µg/L for TCE (Figure 17) both at monitoring well CMP 35D. There were eight monitoring wells (out of 11 sampled) screened in the TZ that had PCE and/or TCE concentrations above the MCL in 2021. Upgradient wells CMP062D and CMP063D were non-detect for both PCE and TCE.

Wells CMP 10D and CMP 11D have shown consistently high PCE and TCE values; however as shown in Appendix B, the trends for these wells over the past 13 years have generally declined. Concentrations in well CMP 10D and CMP 11D during 2021 were similar to concentrations during 2020. Contamination in these two wells is a result of contaminants being transported by localized radial groundwater flow at the CMP Pits knoll, as described in Section 1.4 and shown in Figure 7, or by contaminants following the slopes of the confining units (Figure 4). Due to the shape of the TCCZ surface and the subsequent dry area that is created in the TZ, contamination may have been funneled towards the south and southeast towards CMP 10D and CMP 11D. Well clusters CMP062 and CMP063 remain below MCLs showing that contamination has not spread substantially to the south/southeast.

Well CMP 35D has generally displayed increasing concentrations over the last 11 years; however, this is as wells CMP 10D and CMP 11D have generally shown decreases in their concentrations. The inversely related trends in wells CMP 10D and CMP 35D (Figure 31), for both VOCs and lindane, suggest it could be tied to hydrogeologic processes associated with the complex radial groundwater flow patterns due to the surface shape of the TCCZ and resulting dry zones in the TZ. Water elevation increases due to less drought-like conditions in recent years possibly provided a mechanism for increased flow towards the northwest in the CMP 10D and CMP 35D area. This may also provide more opportunity for dispersion and diffusion from CMP 10D as there is more

water volume available in the TZ. Additionally, the increased water elevations may allow release of trapped secondary sourced contamination in clay horizons or pore space into the groundwater since well CMP 35D is located downgradient of the CMP Pits. Since CMP 35D is located directly outside of the capped area, the low permeability cap at CMP Pits may retard infiltration and the effect of water elevation increases may be more pronounced. Figure 32 indicates a possible correlation between water elevation and contaminant levels of PCE at well CMP 35D.

Due to the increases observed at well CMP 35D, PCE and TCE have been additionally analyzed at nearby well CMP34D. This well had previously shown high levels of PCE (1,460 µg/L) and TCE (417 µg/L) in 2001 but was not included in the CMP OU EMP with VOC analyses and therefore did not include VOC results since 2009. SRS began sampling well CMP 34D for VOCs starting in 2019 and concentrations were observed at levels of 1,940 µg/L for PCE. The 2021 results decreased to a maximum result of 122 µg/L for PCE and 2.24 µg/L for TCE (Appendix B Pages B-15 and B-65). The elevated results in the TZ for wells CMP34D and CMP 35D may indicate that some amount of contaminant source is present within the vadose zone or pore space above the water table. It is noted that the PCE/TCE ratios are significantly different in the two wells, indicating a complex source composition/history from the disposal disposition as degradation of the source material is minimally occurring in the source area. In 2021, additional data (VOC headspace samples) were collected at multiple soil borings to help determine the extent of potential contamination that may still be present in the vicinity of the CMP Pits (See Appendix C).

The TZ plume geometry is shown in Figure 10 for PCE and in Figure 17 for TCE. The main plume at and around the CMP Pits has remained roughly the same in size with concentrations near the actual pits area continuing to decrease at well CMP 10D but increasing at well CMP 35D as previously discussed. The higher concentrations have remained relatively confined near these two wells which may indicate that the mass of contaminants is likely not extensive. PCE concentrations at well CMP 11D have generally decreased since 2010 whereas TCE concentrations at well CMP 11D have generally remained stable. Concentrations of PCE at CMP 13D exceeded the MCL during 2021 and displays a slight increasing trend. Concentrations at well CMP 30D were non-detect for PCE and TCE.

PCE and TCE concentrations in the distal plume in the wetlands in 2021 remained near 2020 concentrations. These wells are generally more variable in contaminant concentrations likely due to the wetland setting and recent rainfall events. PCE and TCE concentrations at CMP 36D, CMP 37D and CMP 39D were less than or near MCLs during 2Q2021 but increased during 4Q2021. Concentrations at CMP 38D are usually less variable and displays steady concentrations. The distal plume was initially thought to originate from an alternative source from the CMP Pits. Particle track modeling indicated it was potentially from a previously contaminated drainage ditch north of the CMP Pits (WSRC 2002) (located on all planar figures). As previously mentioned, characterization results of this area indicated that if a source was previously present in the vadose zone, it has been depleted (WSRC 2003). Due to the dry zone areas within the TZ, it is plausible that bifurcation of the plume into two separate plumes occurred over time, or that some contaminant flow went around the dry zone to the east. Discharging of the MAZ and LAZ into the Pen Branch stream likely brings some contamination up into the TZ as the water discharges into Pen Branch. The clay horizons between the aquifers can be thin and/or leaky and the TCCZ and TCLC are at or near ground surface at the location of the distal plume. The steep topography south of Pen Branch incises the TCCZ and other clay layers, the sediment around the stream has been reworked over time as the stream meanders, and trees and roots have penetrated the clay layers allowing more interchange between aquifers. All of these factors are probable explanations for the distal plume.

A comparison of changes in PCE plume concentrations over the last 13 years (2021 values compared to 2008 values [Pre ERH/SVE]) can be seen in Figure 15 and Table 4. In the TZ, most plume concentrations have decreased or are steady. However, the area directly north of the CMP Pits, including monitoring wells CMP 35D and CMP 13D has increased in PCE concentrations. Concentrations to the south of the CMP Pits at wells CMP 10D and CMP 11D have both decreased more than 90% from their peak levels and show a large reduction in total mass for the TZ. Concentrations to the west at CMP 30D remains non-detect. Concentrations at CMP 35D and CMP 34D will continue to be monitored. The distal plume has decreased in both size and core concentrations indicating that the total mass being transported downgradient is decreasing. TCE trends are similar to PCE and are therefore not mapped.

Middle Aquifer Zone

The maximum concentrations found in the MAZ were 637 $\mu\text{g/L}$ for PCE at well CMP 47D (Figure 10), and 137 $\mu\text{g/L}$ for TCE at well CMP 52C (Figure 17), located north of CMP Pits. The concentration of PCE detected at CMP 47D was similar to 2020 concentrations during 2Q2021, but decreased during 4Q2021. Concentrations of TCE detected at CMP 52C in 2021 were similar to monitoring results reported since 2014.

There are 13 monitoring wells (out of 23 sampled) screened in the MAZ that had PCE concentrations above the MCL in 2021, and 12 monitoring wells had TCE exceedances above the MCL. The majority of the MAZ wells display a steady or decreasing trend in concentrations (Figure 32). Well CMB 24I displays a slight increasing trend; however, the overall plume footprint has not increased. Downgradient locations towards Pen Branch (CMP 40D, CMP 41D, and CMP 43D) were all near to or below MCLs or either non-detect for both PCE and TCE. The remaining MAZ wells show decreasing or no significant change in PCE concentrations. Similar trends were observed for TCE in these wells.

PCE and TCE concentrations rapidly decrease once the plume reaches the wetland area near Pen Branch where VOC degradation is occurring.

A comparison of changes in PCE plume concentrations over the last 13 years (2021 values compared to 2008 values [Pre ERH/SVE]) can be seen in Figure 15 and Table 4. In the MAZ, core plume concentrations have decreased by approximately 35% and the area of higher concentration (250+ $\mu\text{g/L}$) has also decreased in size. The plume footprint appears to have expanded horizontally, but this is likely due to the new monitoring well data points collected starting in 2016 which further defined the plume to the east. Additionally, samples have more recently been able to be collected from well CMP 31C to the west, further defining the plume in that direction. Concentrations near Pen Branch in the wetland area at wells CMP 40D and CMP 39D have decreased, indicating that the flux of VOCs from the source area is decreasing and that VOC degradation in the wetland area is attenuating the plume. TCE trends are similar to PCE and are therefore not mapped.

Lower Aquifer Zone

There are ten (10) monitoring wells (out of 29 sampled) screened in the LAZ that had PCE concentrations above the MCL in 2021. These ten (10) wells also corresponded to the locations in the LAZ having TCE concentrations above the MCL. The LAZ maximum values for PCE decreased from 2020 concentrations and TCE maximum concentrations slightly increased. The 2021 maximum concentrations of PCE and TCE within the LAZ were 285 µg/L at well CMP 32C for PCE and 187 µg/L at well CMP 52BU for TCE (Figure 11). Concentrations downgradient at well CMP064BU decreased from 2020 concentrations. The higher concentrations observed in the LAZ are at wells located in the upper LAZ, directly below the TCLC where contaminants are likely migrating from the MAZ and/or diffusing from the clays above. Concentrations at CMP 32C and CMP 52C appear to have stabilized over the last five years. Concentrations of PCE and TCE at CMP 10C display slight decreasing trends.

Concentrations at four wells (CMP 8B, CMP 10B, CMP 13B, and CMP058B) generally display increasing trends over the last 13 years (Appendix B and Figure 32). However, PCE and TCE concentrations in mid-LAZ plume wells CMP 10B and CMP 13B remained near 2020 concentrations. These four wells are located in the upper or middle portion of the LAZ. Contamination in the LAZ is limited to the upper half portion of the aquifer as seen in the three cross sections, A – A', B – B', and C-C' (Figures 12, 13, and 14). PCE and TCE concentrations in mid-LAZ plume wells CMP 10B and CMP 13B remained near 2020 concentrations. Other wells vertically located mid-plume and deeper remain steady, below MCLs, or non-detect. New monitoring well CMP035B, vertically located in the upper LAZ, had a maximum PCE concentration of 16.6 µg/L and TCE concentration of 21.1 µg/L. These concentrations are consistent with other plume concentrations and fit with the known plume geometry as can be seen in the plume maps (Figures 11 and 18) and cross section A-A' (Figure 12).

Upgradient wells CMP062B and CMP063B were non-detect for PCE and TCE during 2021. Downgradient wells CMP060B, CMP061B, and CMP 8B remain non-detect or below MCLs for PCE and TCE. During 2Q2021 and 4Q2021 PCE and TCE were not detected at both wells which are located north of Pen Branch, CMP066B and CMP067B (Figures 11 and 12).

Similar to the location of the northeast distal plume in the TZ and MAZ aquifers, VOC contaminants are present in the LAZ. Some upward vertical water elevation heads are present in the LAZ closer to Pen Branch (i.e., CMP064BU and CMP064B) which supports that the LAZ is discharging into Pen Branch (Figure 8). Contaminants are from upgradient clay layers and aquifers.

A comparison of changes in PCE plume concentrations over the last 13 years (2021 values compared to 2008 values [Pre ERH/SVE]) can be seen in Figure 16 and Table 4. LAZ plume concentrations have generally increased in the upper half of the aquifer. Increases in the LAZ are expected, as both the previous modeling effort and the more recent 2017 modeling effort predicted increases in the LAZ over time. The area southeast of CMP Pits in the upper LAZ (well CMP 10C) is currently on a decreasing trend over the previous 10 years, suggesting the majority of source contaminants have been remediated; although recent steady trends in PCE may be due to the increased PCE contamination north of CMP Pits in the TZ at wells CMP 35D and CMP 34D. Concentrations on the western edge of the plume (well CMP 33D) have also decreased. The downgradient wells (CMP060B, CMP061B, and CMP 8B) remain below MCLs. The LAZ plume is most likely reaching Pen Branch and the wetland area east and downgradient of CMP 8B, which also correlates to the TZ and MAZ contaminants near Pen Branch. TCE trends are similar to PCE and are therefore not mapped.

Gordon Aquifer

There are seven monitoring wells screened within the GA and all were sampled during 2021. This includes new GA well CMP011A. CMP010A was the only GA monitoring well with PCE and TCE concentrations above MCLs, with concentrations of 106 µg/L for PCE and 43.9 µg/L for TCE. These concentrations have significantly decreased from 2020 concentrations. It is not fully understood how the GA at the CMP010A location became contaminated. It is possible that contamination was brought down from upper layers during drilling of the well. Based on the vertical contaminant profile as seen in cross section A-A' (Figure 12), transfer of contamination vertically was not expected as sampling data in the lower portion of the LAZ has shown no contamination at CMP Pits. Some of the mid LAZ screened wells have displayed PCE and TCE contamination slowly increasing above MCLs; however, this has only occurred within the last

eight years and contaminant levels are not high, including well CMP 10B which is screened vertically in the middle portion of the LAZ. It is plausible that some contamination has migrated along a path vertically from the CMP Pits area to the GCCZ/GA. Appendix C, *Additional Sampling Efforts* describes how SRS conducted additional soil sampling to help identify if there is contamination migrating to the GA in the area of CMP010A. Soil boring CMP-BR-06 was located between CMP Pits and the CMP 10 cluster (Figure 34). Multiple VOC headspace samples were collected to help identify the vertical contaminant that may be feeding the CMP010A GA well. Contamination was only observed in the upper TCCZ and TCLC zones, with none in the LAZ, GCCZ, or GA. This suggests the source may be from drilling activities or caused by other well/boring activities in the past. Although concentration trends are decreasing at CMP010A, SRS plans to redevelop well CMP010A in 4Q2022/1Q2023 to help rule out issues caused by its drilling activities. See Appendix C for more details on the additional sampling efforts.

PCE and TCE were detected at estimated low levels (<1 µg/L) at GA well CMP 12A, which is a normal occurrence. All other GA monitoring wells were non-detect for PCE and TCE.

As stated above, the contamination generally remains in the UTRA and extends down to the upper portion of the LAZ. The GA screened wells are in place to confirm contamination has not migrated farther downward than expected as described in the EMP (WSRC 2006b). Modeling did not predict contamination to reach the GA at levels above MCLs (WSRC 2002, SRNS 2017). In general, low levels of PCE and TCE below MCLs have been seen in the past in monitoring well CMP 12A and rarely at CMP 8A. The recent data collected at new monitoring well CMP010A is the first occurrence of MCL exceedances in the GA. CMP010A will remain on a semi-annual sampling frequency.

2.2.2.2 Cis-1,2-Dichloroethylene (c-1,2-DCE)

C-1,2-DCE was detected in six wells in 2021. Concentrations were all low values, with a maximum of 2.7 µg/L at well CMP 39D, far below the 70 µg/L MCL. All of the wells with c-1,2-DCE are located in the wetland area near Pen Branch, suggesting degradation of PCE and TCE is occurring in the Pen Branch wetlands. The preferential degradation pathway for TCE is

c-1,2-DCE as both trans-1,2-dichloroethylene (t-1,2-DCE) and 1,1-DCE both of which are non-detect as discussed below.

The lack of high detectable results in other monitoring wells confirms that VOC degradation is not widely occurring throughout the aquifers and plume and that advection and dispersion are the main MNA processes occurring. VOC degradation is mainly occurring in the wetland areas near Pen Branch.

2.2.2.3 Trans-1,2-Dichloroethylene (t-1,2-DCE)

All t-1,2-DCE results were non-detect for 2021.

2.2.2.4 1,1-Dichloroethylene (1,1-DCE)

All 1,1-DCE results were non-detect for 2021.

2.2.2.5 Vinyl Chloride (VC)

All VC results were non-detect for 2021.

2.2.2.6 1,4-Dioxane

1,4-Dioxane is analyzed annually at CMP Pits at 64 monitoring wells. During 2021, wells CMP063B, CMP063C, and CMP063D were not sampled for 1,4-dioxane due to an oversight. Well CMP 34D was additionally analyzed for 1,4-dioxane making a total of 62 wells monitored for 1,4-dioxane. There is currently no MCL for 1,4-dioxane, but the current USEPA tap water regional screening level (RSL) is 0.46 µg/L, therefore the USEPA tap water RSL is used for contouring plume maps (Figures 19 and 20) and cross-sections (Figures 21, 22, and 23). During the 2021 monitoring period, 1,4-dioxane was analyzed with two analytical methods, EPA 8260BSIM and EPA 522. As in past years, the EPA 8260BSIM method detection limit and sample quantitation limits could not meet the current USEPA RSL of 0.46 µg/L. However, the EPA 522 method limits are below the USEPA tap water RSL. Annual samples were collected for 1,4-dioxane and analyzed using both methods and are compared in Table 3.

Due to the lower detection limits using the EPA 522 method, there were more detections of 1,4-dioxane than with the EPA 8260BSIM method. Detections of 1,4-dioxane occurred in 31 of

the 62 wells sampled (50%) using the EPA 522 method compared to 18 wells (29%) using the EPA 8260BSIM method. Overall, there was close agreement in the results between the two methods with the EPA 8260BSIM results usually slightly higher.

The 1,4-dioxane plume mimics the distribution of the PCE and TCE plumes in all aquifers as detections and exceedances of the USEPA tap water RSL occurred in the TZ, MAZ (Figure 19), LAZ and GA (Figure 20). The maximum concentration was 101 µg/L at well CMP 35D. It was not detected in any wells north of Pen Branch. As seen in Appendix B, which plots the maximum 1,4-dioxane results for each sampling event, concentrations in wells that have had detections within the last six years have remained steady or generally decreased. However, well CMP 35D has shown an increase in 1,4-dioxane (Appendix B, page B-115) similar to other contaminant trends for this well.

There is no South Carolina certified lab that has detection limits for 1,4-dioxane that can meet the current USEPA RSL. SRS will continue to look for and work with the labs to try to achieve the lowest possible detection limits. SRS will continue to utilize the EPA 522 method that can meet the USEPA tap water RSL, in addition to the current South Carolina Department of Health and Environmental Control (SCDHEC) approved method. If a lab/method has South Carolina accreditation and can meet the USEPA tap water RSL, then that would be the preferable analysis method used.

2.2.2.7 Carbon Tetrachloride (CCl₄)

CCl₄ was detected in 18 wells during April 2021 through March 2022, but only exceeded the MCL of 5.0 µg/L in five wells: CMP 10D, CMP 10C, CMP 35D, CMB 24I, and CMB 15I with a maximum concentration of 27.3 µg/L at well CMP 35D. Plume maps were not created due to the limited number of exceedances.

2.2.2.8 Chloroform

Chloroform was detected in 22 wells during sampling between April 2021 through March 2022. None of the results exceeded the MCL of 80 µg/L. The maximum result was at well CMP 35D

with a value of 50.5 µg/L. The highest concentrations coincide with wells that have CCl₄ contamination as chloroform is a degradation product of CCl₄.

2.2.2.9 Dichloromethane (DCM)

During April 2021 through March 2022, all DCM results were non-detect or low estimated “J” values below the 5 µg/L MCL.

2.2.2.10 Bromodichloromethane

During April 2021 through March 2022, there were no detections of bromodichloromethane in any well.

2.2.2.11 1,1,2-Trichloroethane (1,1,2-TCA)

During April 2021 through March 2022, 1,1,2-TCA was not detected in any well.

2.2.2.12 Lindane

Twenty-three (23) wells were analyzed for lindane in 2021 and early 2022. The MCL for lindane is 0.2 µg/L and two wells (CMP 10C and CMP 35D) had lindane concentrations that exceeded this level (Figures 24 and 25). Cross-sections with lindane plumes and concentrations are provided in Figures 26 through 28. Most wells monitored for lindane in 2021 and 2022 show slightly decreasing or steady trends in concentrations as shown in Appendix B and Figures 29, 30 and 32.

The highest lindane concentration for 2021 was 5.14 µg/L found in CMP 35D. This well has shown fluctuations in concentrations over the years, but it has displayed an increase since 2013 through 2020; however, concentrations in 2021 have decreased (Appendix B, page B-158). Factors contributing to the increase in concentration include the complex hydrogeology of groundwater flow paths, surface shape of the TCCZ (Section 1.3 and Figure 4), perched water table conditions, and water elevation increases (Section 1.4, Figure 7, and Figure 9). Increases at CMP 35D have occurred as concentrations at well CMP 10D have decreased. The inversely related trends in wells CMP 10D and CMP 35D for both lindane and VOCs (Figure 31), suggest the increases could be tied to hydrogeologic processes associated with the radial groundwater flow patterns due to surface shape of the TCCZ and dry zones in the TZ. Higher water table elevations

have possibly provided a mechanism to release contamination trapped in the vadose zone pore space or capillary fringe, as well as for groundwater to flow towards the northwest providing more opportunity for dispersion and diffusion from CMP 10D and the CMP Pits. The low permeability cap retards infiltration so the effect of water table elevation increases may be more pronounced since CMP 35D is located directly outside the cap area. Figure 31 indicates a possible correlation between water elevation and contaminant levels of lindane at CMP 35D.

CMP 10C, in the Upper LAZ, shows concentrations have generally been decreasing over the past eight years. Well CMP 10B, which is screened at the bottom of the LAZ (Figure 26), remains non-detect. Due to the shape of the TCCZ surface and the subsequent dry area that is created in the TZ (Figure 4), contamination may have been funneled towards the south and southeast towards CMP 10D from the high concentration area around CMP 35D and the CMP Pits. Fluctuating water elevations could move groundwater back and forth between CMP 10D and CMP 35D or potentially release contaminants into the water table that were trapped in pore space or clay zones.

The lindane plume is estimated at approximately 2.7 acres (1.1 hectares) in the UTRA (Figures 24 and 25) which has decreased from 2020. During 2021 the area of groundwater contaminated with lindane above the MCL was confined to the CMP Pits area only, as downgradient well CMP064BU (previously above MCLs) remained below the MCL. The majority of the plume (including the highest concentrations) resides in the TZ. The MAZ concentrations showed no increase in 2021 which caused no plume to be within the MAZ, and overall concentrations appear to be stable to decreasing (Figure 24). In the LAZ, Lindane was detected above the MCL only at one well: CMP 10C (Upper LAZ) at a concentration of 0.411 µg/L in 4Q202, which is above the 0.2 µg/L MCL. Lindane was not detected in the underlying lower LAZ well CMP 10B. Concentrations at newer GA well CMP010A have dropped below the 0.2 µg/L MCL with a concentration of 0.162 µg/L in 4Q2021. As described in detail above, this vertical contaminant trend at the CMP 10 cluster is similar to the VOC concentrations and this well is planned to be redeveloped to help determine the possible concentration reasons seen at this well. Lindane will continue to be analyzed at GA well CMP010A on a semi-annual frequency.

A comparison of lindane plume concentrations over the last 13 years (2021 values compared to 2008 values) can be seen in Figures 29 and 30 and Table 5. In the TZ, lindane concentrations

above the MCL are currently limited to wells CMP 10D and CMP 35D. The actual TZ plume may appear larger than actual conditions on the maps due to the contour line size and scale of the maps. In the MAZ, the area to the north and northwest of the CMP Pits has experienced minor fluctuations in concentration over the past 13 years, but concentrations continue a downward trend and there was no plume above the MCL in 2021. Beginning in 2008, the LAZ experienced an initial increase in concentrations southeast of the CMP Pits at well CMP 10C; however, lindane concentrations at this location have decreased since 2015. The increase first seen at CMP 10C in 2008 is believed to be due to the shape of the surface of the Tan Clay, localized radial groundwater flow around the CMP Pits knoll, and leaky conditions within the TCCZ and TCLC. Contamination does not extend deeper than the upper portion of LAZ within the UTRA (Figures 26 and 28). The lindane plumes have minimally increased in previous years, if at all, in extent in the TZ and LAZ. Although lindane does not diffuse in aquifers as quickly as VOCs, the factors mentioned above may be further hindering contaminant advection and dispersion.

2.2.3 Surface Water Sampling Results

Surface water in Pen Branch is sampled semi-annually at eight locations along the groundwater discharge boundary (Figure 5). Two of these stations are collected in a tributary leading to Pen Branch (CMP-SW-20 and CMP-SW-21).

VOCs are analyzed semi-annually and 1,4-dioxane is analyzed annually during the fourth quarter. Table 3 and Figures 10, 11, 17, and 18 show the PCE/TCE results at each station. Modeling results predicted VOC discharge to Pen Branch above MCLs. In 2021, there was one detection of VOCs (PCE) in surface water at station CMP-SW-22 at an estimated value of 0.4 µg/L. All other surface water results were non-detect for all VOCs.

1,4-Dioxane was analyzed with both the EPA 8260BSIM method and the EPA 522 method, as discussed above in Section 2.2.2.6, *1,4-Dioxane*. 1,4-Dioxane was detected at one surface station, CMP-SW-08, with the EPA 522 method at an estimated concentration of 0.104 µg/L, which is below the USEPA tap water RSL of 0.46 µg/L. All other 1,4-dioxane surface water results were non-detect.

The CMP Pits VOC and 1,4-dioxane groundwater plume effects on Pen Branch are negligible as they are generally not detected in surface water. Dispersion, advection, and wetland area VOC degradation are all contributing factors that reduce the groundwater plume impact to Pen Branch.

2.2.4 Additional Data from Independent Analysis

Sampling for VOCs has been conducted in and around Pen Branch by a South Carolina State University (SCSU) group for several years under a grant provided by the United States Department of Energy (USDOE). The focus of their studies is the MNA processes occurring in the stream and wetlands around Pen Branch as the VOC plume moves towards and discharges into Pen Branch. Many of the SCSU samples are collected from the groundwater immediately before discharge into Pen Branch and surface water within Pen Branch. The 2021 efforts were focused on the location where more VOC discharge (upstream of SRS surface water station CMP-SW-22) was observed.

During 2021, SCSU sampled six (6) groundwater stations below the Pen Branch stream. This included 21 groundwater samples within the hyporheic sediments below the stream bed within Pen Branch. Groundwater samples were collected from temporary wells up to 80 centimeters (31.5 inches) below the stream bottom. Samples were collected by pumping and/or the use of passive diffusion bags that were installed for at least two weeks prior to sample collection. Surface water samples were collected by grab method (scooping water out of the stream with another bottle).

Groundwater results indicated that the VOC plume is discharging and mixing within the hyporheic zone upgradient of the SRS CMP-SW-22 surface water station. The maximum groundwater concentration results are as follows: PCE - 94.2 µg/L at SCSU station 5D1BA; TCE - 32.3 at 5D1BA; c-1,2-DCE - 54.0 at 5DB80A; and VC - 47.3 at 5DZ3A. 1,1-DCE and T-1,2-DCE were not detected (Table 6). There were no detections of VOCs in any of the SCSU surface water samples. Additionally, SCSU also sampled three (3) stations (5D1B, 5DZ3, and 5DZ3A) for degradation product ethylene. Ethylene was not detected, but the laboratory was unable to meet detection levels below 10 µg/L. Figure 33 displays the SCSU sample locations and the maximum PCE concentrations in their groundwater stations.

Additionally, SCSU expanded its efforts in 2021 through collaboration with Pacific Northwest National Laboratory (PNNL) with microbial analysis associated with VOC degradation on

sediments collected during their temporary groundwater well installations. In 2021, SCSU sediment samples processed by PNNL identified several bacterial genera in Pen Branch plume fringe sediments associated with dehalogenation of chlorinated organic compounds like PCE. This included genera *Dehalogenimonas* from the bacterial family *Dehalococcoidaceae* and *Dehalobacter* in family *Peptococcaceae*. *Dehalogenimonas* was present in higher concentrations. *Dehalogenimonas* has been shown to reductively dechlorinate PCE to TCE and TCE to cis-DCE anaerobically. Results showed potential matchups with carbon-13 enrichment and higher abundance of *Dehalogenimonas* which indicate PCE degradation that seen in in hyporheic sediments around Pen Branch Stations 5DZ3 and 5DZ3A. Further microbial studies will be done in 2022.

Further results on the SCSU microbial studies and future groundwater and/or surface water sampling data will be provided in subsequent CMP Pits EMRs.

3.0 ADDITIONAL SAMPLING EFFORTS

Due to increasing contaminant trends in source area wells (i.e., CMP 35D and CMP 34D) and the recent discovery of potential GA contamination at well CMP010A, SRS conducted an additional sampling effort to further characterize the current VOC soil concentrations within the vadose zone and aquifers. This included soil headspace sampling at four boring locations around the CMP Pits source area (CMP-BR-05 through -08) and at two well installations (CMP035B and CMP011A) (Figure 34). One LAZ well was installed at the CMP 35D location (CMP035B) and one GA well was installed at the CMP 11 well cluster (CMP011A). These borings and monitoring wells have aided in determining if there is residual contamination left in the vadose zone that is causing the increasing concentrations in some source area wells and have also helped to investigate contaminant sources for the CMP010A well. It is currently speculated that the GA contamination at CMP010A is temporary and resulted from drilling activities at the well and is not representative of actual GA groundwater conditions. The vertical contaminant trends at the well cluster are not supportive of vertical migration and also concentration trends at the CMP010A are decreasing. The results of the details and discussion on the additional sampling efforts for 2021 are discussed in Appendix C, *Additional Sampling Efforts*.

Cation/anion analysis was also performed during 2021 at ten (10) wells (well clusters CMP 10 and CMP052 and individual wells CMP44D and CMP35D). Descriptions and analysis are presented in Appendix C, *Additional Sampling Efforts*.

4.0 SUMMARY

A simple graphical CSM (Figure 3) has been presented to aid in the understanding of potential sources of contamination and the subsequent groundwater transport pathways. Surface maps of the Tan Clay (both the TCCZ and the TCLC) have been presented to aid in the understanding of radial groundwater flow at CMP Pits and probable contaminant transport mechanisms (Figure 4). With decreased rainfall in 2021, water elevations generally decreased slightly during 4Q2021 and/or remained similar to 2020 levels. The areas estimated to be dry in the TZ and MAZ have slightly increased in size from last year. Perched water tables most likely exist in parts of the TZ and MAZ. The shape of the tan clay layer and the level of the water table restrict groundwater flow movement in the TZ and MAZ and cause complex localized groundwater flow paths. This can explain some increasing contaminant trends, as contaminants may have become re-suspended with limited lateral movement.

Advection and dispersion are the main MNA processes occurring at CMP Pits, with some anaerobic biodegradation occurring in the hyporheic zone and within the wetlands around Pen Branch. The majority of groundwater and surface water results are consistent with modeling predictions (WSRC 2002, SRNS 2017), and the effectiveness monitoring data collected through March 2022 indicates that the MNA remedy is working as predicted as the majority of wells (87 %) display steady or decreasing trends or remain non-detect. However, steady increases in PCE, TCE, and/or lindane in well CMP 35D directly north of the CMP Pits have been observed since 2012. Elevated PCE was also detected in well CMP 34D in recent years; however, 2021 concentrations have significantly decreased. This contamination appears to be related to water elevation rise and recent rainfall infiltration releasing residual contamination trapped in the vadose zone. Due to concerns about increasing contaminant trends in the source area and contamination detected in GA well CMP010A, an additional soil characterization effort was conducted in 2021 to determine if residual contamination is present within the vadose zone at CMP Pits that is negatively impacting groundwater and to provide current vertical and horizontal contaminant trend

data. Two additional monitoring wells were installed (CMP035B in the LAZ and CMP011A in the GA) to provide additional groundwater data and improve understanding of contamination profiles in the aquifers. Groundwater results from the new monitoring wells were consistent with the current knowledge of the contaminant and plumes geometry. Results from the VOC headspace sampling show that there is some residual contamination in the vadose zone associated with low permeability zones, especially at the CMP 35 well cluster, and also associated with the TCCZ and TCLC as VOCs will associate and adhere with clay zones. See Appendix C for more detailed analysis and description of the additional VOC headspace sampling results.

Wells located in the distal plume area towards the northeast show a possible preferential pathway for groundwater as relatively high levels of VOCs exist to the northeast. Dry zones may be slightly redirecting groundwater flow which may explain elevated concentrations to the northeast.

The two wells north of Pen Branch, CMP066B and CMP067B, were sampled semi-annually in 2Q2021 and 4Q2021 due to a detection of PCE and TCE below MCLs at well CMP067B in 2019. These detections were not believed to be representative of groundwater conditions, as underflow beneath Pen Branch from a CMP Pit source is highly unlikely. Sampling during 2020 and 2021 did not detect VOCs or 1,4-dioxane.

1,4-Dioxane was analyzed at a majority of the CMP Pits wells and at surface water stations in 2021 using two analytical methods, EPA 8260BSIM and EPA 522. As in past years, the EPA 8260BSIM method detection limit and sample quantitation limits could not meet the current USEPA RSL. However, the EPA 522 method limits are both below the USEPA tap water RSL. Due to the lower detection limits using the EPA 522 method, there were more detections of 1,4-dioxane than with the EPA 8260BSIM method. Detections of 1,4-dioxane occurred in 30 of the 61 wells sampled (49%) using the EPA 522 method compared to 15 wells (25%) using the EPA 8260BSIM method. Overall, there was close agreement in the results between the two methods. The 1,4-dioxane plume mimics the distribution of the PCE and TCE plumes in all aquifers. The maximum 1,4-dioxane concentration was 80 µg/L at TZ well CMP 35D. 1,4-Dioxane was detected at one surface station, CMP-SW-08, with the EPA 522 method at an estimated concentration of 0.104 µg/L, which is below the USEPA tap water RSL of 0.46 µg/L. All other 1,4-dioxane surface water results were non-detect. Due to its presence in groundwater,

1,4-dioxane is monitored annually and SRS will continue to monitor with both the EPA 522 and the EPA 8260BSIM method until a lab/method has SC accreditation and can meet the USEPA tap water RSL.

Screening level data that was collected in 2021 by SCSU demonstrate that the VOCs are present in shallow (<2.5 ft) groundwater beneath Pen Branch in discrete areas, mainly upgradient of SRS surface water station CMP-SW-22. Their data also shows that VOC degradation is occurring as higher concentrations of cis-1,2-DCE and VC are present near Pen Branch, but SRS surface water results are non-detect or at levels far below MCLs. SCSU expanded/shifted their sampling in 2021 to include additional sediment samples from the borings of the temporary monitoring well stations underneath the Pen Branch stream bed and were collected for microbial analysis in partner with PNNL. Microbial results indicate that bacteria *Dehalogenimonas* are contributing to the MNA degradation of PCE/TCE to cis-1,2-DCE and VC. Specific analysis of degradation product ethylene did not show any detections; however, the laboratory analyses were unable to meet detection limits below 10 µg/L. Further sampling and results on the SCSU microbial studies and future sampling data of groundwater/surface water through SCSU will be provided in subsequent CMP Pits EMRs.

Lindane only exceeded the 0.2 µg/L in two wells (CMP 35D – TZ and CMP 10C – LAZ) with a maximum concentration of 5.14 µg/L at CMP 35D. All other wells were below the MCL or non-detect. Lindane concentrations remain below MCLs in the MAZ.

The most important indicator that the MNA remedy is performing as predicted is an evaluation of the long-term concentration trends of many monitoring wells and an interpolation of the data showing decrease in plume size over time. Although the overall plume size has minimally changed since the completion of the source zone RA 13 years ago, many core concentrations (higher concentration areas of the plume) continue to decline, and surface water continues to be only minimally impacted as concentrations are generally non-detect. VOC biodegradation in the wetlands around Pen Branch is likely reducing the flux of VOCs into Pen Branch.

5.0 REFERENCES

Adrian A. Schieflera,b,* , Dominique J. Toblerb, Niels D. Overheua, Nina Tuxena. 2018. *Extent of natural attenuation of chlorinated ethenes at a contaminated site in Denmark. Energy Procedia* 146: 188–193

SRNS, 2008. *Post-Construction Report (PCR) for the Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G and 080-190G) (U)*, WSRC-RP-2007-4070, Rev. 1.1, April, Savannah River Nuclear Solutions LLC, Savannah River Site, Aiken, SC

SRNS, 2009. *Effectiveness Monitoring Report for the Electrical Resistance Heating (ERH)/Soil Vapor Extraction (SVE) System and Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU) (U) March 2008 through March 2009*, SRNS-RP-2009-00573, Rev. 0, June, Savannah River Nuclear Solutions LLC, Aiken, SC

SRNS, 2010. *Effectiveness Monitoring Report for the Electrical Resistance Heating (ERH)/Soil Vapor Extraction (SVE) and Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU) (U) March 2009 through March 2010*, SRNS-RP-2010-00896, Savannah River Site, Rev. 0, June, Savannah River Nuclear Solutions LLC, Aiken, SC

SRNS, 2017. *Groundwater Flow and Solute Transport Model of the CMP Pits OU (U)*, SRNS-TR-2017-00312, Savannah River Site, Rev. 0, December, Savannah River Nuclear Solutions LLC, Aiken, SC

WSRC, 1999. *Interim Record of Decision Remedial Alternative Selection for the Chemicals, Metals, and Pesticides Pits (U)*. WSRC-RP-98-4192, Rev. 1, August, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2002. *Groundwater Modeling for the Chemicals, Metals, and Pesticides (CMP) Pits (U)*. WSRC-RP-2002-4195, October, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2003. *RCRA Facility Investigation/Remedial Investigation Addendum with Baseline Risk Assessment for the CMP Pits (U)*, WSRC-RP-2002-4049, Rev. 1.1, August, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004. *Record of Decision/Remedial Alternative Selection for the Chemicals, Metals, and Pesticides Pits Operable Unit (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G and 080-190G) (U)*, WSRC-RP-2004-4090, Rev. 1, December, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2006a. *Interim Post-Construction Report (IPCR) for the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit – Ballast Area (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G and 080-190G) (U)*, WSRC-RP-2005-4065, Rev. 1, January, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2006b. *Effectiveness Monitoring Plan for the Electrical Resistance Heating (ERH)/Soil Vapor Extraction (SVE) System and Monitored Natural Attenuation at the Chemicals, Metals, and Pesticides Pits Operable Unit (U)*, WSRC-RP-2005-4077, Rev. 1, February, Washington Savannah River Company, Savannah River Site, Aiken, SC

This page is intentionally left blank.

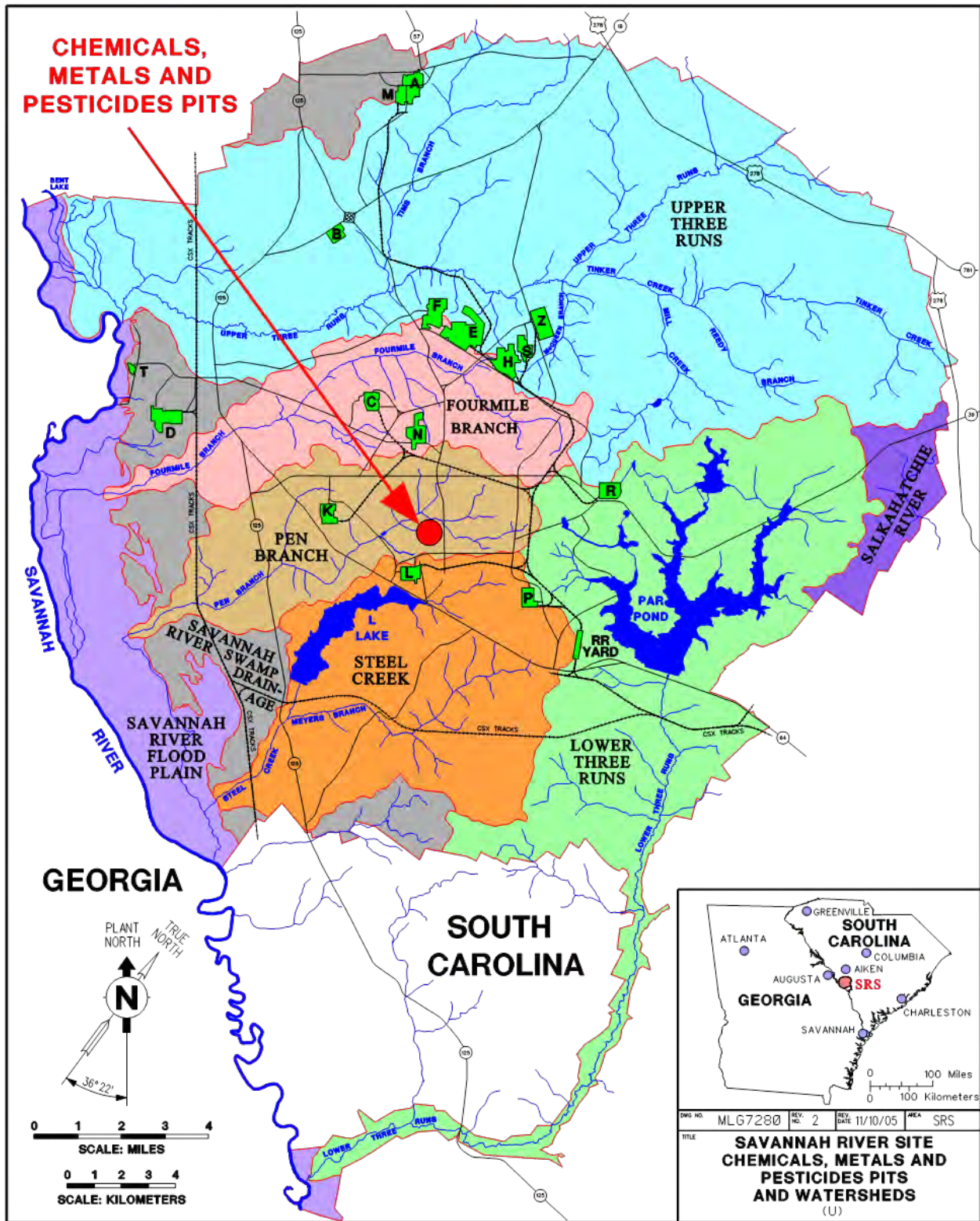


Figure 1. Location of the CMP Pits OU within the Savannah River Site

This page is intentionally left blank.

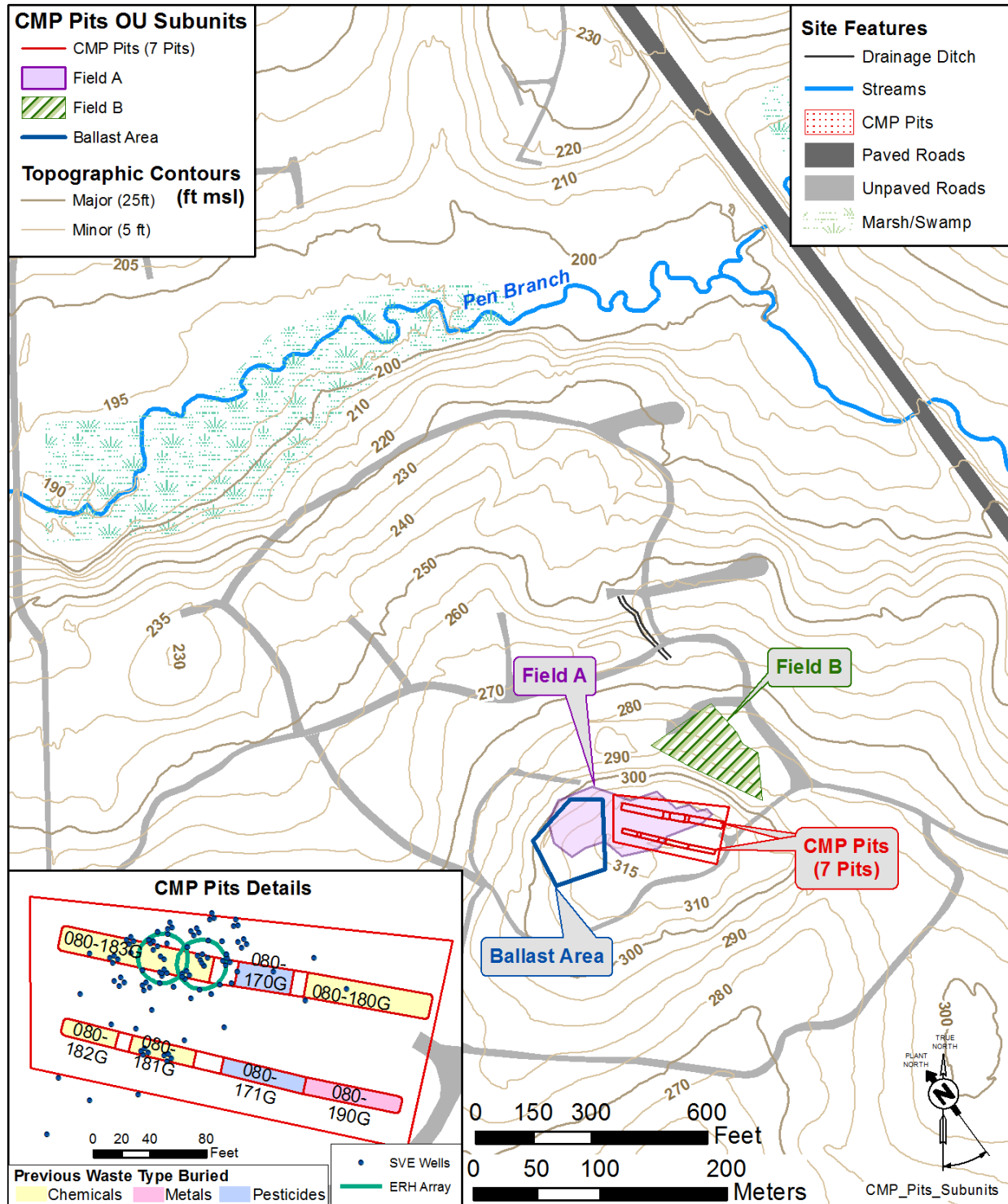
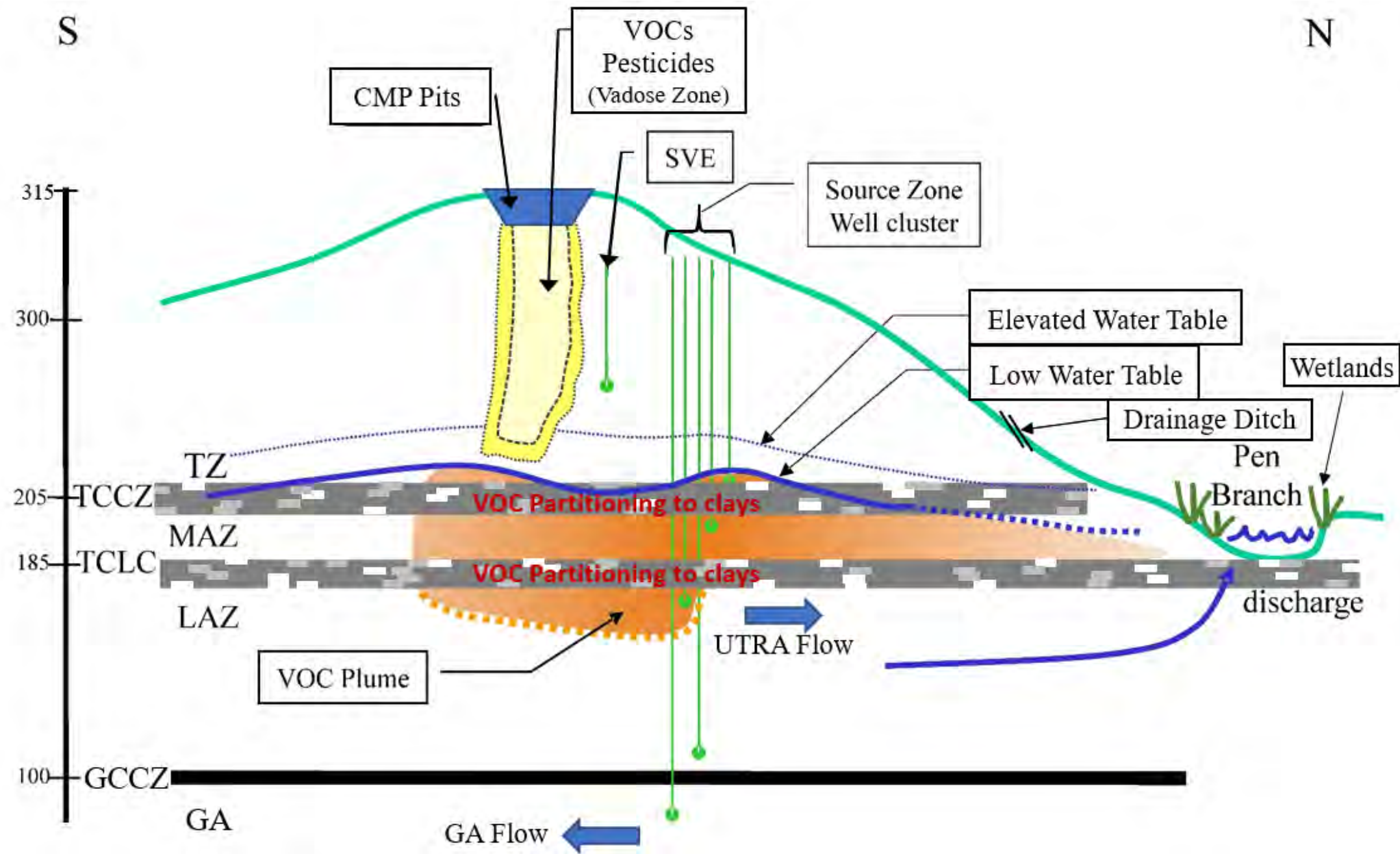


Figure 2. CMP Pits OU Subunits

This page is intentionally left blank.



note: The TCCZ, TCLC, and GCCZ may not be competent clay units and may be hummocky, discontinuous, and/or leaky in some areas.

Figure 3. CMP Pits Groundwater OU Conceptual Site Model (CSM)

This page is intentionally left blank.

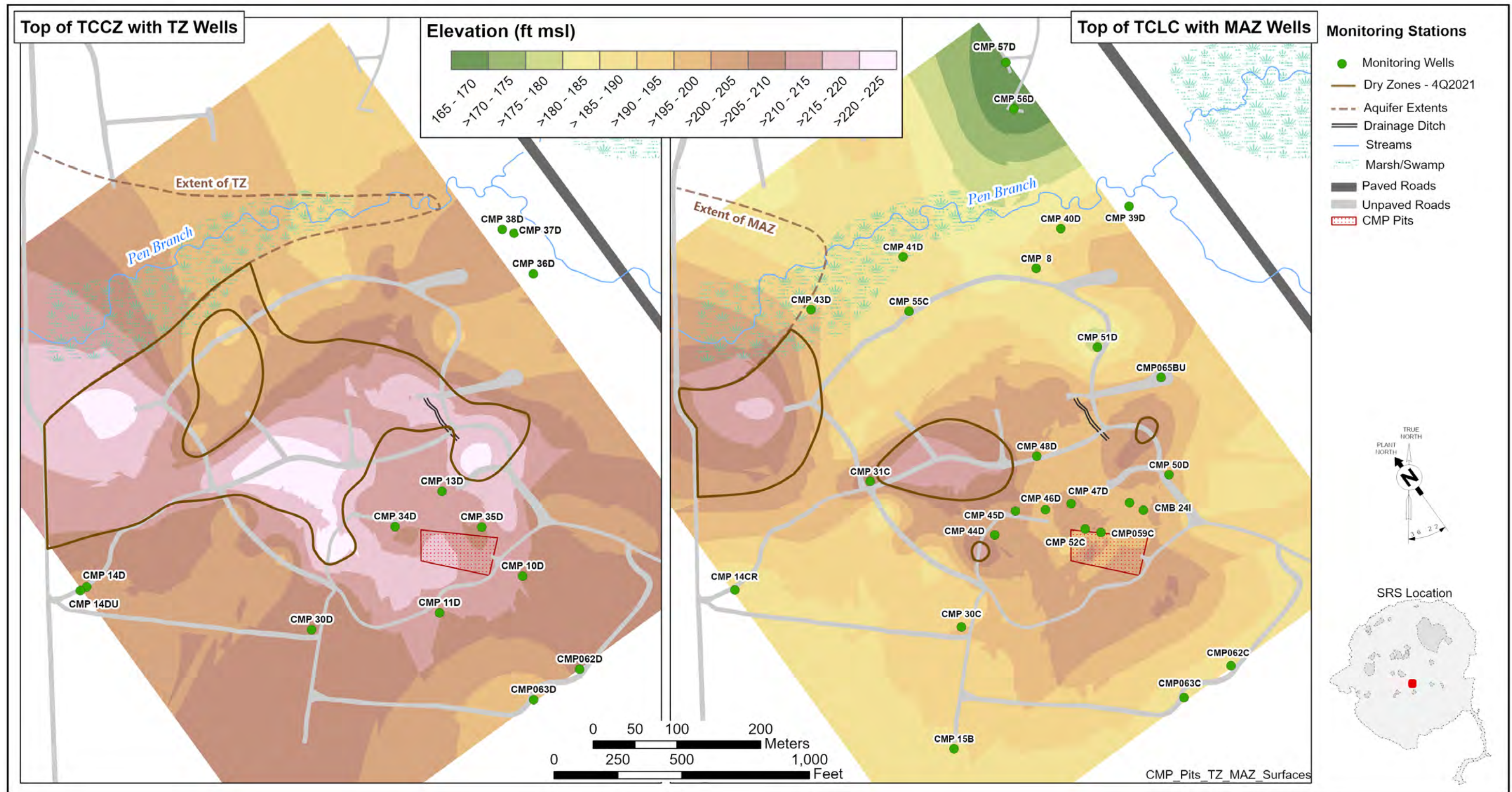


Figure 4. Stratigraphic Surfaces of the TCCZ and TCLC with 4Q2021 Dry Zones of the TZ and MAZ

This page is intentionally left blank.

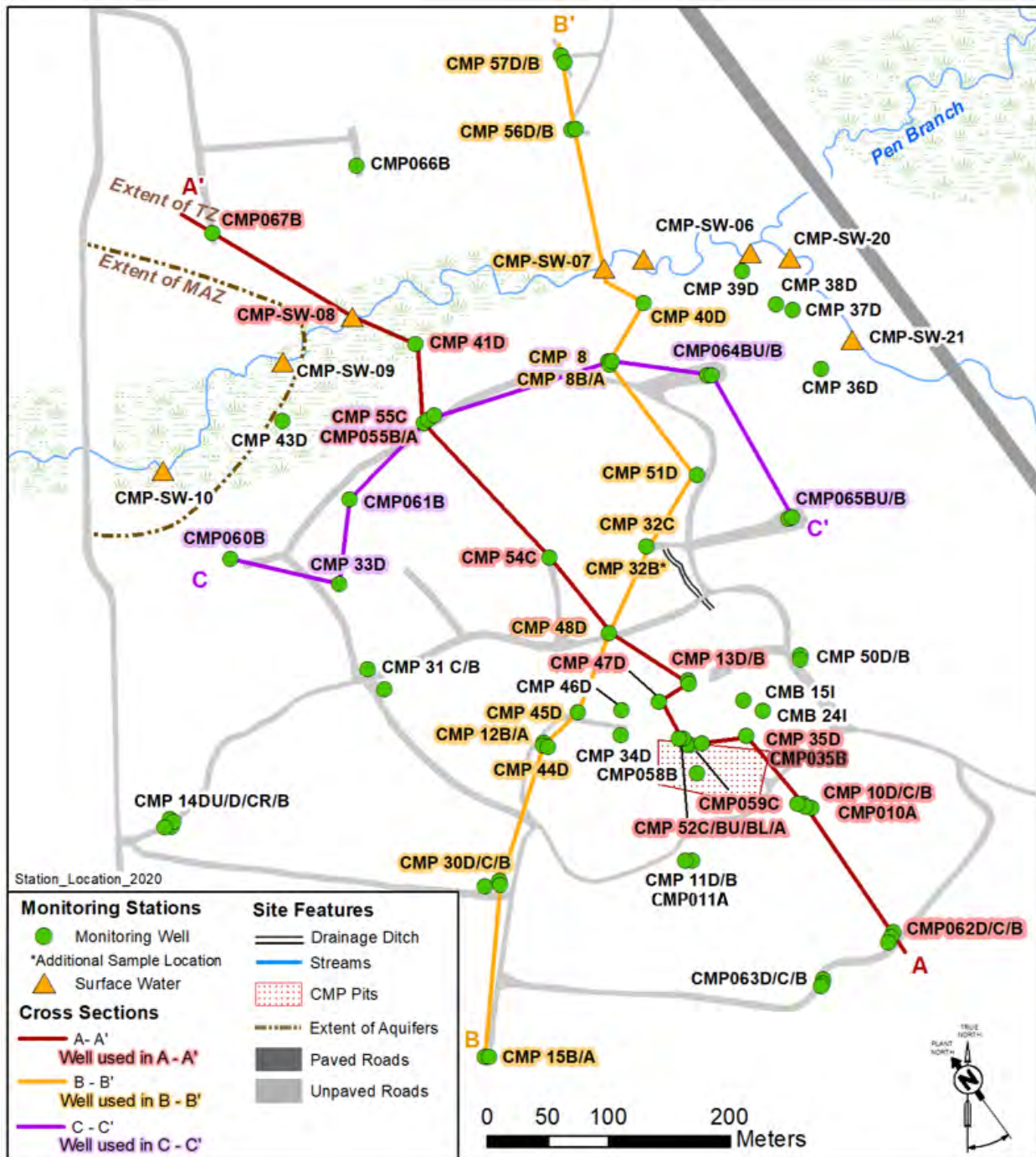
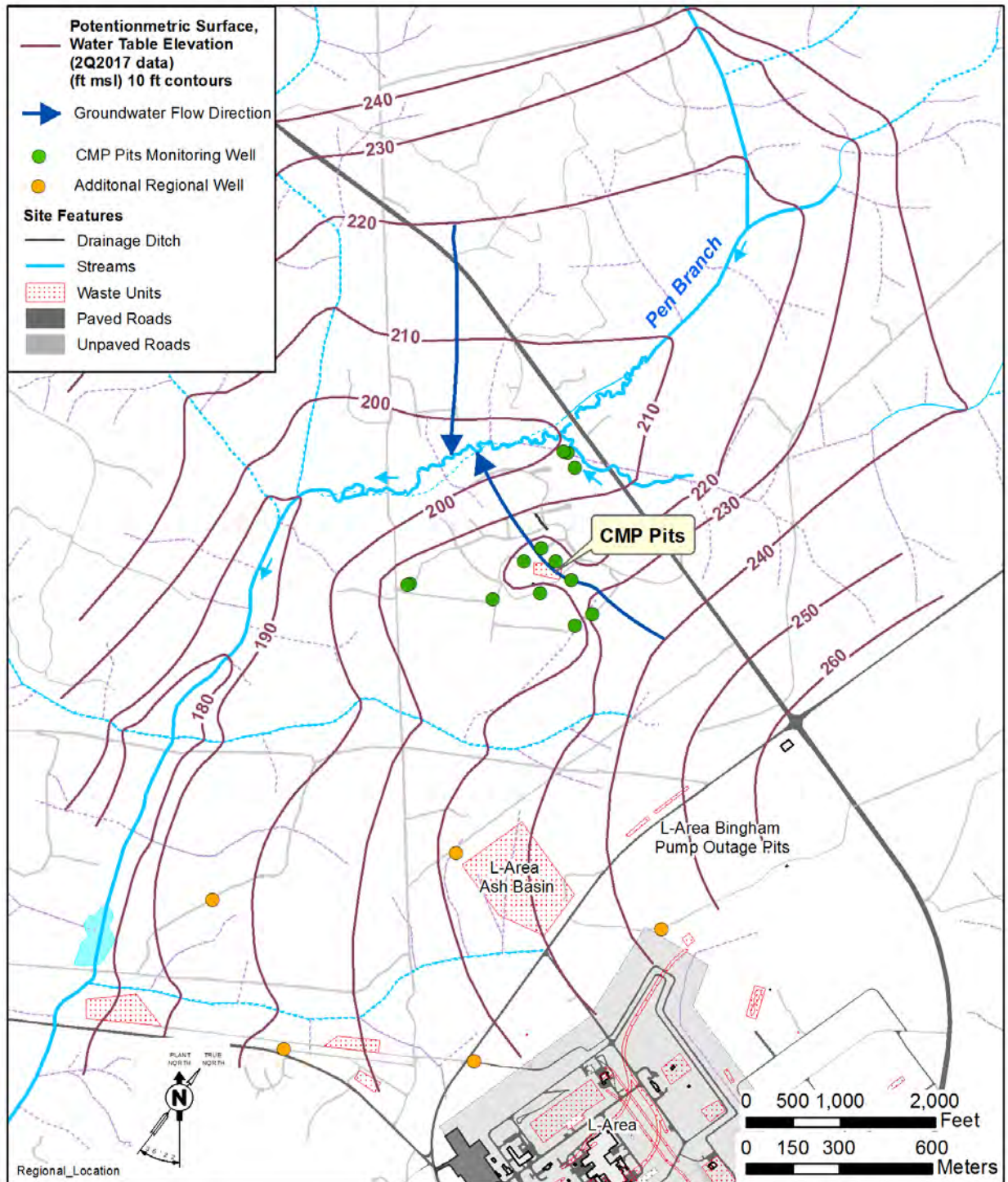


Figure 5. CMP Pits OU Monitoring Network, and Cross Section Lines

This page is intentionally left blank.



Note: Updated regional water table (UTRA) and GA potentiometric surfaces will be compiled from data collected during 3Q2022 and 4Q2022 and will be provided in the June 2023 CMP Pits EMR.

Figure 6. Regional Water Table Potentiometric Surface

This page is intentionally left blank.

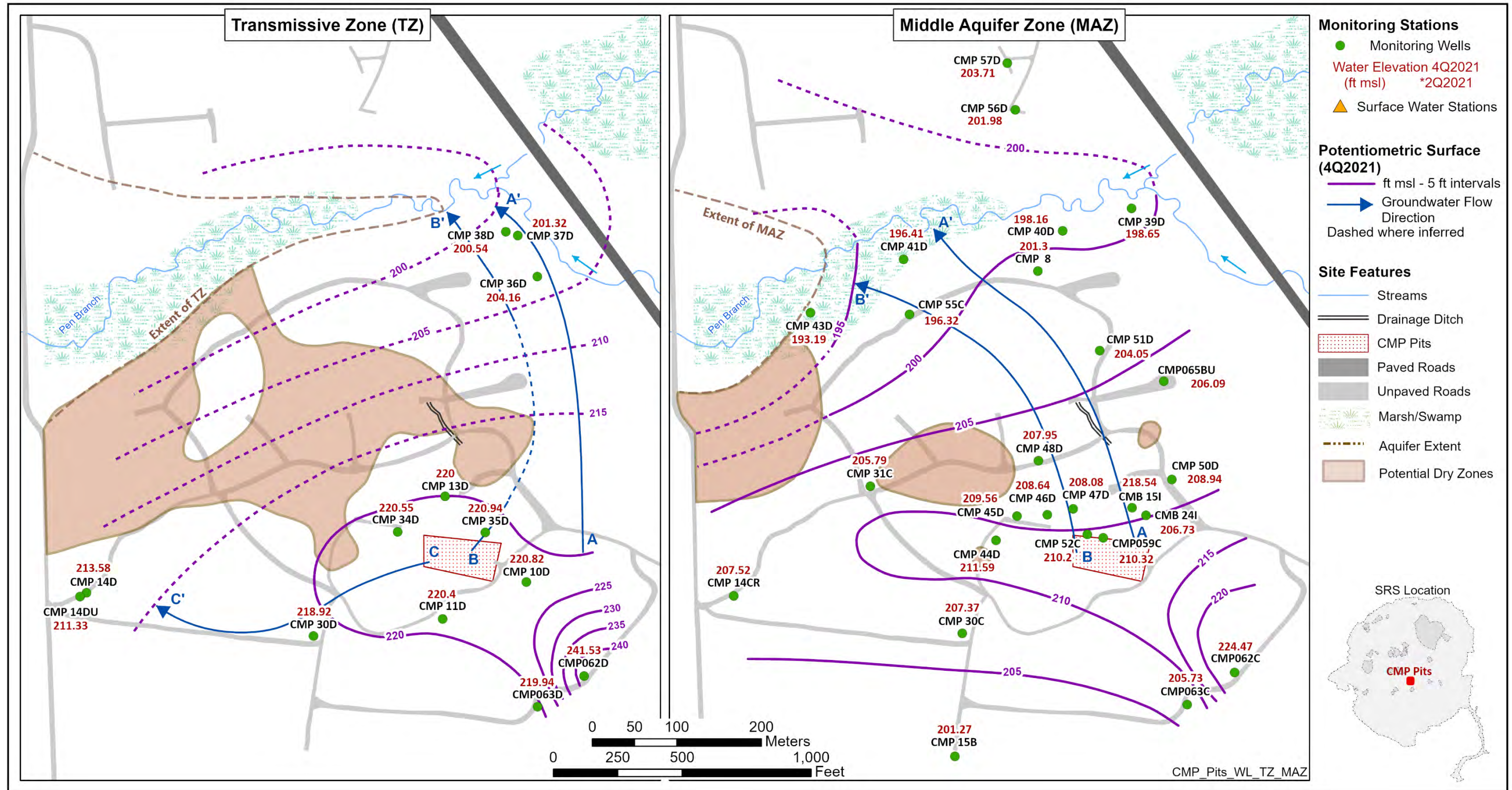


Figure 7. 2021 Potentiometric Surface for the TZ and MAZ

This page is intentionally left blank.

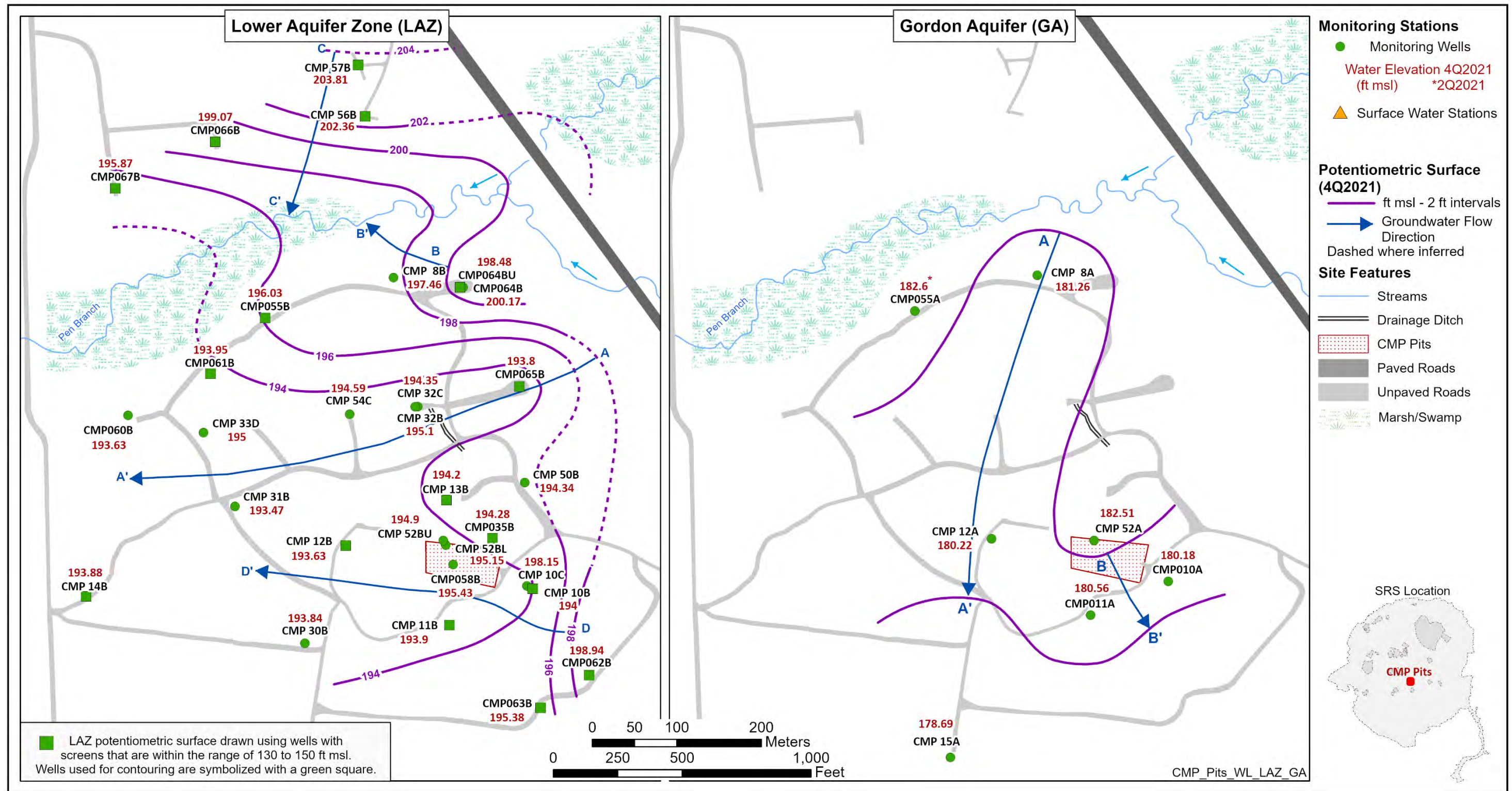


Figure 8. 2021 Potentiometric Surface for the LAZ and GA

This page is intentionally left blank.

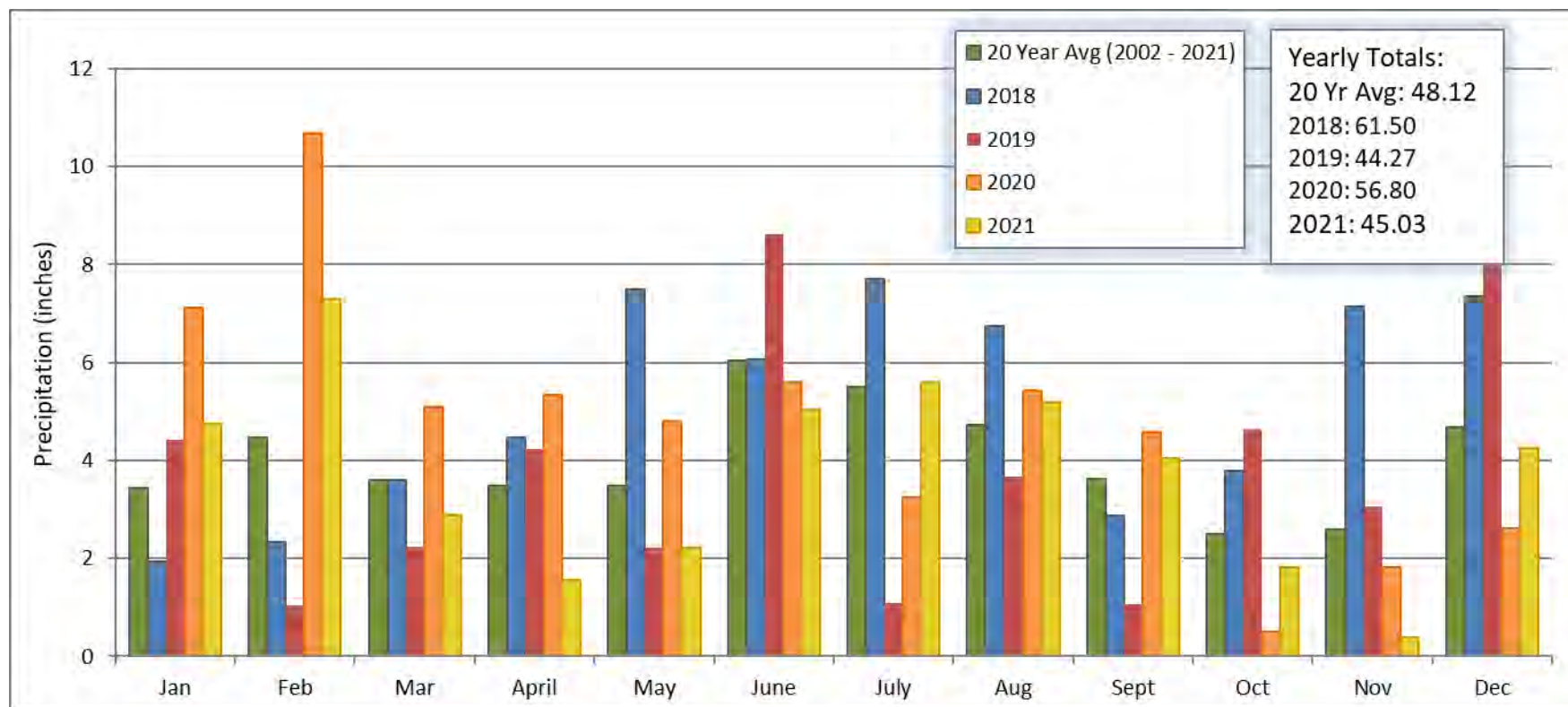


Figure 9. Monthly Rainfall Measurements in L-Area for 2021, 2020, 2019, 2018, and the 20-Year Average

This page is intentionally left blank.

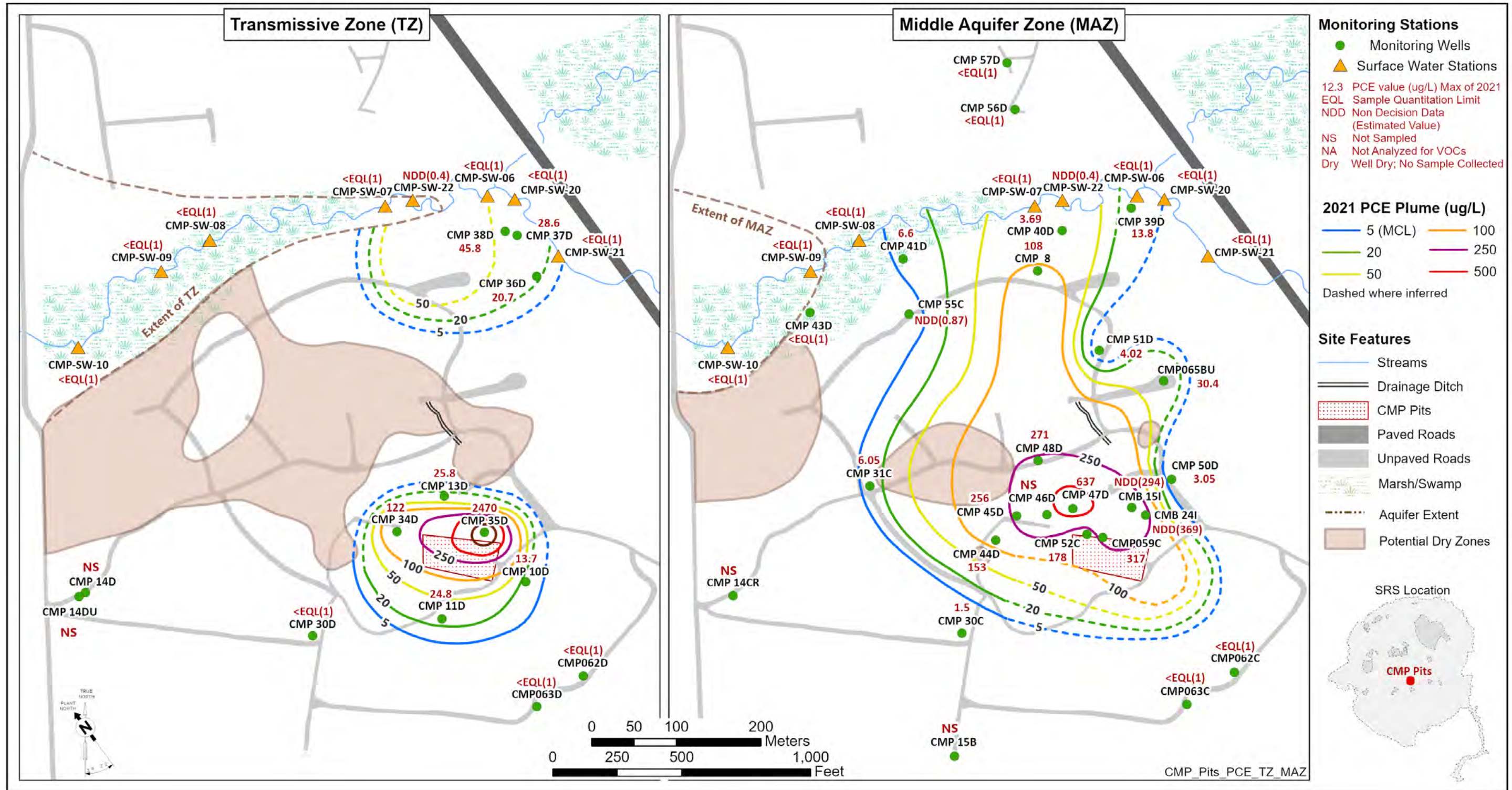


Figure 10. 2021 PCE Plume and Groundwater and Surface Water Results for the TZ and MAZ

This page is intentionally left blank.

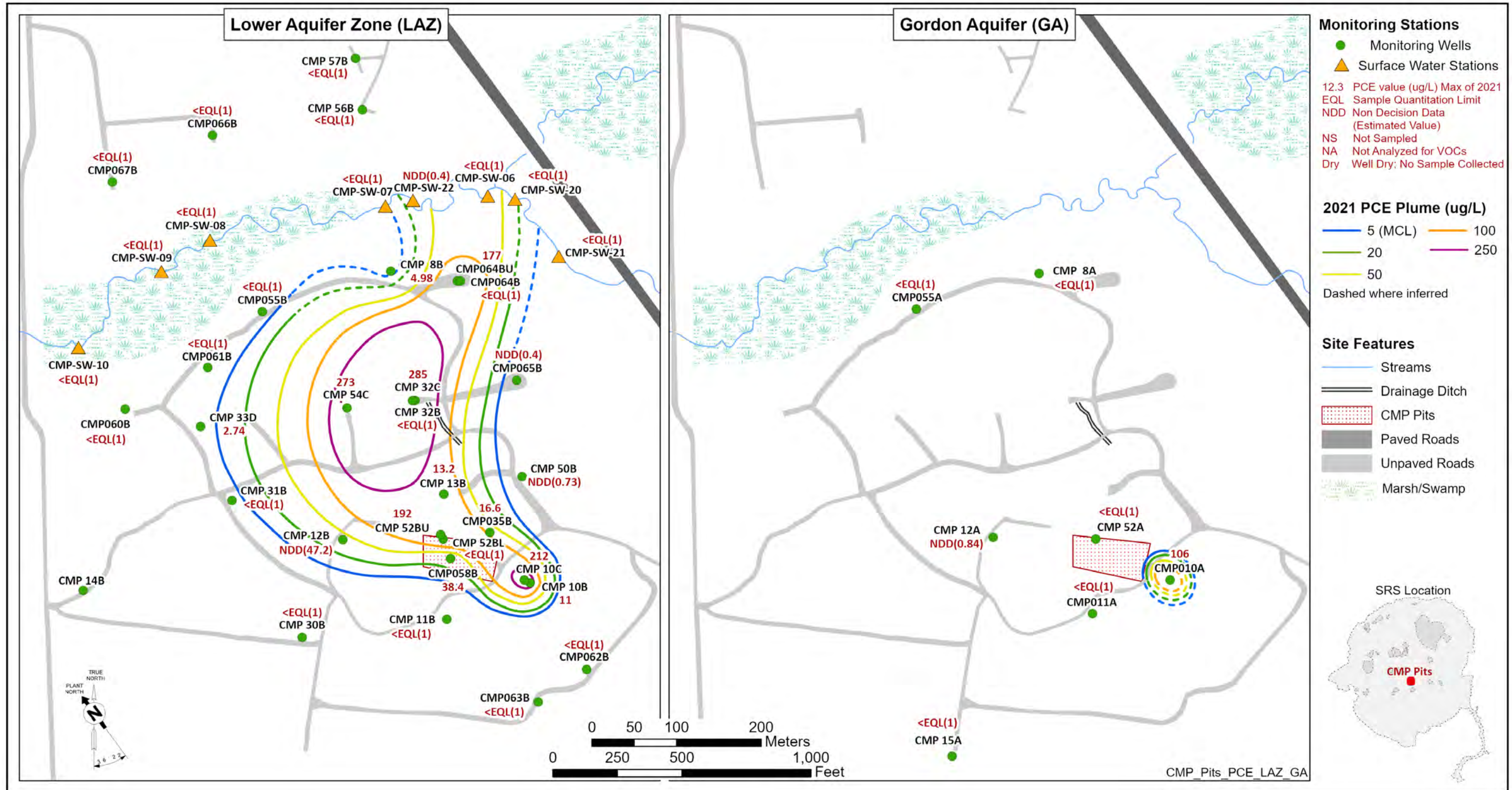


Figure 11. 2021 PCE Plume and Groundwater Results for the LAZ and GA

This page is intentionally left blank.

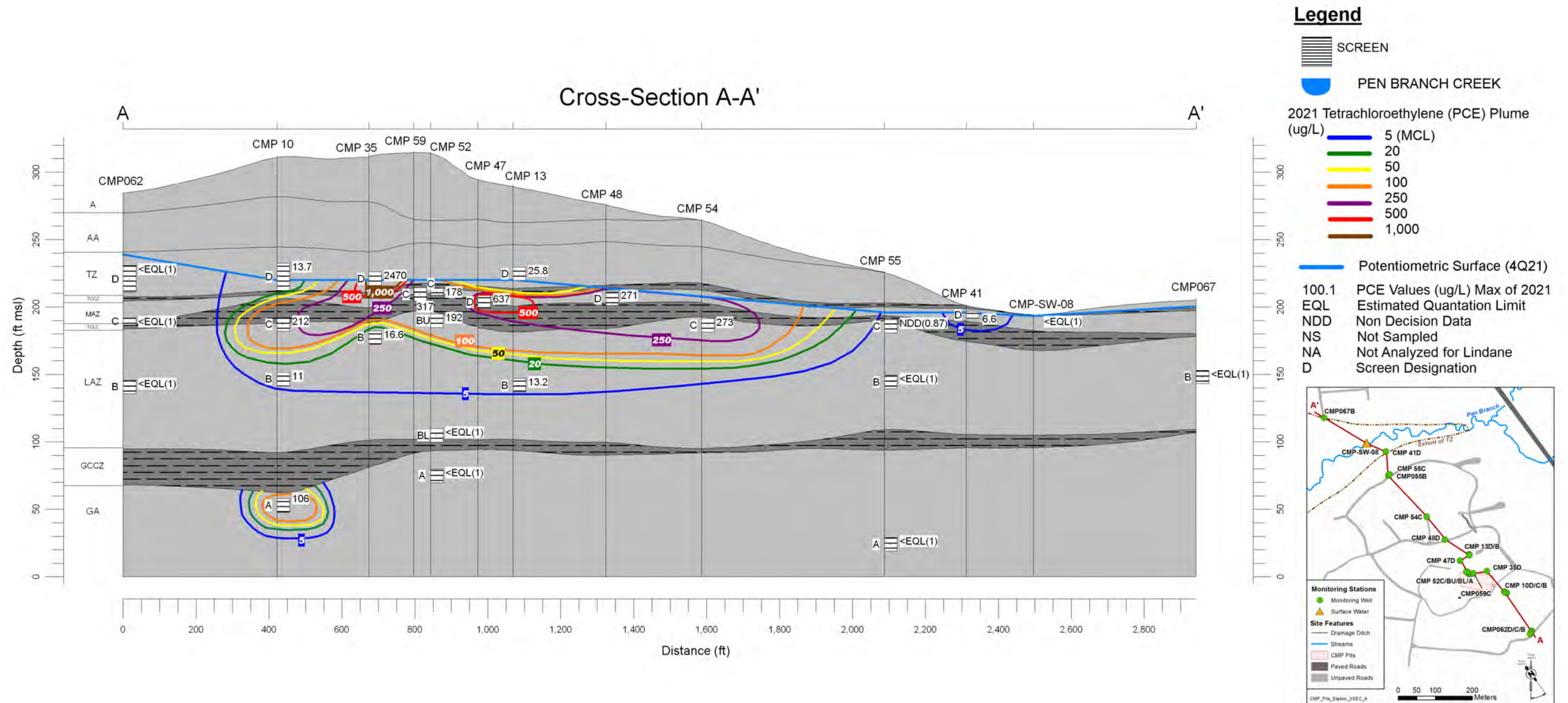


Figure 12. Cross Section A - A' at the CMP Pits OU Area with 2021 PCE Plume and Results

This page is intentionally left blank.

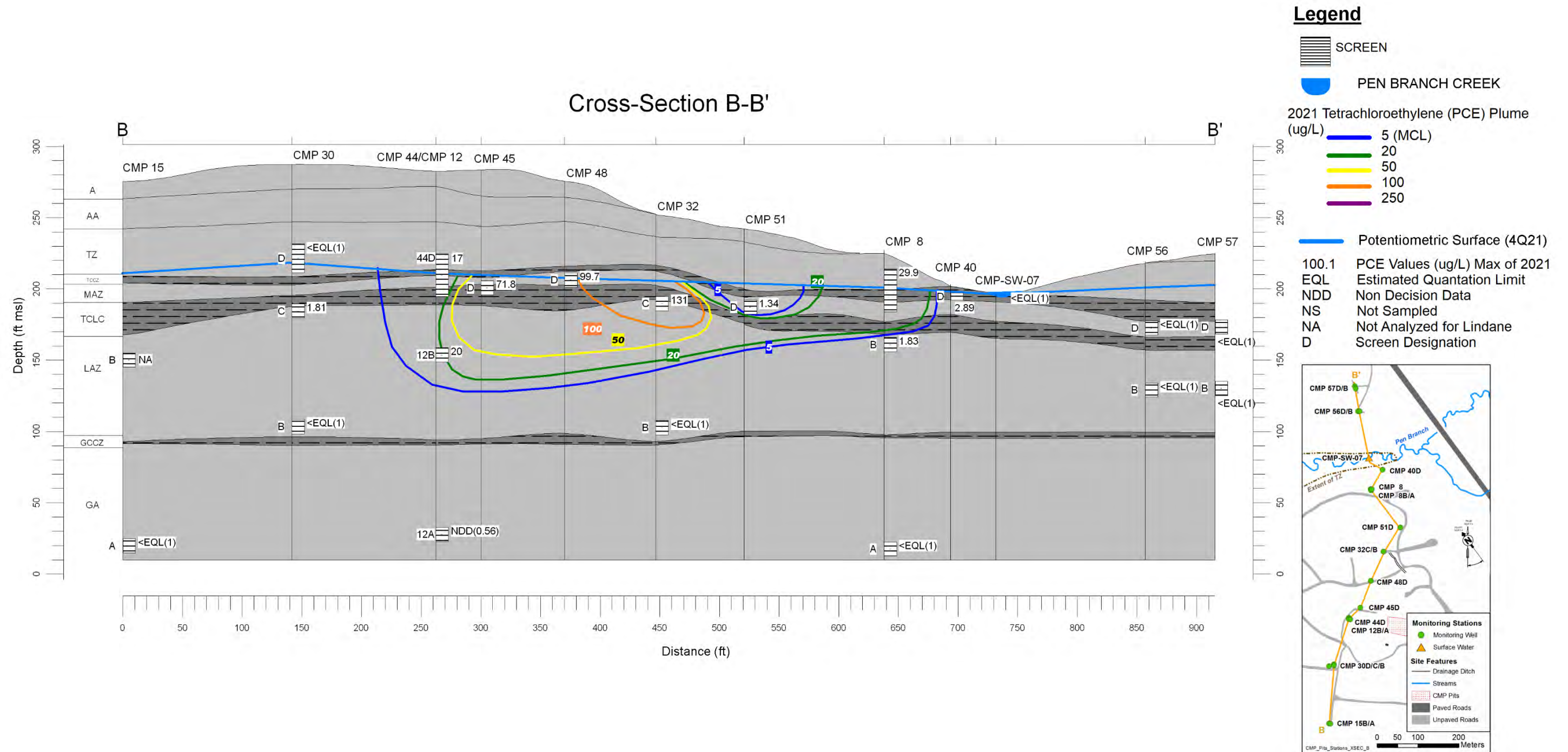


Figure 13. Cross Section B - B' at the CMP Pits OU Area with 2021 PCE Plume and Results

This page is intentionally left blank.

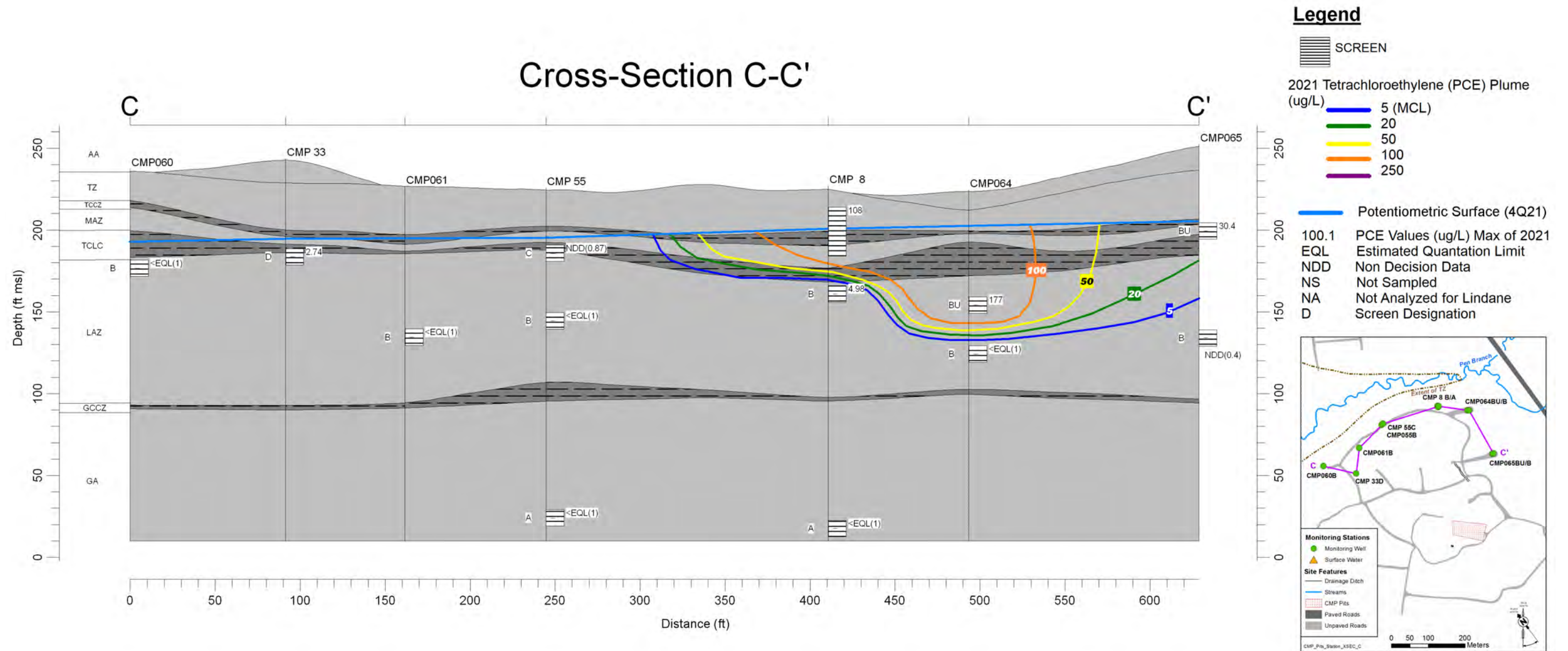


Figure 14. Cross Section C - C' at the CMP Pits OU Area with 2021 PCE Plume and Results

This page is intentionally left blank.

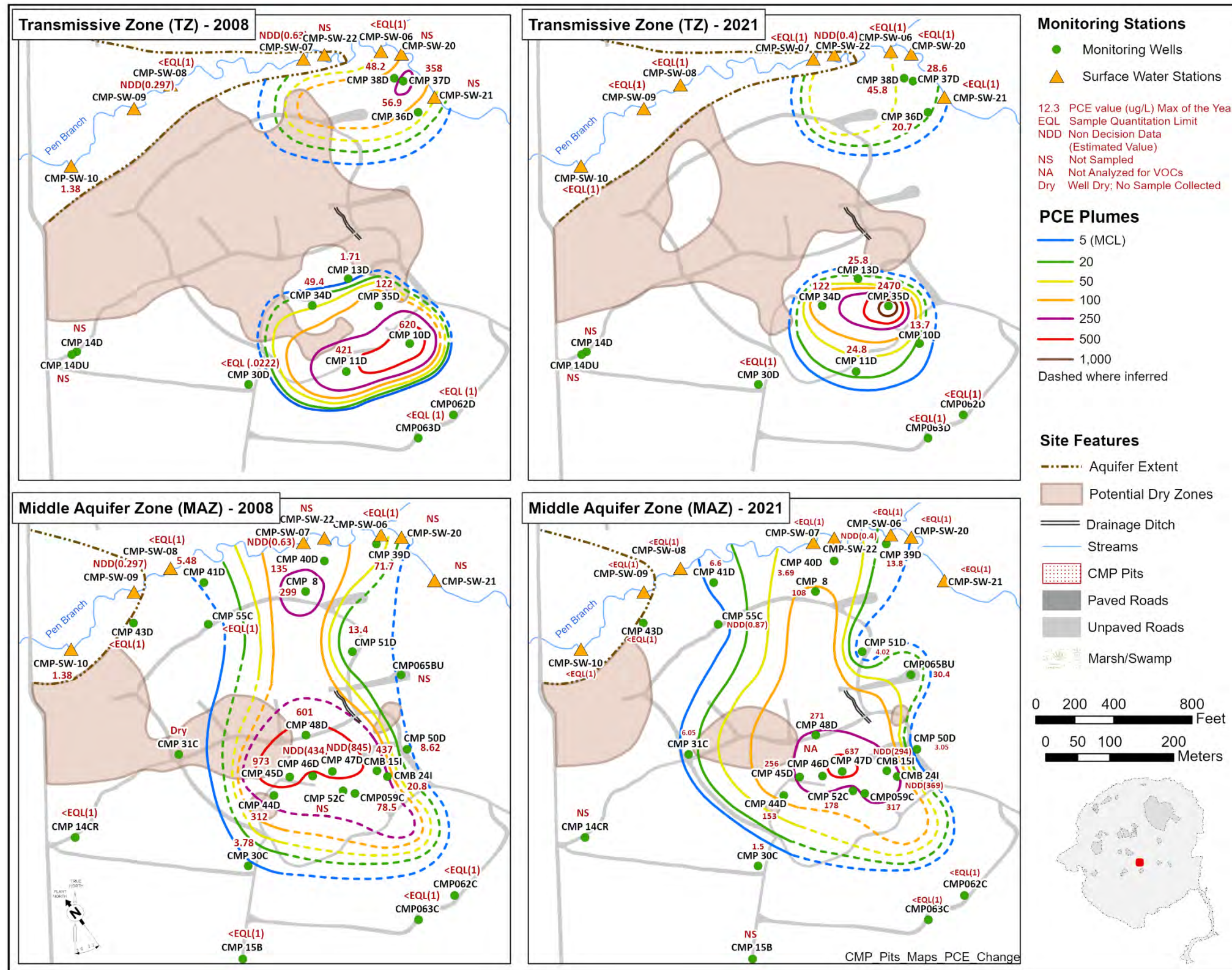


Figure 15. PCE Plume Comparison from 2008 and 2021 in the TZ and MAZ

This page is intentionally left blank.

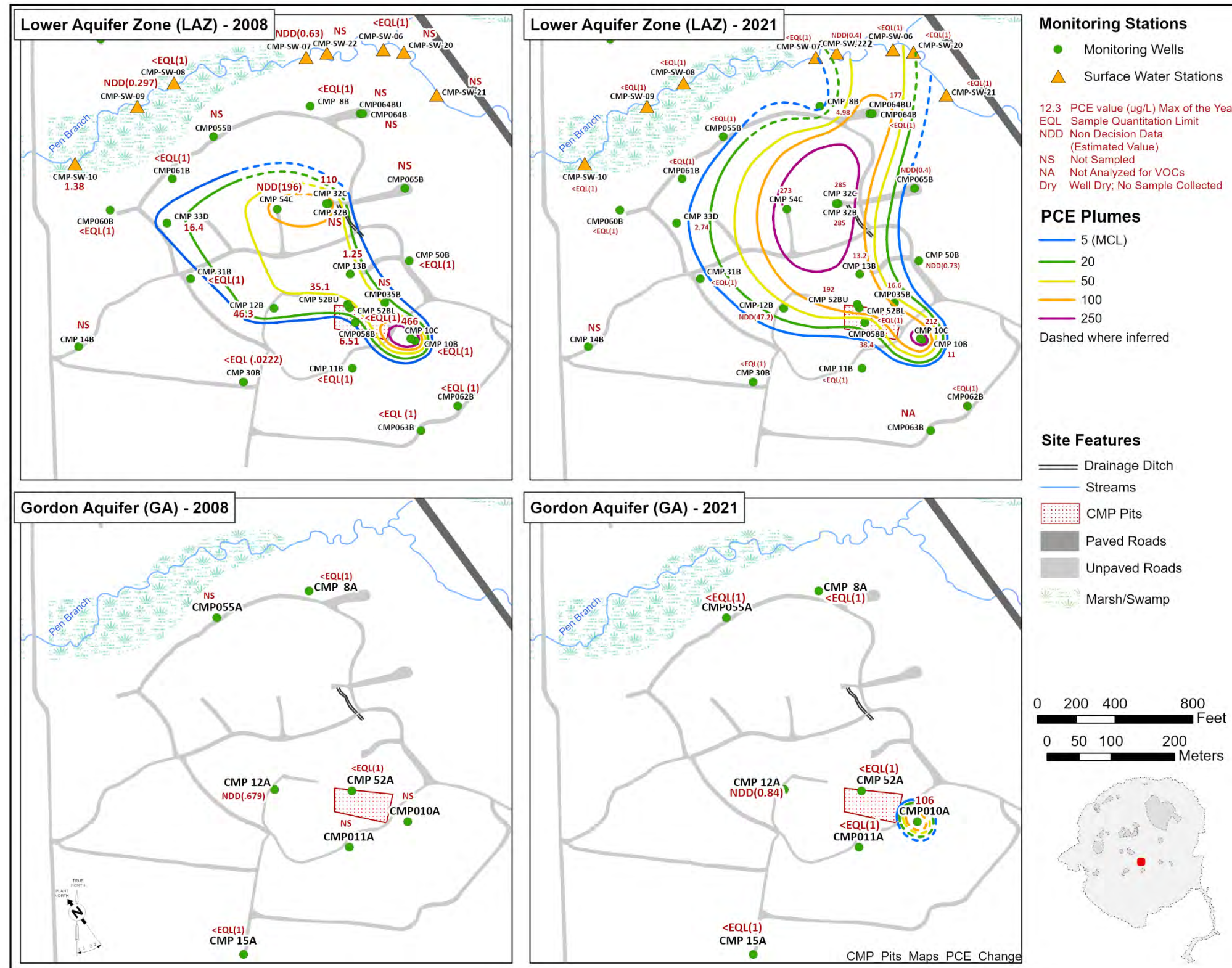


Figure 16. PCE Plume Comparison from 2008 and 2021 in the LAZ and GA

This page is intentionally left blank.

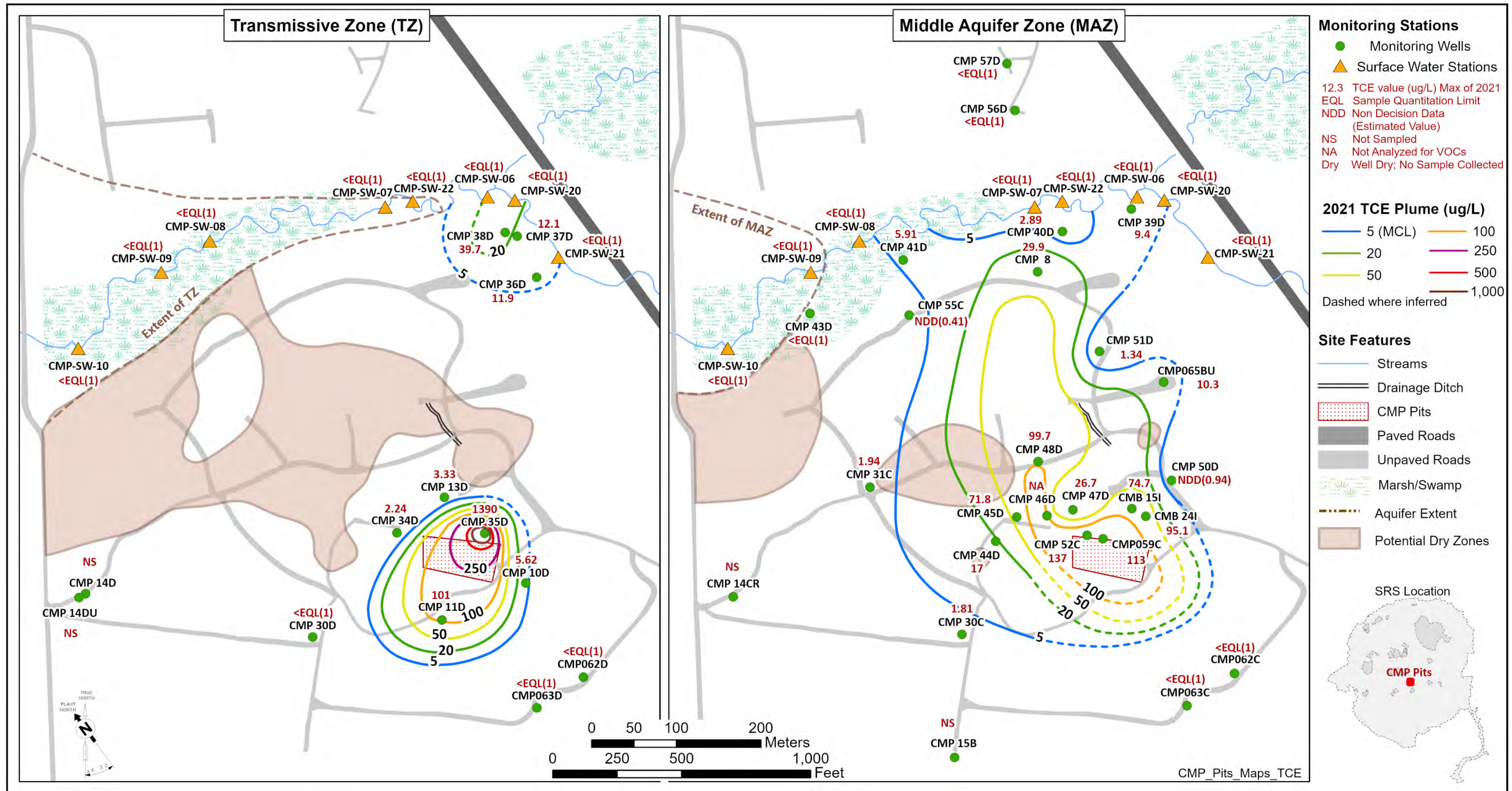


Figure 17. 2021 TCE Plume and Groundwater and Surface Water Results in the TZ and MAZ

This page is intentionally left blank.

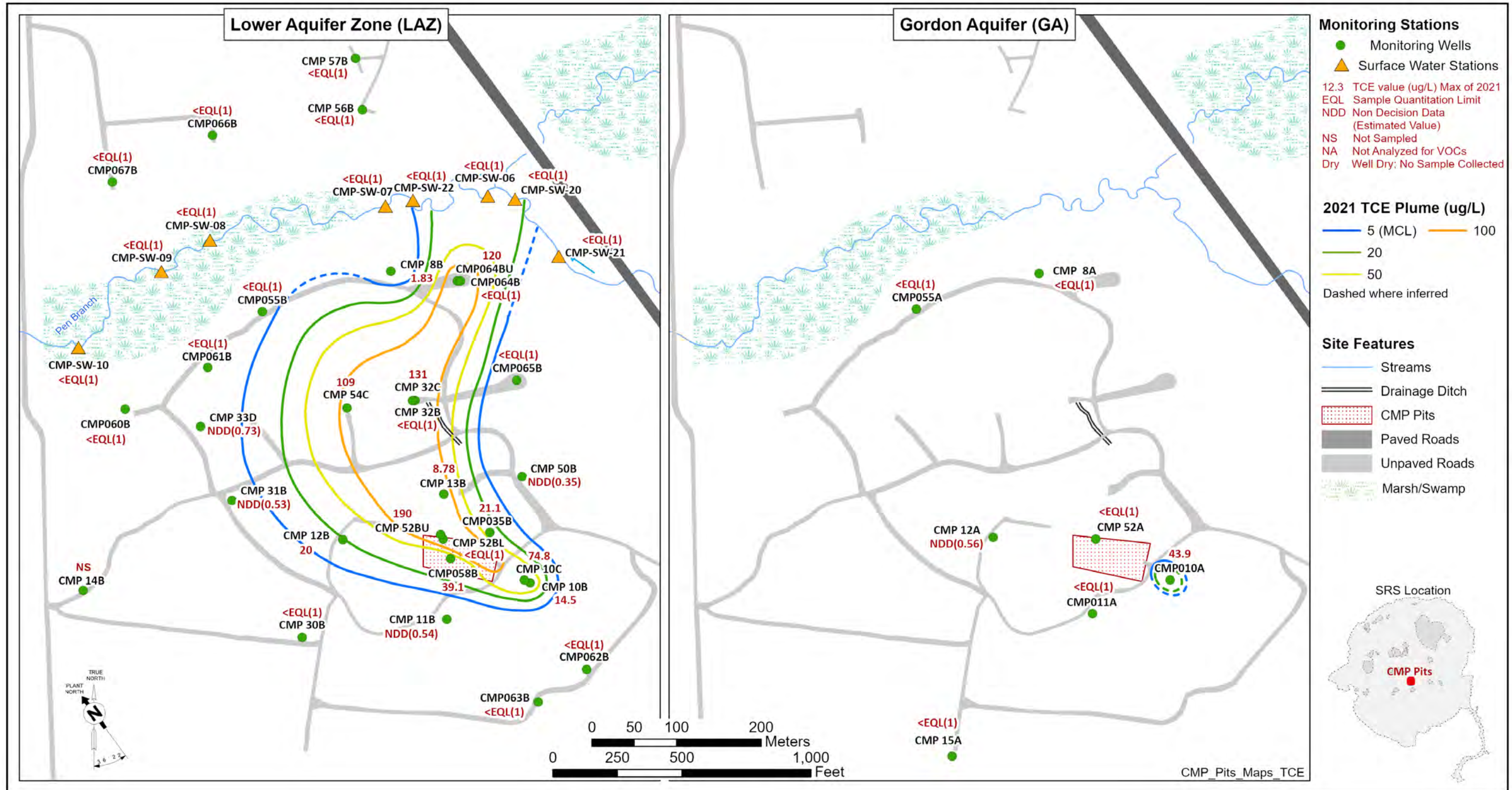


Figure 18. 2021 TCE Plume and Groundwater Results for the LAZ and GA

This page is intentionally left blank.

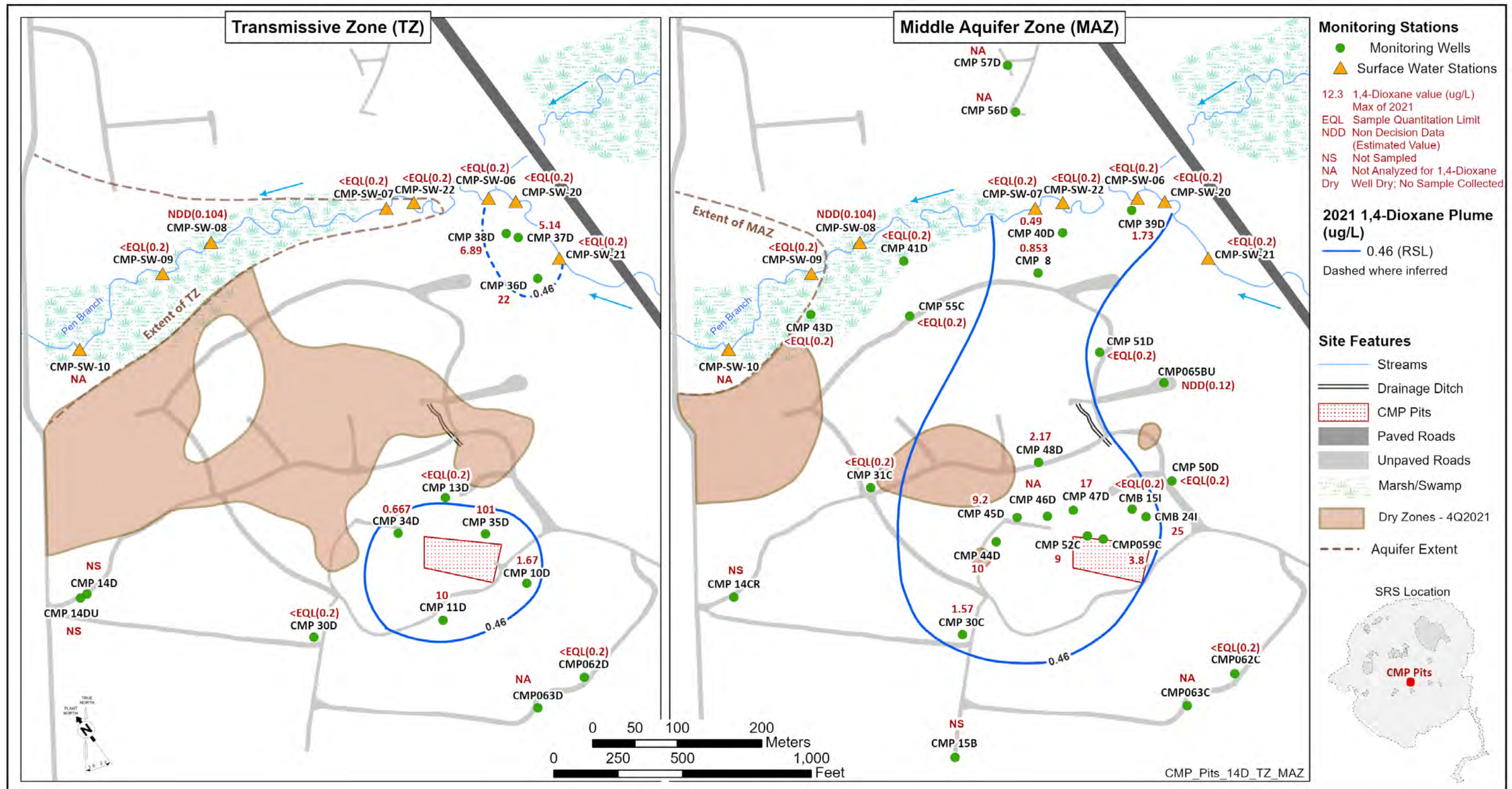


Figure 19. 2021 1,4-Dioxane Plume and Groundwater Results for the TZ and MAZ

This page is intentionally left blank.

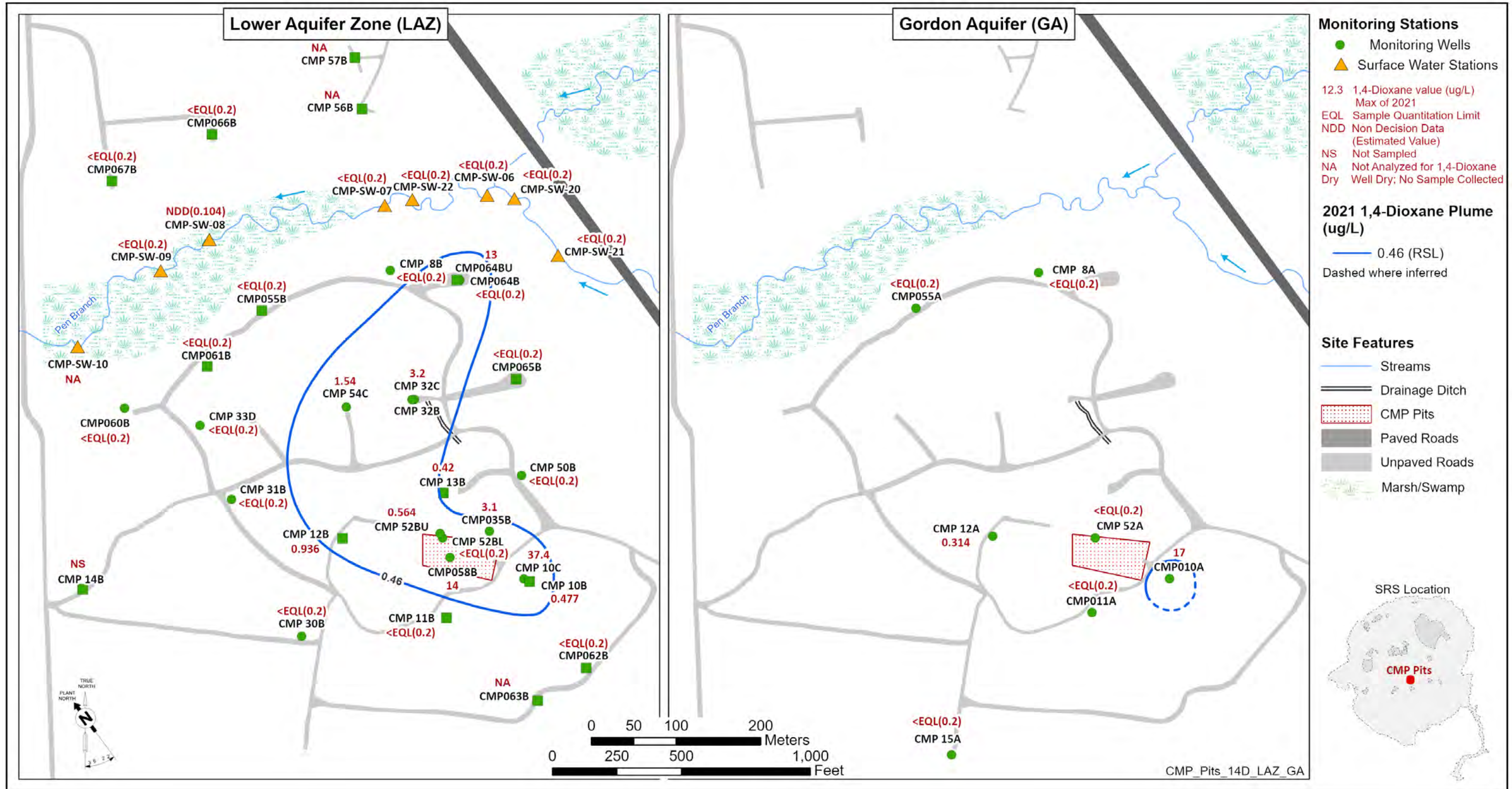


Figure 20. 2021 1,4-Dioxane Plume and Groundwater Results for the LAZ and GA

This page is intentionally left blank.

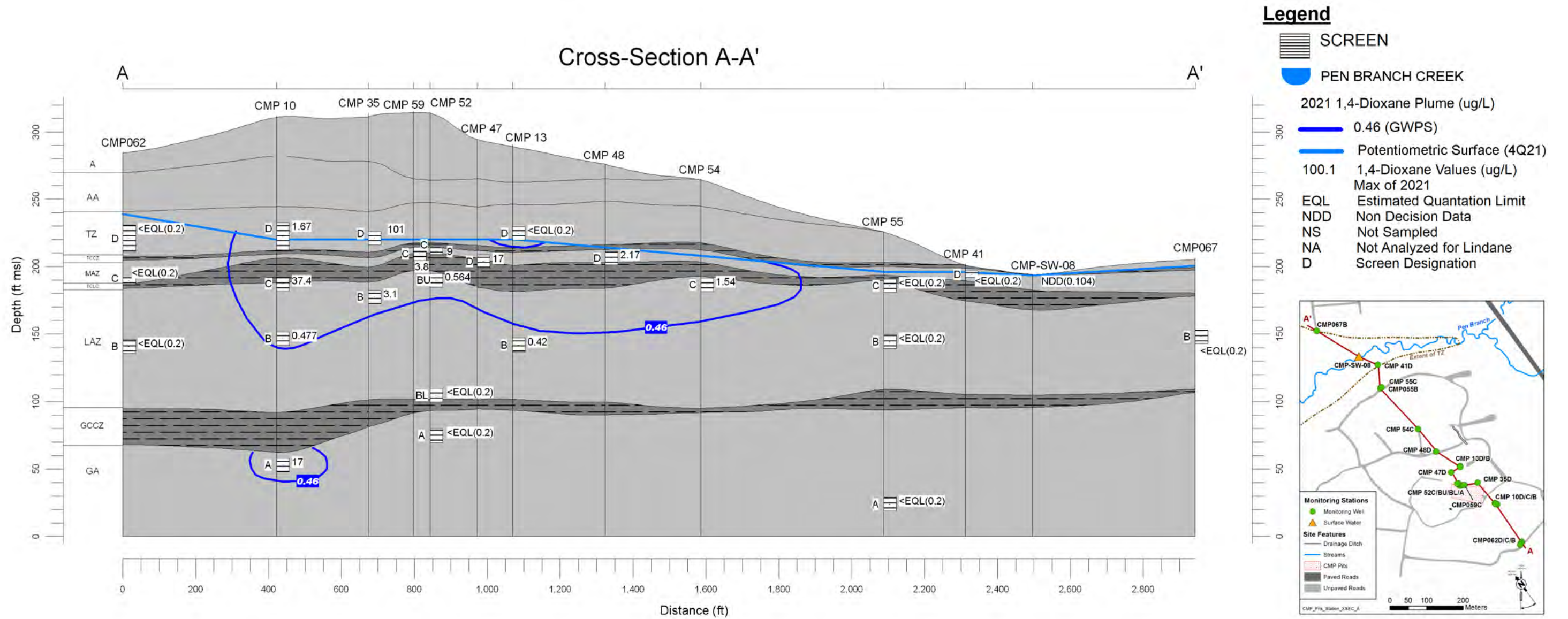


Figure 21. Cross Section A - A' at the CMP Pits OU Area with 2021 1,4-Dioxane Plume and Results

This page is intentionally left blank.

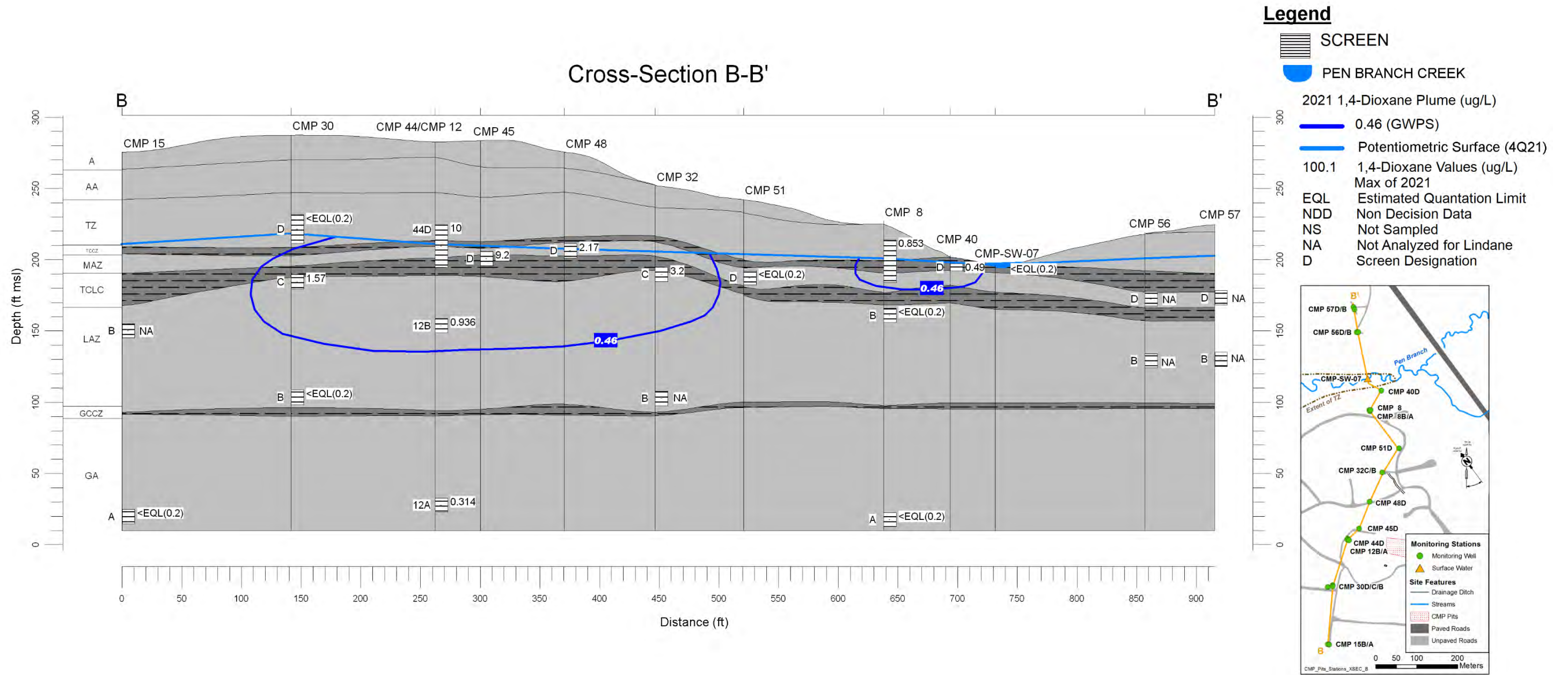


Figure 22. Cross Section B - B' at the CMP Pits OU Area with 2021 1,4-Dioxane Plume and Results

This page is intentionally left blank.

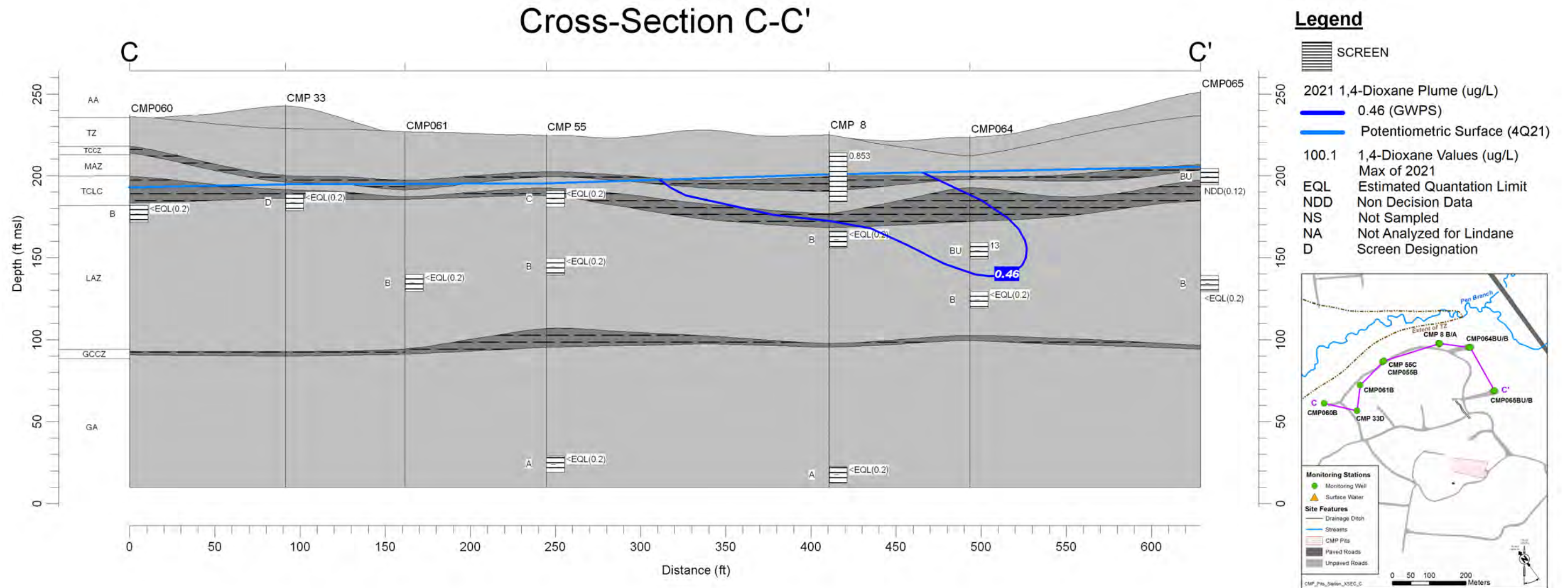


Figure 23. Cross Section C - C' at the CMP Pits OU Area with 2021 1,4-Dioxane Plume and Results

This page is intentionally left blank.

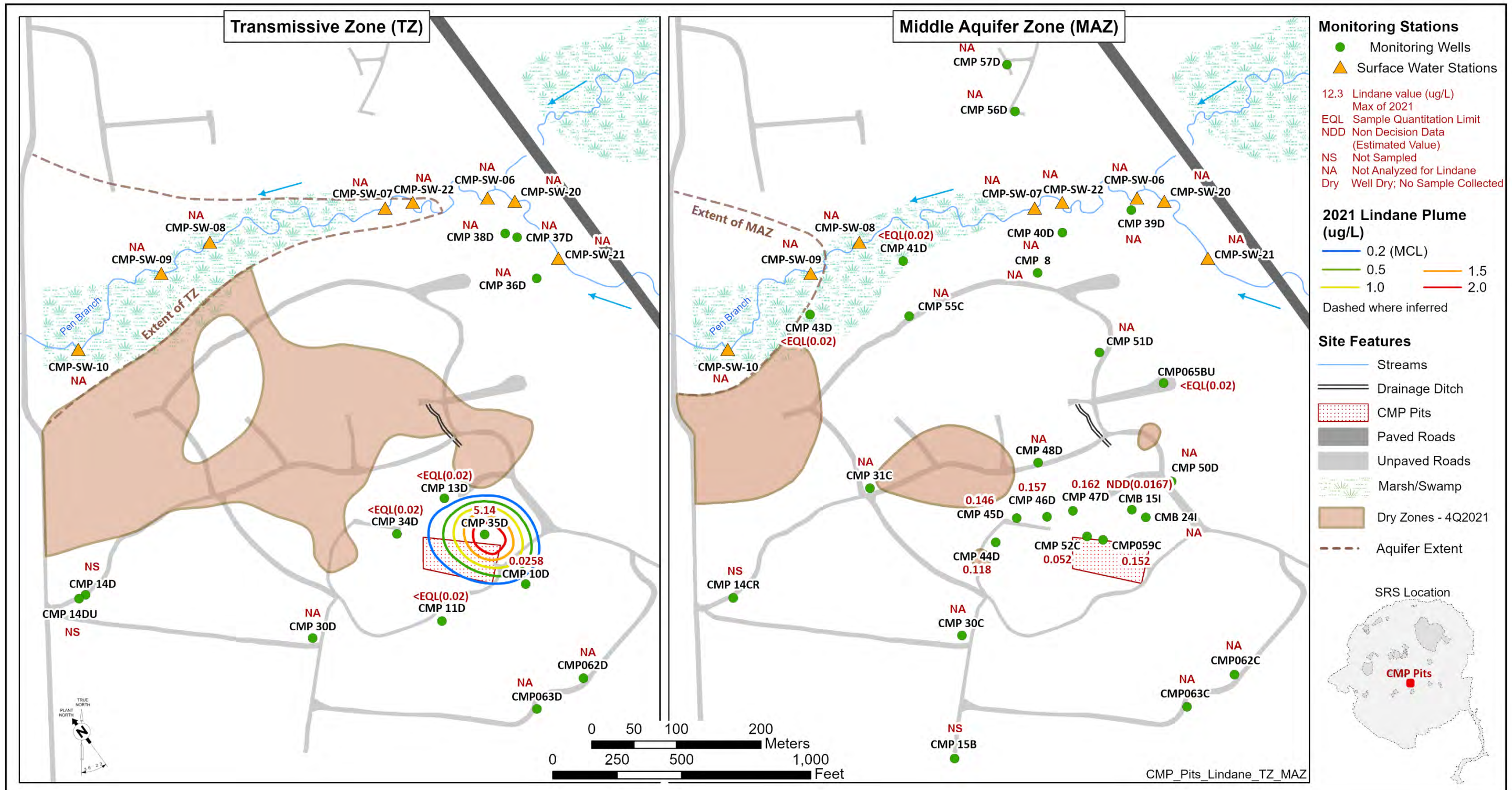


Figure 24. 2021 Lindane Plume and Groundwater Results for the TZ and MAZ

This page is intentionally left blank.

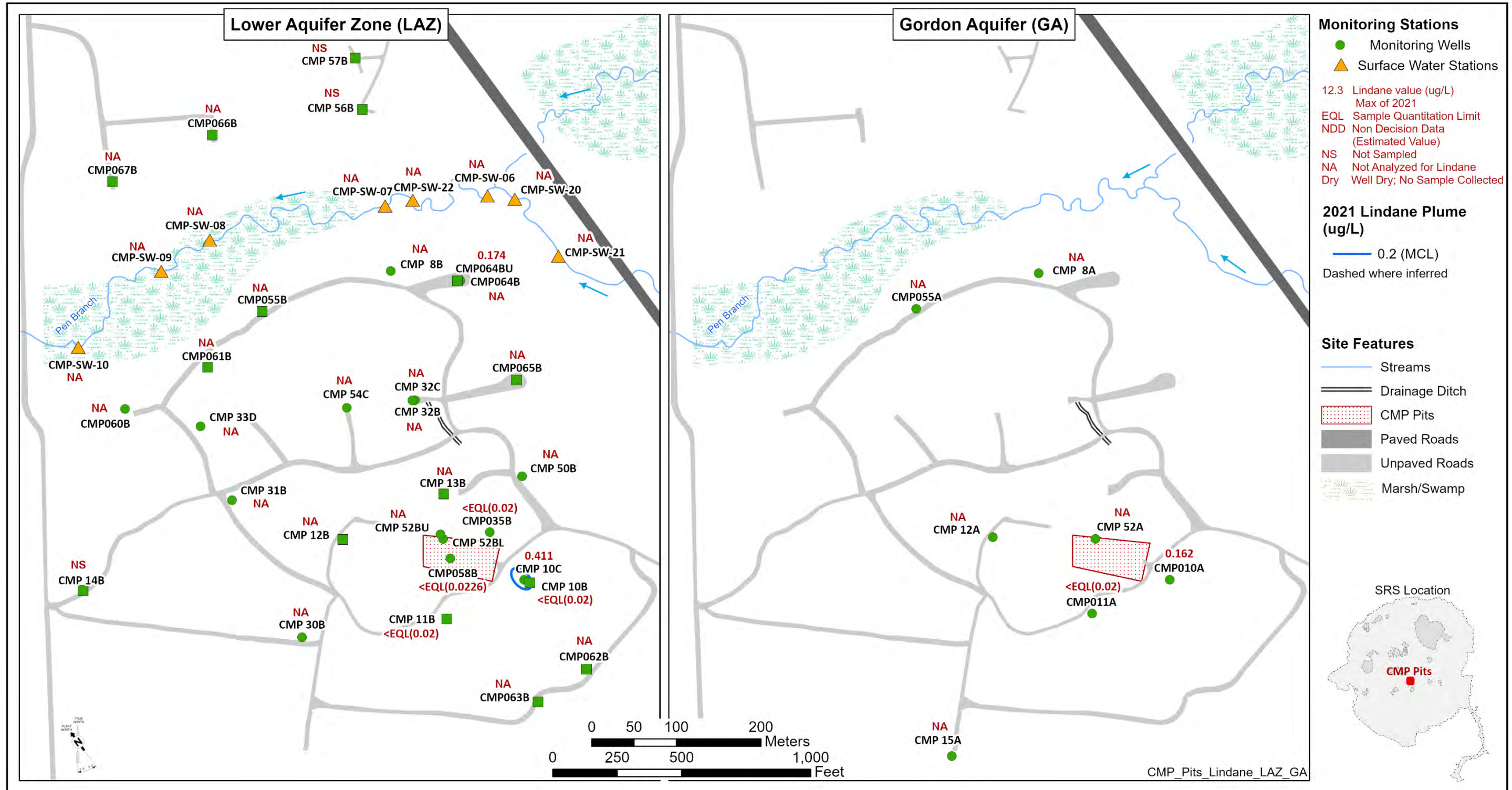


Figure 25. 2021 Lindane Plume and Groundwater Results for the LAZ and GA

This page is intentionally left blank.

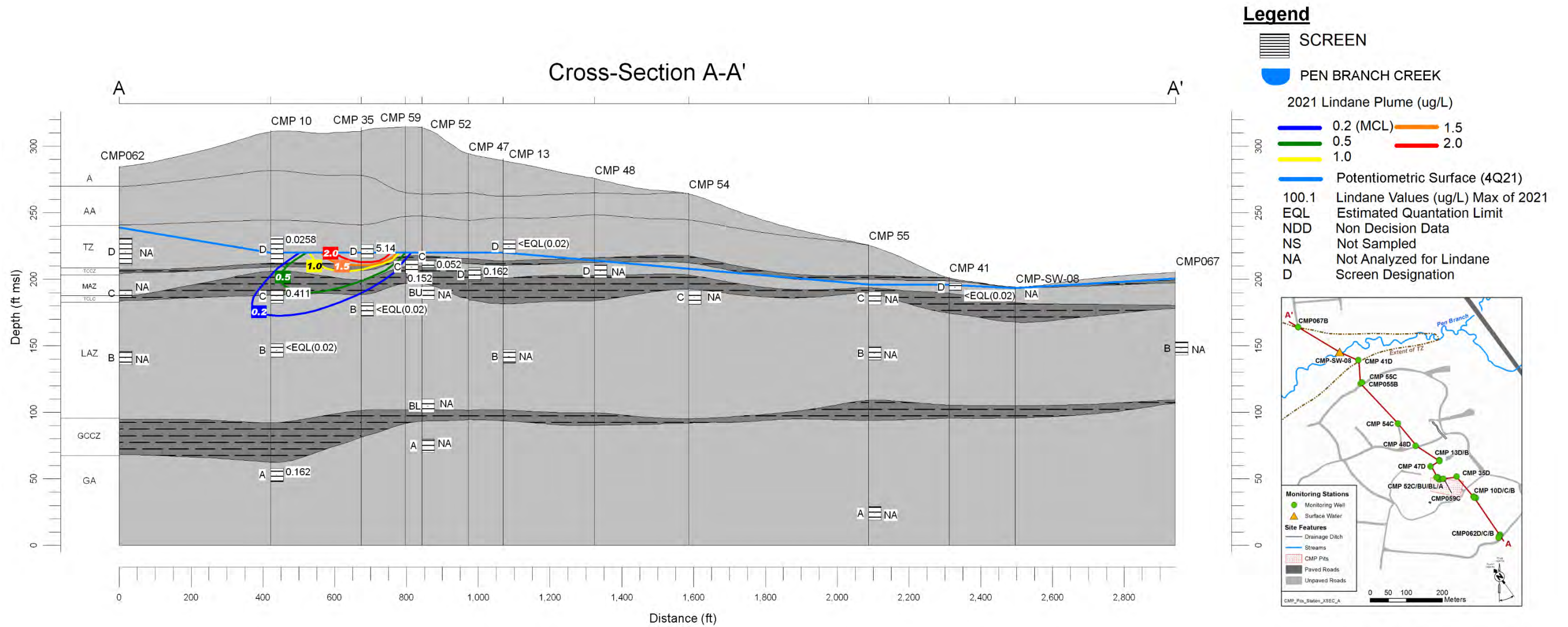


Figure 26. Cross Section A - A' at the CMP Pits OU Area with 2021 Lindane Plume and Results

This page is intentionally left blank.

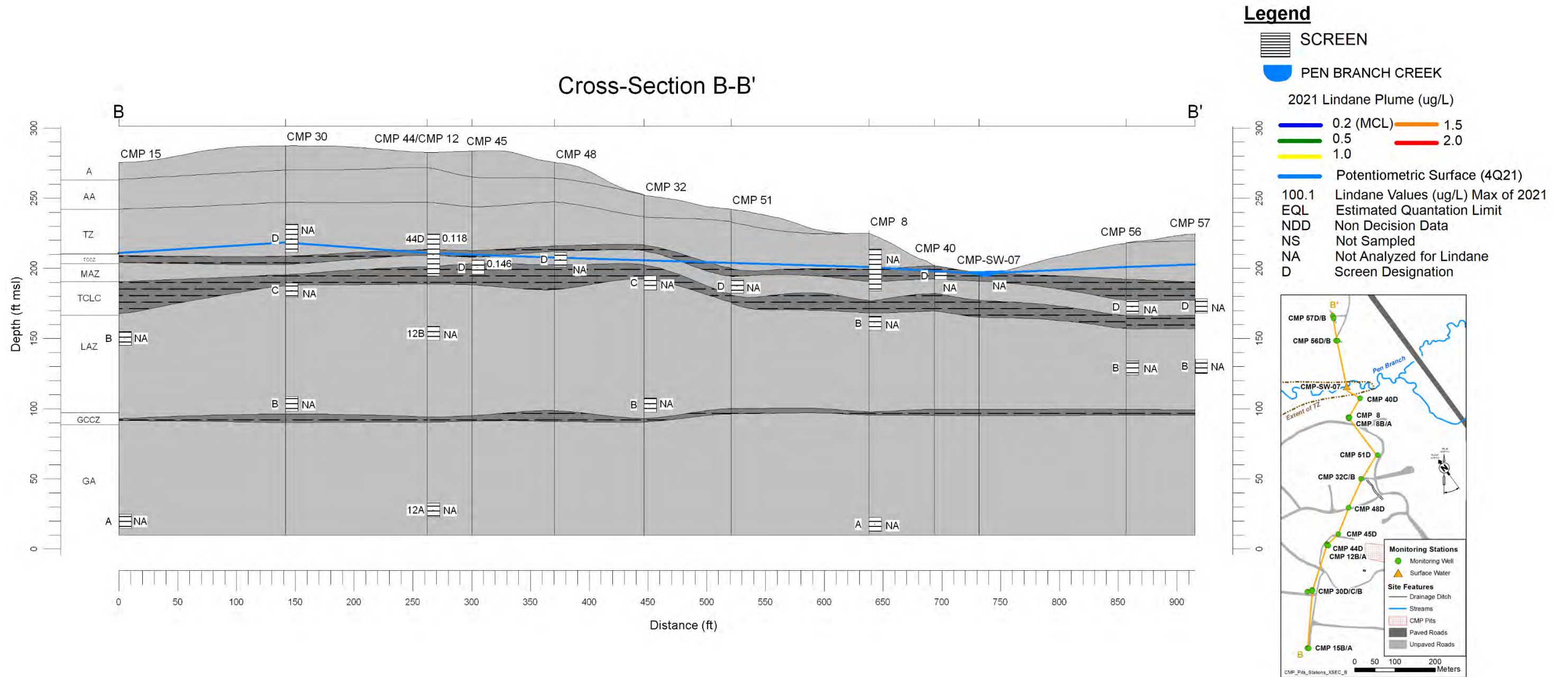
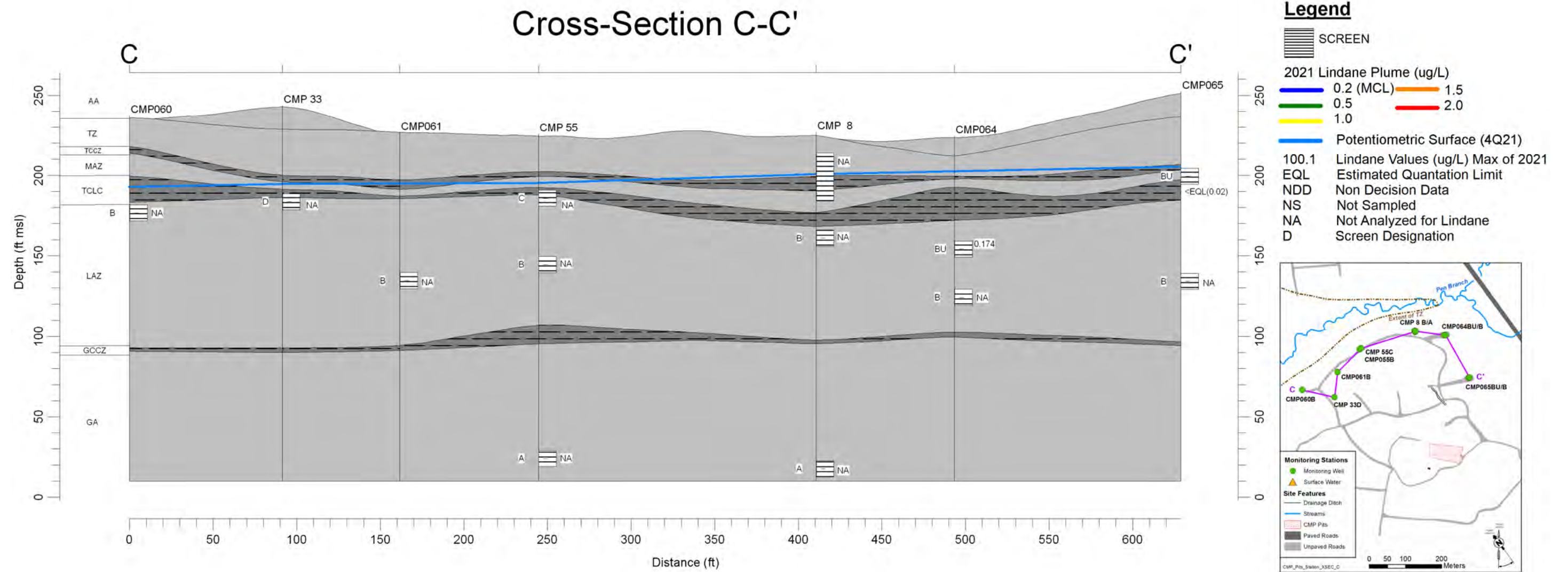


Figure 27. Cross Section B - B' at the CMP Pits OU Area with 2021 Lindane Plume and Results

This page is intentionally left blank.



This page is intentionally left blank.

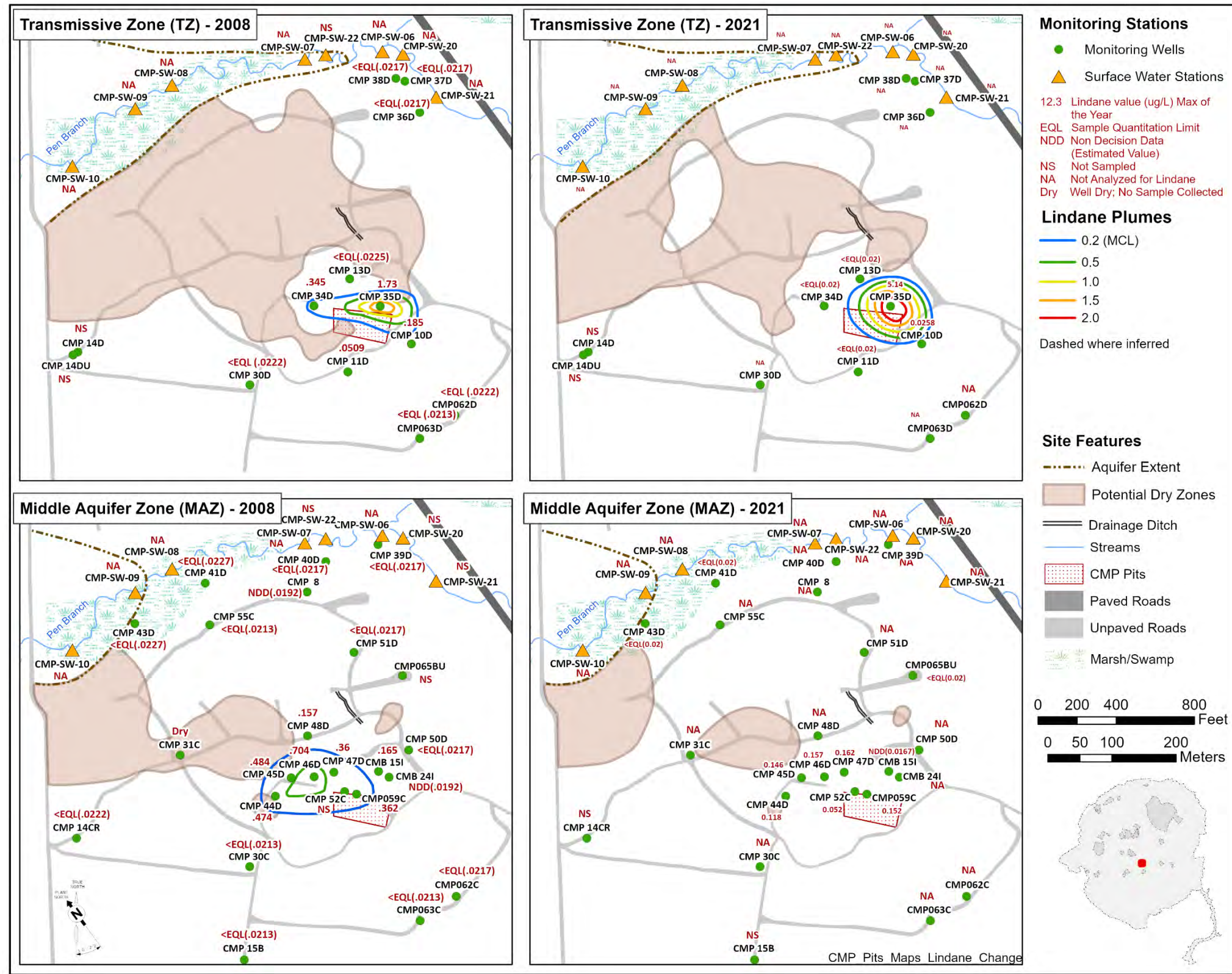


Figure 29. Lindane Plume Comparison from 2008 and 2021 in the TZ and MAZ

This page is intentionally left blank.

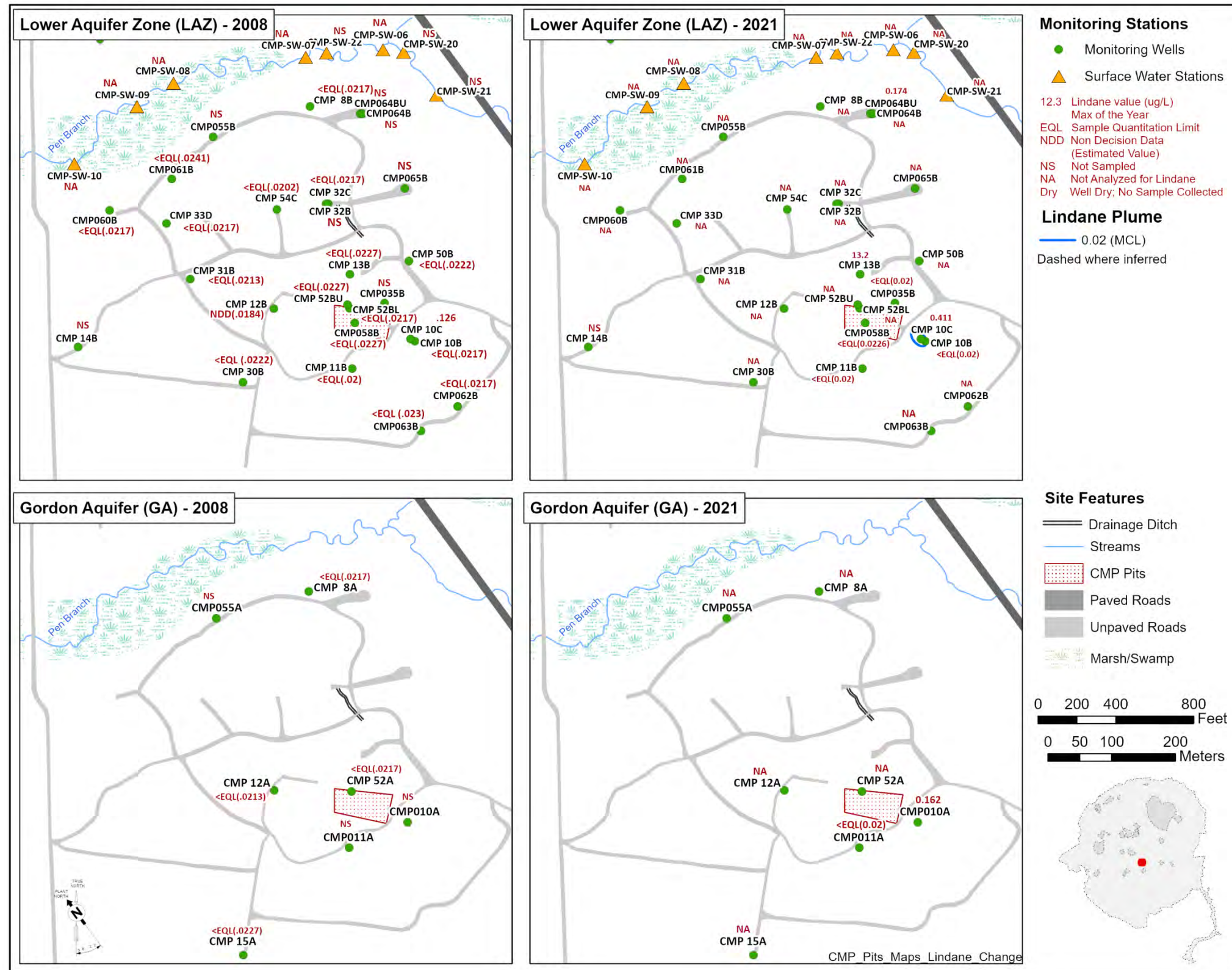


Figure 30. Lindane Plume Comparison from 2008 and 2021 in the LAZ and GA

This page is intentionally left blank.

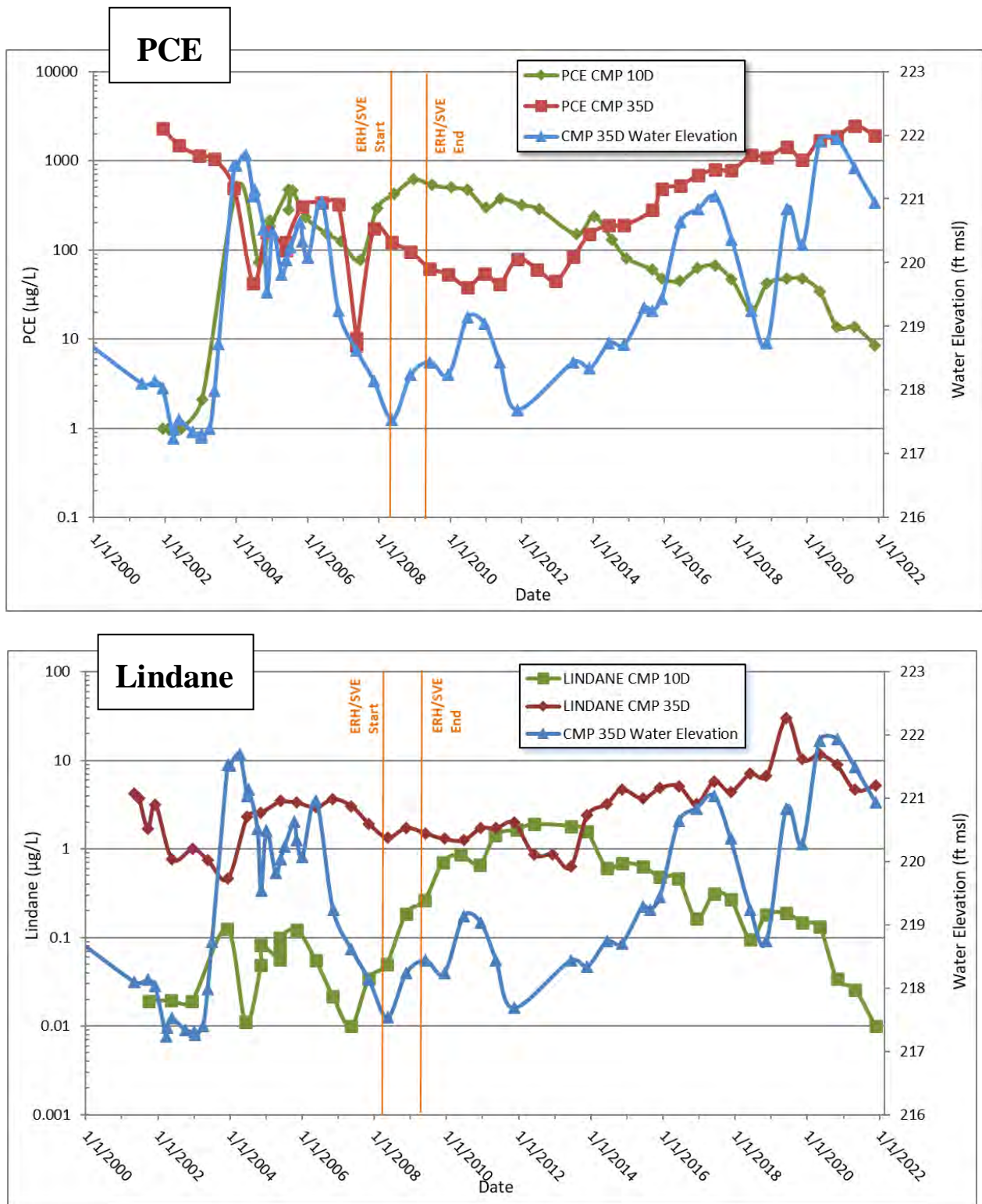
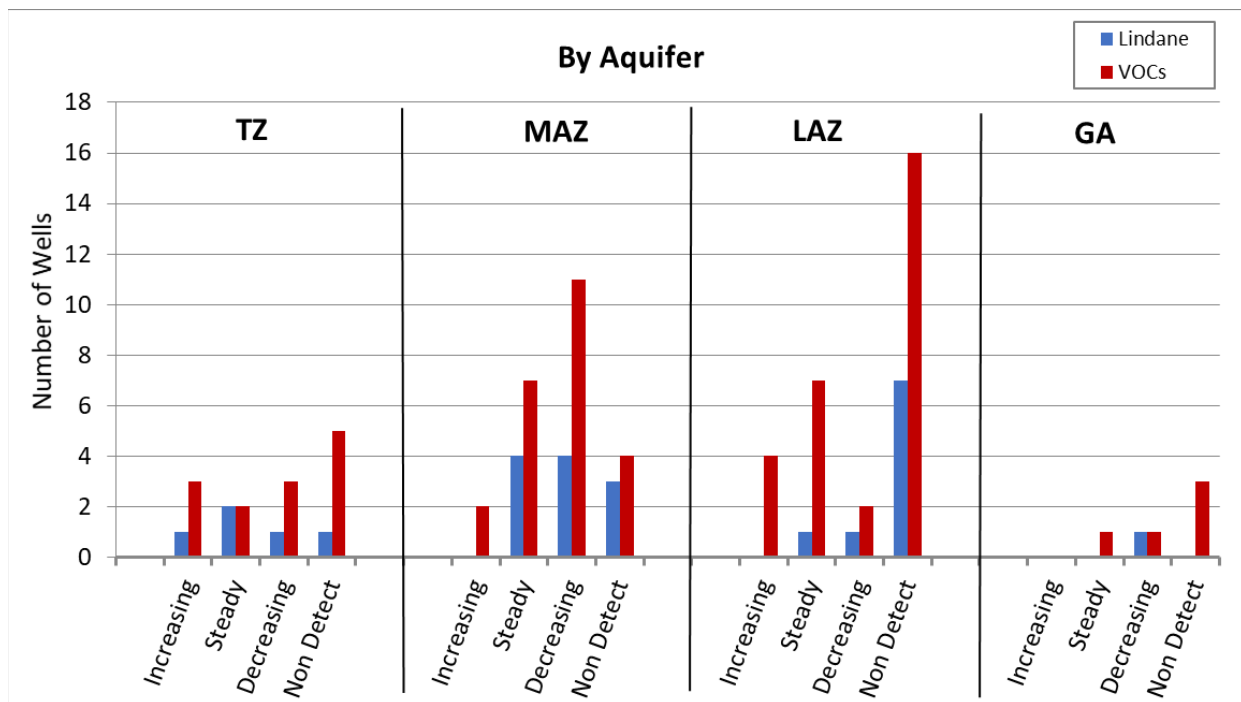
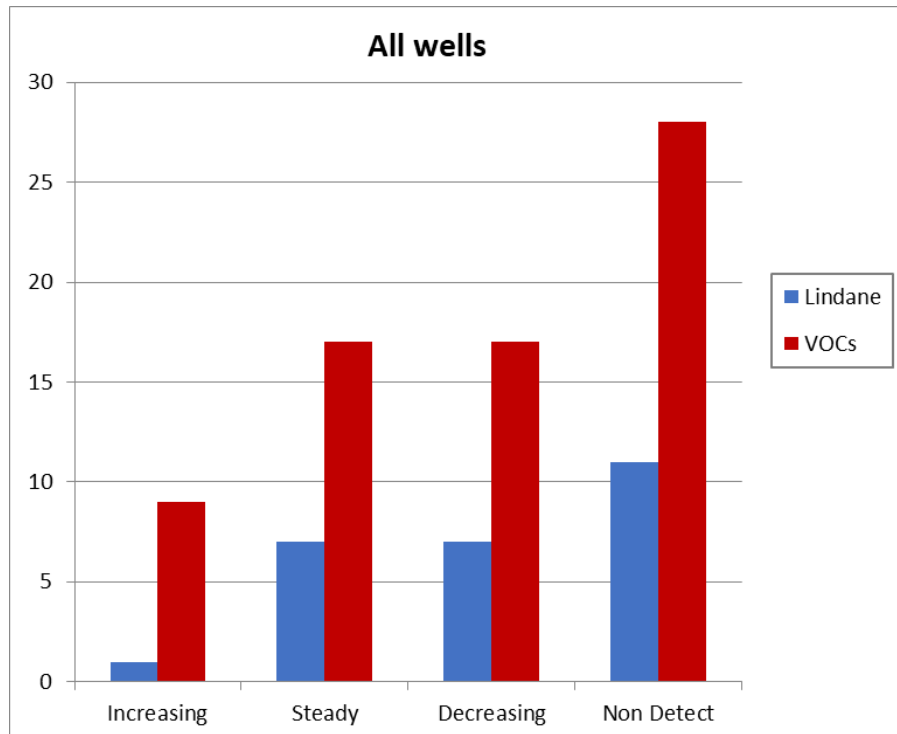


Figure 31. Comparison of PCE and Lindane Trends in CMP 10D and CMP 35D

This page is intentionally left blank.



Identification of the wells trend type can be found on the “Trends” tab in the Excel file (CMP_EMR_2021) located on the CD supplied with this report.

Figure 32. Contaminant Concentration Well Trends and Well Trends by Aquifer

This page is intentionally left blank.

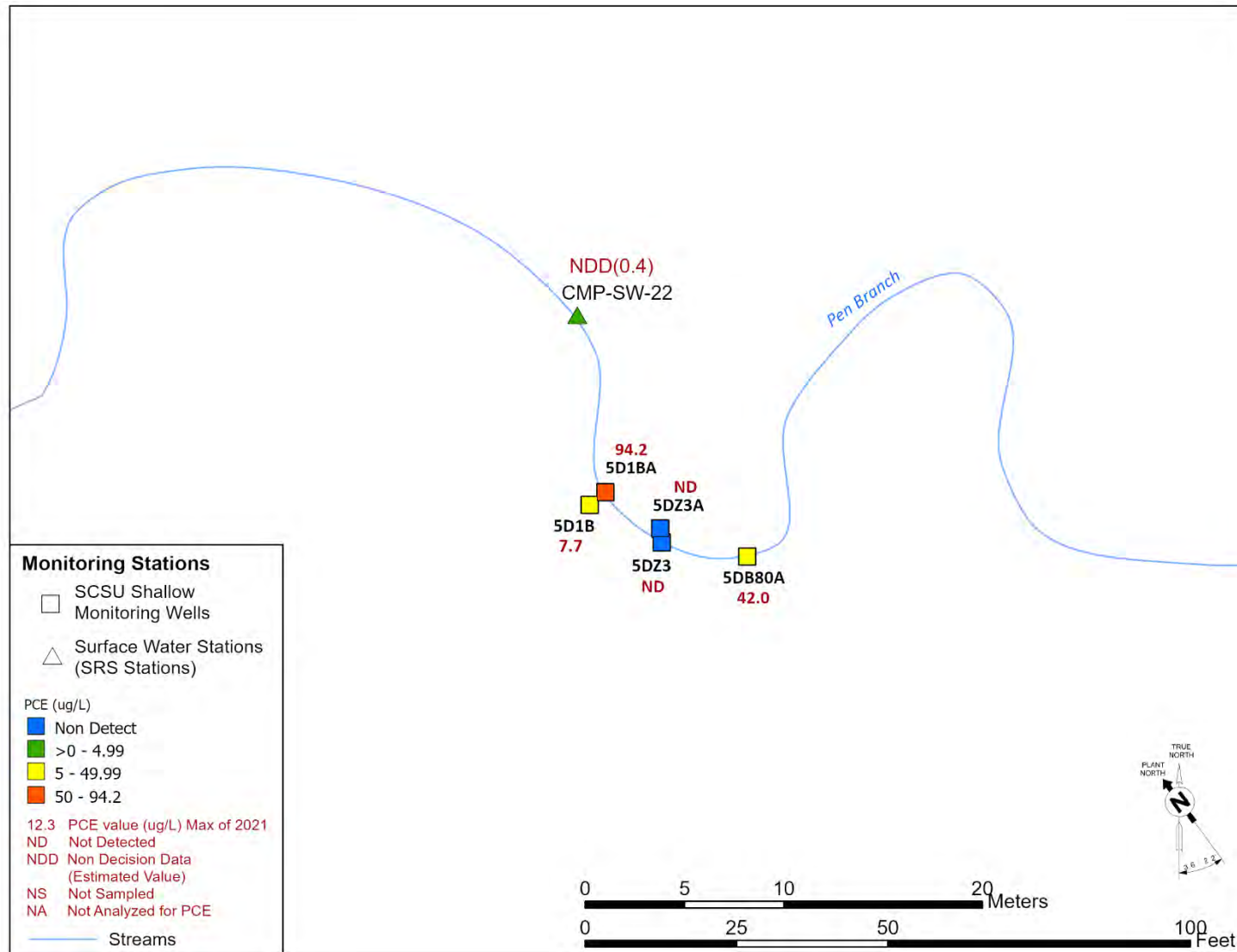


Figure 33. SCSU 2021 PCE Groundwater and Surface Water Results

This page is intentionally left blank.

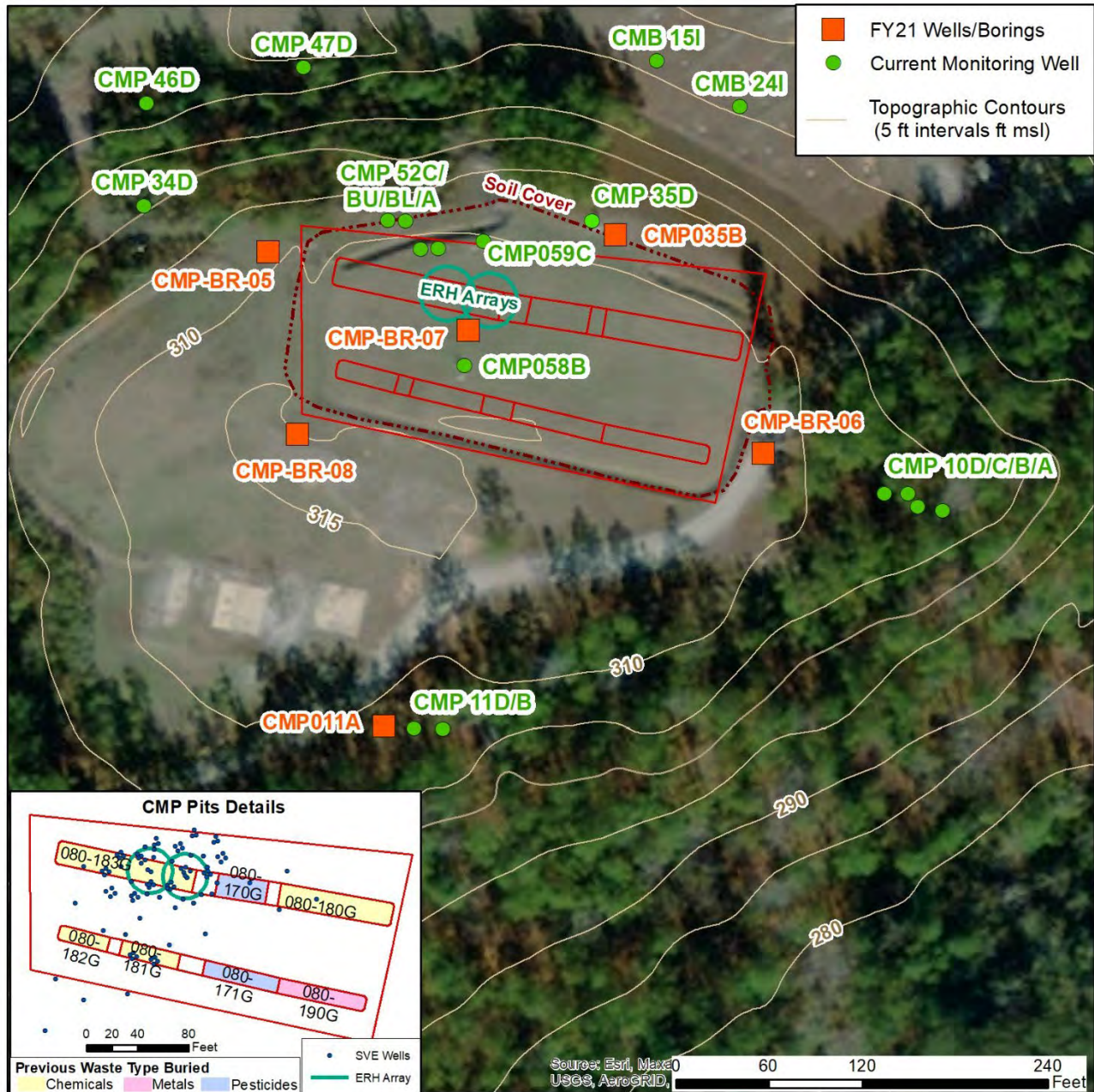


Figure 34. SRS Additional Sampling Locations in 2021

Table 1. CMP Pits OU MNA Monitoring Network

Station	Aquifer Unit	Lab Analyses			Screen Zone (ft msl)		screen length (ft)
		VOCs	1,4-Dioxane	Lindane	Bottom	Top	
CMB 15I	MAZ	2Q, 4Q	4Q	2Q, 4Q	210.7	212.4	1.7
CMB 24I	MAZ	2Q, 4Q	4Q		201	203	2
CMP 8	MAZ	2Q, 4Q	4Q		184	214	30
CMP 8A	GA	2Q	2Q		13.7	23.5	9.8
CMP 8B	LAZ (Upper)	2Q, 4Q	4Q		156.6	166.6	10
CMP010A	GA	2Q, 4Q	4Q		45.55	55.55	10
CMP 10B	LAZ (Mid)	2Q, 4Q	4Q	2Q, 4Q	137.4	147.4	10
CMP 10C	LAZ (Upper)	2Q, 4Q	4Q	2Q, 4Q	179.6	189.6	10
CMP 10D	TZ	2Q, 4Q	4Q	2Q, 4Q	209.6	229.6	20
CMP011A ⁺	GA	2Q	2Q		46.2	56.2	10
CMP 11B	LAZ (Mid)	2Q, 4Q	4Q	2Q, 4Q	139.7	149.7	10
CMP 11D	TZ	2Q, 4Q	4Q		209.47	229.87	20.4
CMP 12A	GA	2Q	2Q		22.1	32.1	10
CMP 12B	LAZ (Mid)	2Q, 4Q	4Q		148	158	10
CMP 13B	LAZ (Mid)	2Q, 4Q	4Q		134.2	144.2	10
CMP 13D	TZ	2Q, 4Q	4Q		217.5	227.5	10
CMP 14B	LAZ (Mid)				130	140	10
CMP 14CR	MAZ				186.49	196.49	10
CMP 14D	TZ				204.1	224.5	20.4
CMP 14DU	TZ				202.57	212.57	10
CMP 15A	GA	2Q	2Q		14.2	24.2	10
CMP 15B	MAZ				145.1	155.1	10
CMP 30B	LAZ (Lower)	2Q, 4Q	4Q		97.4	107.5	10.1
CMP 30C	MAZ	2Q, 4Q	4Q		179.5	189.5	10
CMP 30D	TZ	2Q, 4Q	4Q		211.6	231.6	20
CMP 31B	LAZ (Lower)	2Q, 4Q	4Q		110.03	120.03	10
CMP 31C	MAZ	2Q, 4Q	4Q		197.9	207.9	10
CMP 32C	LAZ (Upper)	2Q, 4Q	4Q		185.2	195.2	10
CMP 32B	LAZ (Lower)	2Q			97.7	107.7	10
CMP 33D	LAZ (Upper)	2Q, 4Q	4Q		178.6	188.6	10
CMP 34D	TZ			2Q, 4Q	215.6	225.6	10
CMP 35D	TZ	2Q, 4Q	4Q	2Q, 4Q	213.8	223.8	10
CMP035B ⁺	MAZ	2Q, 4Q	4Q	2Q	169.4	179.4	10
CMP 36D	TZ	2Q, 4Q	4Q		199.2	204.2	5
CMP 37D	TZ	2Q, 4Q	4Q		193.3	198.3	5
CMP 38D	TZ	2Q, 4Q	4Q		196.7	201.7	5
CMP 39D	MAZ	2Q, 4Q	4Q		190.9	195.9	5
CMP 40D	MAZ	2Q, 4Q	4Q		192.13	197.13	5
CMP 41D	MAZ	2Q, 4Q	4Q	2Q	191.7	196.7	5
CMP 43D	MAZ	2Q, 4Q	4Q	2Q	187.8	192.8	5
CMP 44D	MAZ	2Q, 4Q	4Q	2Q, 4Q	204.06	214.06	10
CMP 45D	MAZ	2Q, 4Q	4Q	2Q, 4Q	195.84	205.84	10
CMP 46D	MAZ			2Q, 4Q	198.44	208.44	10

⁺ Newly installed well during 2021. Proposed sampling listed.

Table 1. CMP Pits OU MNA Monitoring Network (*continued; end*)

Station	Aquifer Unit	Lab Analyses			Screen Zone (ft msl)		Screen Length (ft)
		VOCs	1,4-Dioxane	Lindane	Bottom	Top	
CMP 47D	MAZ	2Q, 4Q	4Q	2Q, 4Q	196.37	206.37	10
CMP 48D	MAZ	2Q, 4Q	4Q	4Q – 3 rd year*	198.83	208.83	10
CMP 50B	LAZ (Upper)	2Q, 4Q	4Q		167.33	172.33	5
CMP 50D	MAZ	2Q, 4Q	4Q		202.99	212.99	10
CMP 51D	MAZ	2Q, 4Q	4Q		182.27	192.27	10
CMP 52A	GA	2Q	2Q		66.65	76.65	10
CMP 52BL	LAZ (Lower)	2Q, 4Q	4Q		96.59	106.59	10
CMP 52BU	LAZ (Upper)	2Q, 4Q	4Q		180.91	190.91	10
CMP 52C	MAZ	2Q, 4Q	4Q		204.69	209.69	5
CMP 54C	LAZ (Upper)	2Q, 4Q	4Q		178.34	188.34	10
CMP055A	GA	2Q	2Q		16.92	26.92	10
CMP055B	LAZ (Mid)	2Q, 4Q	4Q		136.4	146.4	10
CMP 55C	MAZ	2Q, 4Q	4Q		177.62	187.62	10
CMP 56B	LAZ (Mid)				124.6	134.6	10
CMP 56D	MAZ				167.55	177.55	10
CMP 57B	LAZ (Mid)				125.25	135.25	10
CMP 57D	MAZ				168.21	178.21	10
CMP058B	LAZ (Upper)	2Q, 4Q	4Q	2Q, 4Q	182.7	192.6	9.9
CMP059C	MAZ	2Q, 4Q	4Q	2Q, 4Q	200.8	210.7	9.9
CMP060B	LAZ (Upper)	2Q, 4Q	4Q		171.6	181.6	10
CMP061B	LAZ (Mid)	2Q, 4Q	4Q		129.5	139.5	10
CMP062B	LAZ (Mid)	2Q	2Q		136	146	10
CMP062C	MAZ	2Q	2Q		186.8	191.8	5
CMP062D	TZ	2Q	2Q		210.6	230.6	20
CMP063B	LAZ (Mid)	4Q	2Q		126.1	136.1	10
CMP063C	MAZ	4Q	2Q		184.4	189.4	5
CMP063D	TZ	4Q	2Q		195.7	215.7	20
CMP064BU	LAZ (Upper)	2Q, 4Q	4Q	2Q, 4Q	149.2	159.2	10
CMP064B	LAZ (Lower)	2Q, 4Q	4Q		118.8	128.8	10
CMP065BU	MAZ	2Q, 4Q	4Q	2Q, 4Q	194.37	204.37	10
CMP065B	LAZ (Mid)	2Q, 4Q	4Q		128.94	138.94	10
CMP066B	LAZ (Mid)	4Q	4Q		138.7	148.7	10
CMP067B	LAZ (Mid)	4Q	4Q		143.1	153.1	10
CMPSW-06	SW	2Q, 4Q	4Q				
CMPSW-07	SW	2Q, 4Q	4Q				
CMPSW-08	SW	2Q, 4Q	4Q				
CMPSW-09	SW	2Q, 4Q	4Q				
CMPSW-10	SW	2Q, 4Q	4Q				
CMP-SW-20	SW	2Q, 4Q	4Q				
CMP-SW-21	SW	2Q, 4Q	4Q				
CMP-SW-22	SW	2Q, 4Q	4Q				

*Lindane is analyzed every third year (i.e., 2020, 2023, 2026, etc.)

Table 2. CMP Pits OU Horizontal Groundwater Flow Velocities (4Q21)

GW Flow Line	dh	dl	Conductivity	Porosity	Velocity (ft/day)	Velocity (ft/year)
TZ						
A - A'	20	1438	8	0.3	0.37	135.47
B - B'	20.8	1452	8	0.3	0.38	139.53
C - C'	5.5	1141	8	0.3	0.13	46.95
TZ Avg.					0.29	107.31
MAZ						
A - A'	15	1516	50	0.3	1.65	602.33
B - B'	15	1454	50	0.3	1.72	628.01
MAZ Avg.					1.68	615.17
LAZ						
A - A'	4.4	1885	30	0.3	0.23	85.26
B - B'	3	366	30	0.3	0.82	299.39
C - C'	7.5	658	30	0.3	1.14	416.32
D - D'	4.4	1262	30	0.3	0.35	127.35
LAZ Avg.					0.64	232.08
GA						
A - A'	2	1458	20	0.3	0.09	33.40
B - B'	2	335	20	0.3	0.40	145.37
GA Avg.					0.24	89.39

dh= difference in head; dl= difference in length

Table 3. CMP Pits OU Annual MNA Results, April 2021 through March 2022

See insert on the next page

This page is intentionally left blank.

Table 3.
CMP Pits OU Annual MNA Results,
April 2021 through March 2022

Field Data															CMP MNA Analyte Suite																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Station	Well Use	Aquifer Zone	Sample Collection Date	Water Temperature	pH	Specific Conductance	Oxygen	Oxidation/Reduction Potential	Turbidity	Depth to Water	Phenolphthalein Alkalinity (AS CaCO3)	Total Alkalinity (AS CaCO3)	Flow Rate	Air Temperature	Volume Purged	Sampling Event Water Elevation	Synchronous Measurement Date	Synchronous Water Elevation	Conductivity	Field Conditions	Pesticides																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
																					4/2021	5/2021	6/2021	7/2021	8/2021	9/2021	10/2021	11/2021	12/2021	1/2022	2/2022	3/2022	4/2022	5/2022	6/2022	7/2022	8/2022	9/2022	10/2022	11/2022	12/2022	1/2023	2/2023	3/2023	4/2023	5/2023	6/2023	7/2023	8/2023	9/2023	10/2023	11/2023	12/2023	1/2024	2/2024	3/2024	4/2024	5/2024	6/2024	7/2024	8/2024	9/2024	10/2024	11/2024	12/2024	1/2025	2/2025	3/2025	4/2025	5/2025	6/2025	7/2025	8/2025	9/2025	10/2025	11/2025	12/2025	1/2026	2/2026	3/2026	4/2026	5/2026	6/2026	7/2026	8/2026	9/2026	10/2026	11/2026	12/2026	1/2027	2/2027	3/2027	4/2027	5/2027	6/2027	7/2027	8/2027	9/2027	10/2027	11/2027	12/2027	1/2028	2/2028	3/2028	4/2028	5/2028	6/2028	7/2028	8/2028	9/2028	10/2028	11/2028	12/2028	1/2029	2/2029	3/2029	4/2029	5/2029	6/2029	7/2029	8/2029	9/2029	10/2029	11/2029	12/2029	1/2030	2/2030	3/2030	4/2030	5/2030	6/2030	7/2030	8/2030	9/2030	10/2030	11/2030	12/2030	1/2031	2/2031	3/2031	4/2031	5/2031	6/2031	7/2031	8/2031	9/2031	10/2031	11/2031	12/2031	1/2032	2/2032	3/2032	4/2032	5/2032	6/2032	7/2032	8/2032	9/2032	10/2032	11/2032	12/2032	1/2033	2/2033	3/2033	4/2033	5/2033	6/2033	7/2033	8/2033	9/2033	10/2033	11/2033	12/2033	1/2034	2/2034	3/2034	4/2034	5/2034	6/2034	7/2034	8/2034	9/2034	10/2034	11/2034	12/2034	1/2035	2/2035	3/2035	4/2035	5/2035	6/2035	7/2035	8/2035	9/2035	10/2035	11/2035	12/2035	1/2036	2/2036	3/2036	4/2036	5/2036	6/2036	7/2036	8/2036	9/2036	10/2036	11/2036	12/2036	1/2037	2/2037	3/2037	4/2037	5/2037	6/2037	7/2037	8/2037	9/2037	10/2037	11/2037	12/2037	1/2038	2/2038	3/2038	4/2038	5/2038	6/2038	7/2038	8/2038	9/2038	10/2038	11/2038	12/2038	1/2039	2/2039	3/2039	4/2039	5/2039	6/2039	7/2039	8/2039	9/2039	10/2039	11/2039	12/2039	1/2040	2/2040	3/2040	4/2040	5/2040	6/2040	7/2040	8/2040	9/2040	10/2040	11/2040	12/2040	1/2041	2/2041	3/2041	4/2041	5/2041	6/2041	7/2041	8/2041	9/2041	10/2041	11/2041	12/2041	1/2042	2/2042	3/2042	4/2042	5/2042	6/2042	7/2042	8/2042	9/2042	10/2042	11/2042	12/2042	1/2043	2/2043	3/2043	4/2043	5/2043	6/2043	7/2043	8/2043	9/2043	10/2043	11/2043	12/2043	1/2044	2/2044	3/2044	4/2044	5/2044	6/2044	7/2044	8/2044	9/2044	10/2044	11/2044	12/2044	1/2045	2/2045	3/2045	4/2045	5/2045	6/2045	7/2045	8/2045	9/2045	10/2045	11/2045	12/2045	1/2046	2/2046	3/2046	4/2046	5/2046	6/2046	7/2046	8/2046	9/2046	10/2046	11/2046	12/2046	1/2047	2/2047	3/2047	4/2047	5/2047	6/2047	7/2047	8/2047	9/2047	10/2047	11/2047	12/2047	1/2048	2/2048	3/2048	4/2048	5/2048	6/2048	7/2048	8/2048	9/2048	10/2048	11/2048	12/2048	1/2049	2/2049	3/2049	4/2049	5/2049	6/2049	7/2049	8/2049	9/2049	10/2049	11/2049	12/2049	1/2050	2/2050	3/2050	4/2050	5/2050	6/2050	7/2050	8/2050	9/2050	10/2050	11/2050	12/2050	1/2051	2/2051	3/2051	4/2051	5/2051	6/2051	7/2051	8/2051	9/2051	10/2051	11/2051	12/2051	1/2052	2/2052	3/2052	4/2052	5/2052	6/2052	7/2052	8/2052	9/2052	10/2052	11/2052	12/2052	1/2053	2/2053	3/2053	4/2053	5/2053	6/2053	7/2053	8/2053	9/2053	10/2053	11/2053	12/2053	1/2054	2/2054	3/2054	4/2054	5/2054	6/2054	7/2054	8/2054	9/2054	10/2054	11/2054	12/2054	1/2055	2/2055	3/2055	4/2055	5/2055	6/2055	7/2055	8/2055	9/2055	10/2055	11/2055	12/2055	1/2056	2/2056	3/2056	4/2056	5/2056	6/2056	7/2056	8/2056	9/2056	10/2056	11/2056	12/2056	1/2057	2/2057	3/2057	4/2057	5/2057	6/2057	7/2057	8/2057	9/2057	10/2057	11/2057	12/2057	1/2058	2/2058	3/2058	4/2058	5/2058	6/2058	7/2058	8/2058	9/2058	10/2058	11/2058	12/2058	1/2059	2/2059	3/2059	4/2059	5/2059	6/2059	7/2059	8/2059	9/2059	10/2059	11/2059	12/2059	1/2060	2/2060	3/2060	4/2060	5/2060	6/2060	7/2060	8/2060	9/2060	10/2060	11/2060	12/2060	1/2061	2/2061	3/2061	4/2061	5/2061	6/2061	7/2061	8/2061	9/2061	10/2061	11/2061	12/2061	1/2062	2/2062	3/2062	4/2062	5/2062	6/2062	7/2062	8/2062	9/2062	10/2062	11/2062	12/2062	1/2063	2/2063	3/2063	4/2063	5/2063	6/2063	7/2063	8/2063	9/2063	10/2063	11/2063	12/2063	1/2064	2/2064	3/2064	4/2064	5/2064	6/2064	7/2064	8/2064	9/2064	10/2064	11/2064	12/2064	1/2065	2/2065	3/2065	4/2065	5/2065	6/2065	7/2065	8/2065	9/2065	10/2065	11/2065	12/2065	1/2066	2/2066	3/2066	4/2066	5/2066	6/2066	7/2066	8/2066	9/2066	10/2066	11/2066	12/2066	1/2067	2/2067	3/2067	4/2067	5/2067	6/2067	7/2067	8/2067	9/2067	10/2067	11/2067	12/2067	1/2068	2/2068	3/2068	4/2068	5/2068	6/2068	7/2068	8/2068	9/2068	10/2068	11/2068	12/2068	1/2069	2/2069	3/2069	4/2069	5/2069	6/2069	7/2069	8/2069	9/2069	10/2069	11/2069	12/2069	1/2070	2/2070	3/2070	4/2070	5/2070	6/2070	7/2070	8/2070	9/2070	10/2070	11/2070	12/2070	1/2071	2/2071	3/2071	4/2071	5/2071	6/2071	7/2071	8/2071	9/2071	10/2071	11/2071	12/2071	1/2072	2/2072	3/2072	4/2072	5/2072	6/2072	7/2072	8/2072	9/2072	10/2072	11/2072	12/2072	1/2073	2/2073	3/2073	4/2073	5/2073	6/2073	7/2073	8/2073	9/2073	10/2073	11/2073	12/2073	1/2074	2/2074	3/2074	4/2074	5/2074	6/2074	7/2074	8/2074	9/2074	10/2074	11/2074	12/2074	1/2075	2/2075	3/2075	4/2075	5/2075	6/2075	7/2075	8/2075	9/2075	10/2075	11/2075	12/2075	1/2076	2/2076	3/2076	4/2076	5/2076	6/2076	7/2076	8/2076	9/2076	10/2076	11/2076	12/2076	1/2077	2/2077	3/2077	4/2077	5/2077	6/2077	7/2077	8/2077	9/2077	10/2077	11/2077	12/2077	1/2078	2/2078	3/2078	4/2078	5/2078	6/2078	7/2078	8/2078	9/2078	10/2078	11/2078	12/2078	1/2079	2/2079	3/2079	4/2079	5/2079	6/2079	7/2079	8/2079	9/2079	10/2079	11/2079	12/2079	1/2080	2/2080	3/2080	4/2080	5/2080	6/2080	7/2080	8/2080	9/2080	10/2080	11/2080	12/2080	1/2081	2/2081	3/2081	4/2081	5/2081	6/2081	7/2081	8/2081	9/2081	10/2081	11/2081	12/2081	1/2082	2/2082	3/2082	4/2082	5/2082	6/2082	7/2082	8/2082	9/2082	10/2082	11/2082	12/2082	1/2083	2/2083	3/2083	4/2083	5/2083	6/2083	7/2083	8/2083	9/2083	10/2083	11/2083	12/2083	1/2084	2/2084	3/2084	4/2084	5/2084	6/2084	7/2084	8/2084	9/2084	10/2084	11/2084	12/2084	1/2085	2/2085	3/2085	4/2085	5/2085	6/2085	7/2085	8/2085	9/2085	10/2085	11/2085	12/2085	1/2086	2/2086	3/2086	4/2086	5/2086	6/2086	7/2086	8/2086	9/2086	10/2086	11/2086	12/2086	1/2087	2/2087	3/2087	4/2087	5/2087	6/2087	7/2087	8/2087	9/2087	10/2087	11/2087	12/2087	1/2088	2/2088	3/2088	4/2088	5/2088	6/2088	7/2088	8/2088	9/2088	10/2088	11/2088	12/2088	1/2089	2/2089	3/2089	4/2089	5/2089	6/2089	7/2089	8/2089	9/2089	10/2089	11/2089	12/2089	1/2090	2/2090	3/2090	4/2090	5/2090	6/2090	7/2090	8/2090	9/2090	10/2090	11/2090	12/2090	1/2091	2/2091	3/2091	4/2091	5/2091	6/2091	7/2091	8/2091	9/2091	10/2091	11/2091	12/2091	1/2092	2/2092	3/2092	4/2092	5/2092	6/2092	7/2092	8/2092	9/2092	10/2092	11/2092	12/2092	1/2093	2/2093	3/2093	4/2093	5/2093	6/2093	7/2093	8/2093	9/2093	10/2093	11/2093	12/2093	1/2094	2/2094	3/2094	4/2094	5/2094	6/2094	7/2094	8/2094	9/2094	10/2094	11/2094	12/2094	1/2095	2/2095	3/2095	4/2095	5/2095	6/2095	7/2095	8/2095	9/2095	10/2095	11/2095	12/2095	1/2096	2/2096	3/2096	4/2096	5/2096	6/2096	7/2096	8/2096	9/2096	10/2096	11/2096	12/2096	1/2097	2/2097	3/2097	4/2097	5/2097	6/2097	7/2097	8/2097	9/2097	10/2097	11/2097	12/2097	1/2098	2/2098	3/2098	4/2098	5/2098	6/2098	7/2098	8/2098	9/2098	10/2098	11/2098	12/2098	1/2099	2/2099	3/2099
CMP 10D	Monitoring Well	TZ UAZ UTRAU	28-Apr-2021	18.5	3.1	2703	NS	NS	8.4	90.1	NS	NS	0.1	17.8	3	221.6	26-Apr-2021	221.4	0.0258																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

Table 4. CMP Pits OU PCE Max Results from 2008 and 2021 (µg/L)

Station	Aquifer	2008 Max (Pre ERH/SVE)	2021 Max
CMP 10D	TZ	620	13.7
CMP 11D	TZ	421	24.8
CMP 13D	TZ	1.71	25.8
CMP 14D	TZ	NS	NS
CMP 14DU	TZ	NS	NS
CMP 30D	TZ	<EQL(1)	<EQL(1)
CMP 34D	TZ	49.4	122
CMP 35D	TZ	122	NDD(1,890)
CMP 36D	TZ	56.9	20.7
CMP 37D	TZ	358	28.6
CMP 38D	TZ	48.2	45.8
CMP062D	TZ	<EQL(1)	<EQL(1)
CMP063D	TZ	<EQL(1)	<EQL(1)
CMB 15I	MAZ	437	NDD(294)
CMB 24I	MAZ	20.8	248
CMP 8	MAZ	299	108
CMP 14CR	MAZ	<EQL(1)	NS
CMP 15B	MAZ	<EQL(1)	<EQL(1)
CMP 30C	MAZ	3.78	1.44
CMP 31C	MAZ	NS - Dry	1.69
CMP 39D	MAZ	71.7	13.8
CMP 40D	MAZ	135	3.69
CMP 41D	MAZ	5.48	6.6
CMP 43D	MAZ	<EQL(1)	<EQL(1)
CMP 44D	MAZ	312	153
CMP 45D	MAZ	973	256
CMP 46D	MAZ	NDD(434)	NA
CMP 47D	MAZ	NDD(845)	637
CMP 48D	MAZ	601	271
CMP 50D	MAZ	8.62	3.01
CMP 51D	MAZ	13.4	4.02
CMP 52C	MAZ	NS	178
CMP 55C	MAZ	<EQL(1)	NDD(.87)
CMP 56D	MAZ	NS	NS
CMP 57D	MAZ	NS	NS
CMP059C	MAZ	78.5	317
CMP062C	MAZ	<EQL(1)	<EQL(1)
CMP063C	MAZ	<EQL(1)	<EQL(1)
CMP065BU	MAZ	NS	30.4
CMP 8B	LAZ	<EQL(1)	4.98
CMP 10B	LAZ	<EQL(1)	11

Station	Aquifer	2008 Max (Pre ERH/SVE)	2021 Max
CMP 10C	LAZ	466	212
CMP 11B	LAZ	<EQL(1)	<EQL(1)
CMP 12B	LAZ	46.3	42.6
CMP 13B	LAZ	1.25	13.2
CMP 14B	LAZ	<EQL(1)	NS
CMP 30B	LAZ	<EQL(1)	<EQL(1)
CMP 31B	LAZ	<EQL(1)	NDD(1)
CMP 32C	LAZ	110	285
CMP 33D	LAZ	16.4	2.74
CMP 50B	LAZ	<EQL(1)	NDD(0.73)
CMP 52BL	LAZ	<EQL(1)	<EQL(1)
CMP 52BU	LAZ	35.1	192
CMP 54C	LAZ	NDD(196)	273
CMP055B	LAZ	NS	<EQL(1)
CMP 56B	LAZ	NS	<EQL(1)
CMP 57B	LAZ	NS	<EQL(1)
CMP058B	LAZ	6.51	38.4
CMP060B	LAZ	<EQL(1)	<EQL(1)
CMP061B	LAZ	<EQL(1)	<EQL(1)
CMP062B	LAZ	<EQL(1)	<EQL(1)
CMP063B	LAZ	<EQL(1)	<EQL(1)
CMP064BU	LAZ	NS	177
CMP064B	LAZ	NS	<EQL(1)
CMP065B	LAZ	NS	NDD(0.4)
CMP066B	LAZ	NS	<EQL(1)
CMP067B	LAZ	NS	<EQL(1)
CMP 8A	GA	<EQL(1)	<EQL(1)
CMP010A	GA	NS	106
CMP 12A	GA	NDD(0.679)	NDD(0.84)
CMP 15A	GA	<EQL(1)	<EQL(1)
CMP 52A	GA	<EQL(1)	<EQL(1)
CMP055A	GA	NS	<EQL(1)
CMP-SW-06	SW	<EQL(1)	<EQL(1)
CMP-SW-07	SW	NDD(0.63)	<EQL(1)
CMP-SW-08	SW	<EQL(1)	<EQL(1)
CMP-SW-09	SW	<EQL(1)	<EQL(1)
CMP-SW-10	SW	1.38	<EQL(1)
CMP-SW-20	SW	NS	<EQL(1)
CMP-SW-21	SW	NS	<EQL(1)
CMP-SW-22	SW	NS	NDD(0.4)

EQL=Sample Quantitation Limit (non-detect result); NDD=Not Decision Data (estimated result); NS = Not sampled; NA= Not analyzed for VOCs

Table 5. CMP Pits OU Lindane Max Results from 2008 and 2021 (µg/L)

Station	Aquifer	2008 Max (Pre ERH/SVE)	2021 Max
CMP 10D	TZ	0.185	0.0258
CMP 11D	TZ	0.0509	NDD(0.02)
CMP 13D	TZ	<EQL(0.0225)	NDD(0.02)
CMP 14D	TZ	NS	NS
CMP 14DU	TZ	NS	NS
CMP 30D	TZ	<EQL(0.0222)	NA
CMP 34D	TZ	0.345	0.0938
CMP 35D	TZ	1.73	5.14
CMP 36D	TZ	<EQL(0.0217)	NA
CMP 37D	TZ	<EQL(0.0217)	NA
CMP 38D	TZ	<EQL(0.0217)	NA
CMP062D	TZ	<EQL(1)	NA
CMP063D	TZ	<EQL(1)	NA
CMB 15I	MAZ	0.165	NDD(0.0214)
CMB 24I	MAZ	NDD(0.0192)	NA
CMP 8	MAZ	NDD(0.0192)	NA
CMP 14CR	MAZ	<EQL(0.0222)	NS
CMP 15B	MAZ	<EQL(0.0213)	NS
CMP 30C	MAZ	<EQL(0.0213)	NA
CMP 31C	MAZ	NS - Dry	NA
CMP 39D	MAZ	<EQL(0.0217)	NA
CMP 40D	MAZ	<EQL(0.0217)	NA
CMP 41D	MAZ	<EQL(0.0227)	NA
CMP 43D	MAZ	<EQL(1)	NA
CMP 44D	MAZ	0.474	0.118
CMP 45D	MAZ	0.484	0.146
CMP 46D	MAZ	0.704	0.162
CMP 47D	MAZ	0.36	0.162
CMP 48D	MAZ	0.157	NA
CMP 50D	MAZ	<EQL(0.0217)	NA
CMP 51D	MAZ	<EQL(0.0217)	NA
CMP 52C	MAZ	NS	0.052
CMP 55C	MAZ	<EQL(0.0213)	NA
CMP 56D	MAZ	NS	NA
CMP 57D	MAZ	NS	NA
CMP059C	MAZ	0.362	0.152
CMP062C	MAZ	<EQL(0.0213)	NA
CMP063C	MAZ	<EQL(0.0217)	NA
CMP065BU	MAZ	NS	NDD(.02)
CMP 8B	LAZ	<EQL(0.0217)	NA
CMP 10B	LAZ	<EQL(0.0217)	NDD(0.0219)

Station	Aquifer	2008 Max (Pre ERH/SVE)	2021 Max
CMP 10C	LAZ	0.126	0.411
CMP 11B	LAZ	<EQL(0.02)	<EQL(.02)
CMP 12B	LAZ	NDD(0.0184)	NA
CMP 13B	LAZ	<EQL(0.0227)	NA
CMP 14B	LAZ	<EQL(0.0222)	NS
CMP 30B	LAZ	<EQL(0.0213)	NA
CMP 31B	LAZ	<EQL(0.0213)	NA
CMP 32C	LAZ	<EQL(0.0217)	NA
CMP 33D	LAZ	<EQL(0.0217)	NA
CMP 50B	LAZ	<EQL(0.0222)	NA
CMP 52BL	LAZ	<EQL(0.0217)	NA
CMP 52BU	LAZ	<EQL(0.0227)	NA
CMP 54C	LAZ	<EQL(0.0202)	NA
CMP 56B	LAZ	NS	NA
CMP 57B	LAZ	NS	NA
CMP055B	LAZ	NS	NA
CMP058B	LAZ	<EQL(0.0227)	<EQL(.02)
CMP060B	LAZ	<EQL(0.0217)	NA
CMP061B	LAZ	<EQL(0.0241)	NA
CMP062B	LAZ	<EQL(0.023)	NA
CMP063B	LAZ	<EQL(0.0217)	NA
CMP064B	LAZ	NS	NA
CMP064BU	LAZ	NS	0.174
CMP065B	LAZ	NS	NA
CMP066B	LAZ	NS	NA
CMP067B	LAZ	NS	NA
CMP 8A	GA	<EQL(0.0217)	NA
CMP010A	GA	NS	0.162
CMP 12A	GA	<EQL(0.0213)	NA
CMP 15A	GA	<EQL(0.0227)	NA
CMP 52A	GA	<EQL(0.0217)	NA
CMP055A	GA	NS	NA
CMP-SW-06	SW	NA	NA
CMP-SW-07	SW	NA	NA
CMP-SW-08	SW	NA	NA
CMP-SW-09	SW	NA	NA
CMP-SW-10	SW	NA	NA
CMP-SW-20	SW	NS	NA
CMP-SW-21	SW	NS	NA
CMP-SW-22	SW	NS	NA

EQL=Sample Quantitation Limit (non-detect result); NDD=Not Decision Data (estimated result); NS = Not sampled;
NA= Not analyzed for lindane

Table 6. SCSU Groundwater Water Results from 2021

PEN BRANCH STATION ID	COLLECTION DATE	SAMPLE TYPE	SAMPLE LOCATION	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans1,2-DCE	VC	Ethylene
				(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
				5	5	7	70	100	2	--
SCSU-CMP-5D1B	6/23/2021	GW - Pump	Below Stream Bottom	7.7	4.8	ND	15.3	ND	1.2	--
SCSU-CMP-5D1B	7/15/2021	GW - PDB	Below Stream Bottom	ND	ND	ND	6.83	ND	3.5	--
SCSU-CMP-5D1B	7/19/2021	GW - Pump	Below Stream Bottom	--	--	--	--	--	--	ND
SCSU-CMP-5D1BA	1/5/2021	GW - Pump	Below Stream Bottom	69.2	22.5	ND	21.8	ND	2.2	--
SCSU-CMP-5D1BA	1/5/2021	GW - PDB	Below Stream Bottom	94.2	32.3	ND	30.5	ND	2.4	--
SCSU-CMP-5DB80	6/23/2021	GW - Pump	Below Stream Bottom	61.0	22.7	ND	7.1	ND	ND	--
SCSU-CMP-5DB80	7/15/2021	GW - PDB	Below Stream Bottom	51.0	25.0	ND	15.0	ND	ND	--
SCSU-CMP-5DB80A	1/5/2021	GW - Pump	Below Stream Bottom	27.8	13.8	ND	51.5	ND	4.3	--
SCSU-CMP-5DB80A	1/5/2021	GW - PDB	Below Stream Bottom	42.0	19.8	ND	54.0	ND	4.2	--
SCSU-CMP-5DB80A	6/23/2021	GW - Pump	Below Stream Bottom	34.7	15.0	ND	28.0	ND	3.0	--
SCSU-CMP-5DB80A	7/15/2021	GW - PDB	Below Stream Bottom	15.0	8.3	ND	42.3	ND	1.9	
SCSU-CMP-5DZ3	6/23/2021	GW - Pump	Below Stream Bottom	ND	ND	ND	13.7	ND	47.3	
SCSU-CMP-5DZ3	7/15/2021	GW - PDB	Below Stream Bottom	ND	ND	ND	10.3	ND	27.3	
SCSU-CMP-5DZ3	7/19/2021	GW - PDB	Below Stream Bottom	--	--	--	--	--	--	ND
SCSU-CMP-5DZ3	7/19/2021	GW - Pump	Below Stream Bottom	--	--	--	--	--	--	ND
SCSU-CMP-5DZ3A	1/5/2021	GW - PDB	Below Stream Bottom	ND	ND	ND	4.0	ND	31.8	--
SCSU-CMP-5DZ3A	1/5/2021	GW - Pump	Below Stream Bottom	ND	ND	ND	3.2	ND	27.5	--
SCSU-CMP-5DZ3A	6/23/2021	GW - PDB	Below Stream Bottom	ND	ND	ND	23.5	ND	35.5	
SCSU-CMP-5DZ3A	7/15/2021	GW - Pump	Below Stream Bottom	ND	ND	ND	11.0	ND	11.0	
SCSU-CMP-5DZ3A	7/19/2021	GW - PDB	Below Stream Bottom	--	--	--	--	--	--	ND
SCSU-CMP-5DZ3A	7/19/2021	GW - Pump	Below Stream Bottom	--	--	--	--	--	--	ND

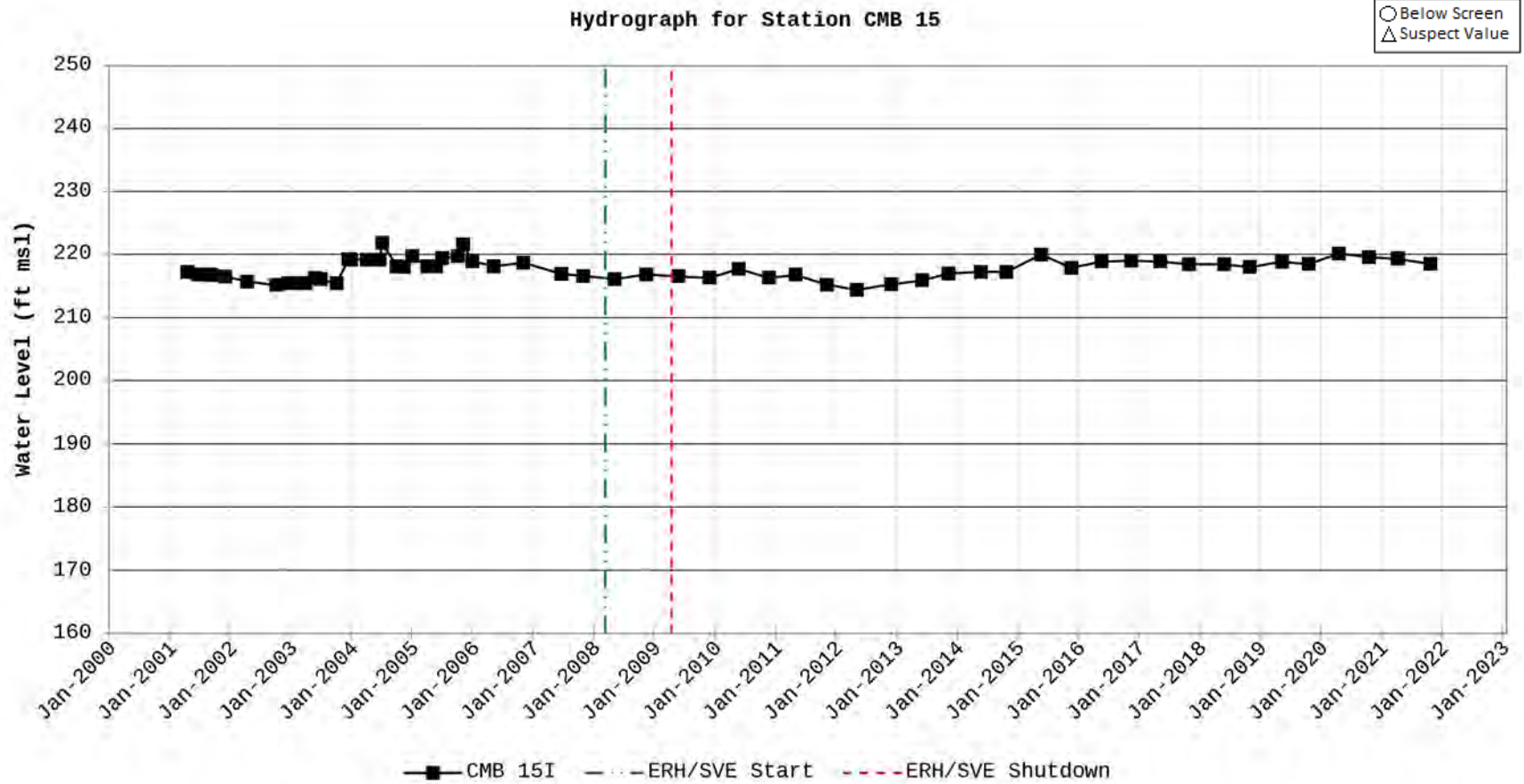
ND = not detected; detection >MCL

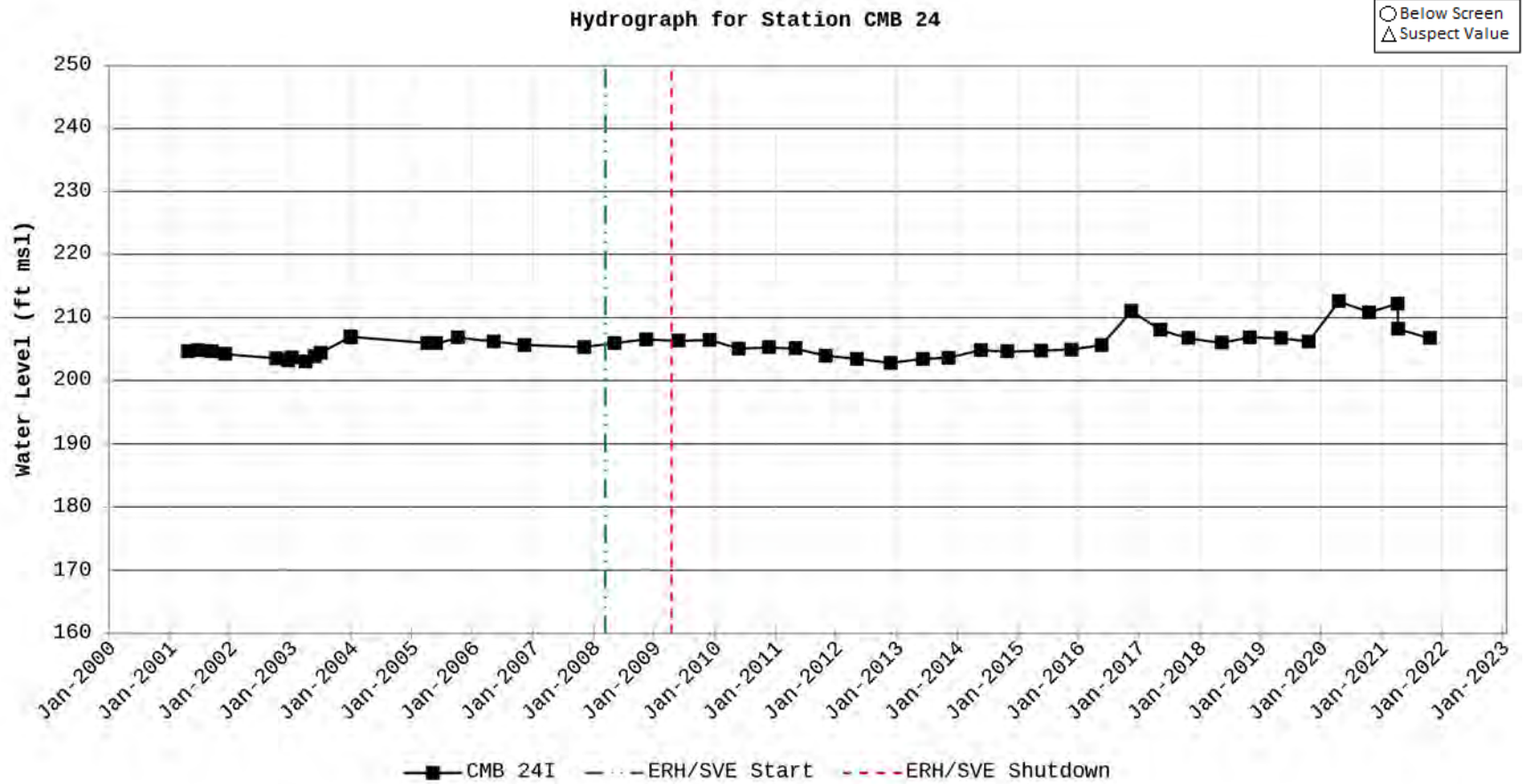
This page is intentionally left blank.

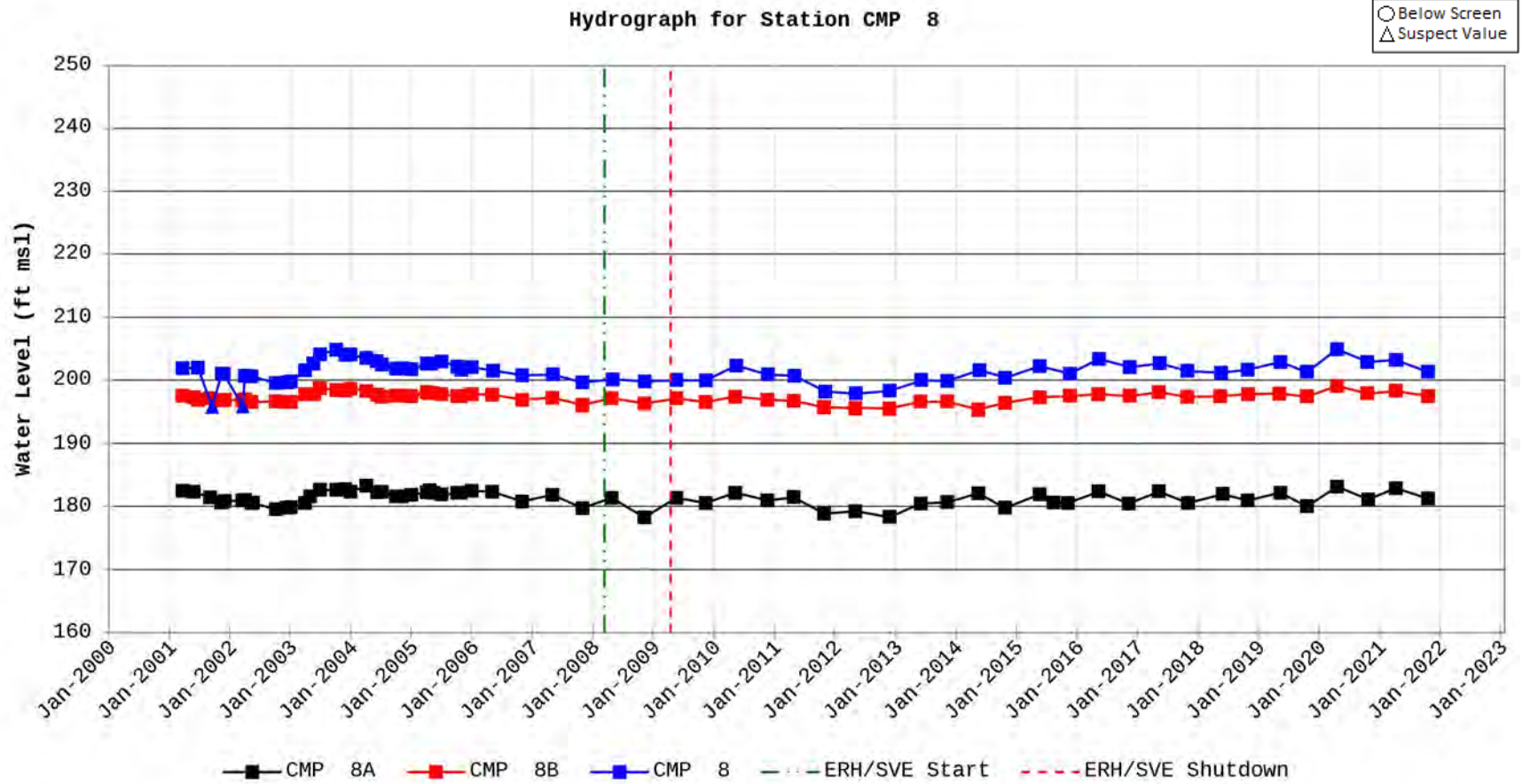
Appendix A

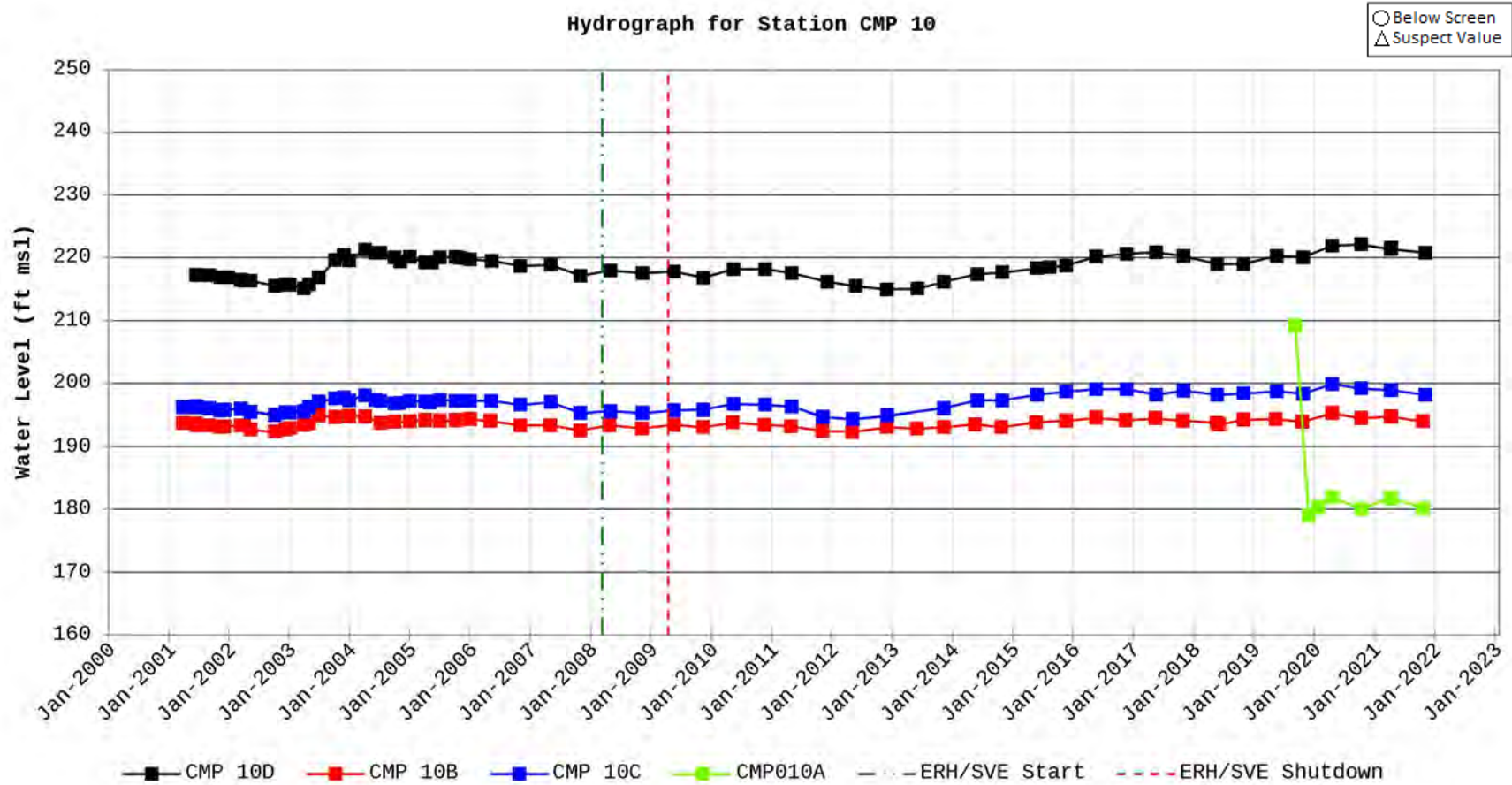
Hydrographs

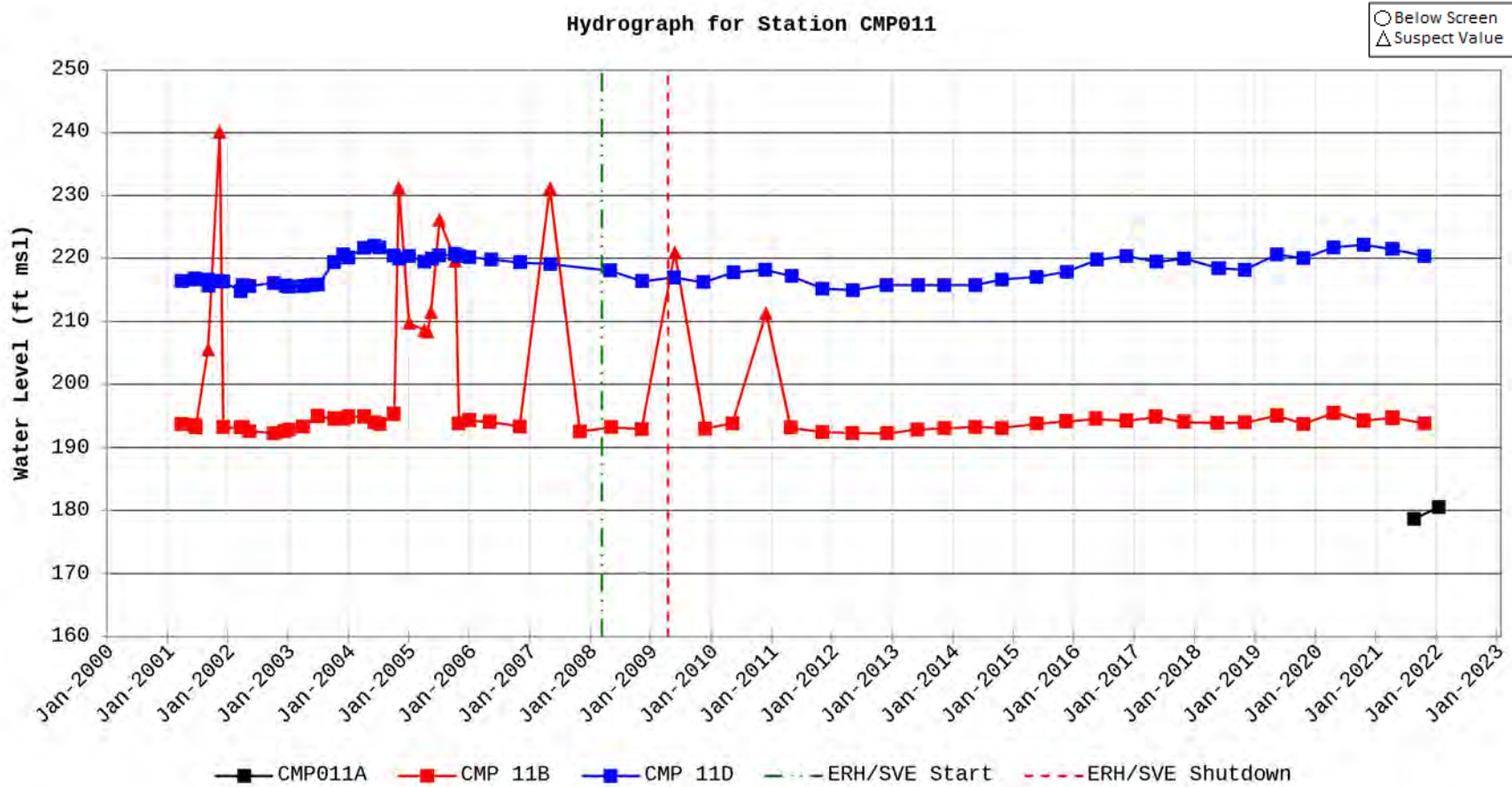
This page is intentionally left blank.

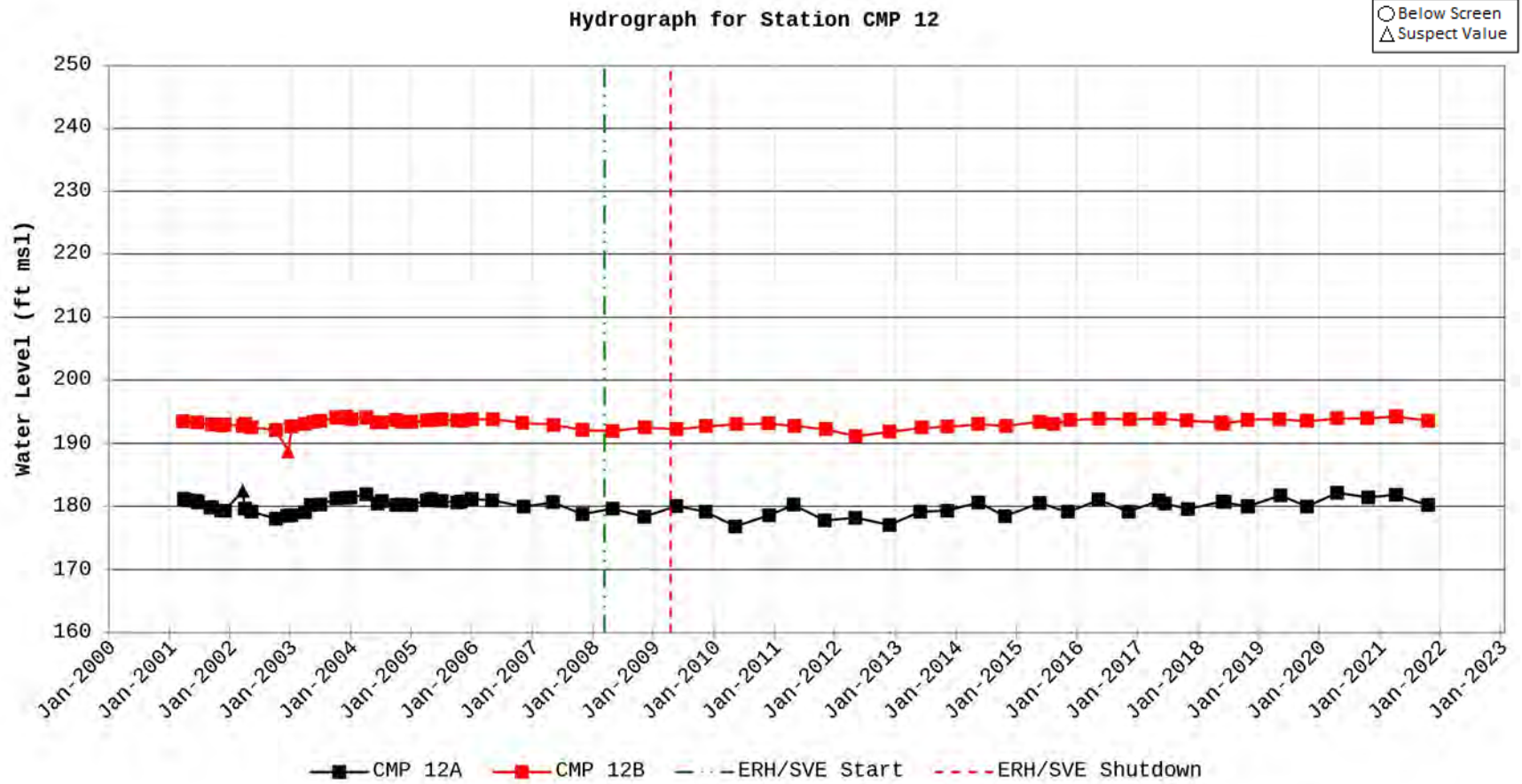


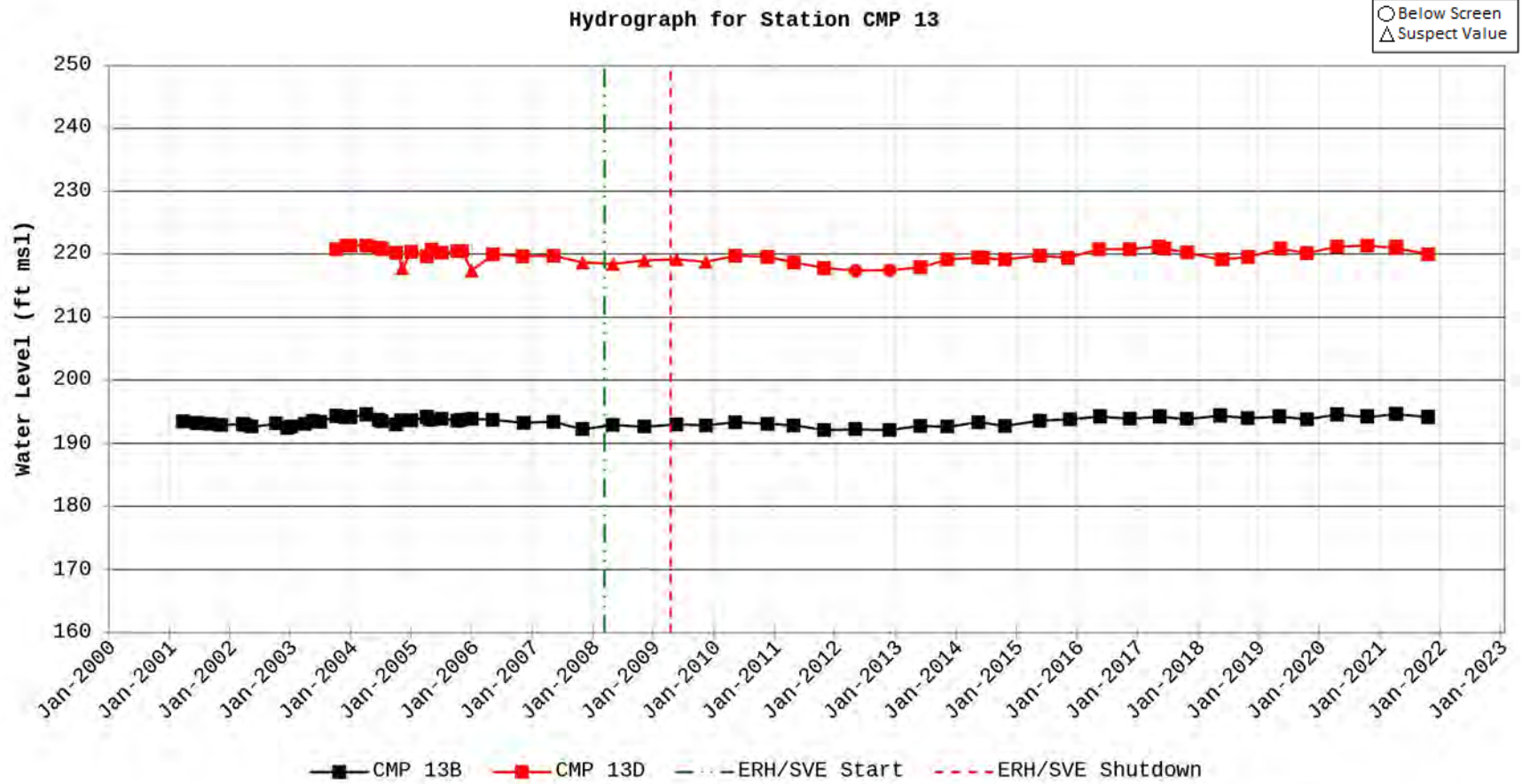


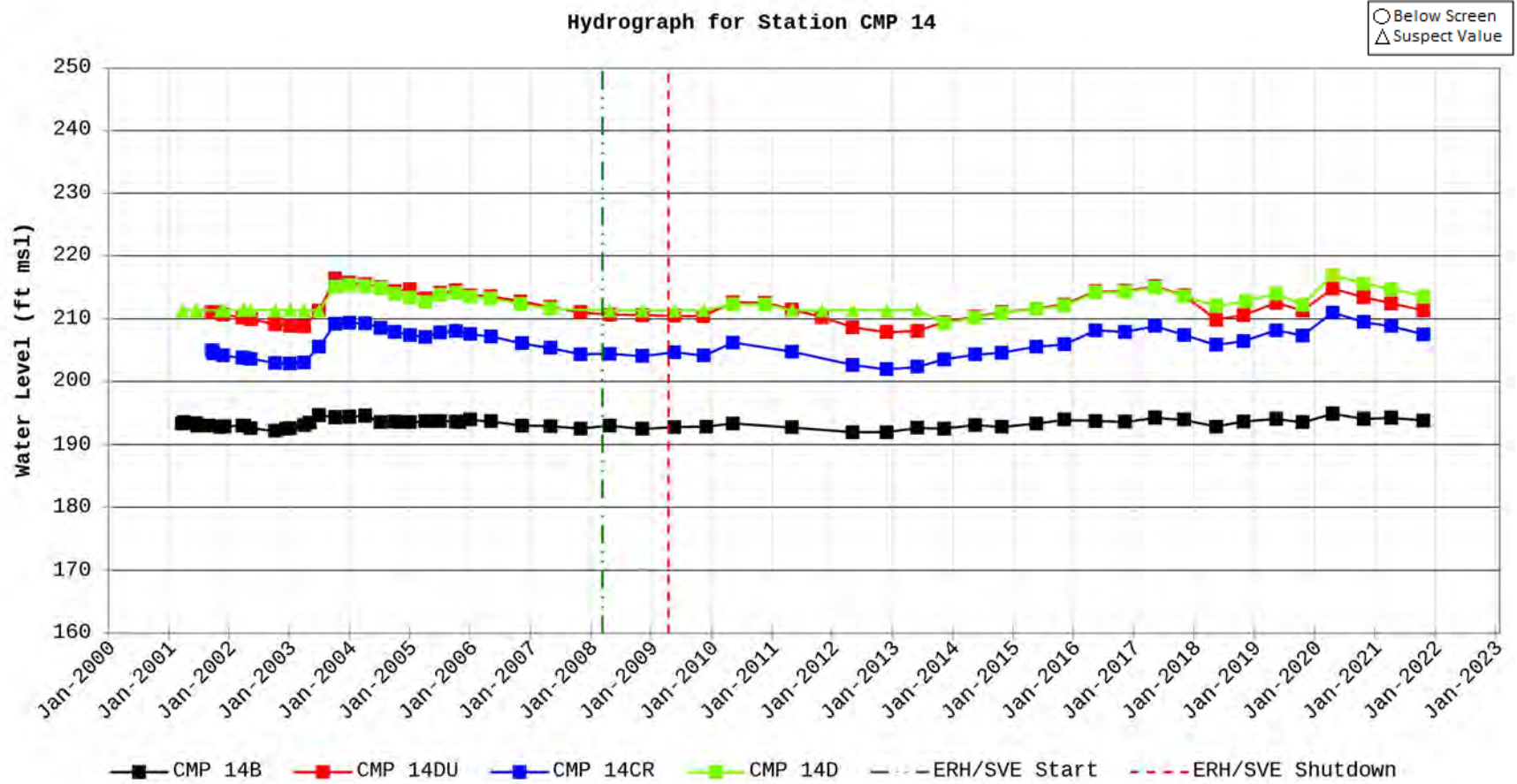


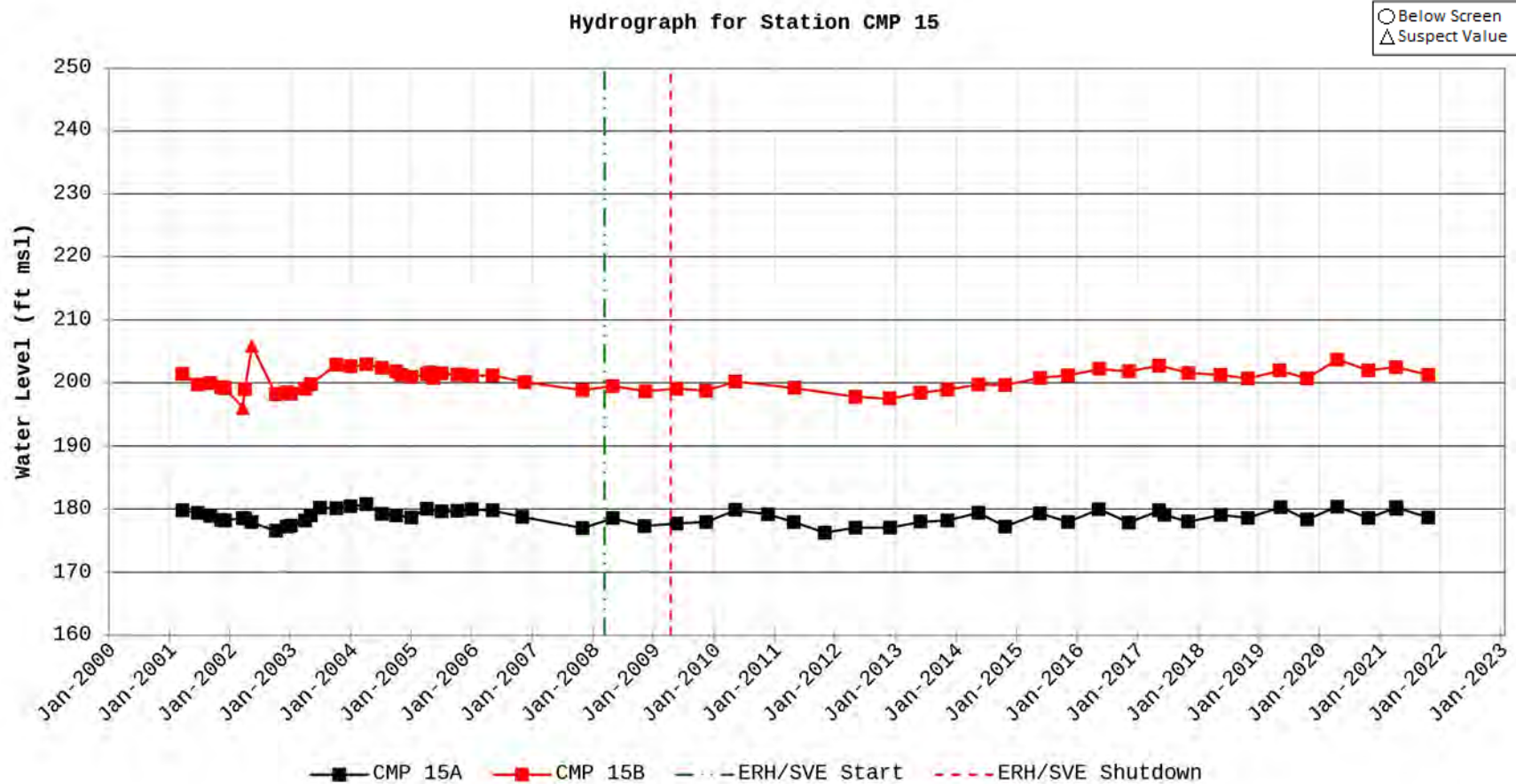


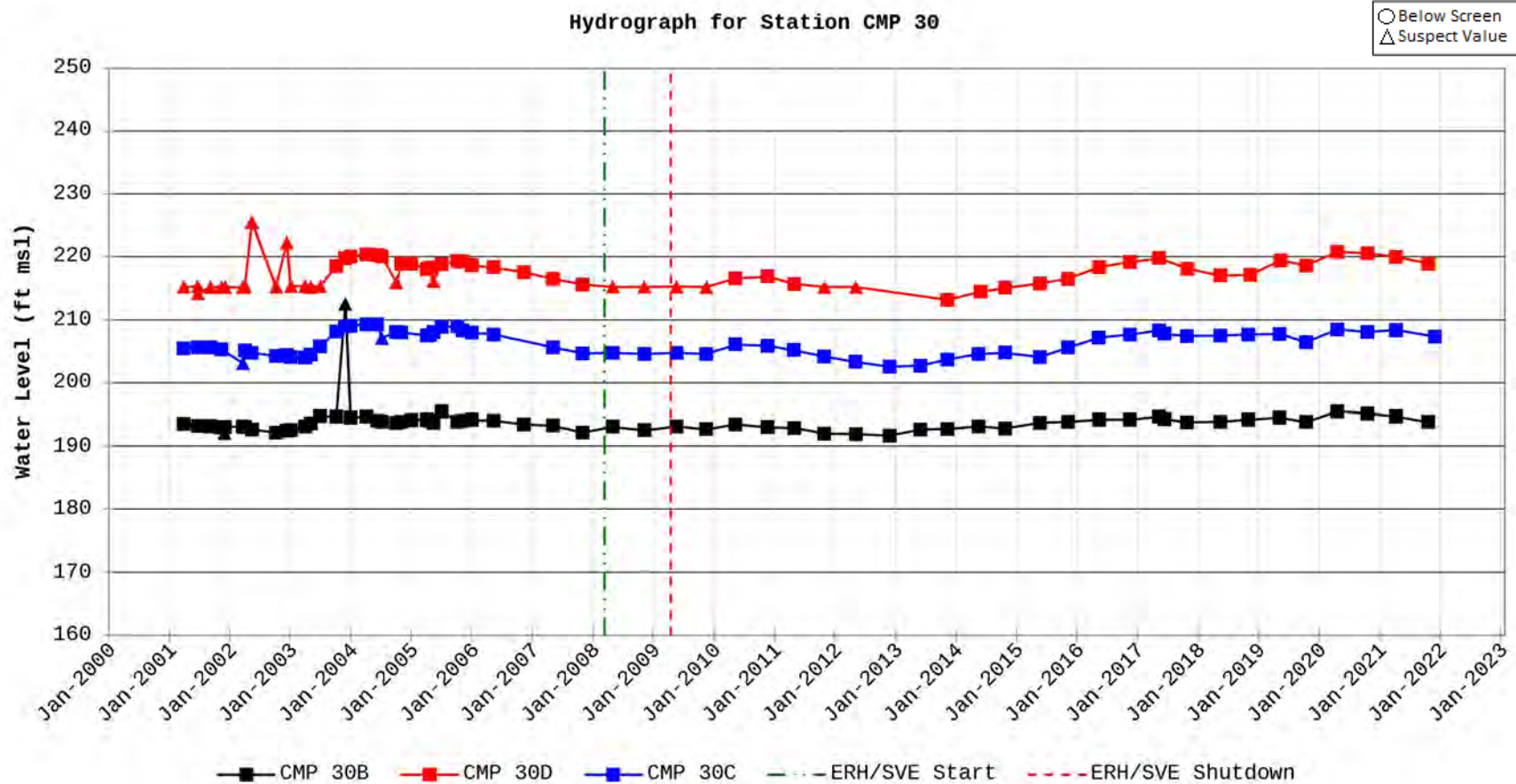


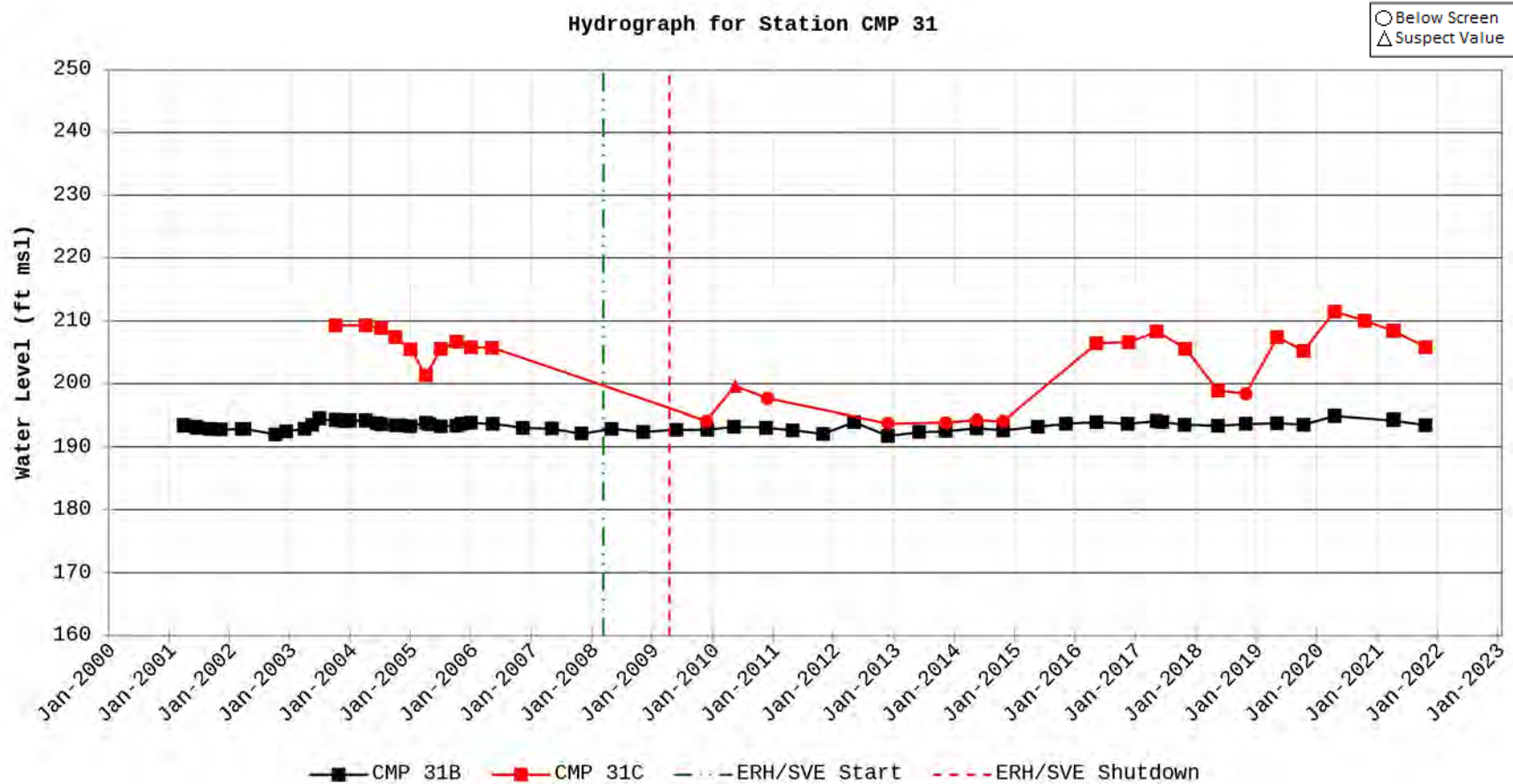


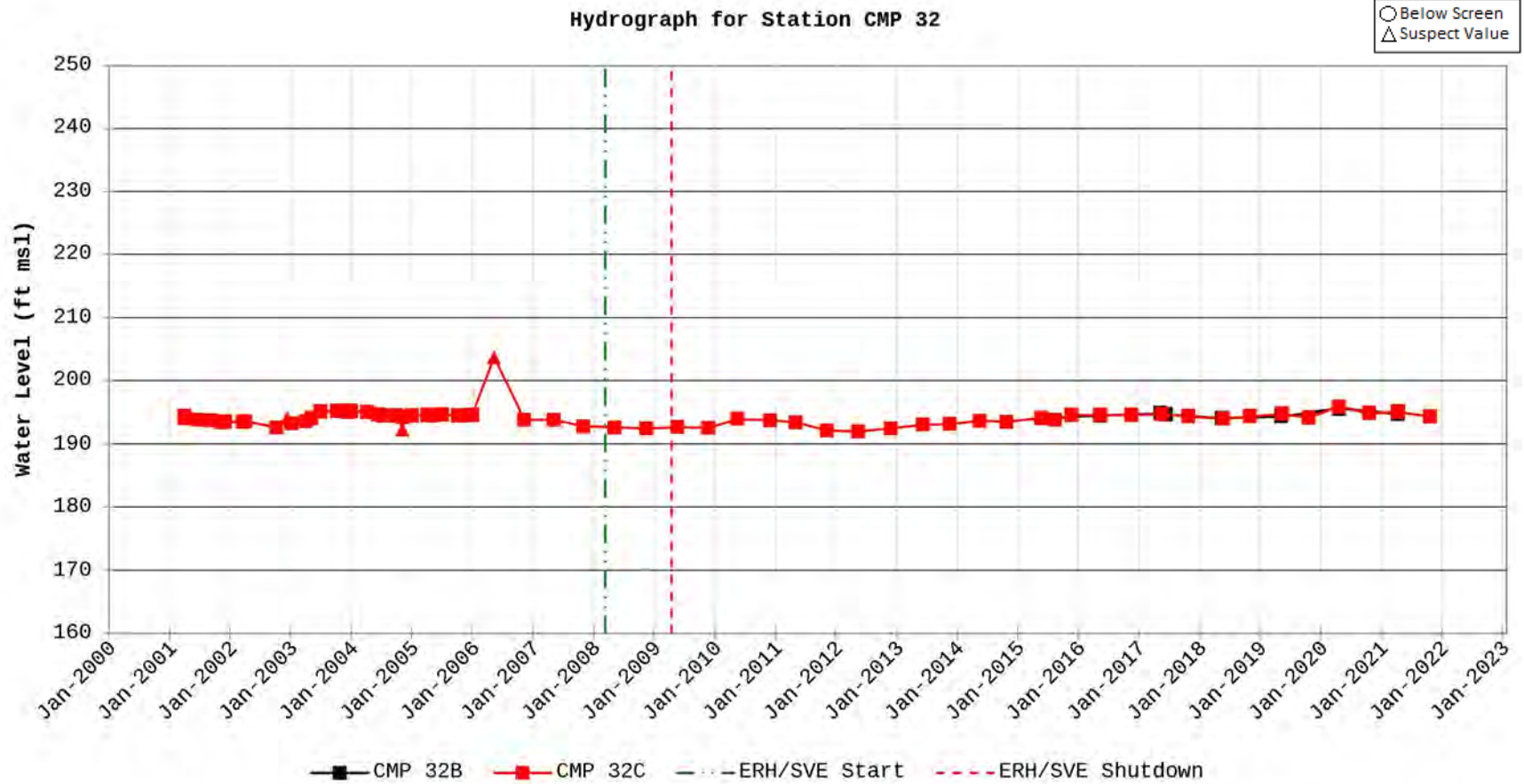


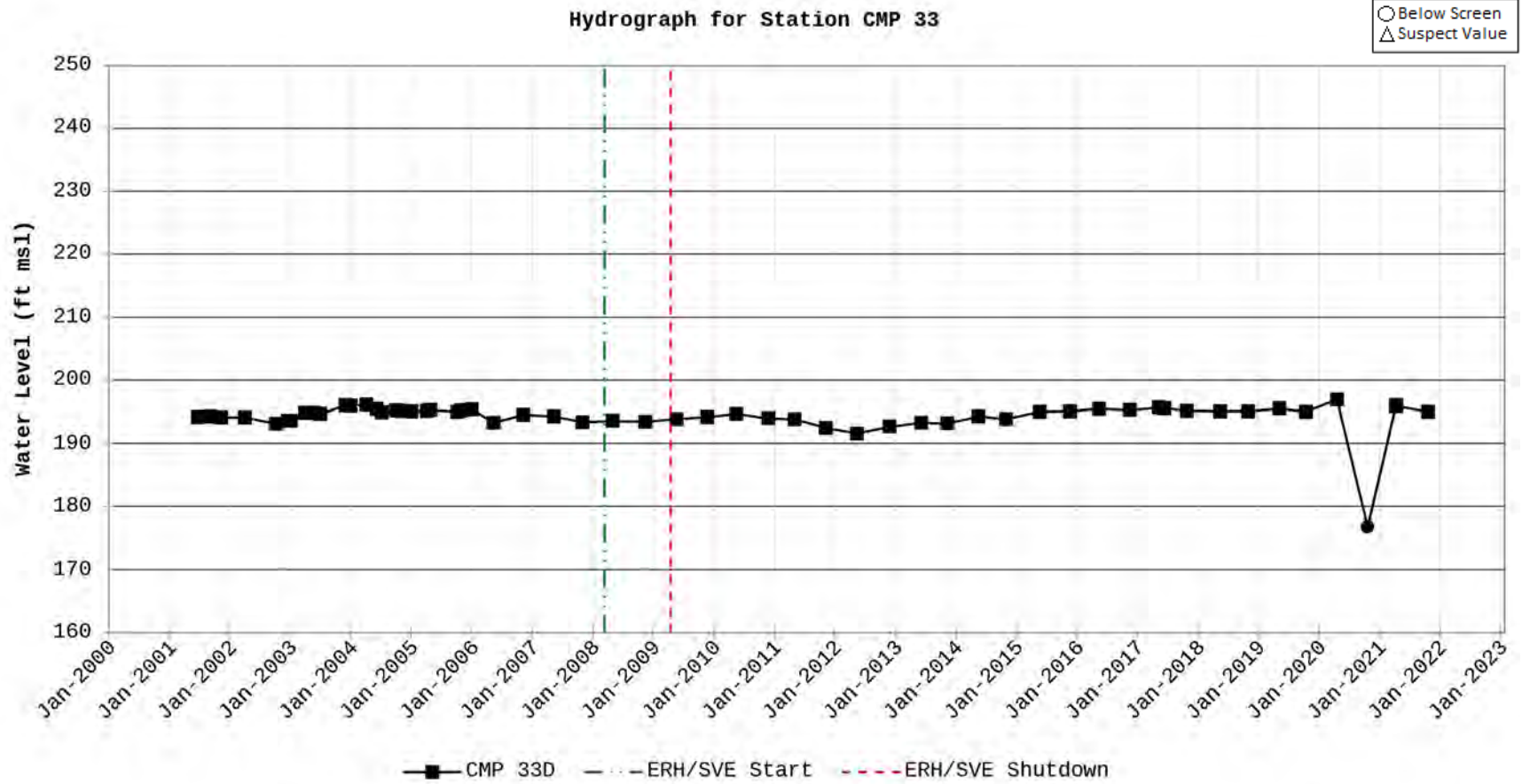


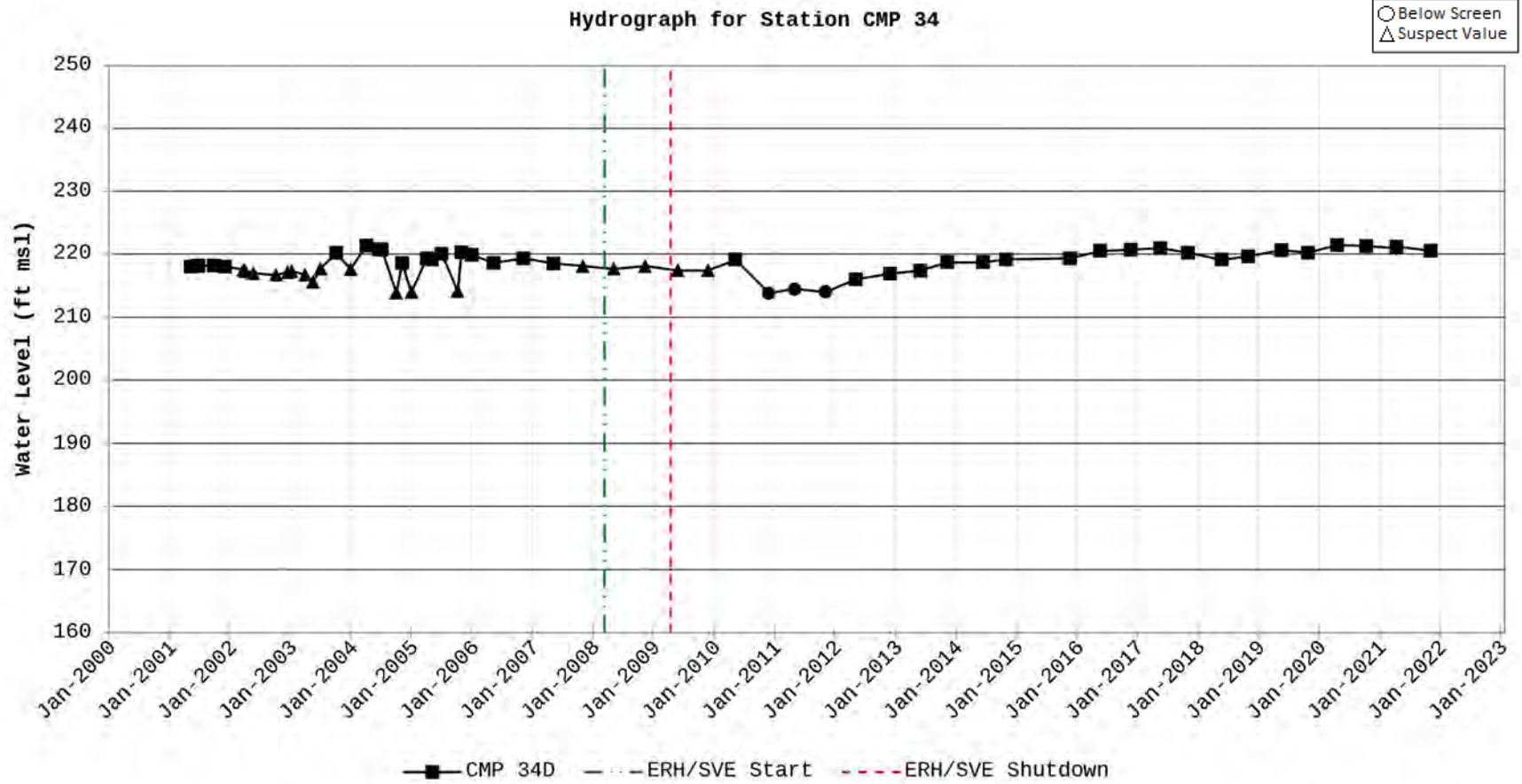


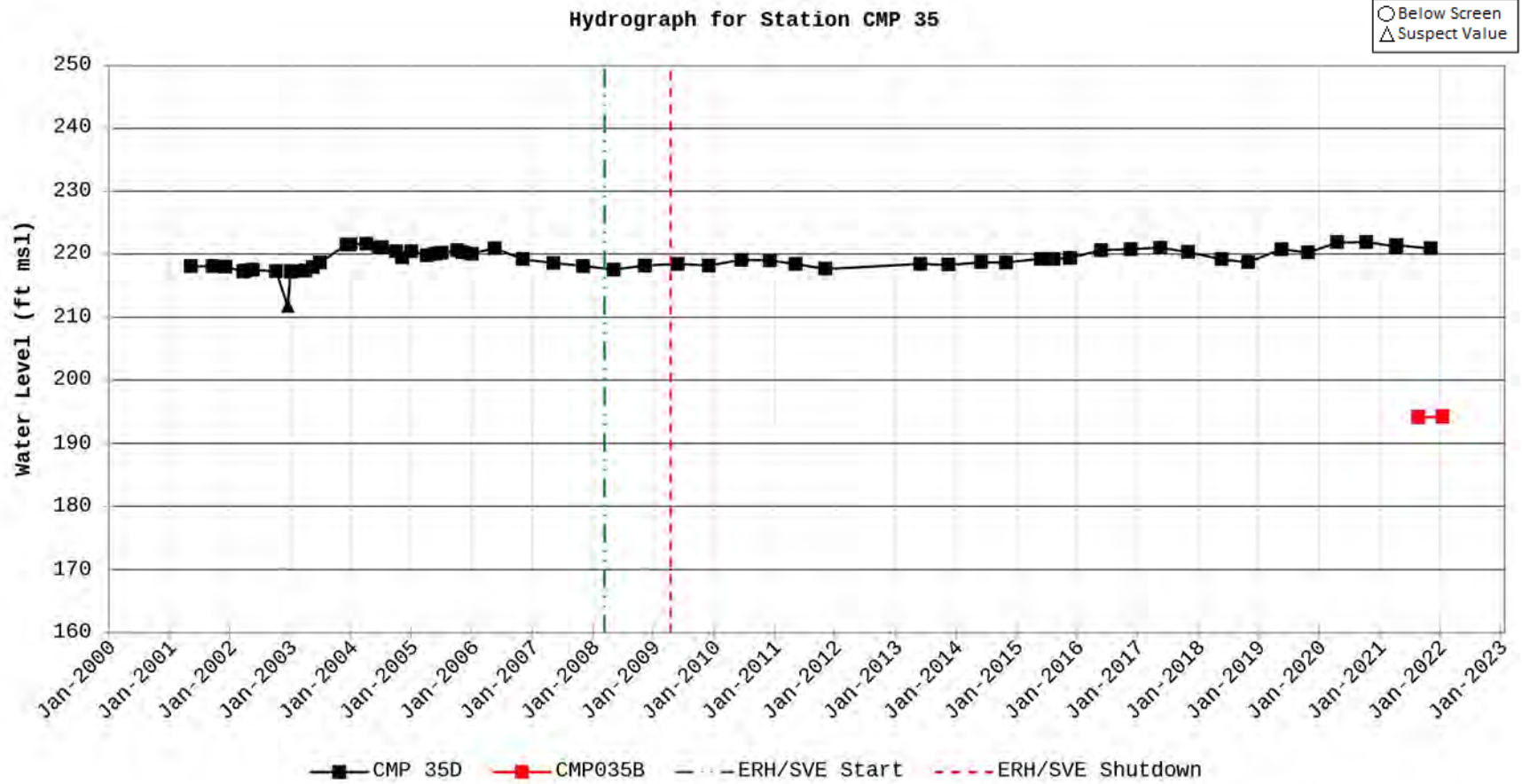


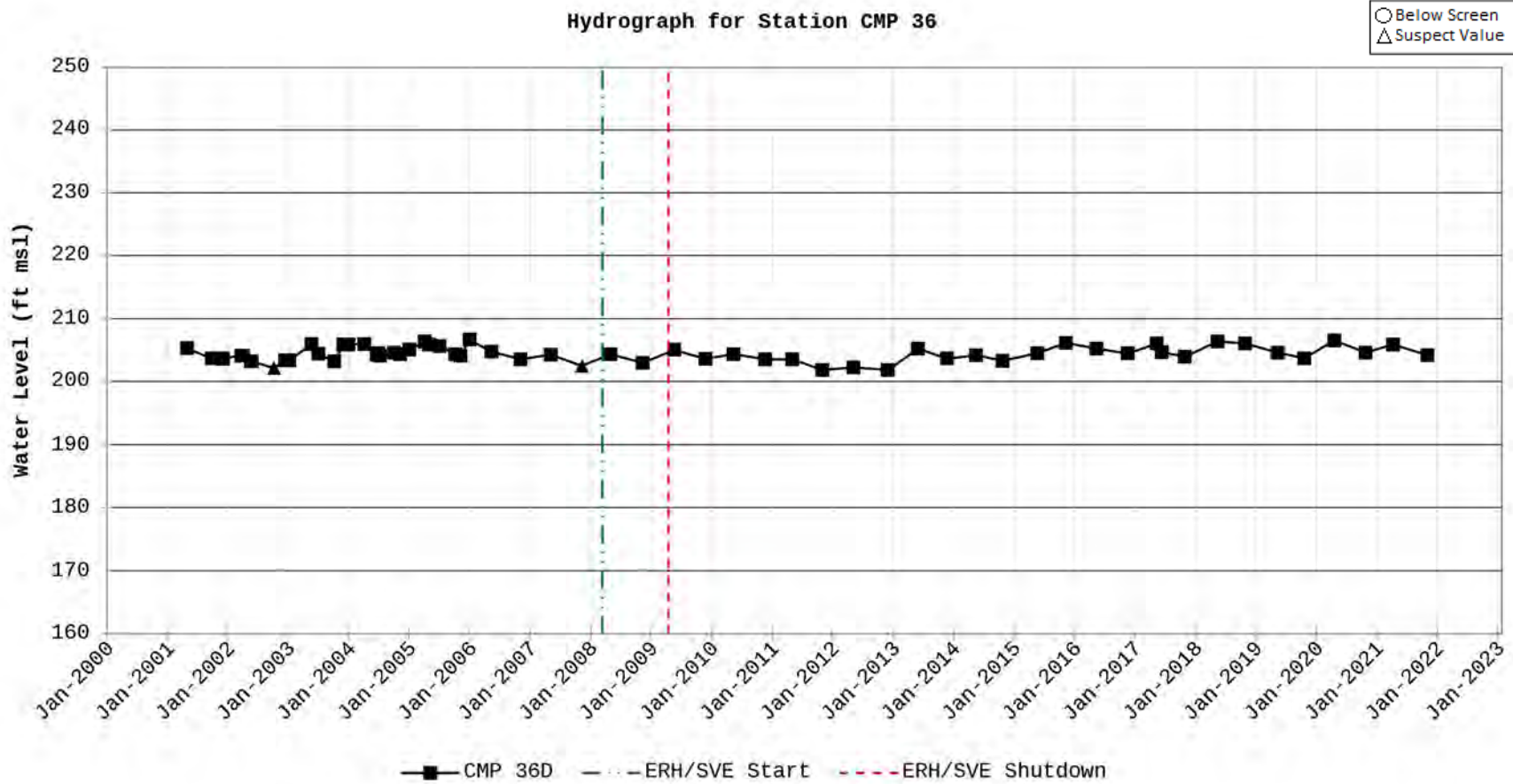


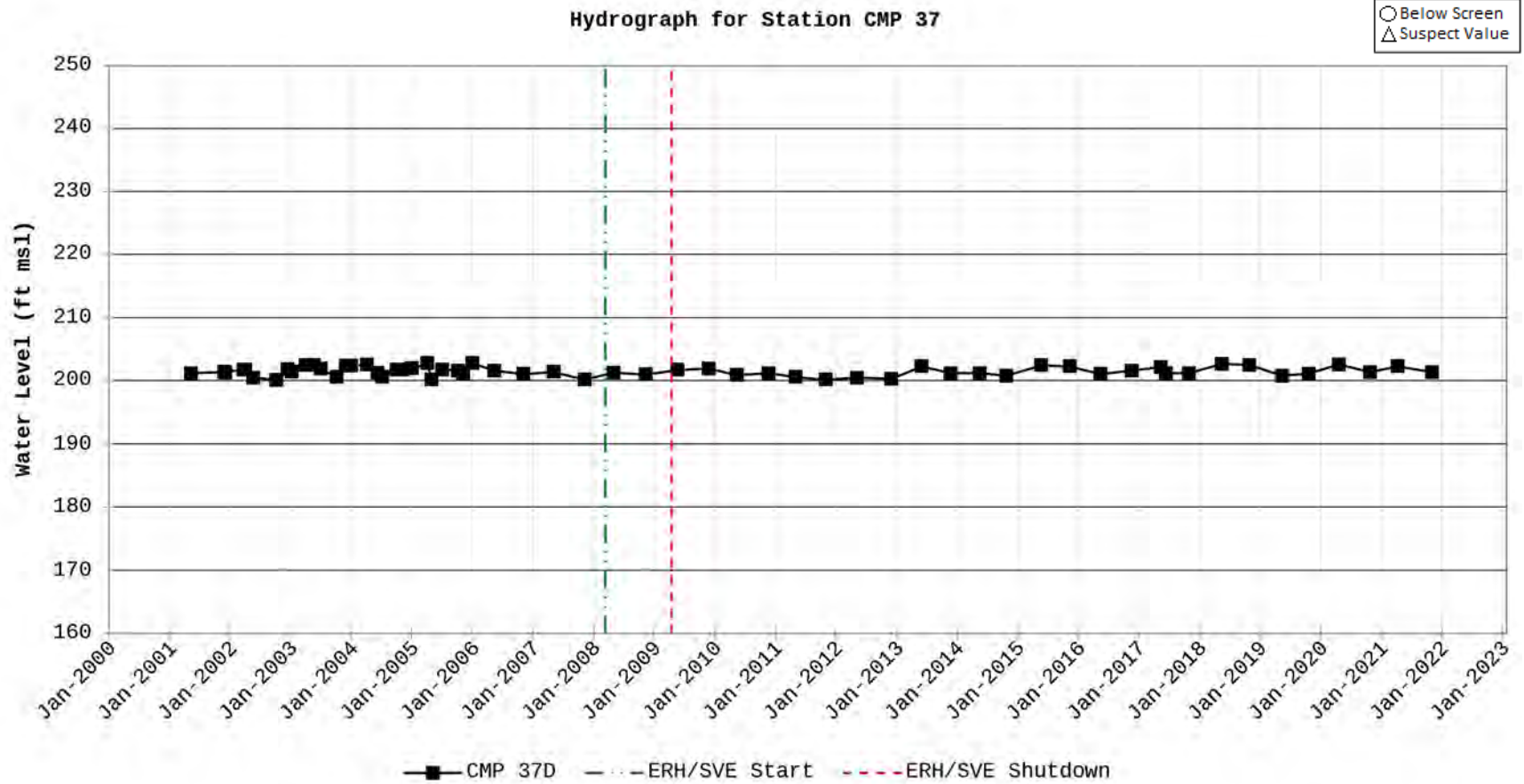


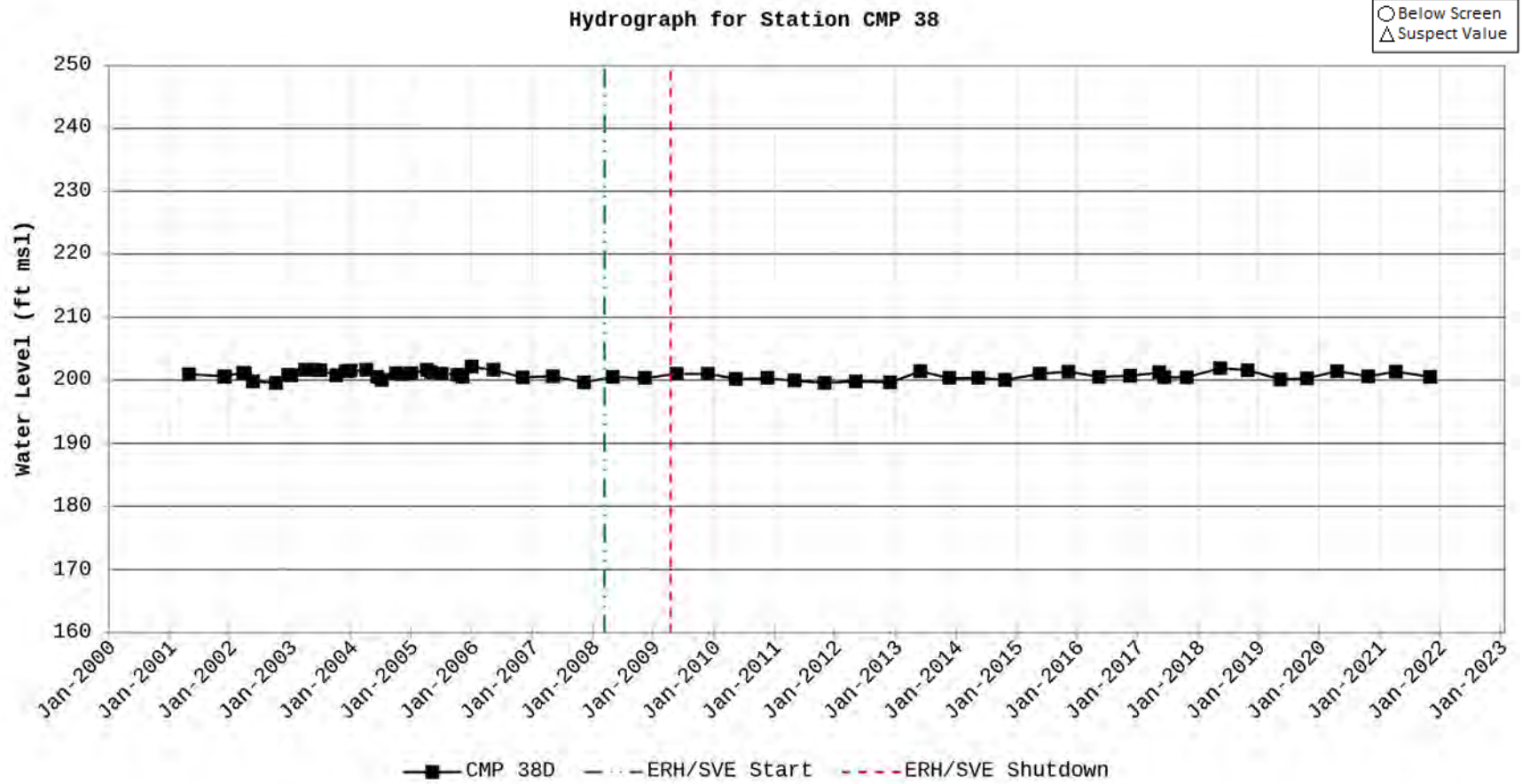


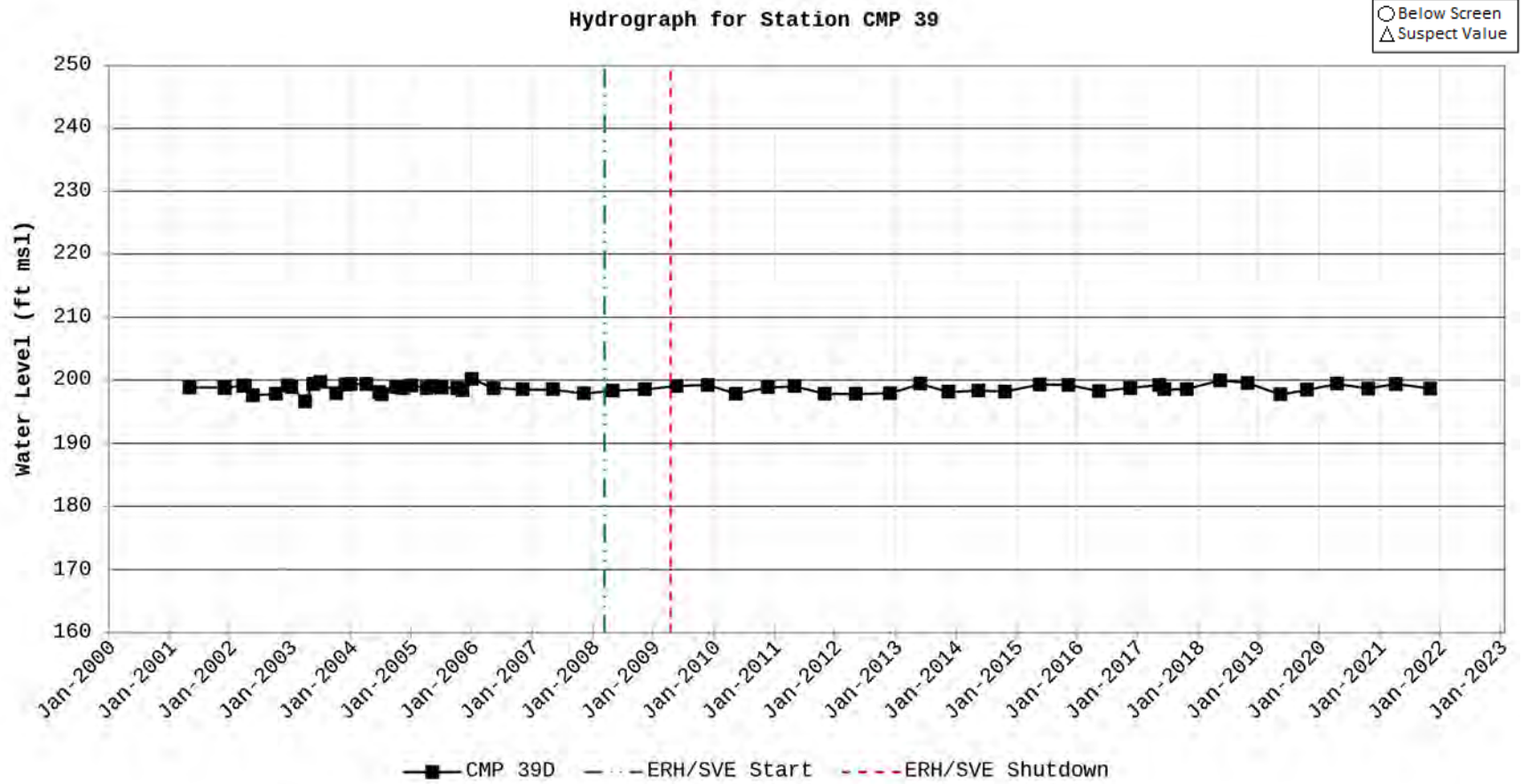


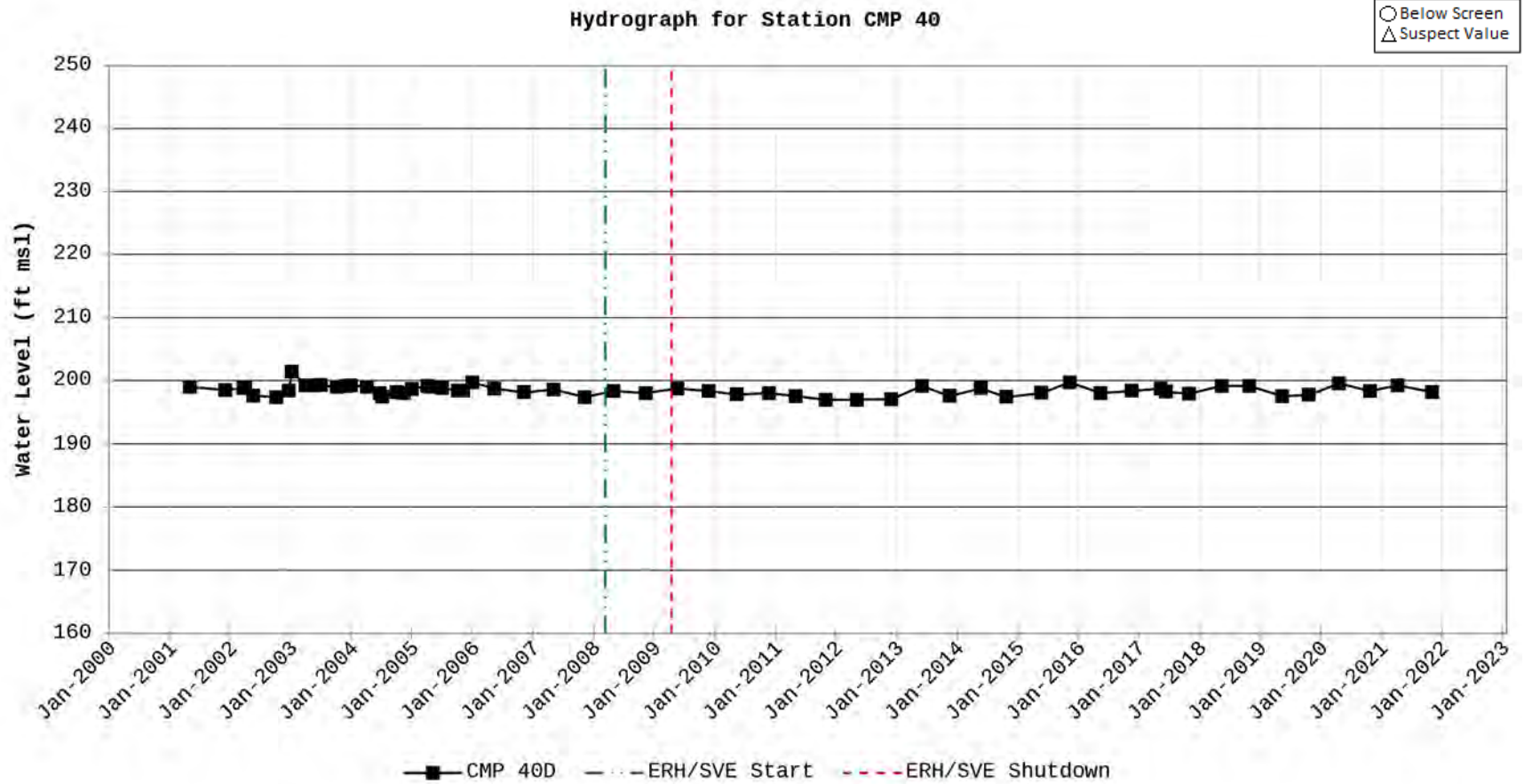


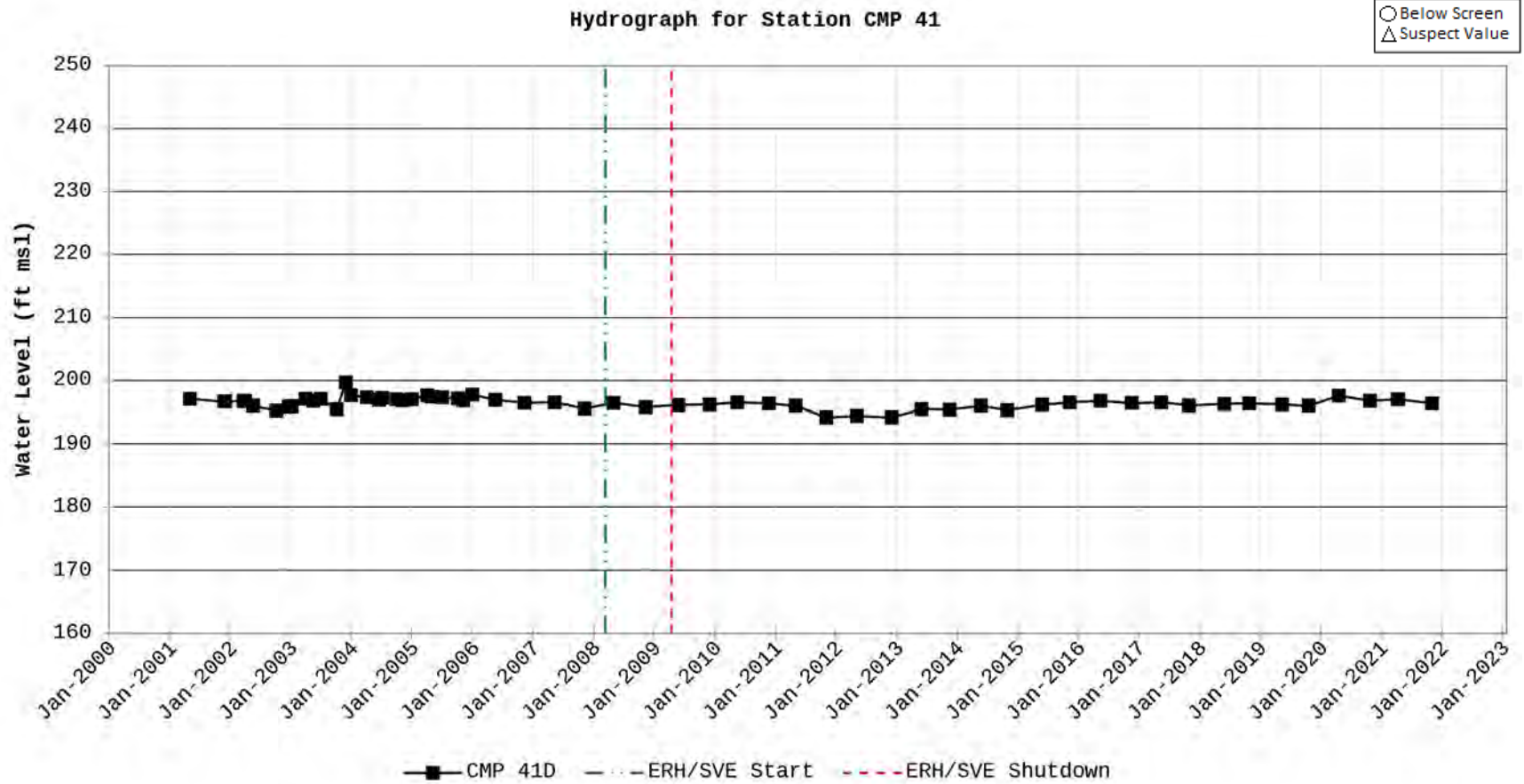


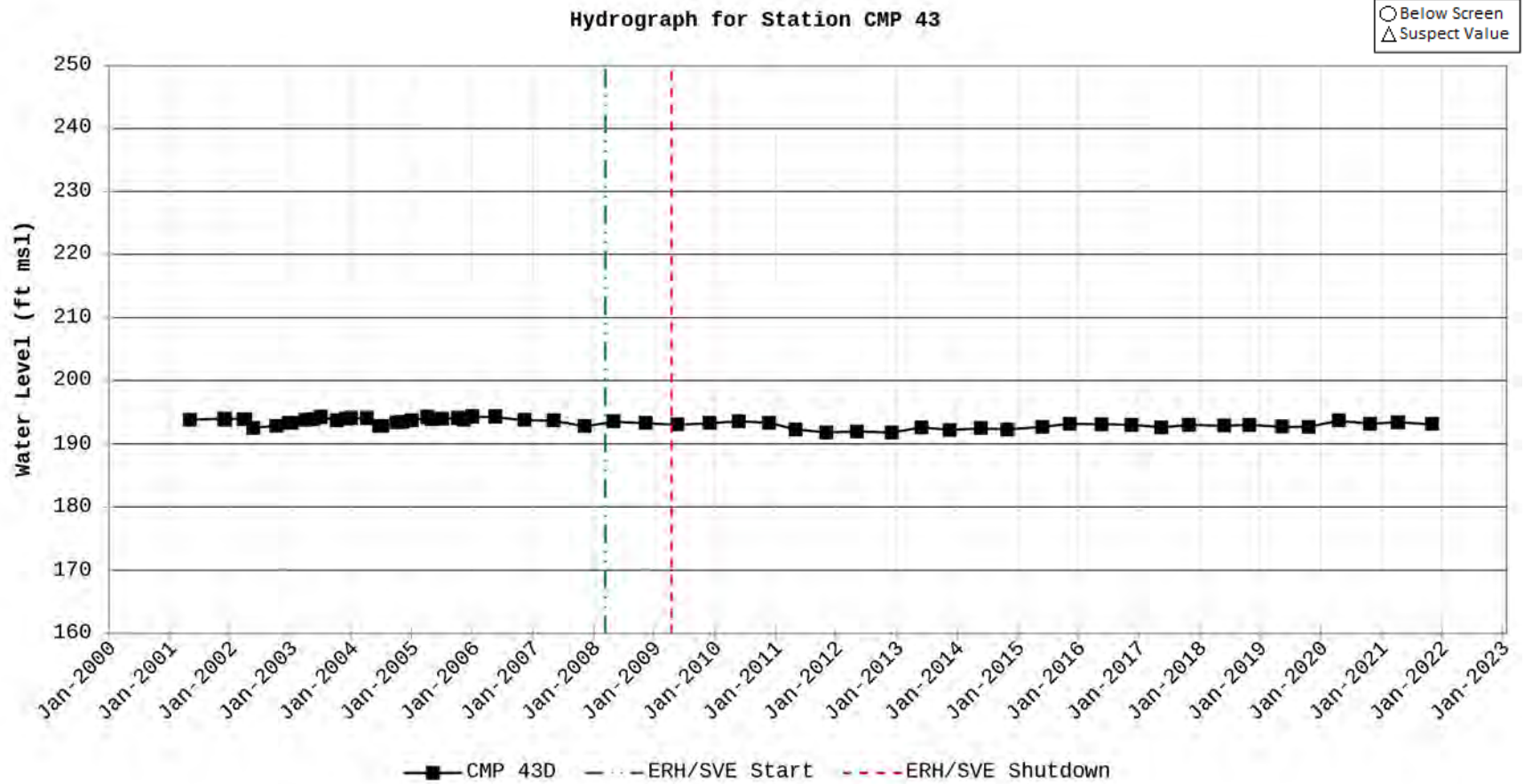


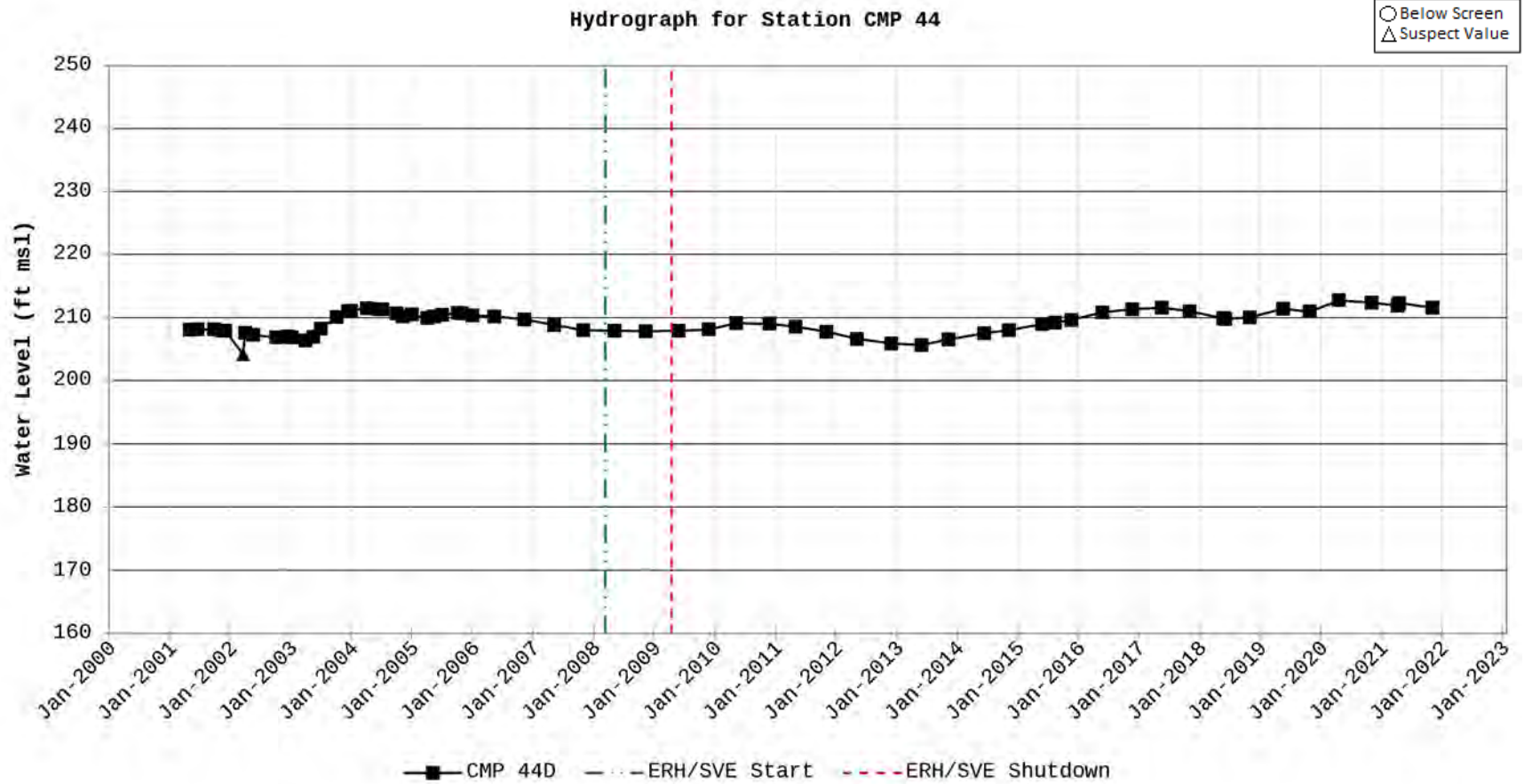


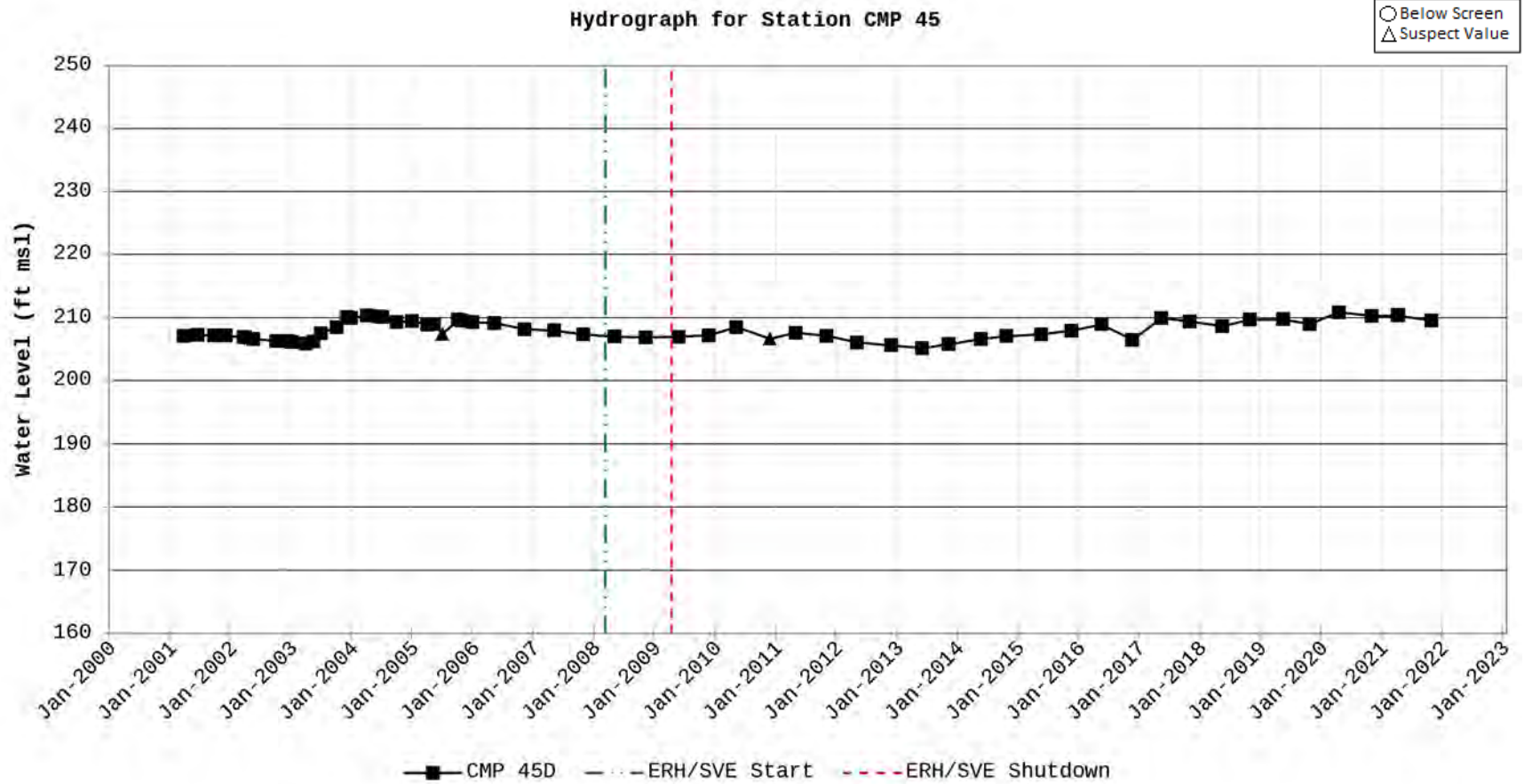


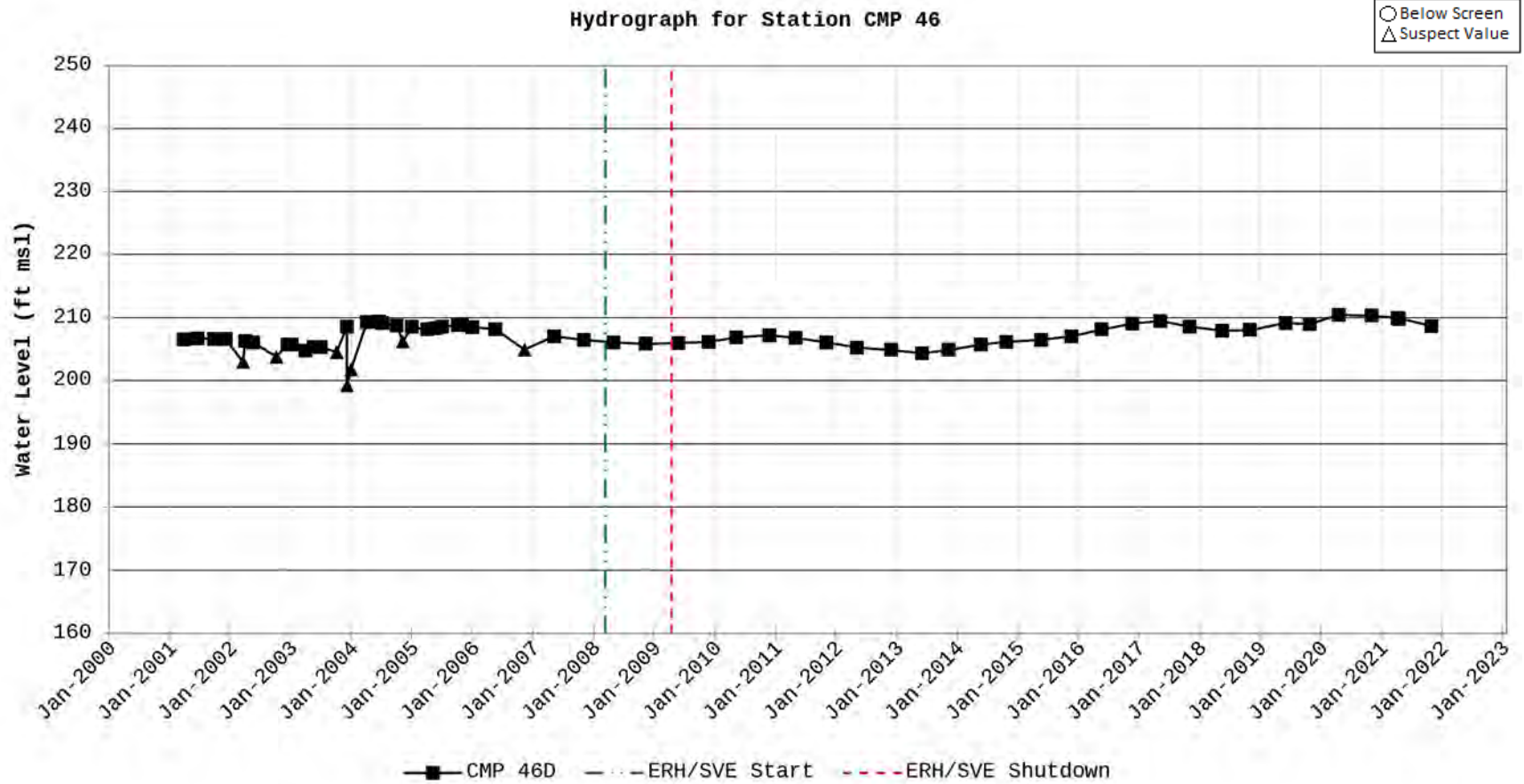


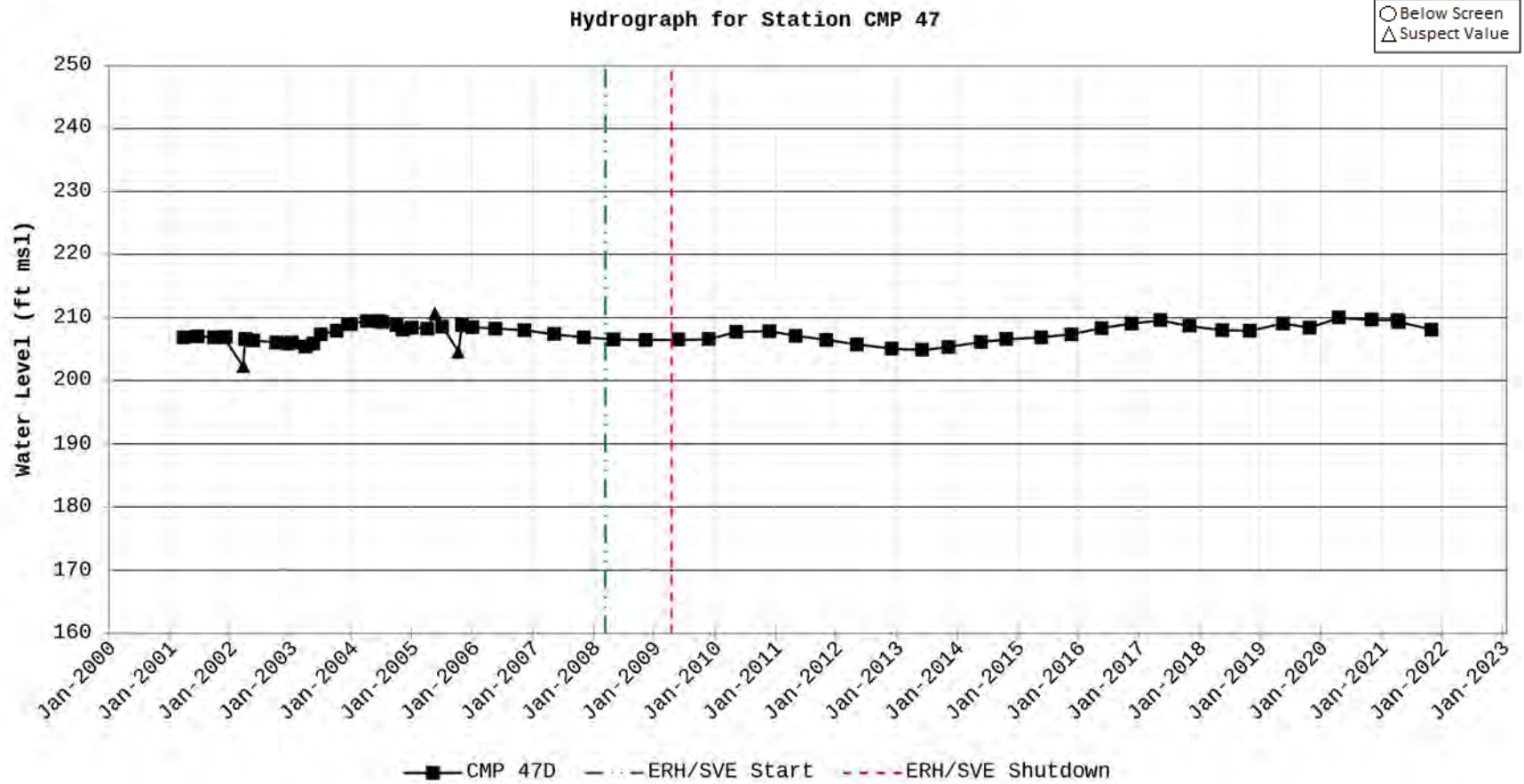


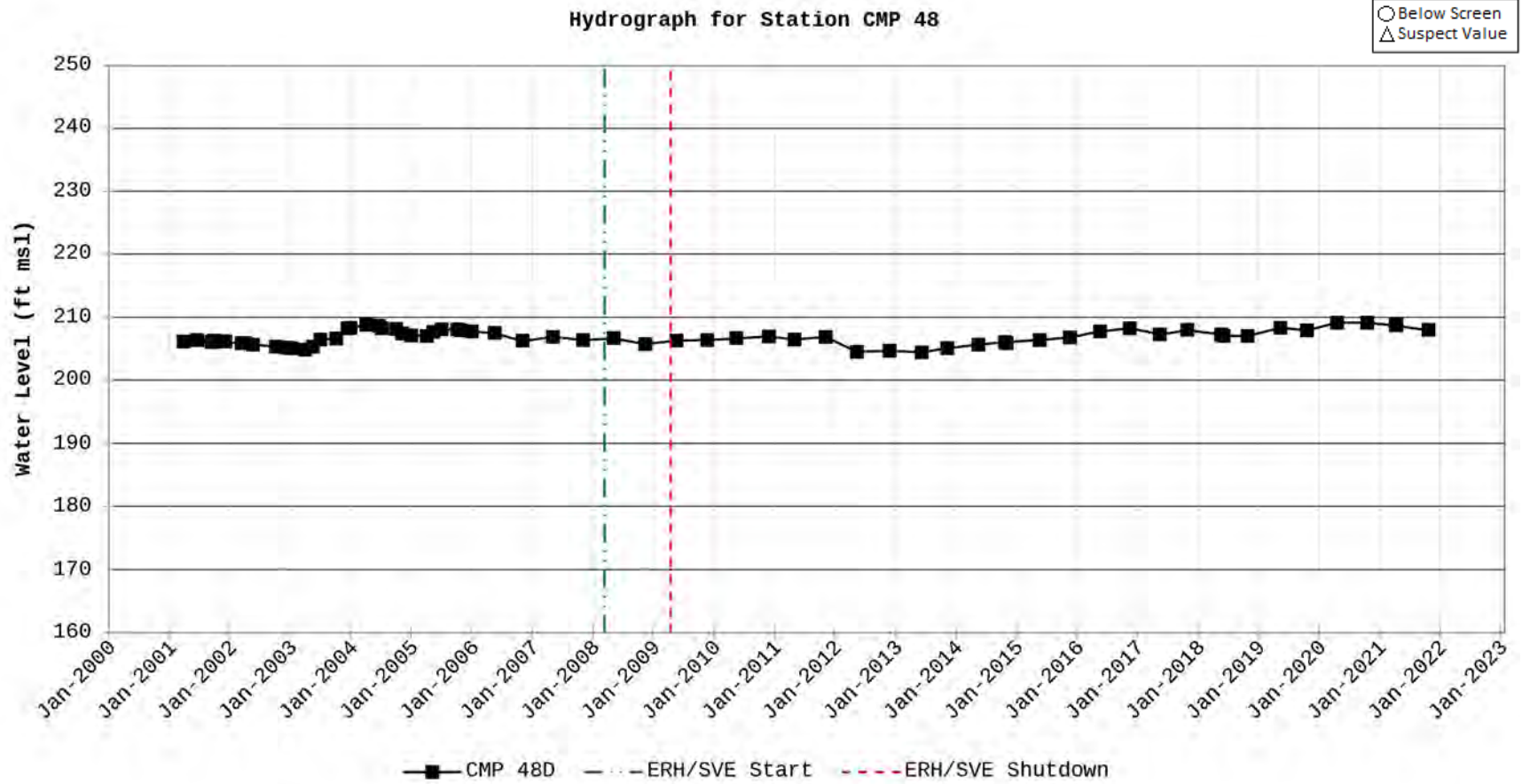


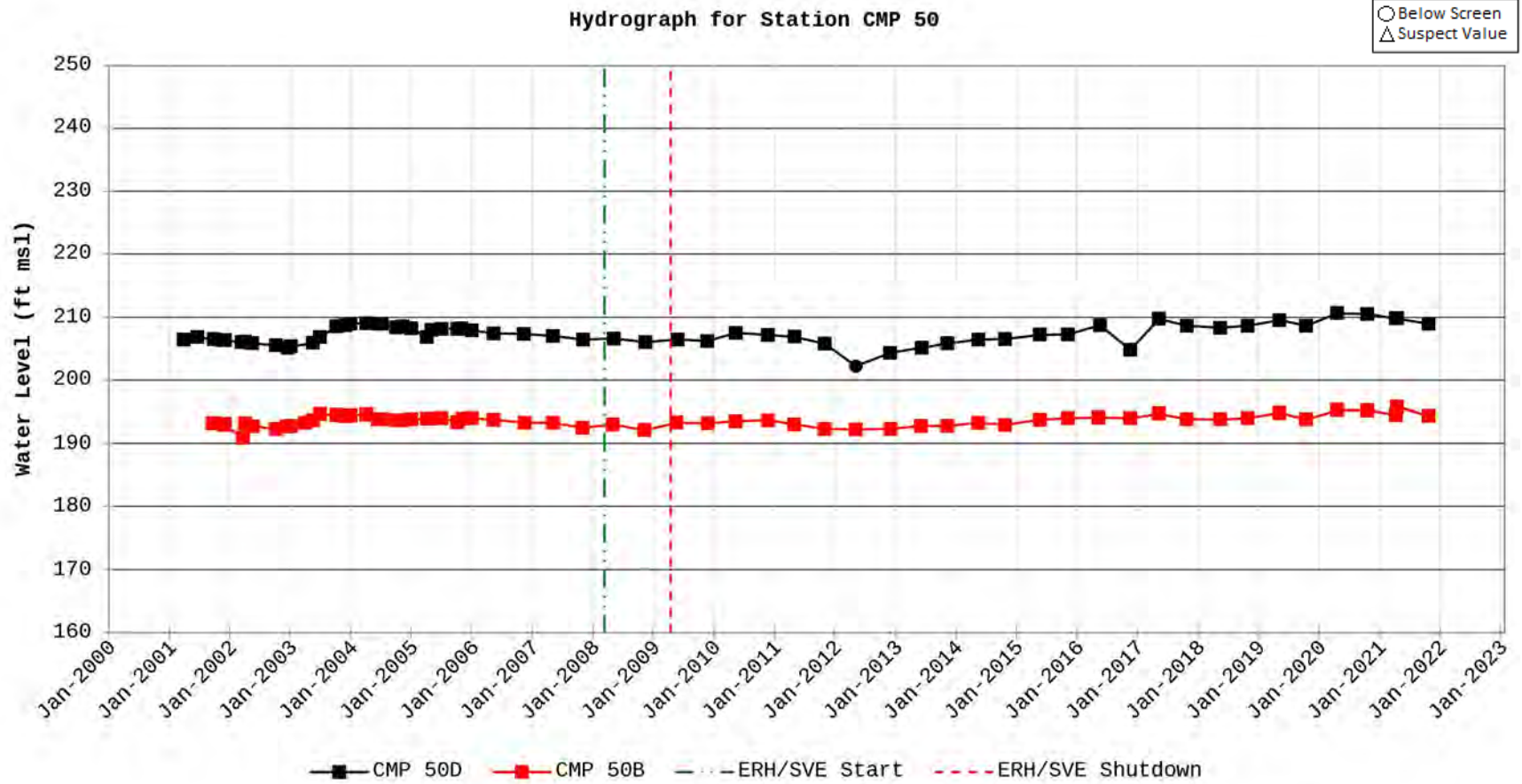


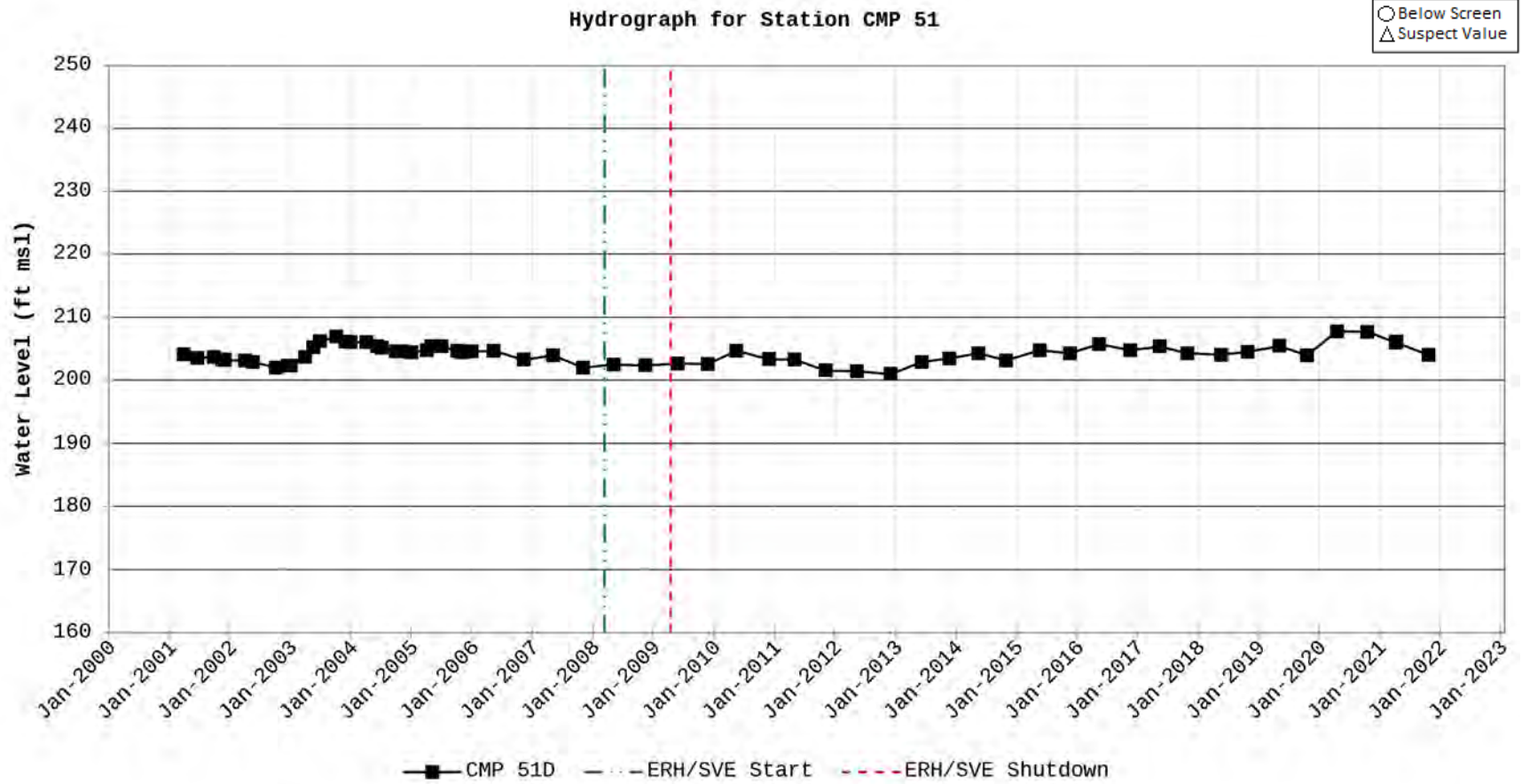


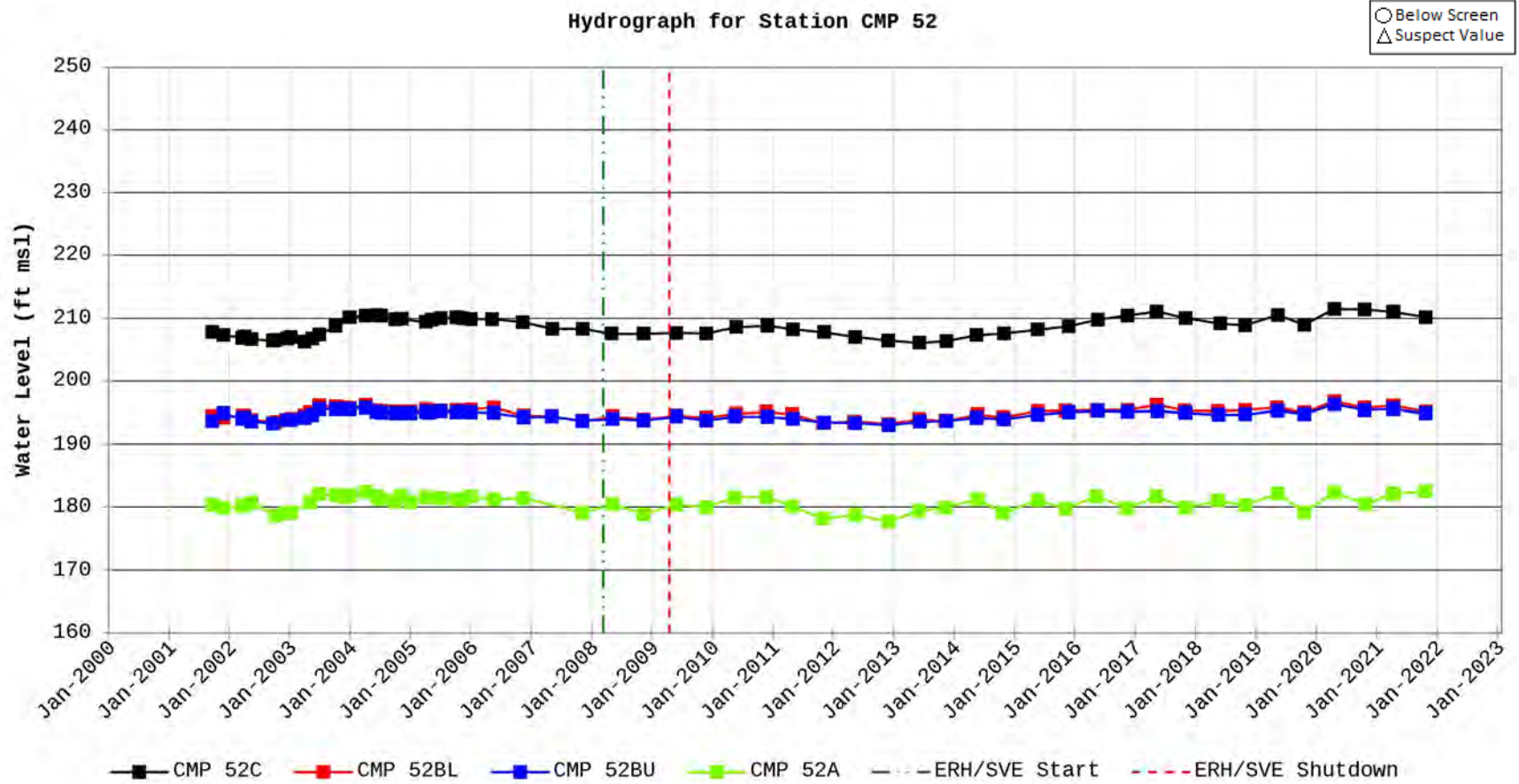


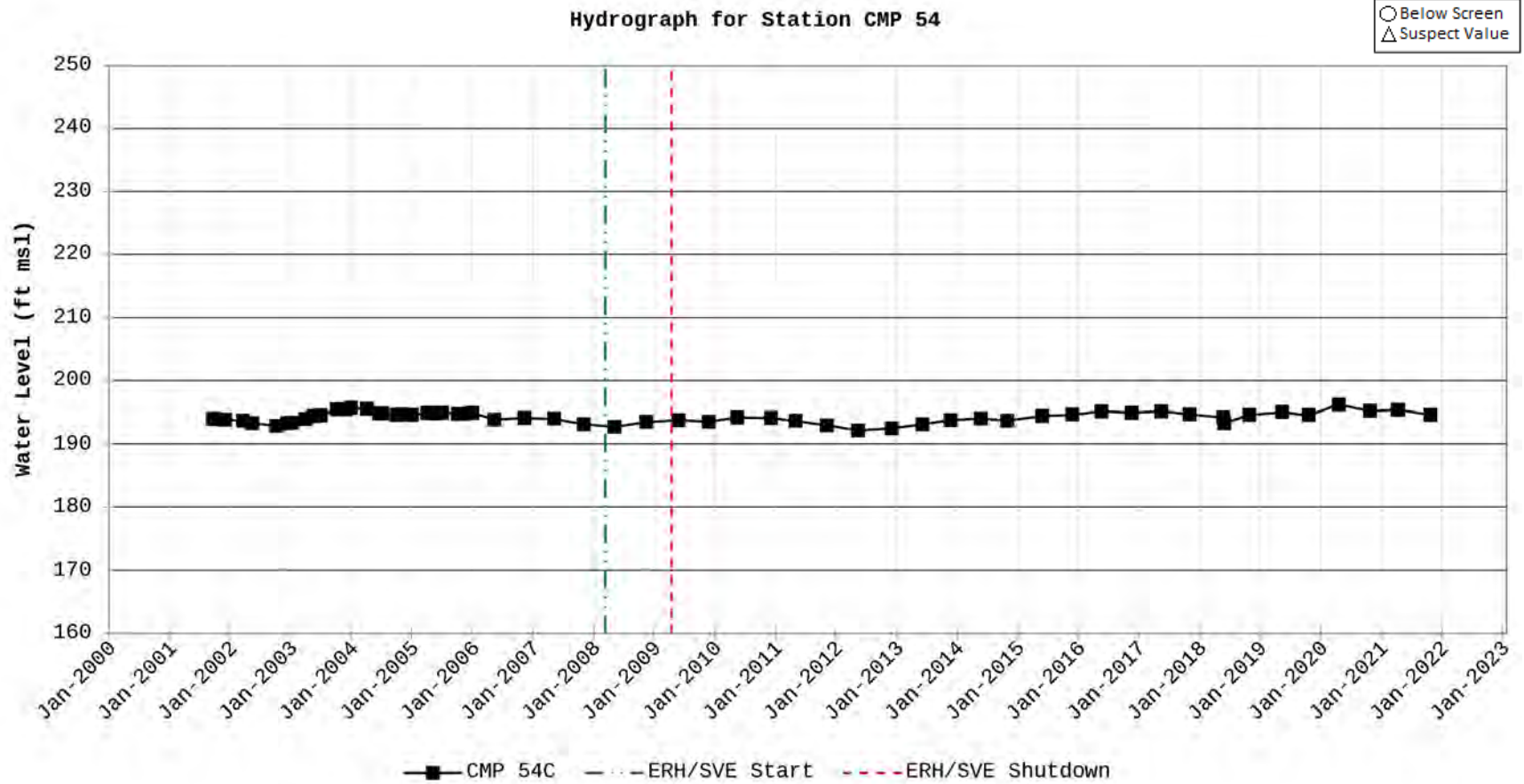


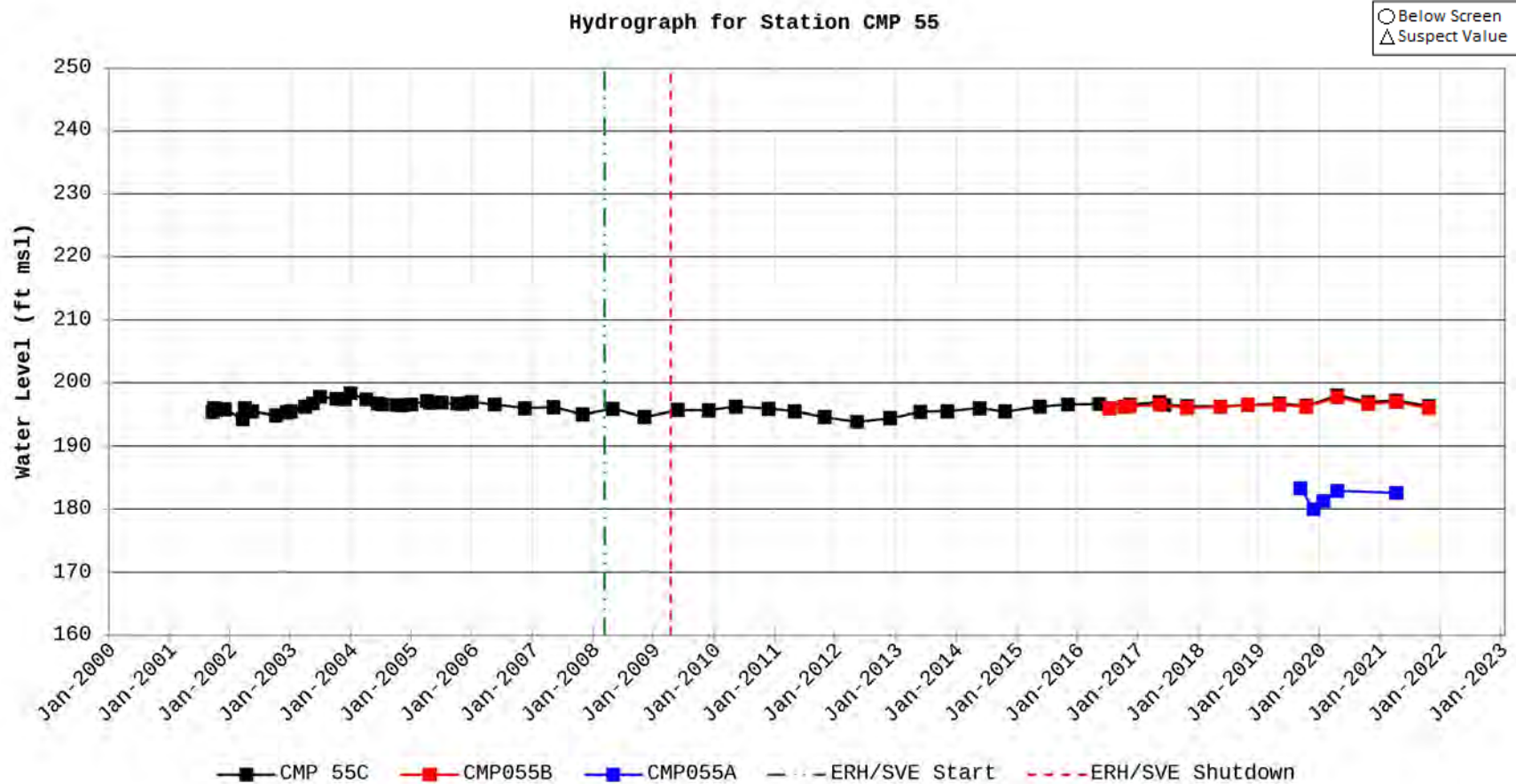


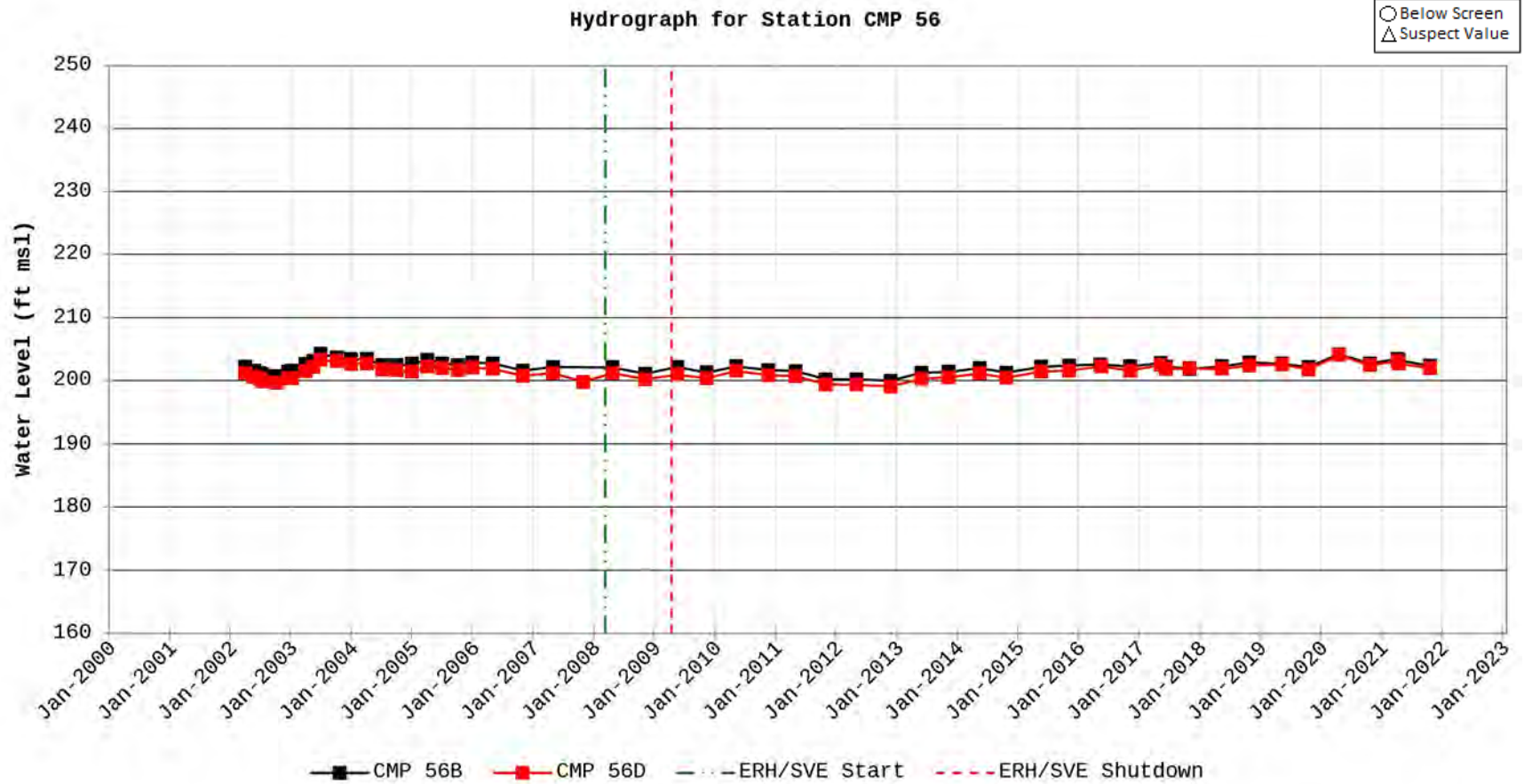


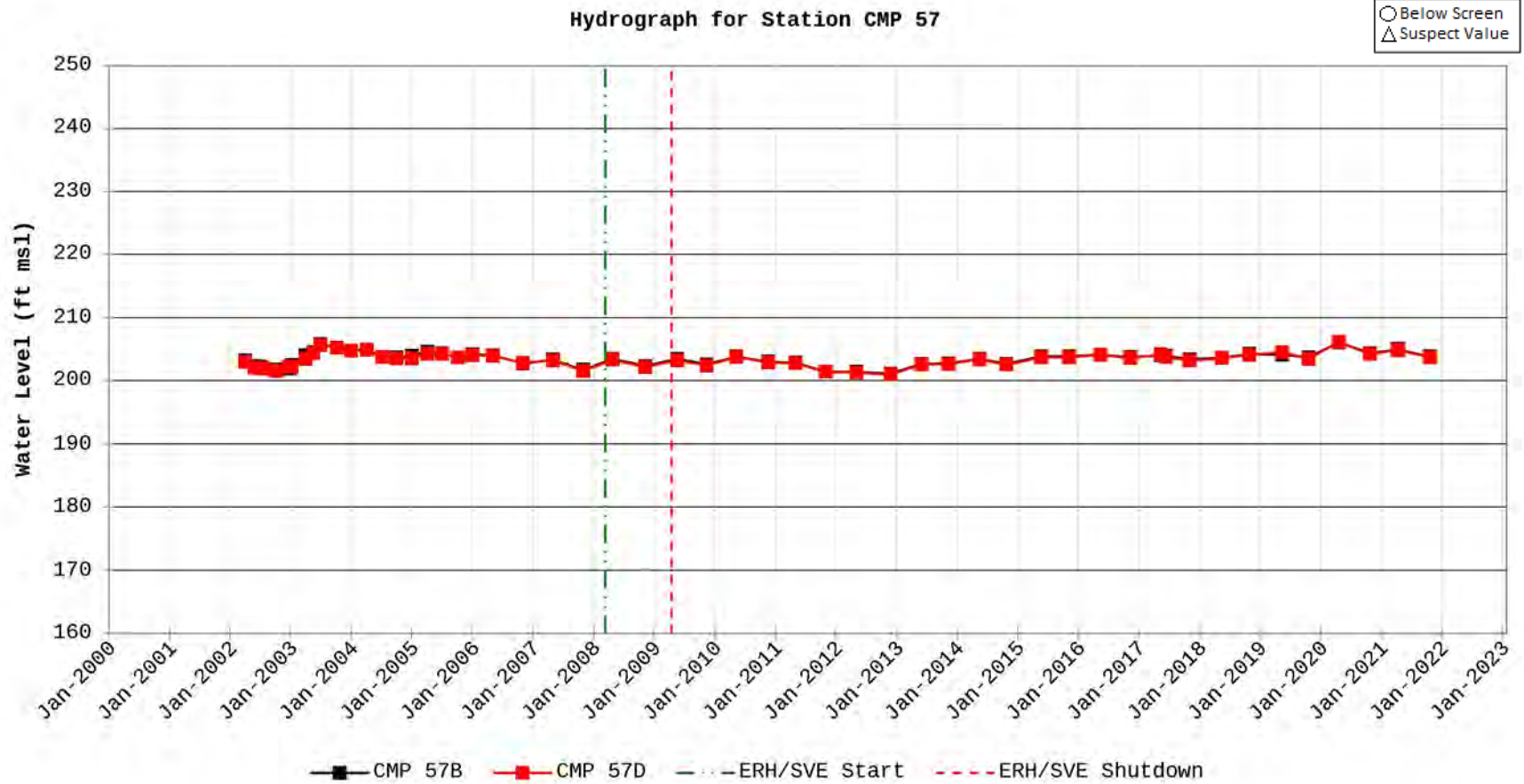


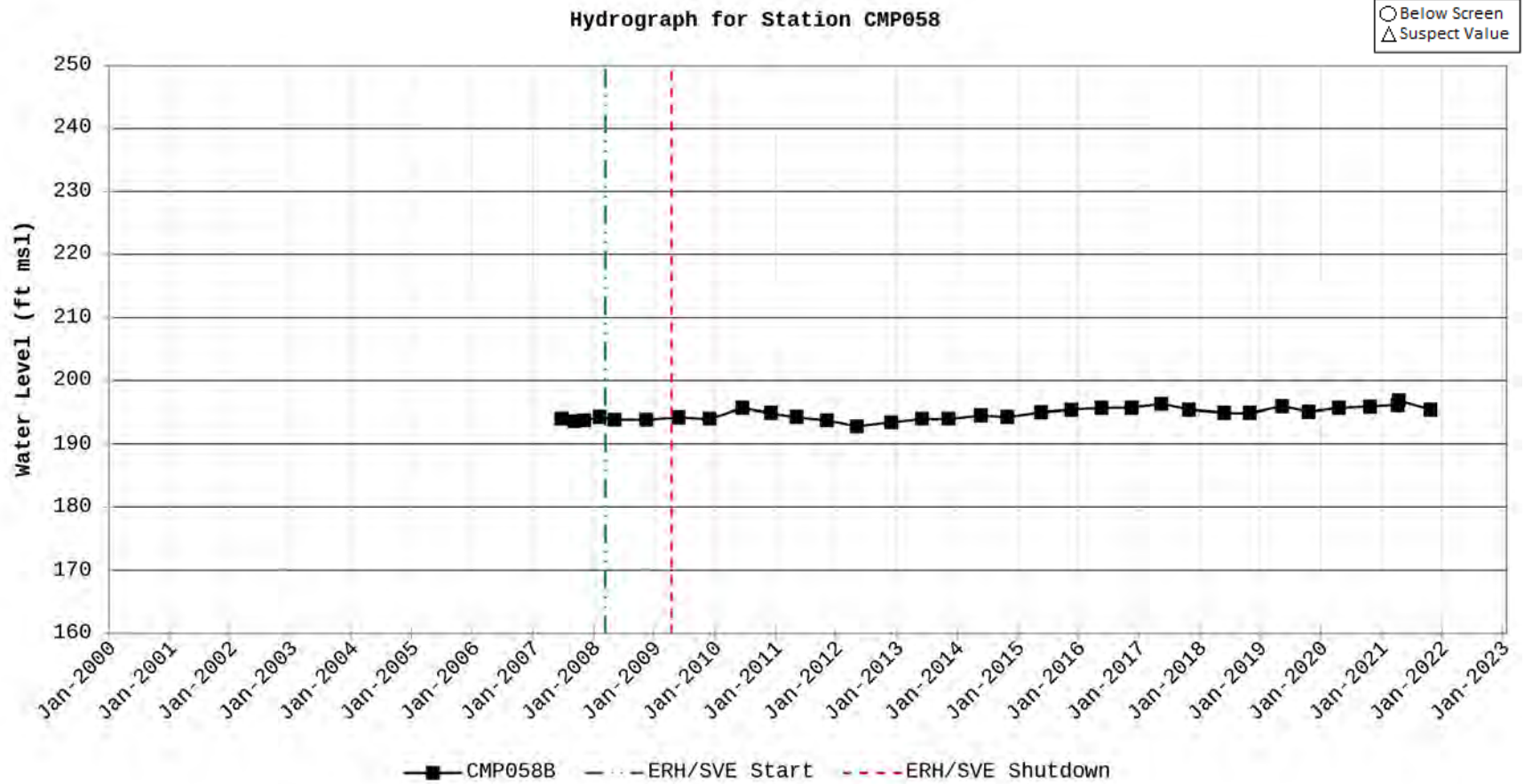


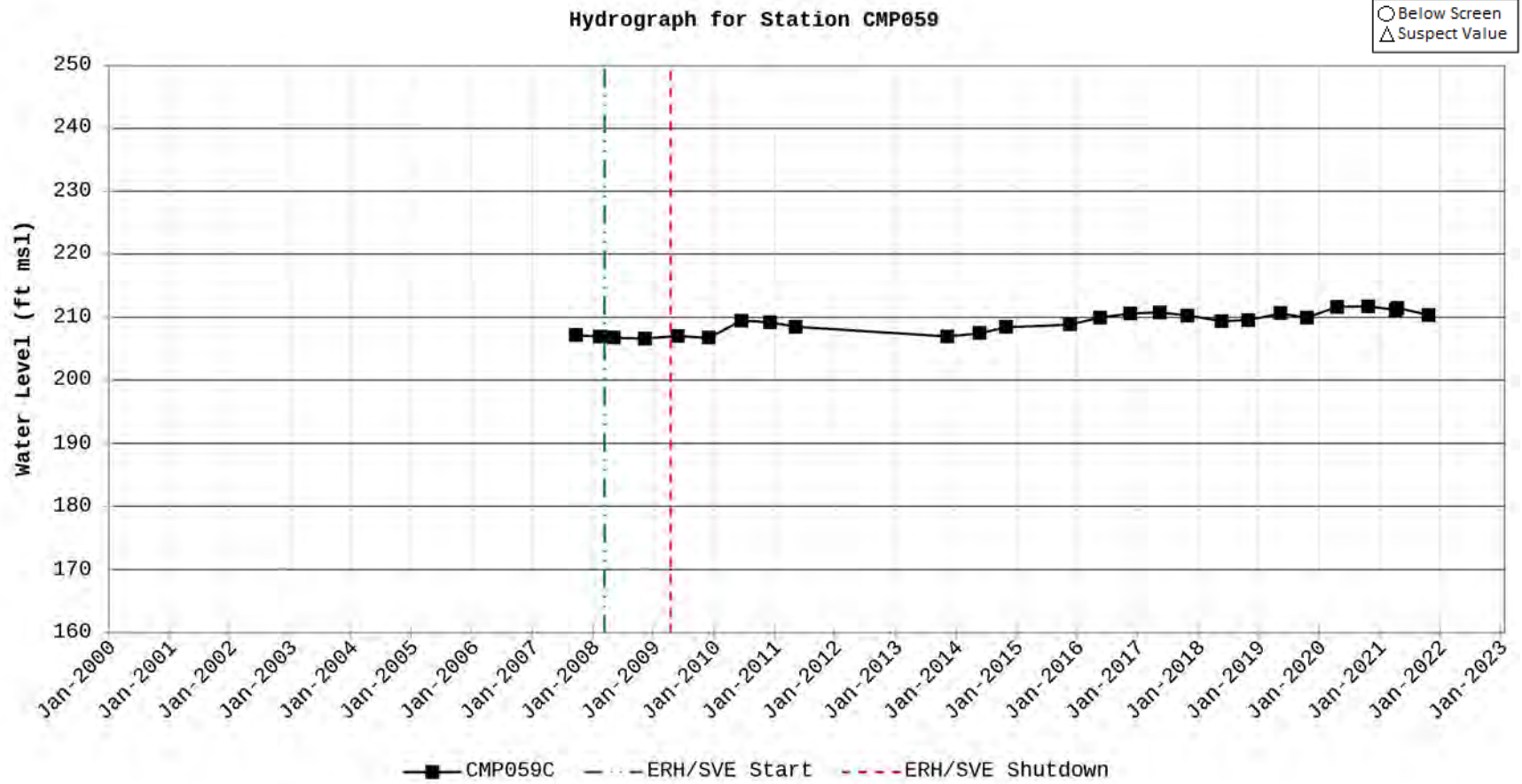


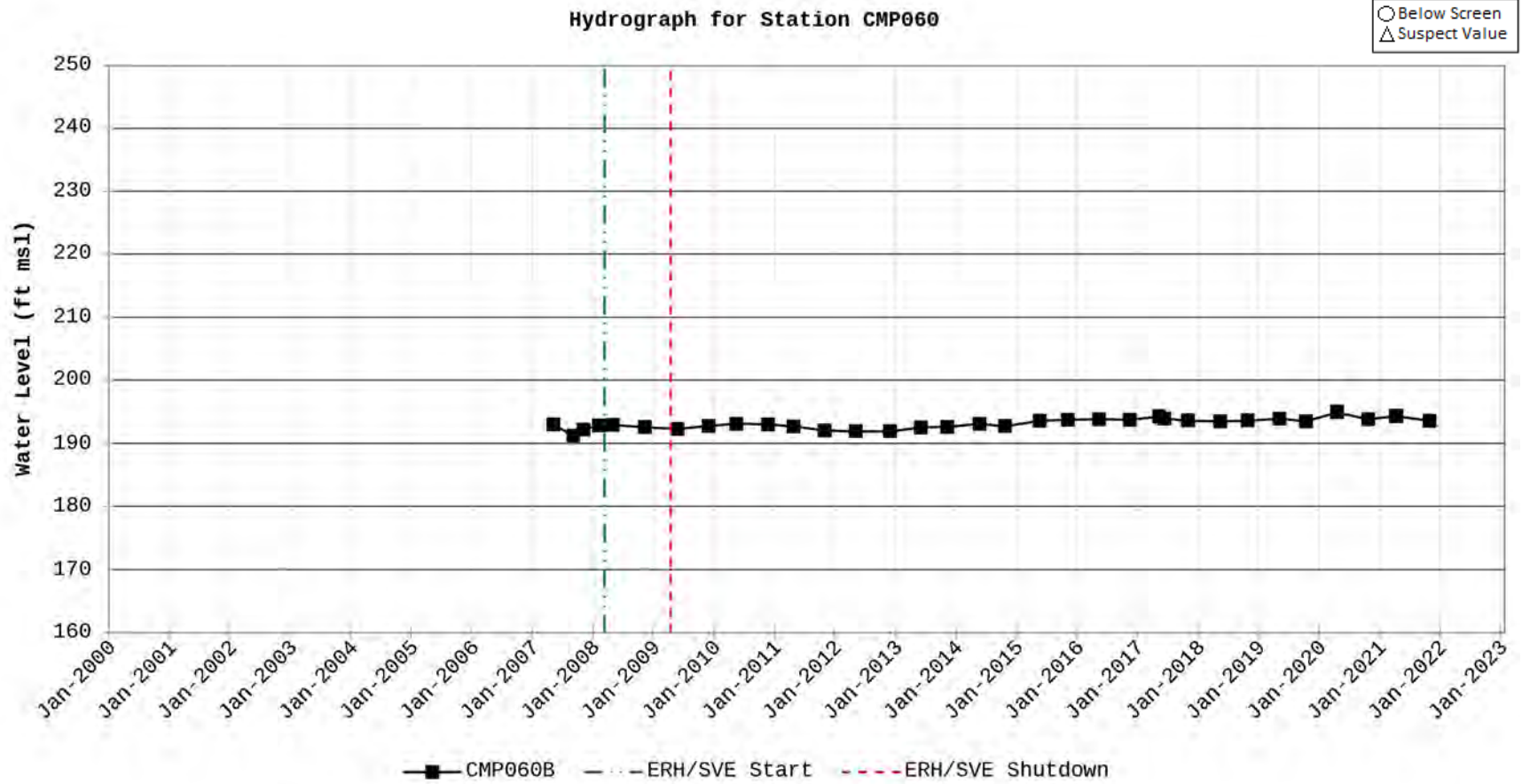


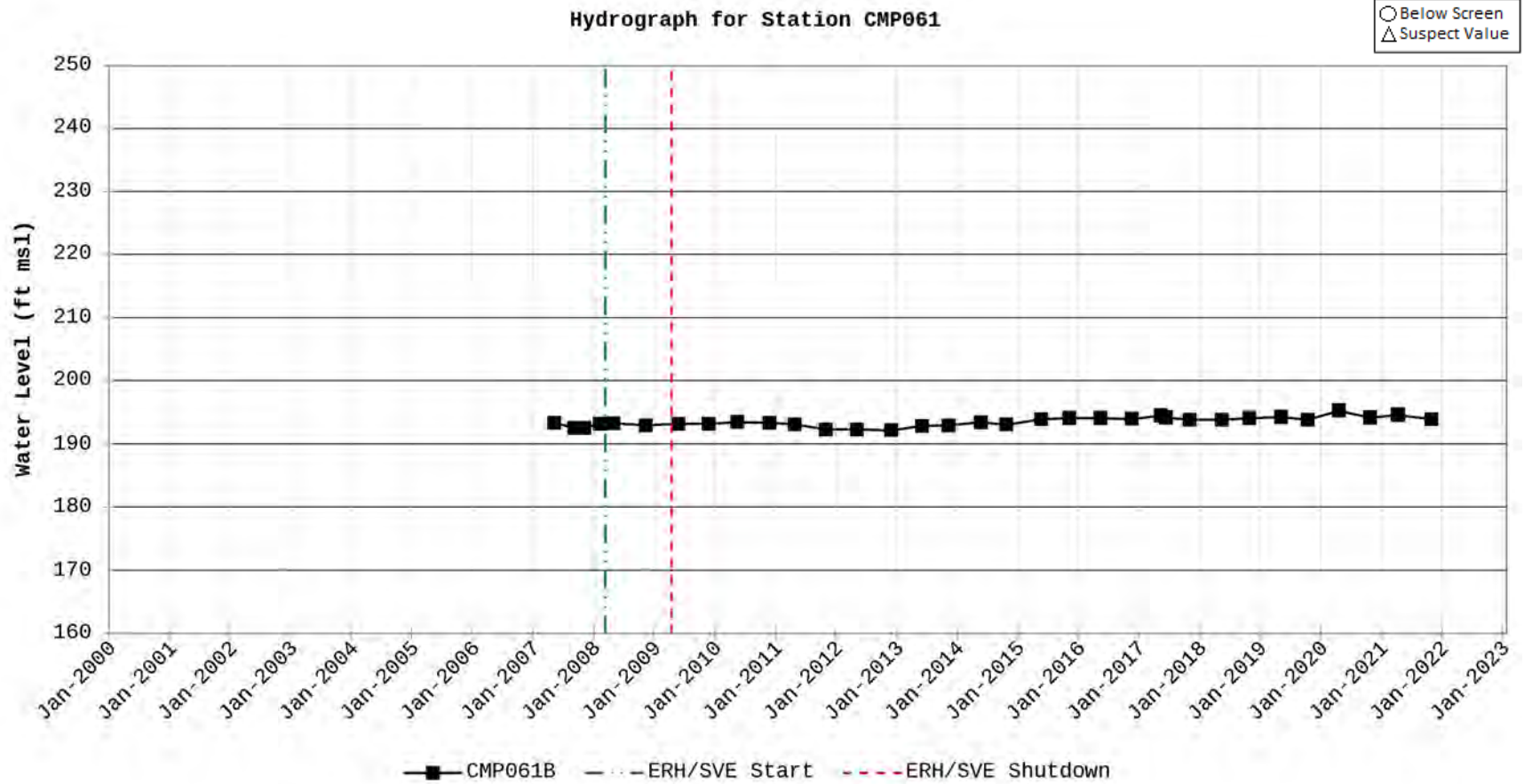


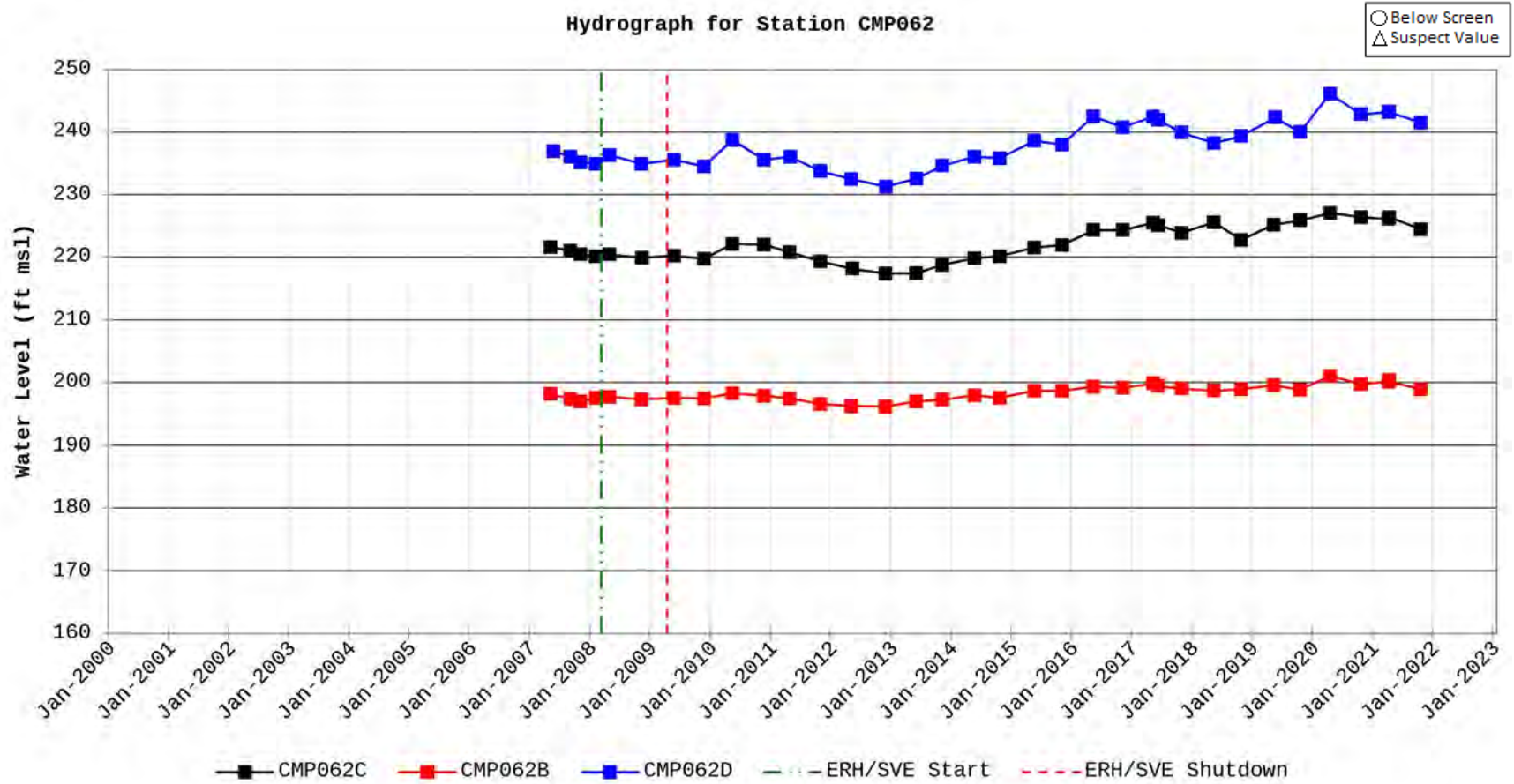


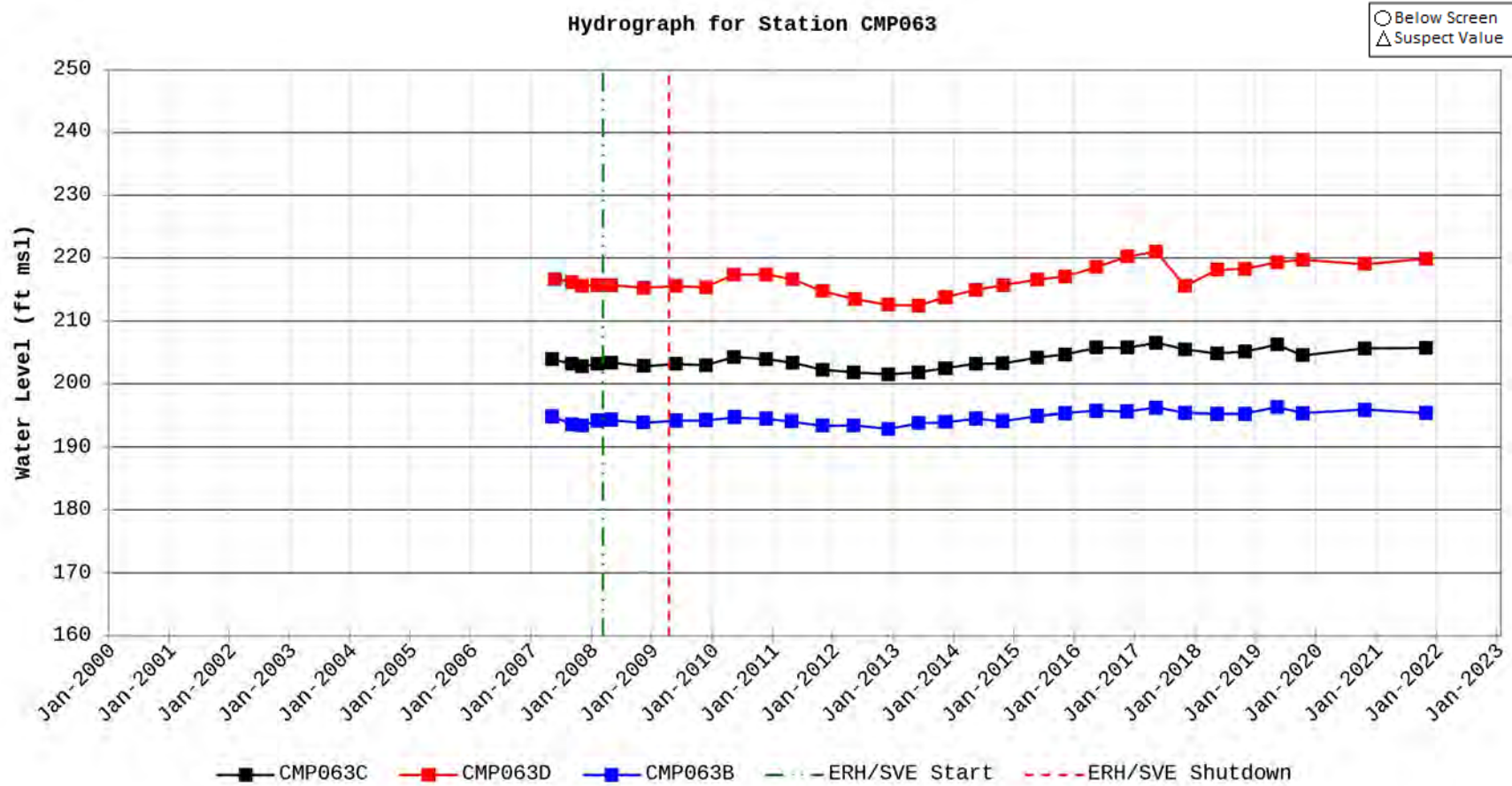


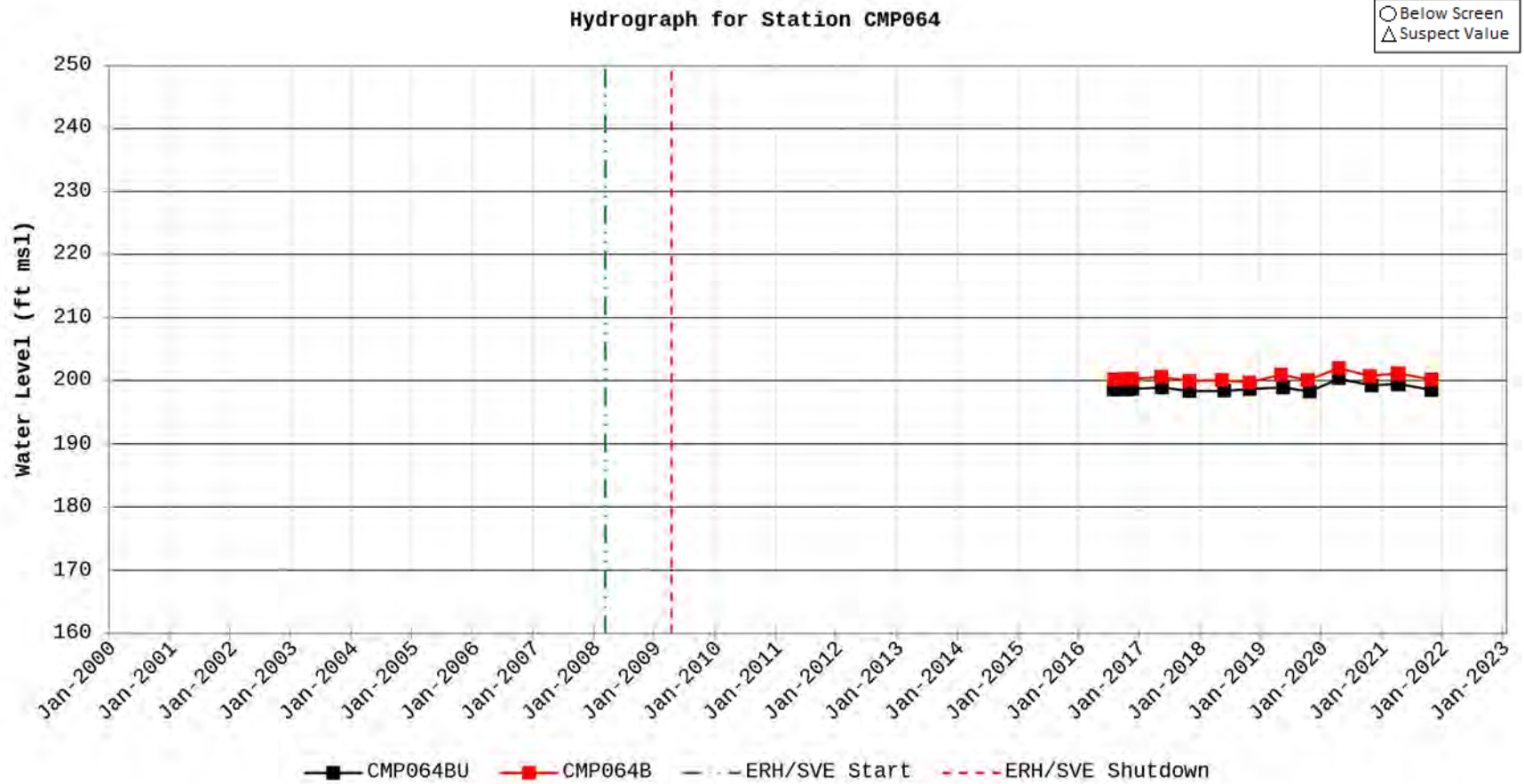


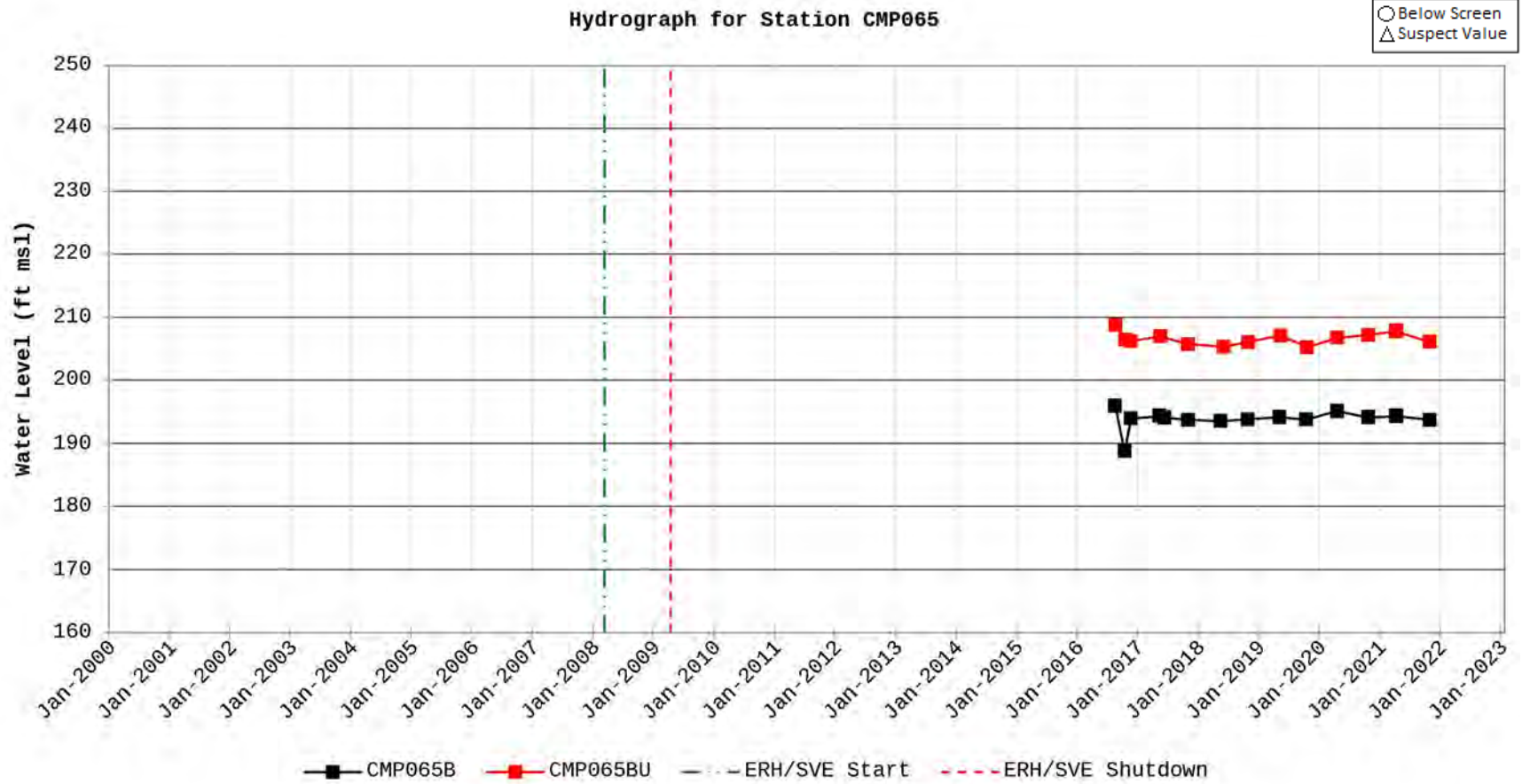


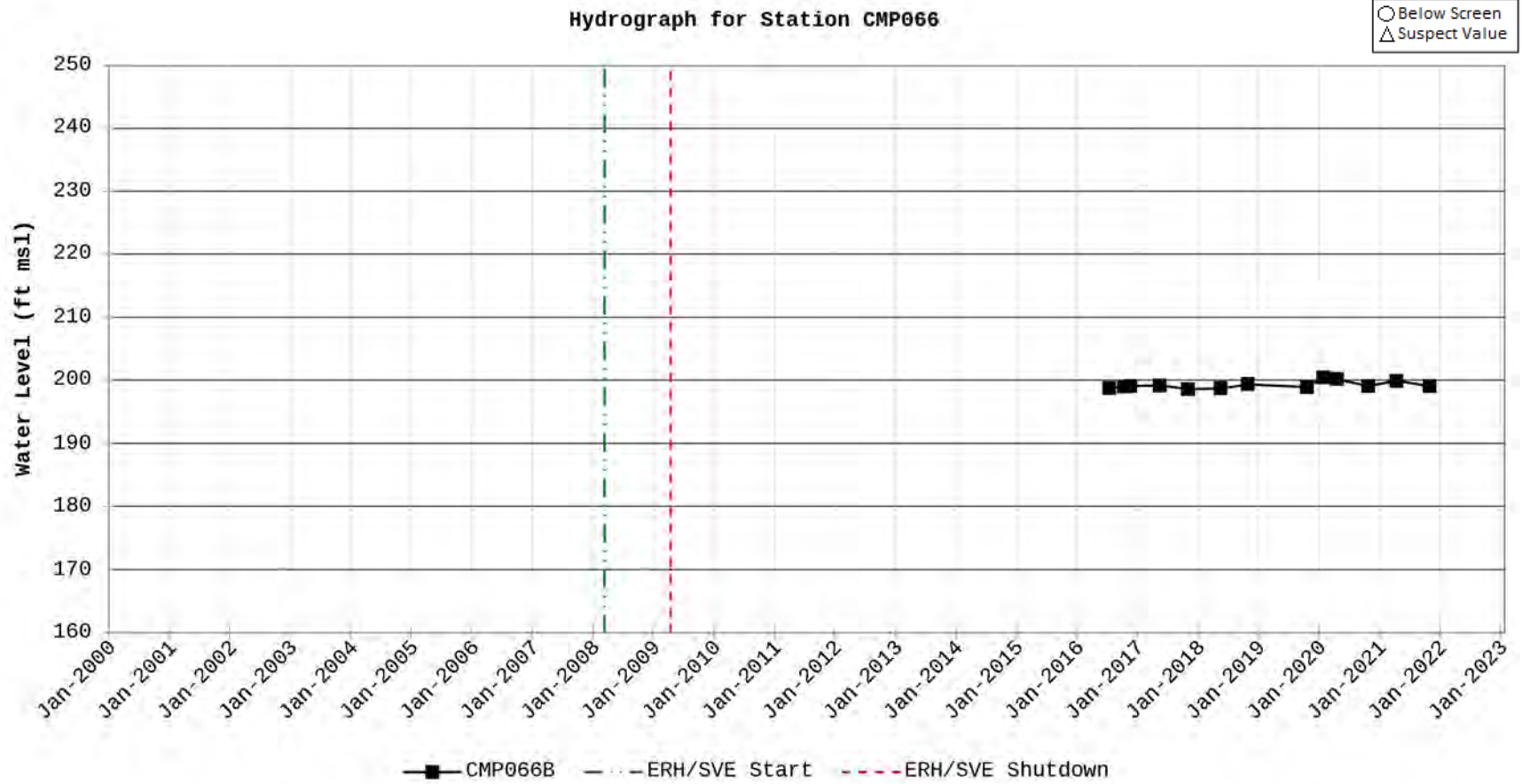


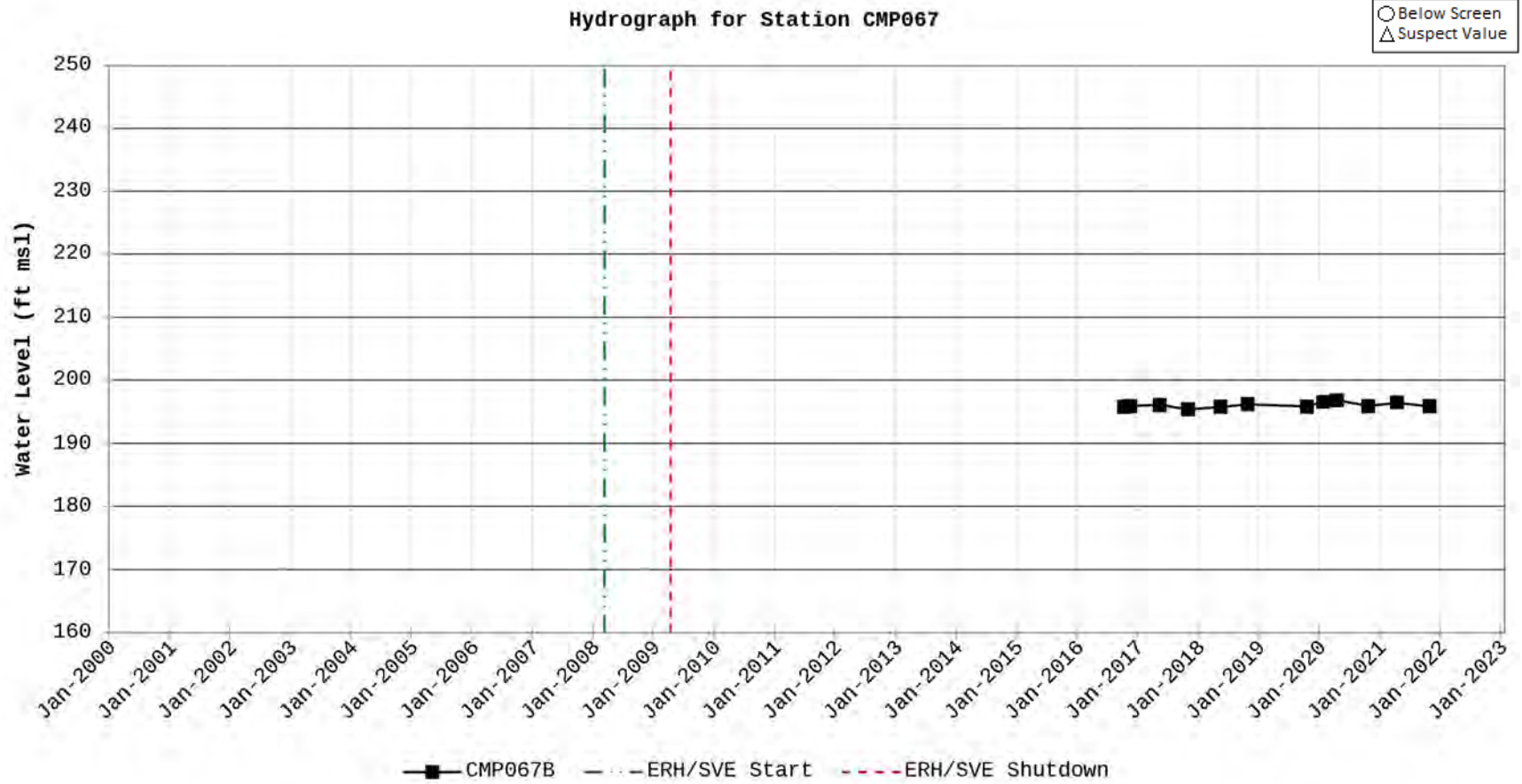








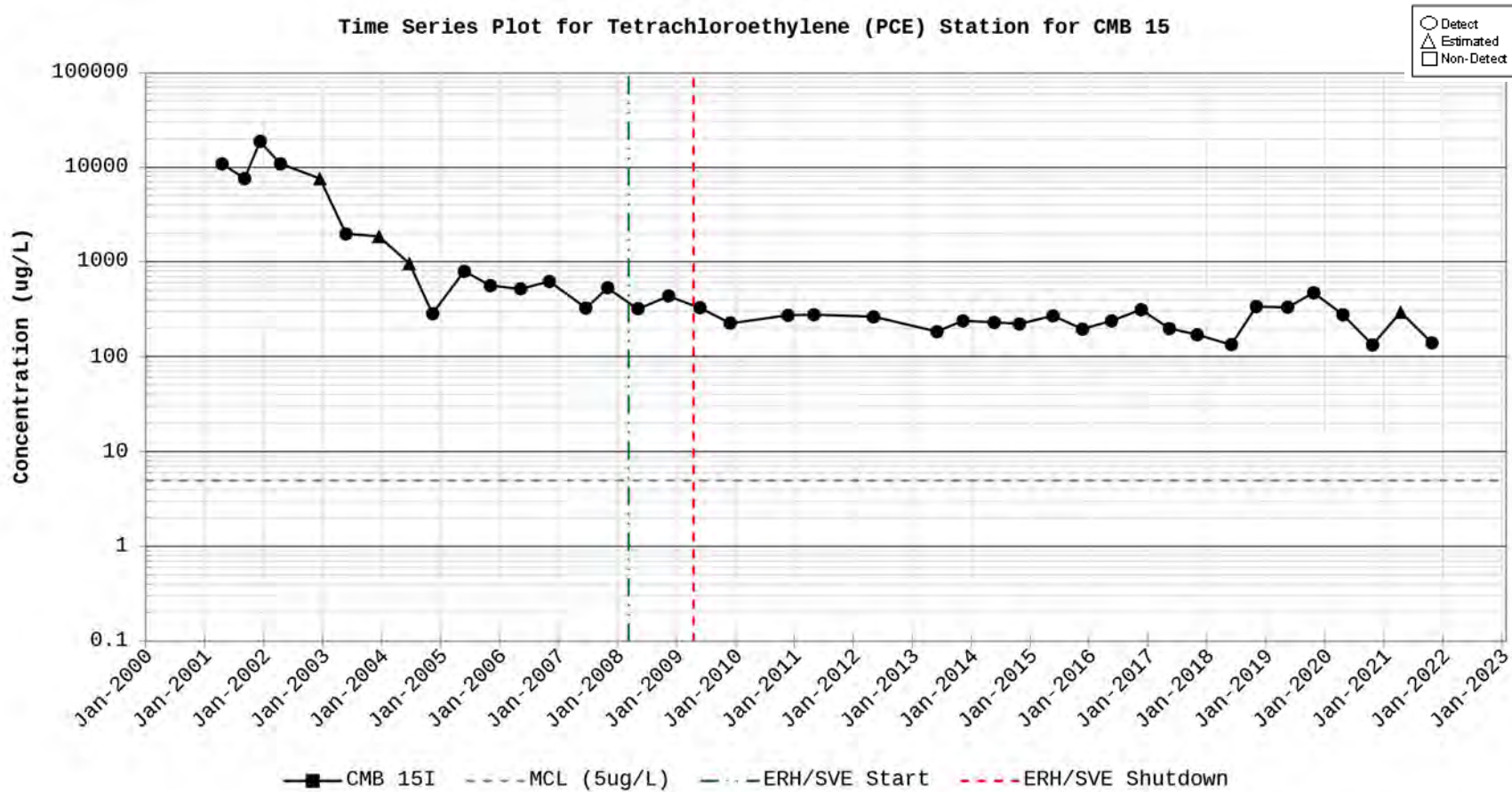


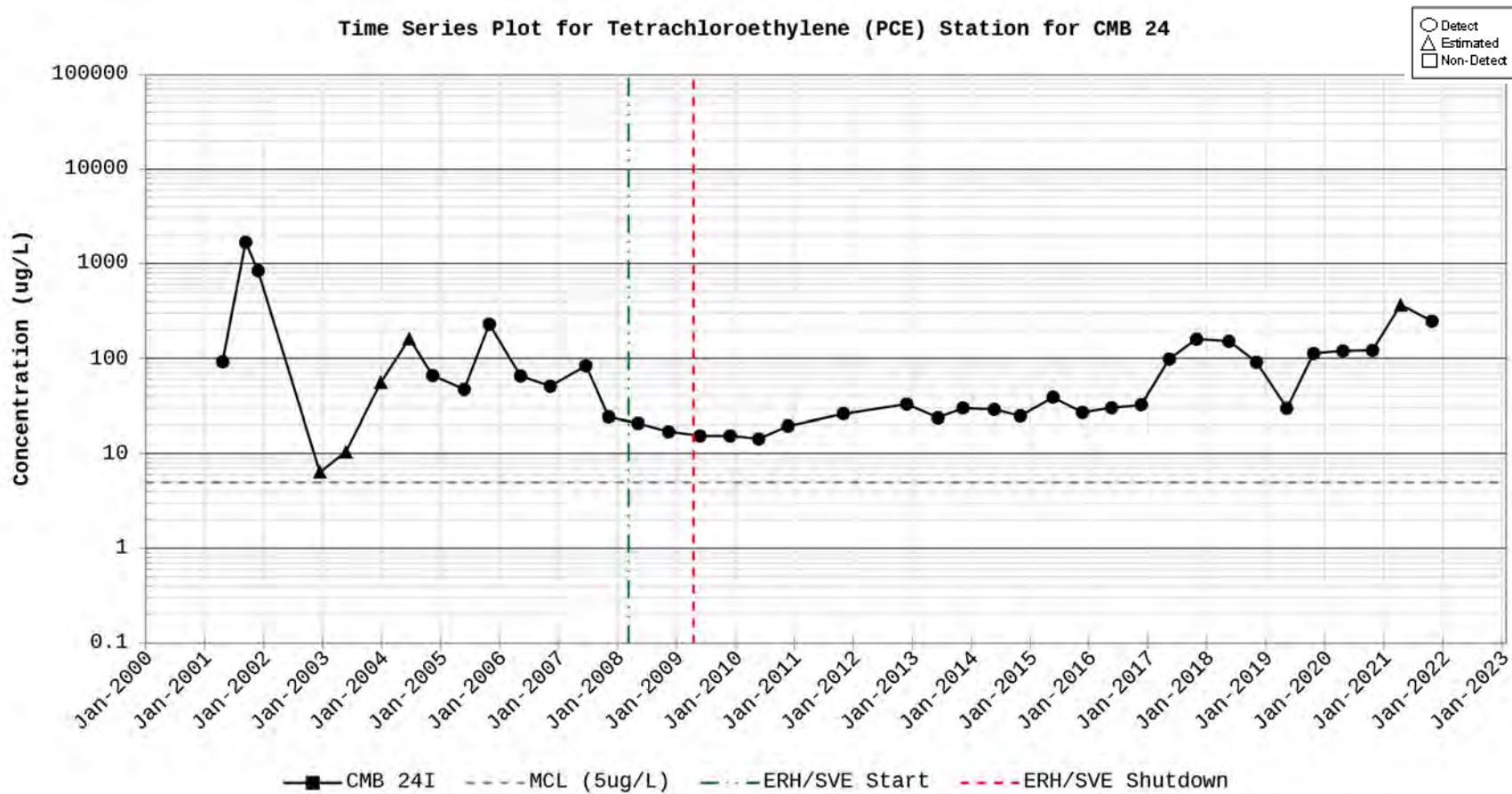


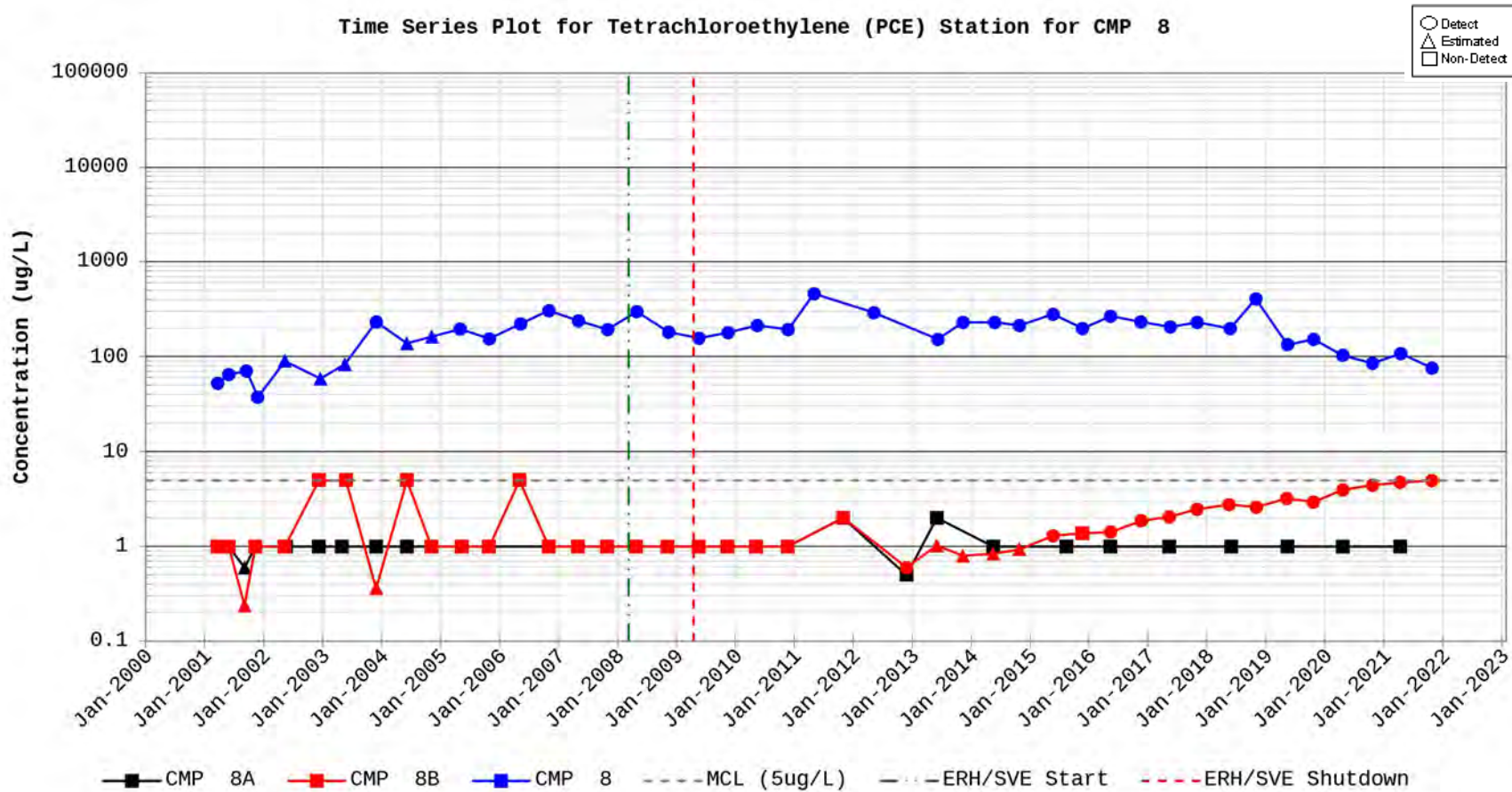
Appendix B

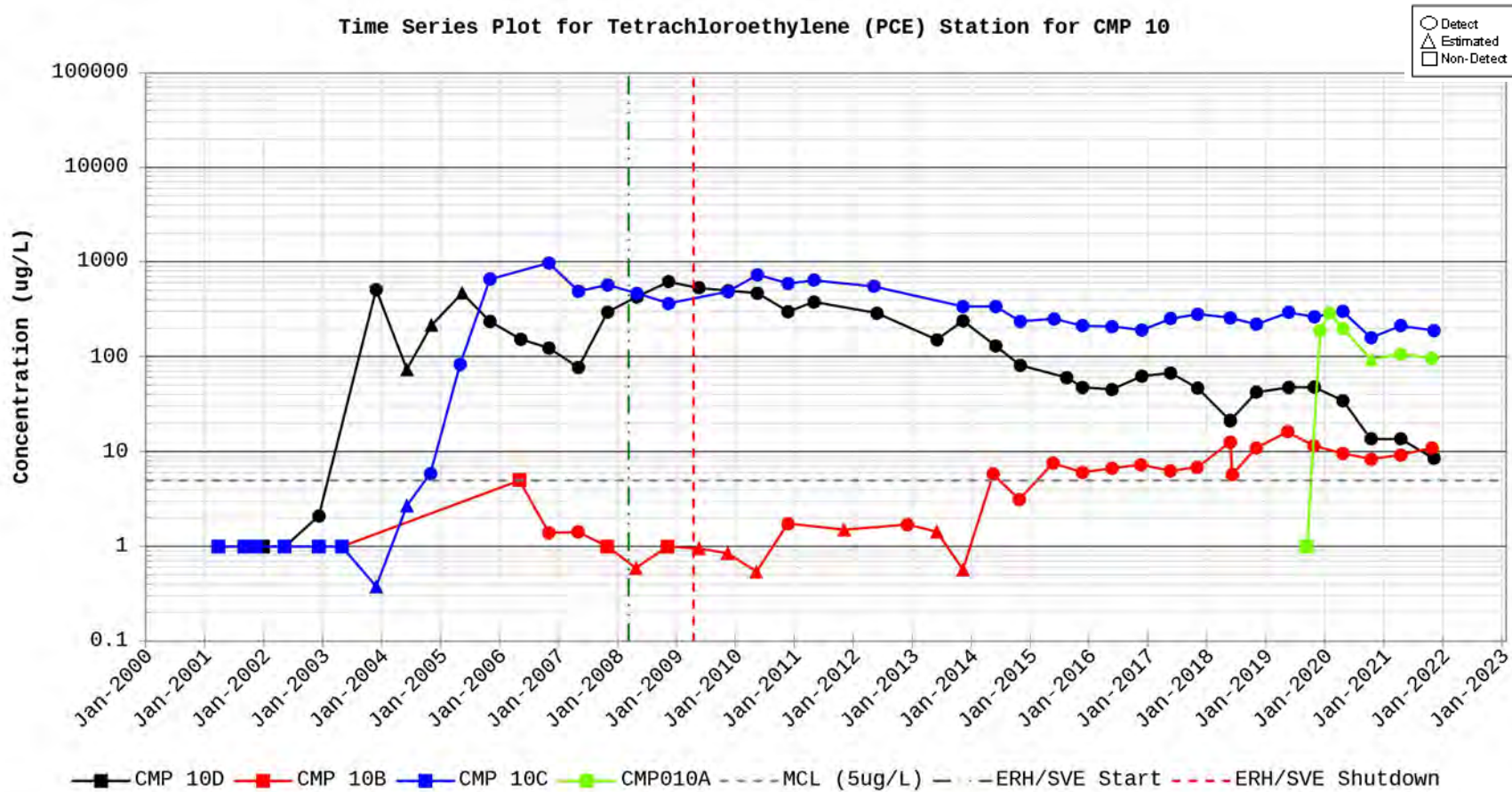
Time-Series Plots

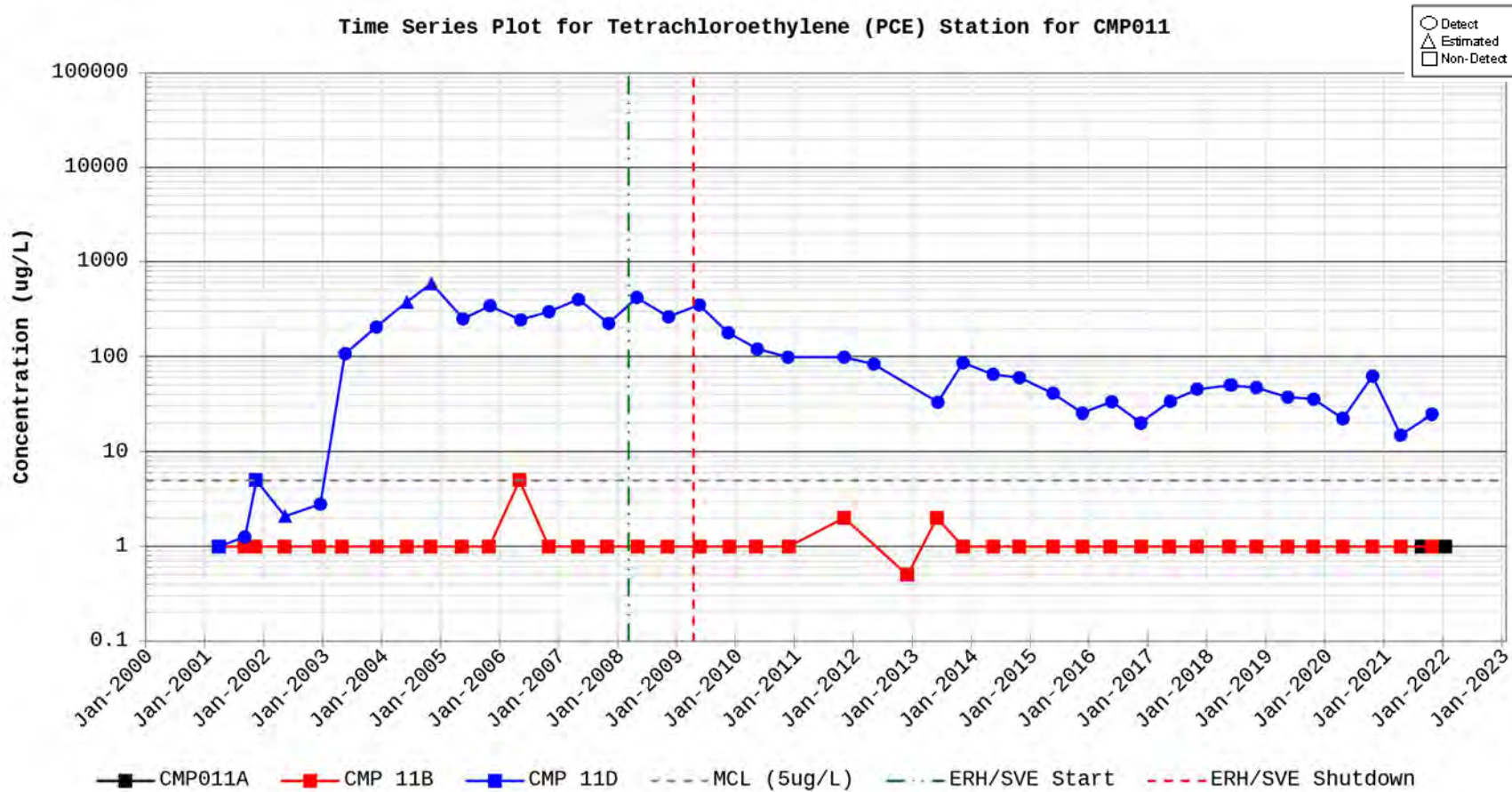
This page is intentionally left blank.

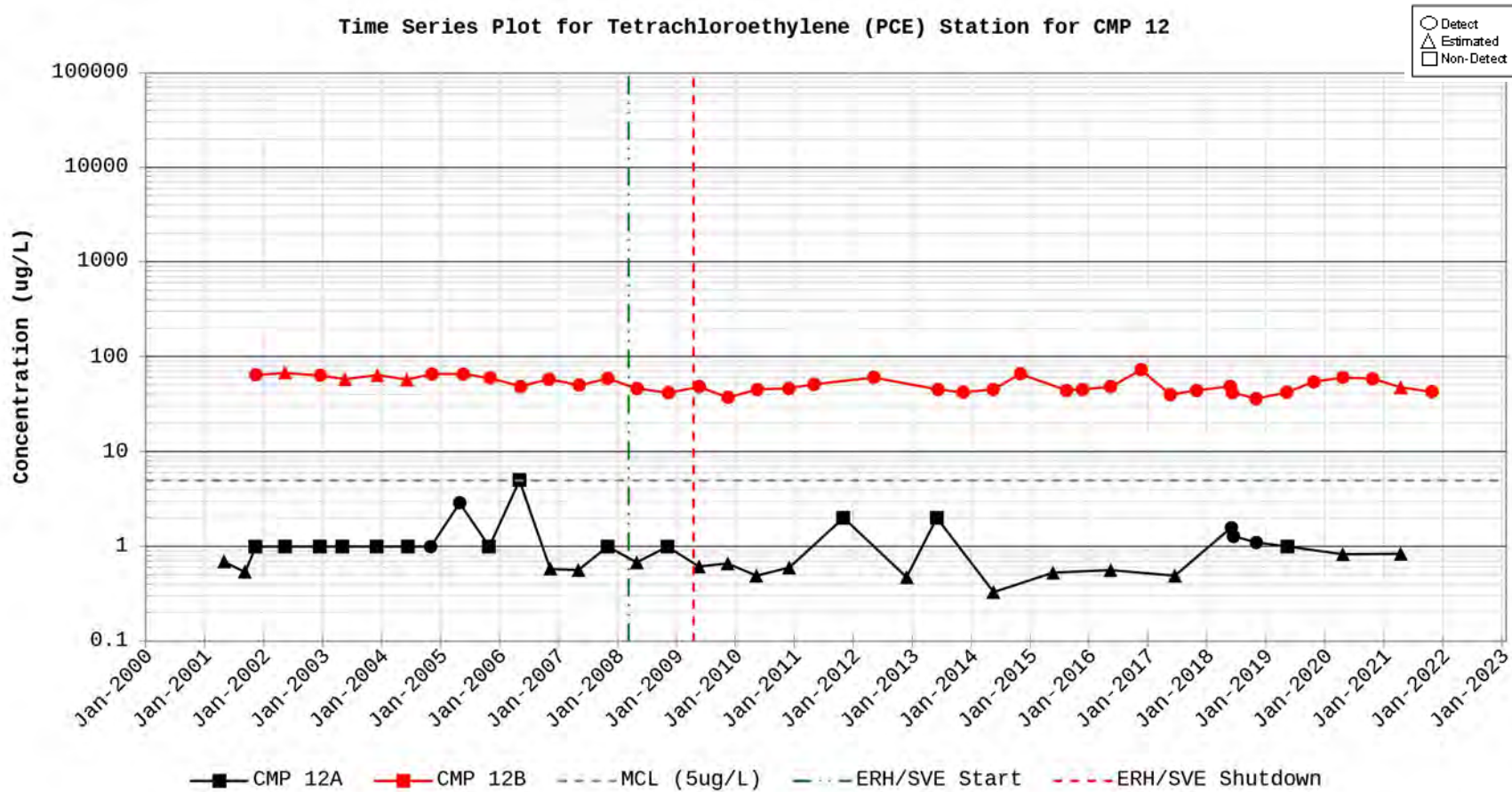


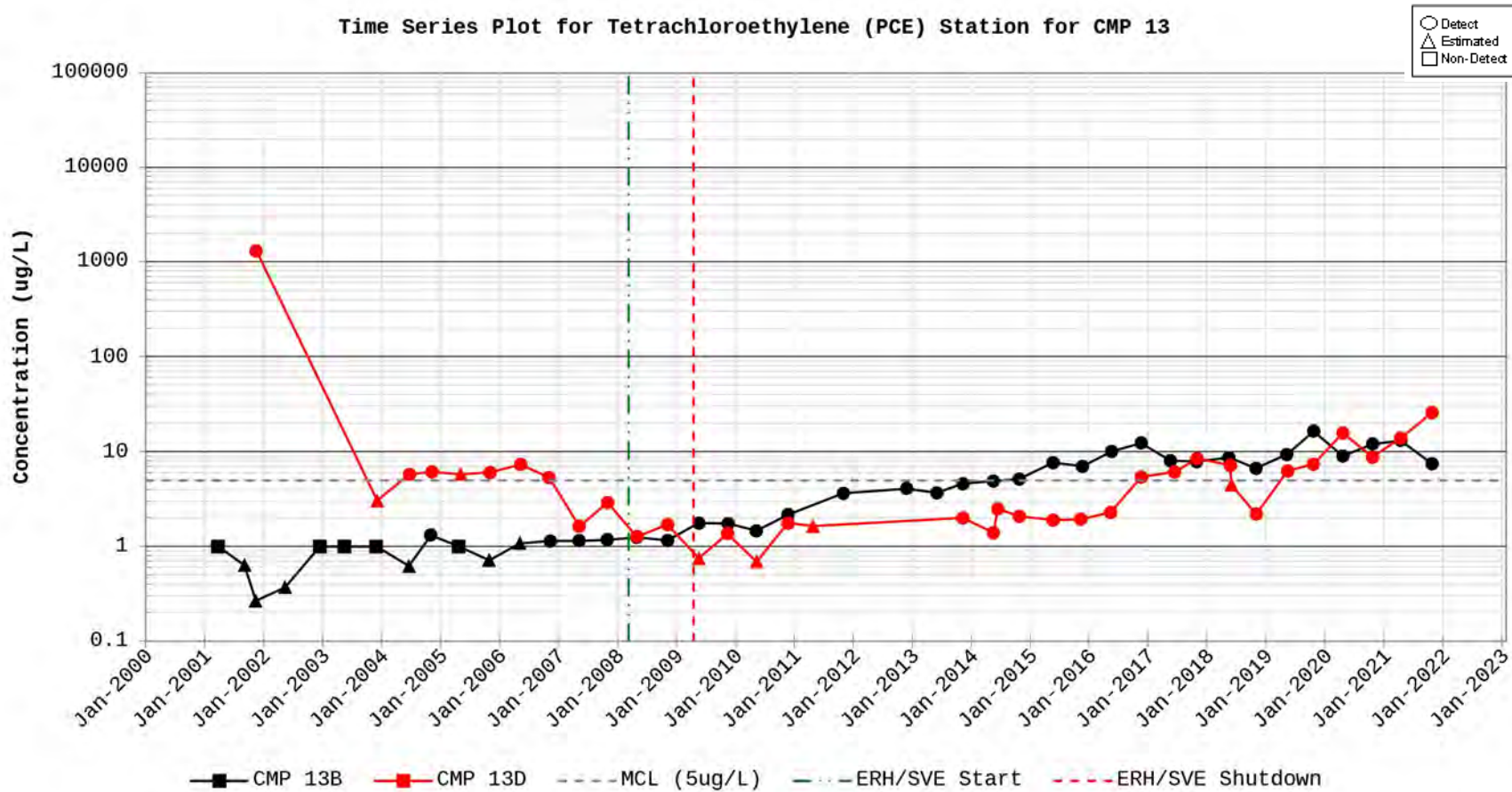


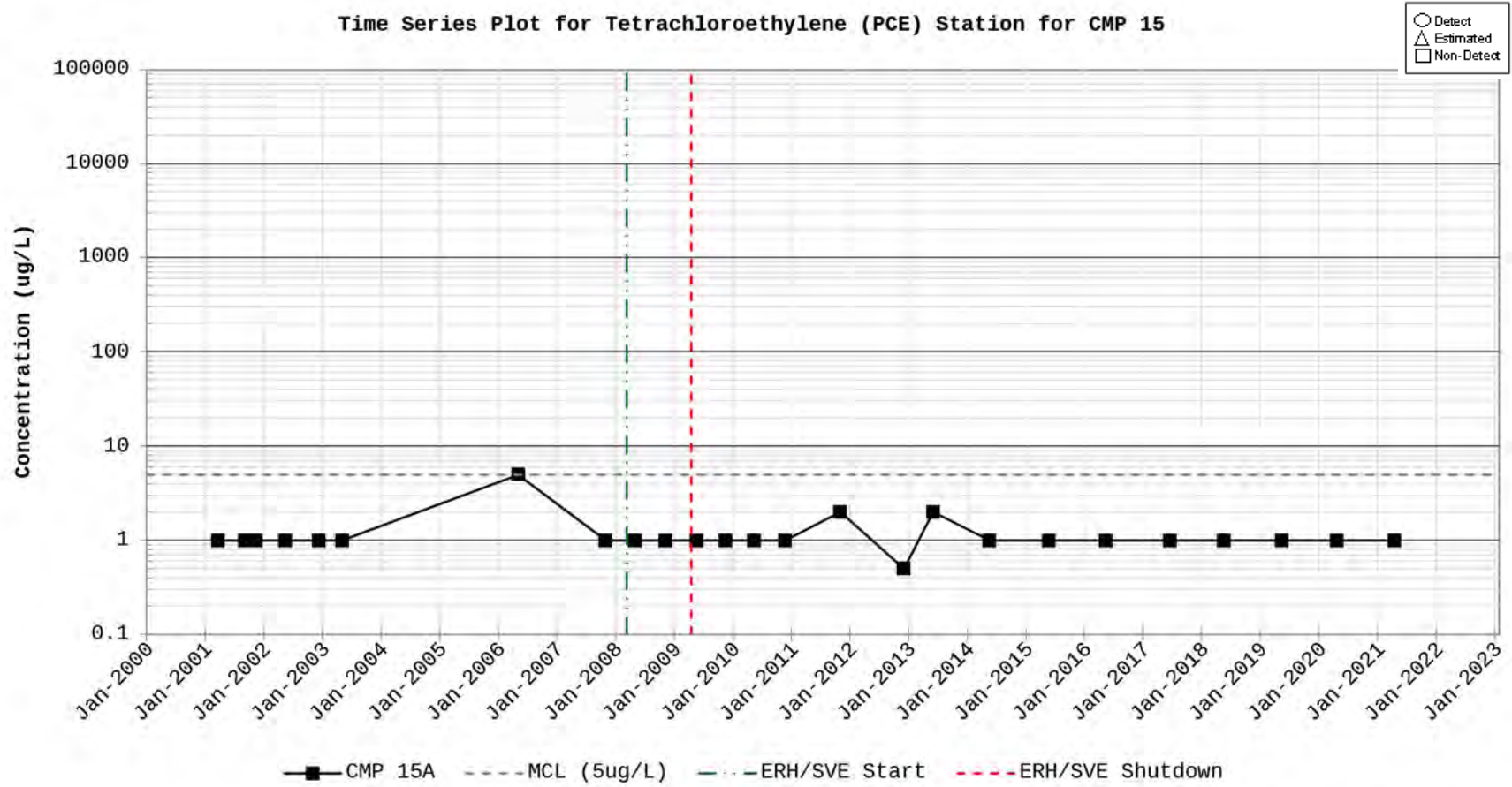


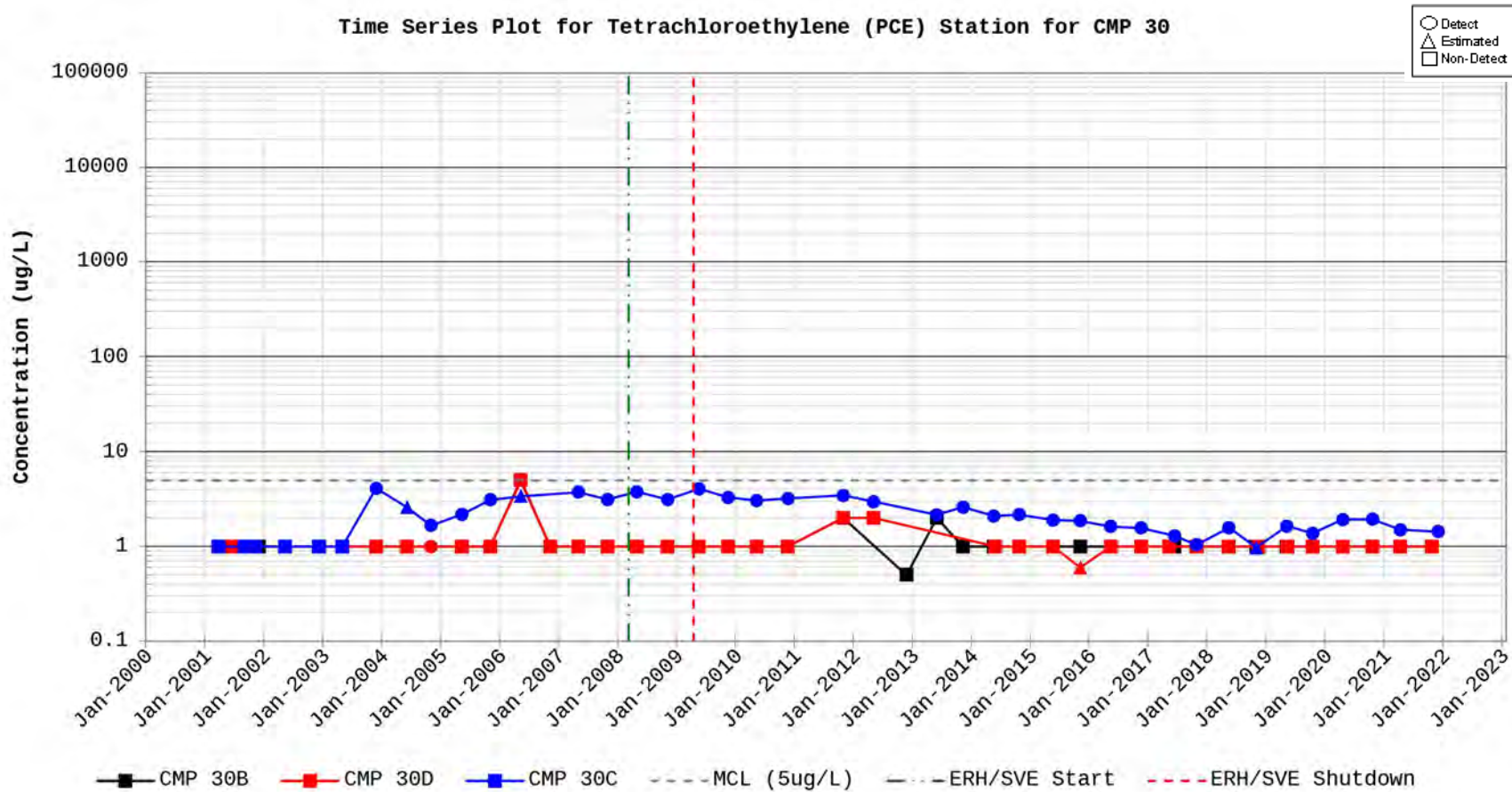


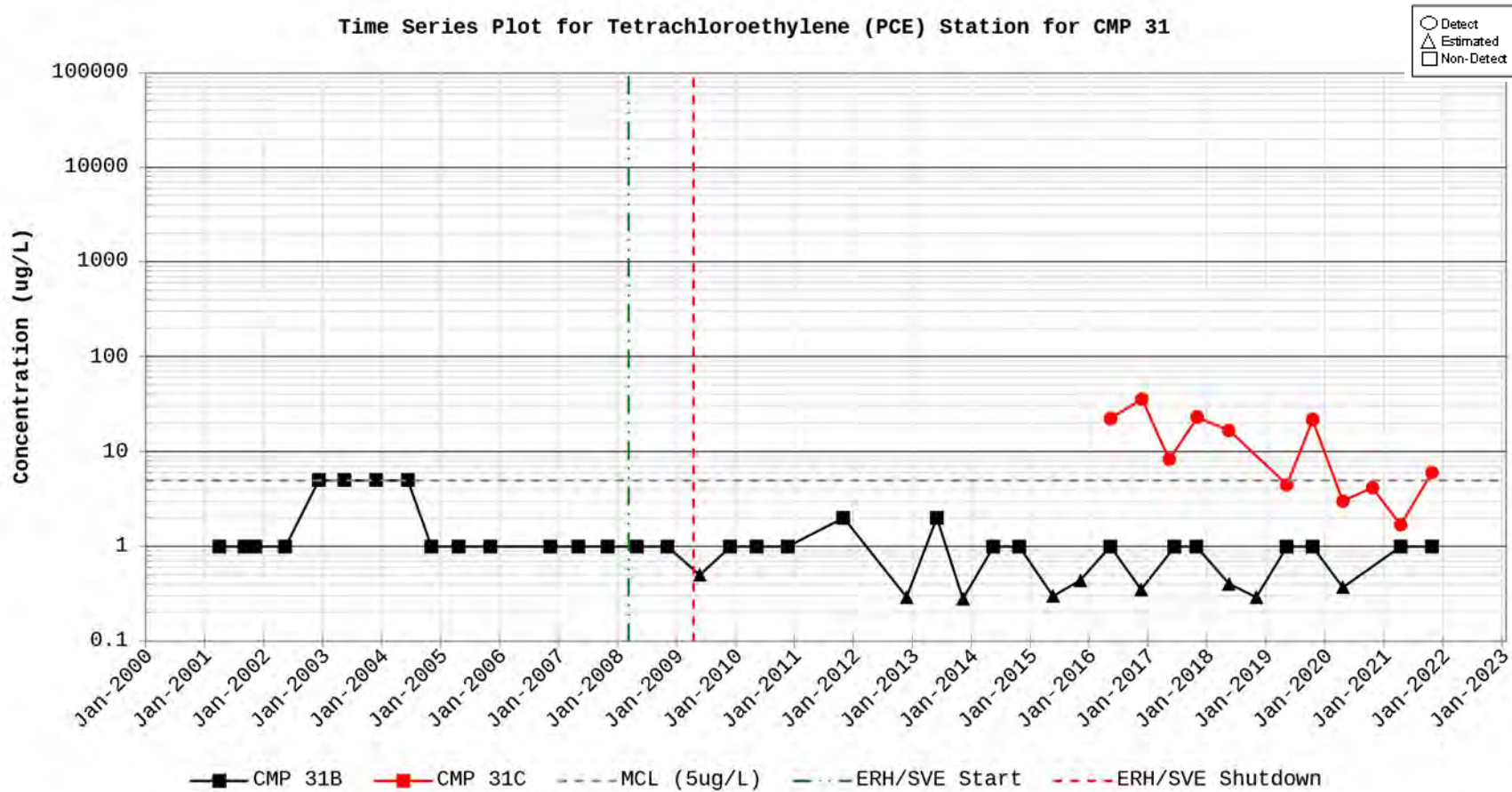


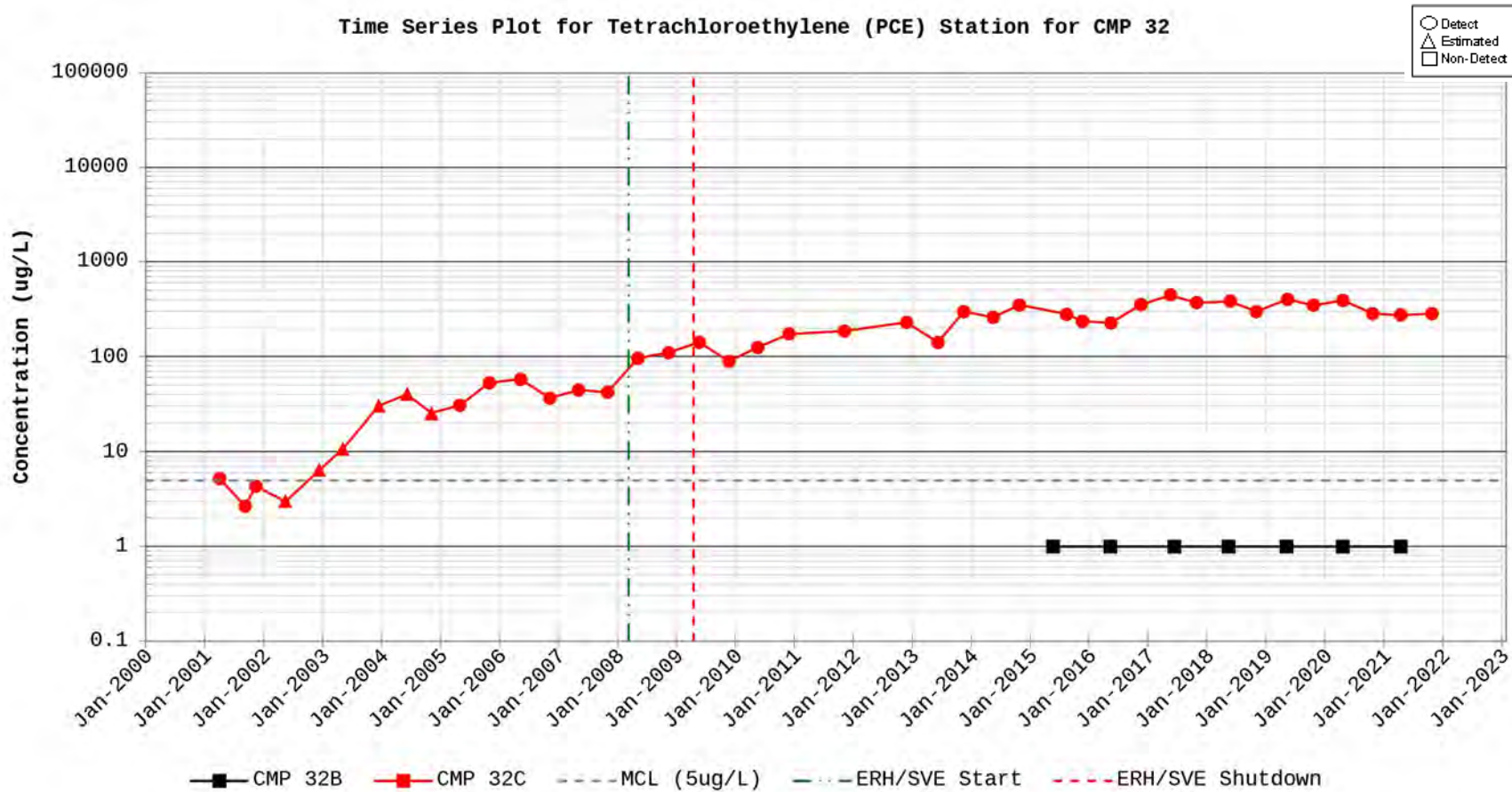


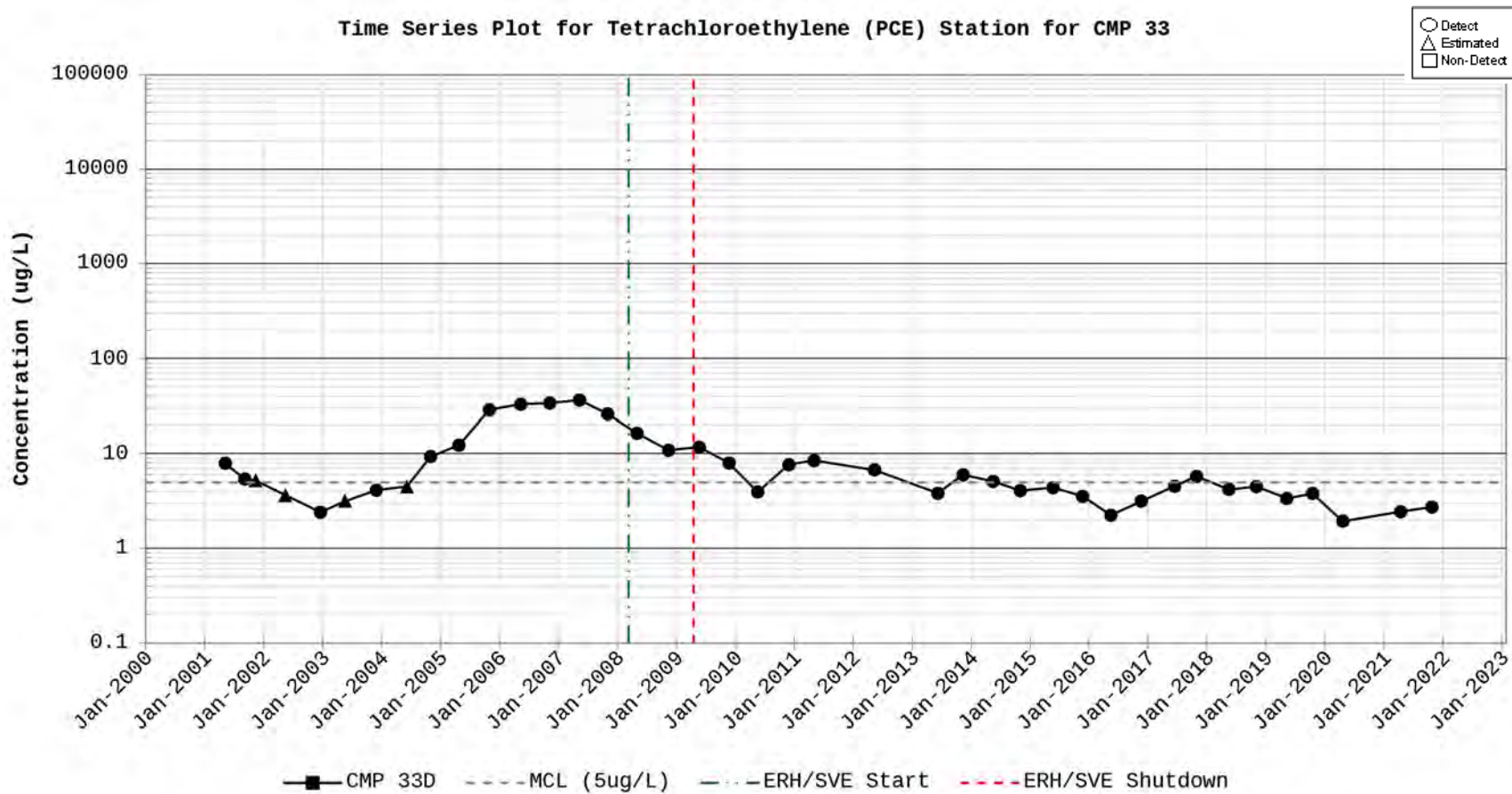


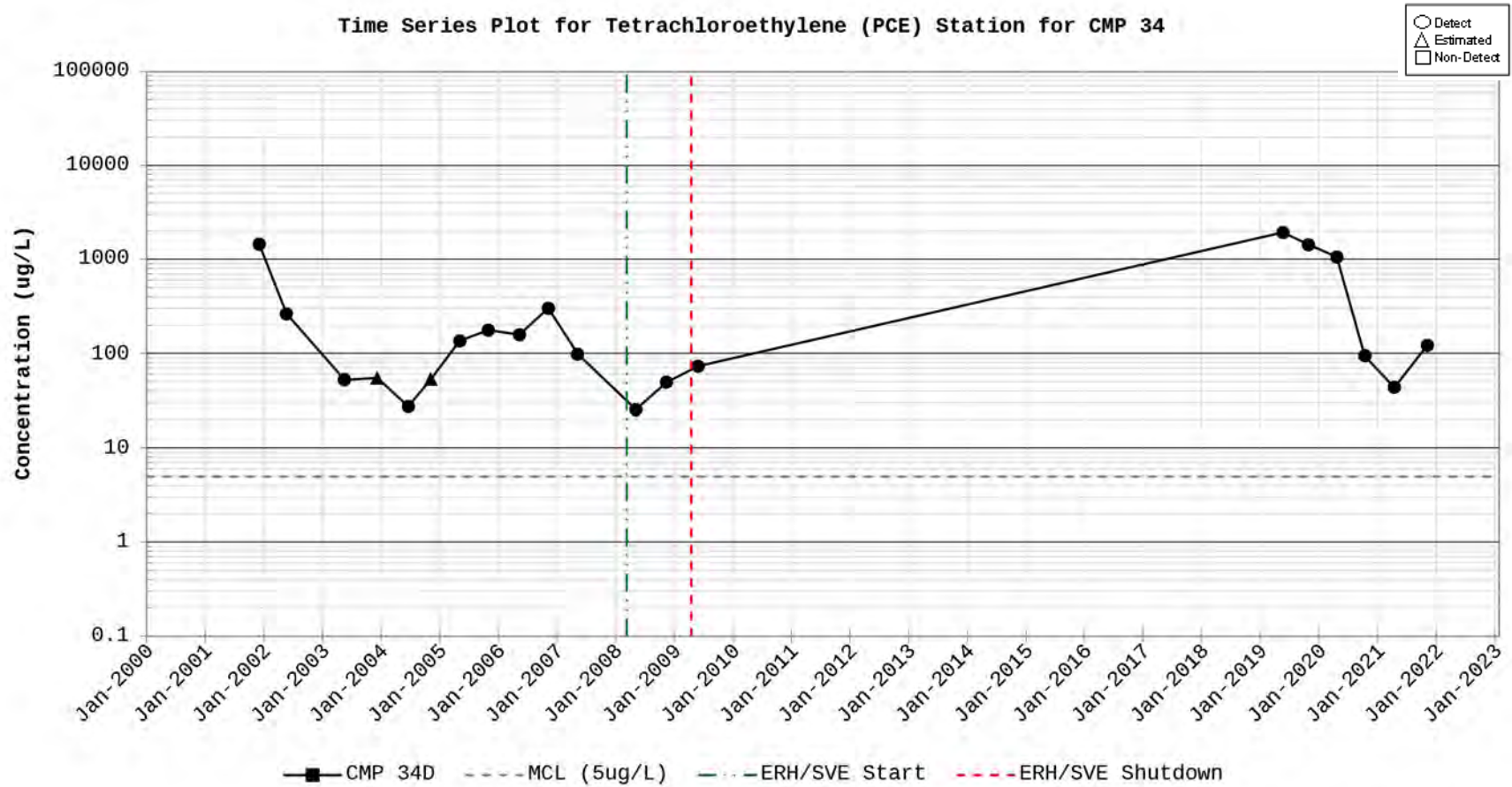


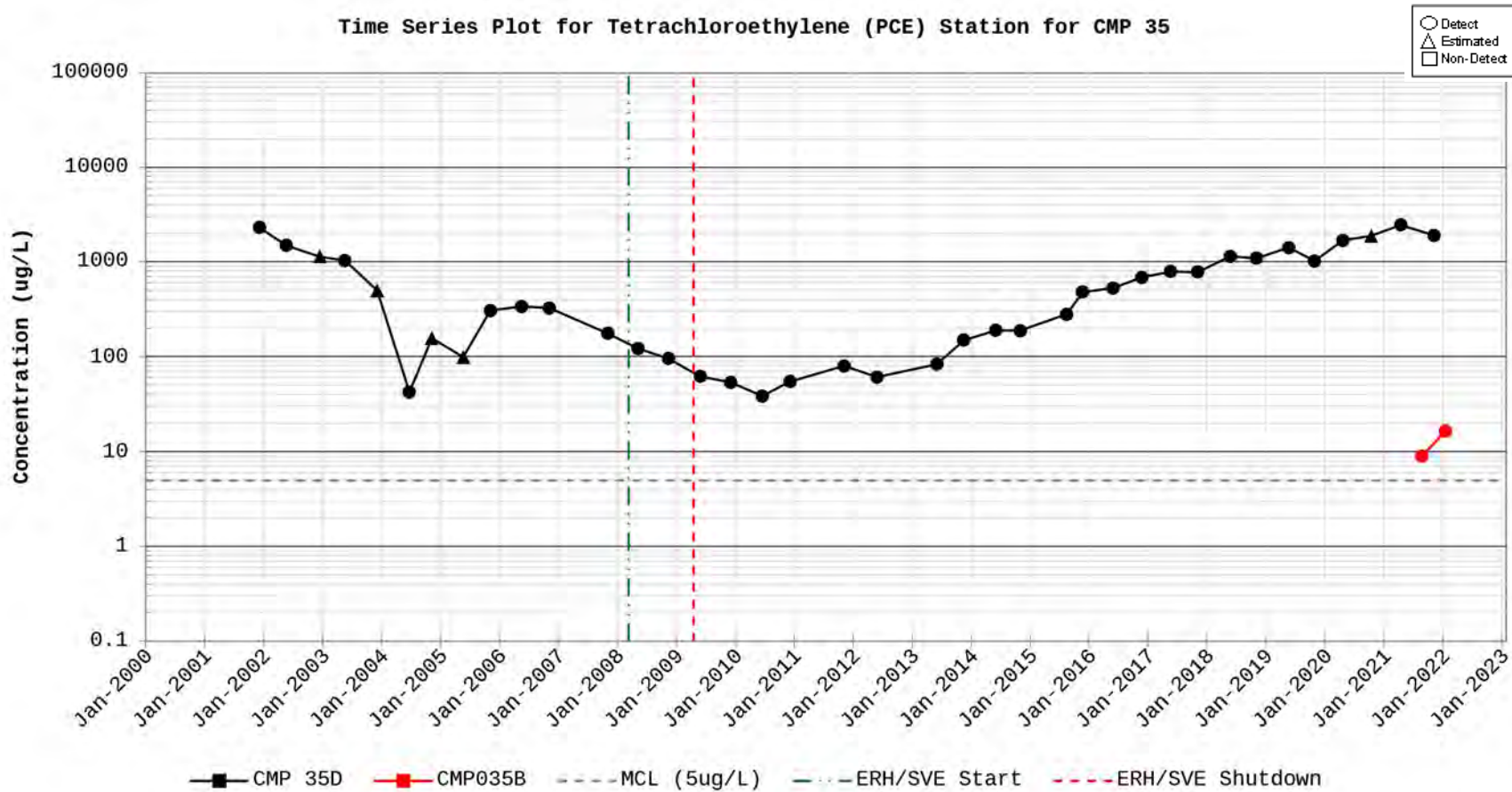


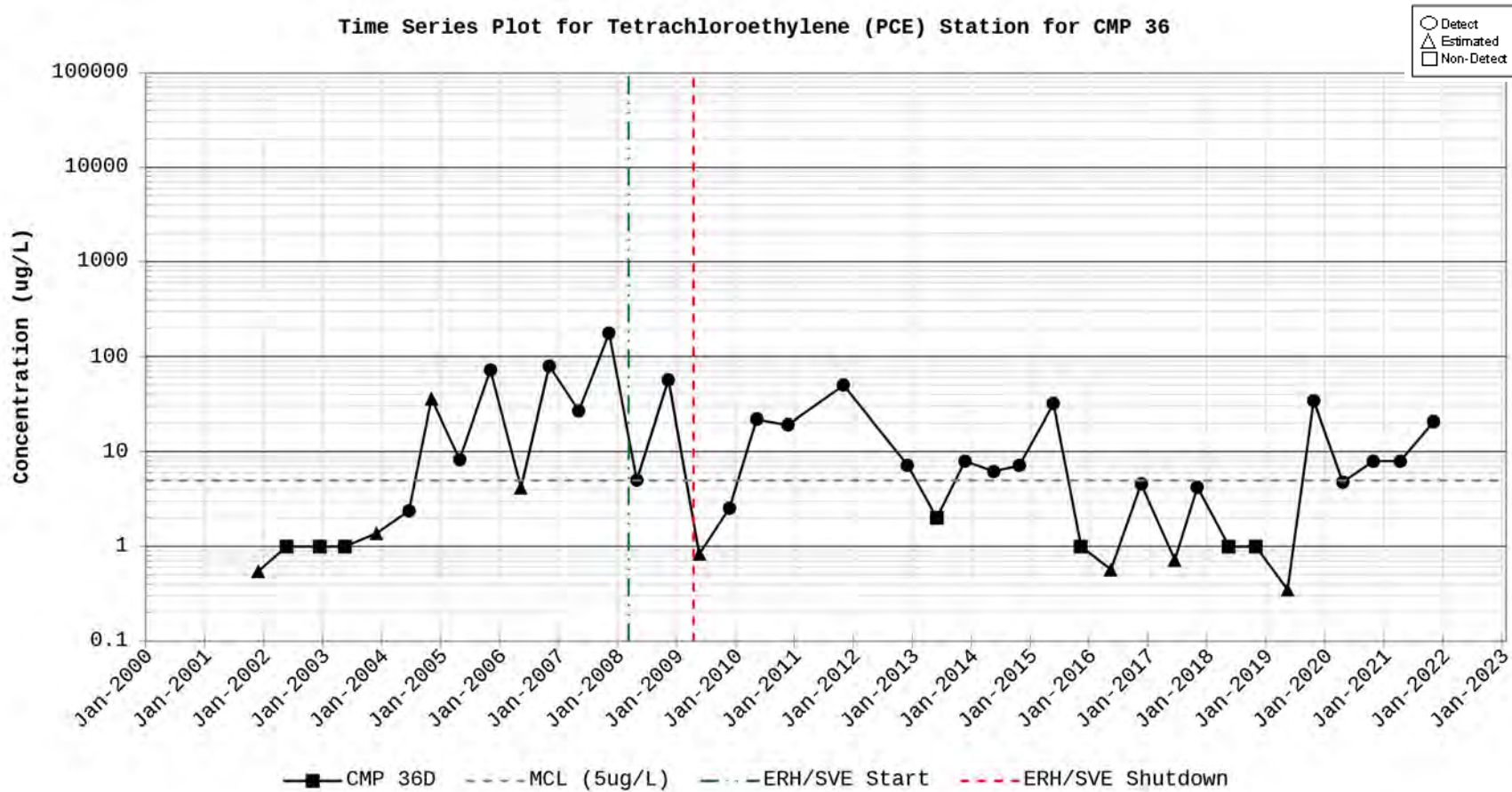


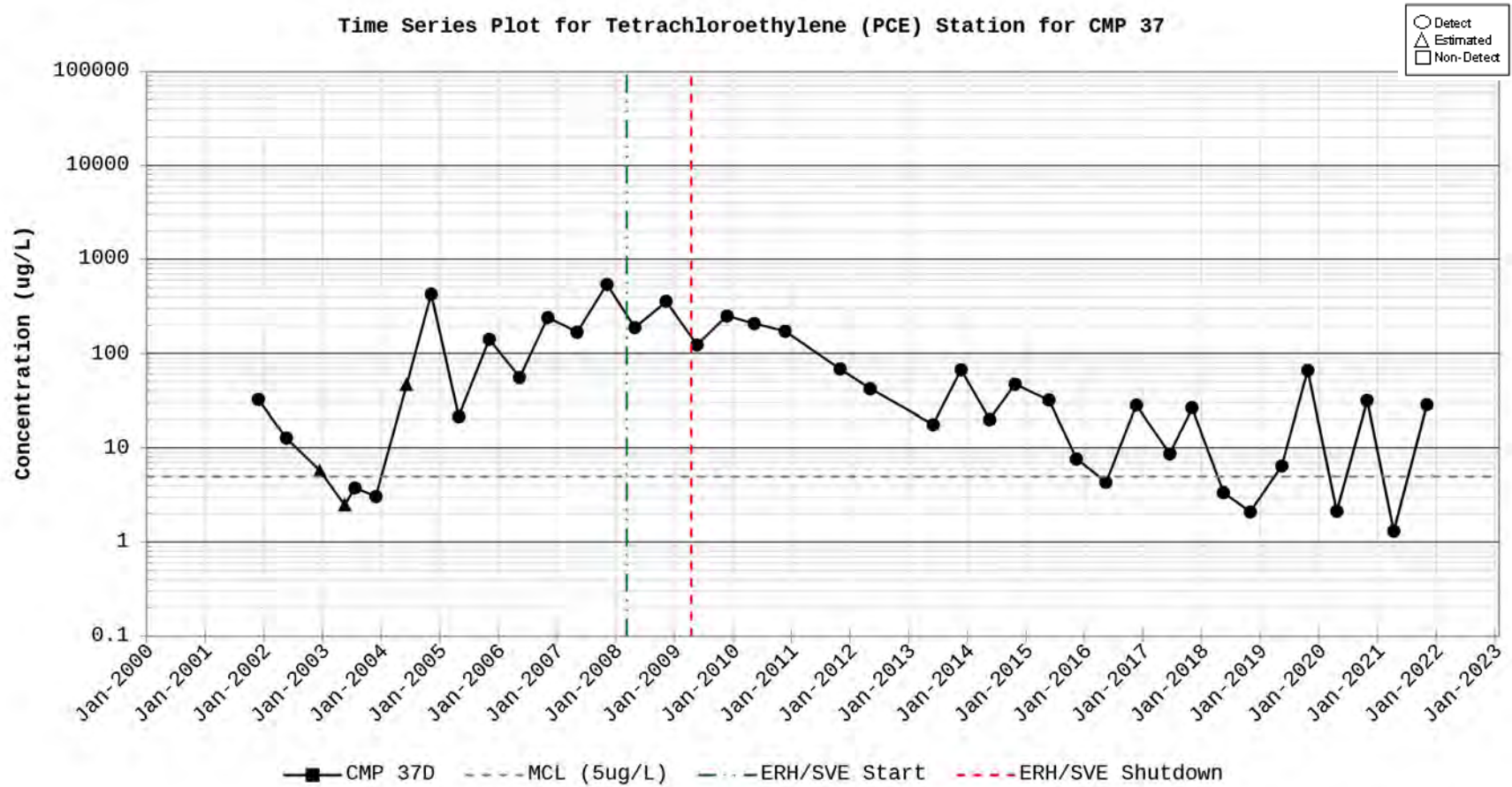


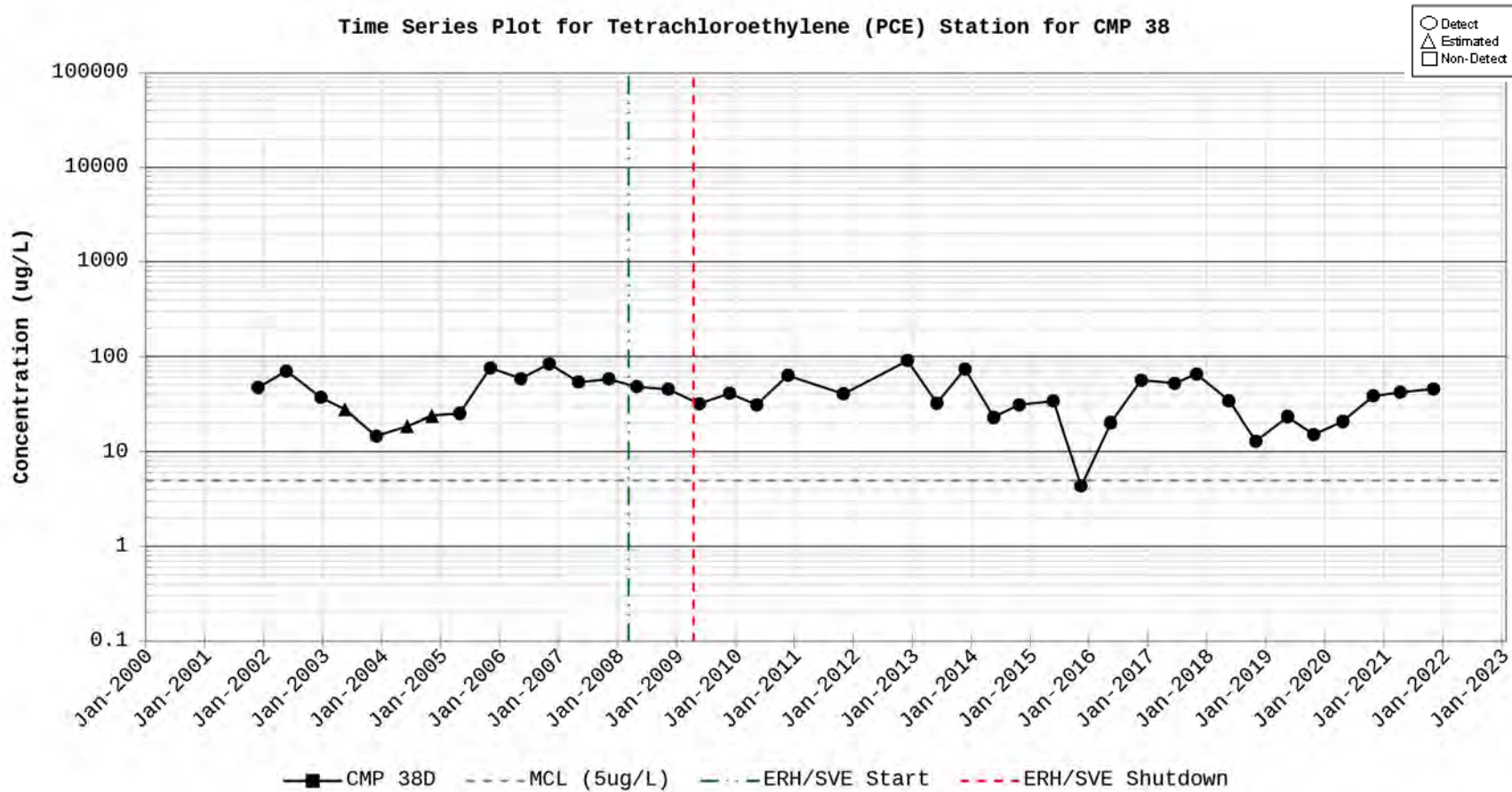


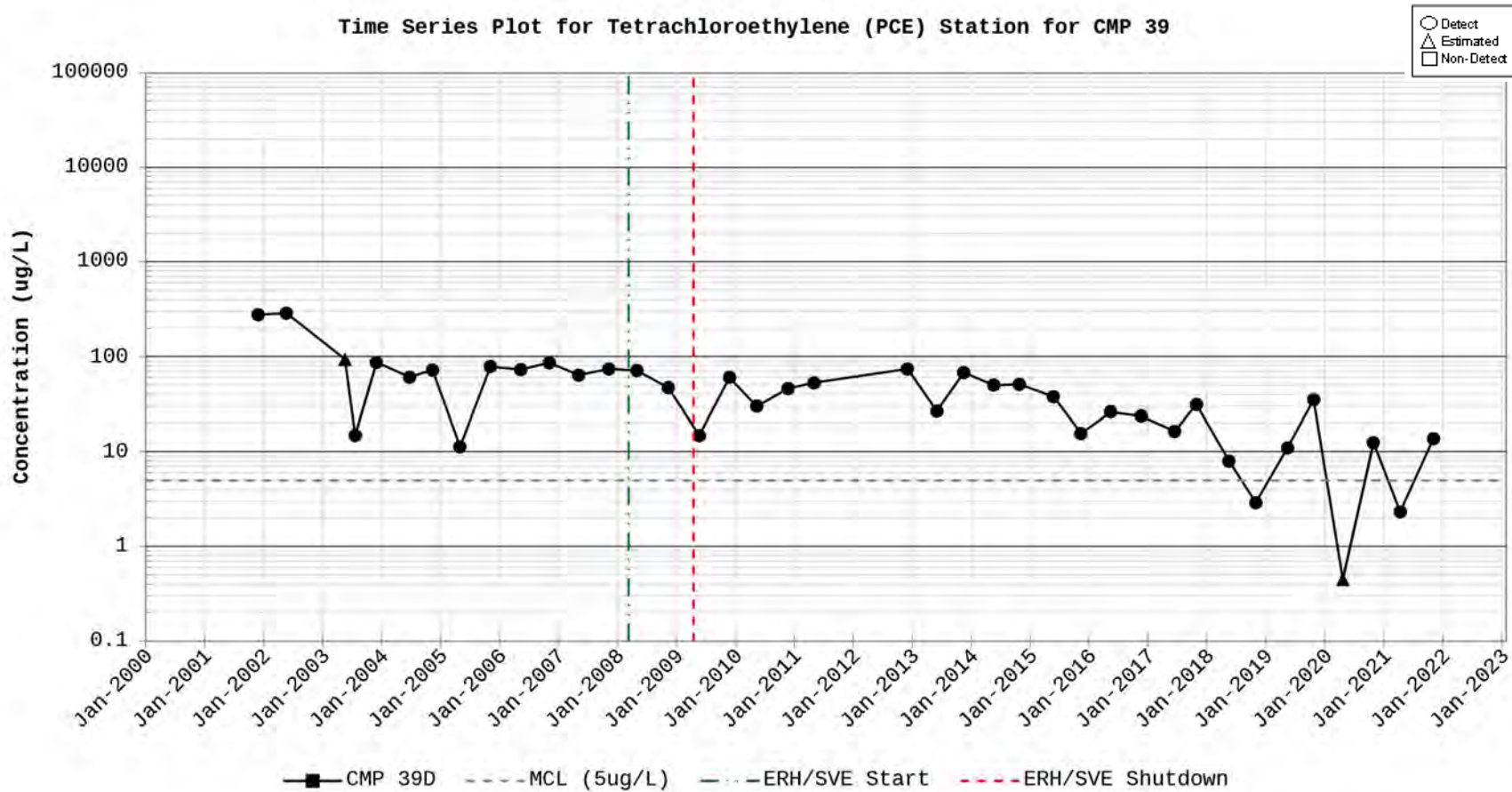


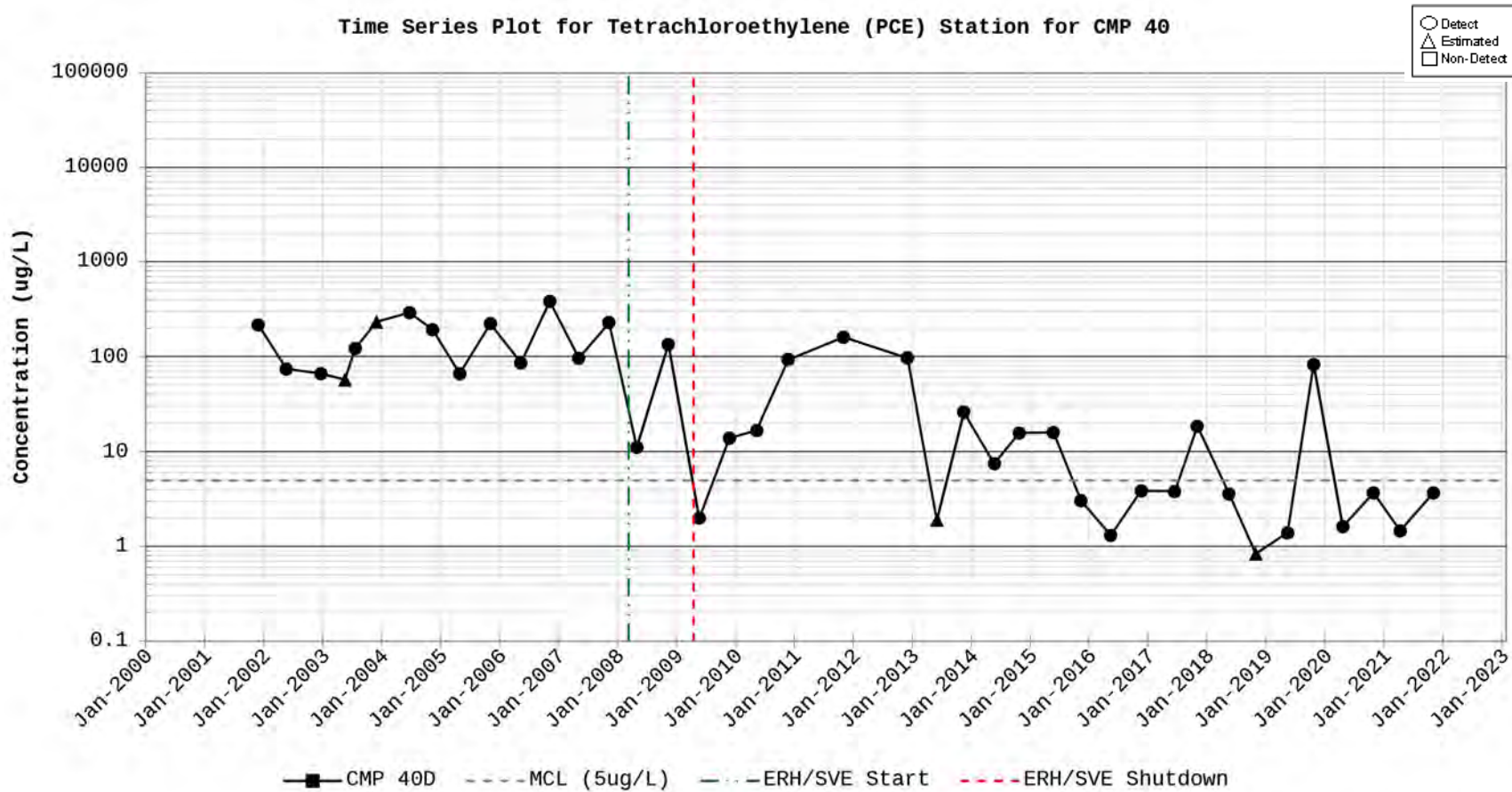


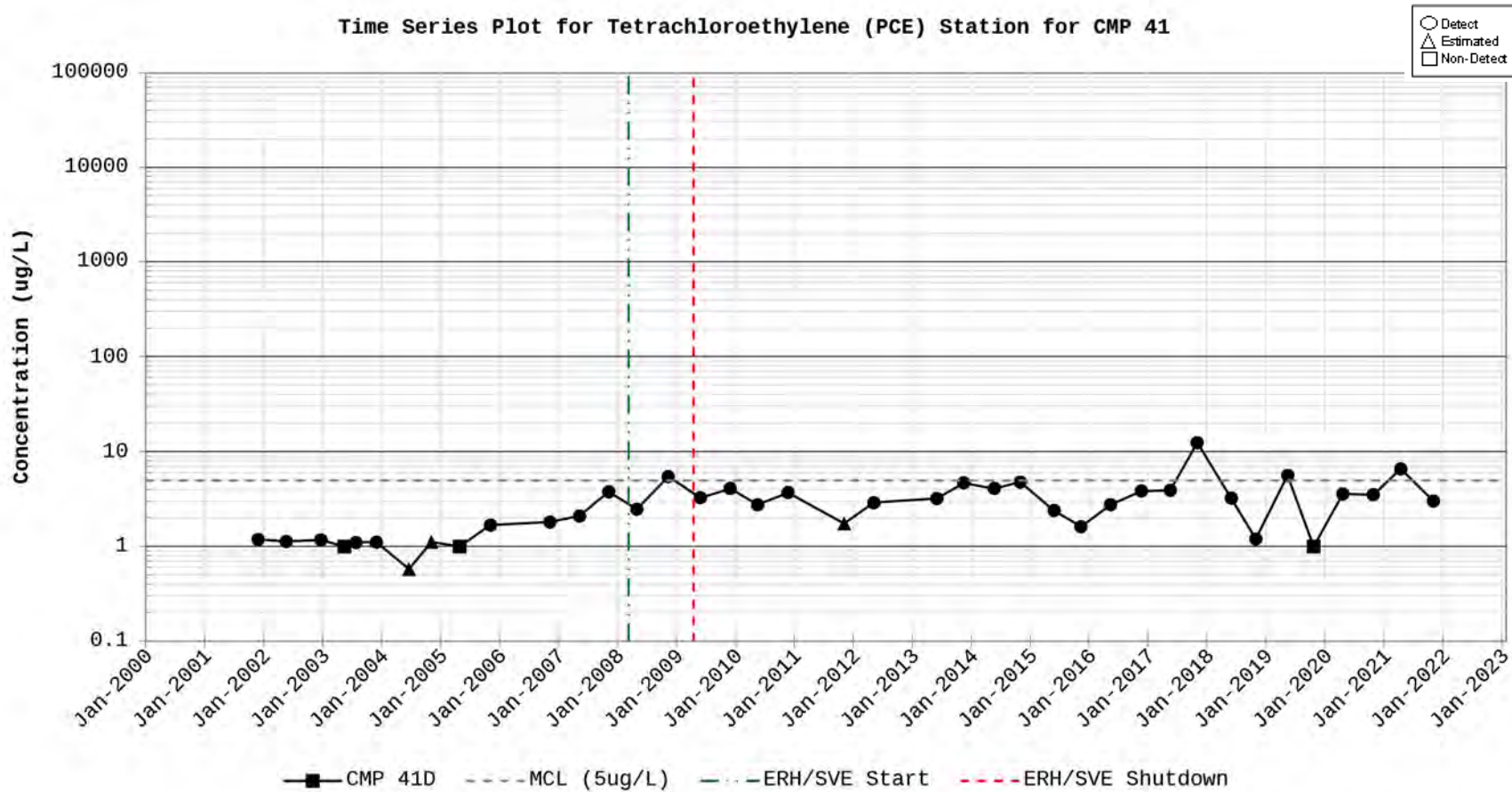


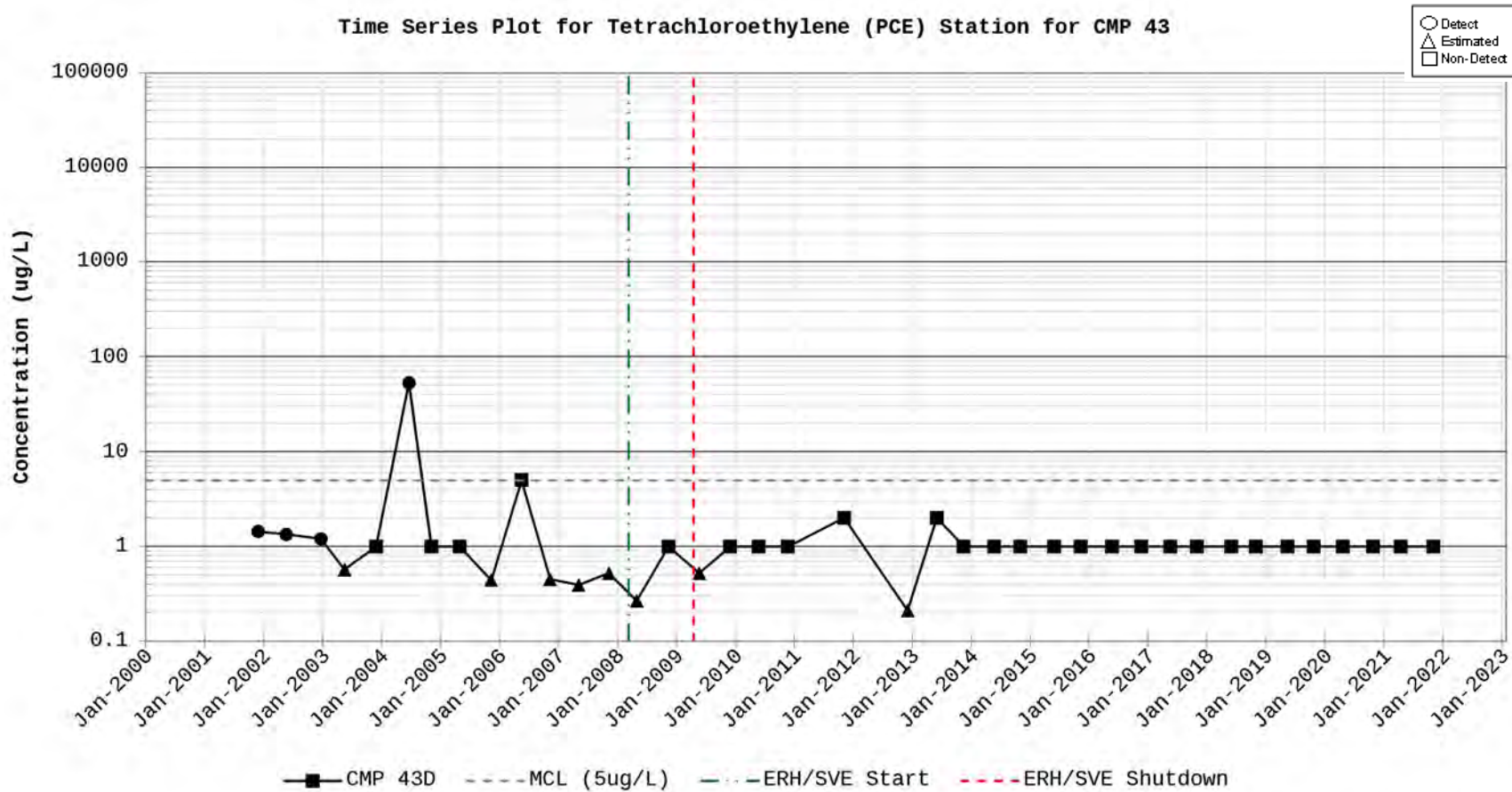


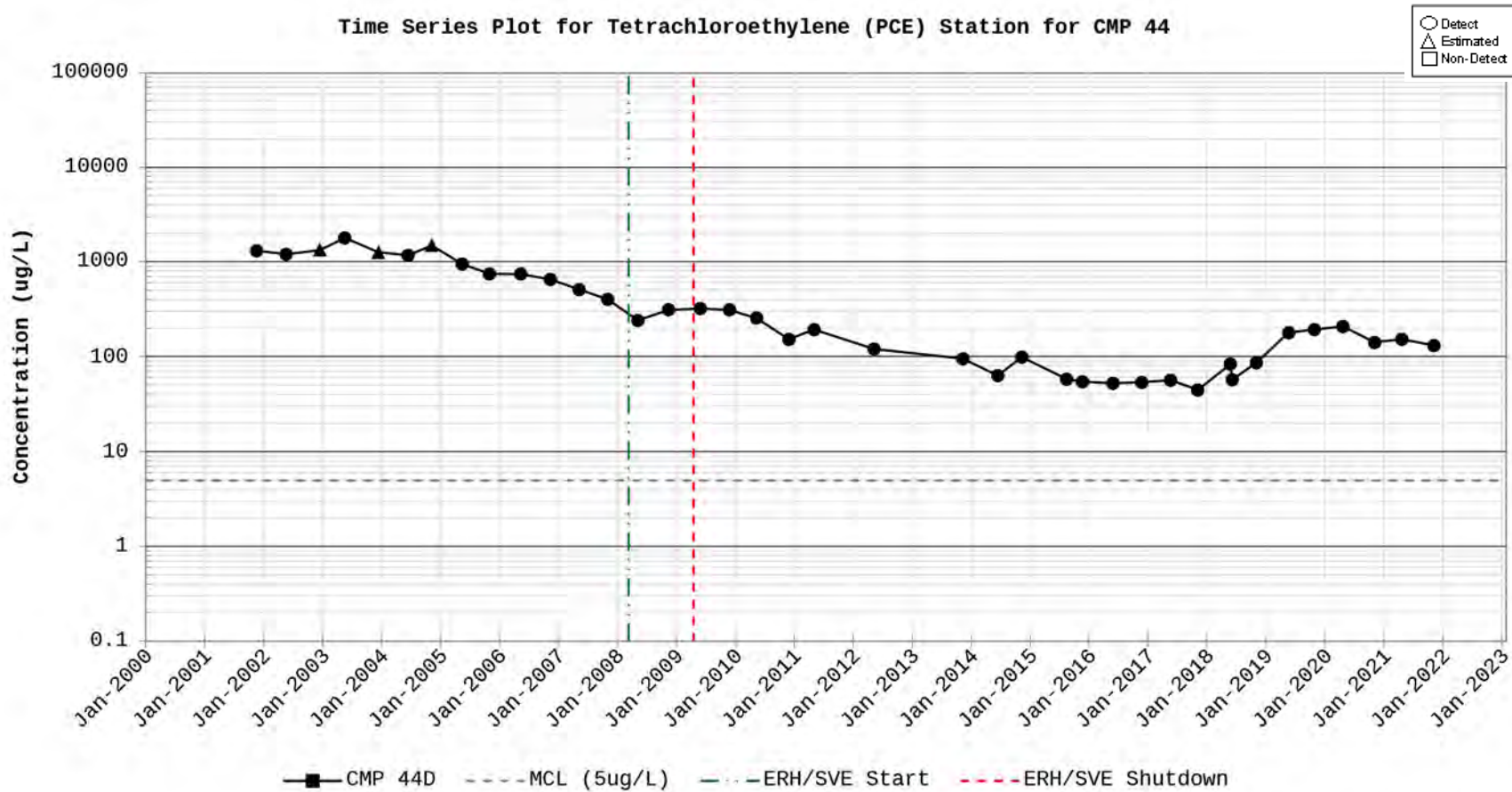


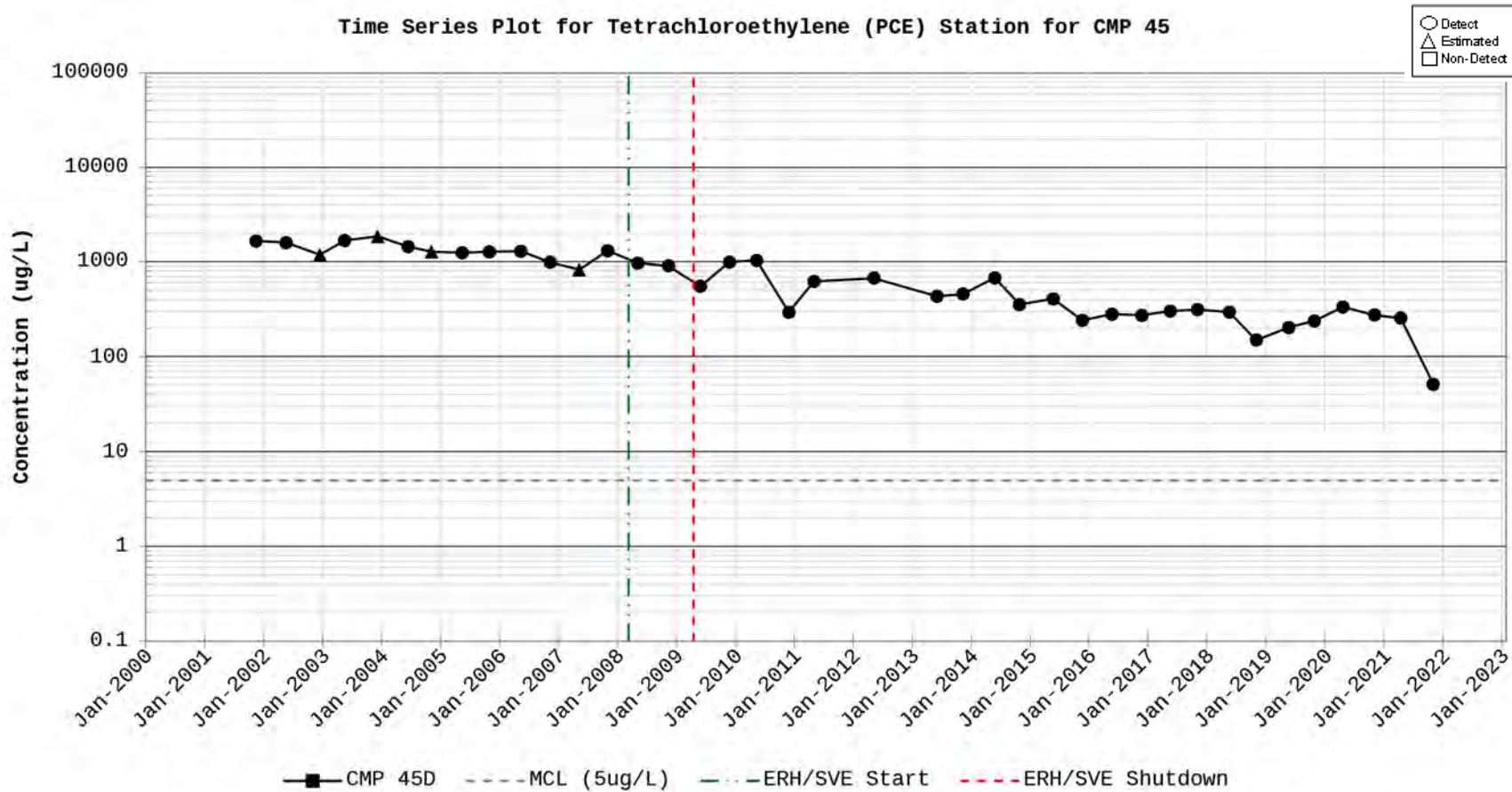


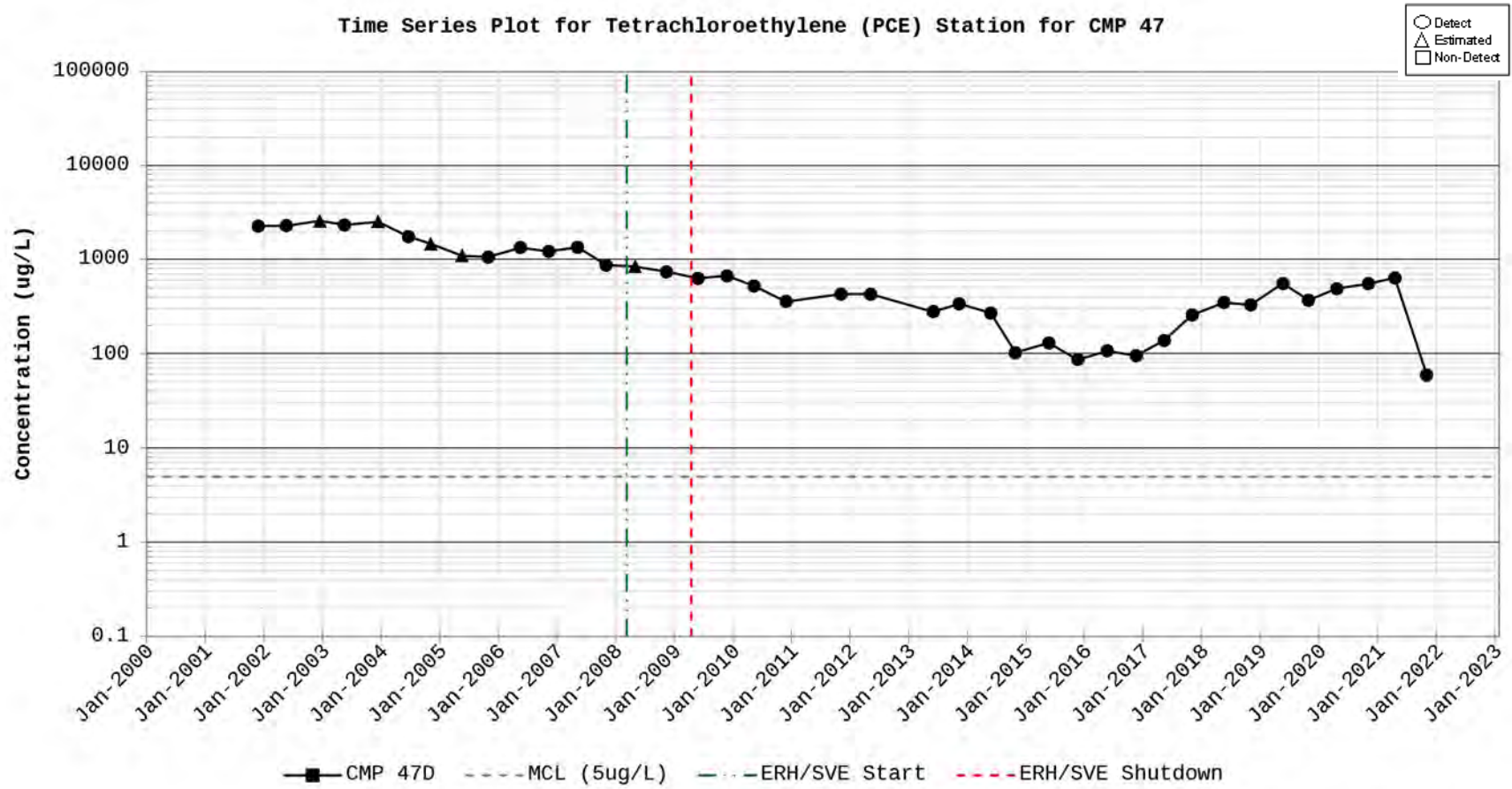


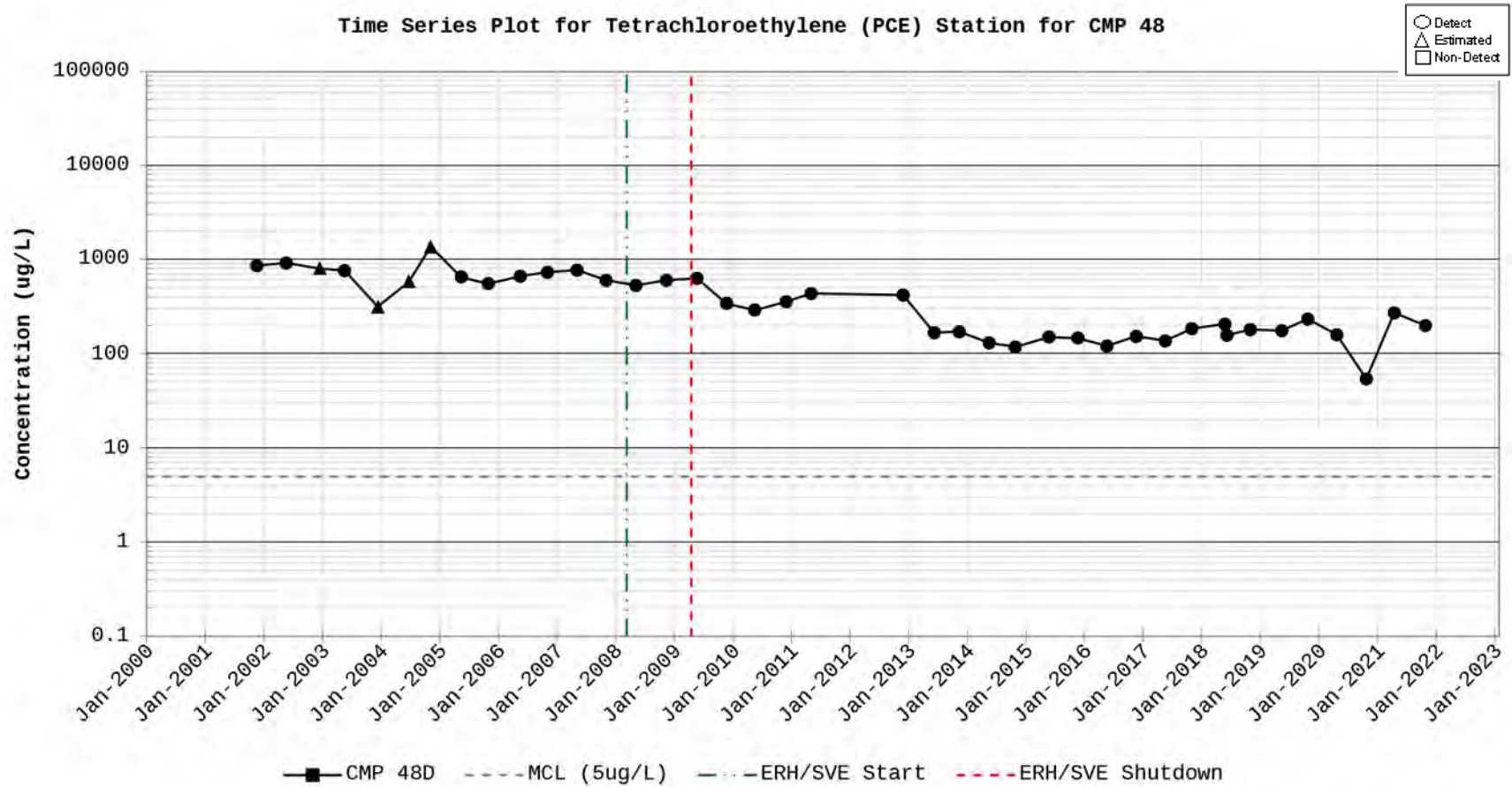


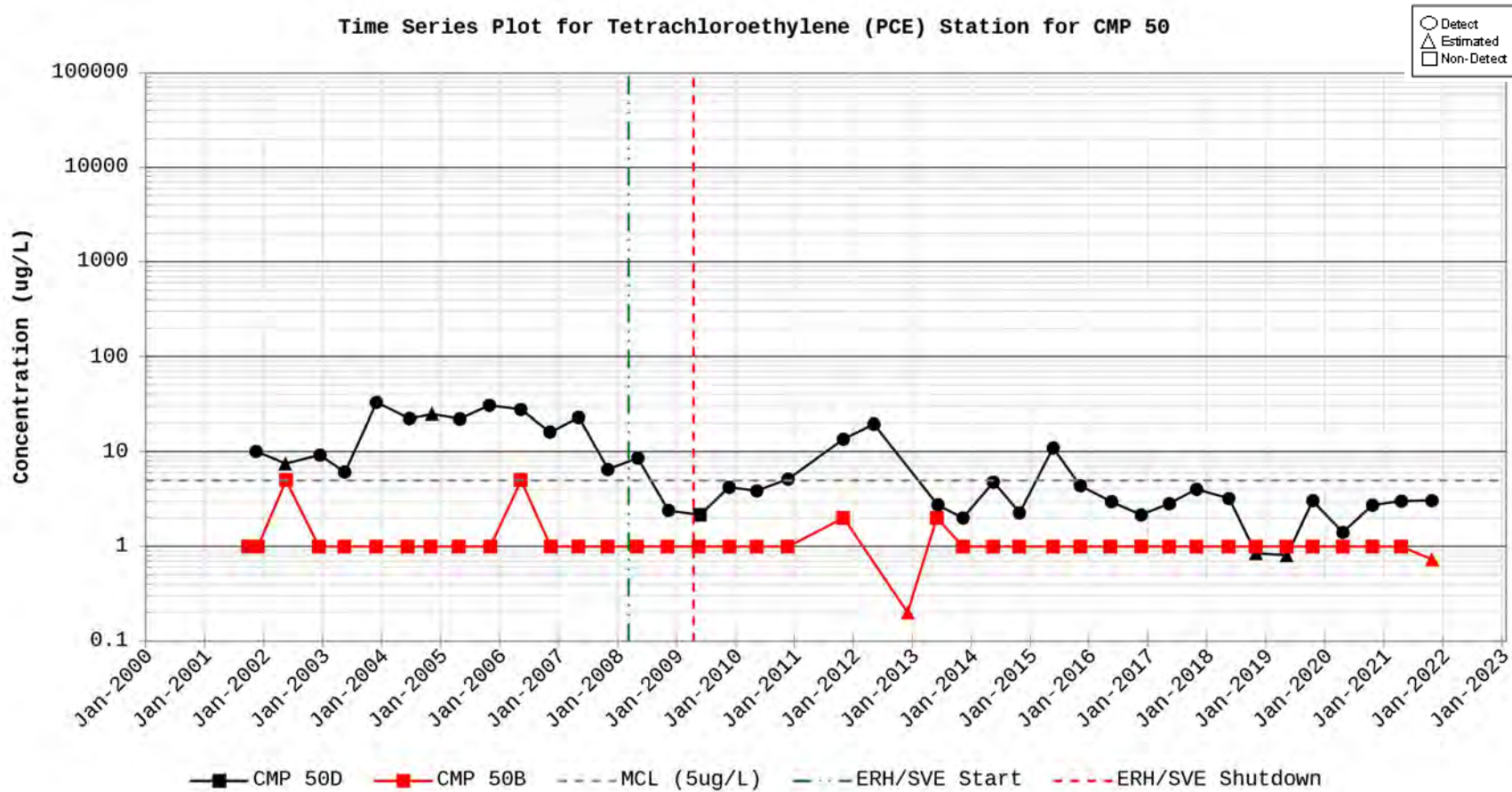


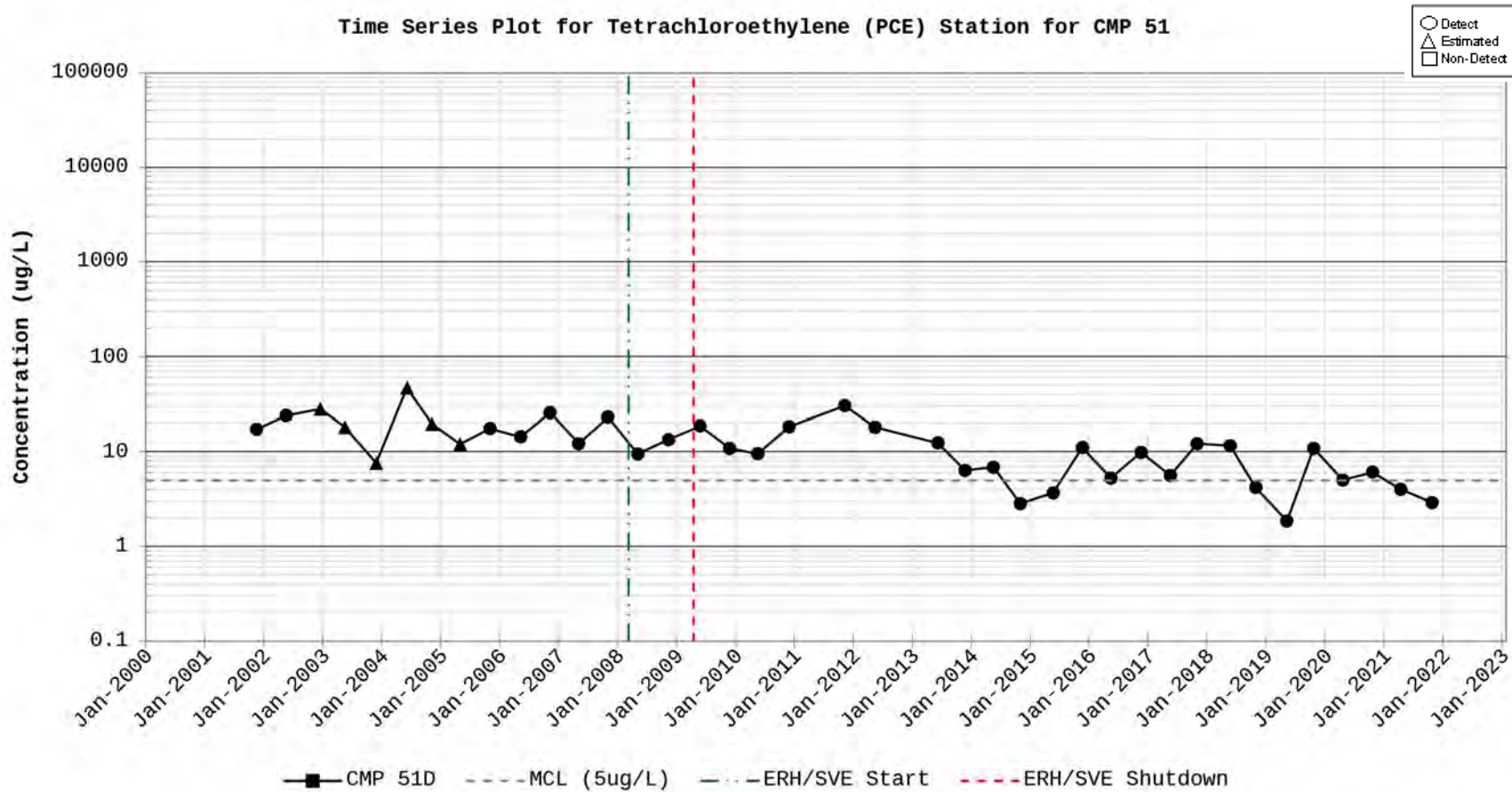


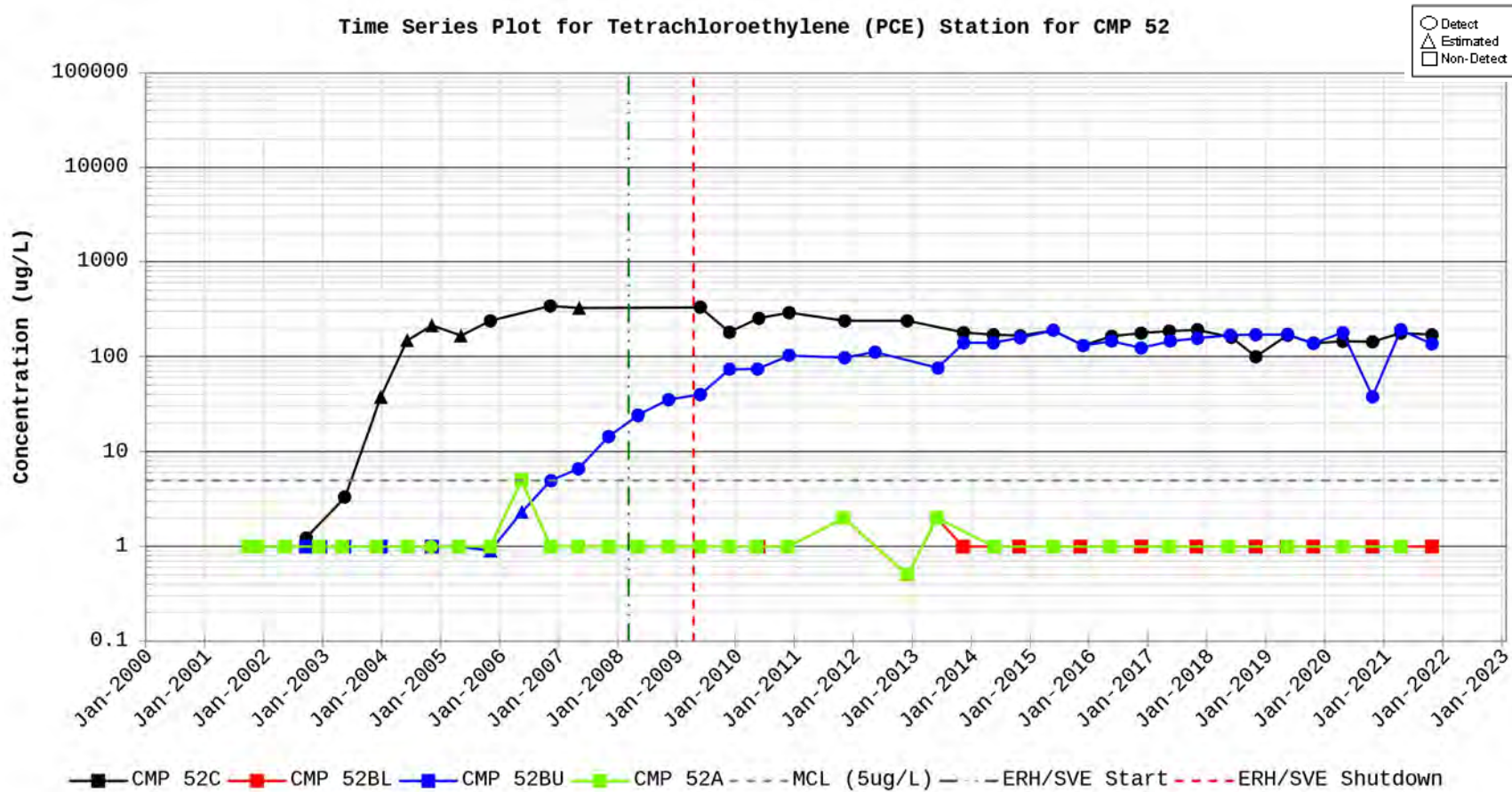


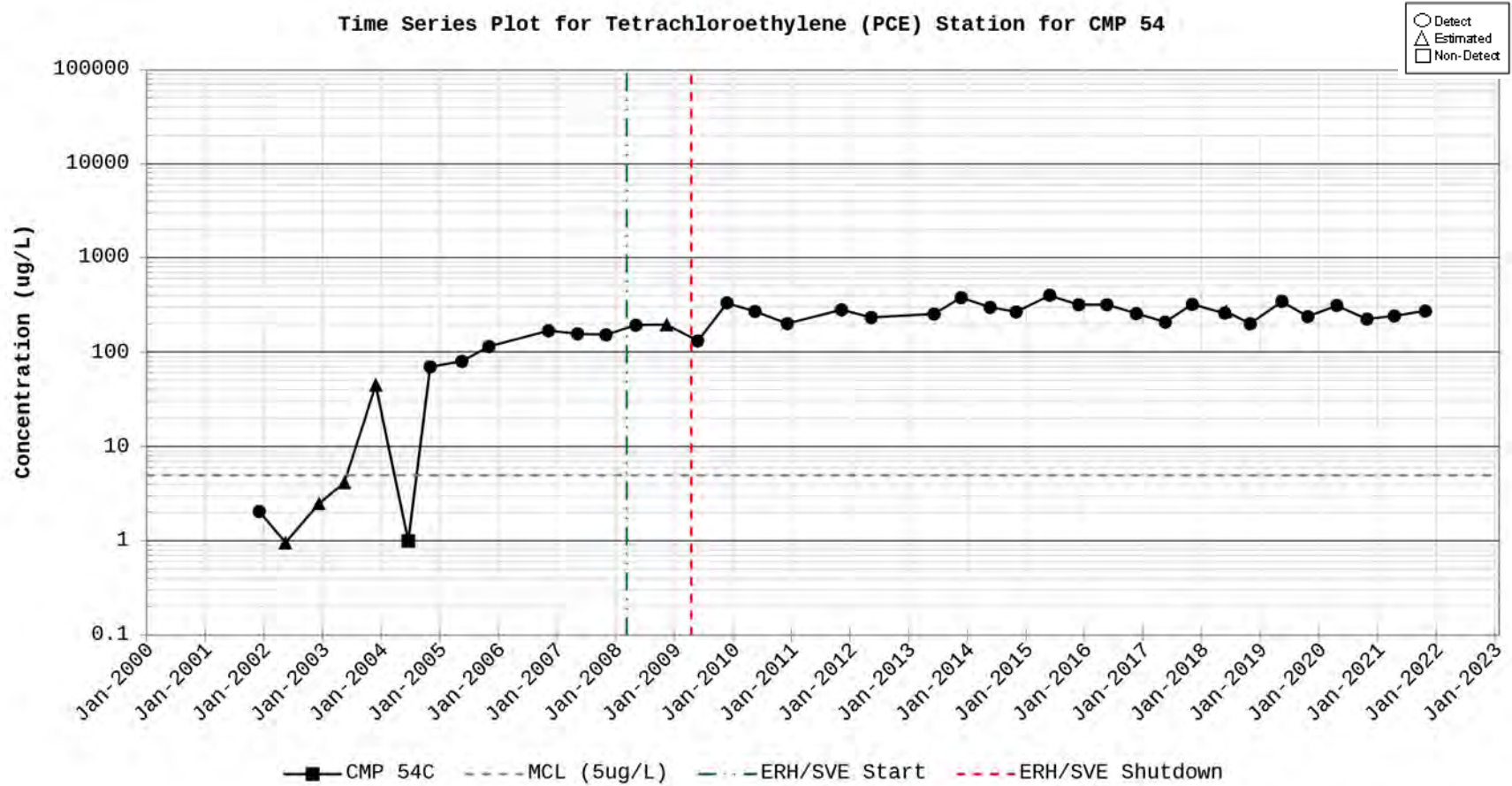


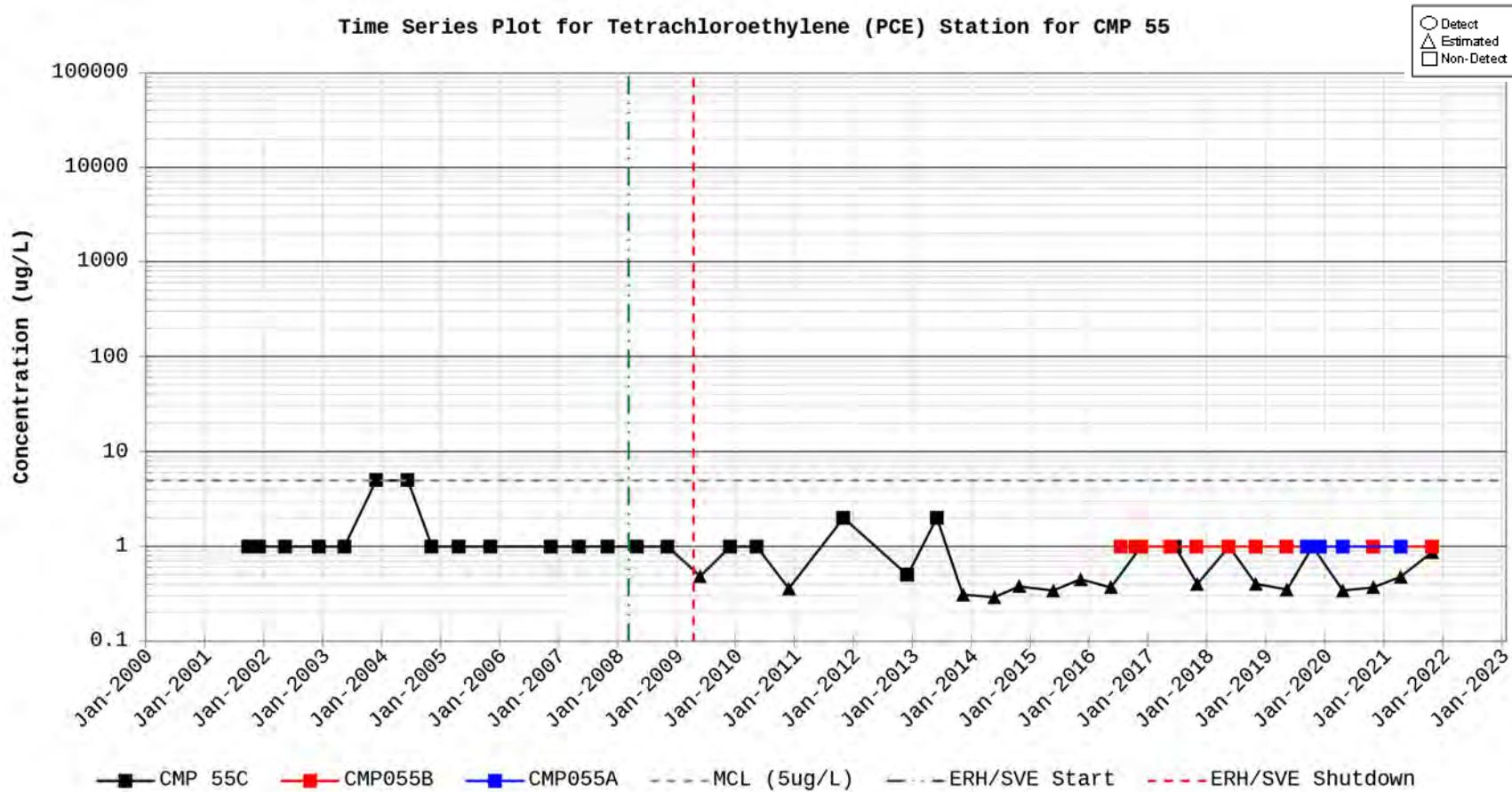


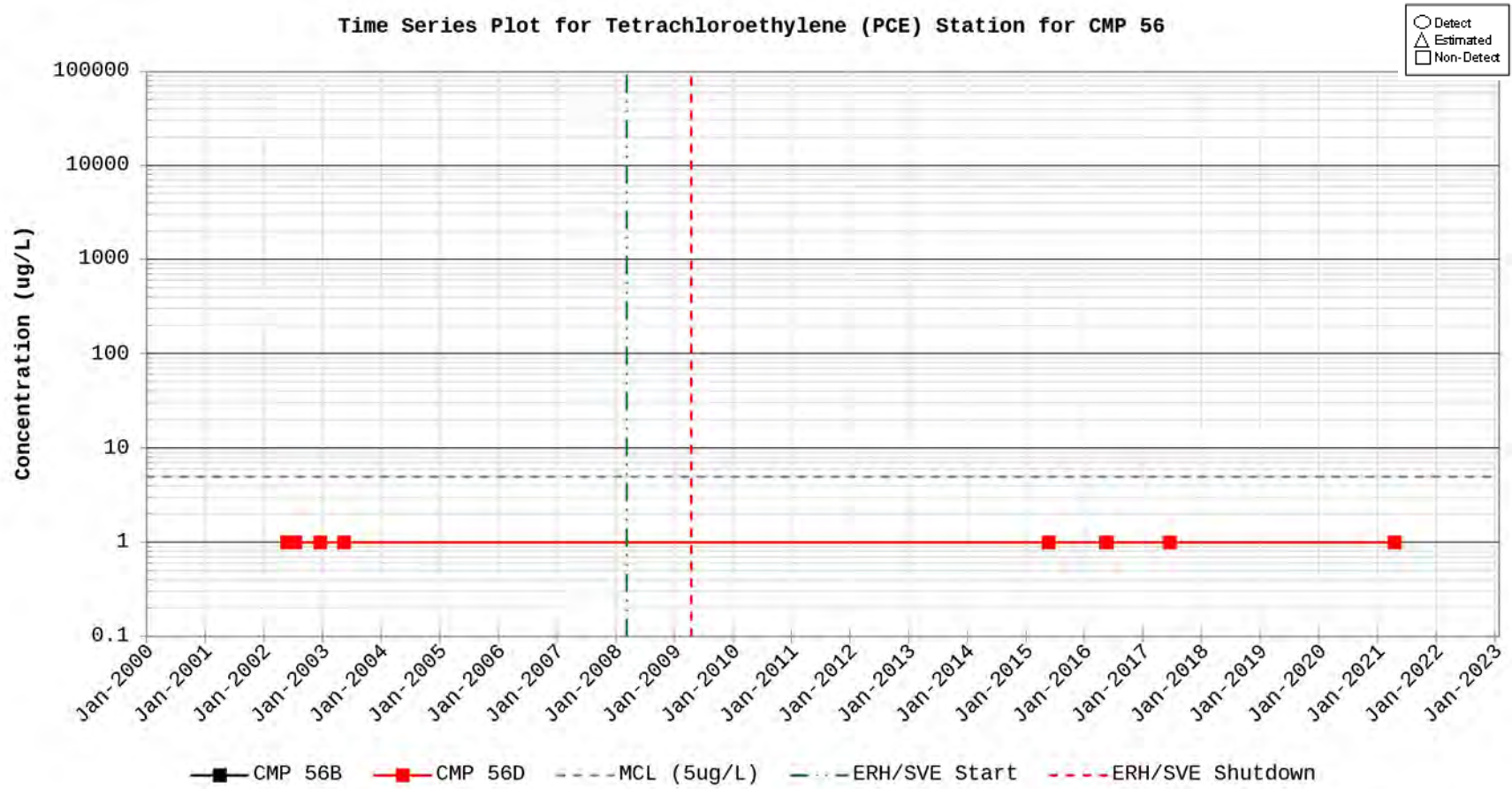


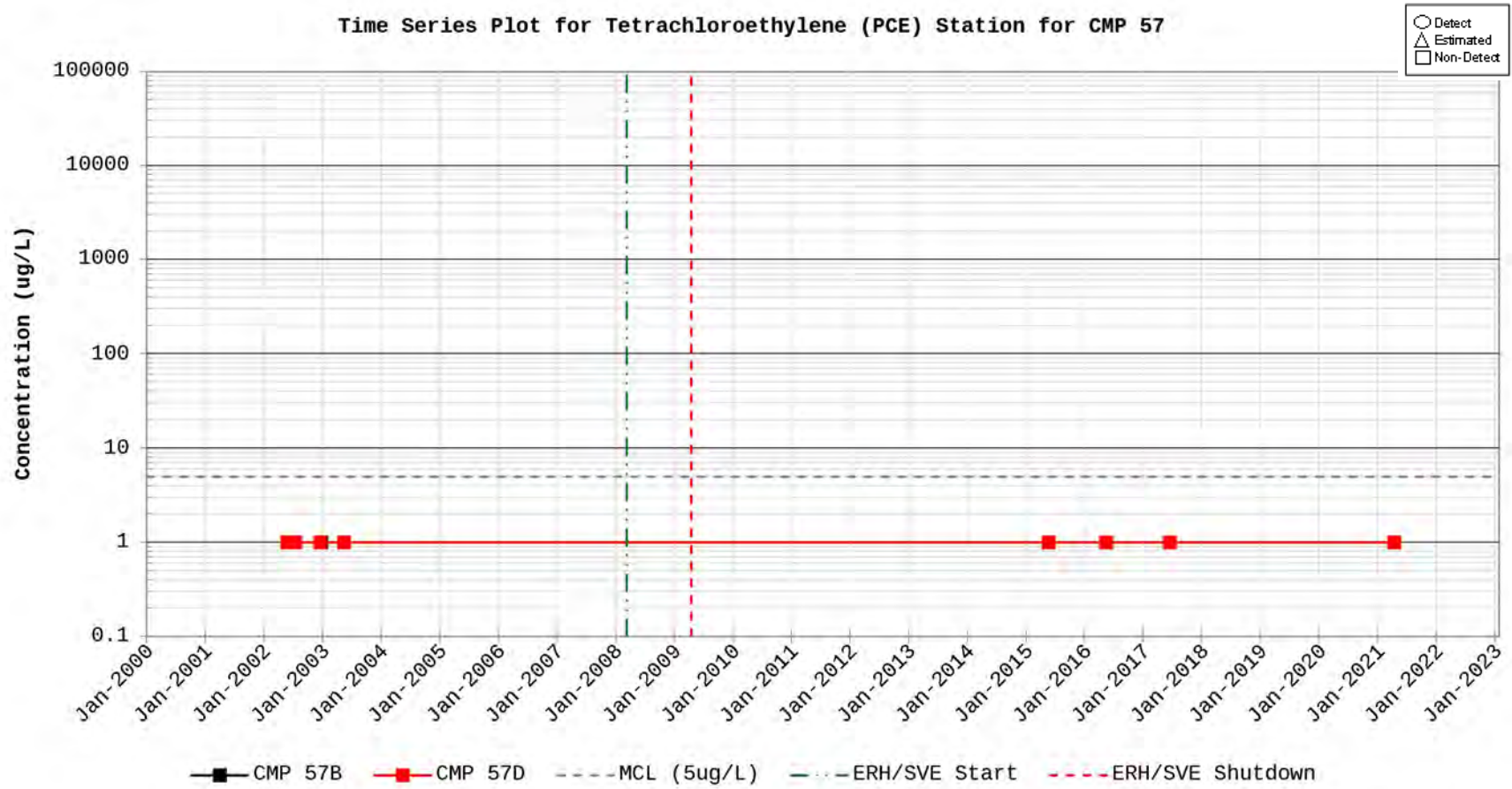


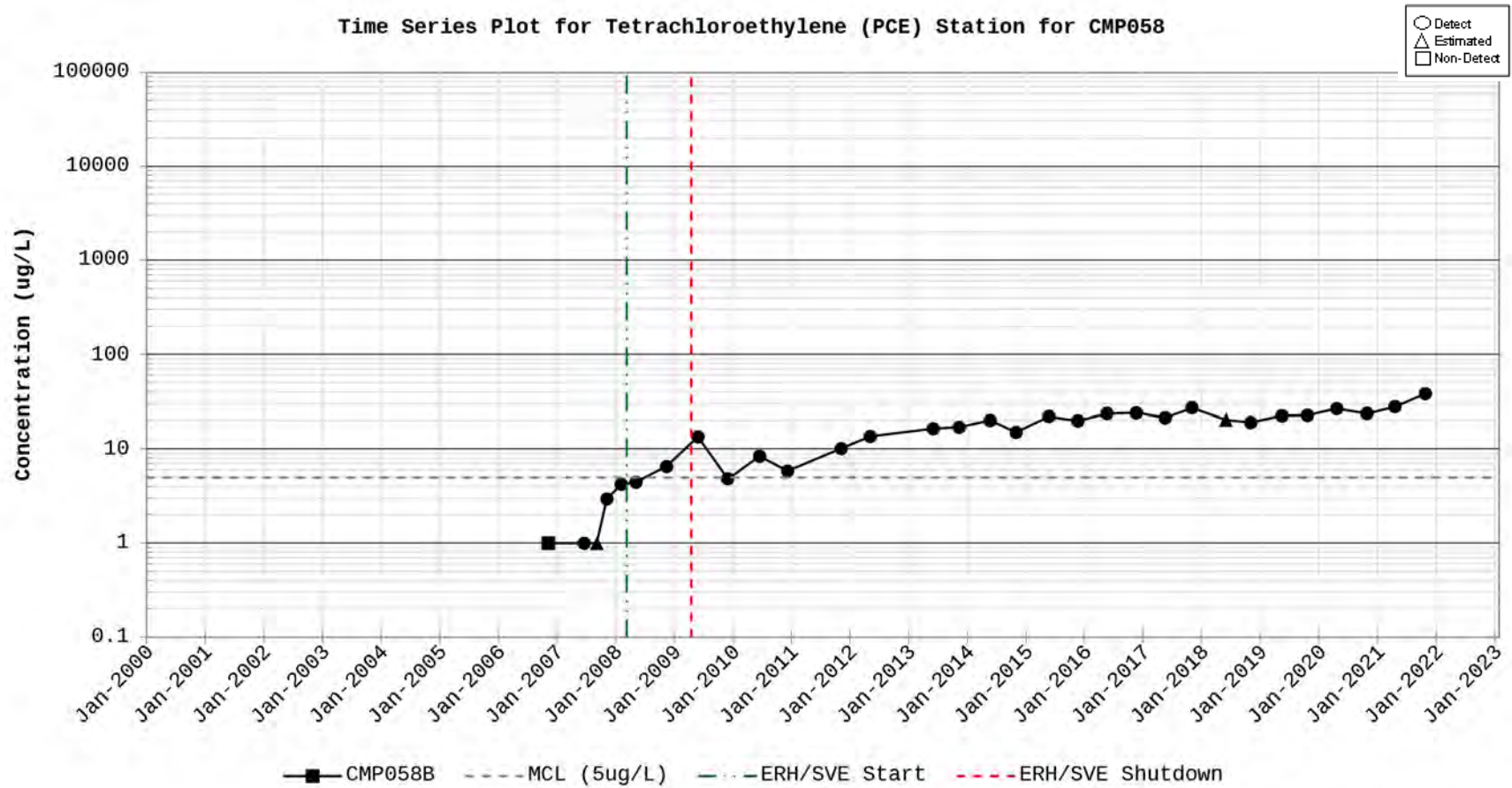


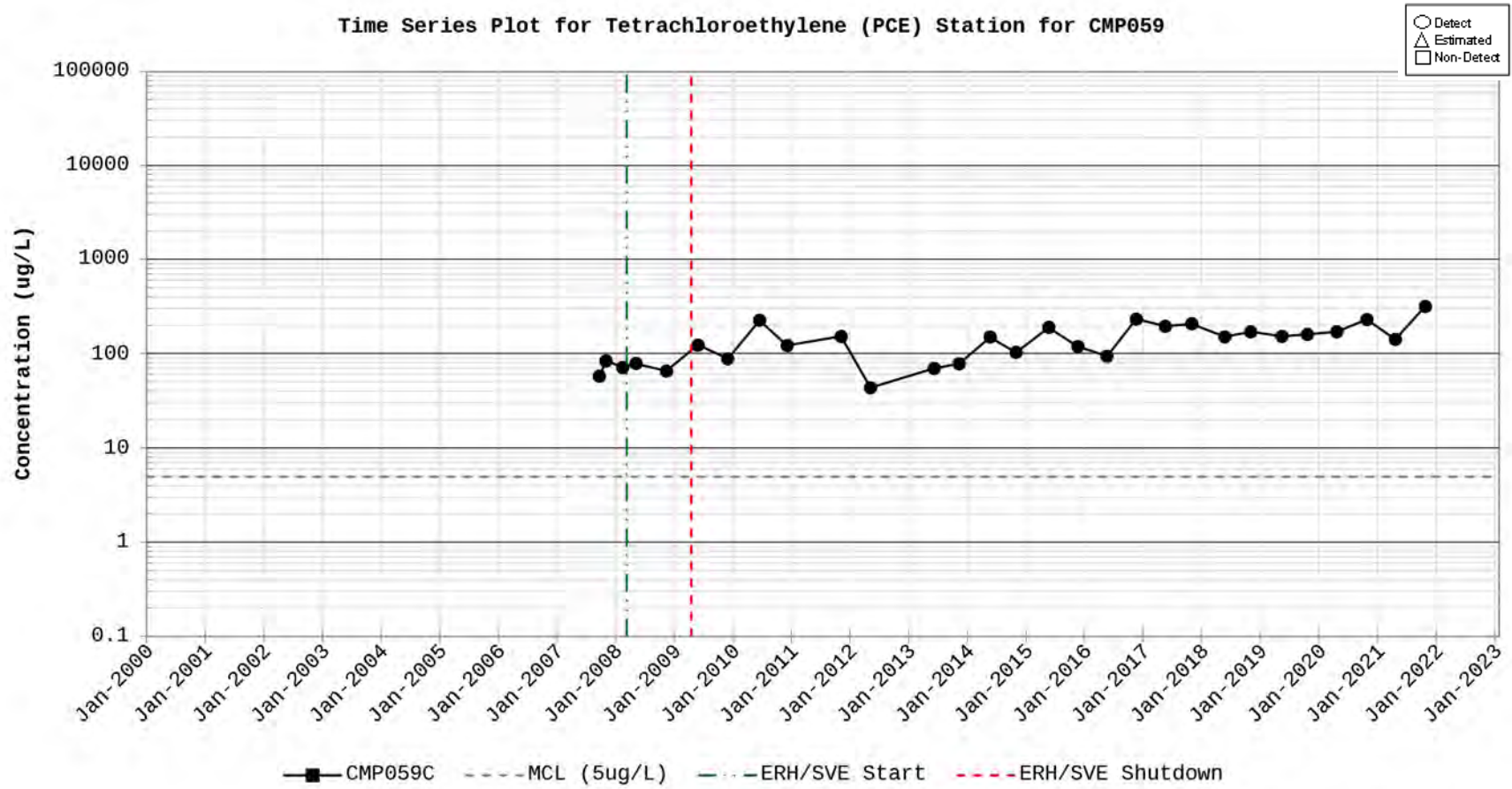


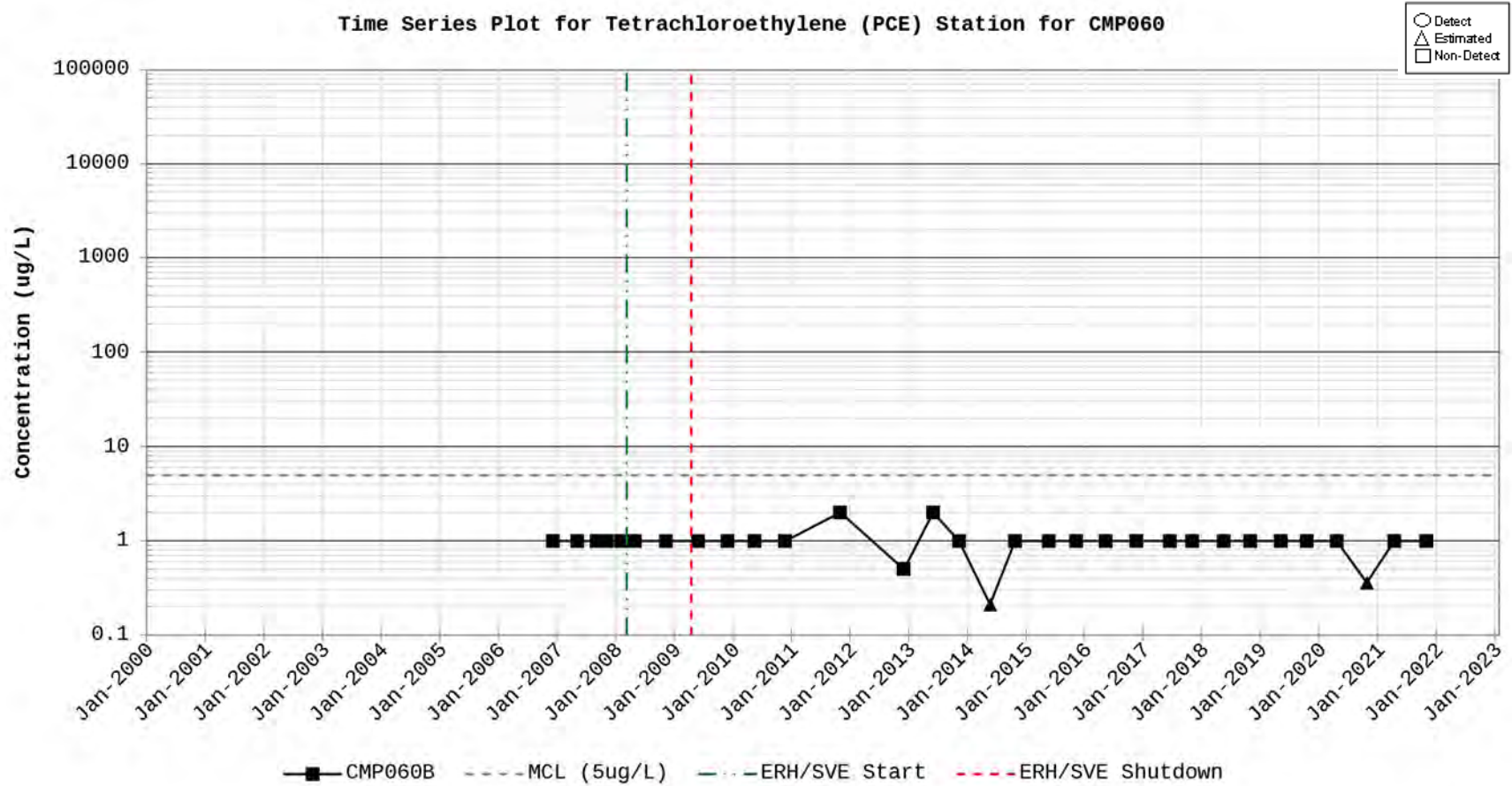


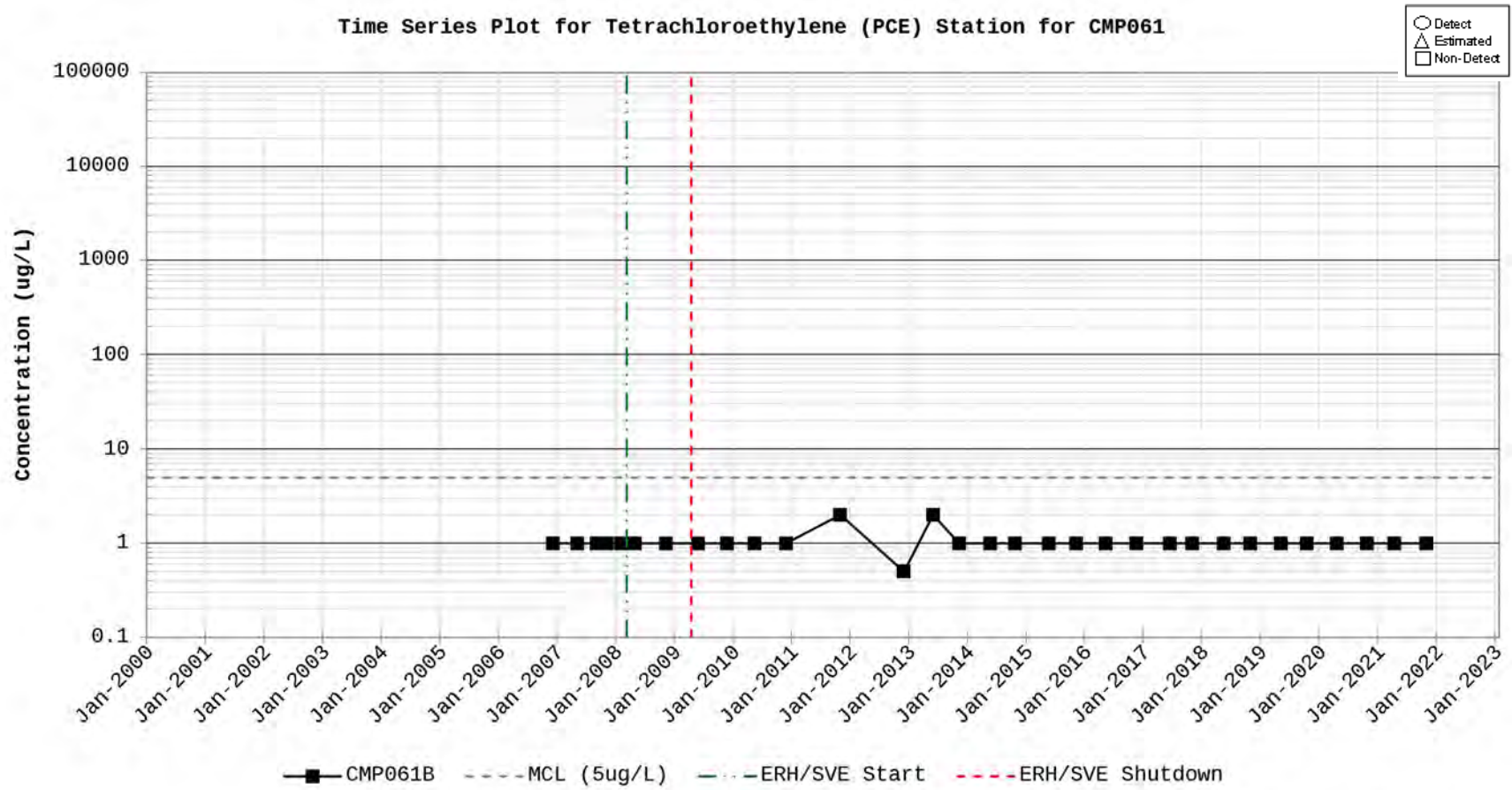


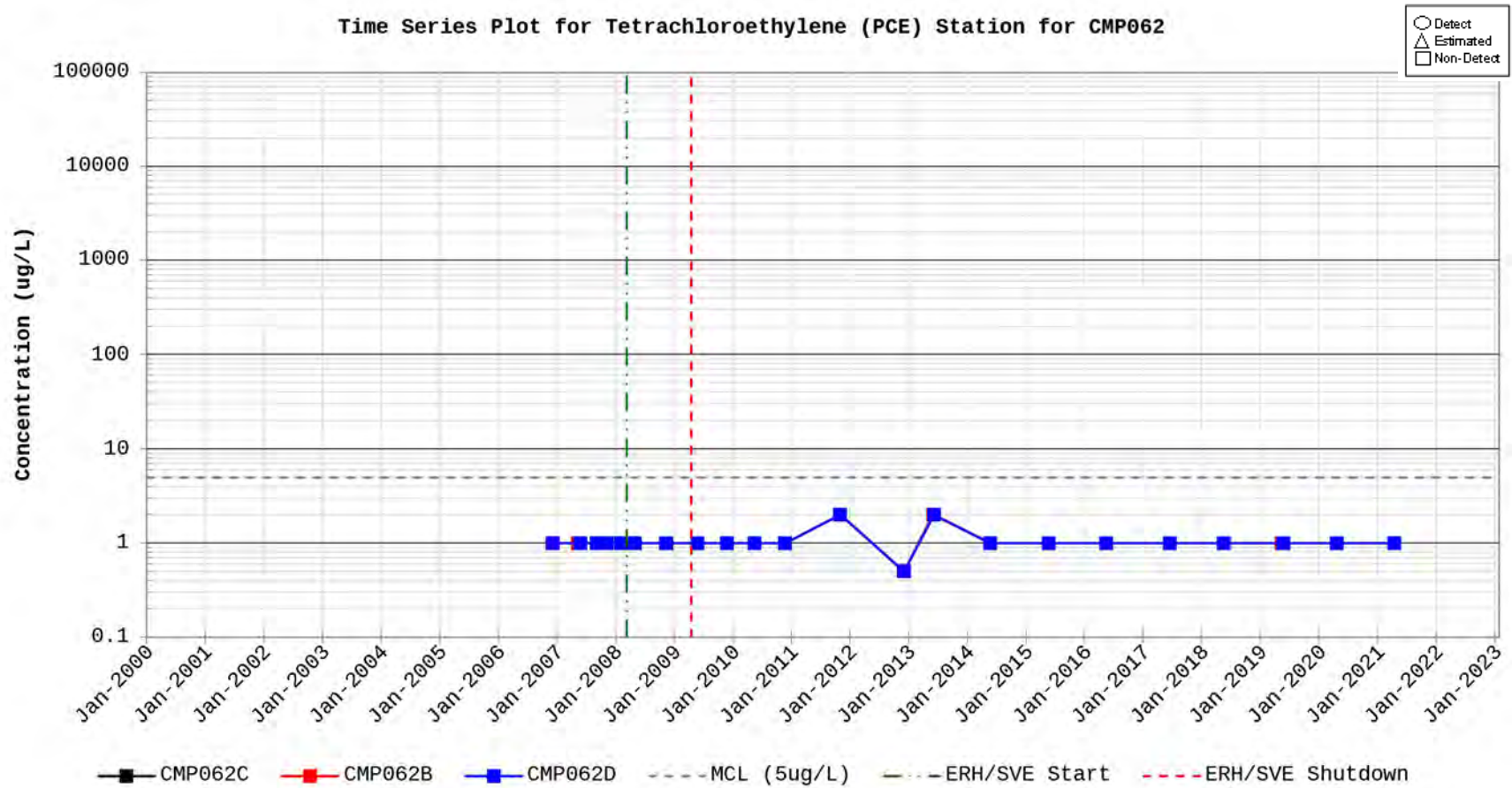


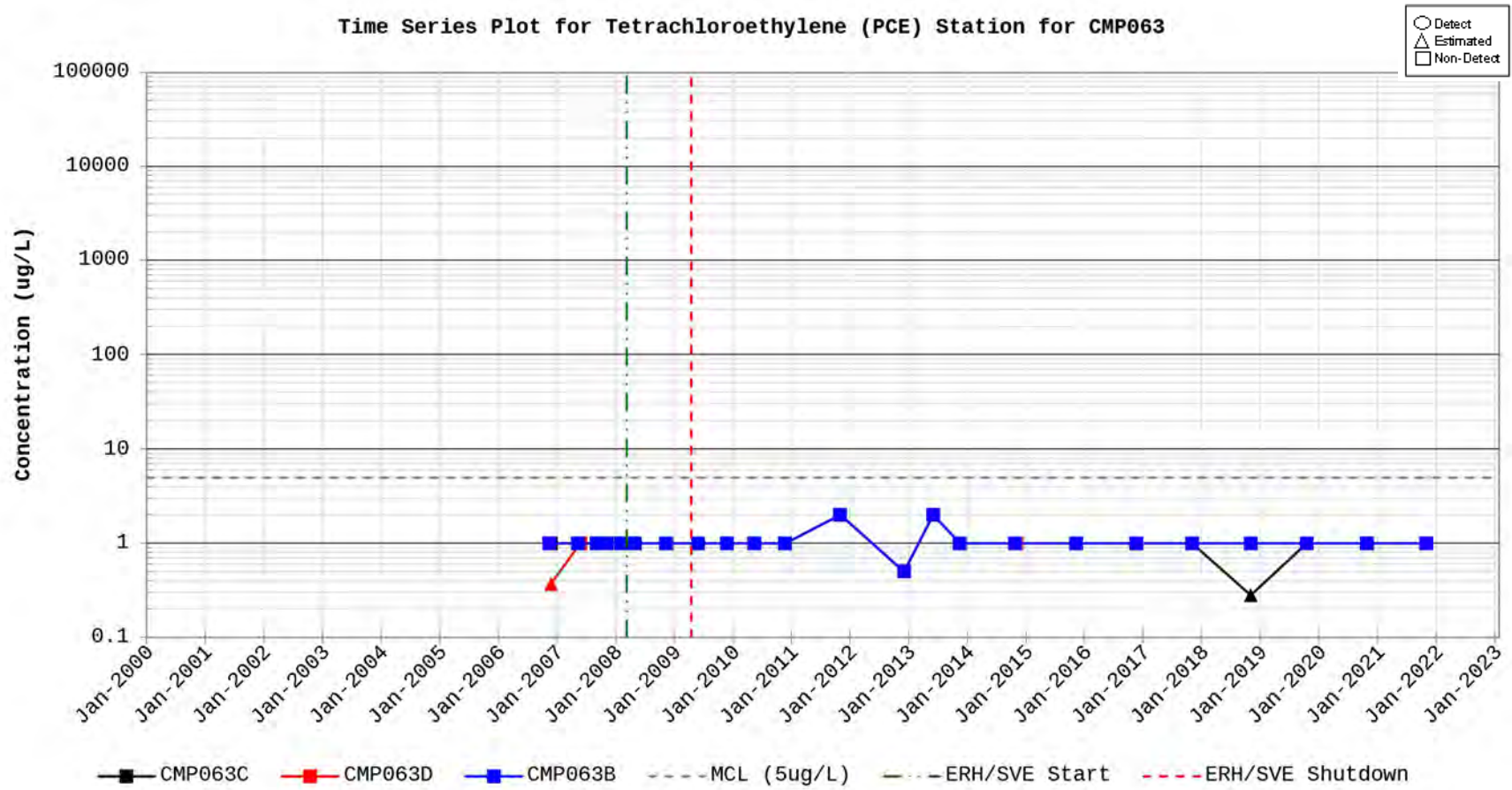


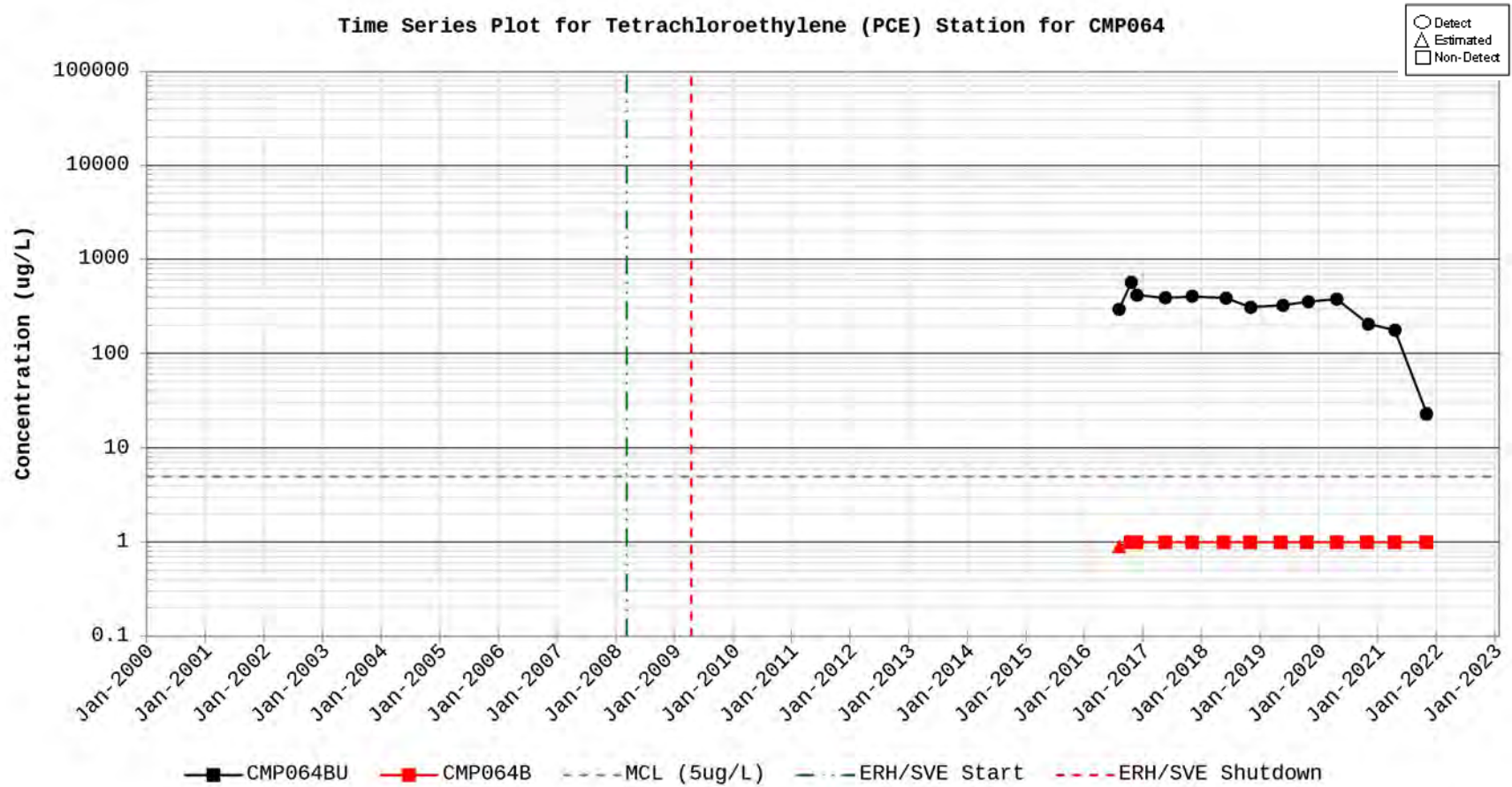


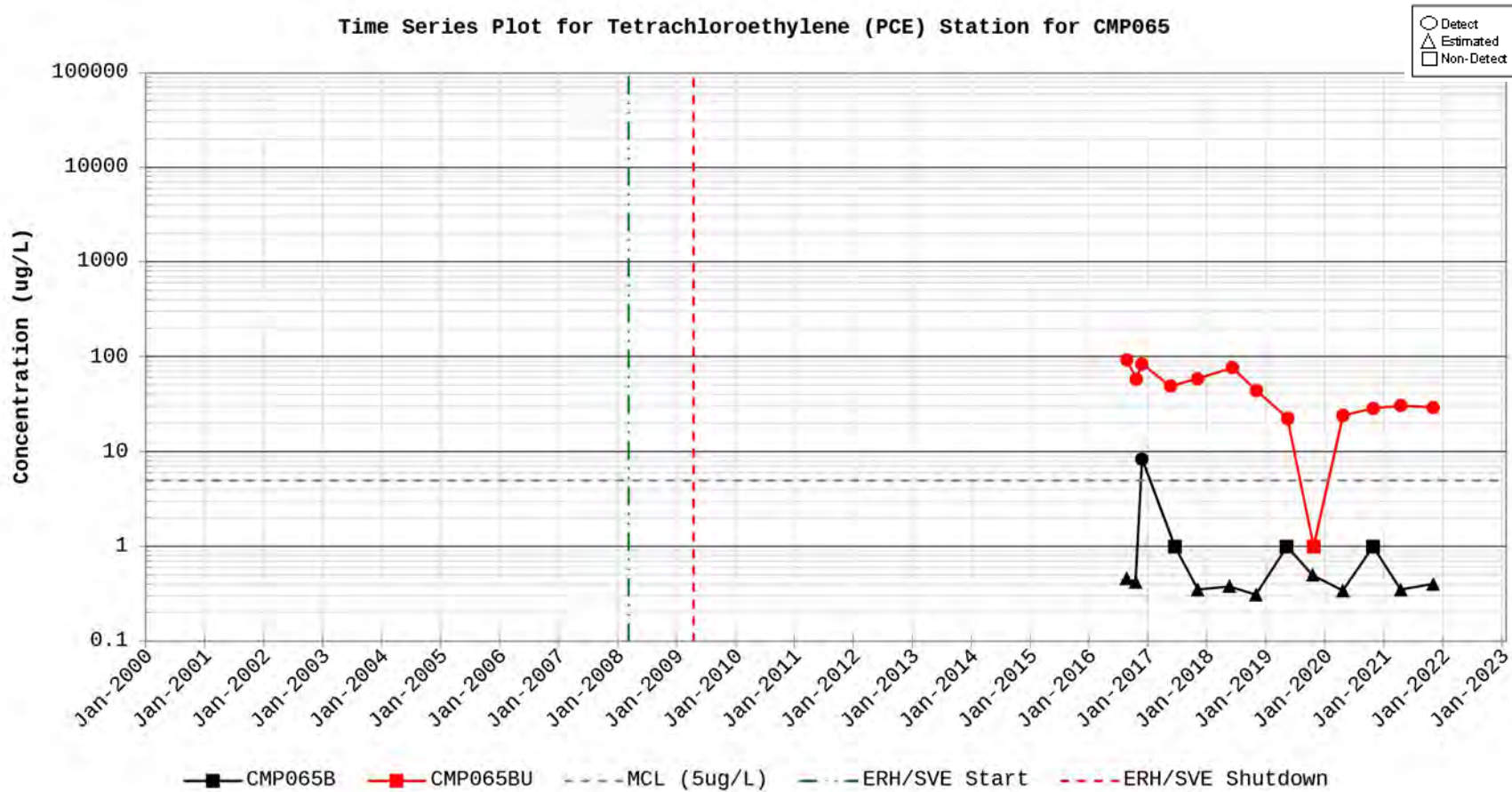


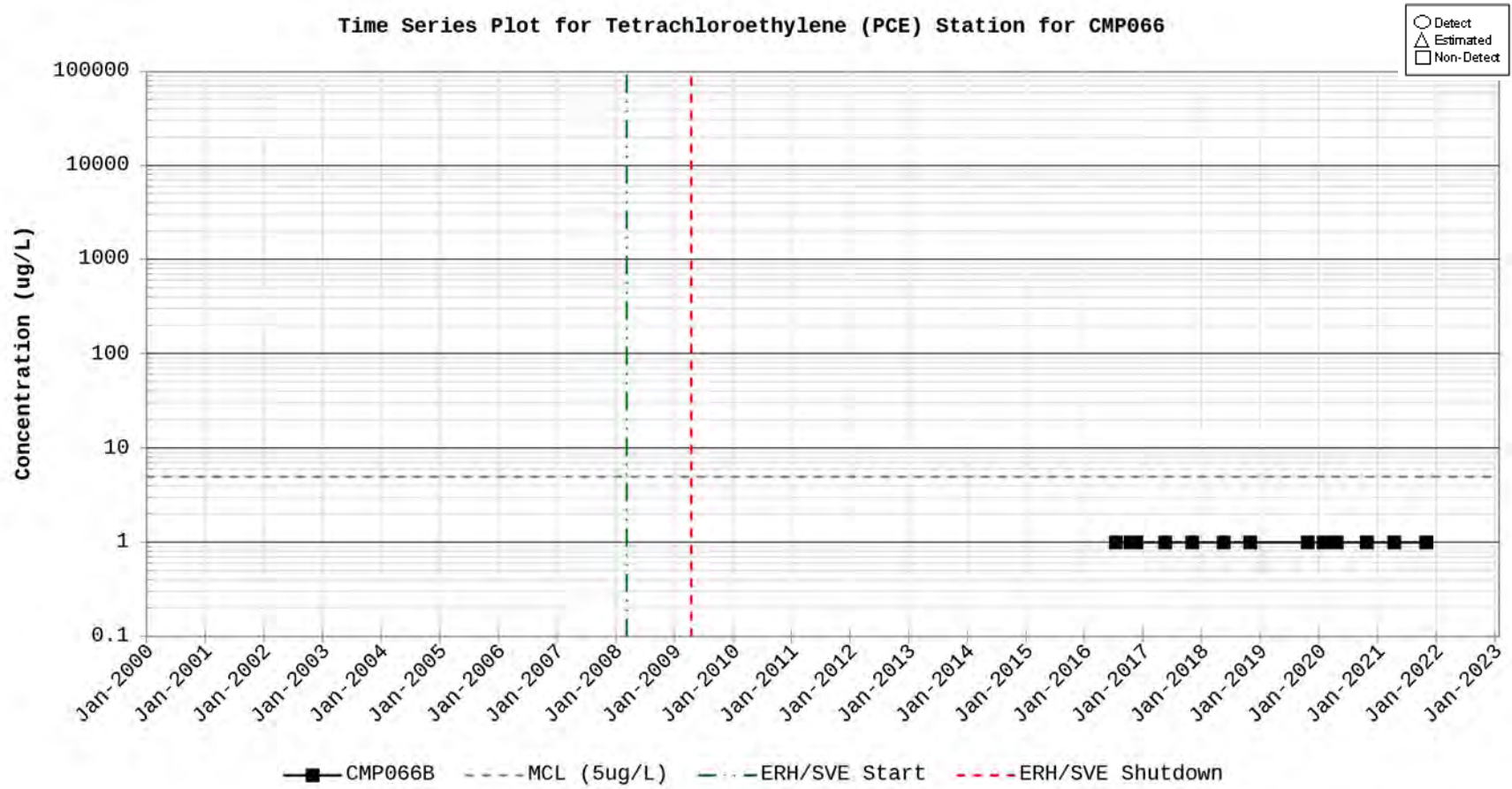


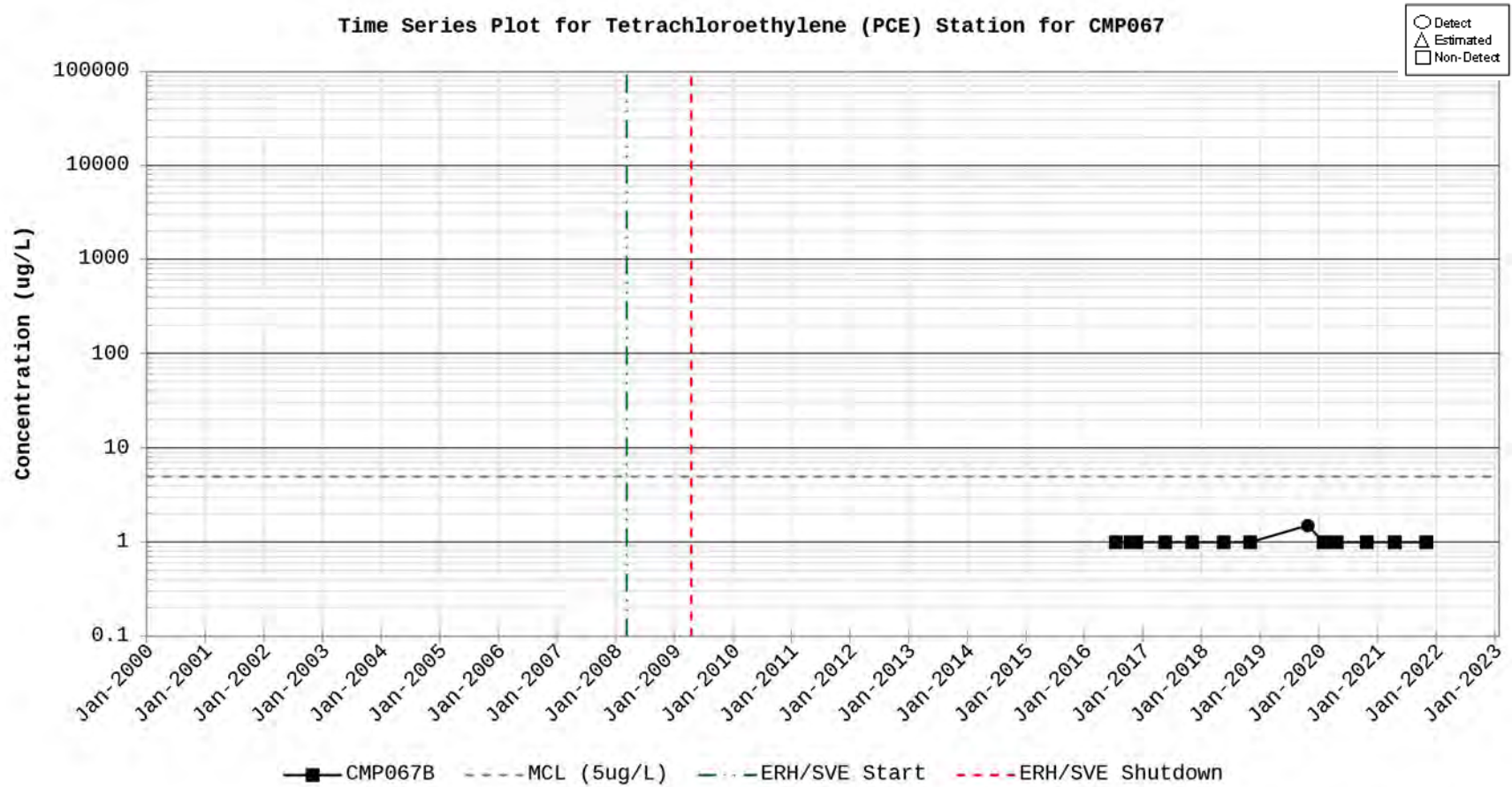


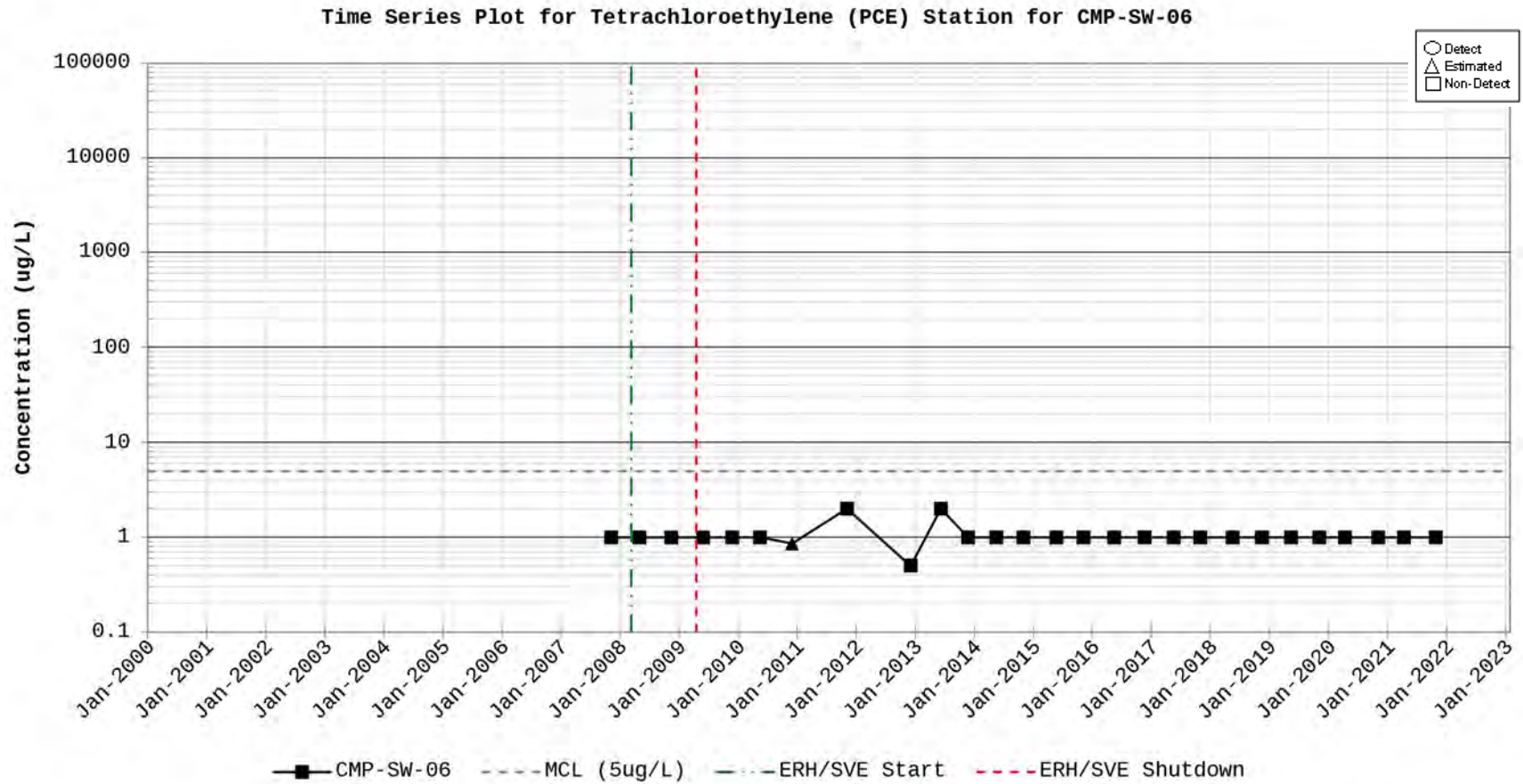


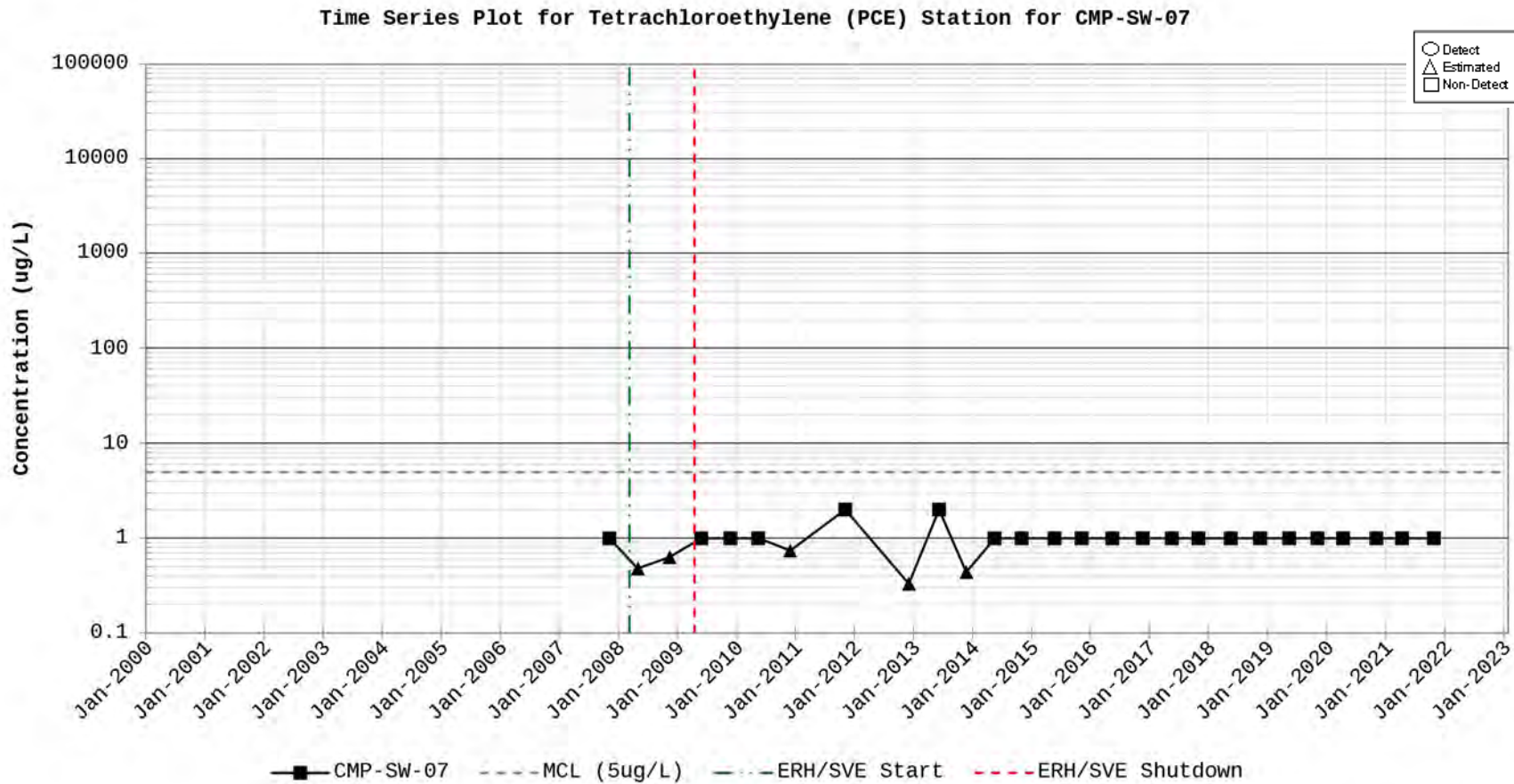


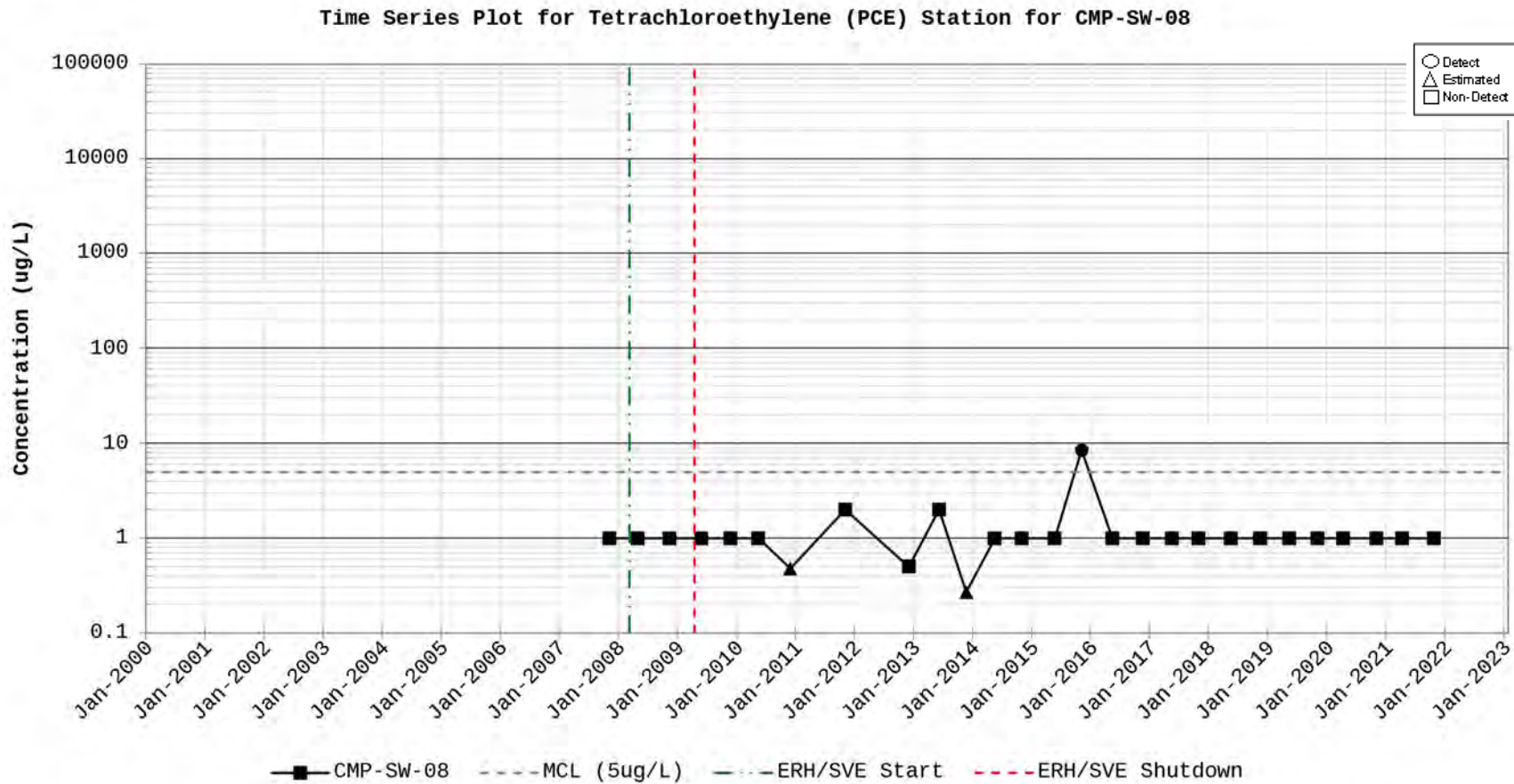


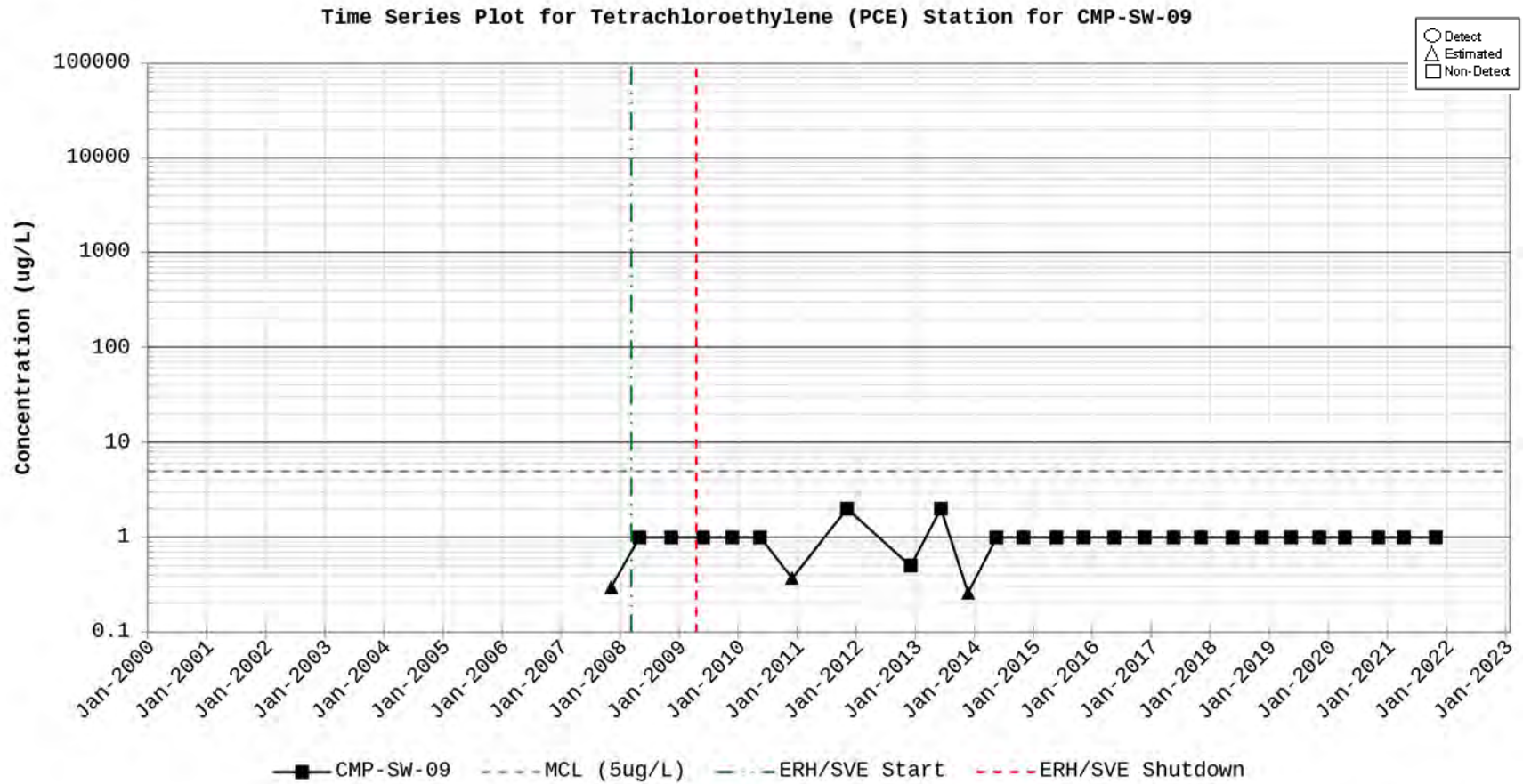


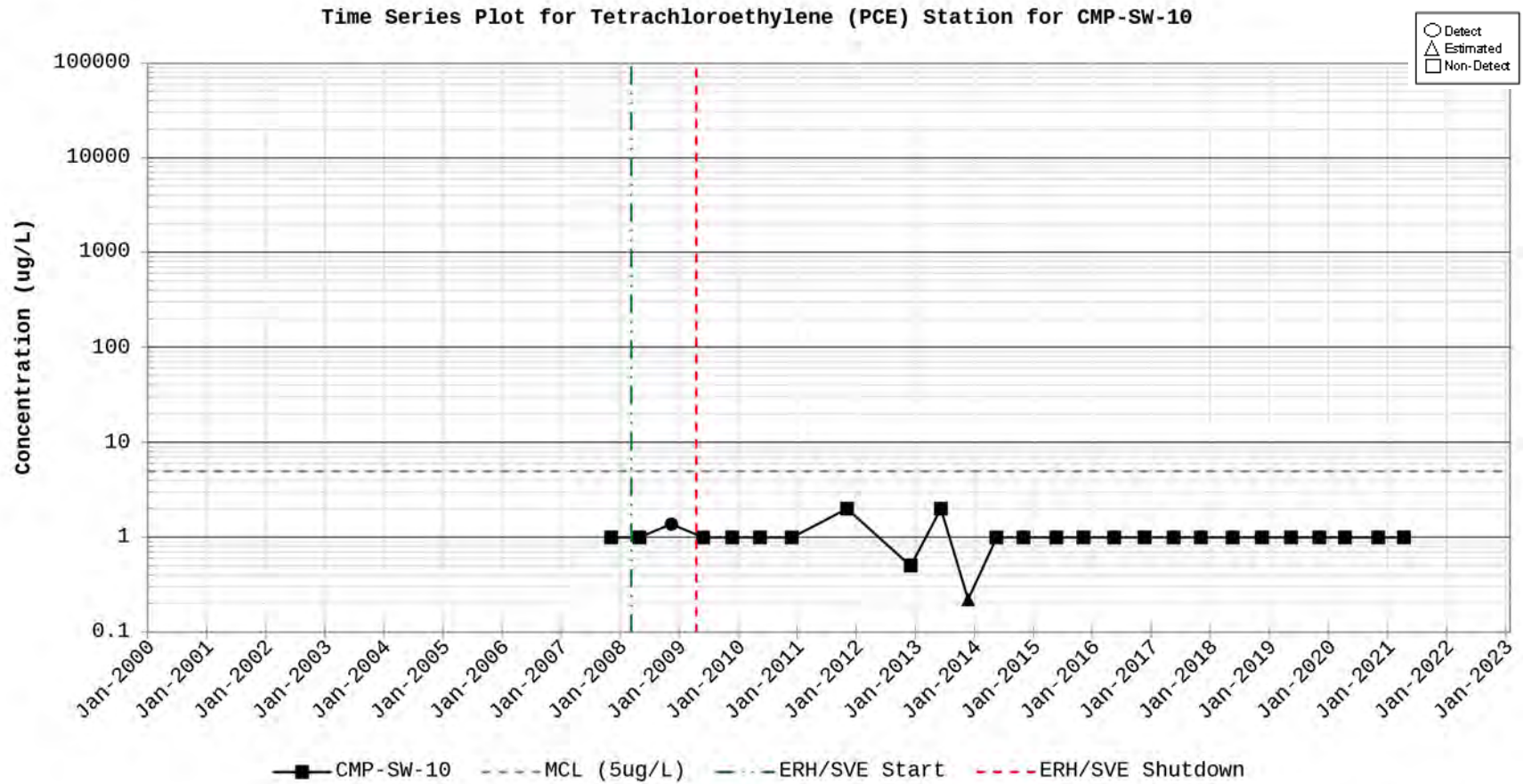


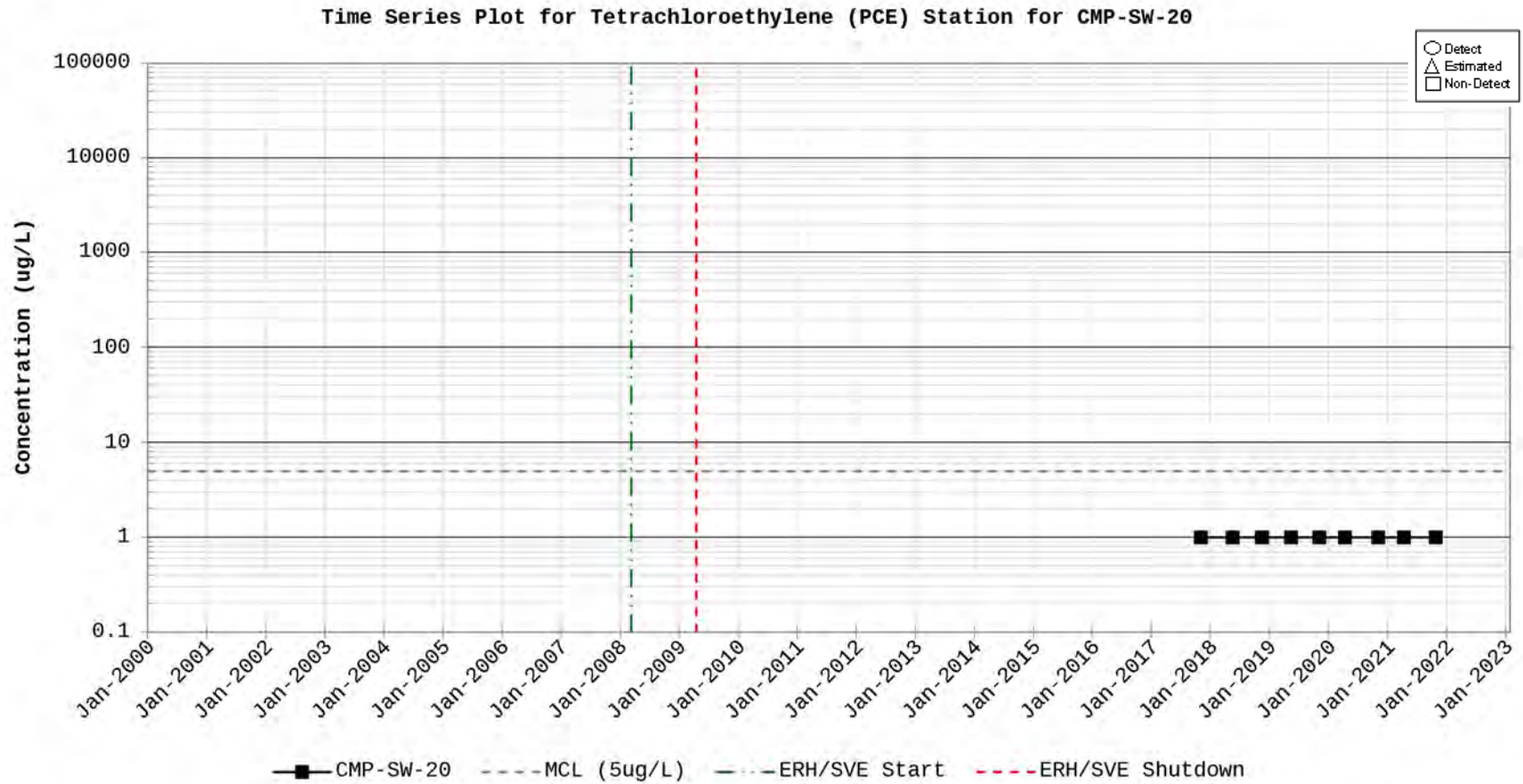


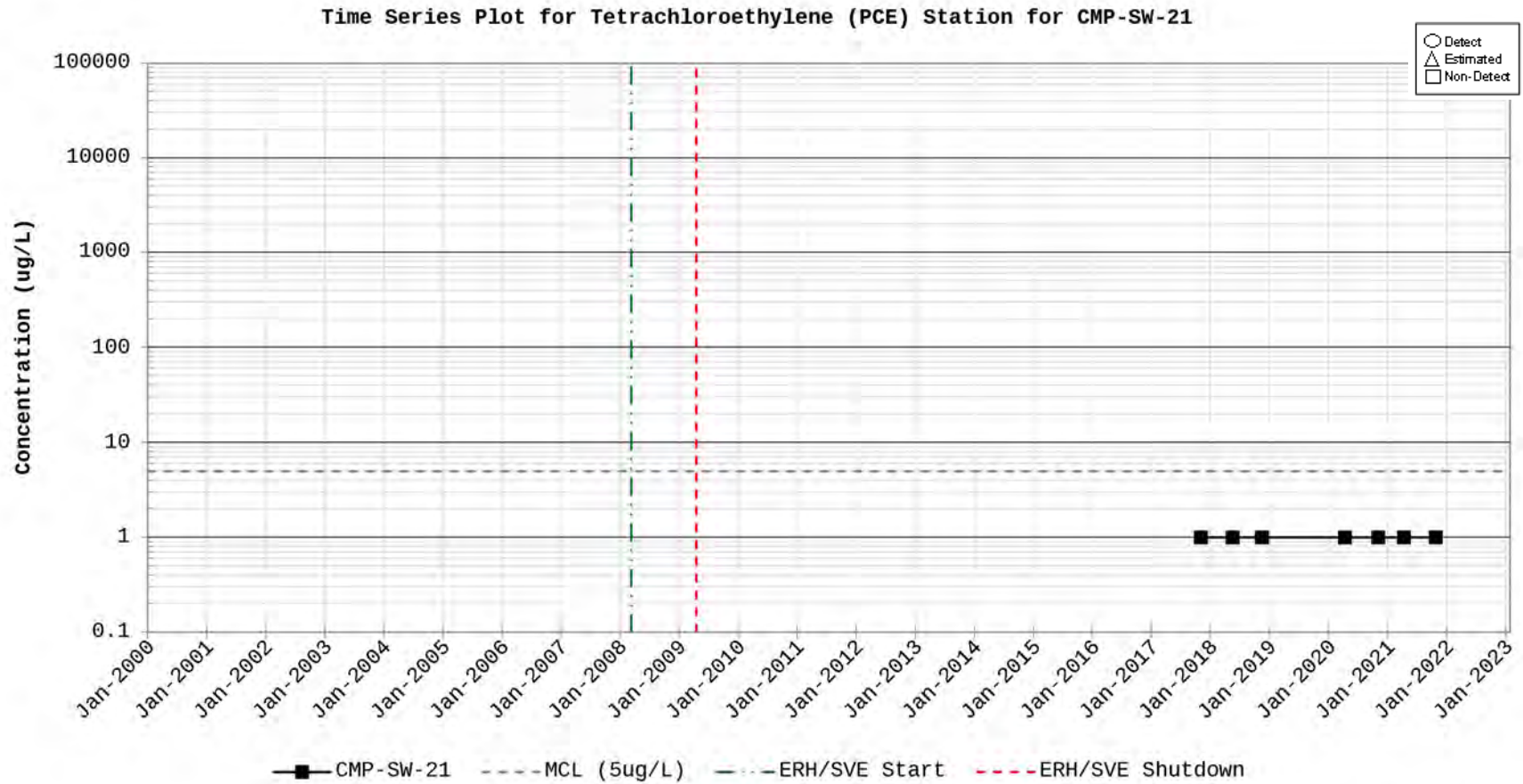


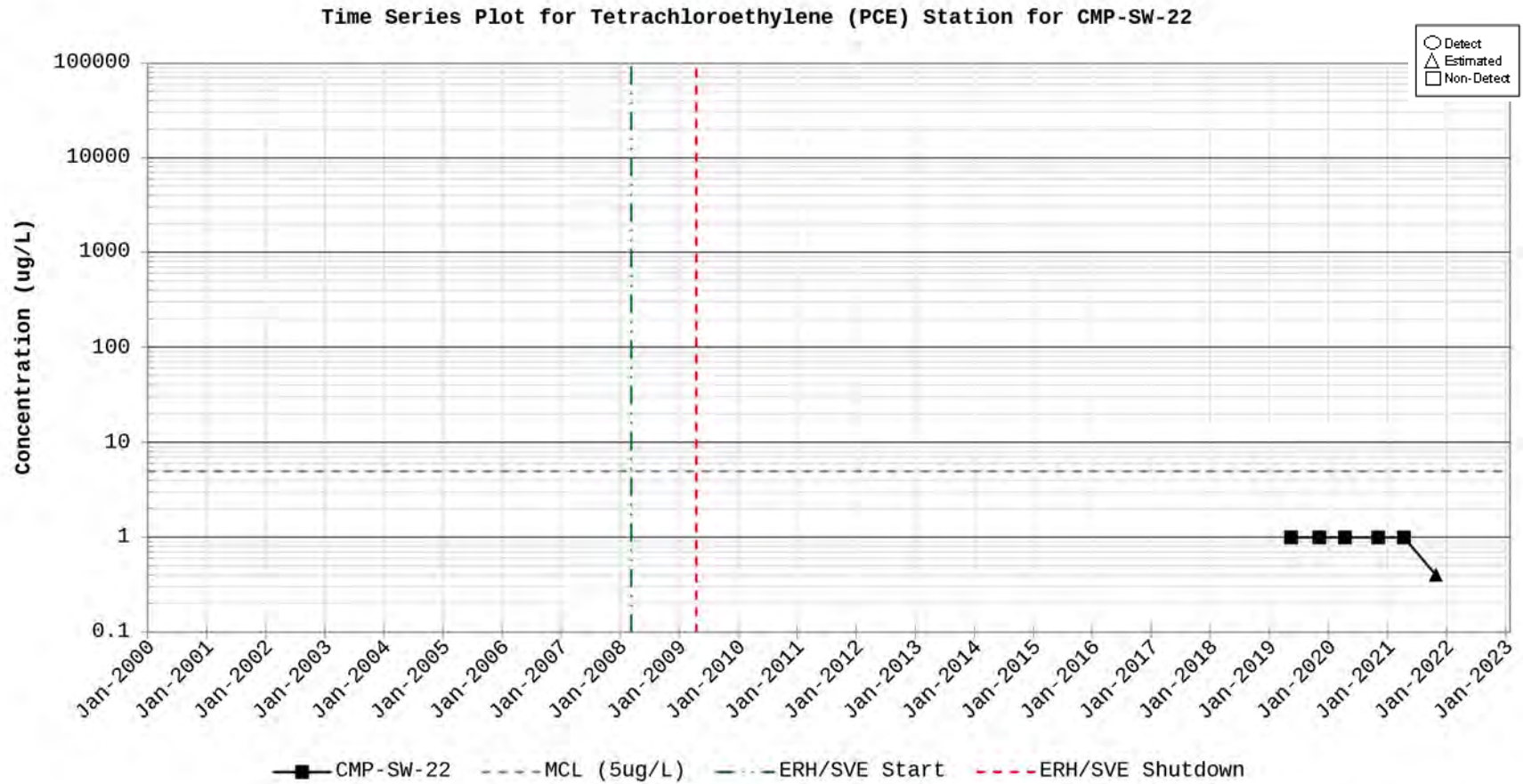


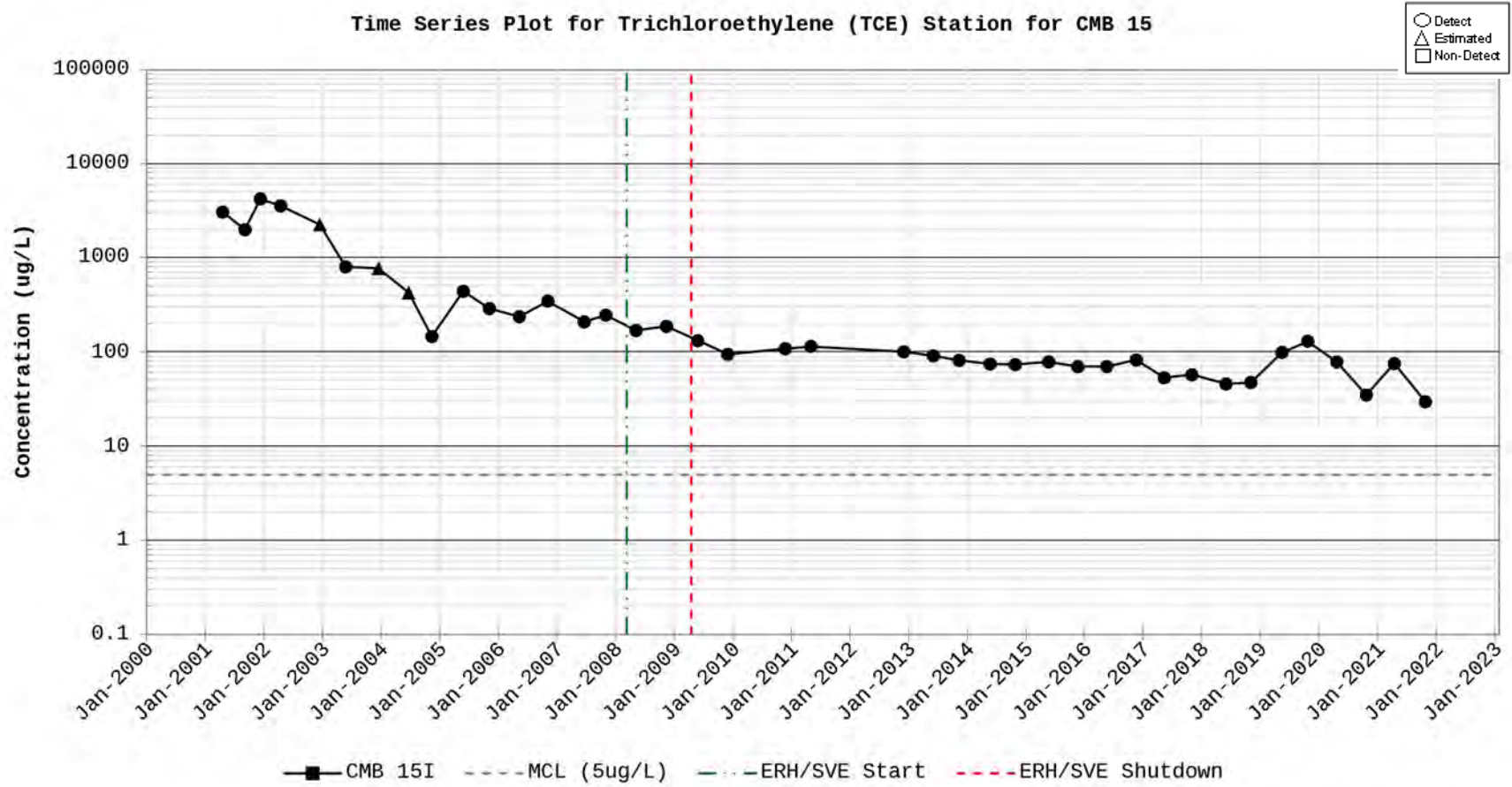


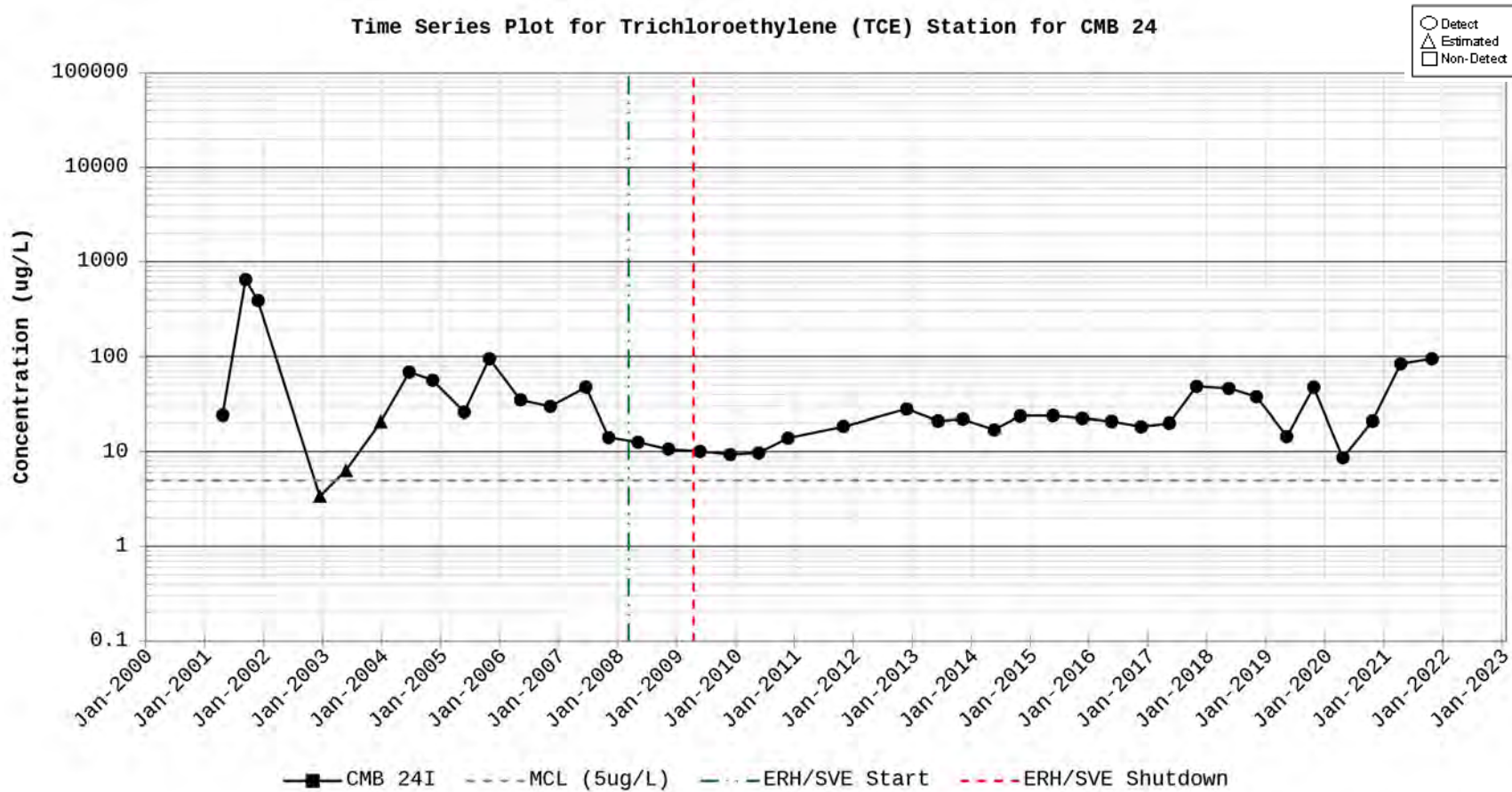


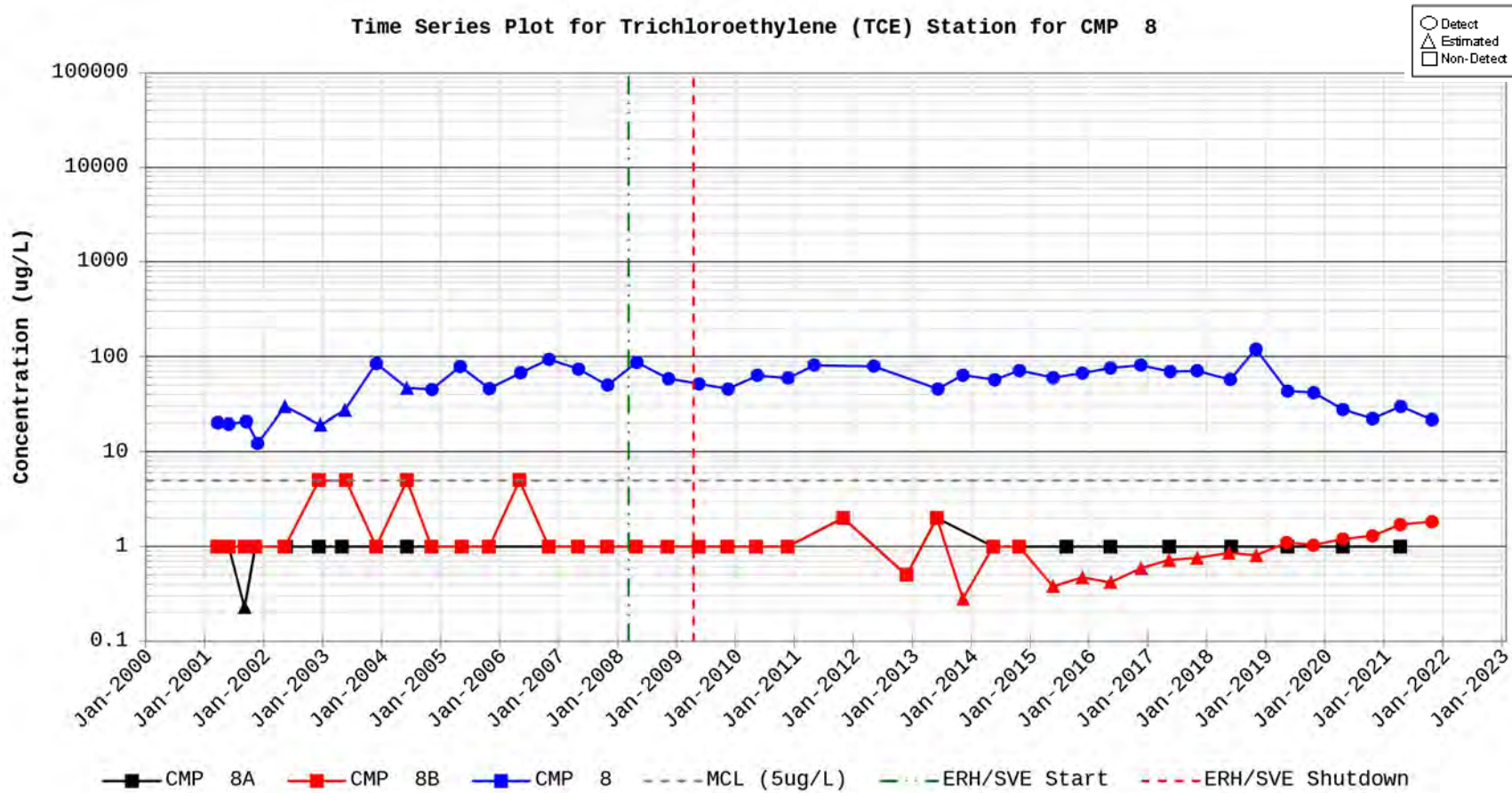


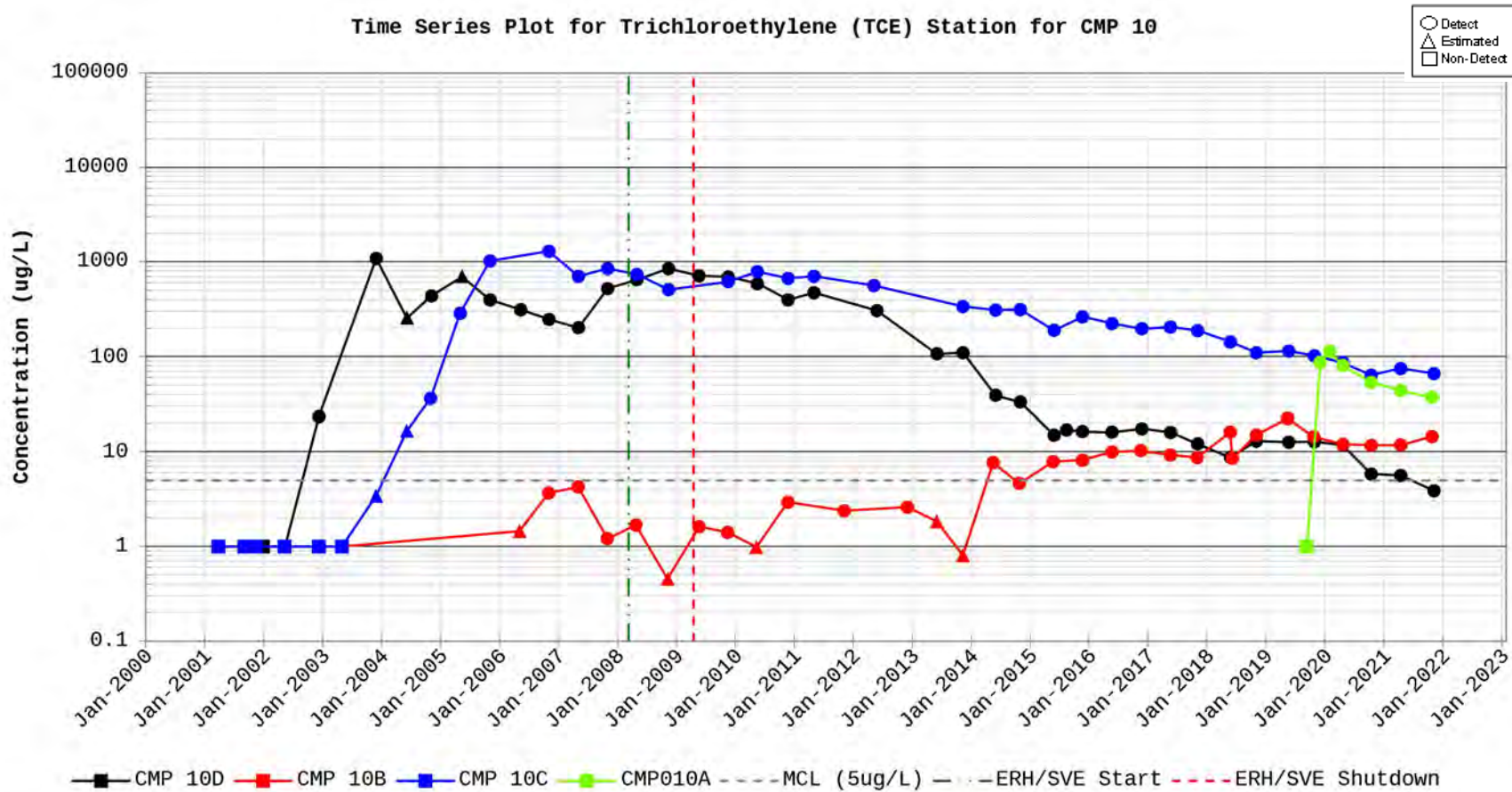


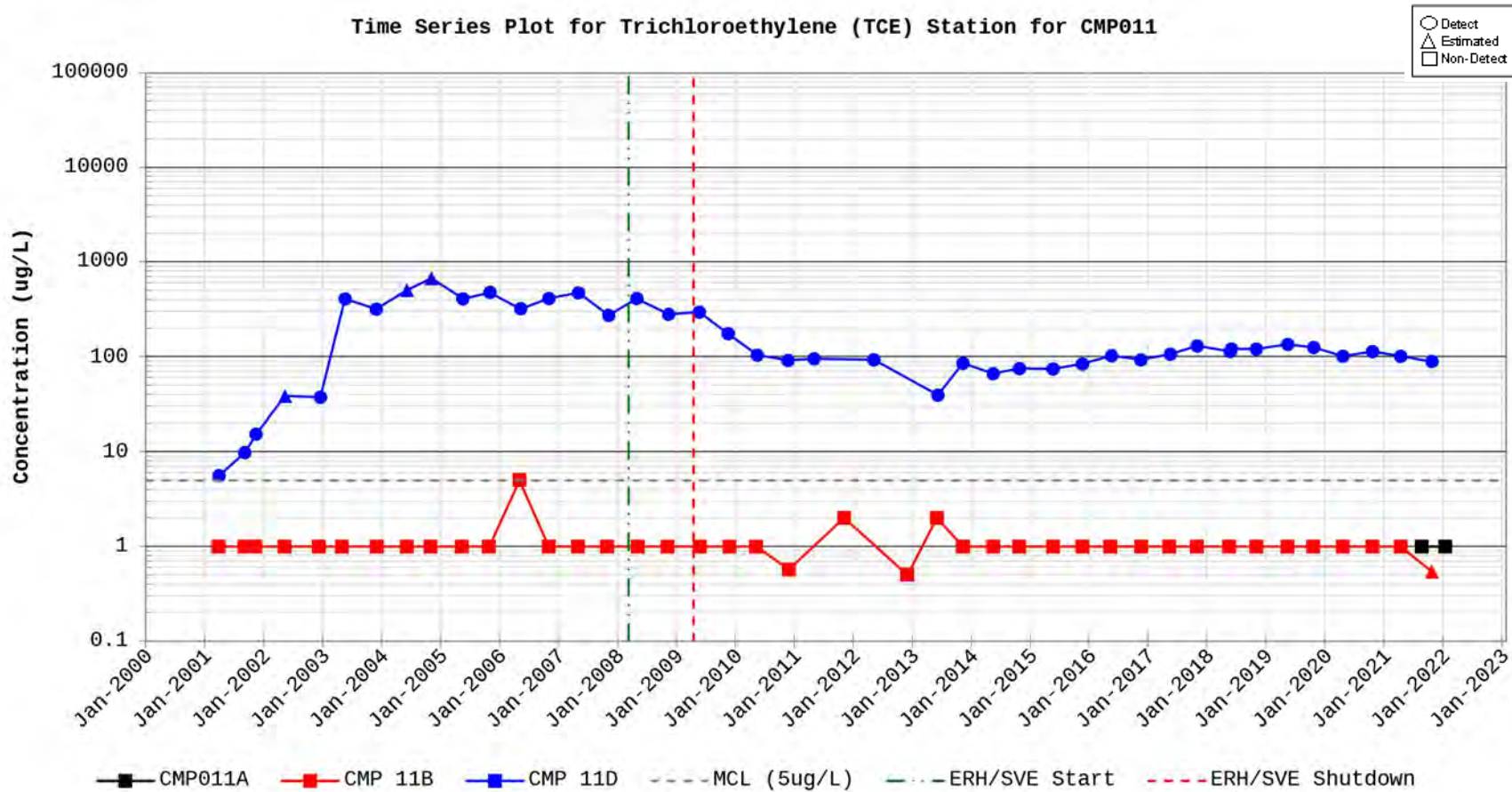


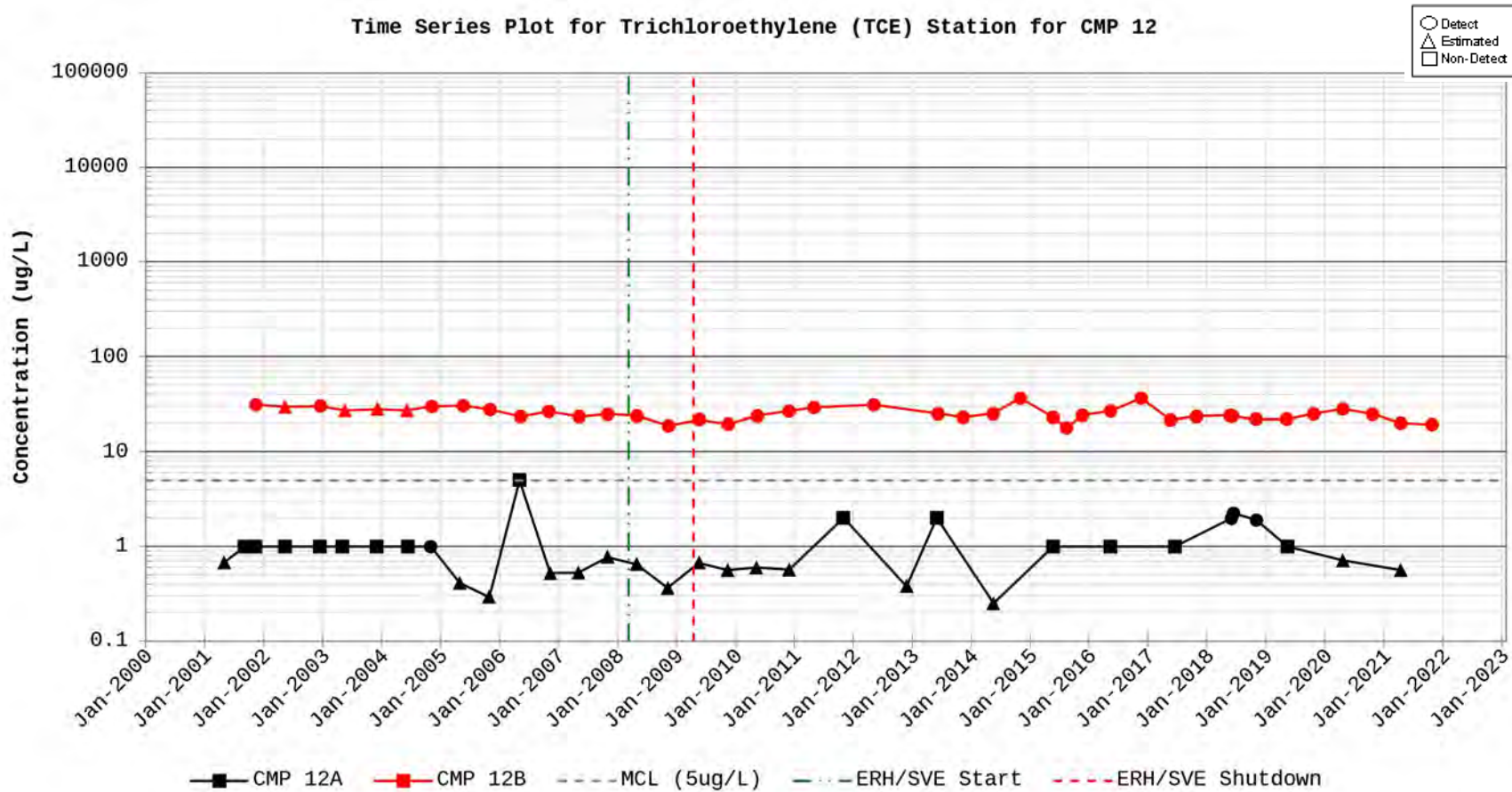


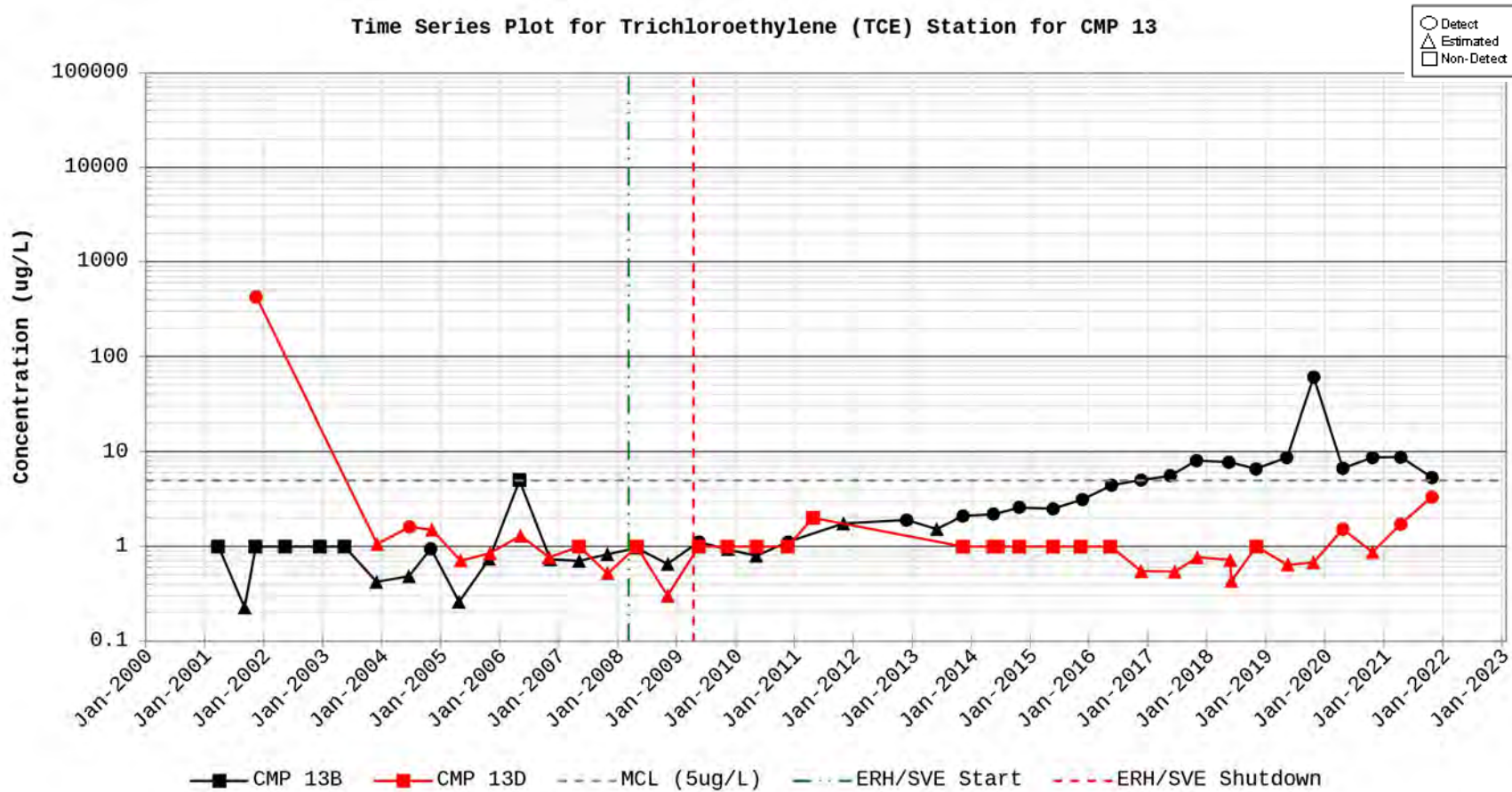


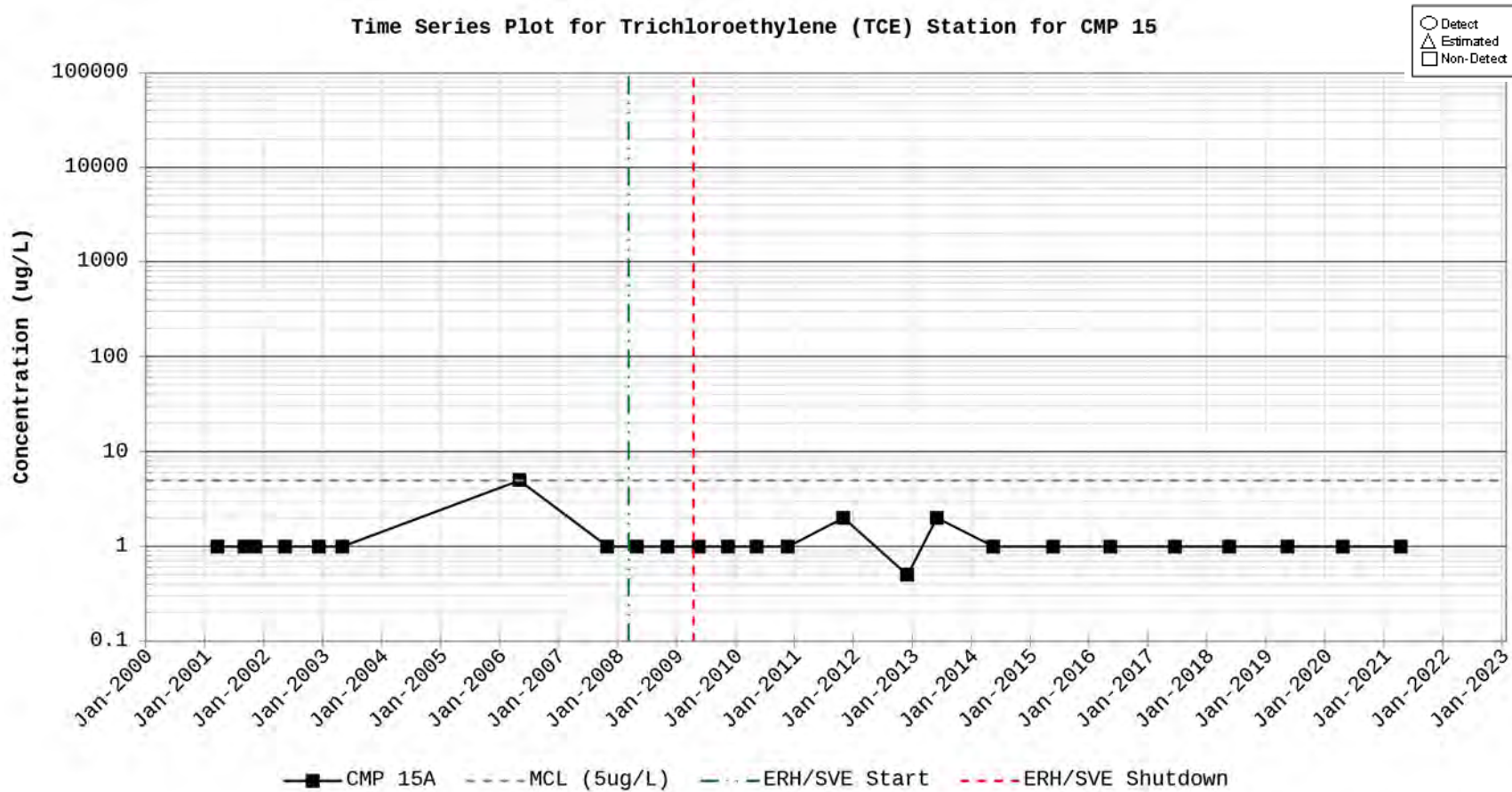


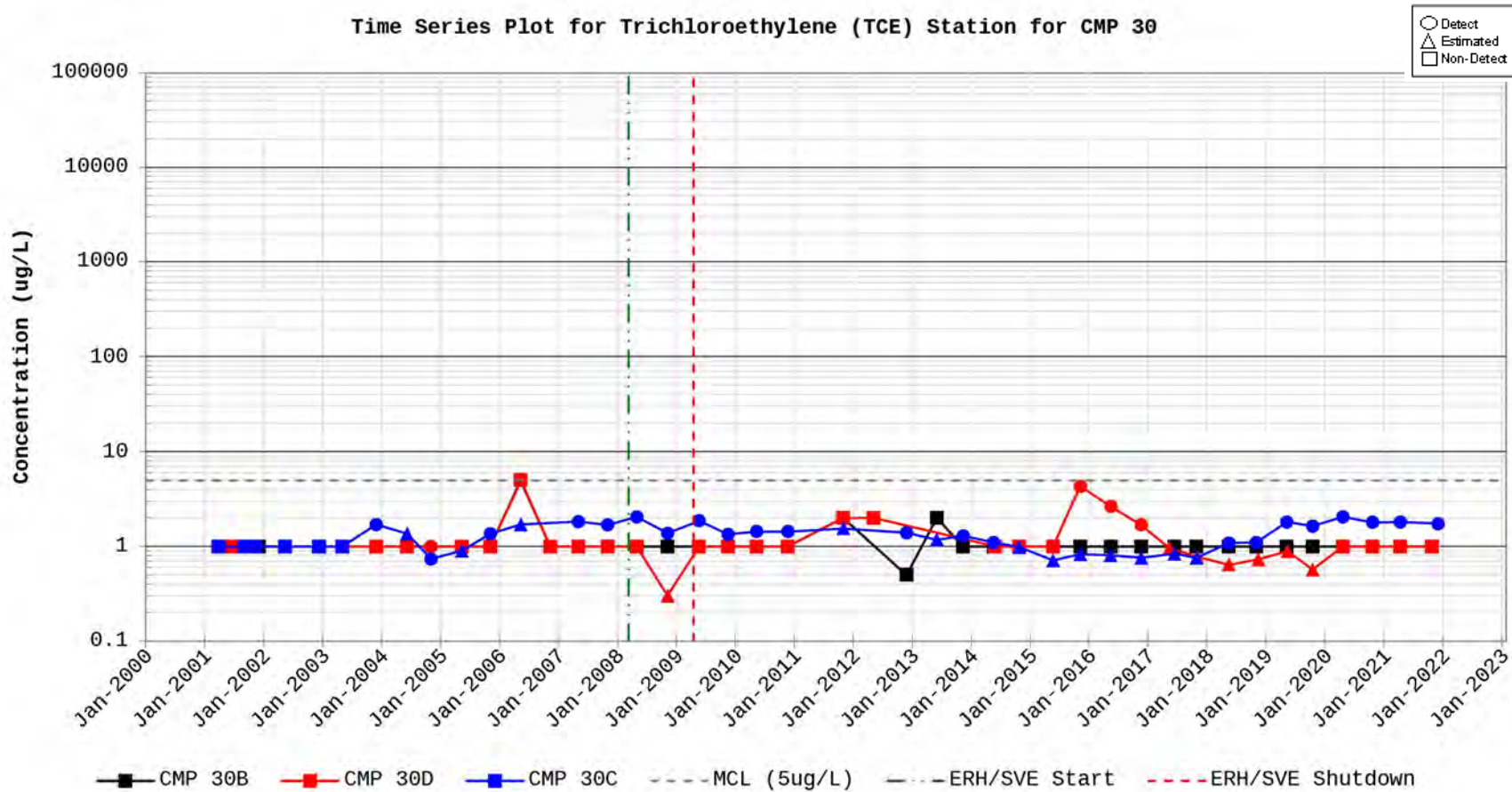


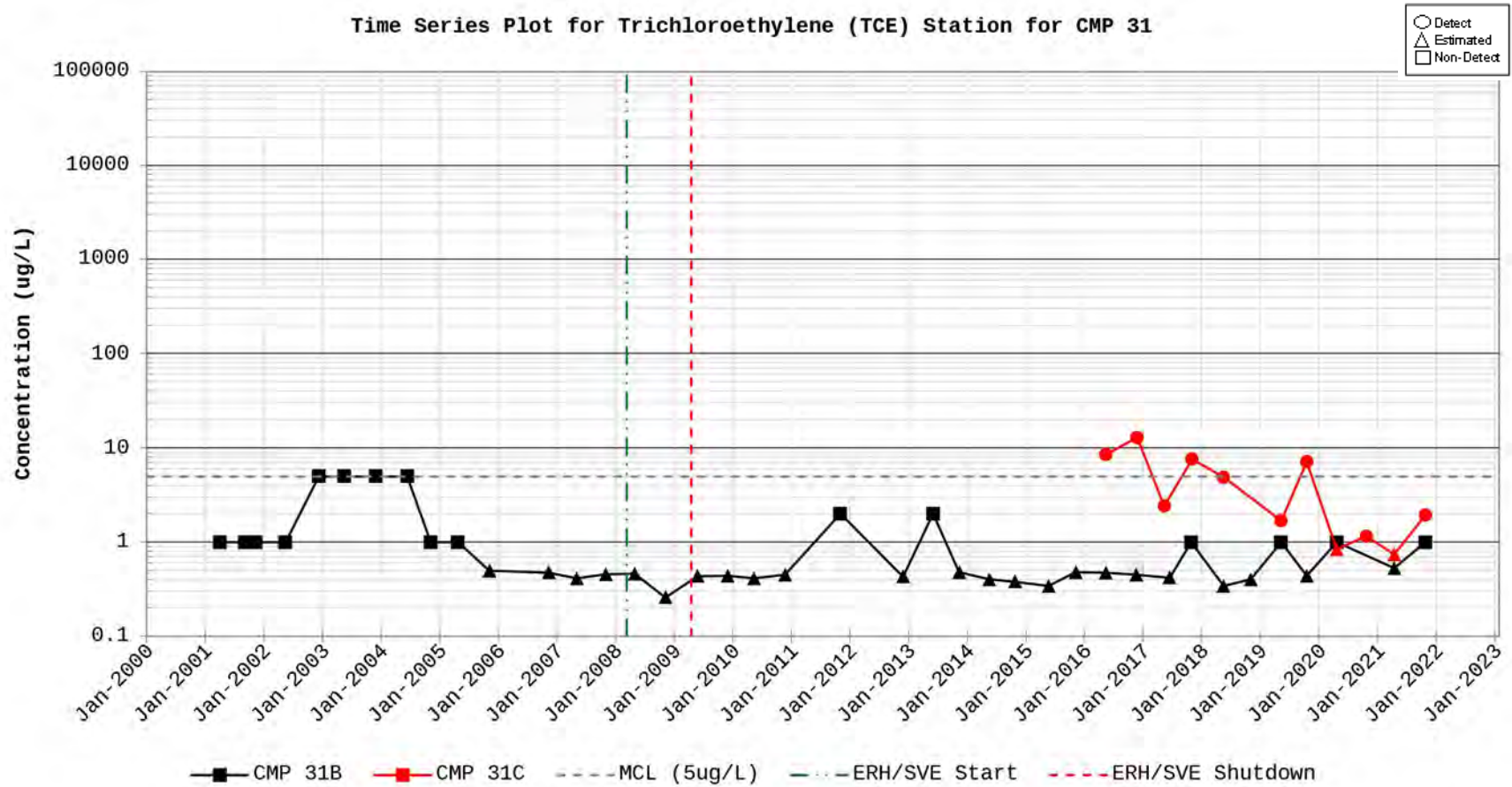


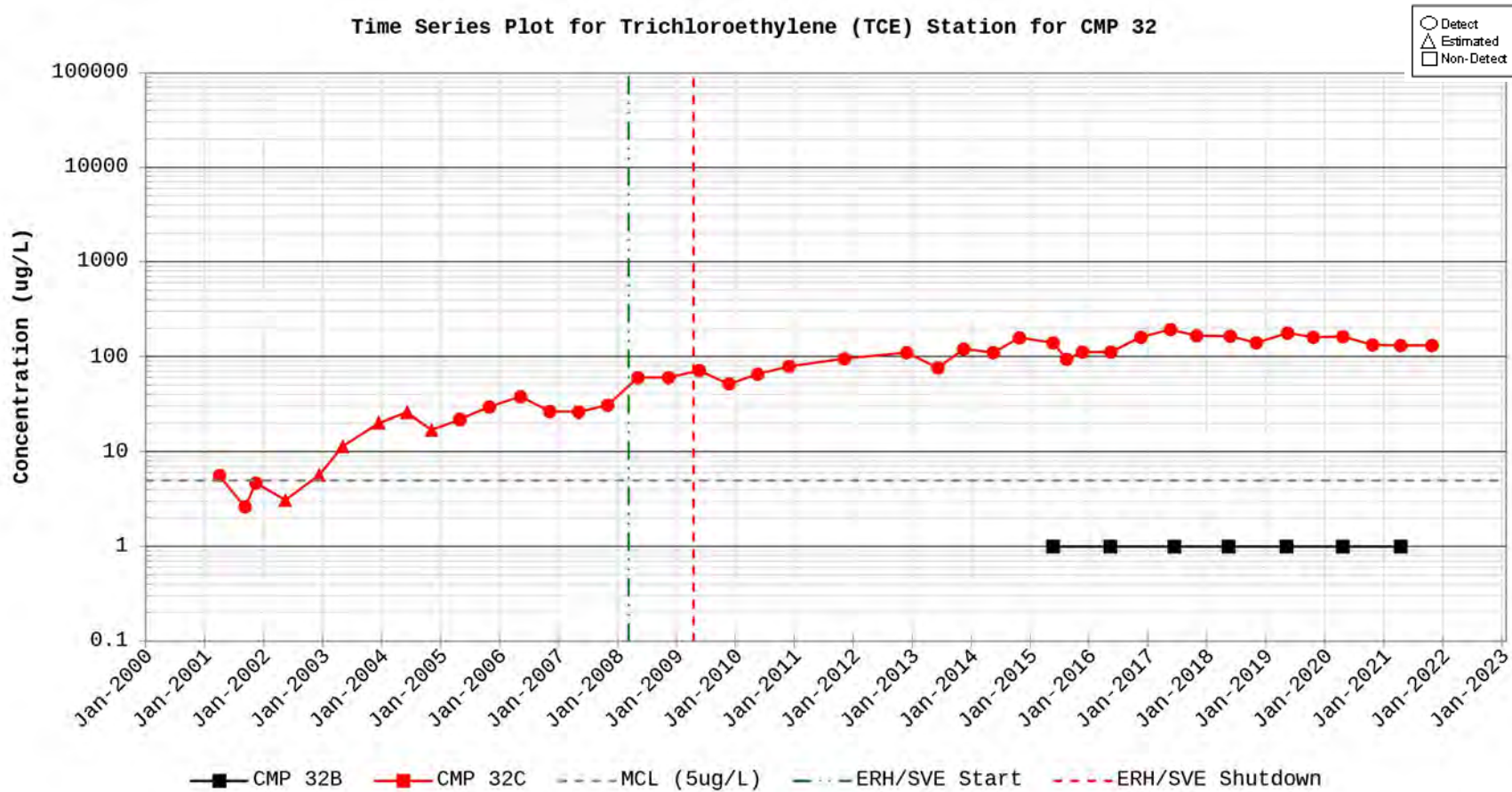


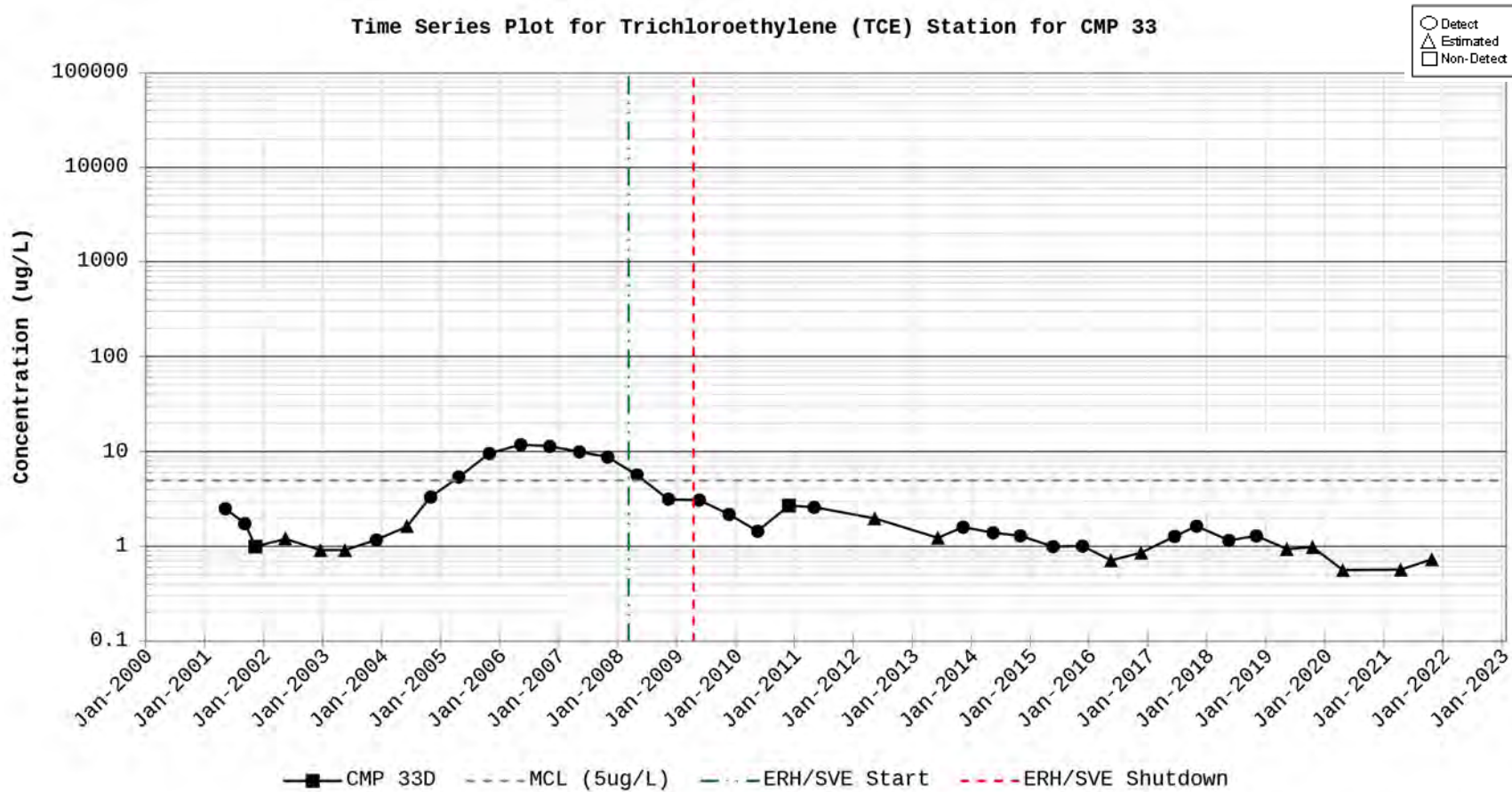


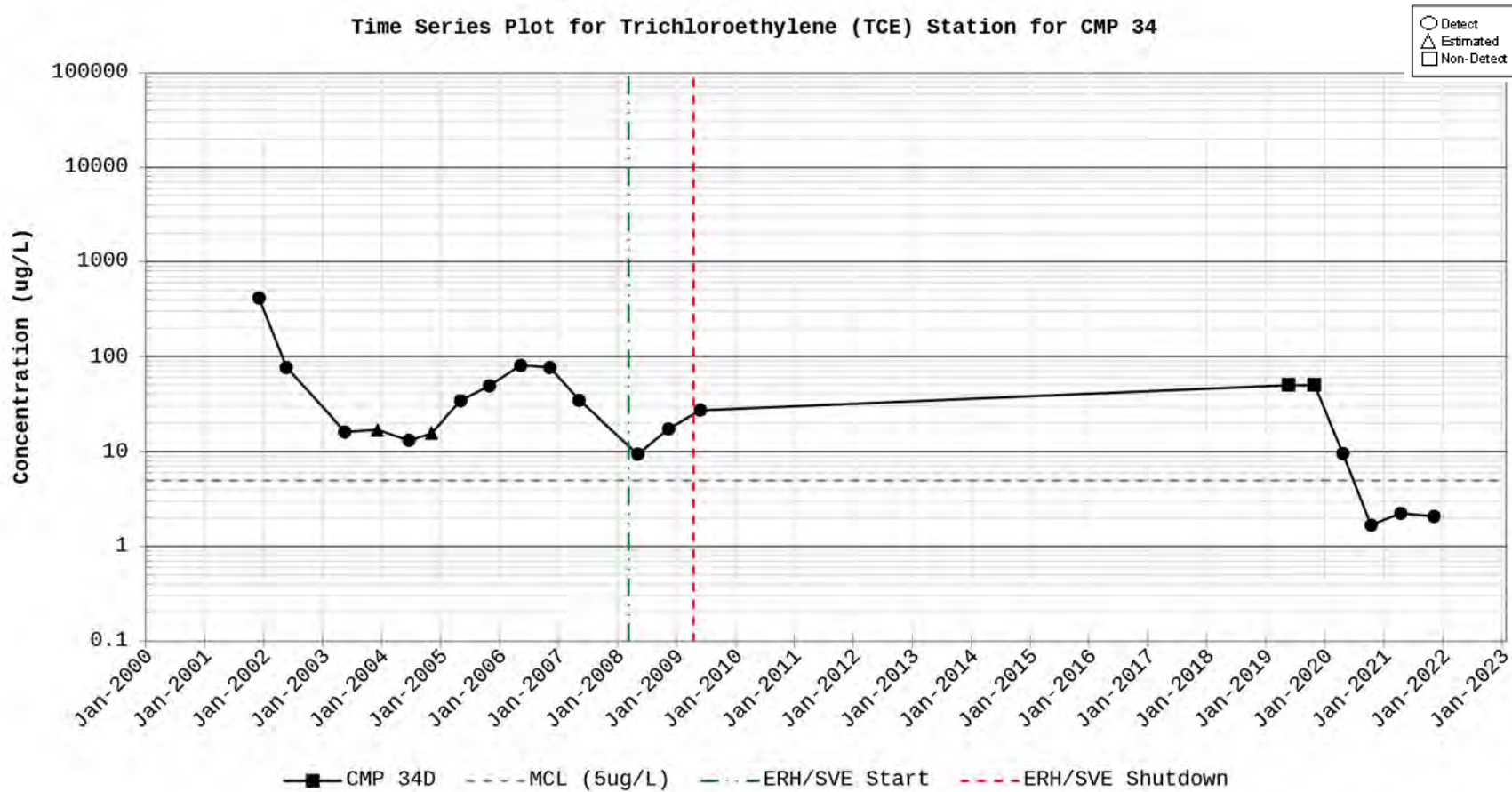


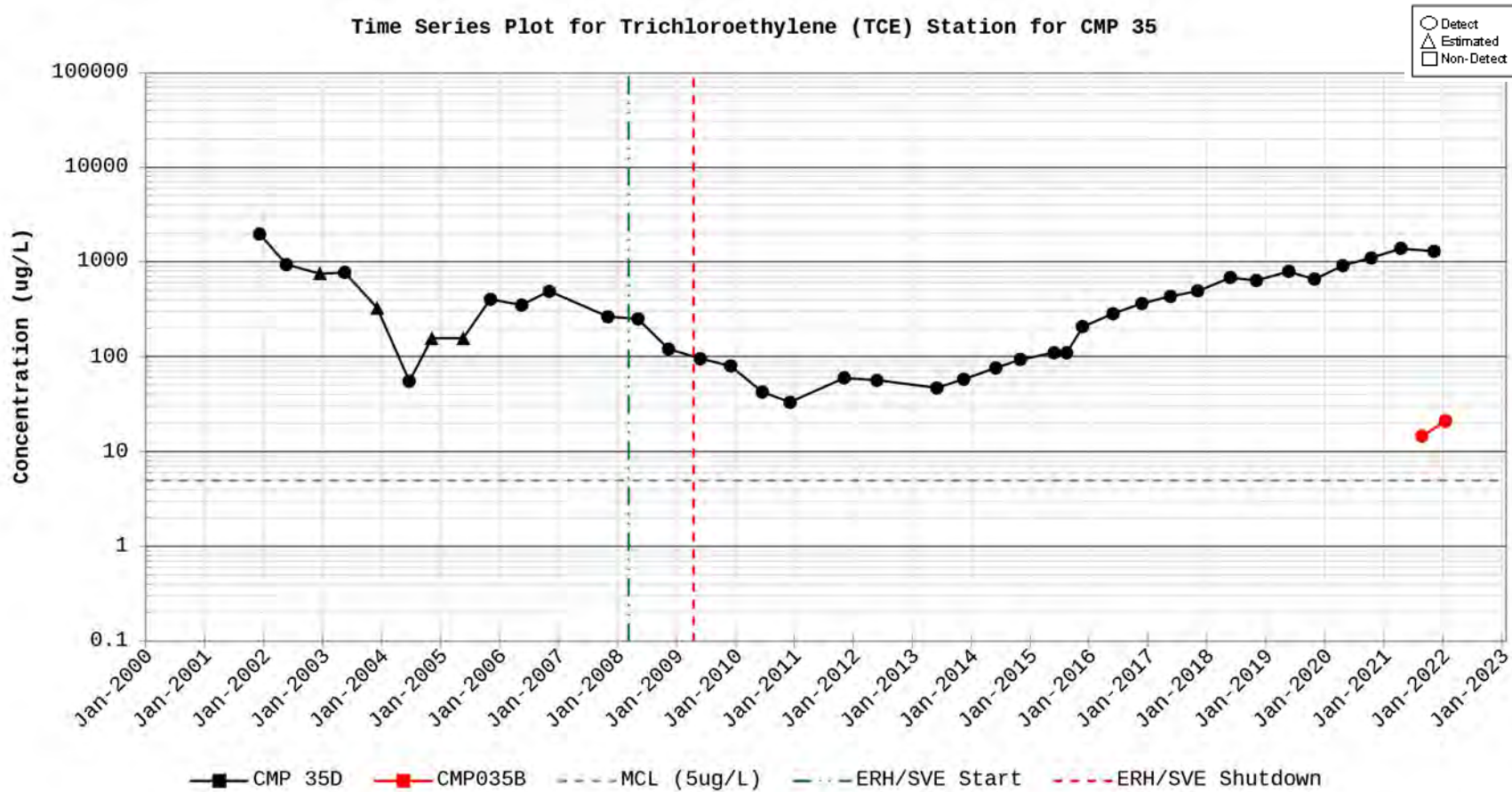


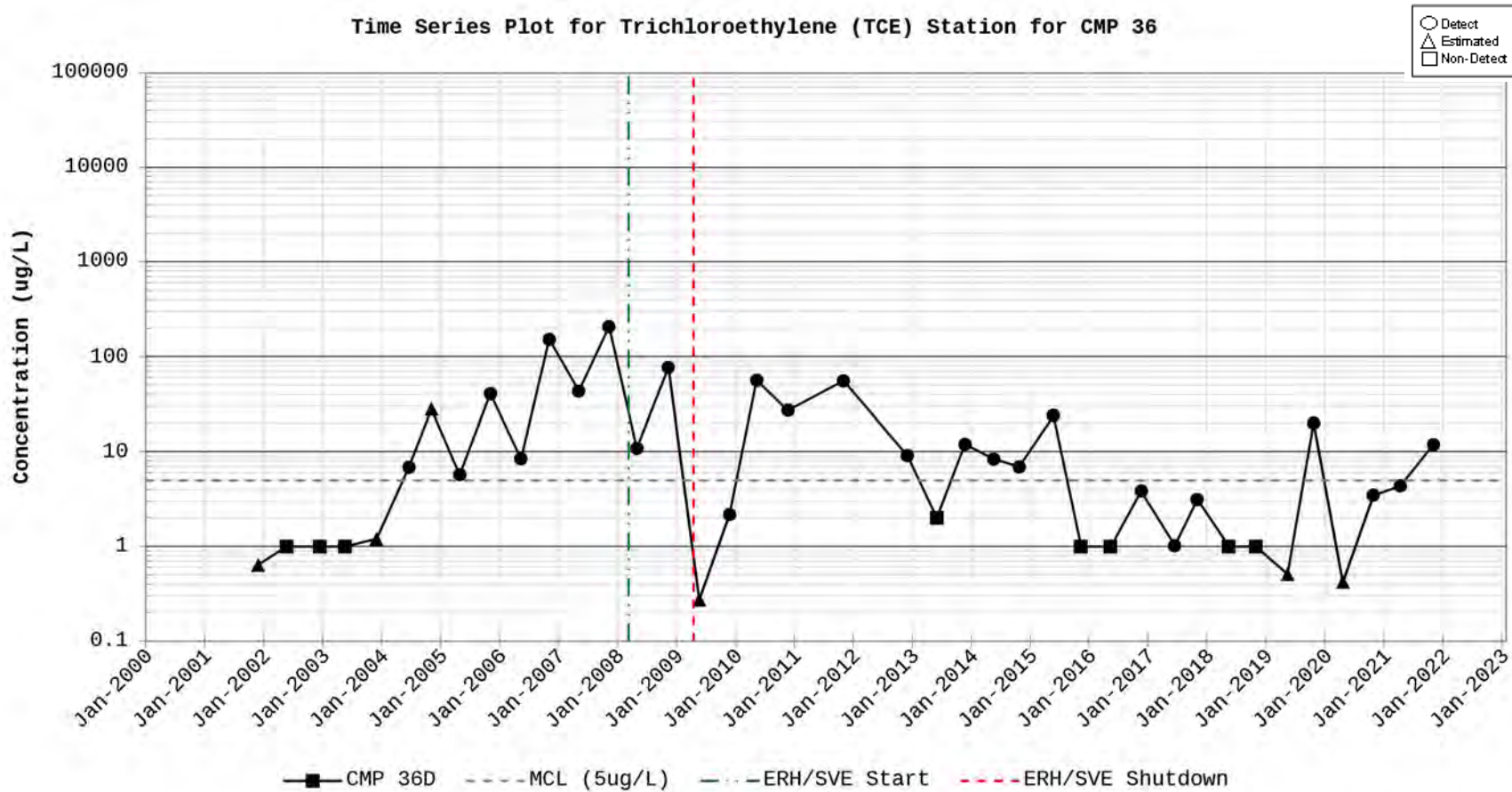


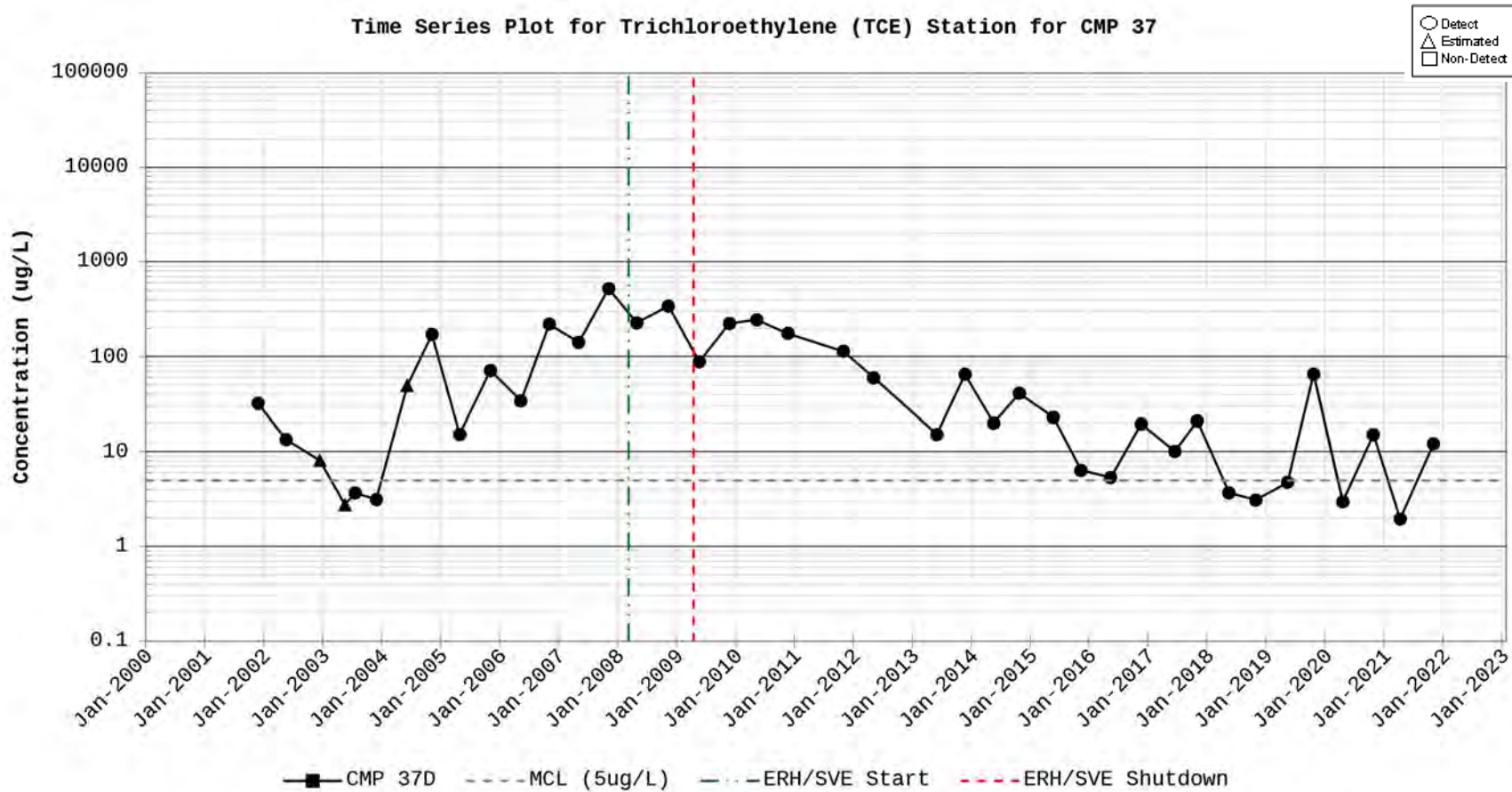


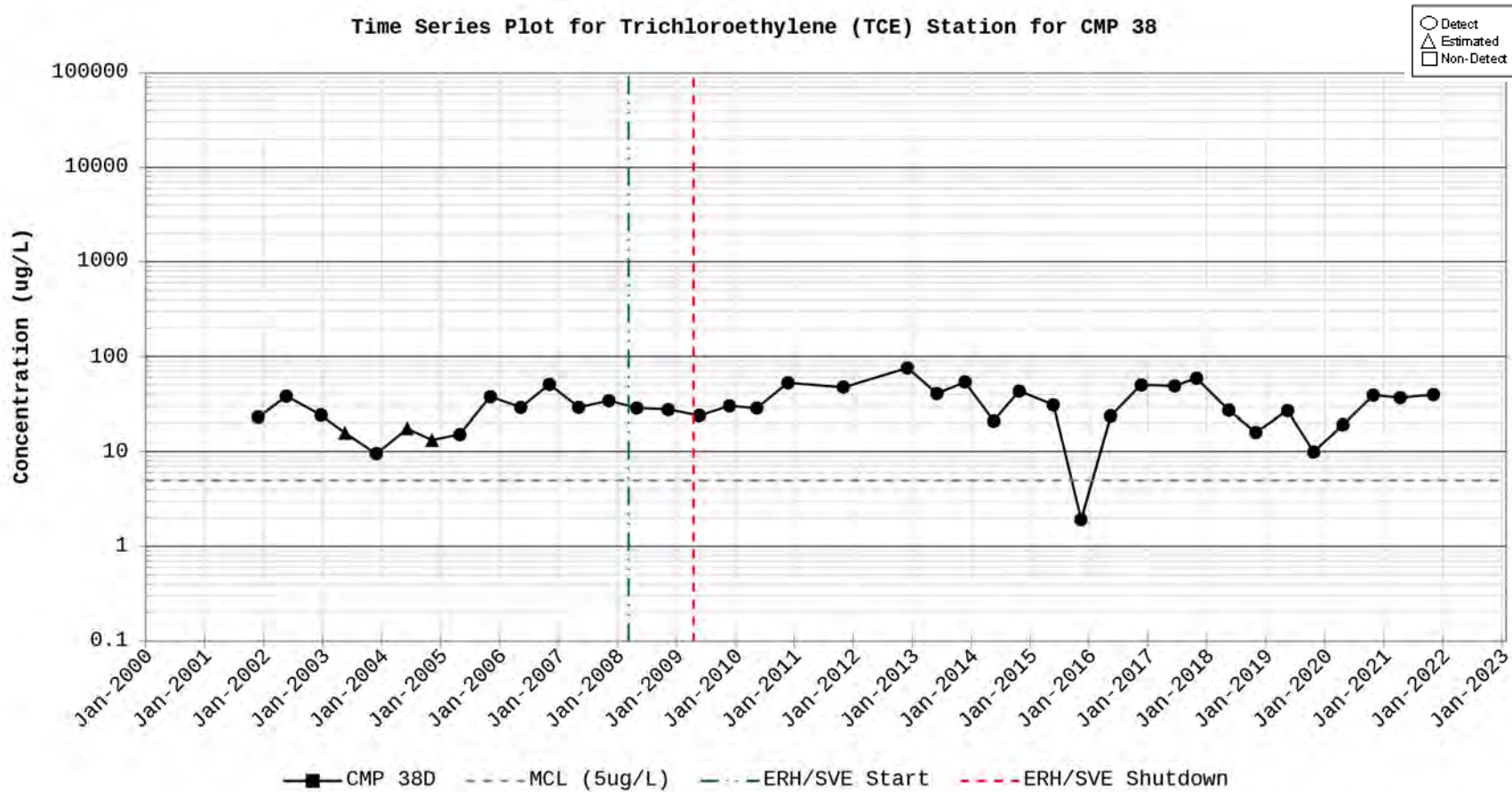


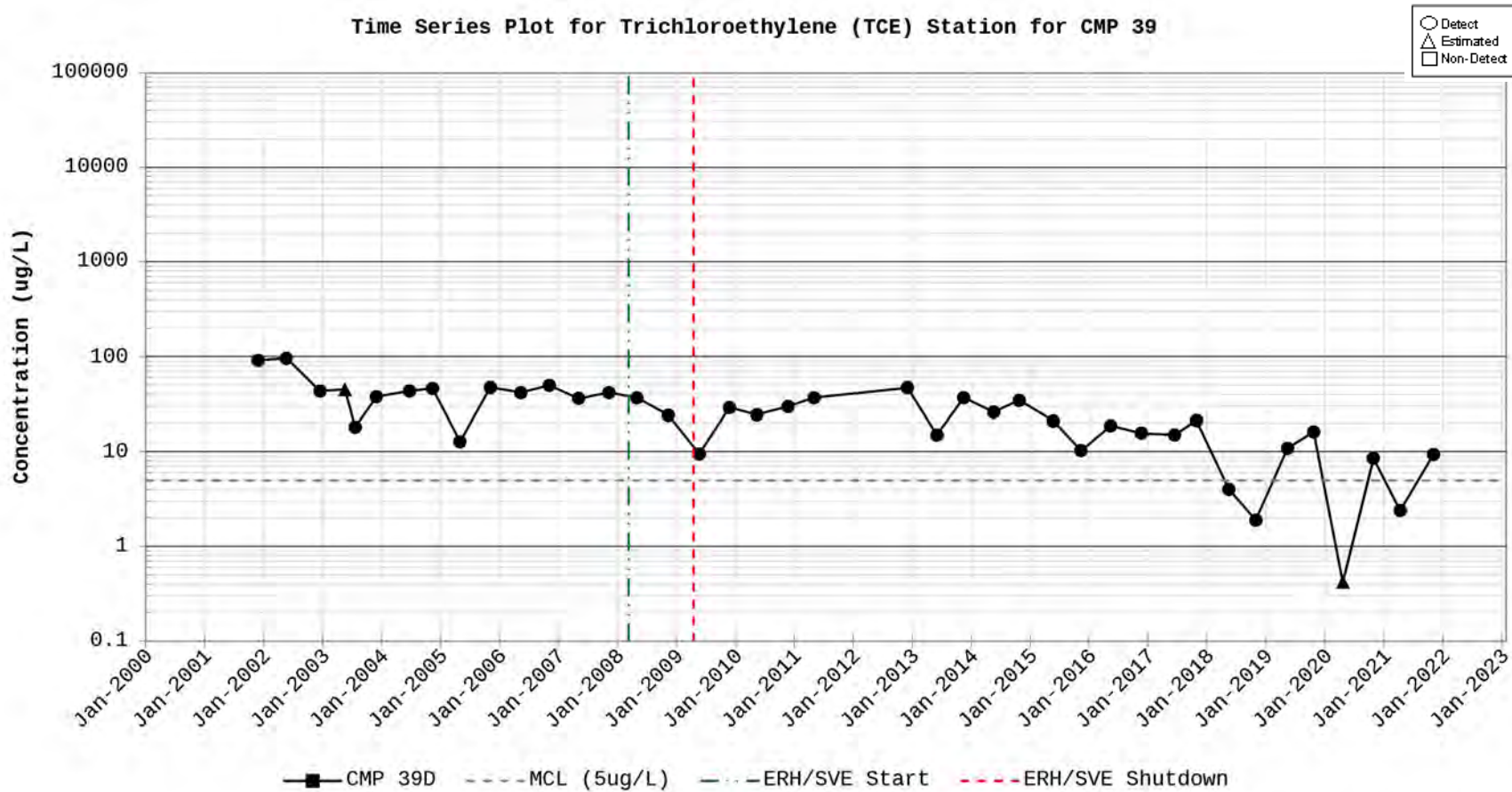


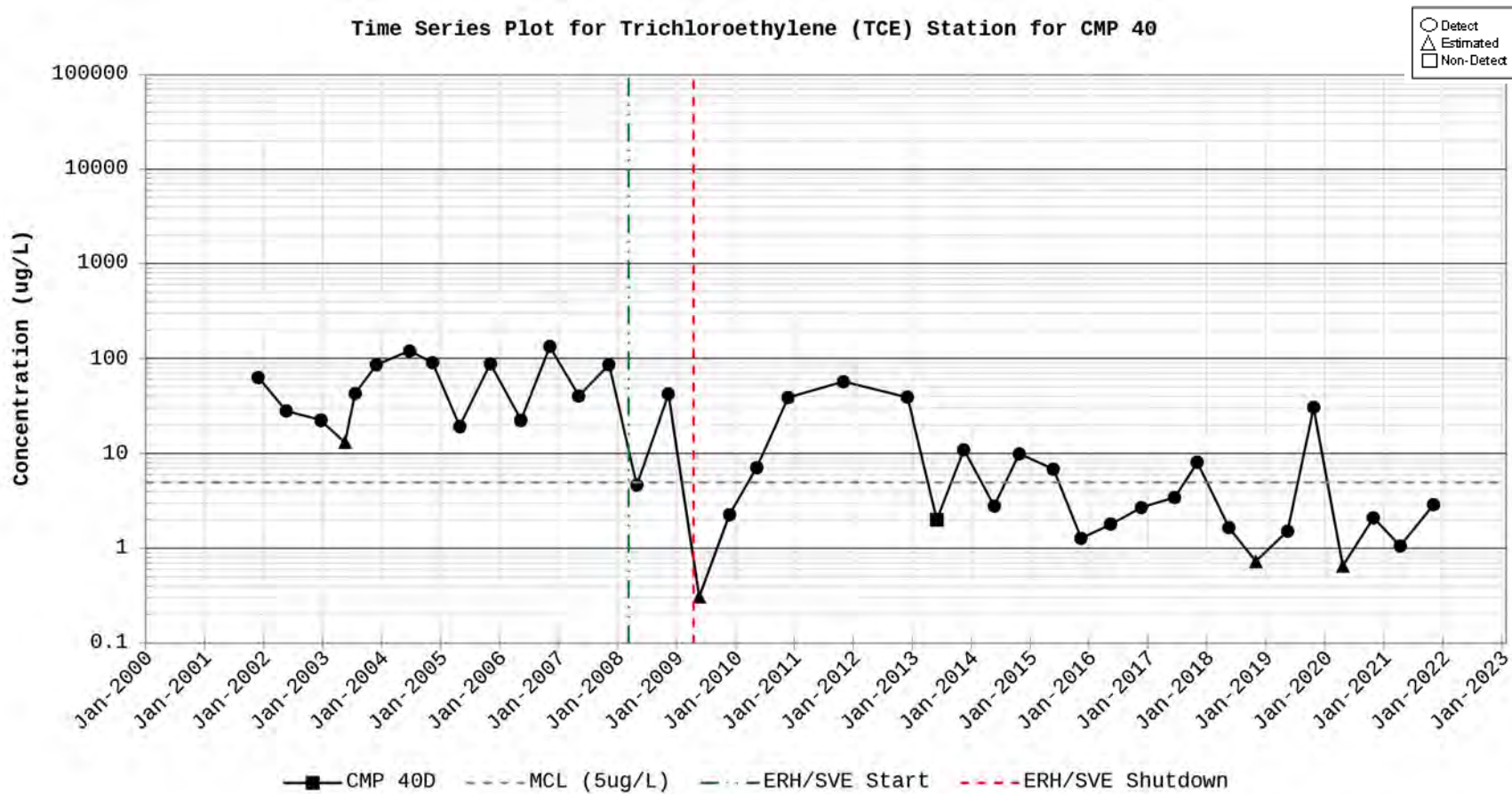


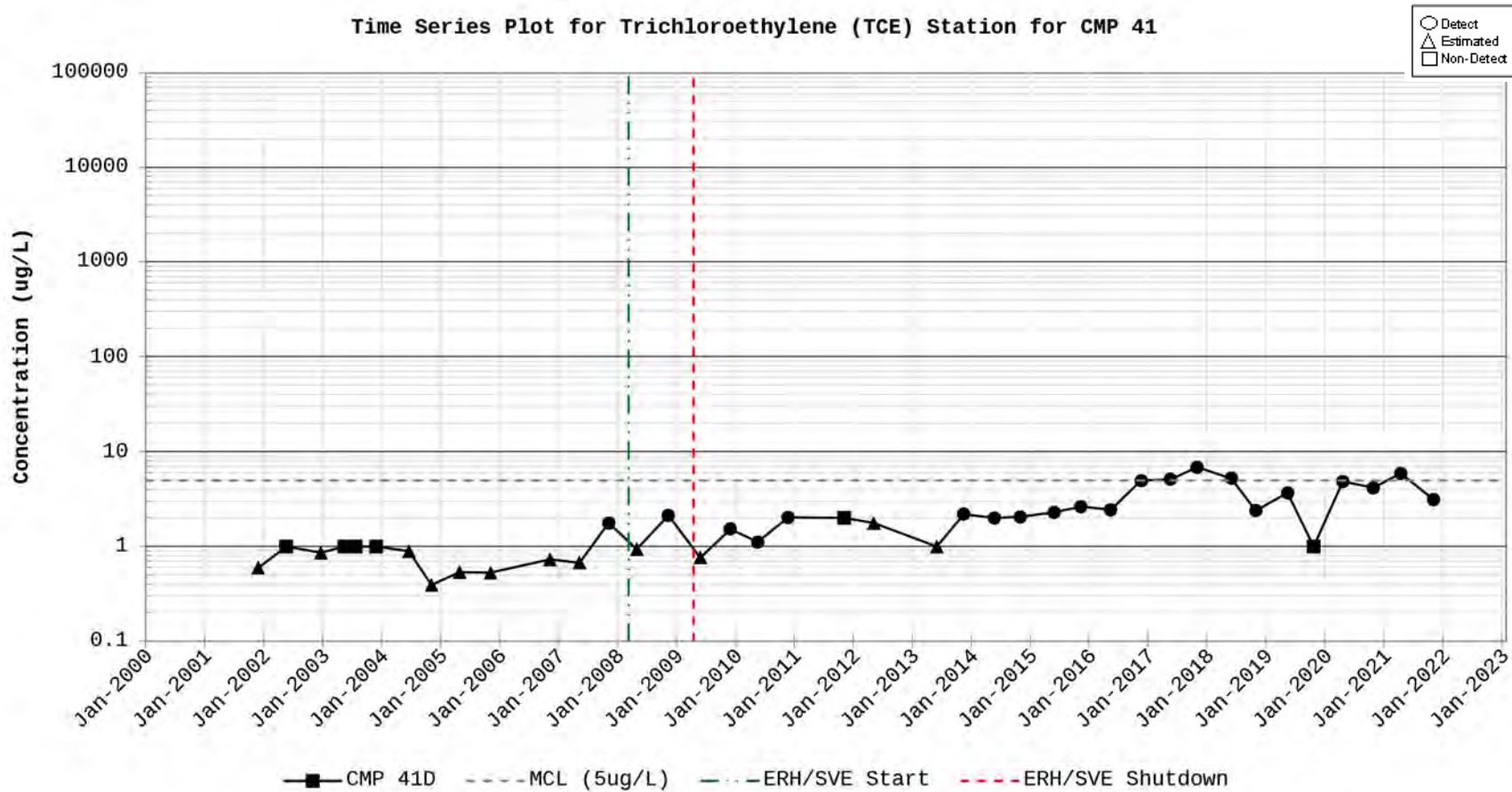


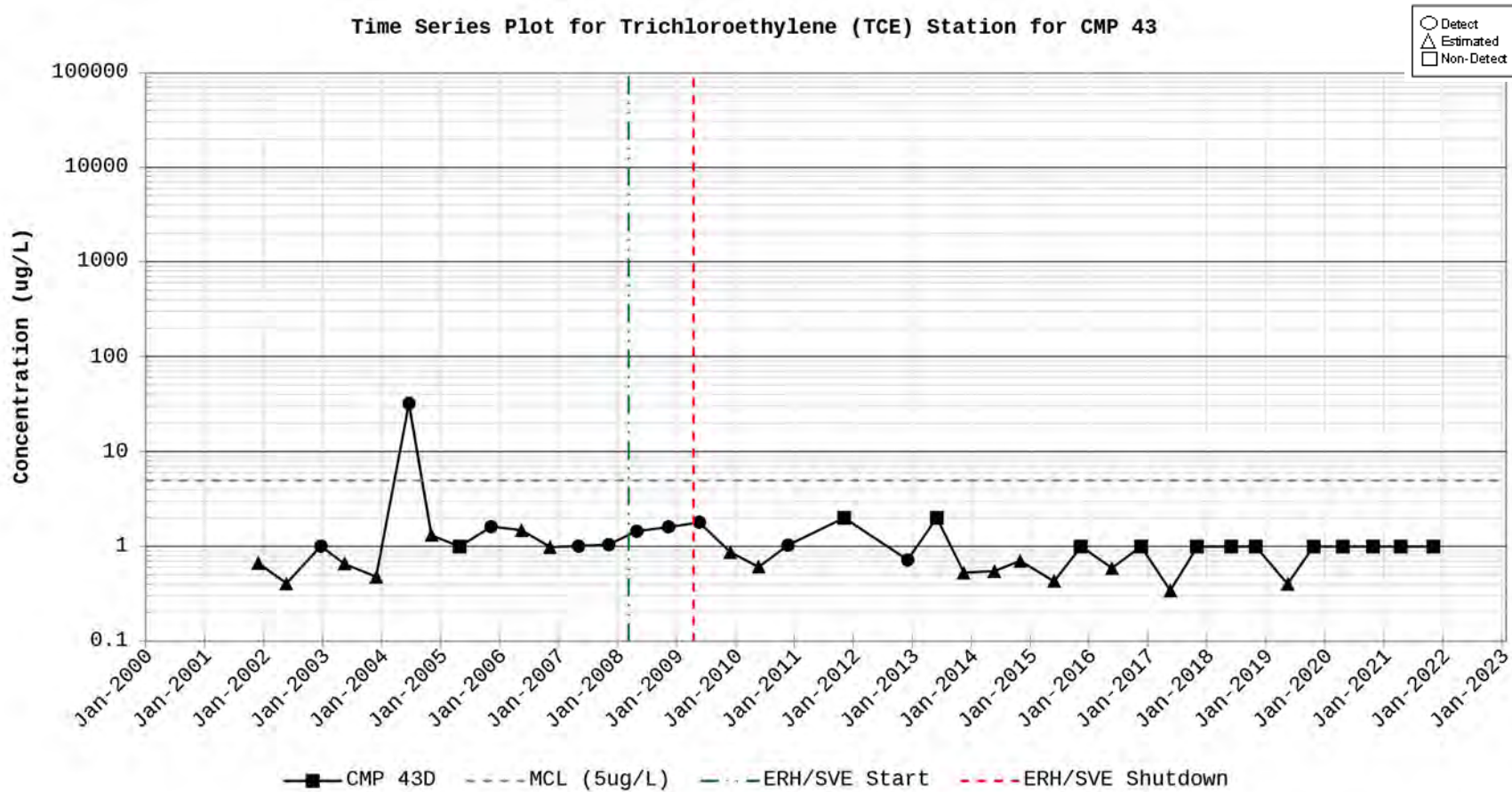


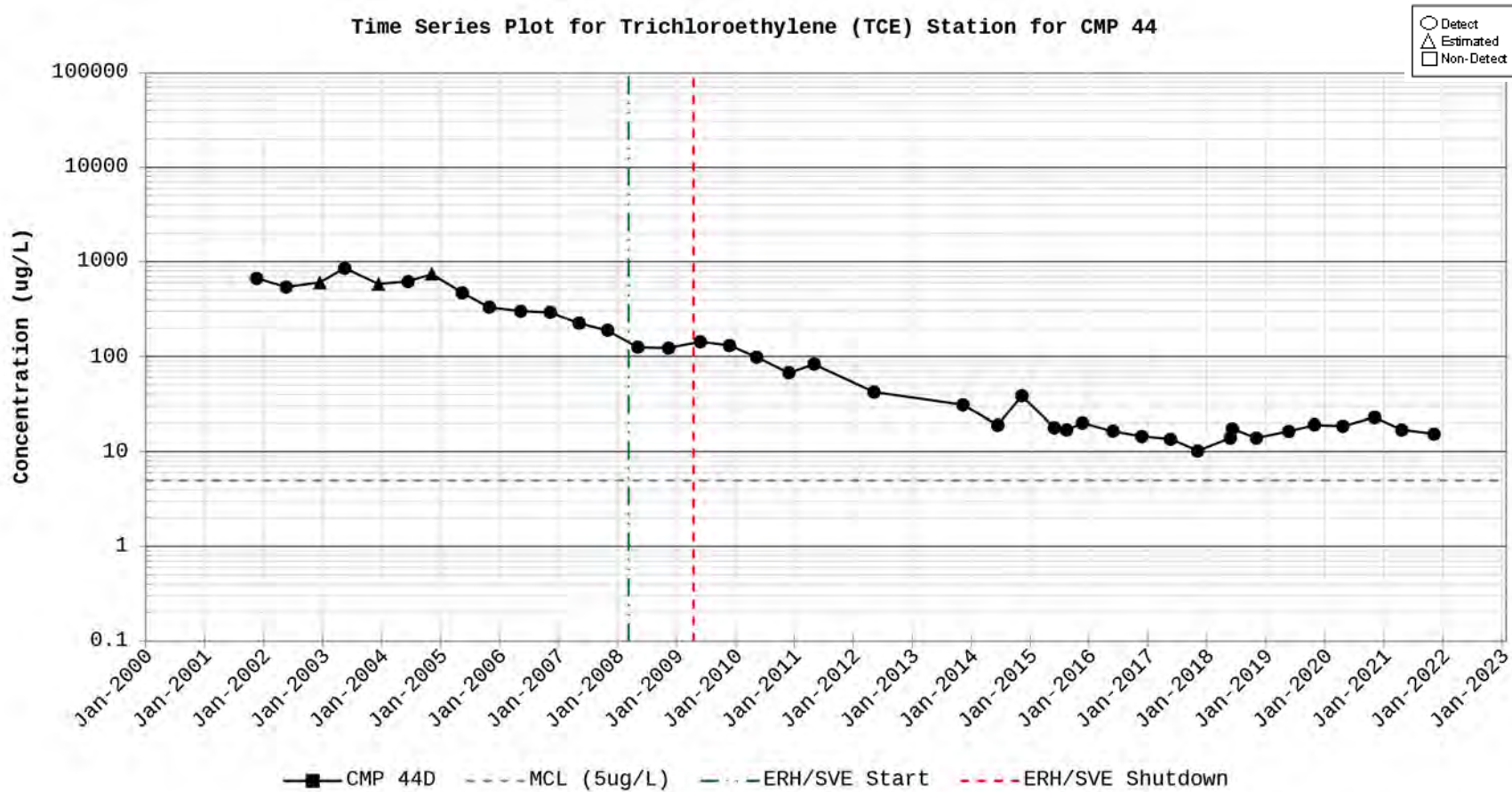


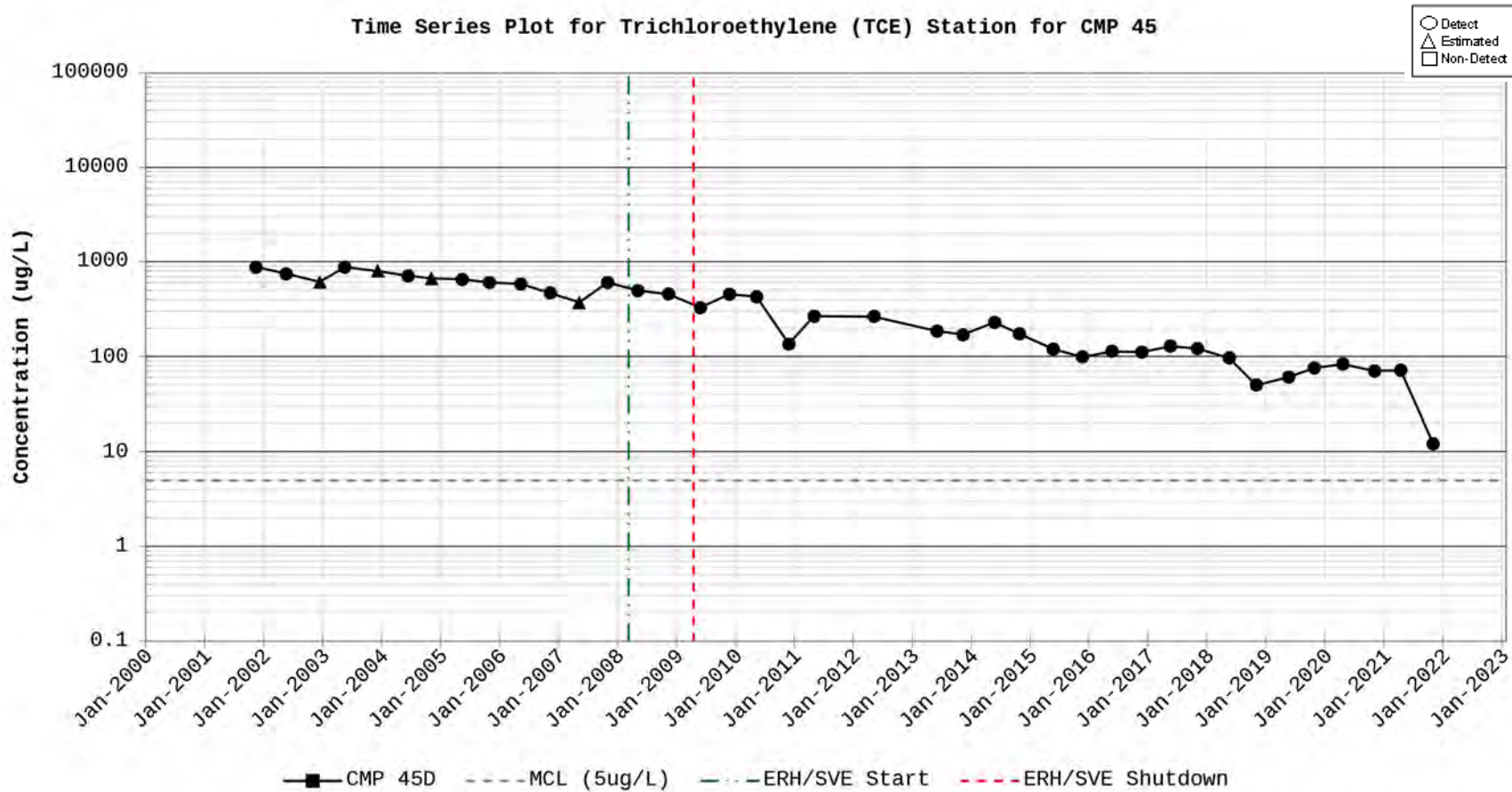


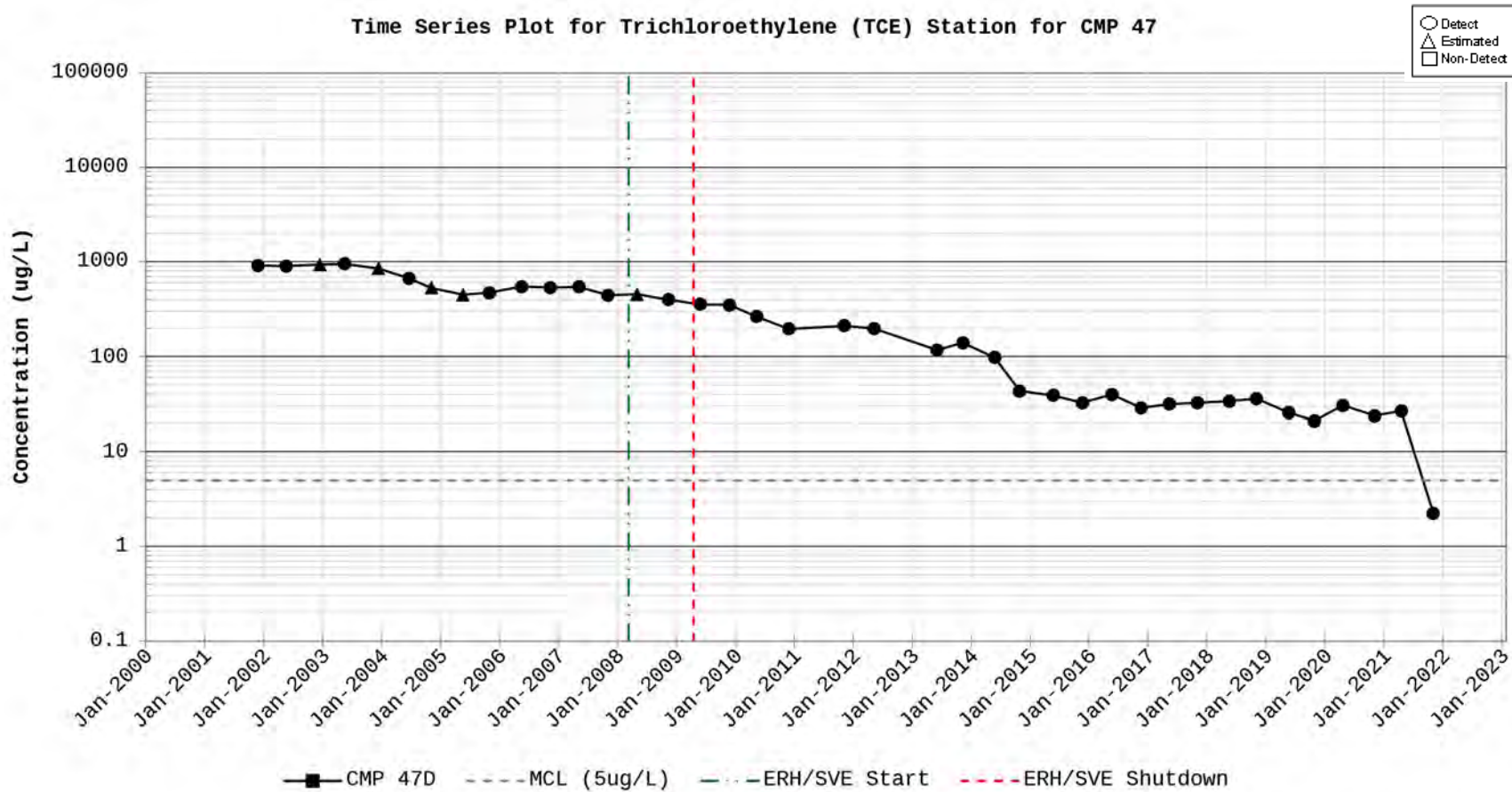


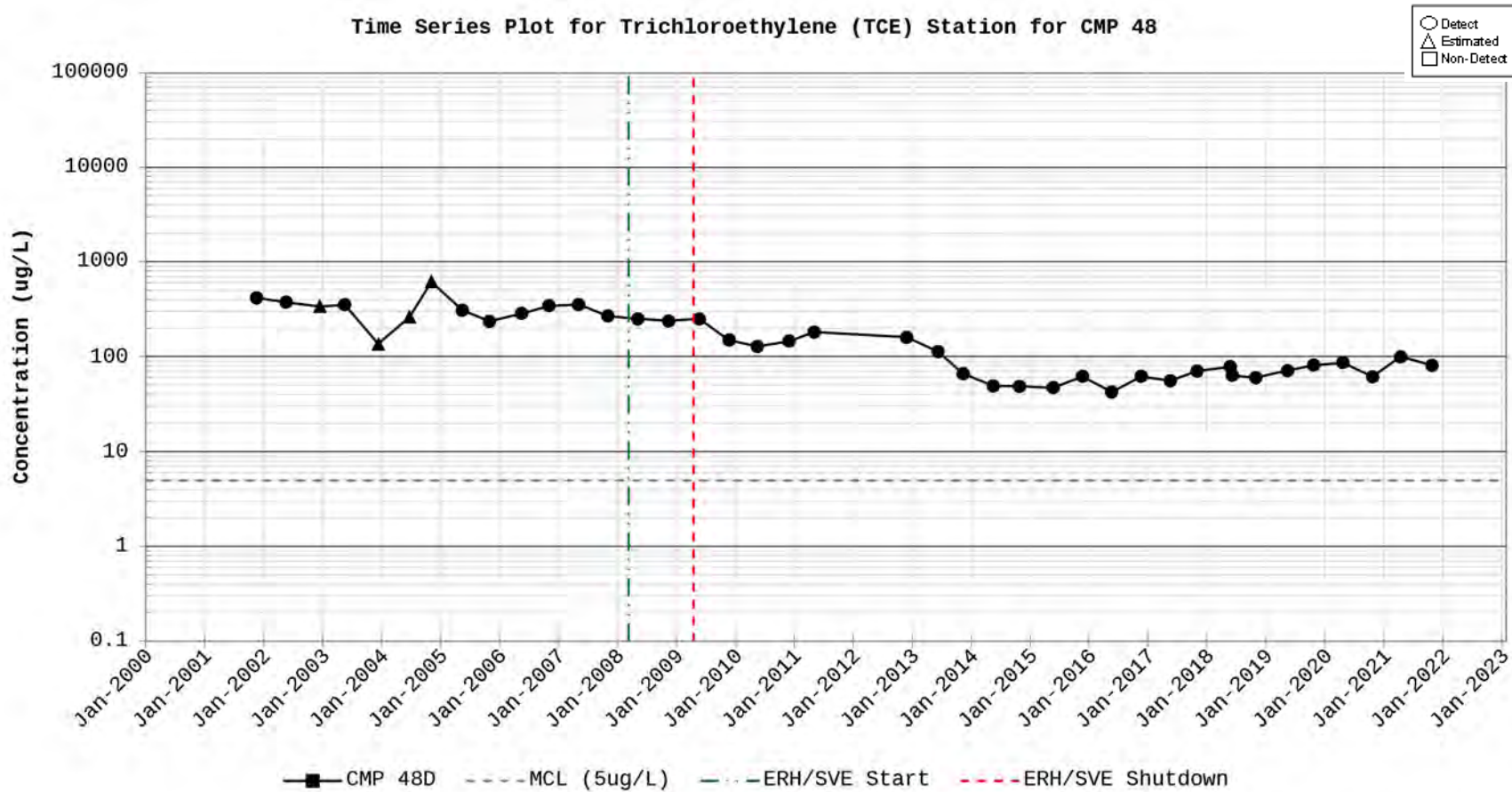


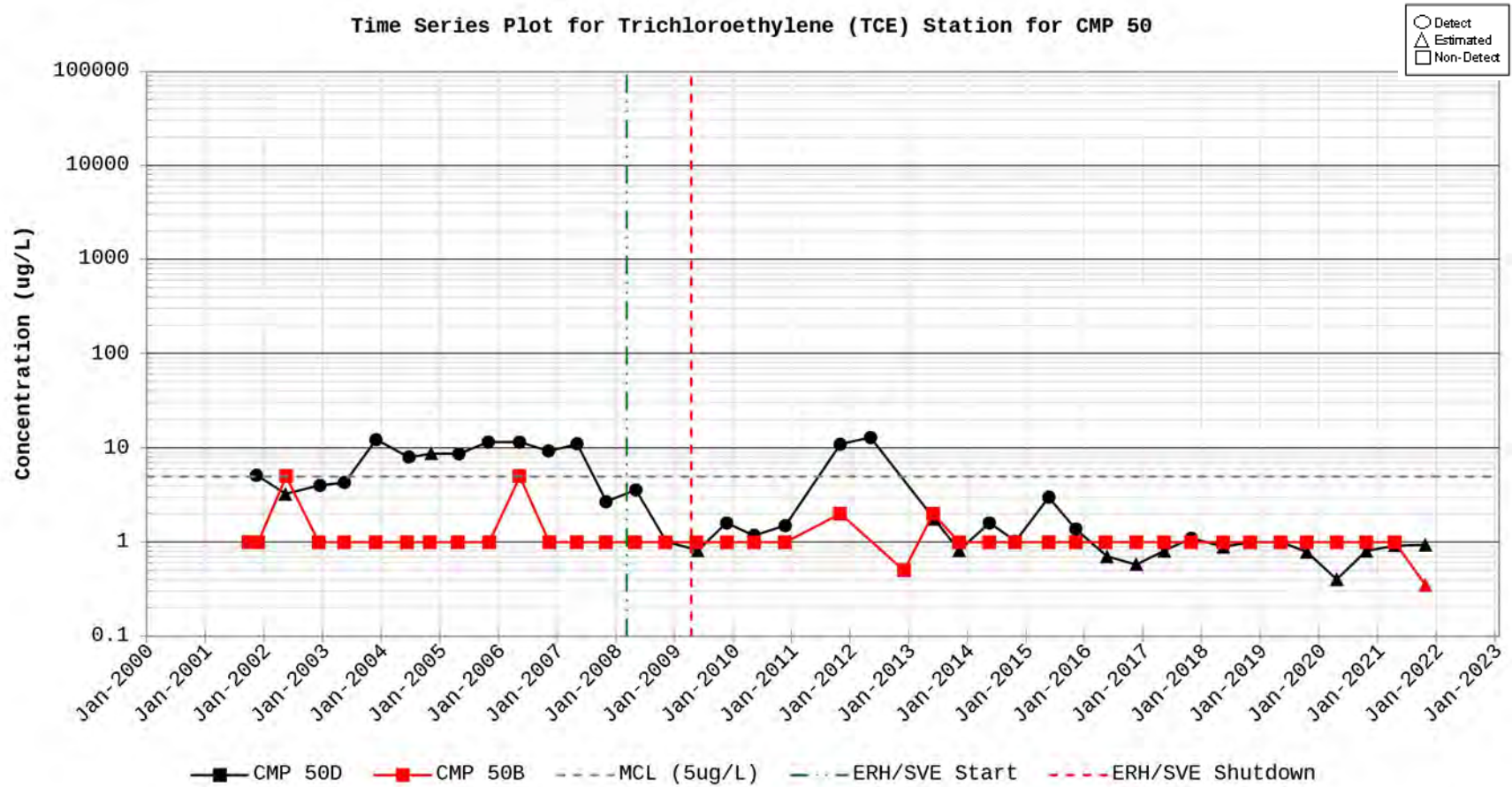


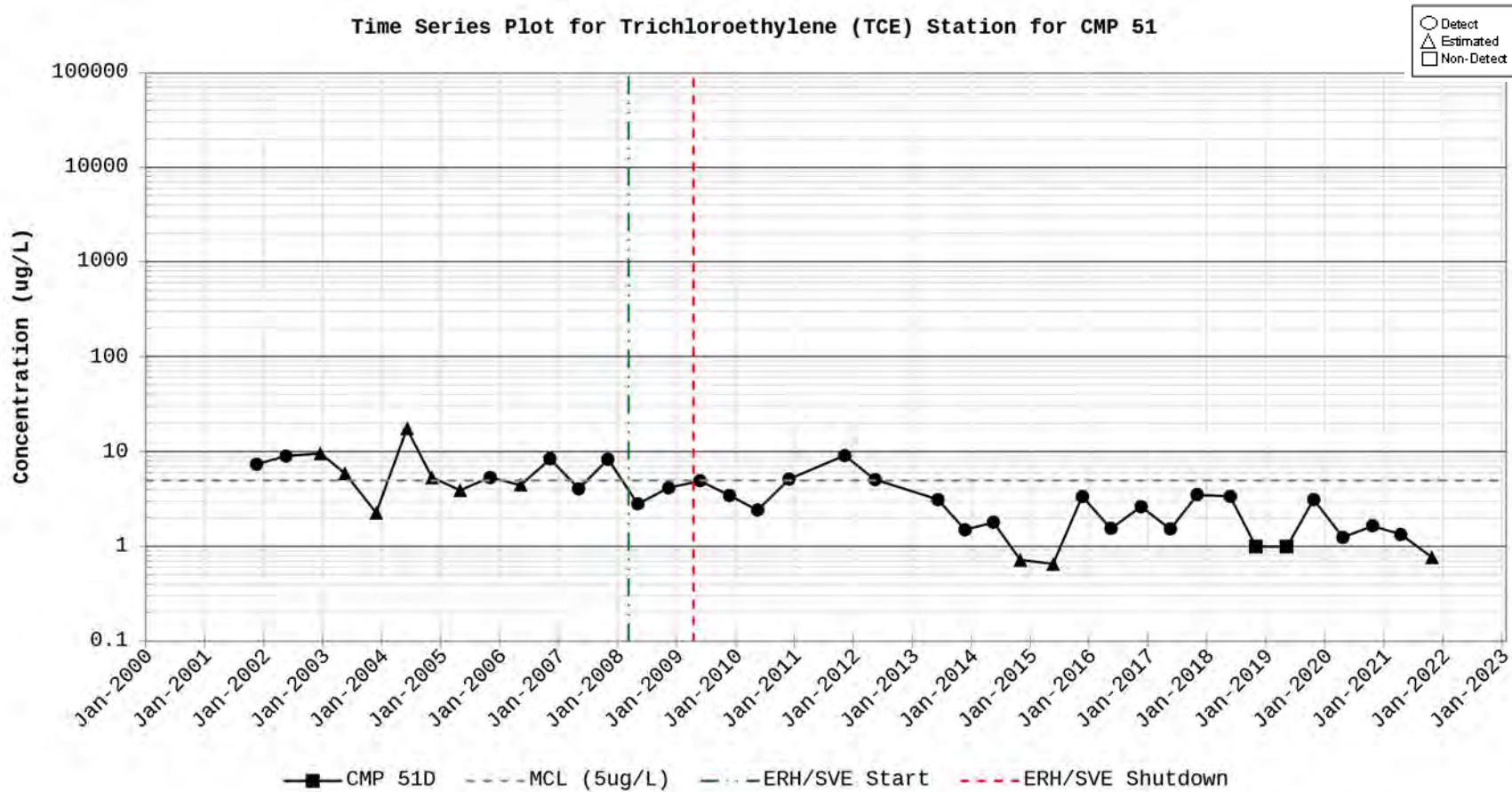


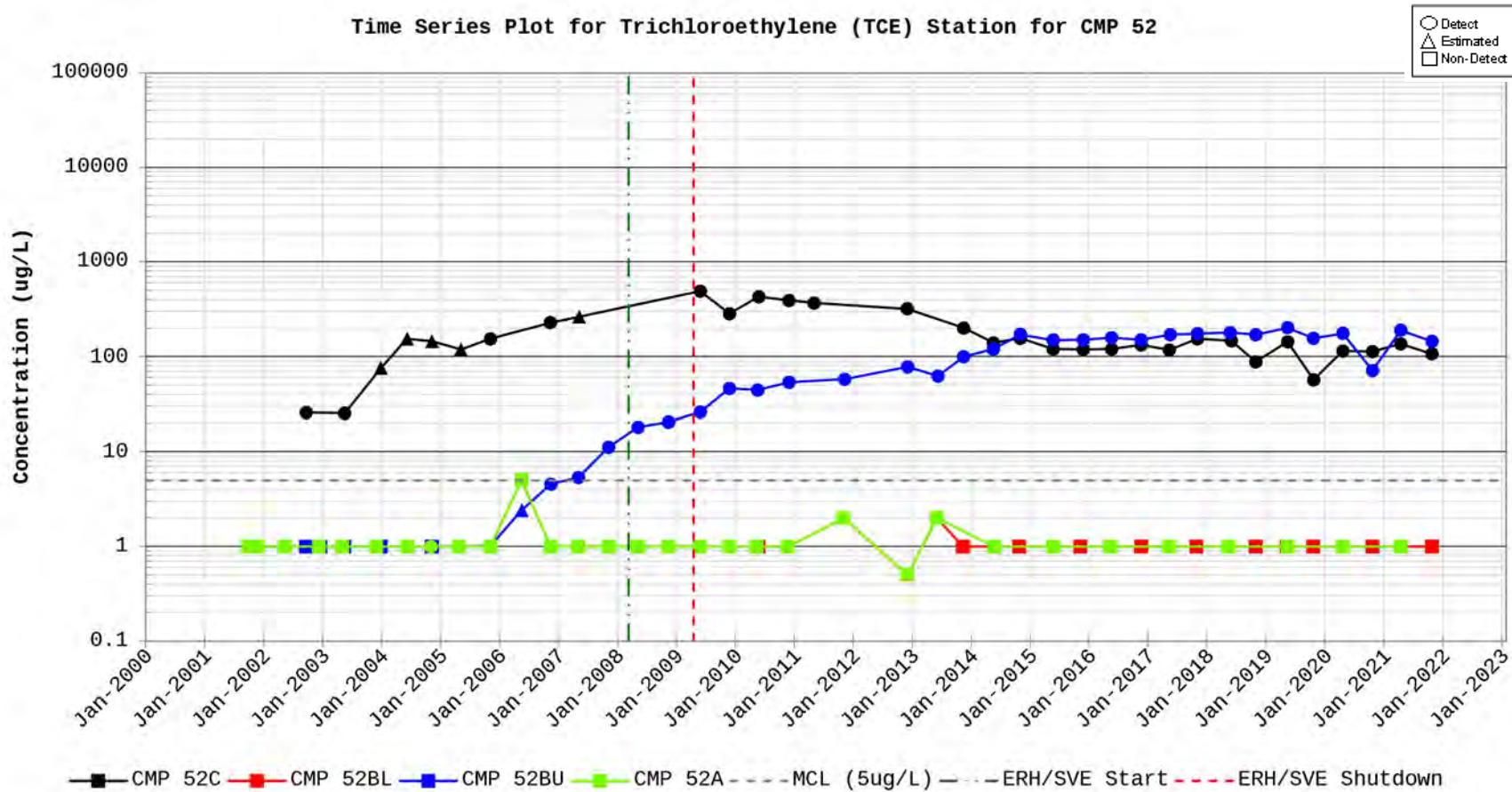


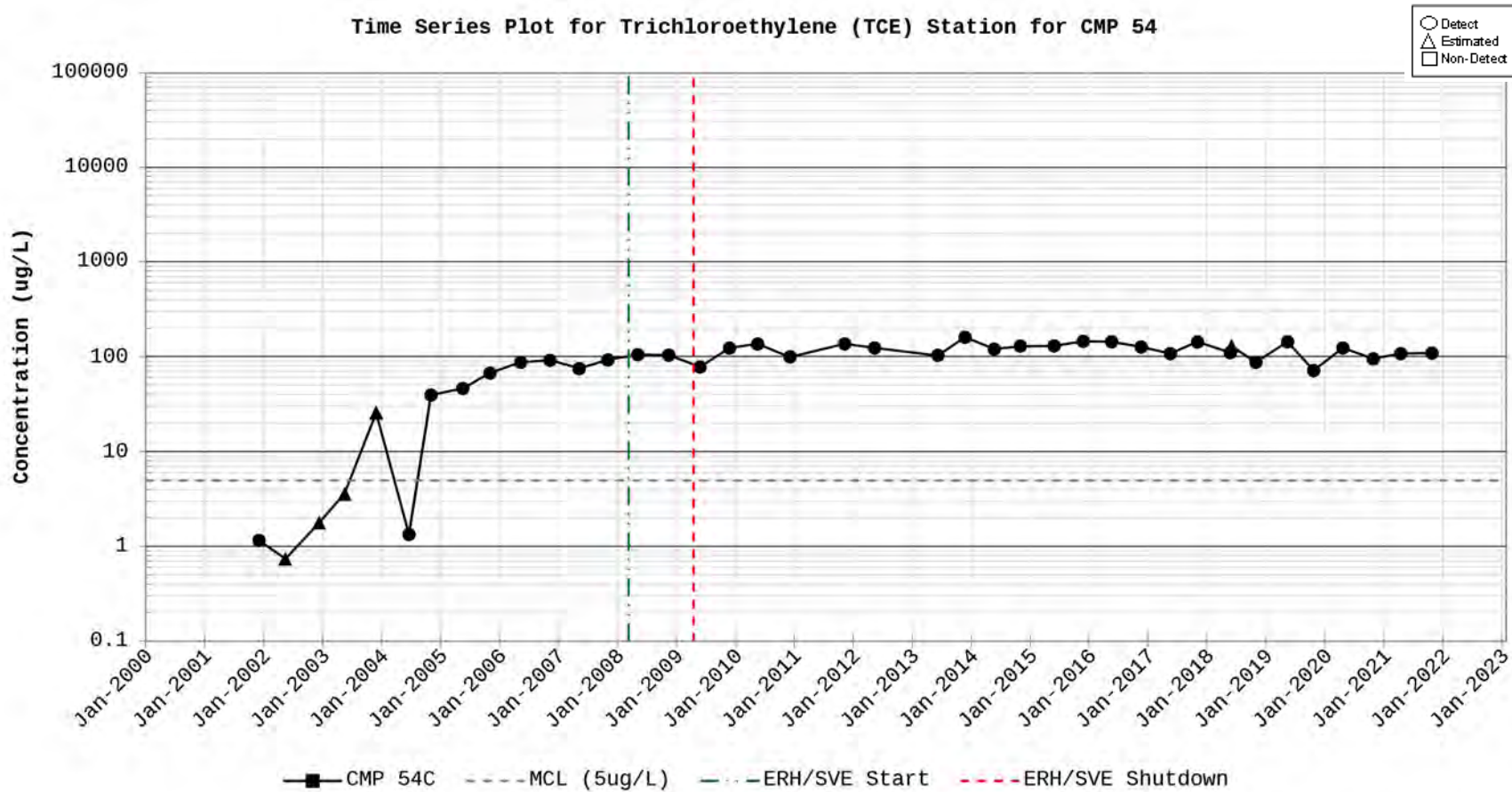


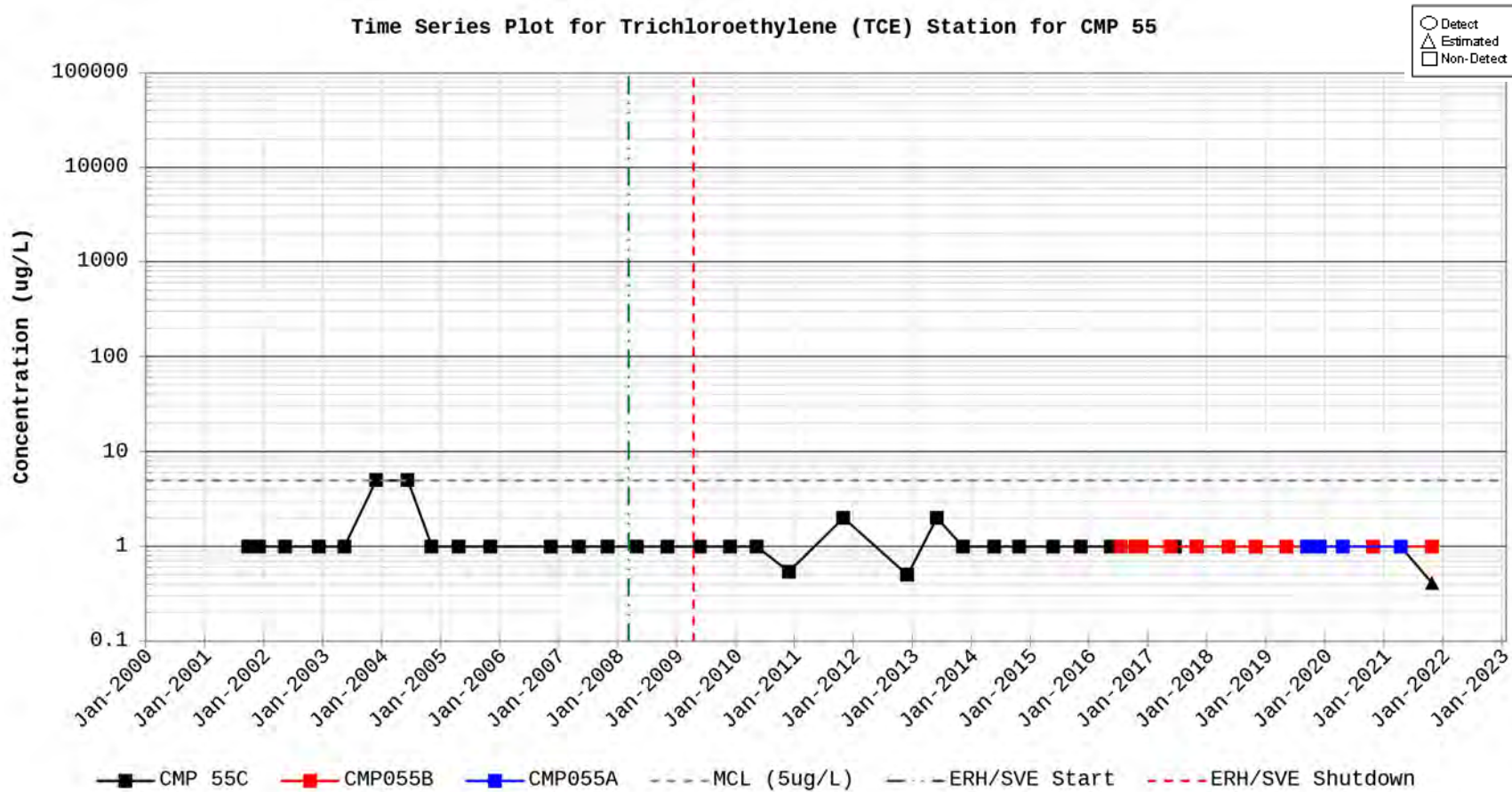


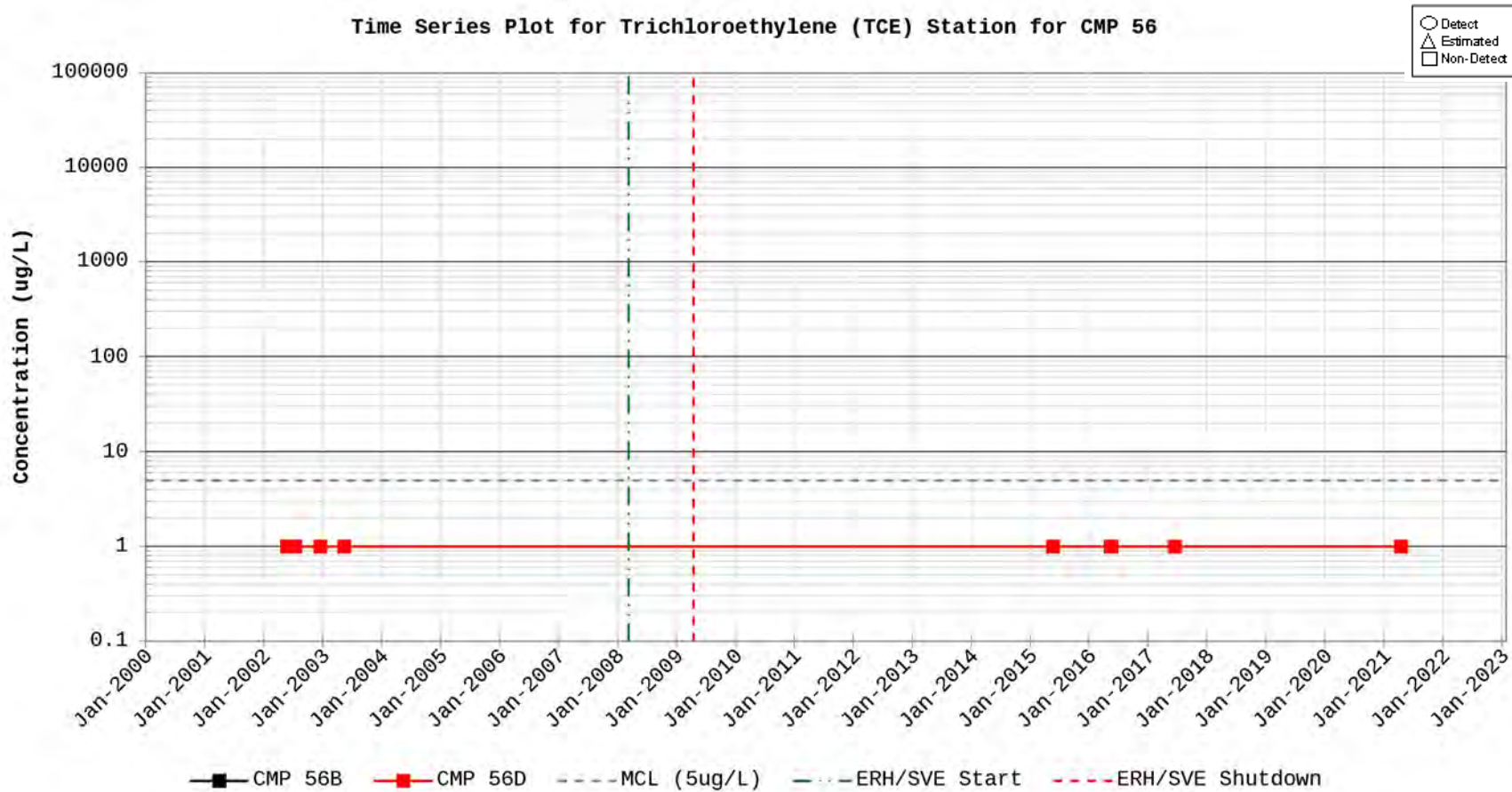


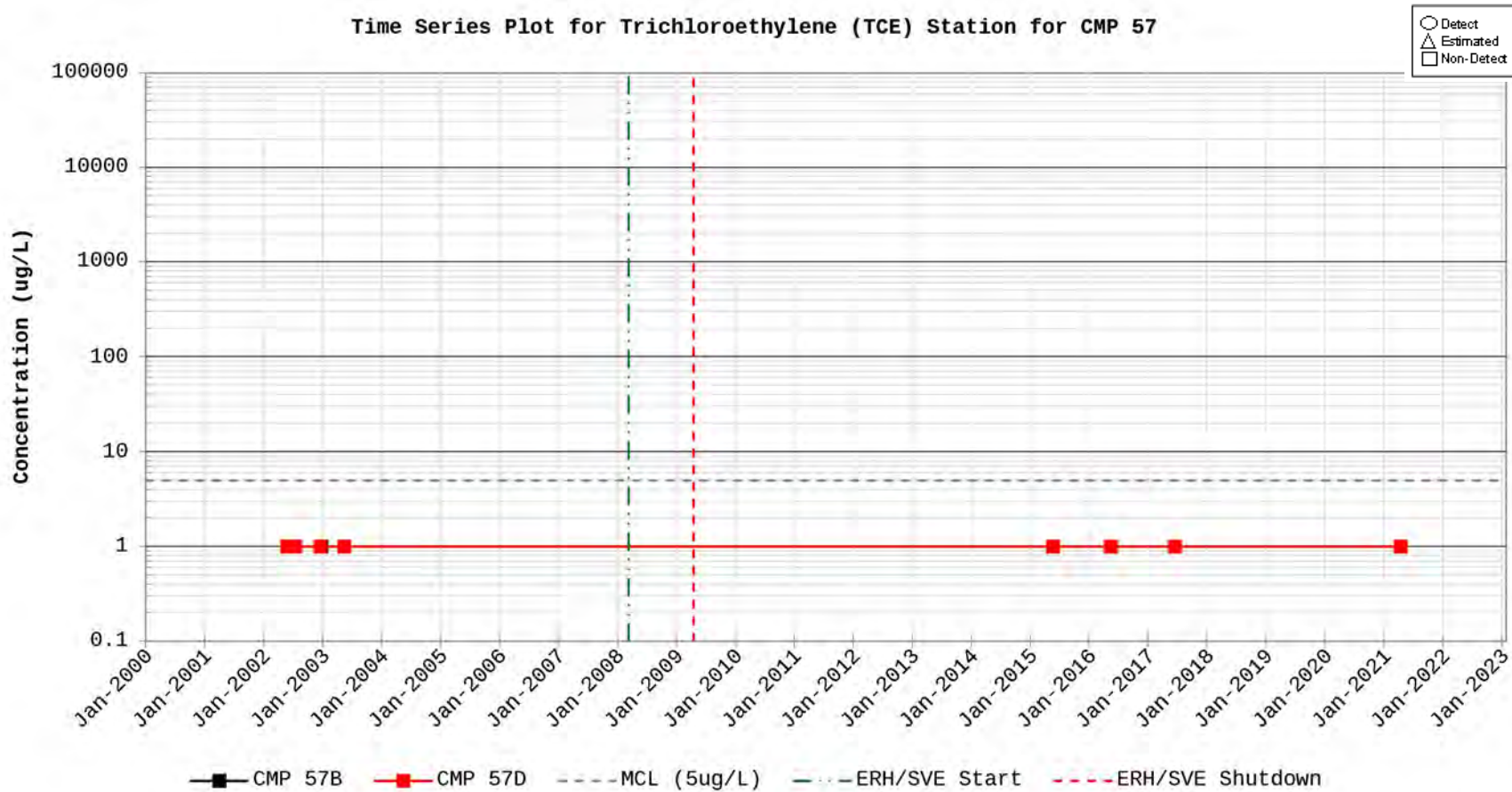


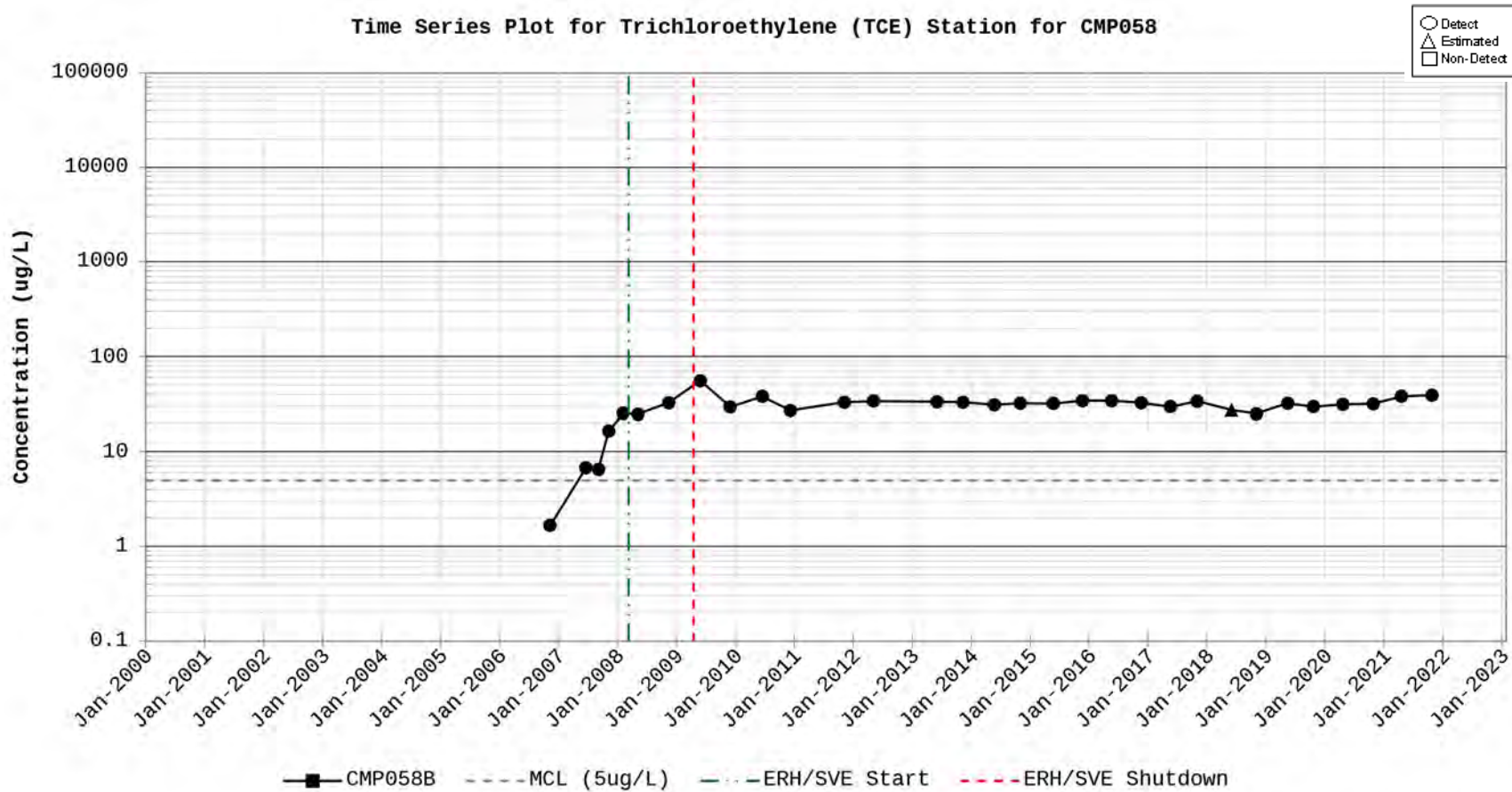


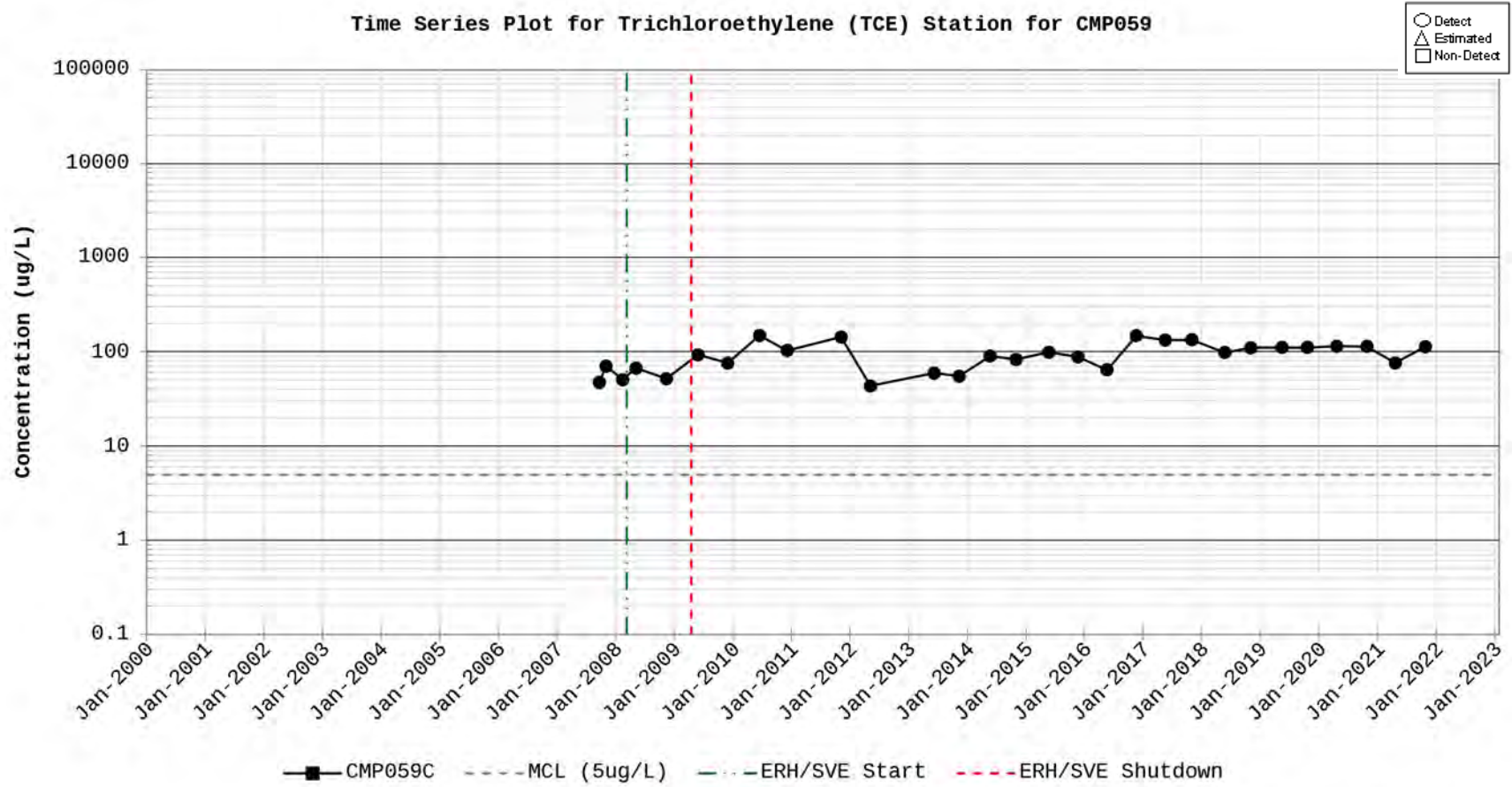


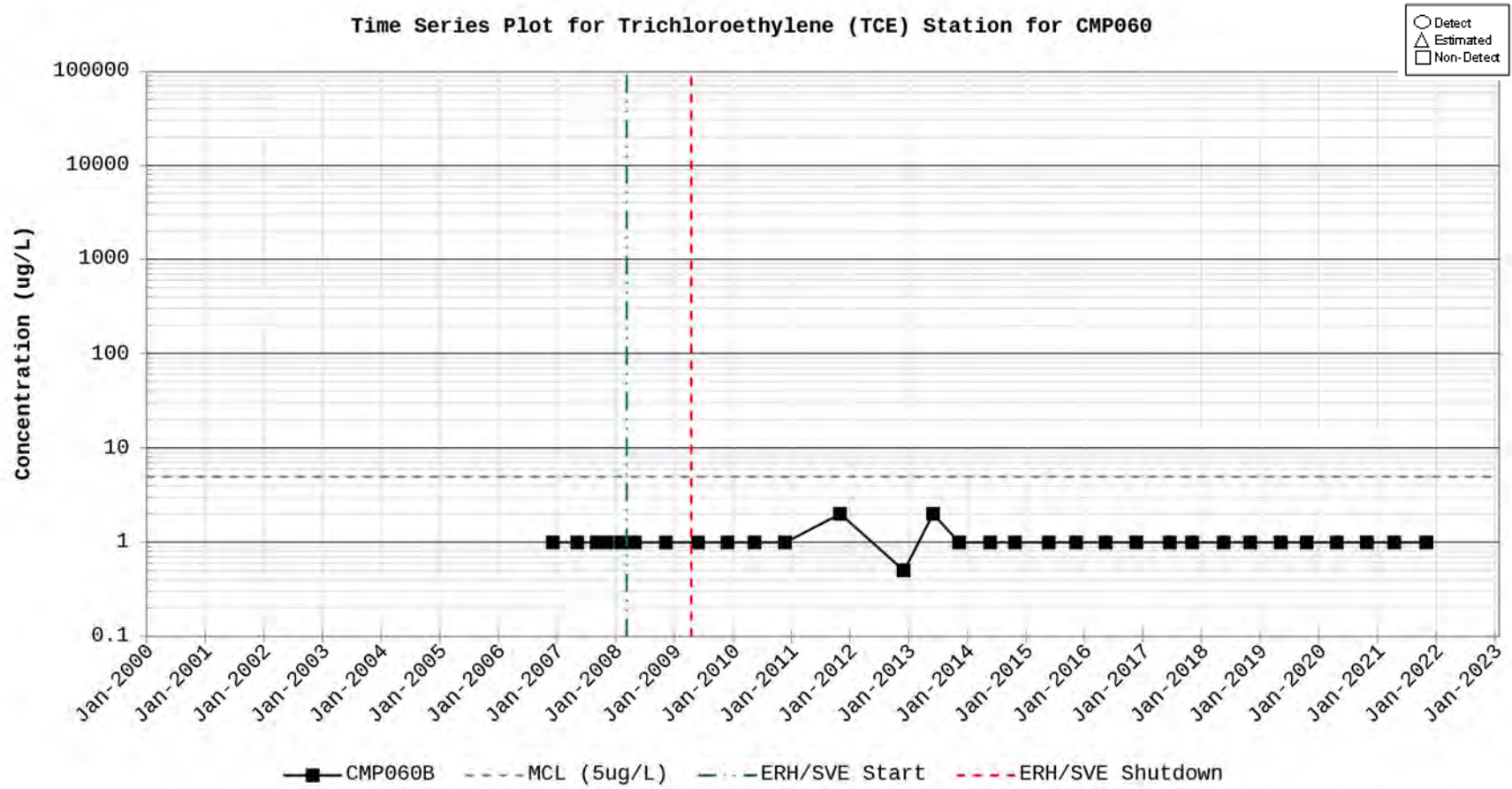


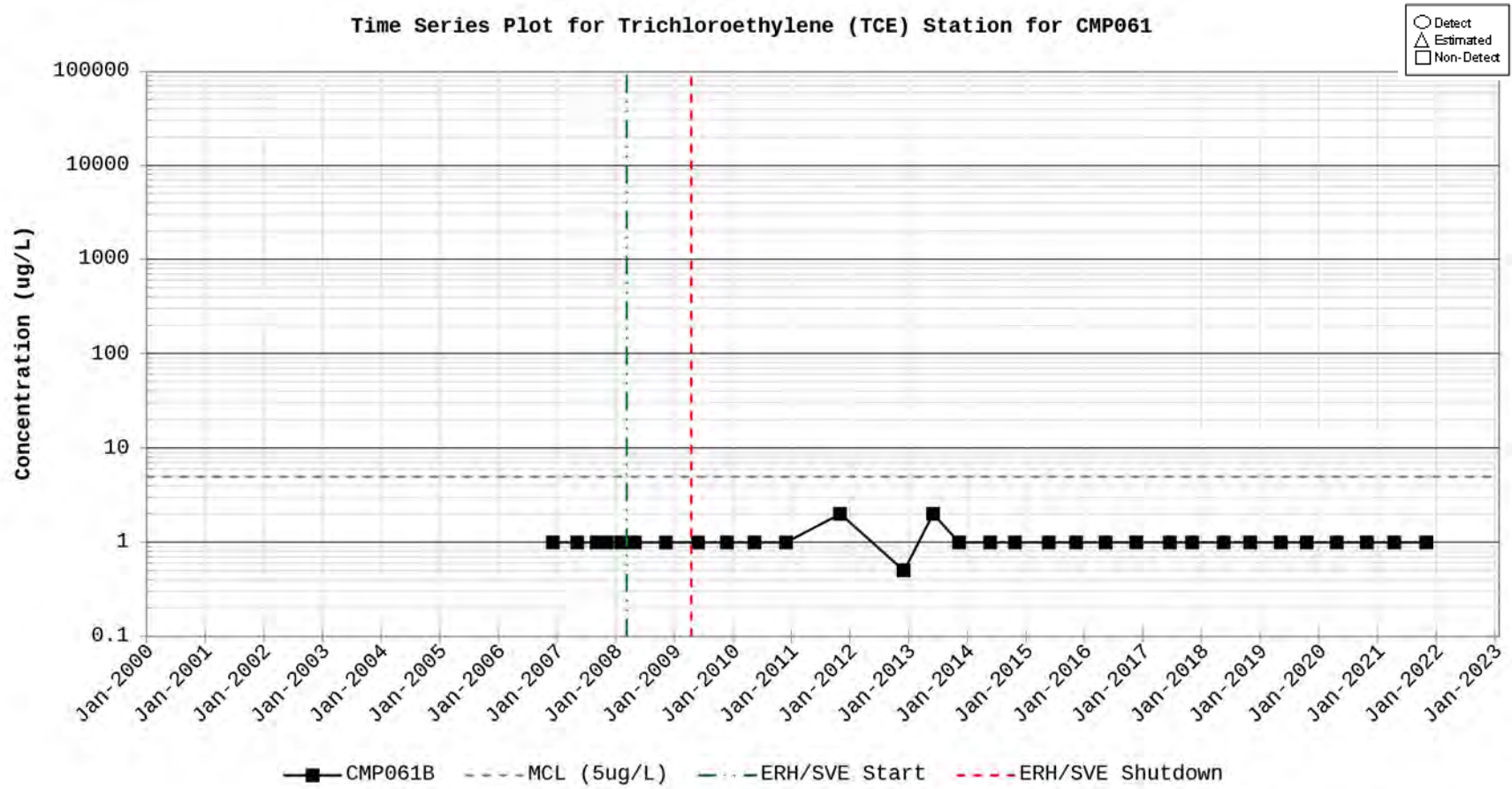


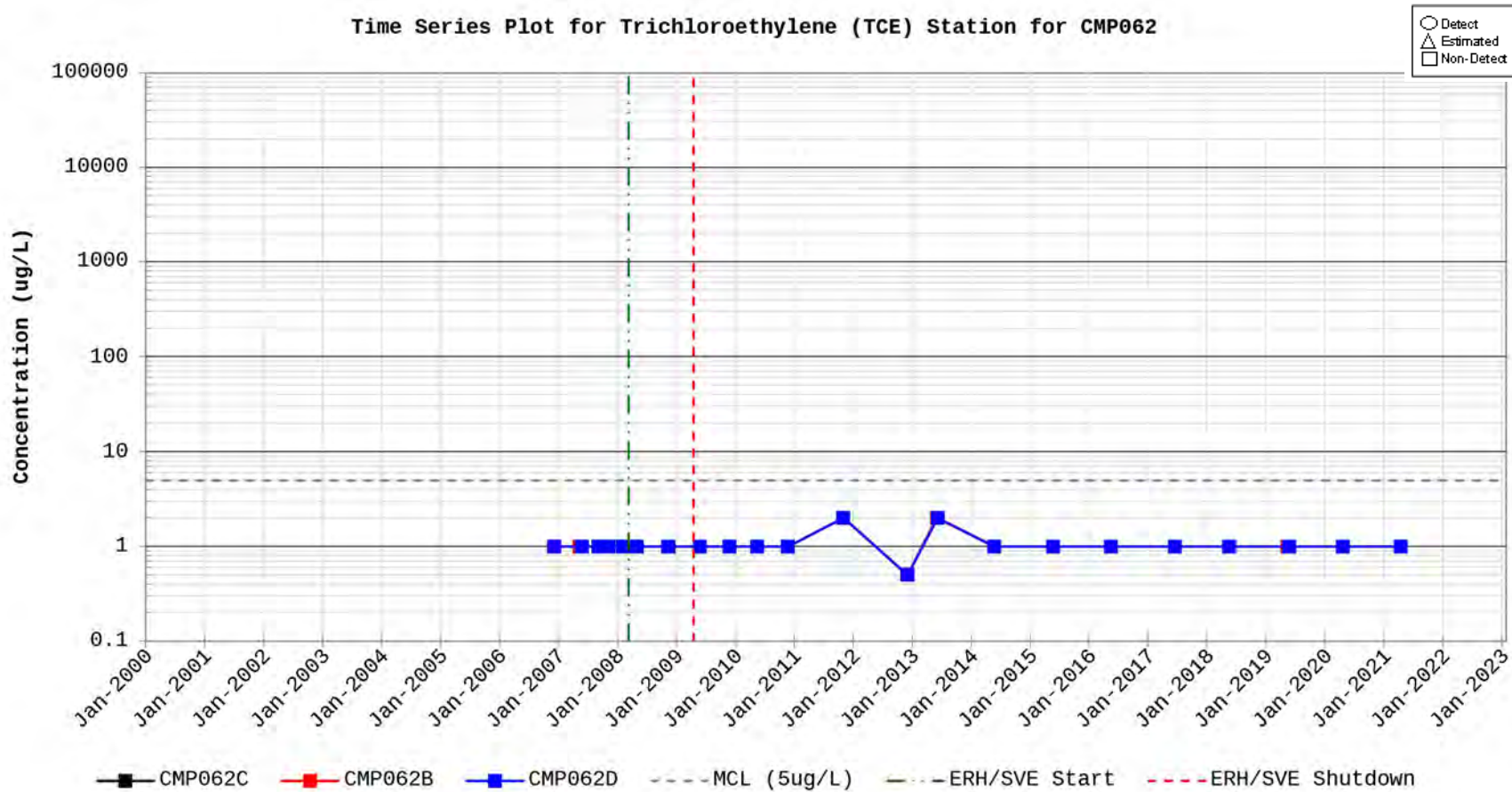


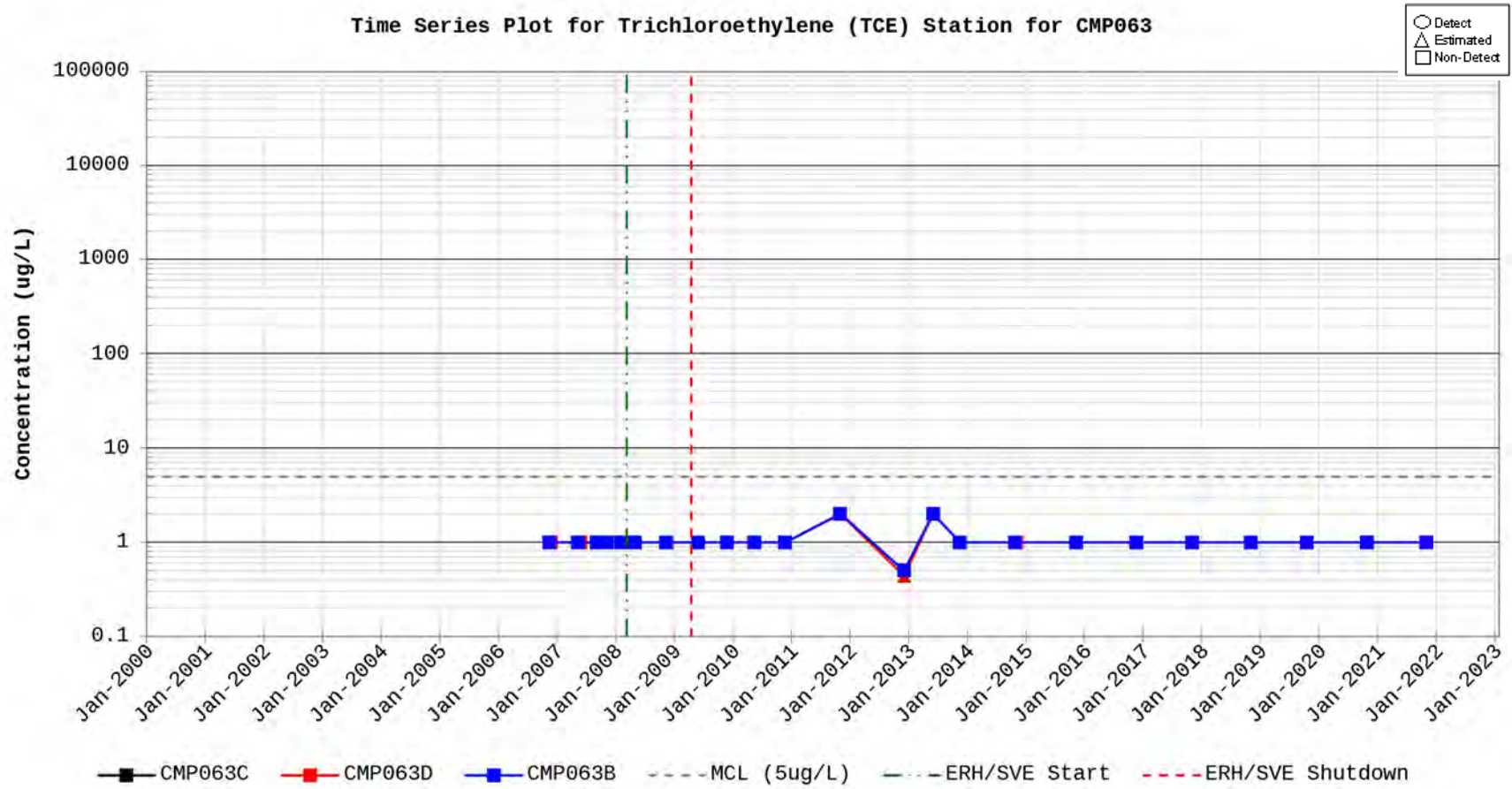


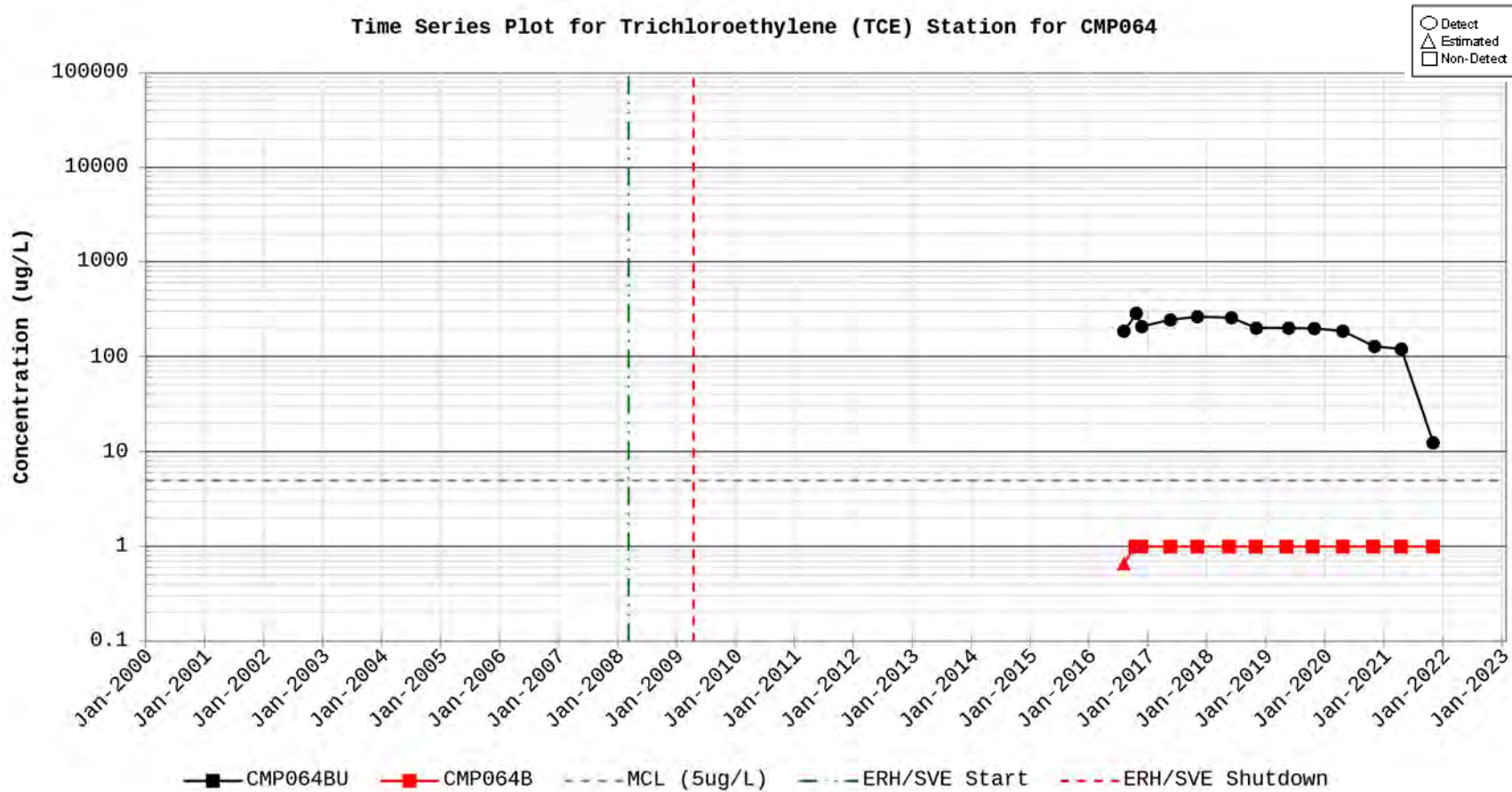


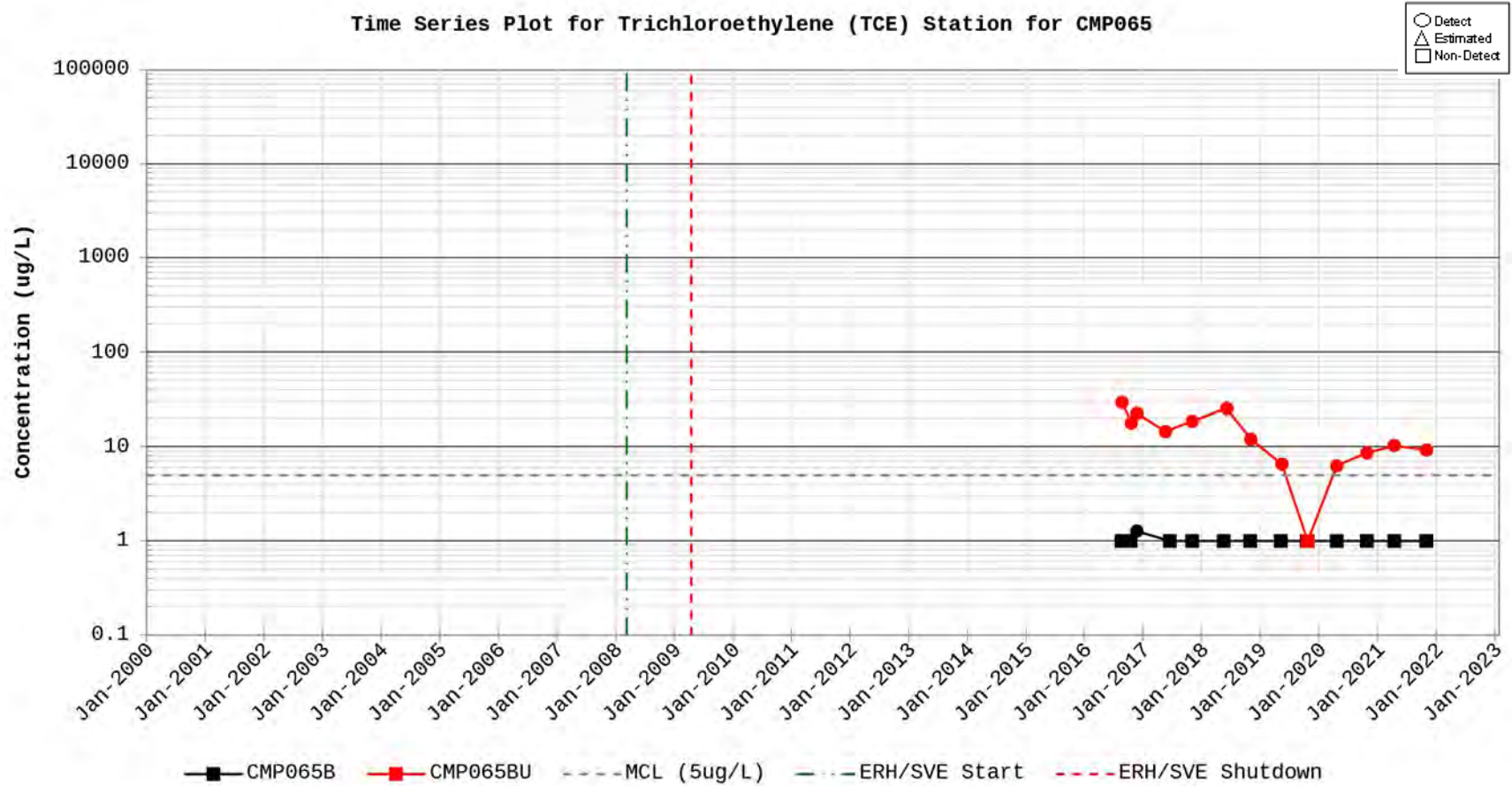


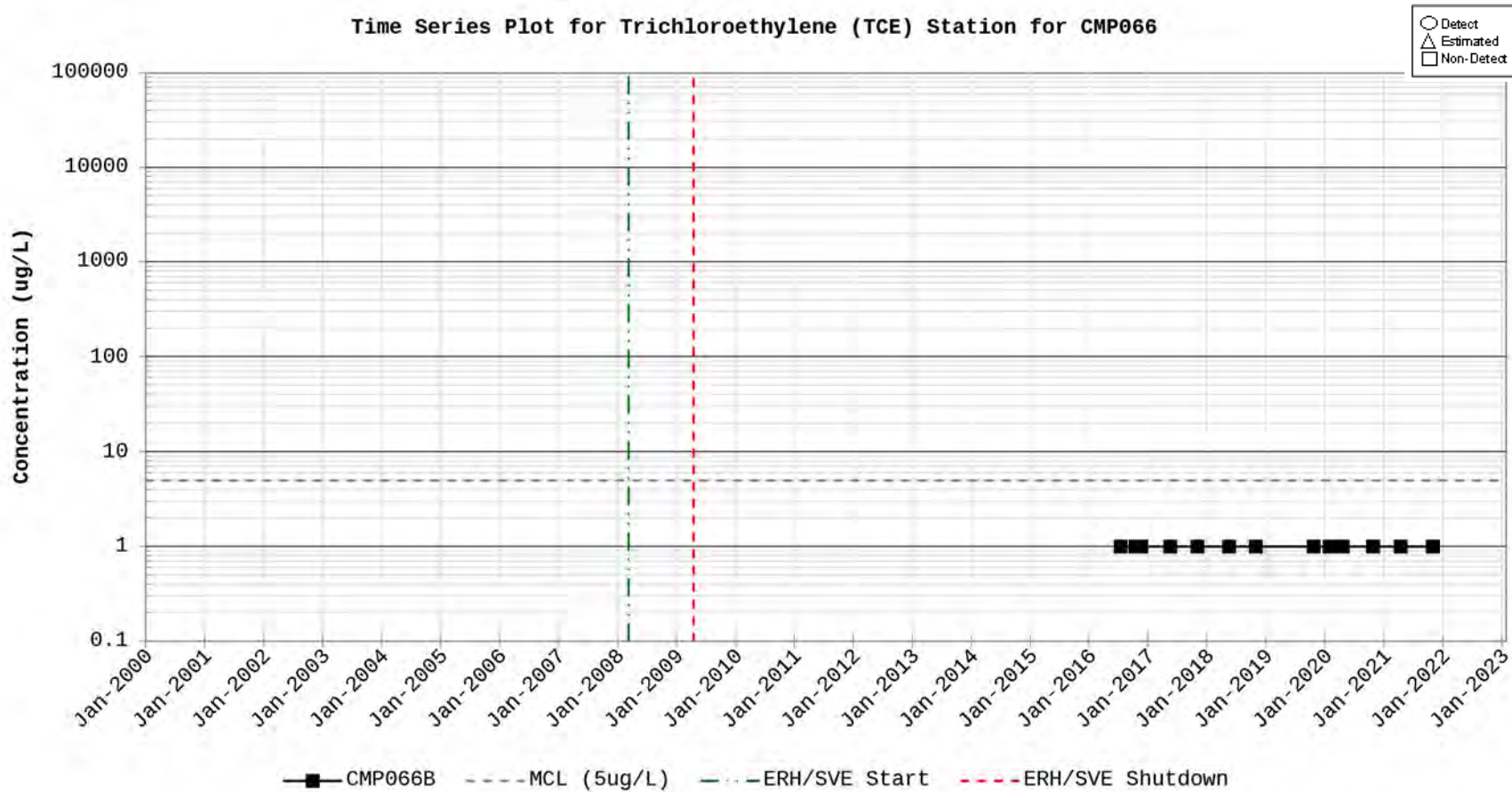


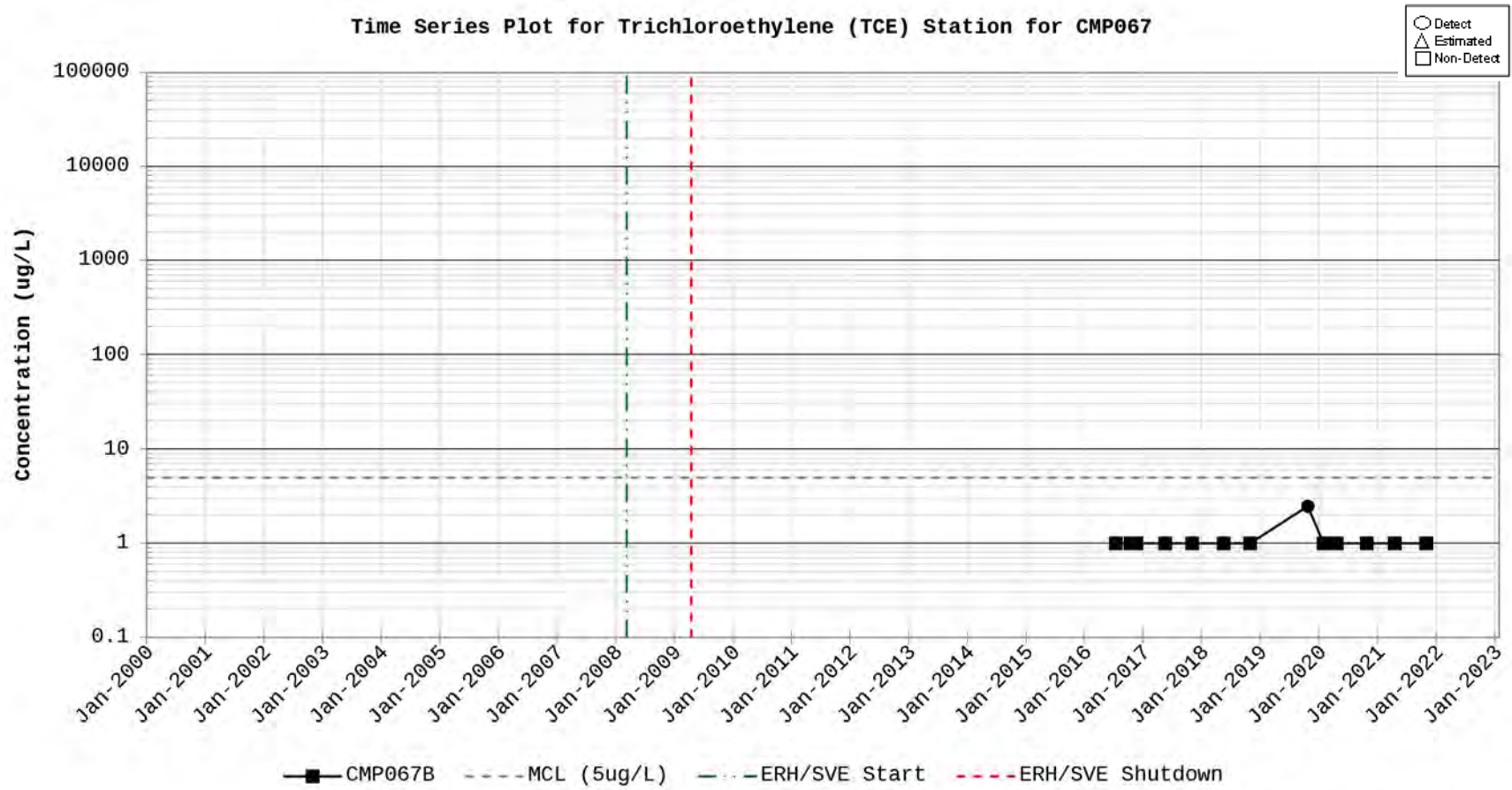


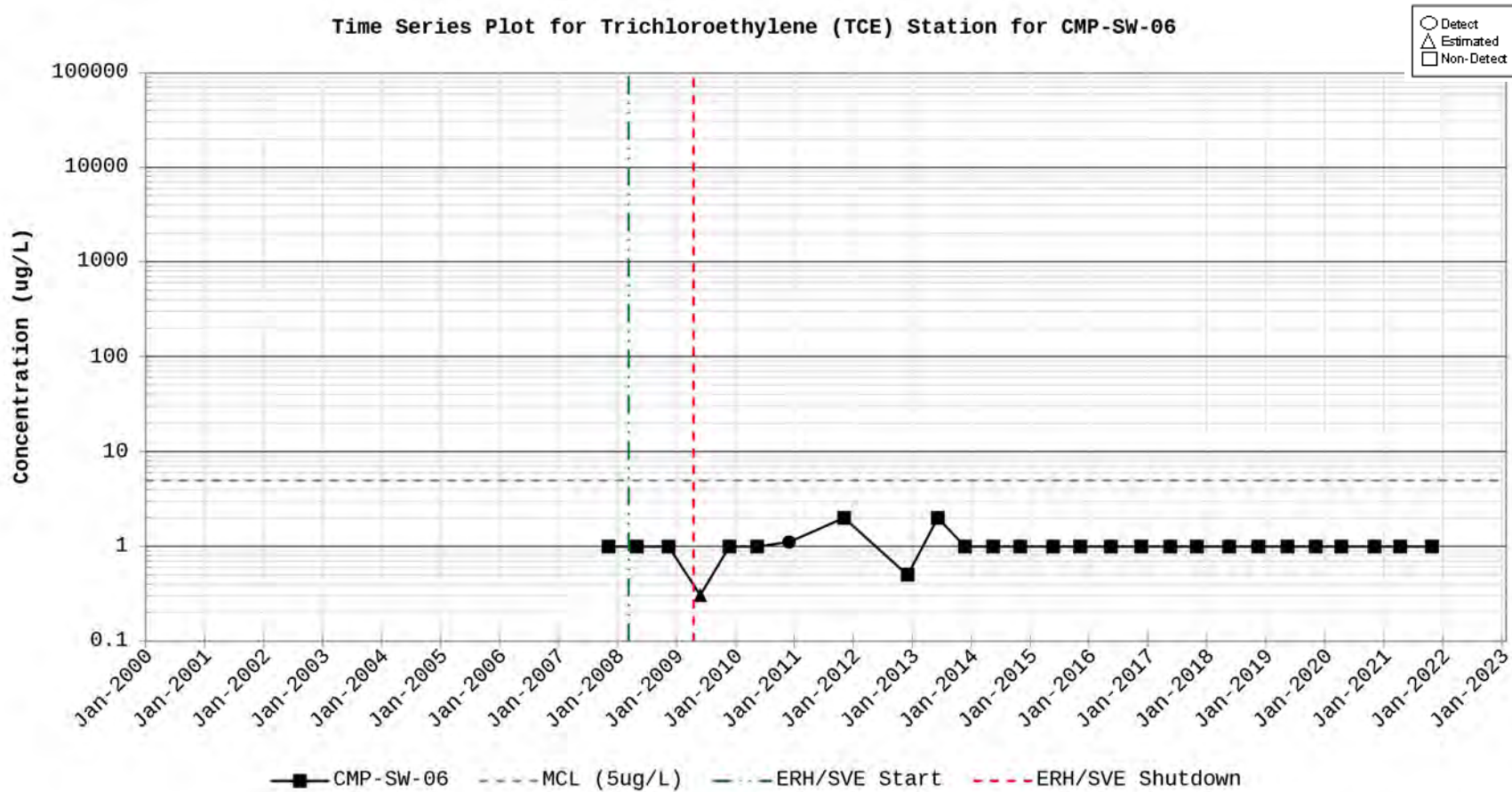


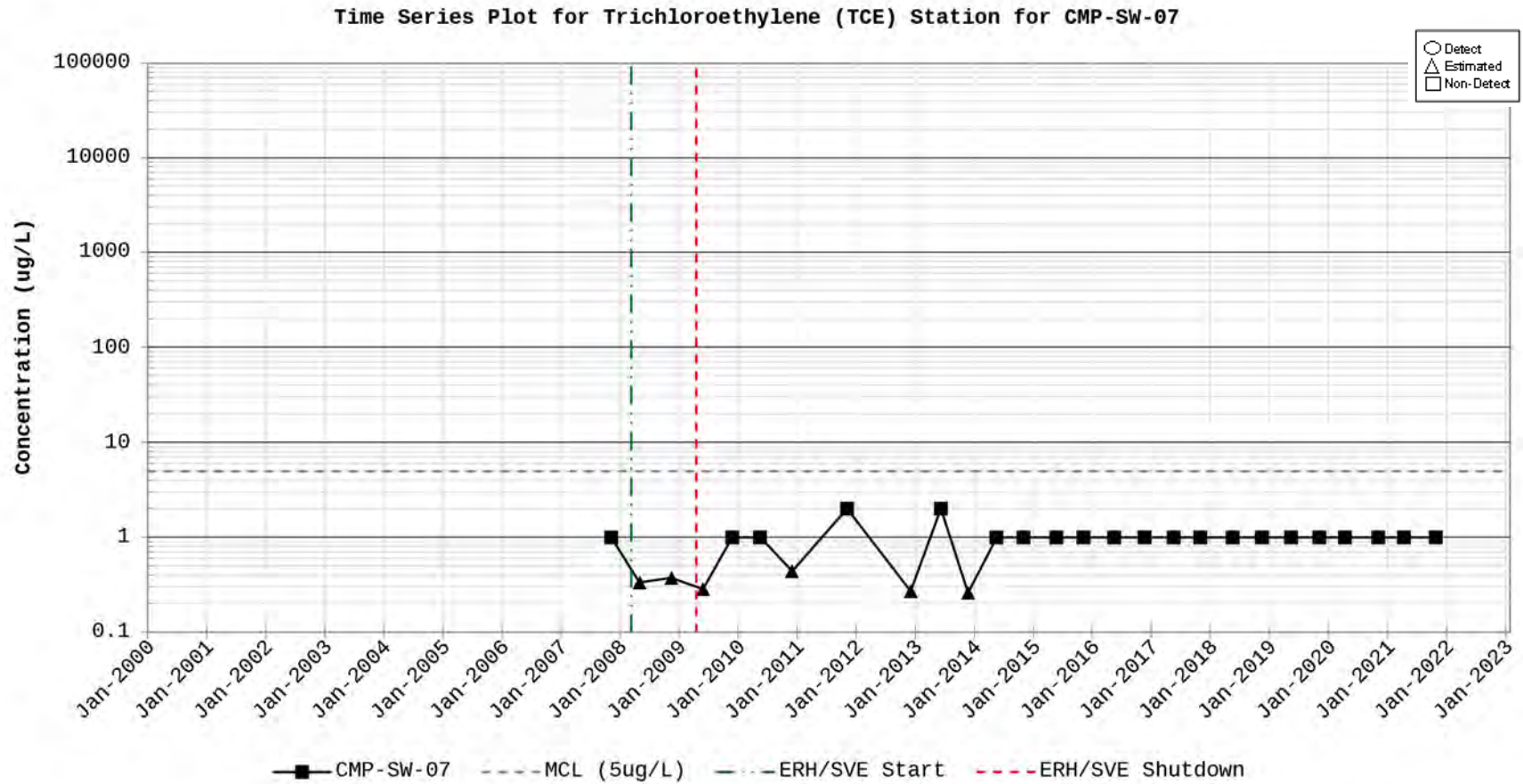


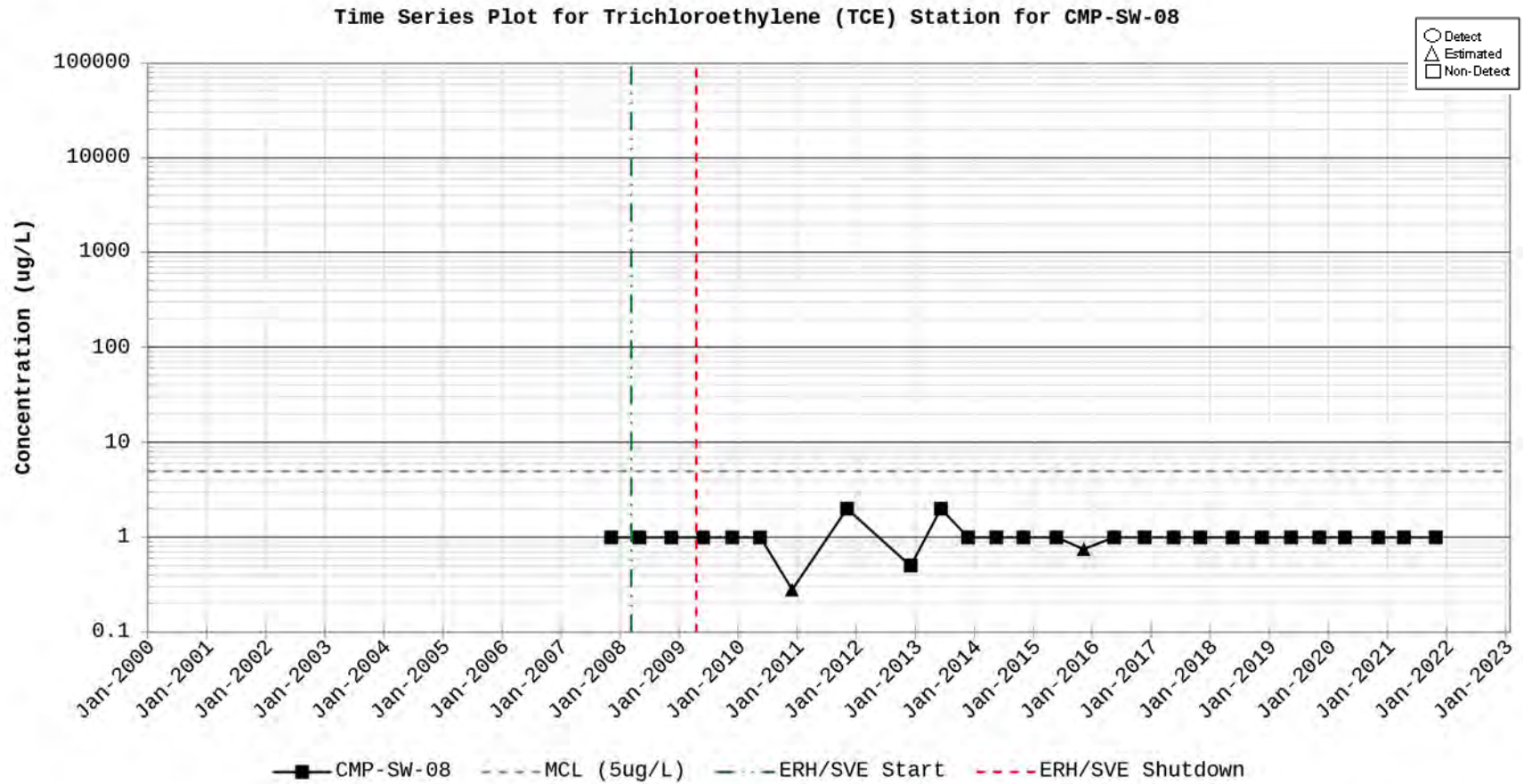


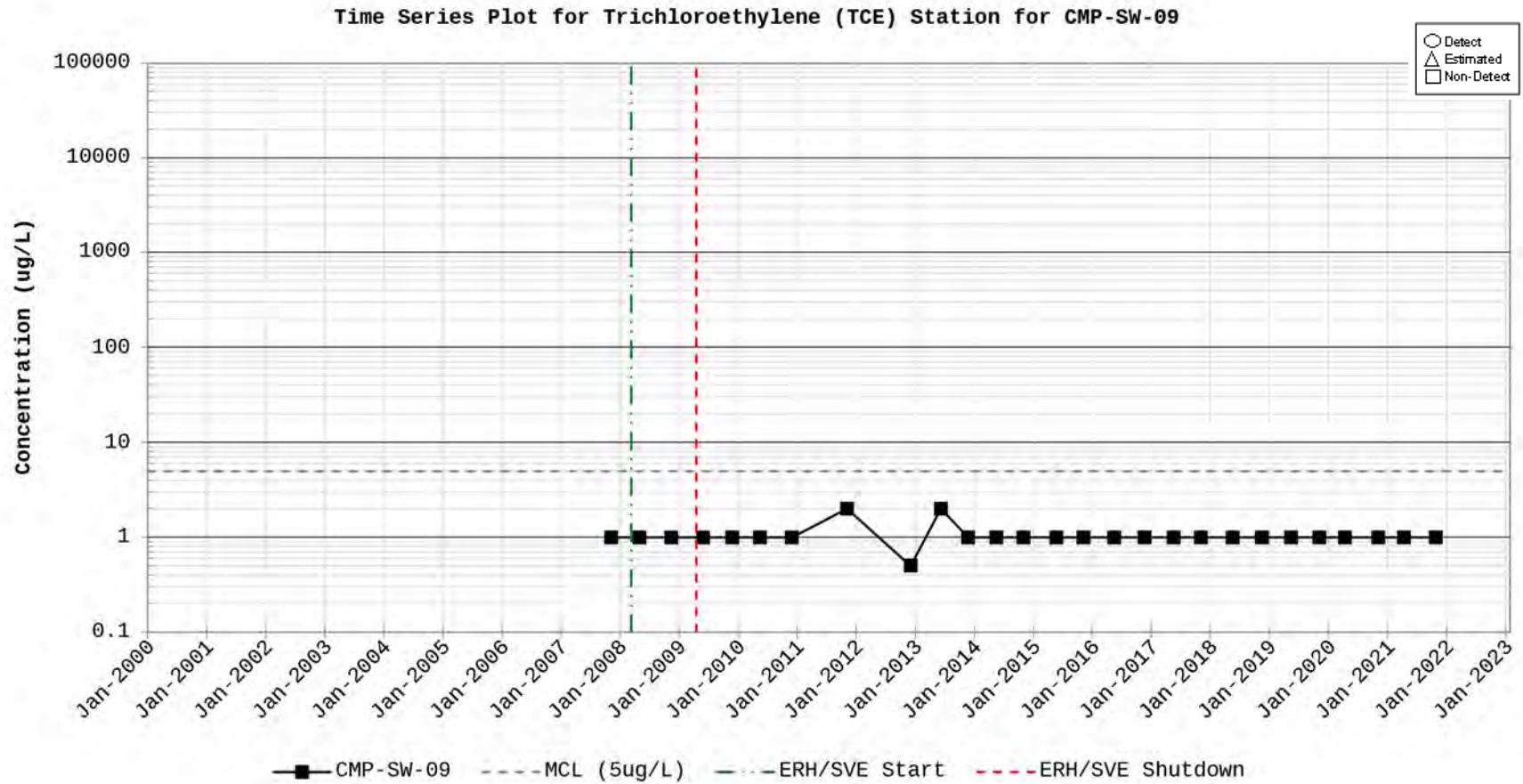


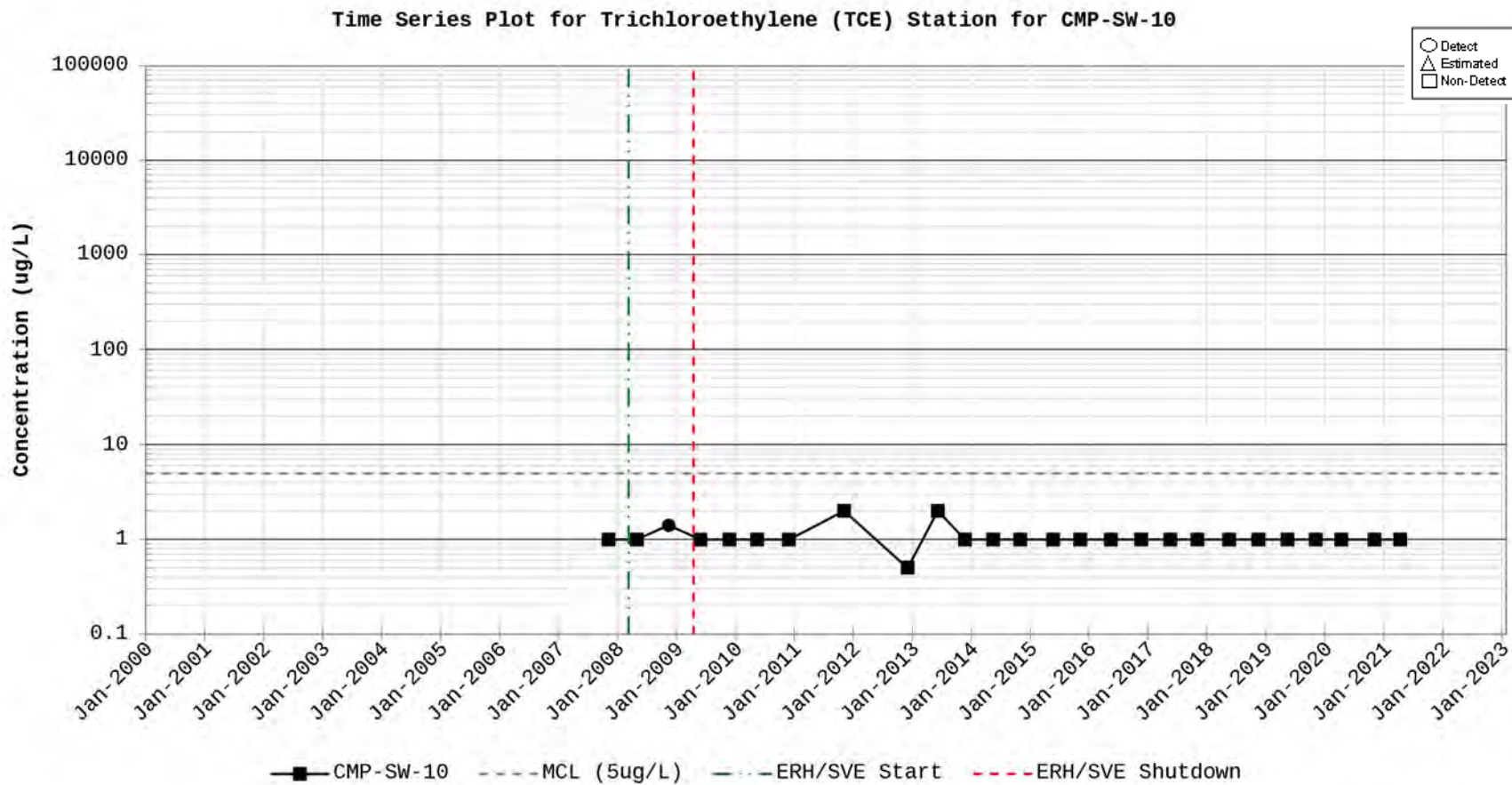


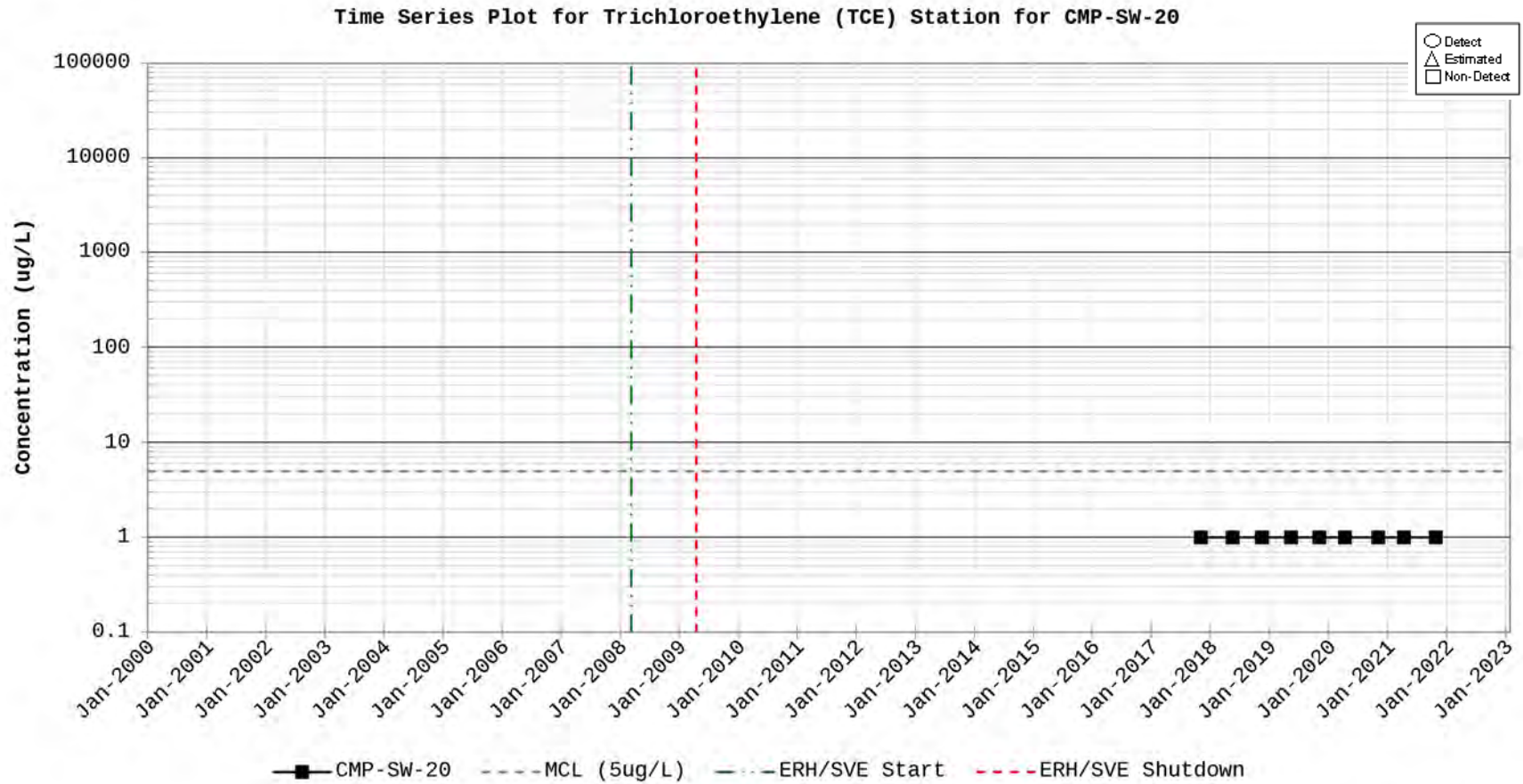


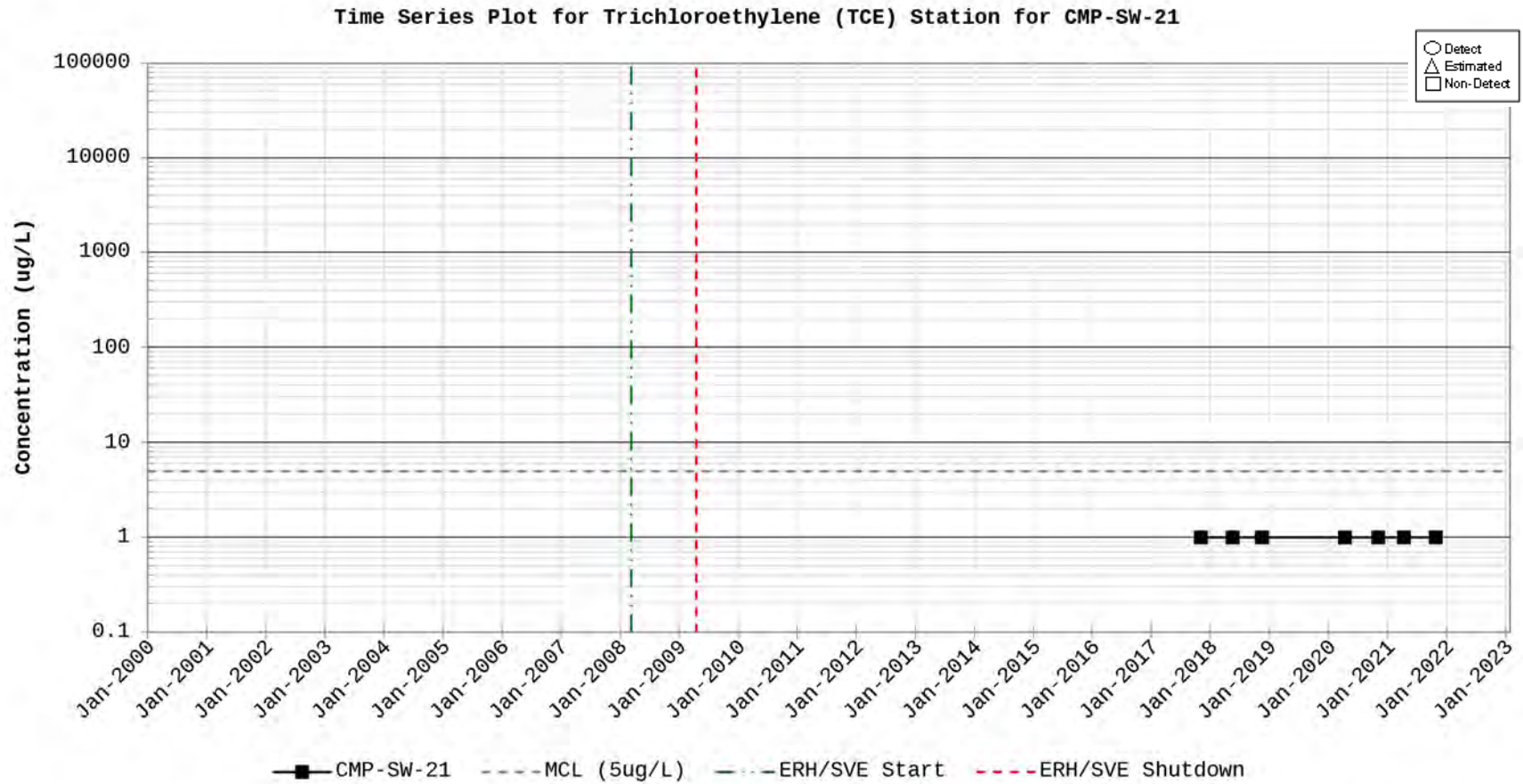


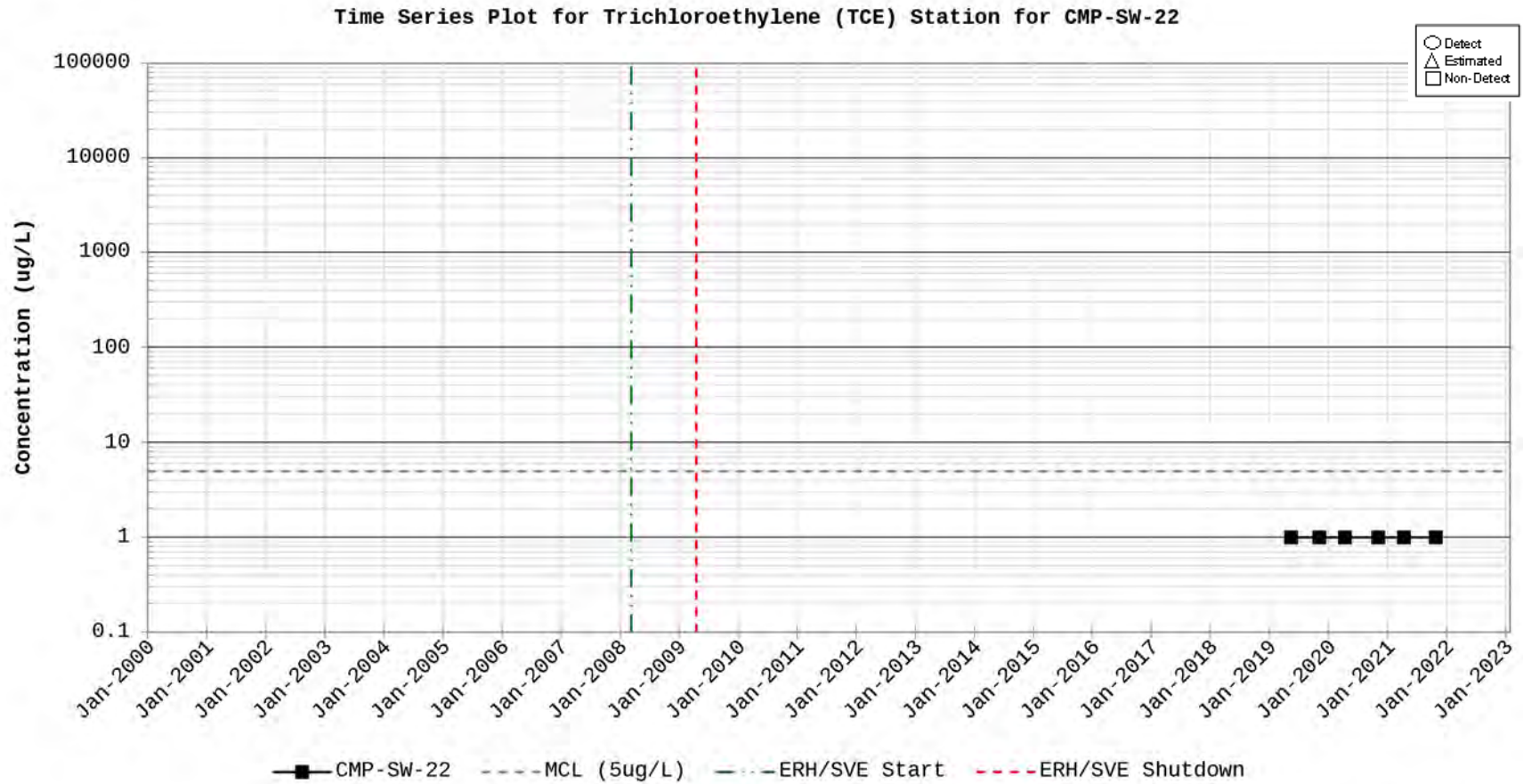


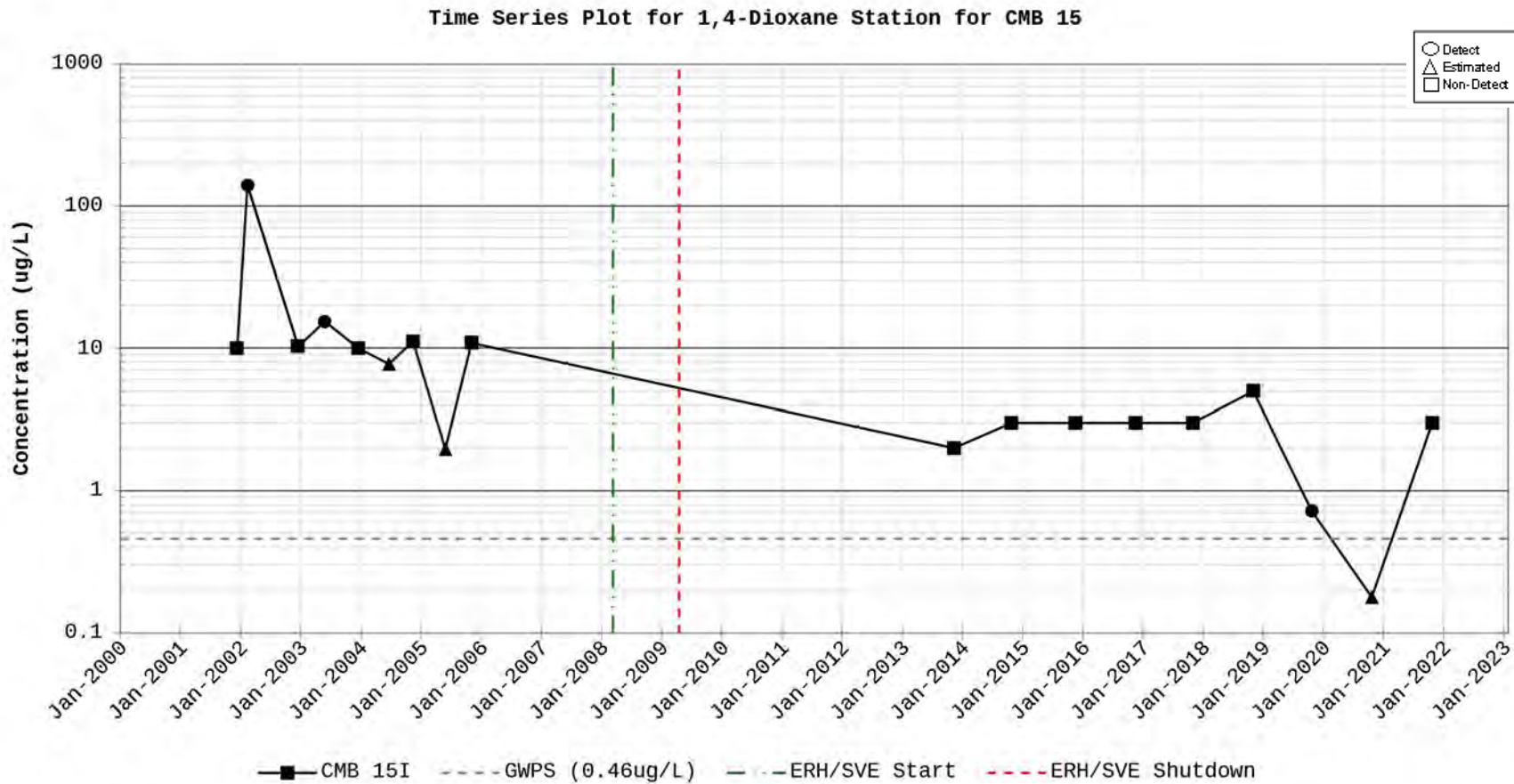


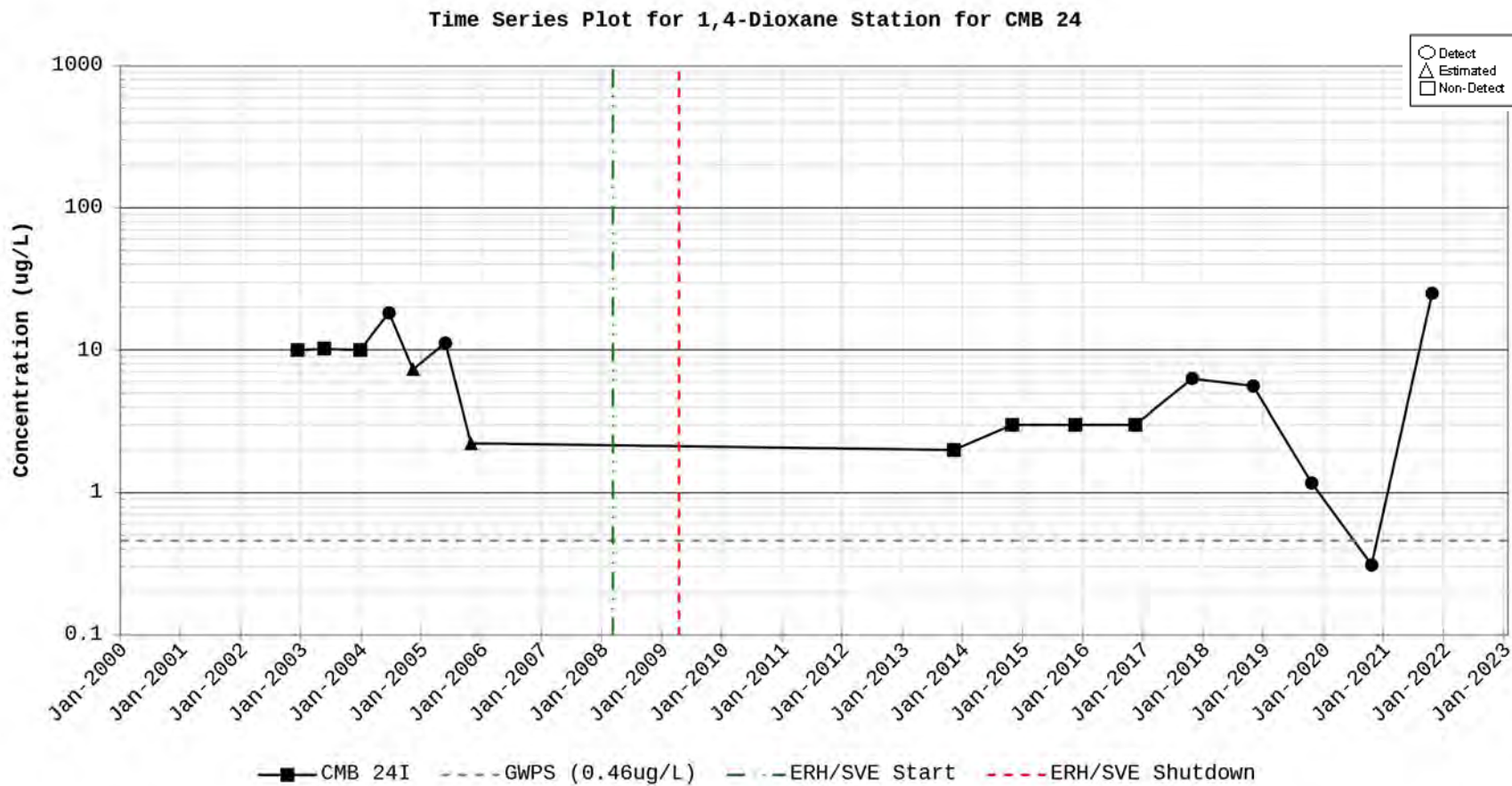


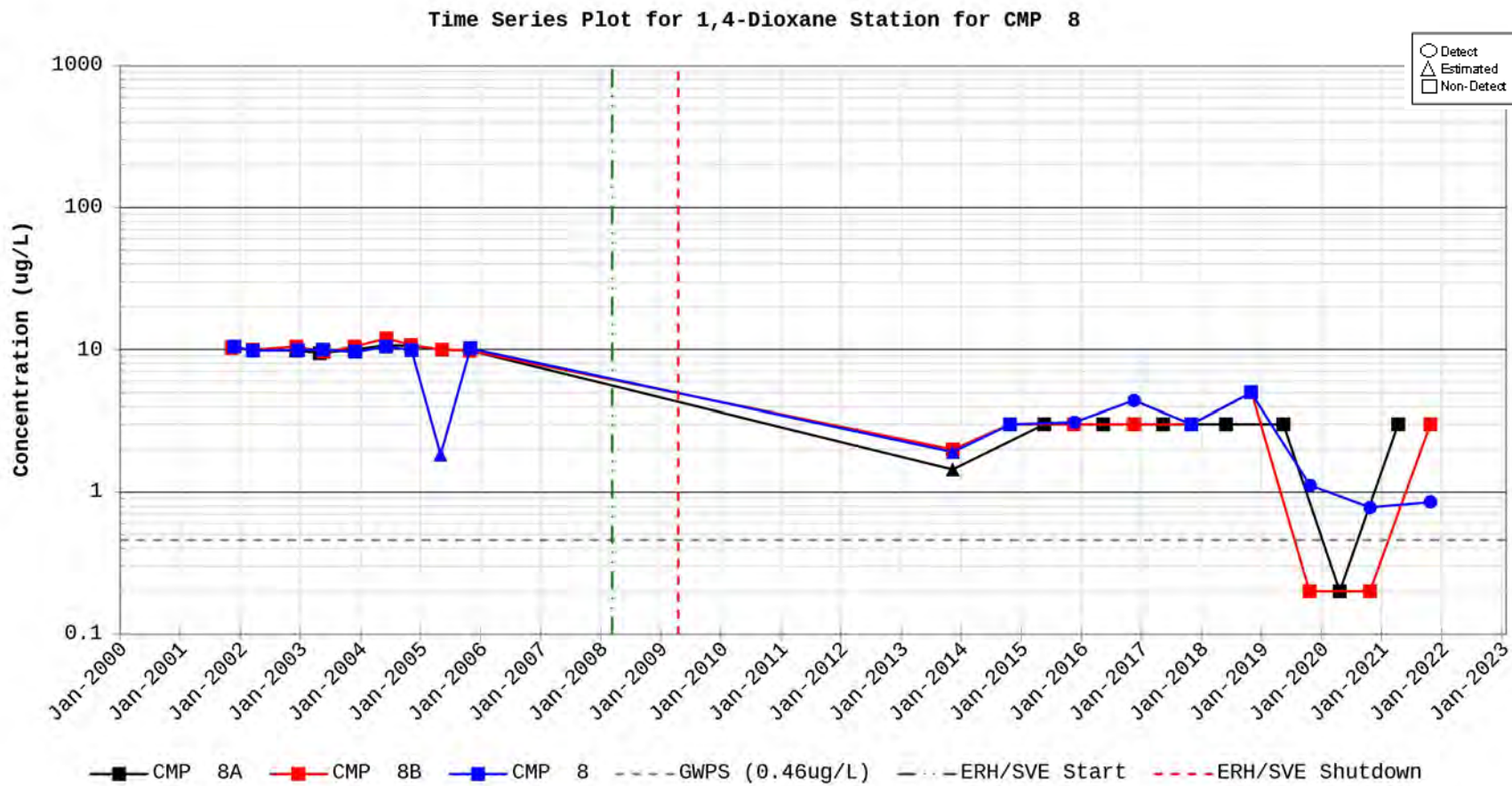


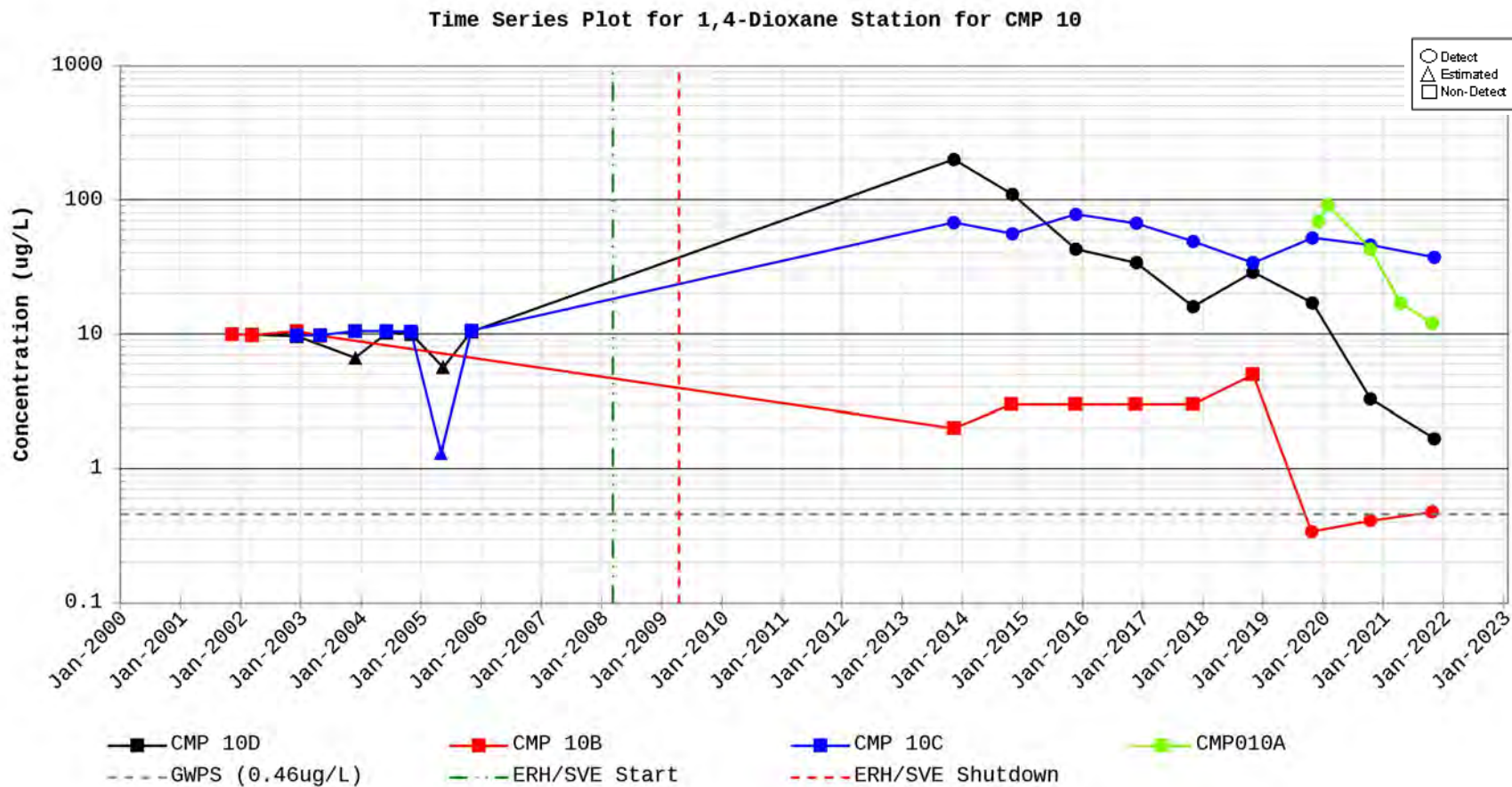


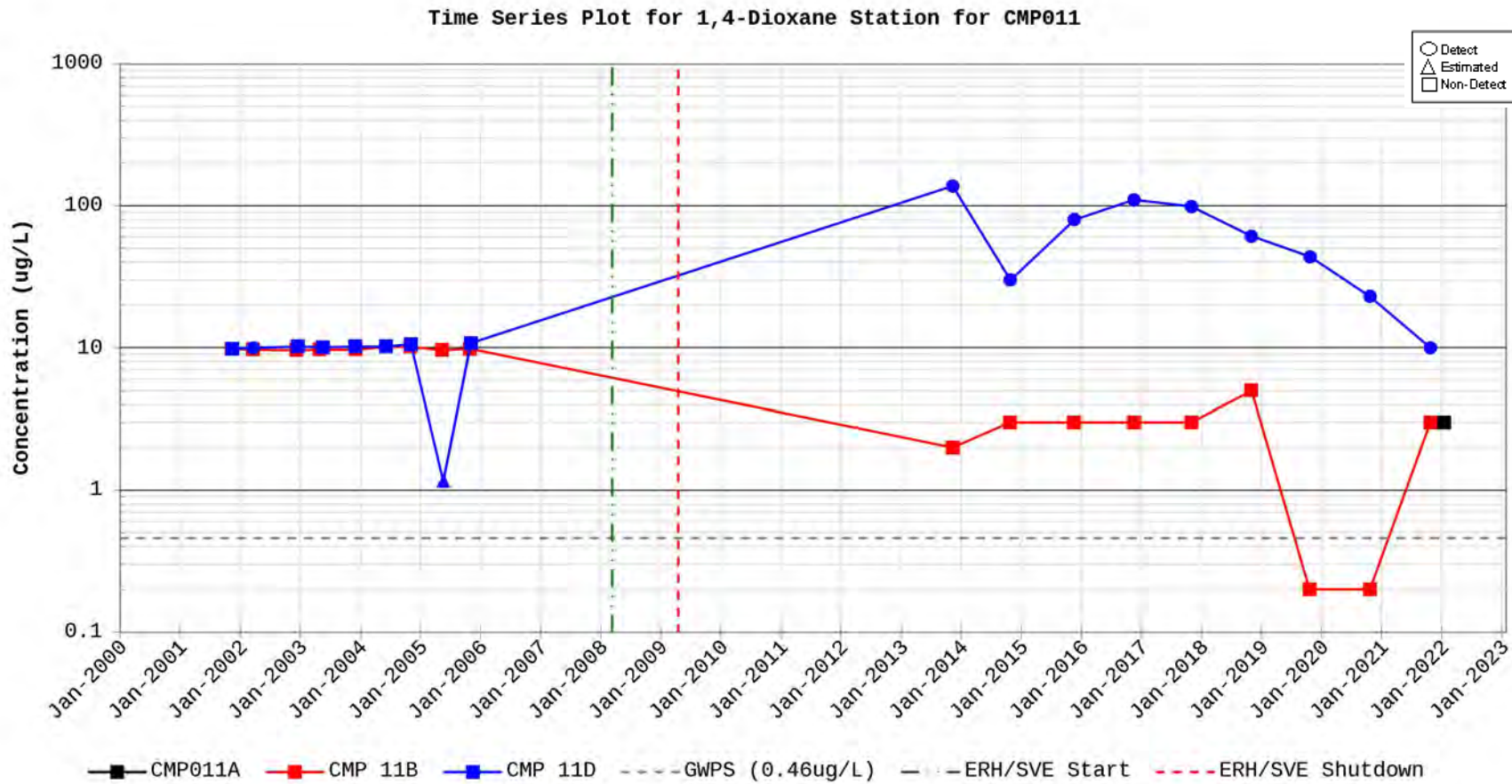


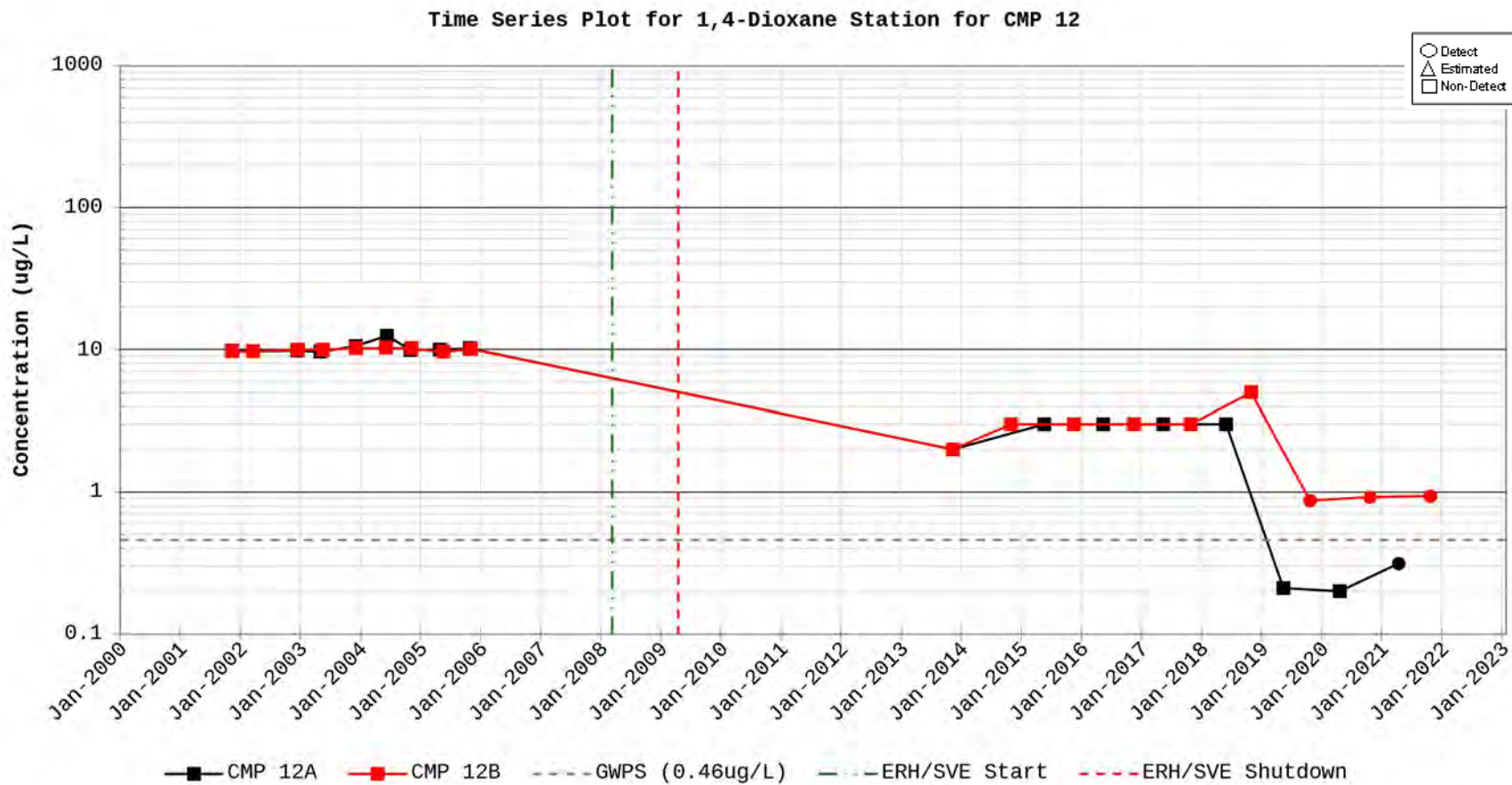




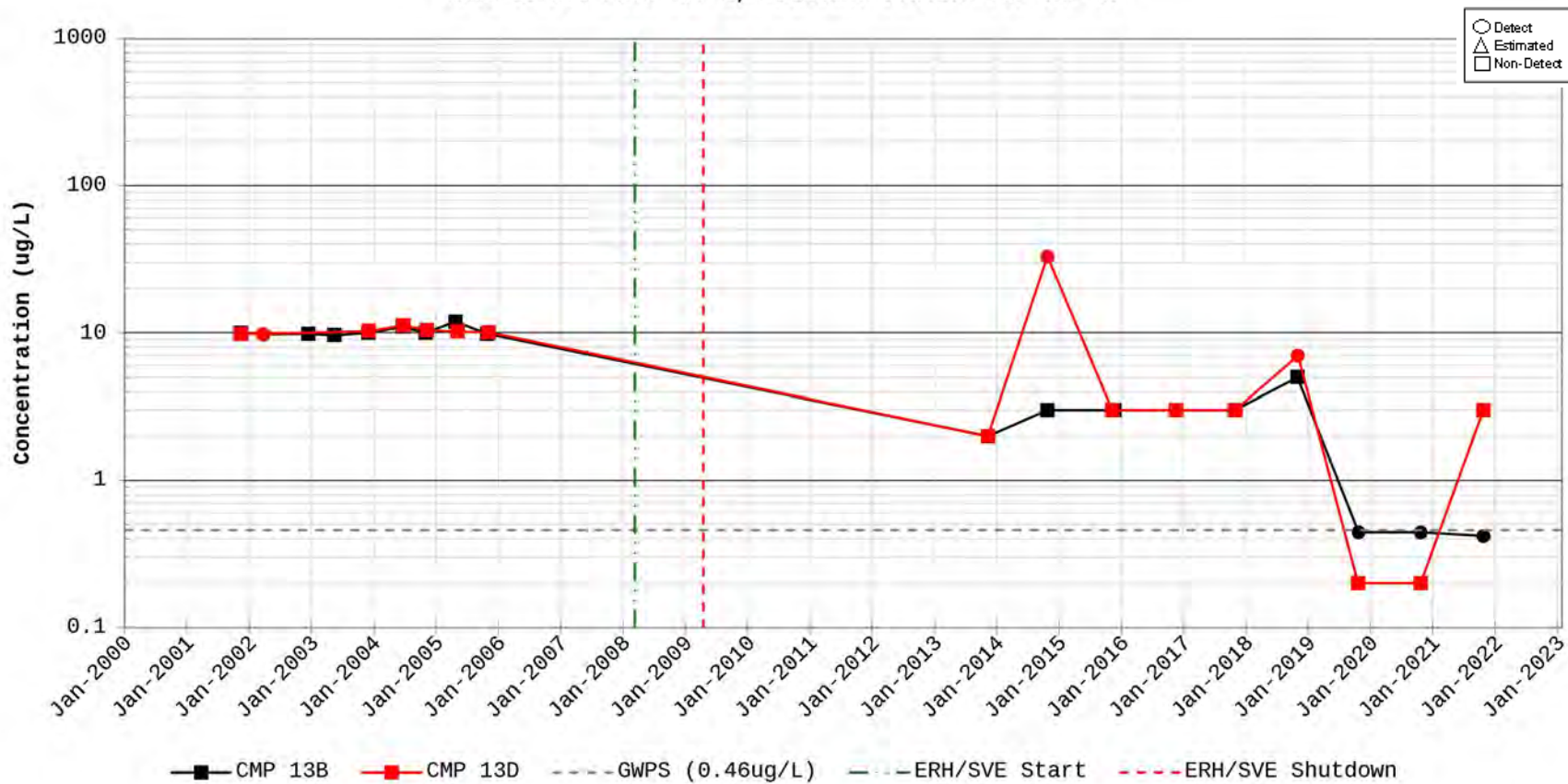


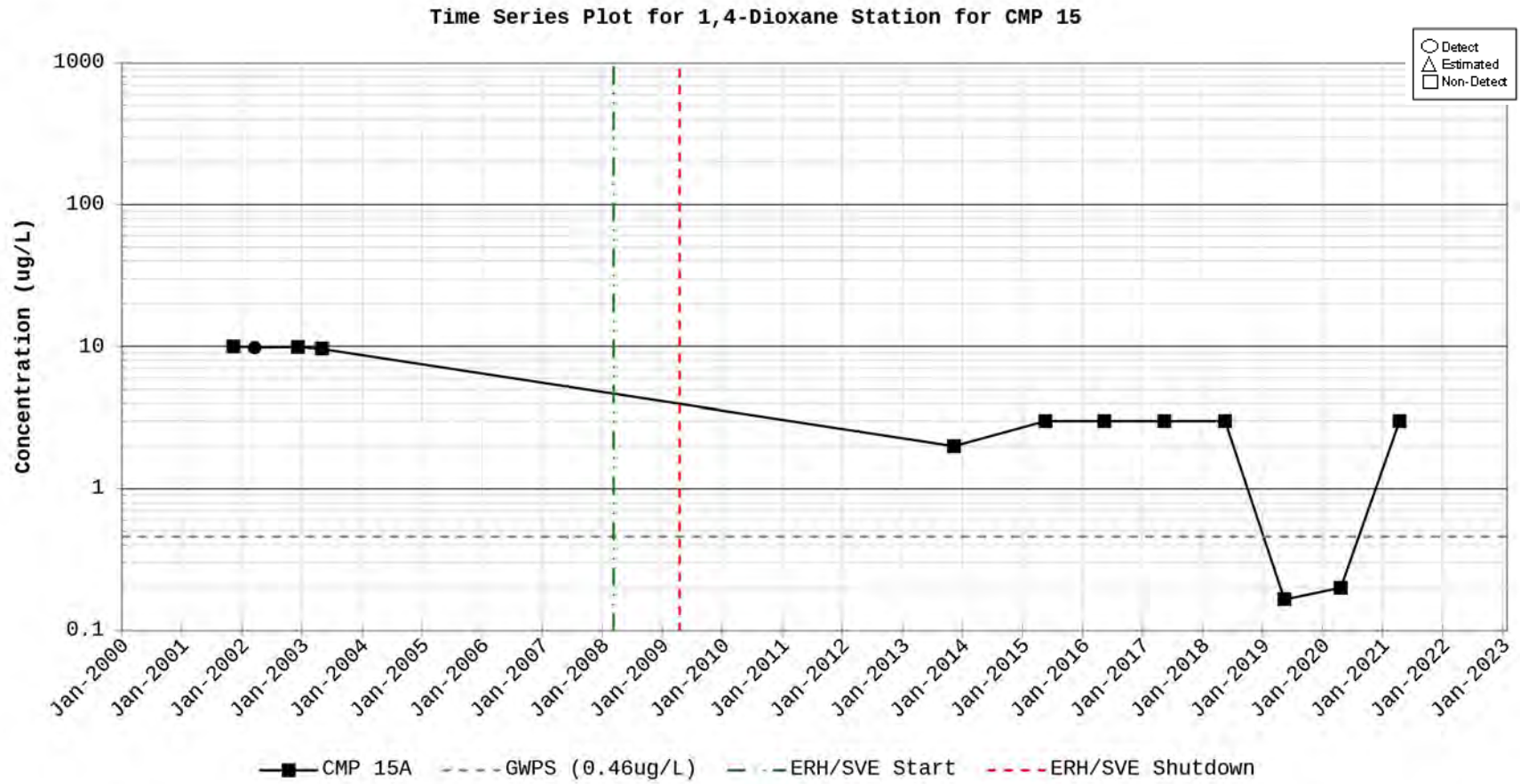


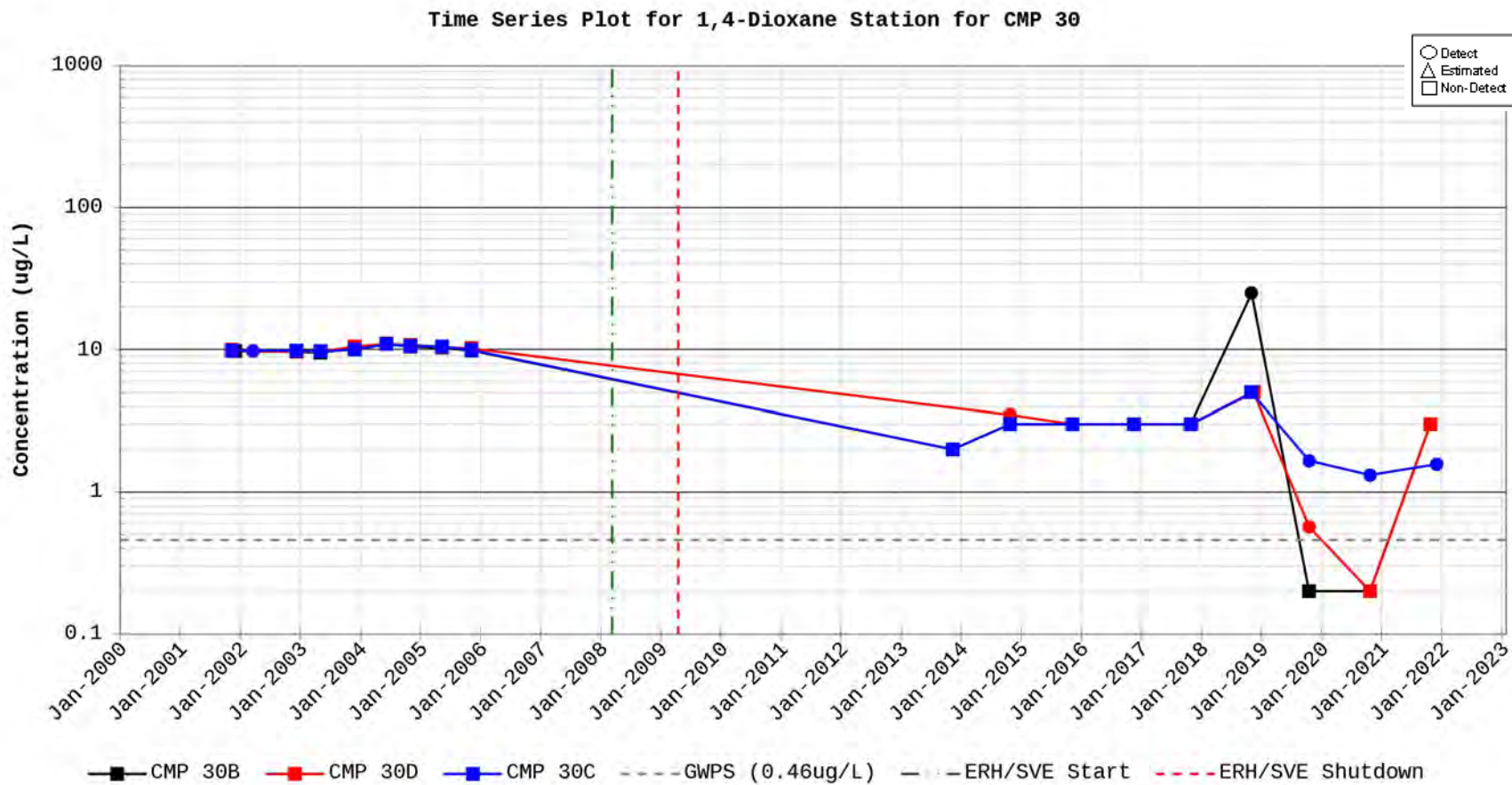


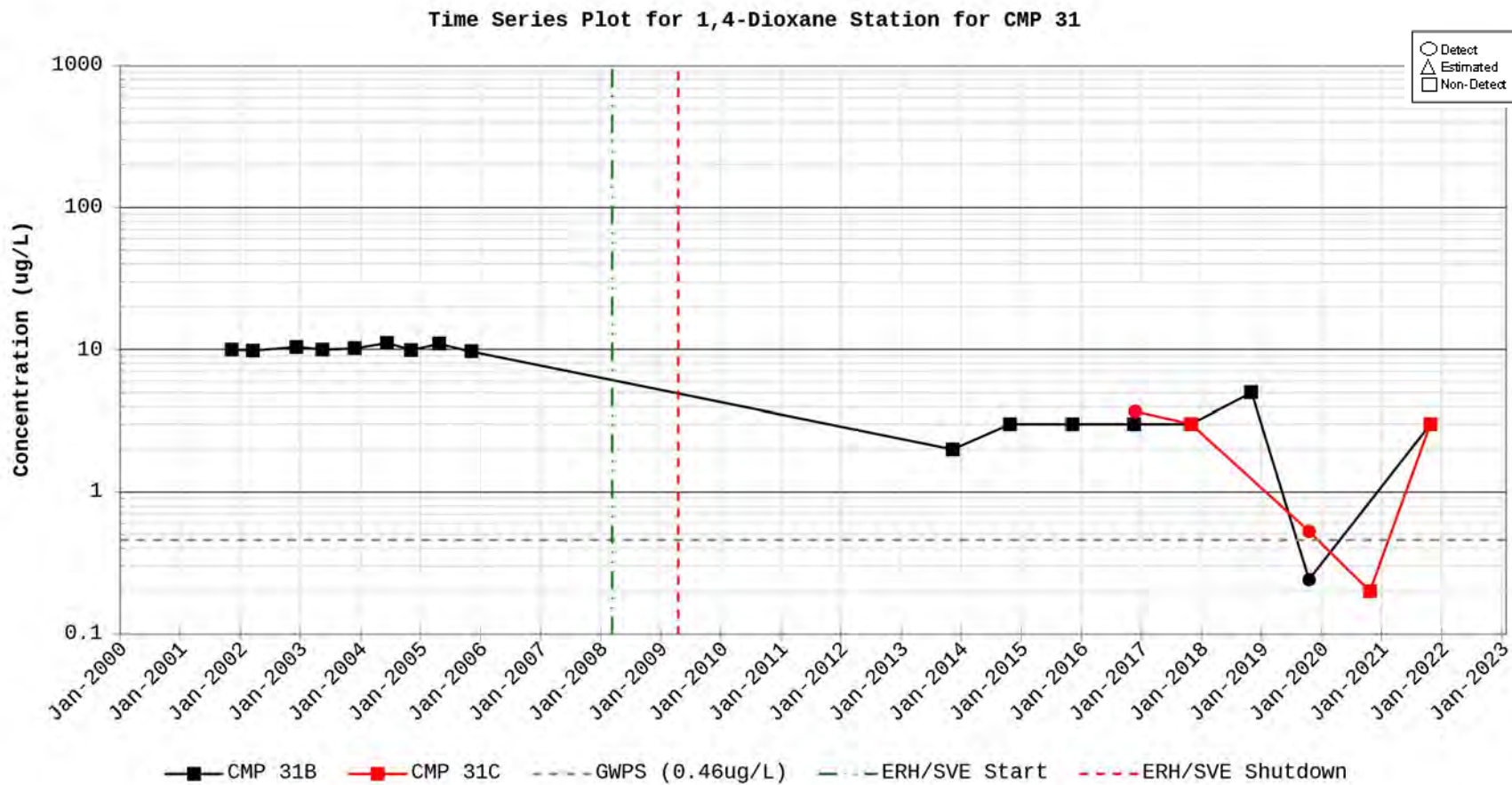


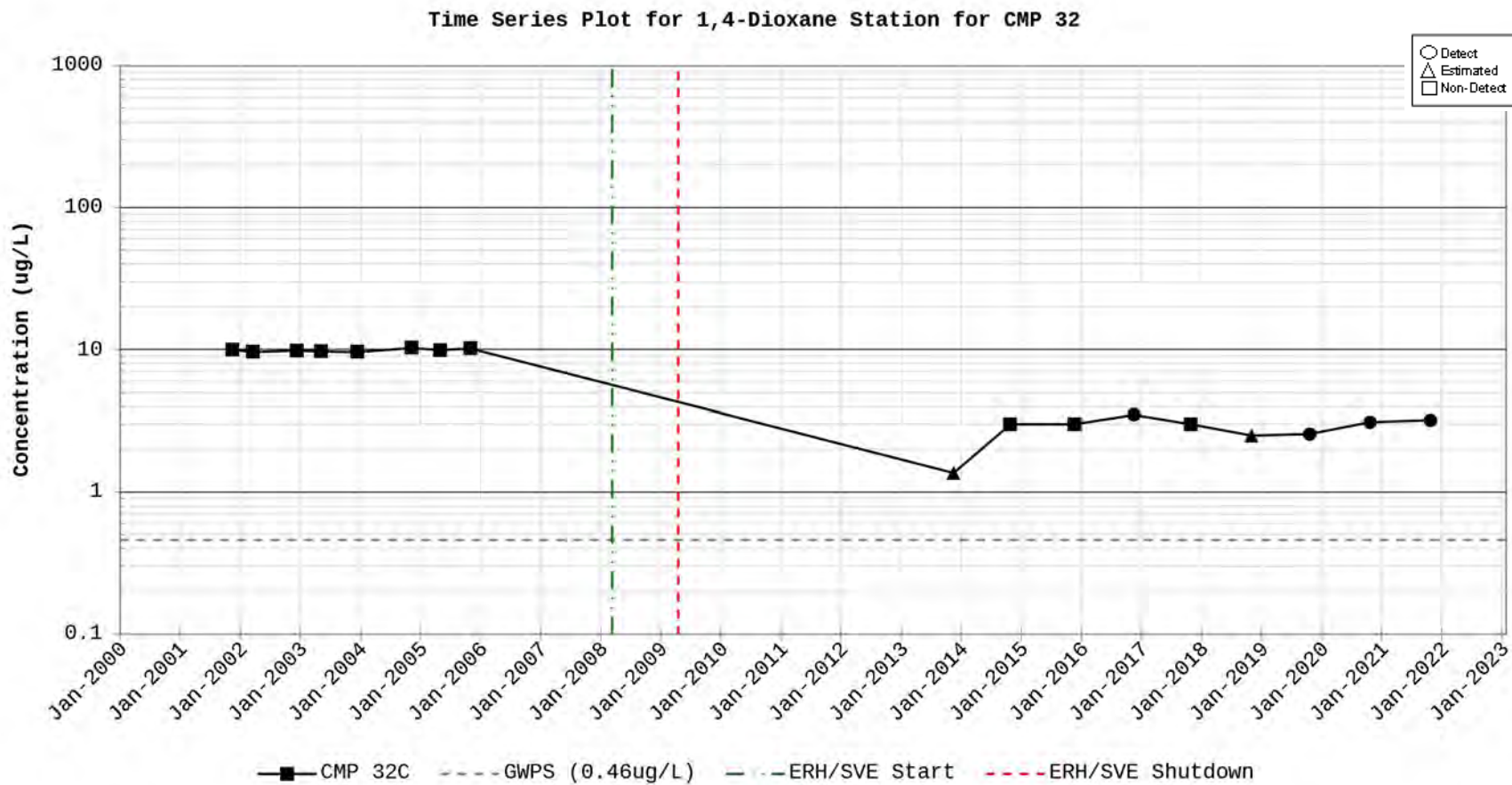
Time Series Plot for 1,4-Dioxane Station for CMP 13

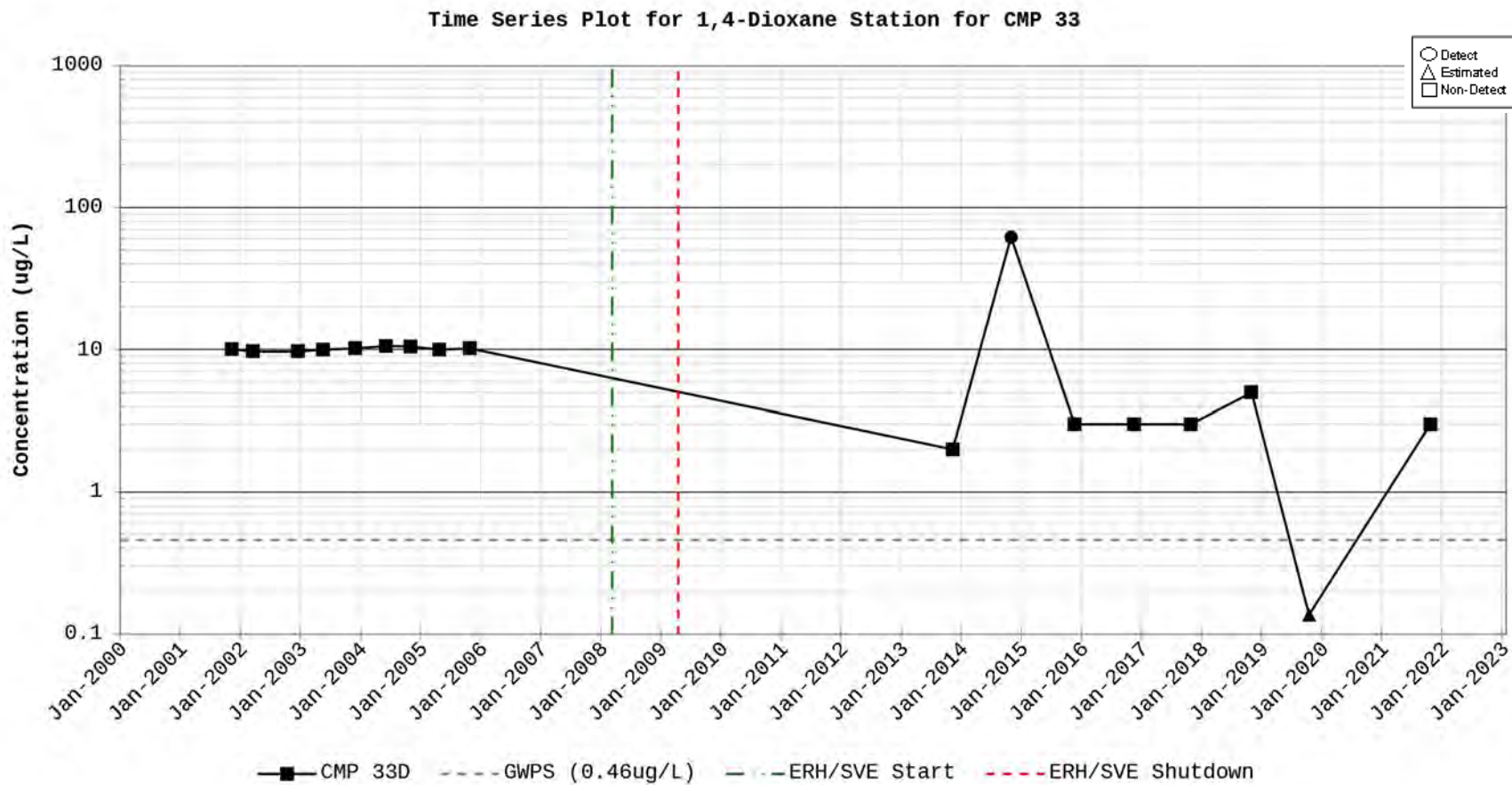




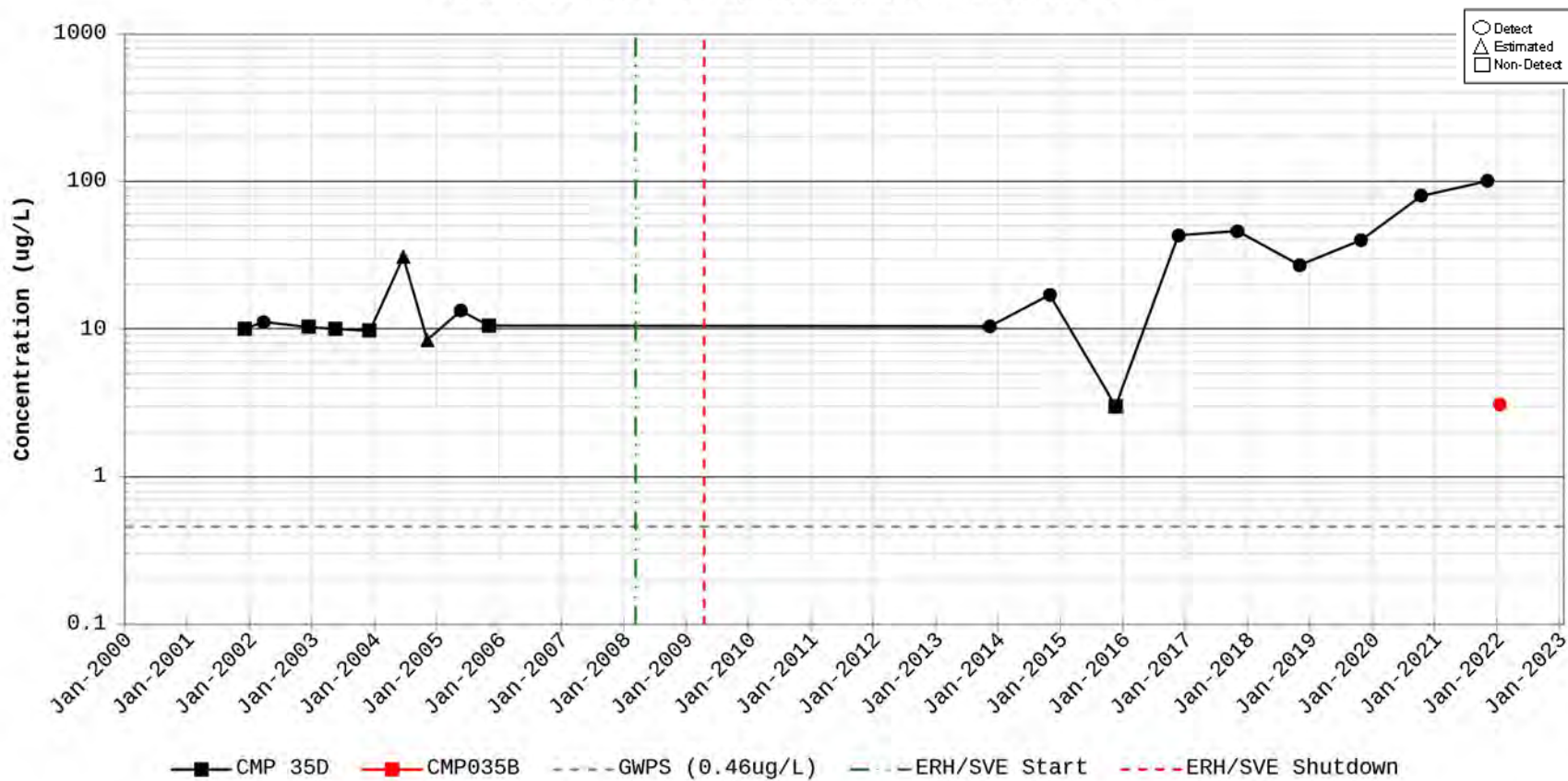




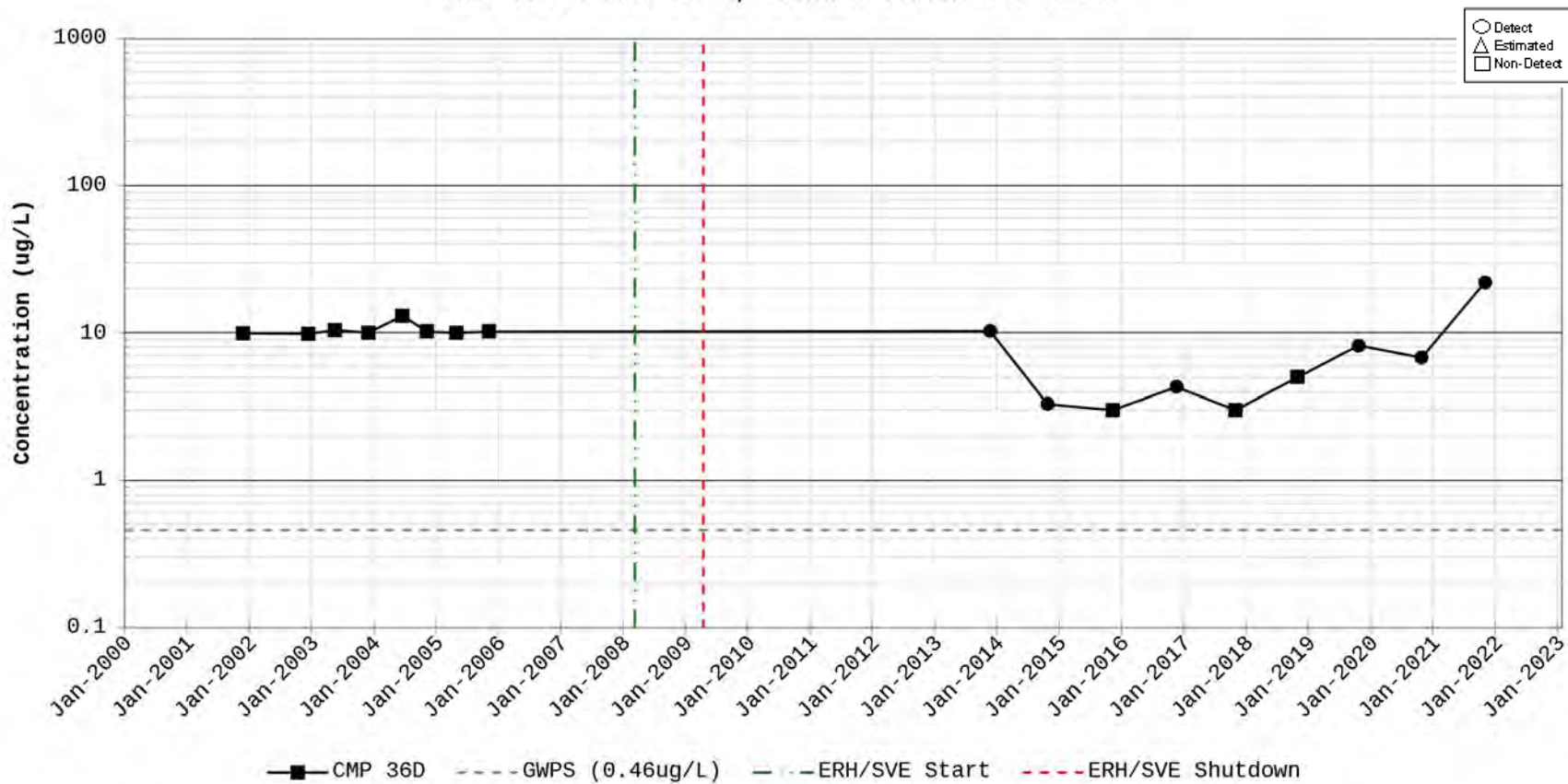




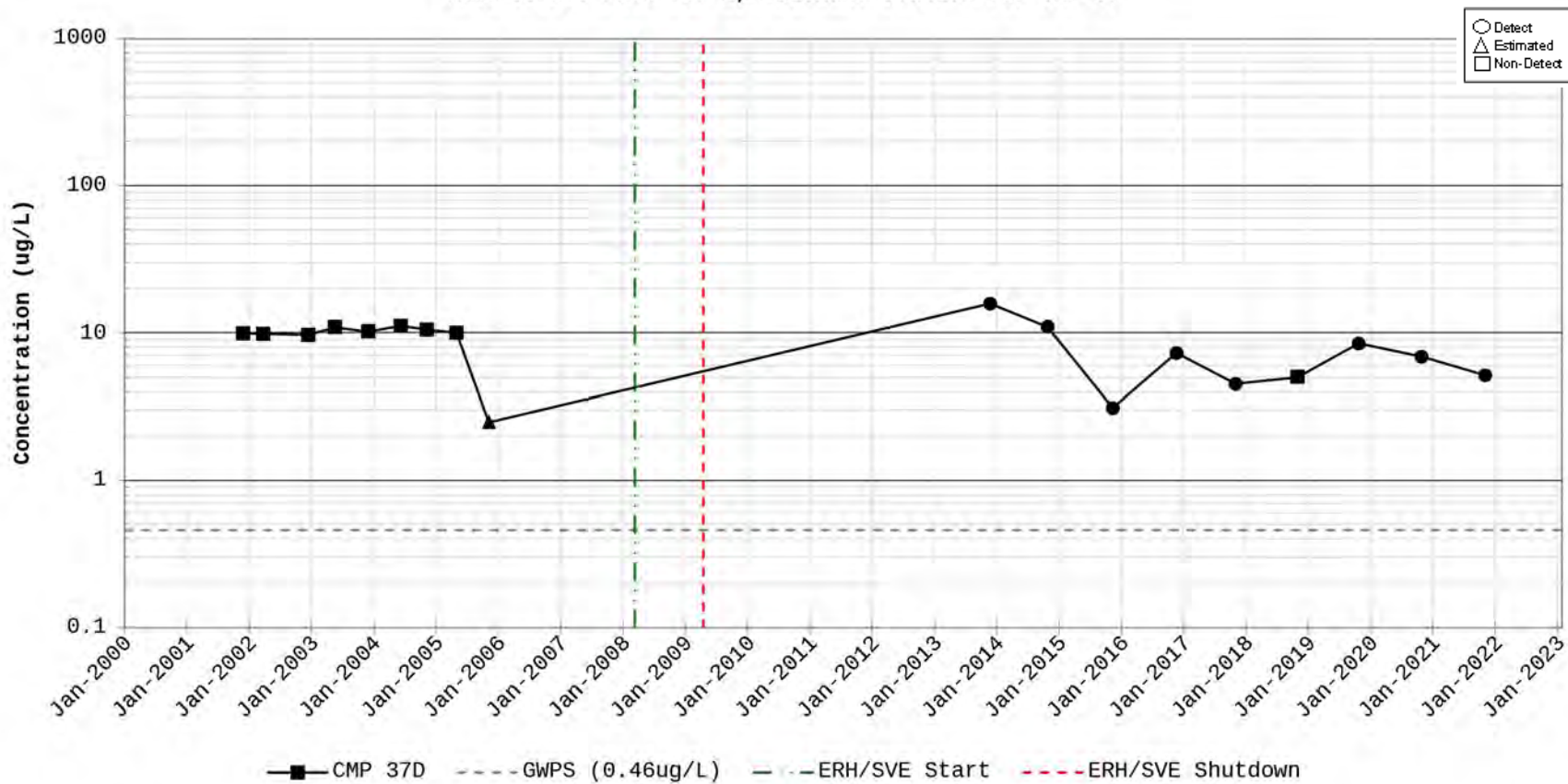
Time Series Plot for 1,4-Dioxane Station for CMP 35



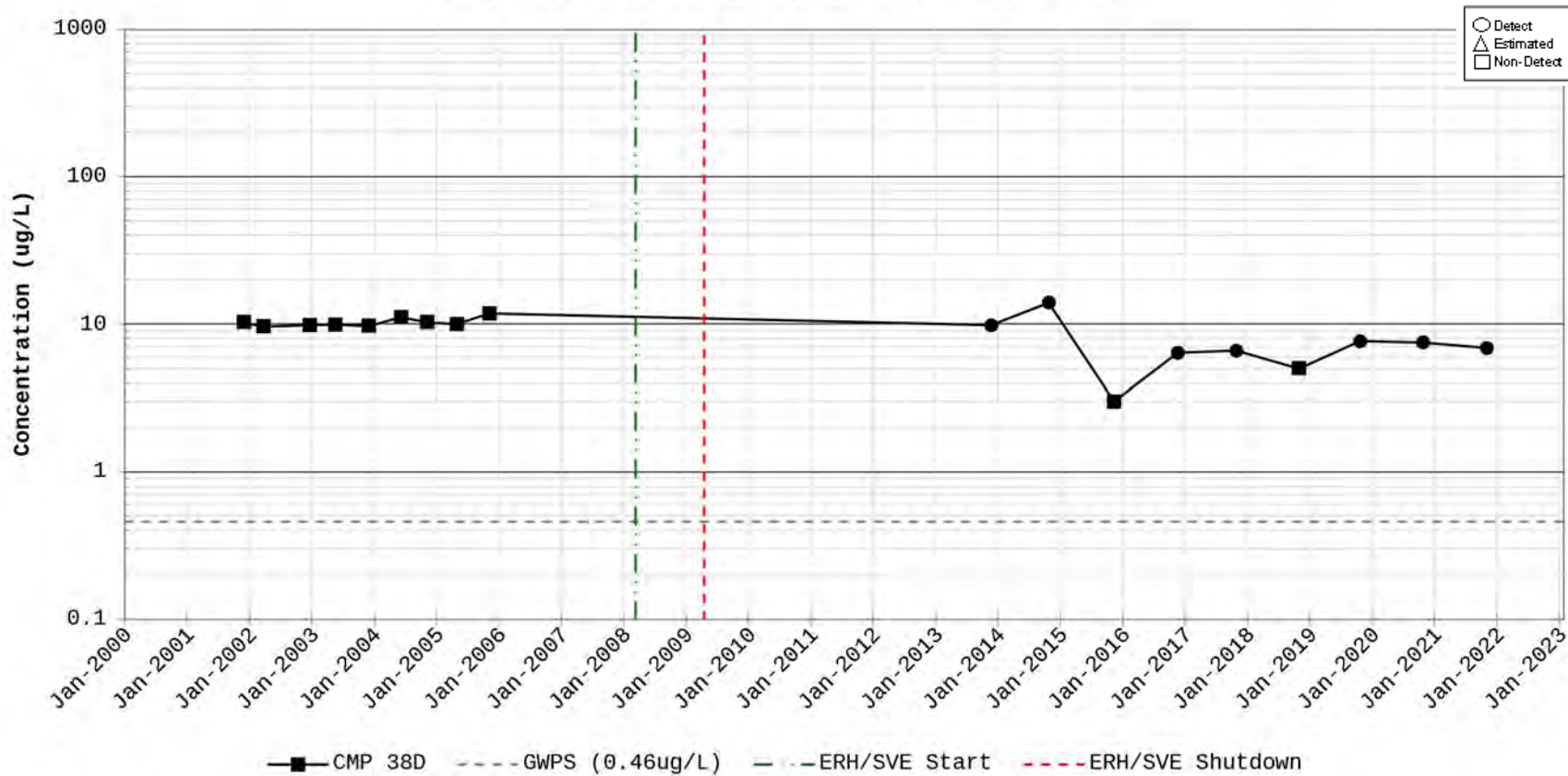
Time Series Plot for 1,4-Dioxane Station for CMP 36



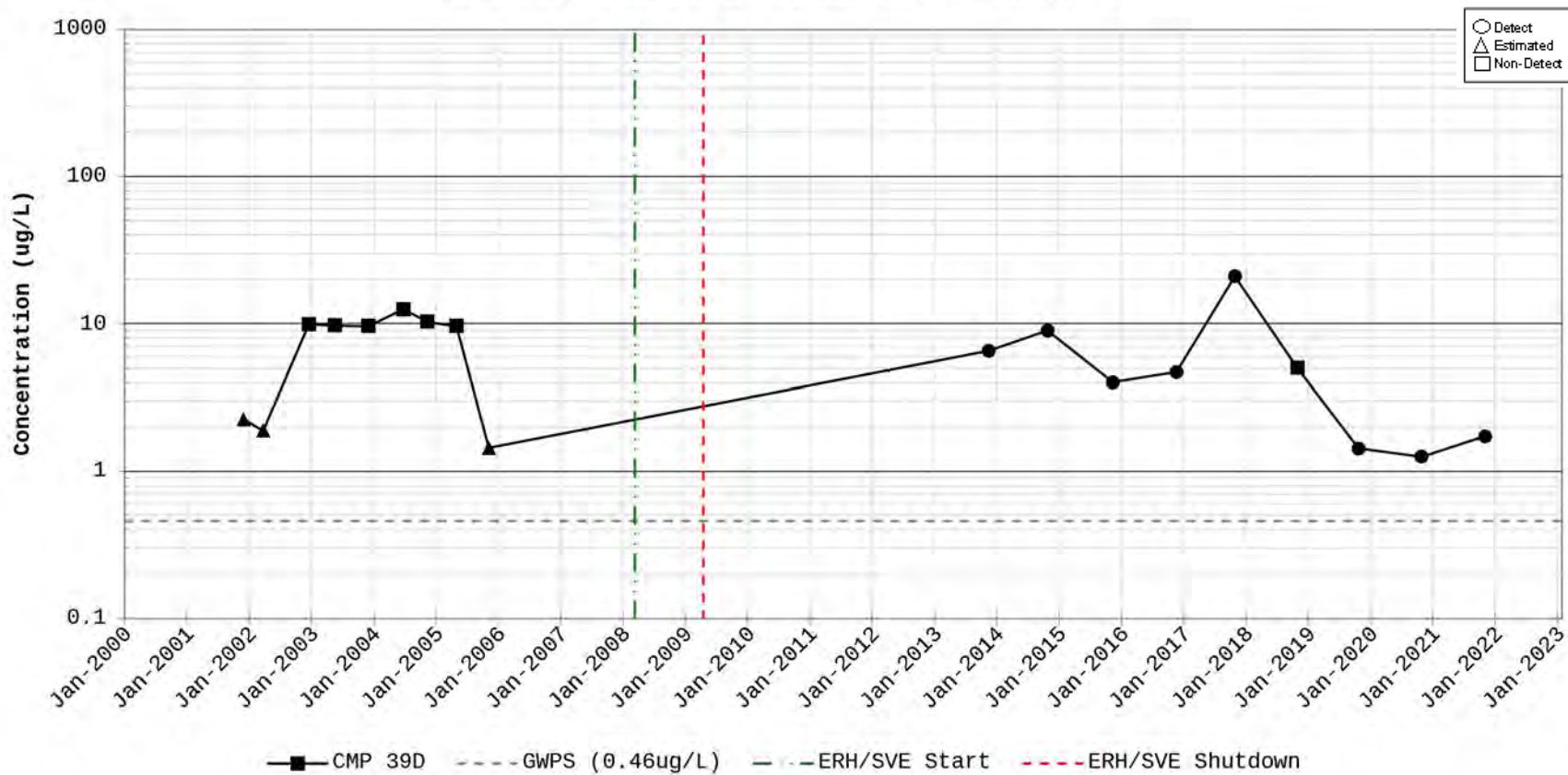
Time Series Plot for 1,4-Dioxane Station for CMP 37

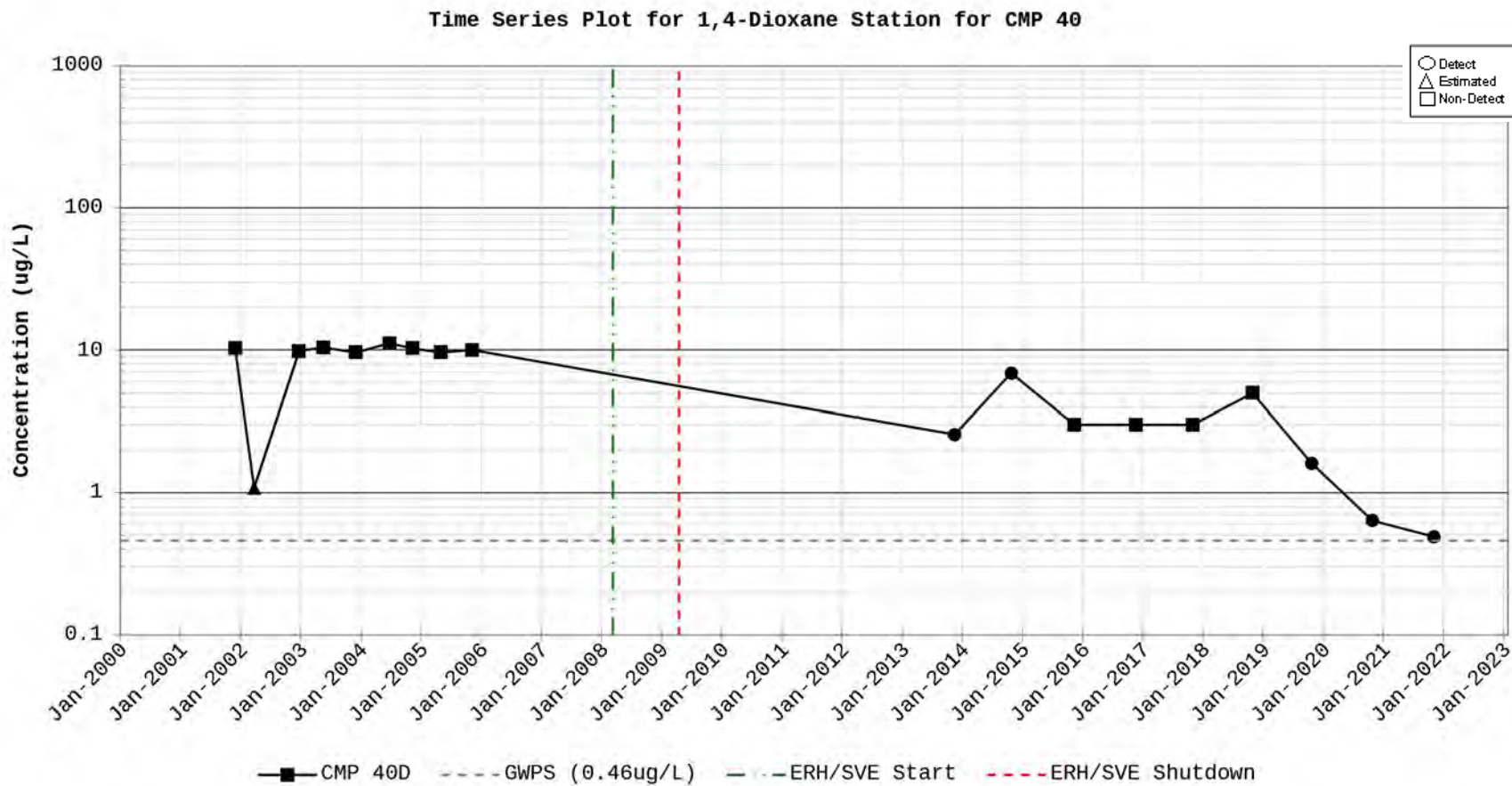


Time Series Plot for 1,4-Dioxane Station for CMP 38

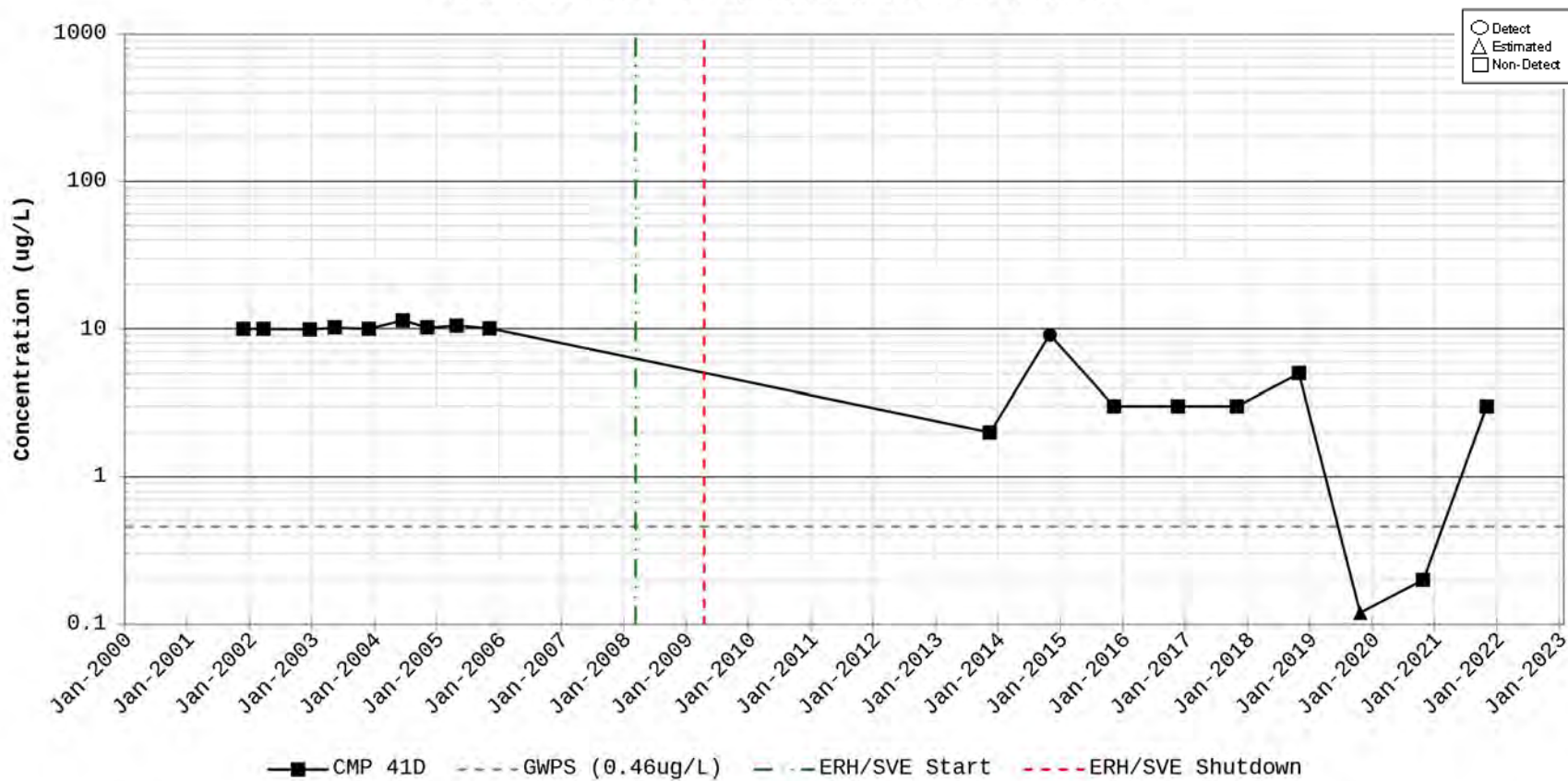


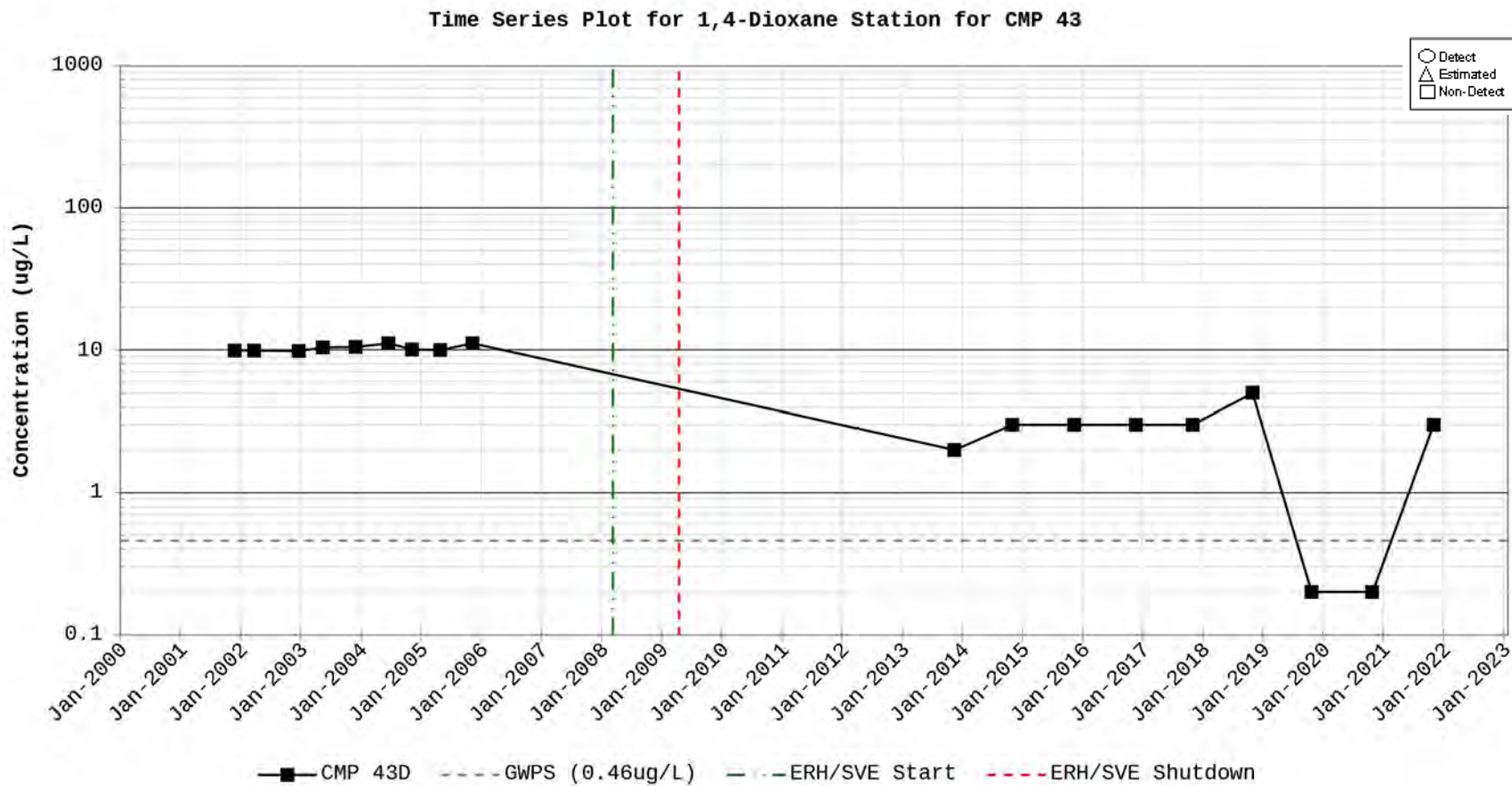
Time Series Plot for 1,4-Dioxane Station for CMP 39

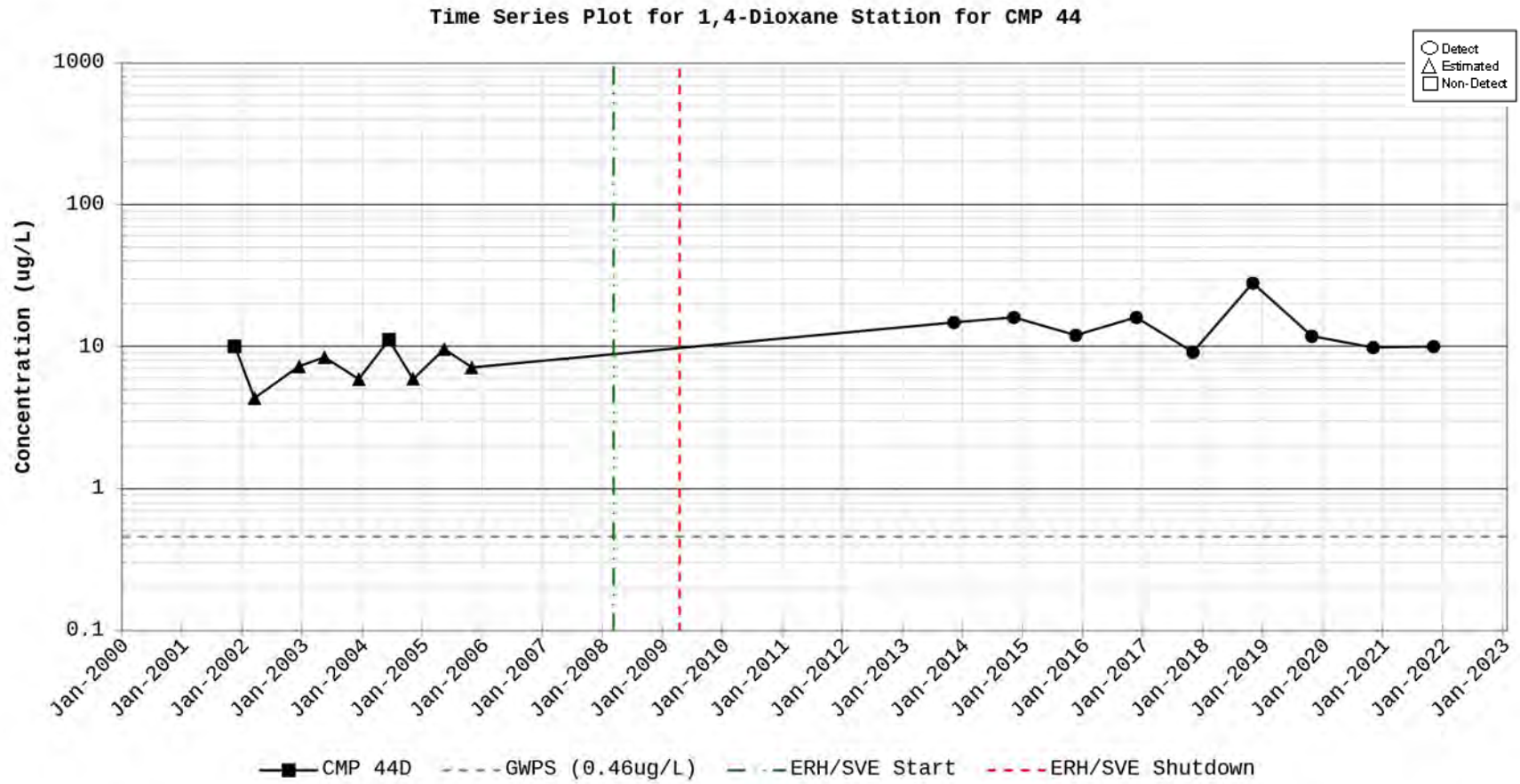


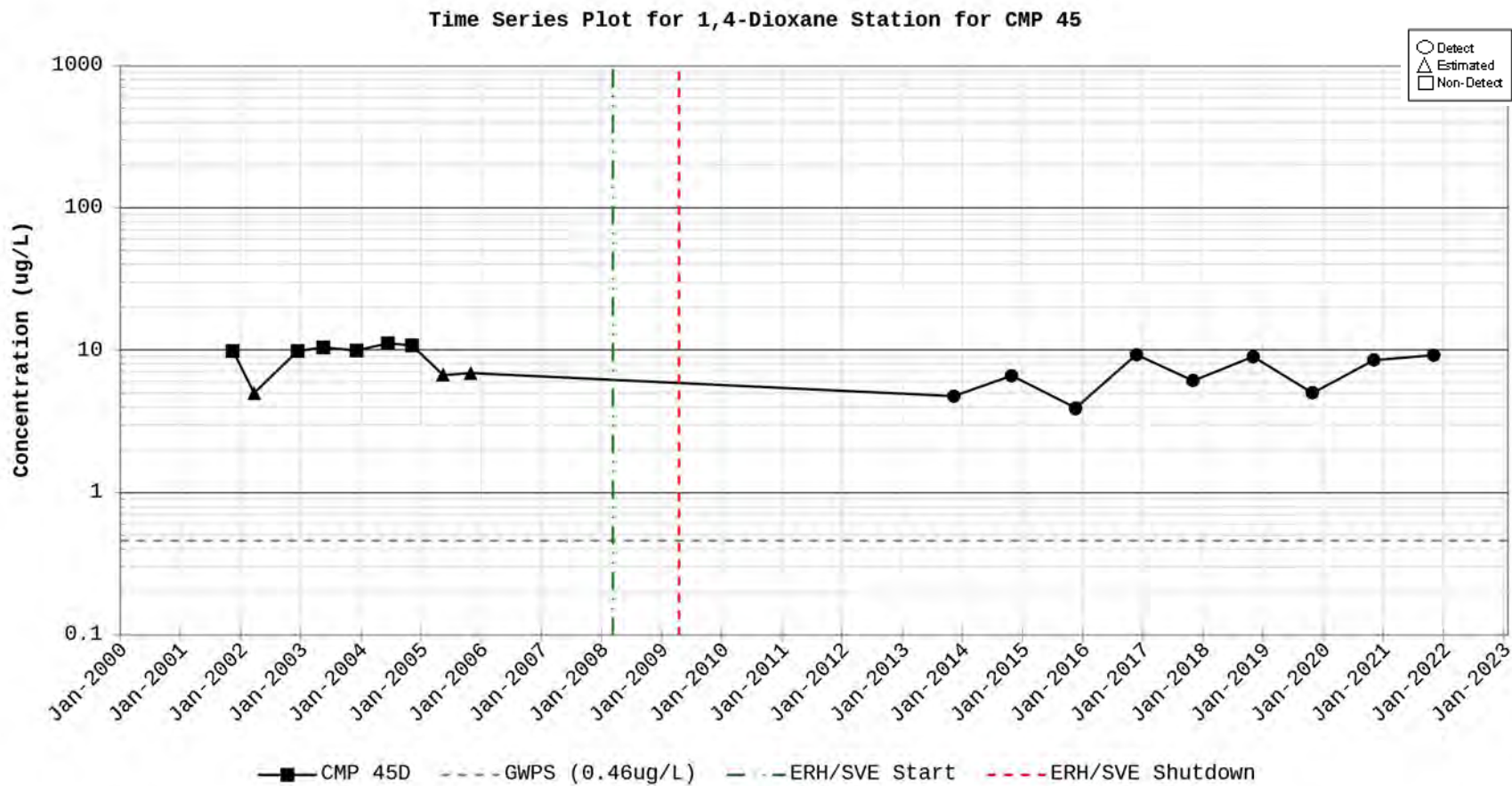


Time Series Plot for 1,4-Dioxane Station for CMP 41

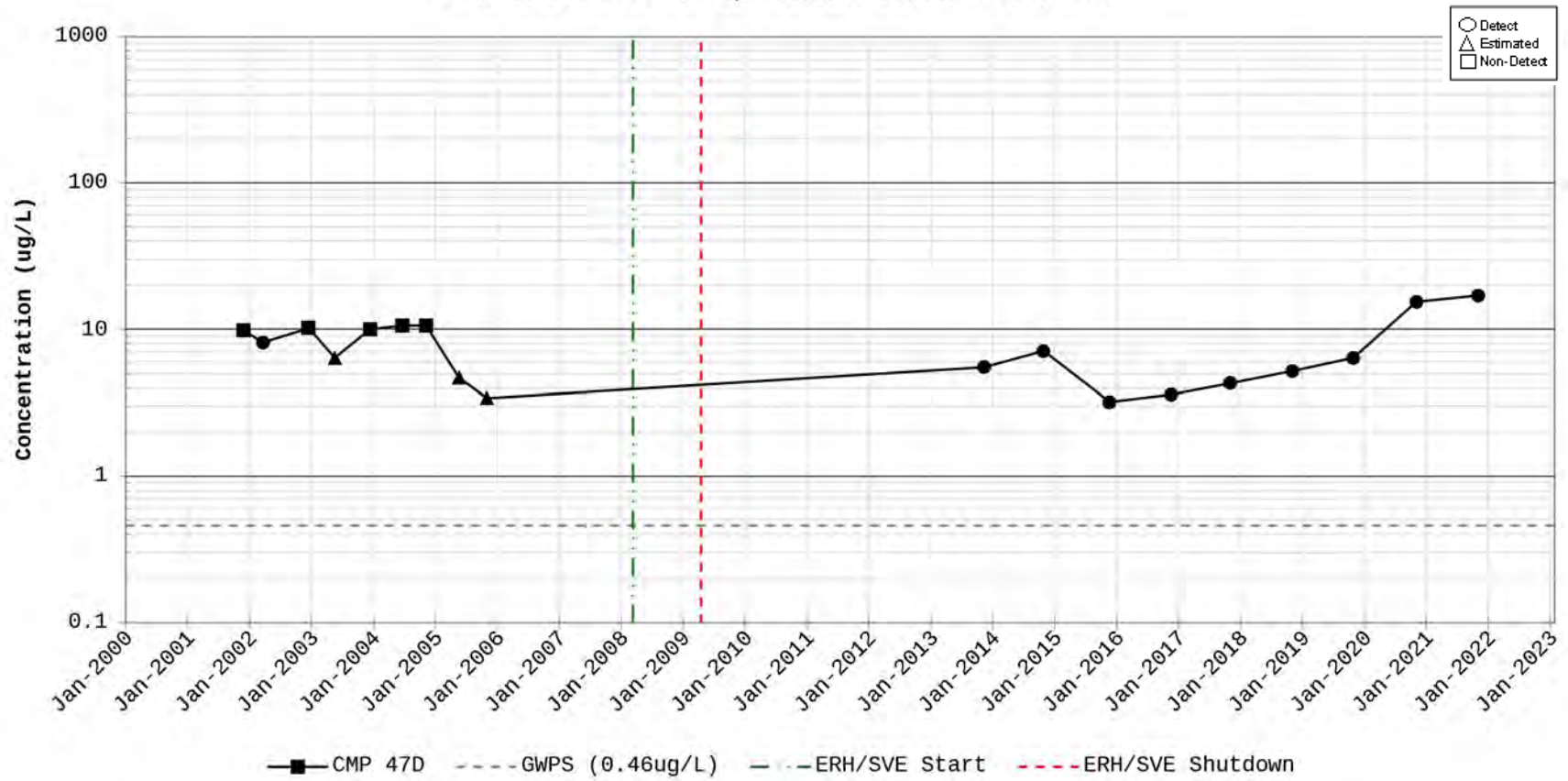




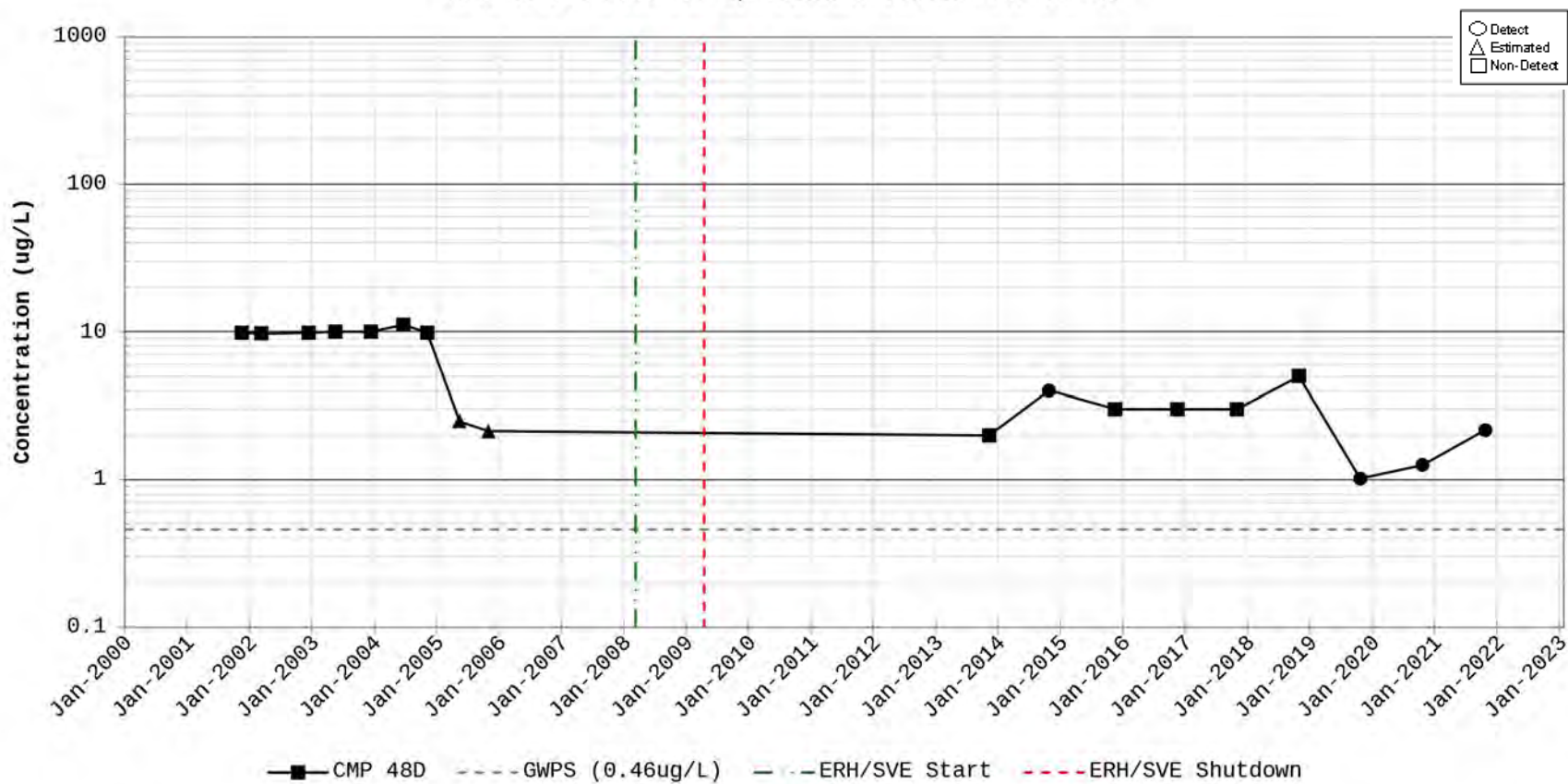




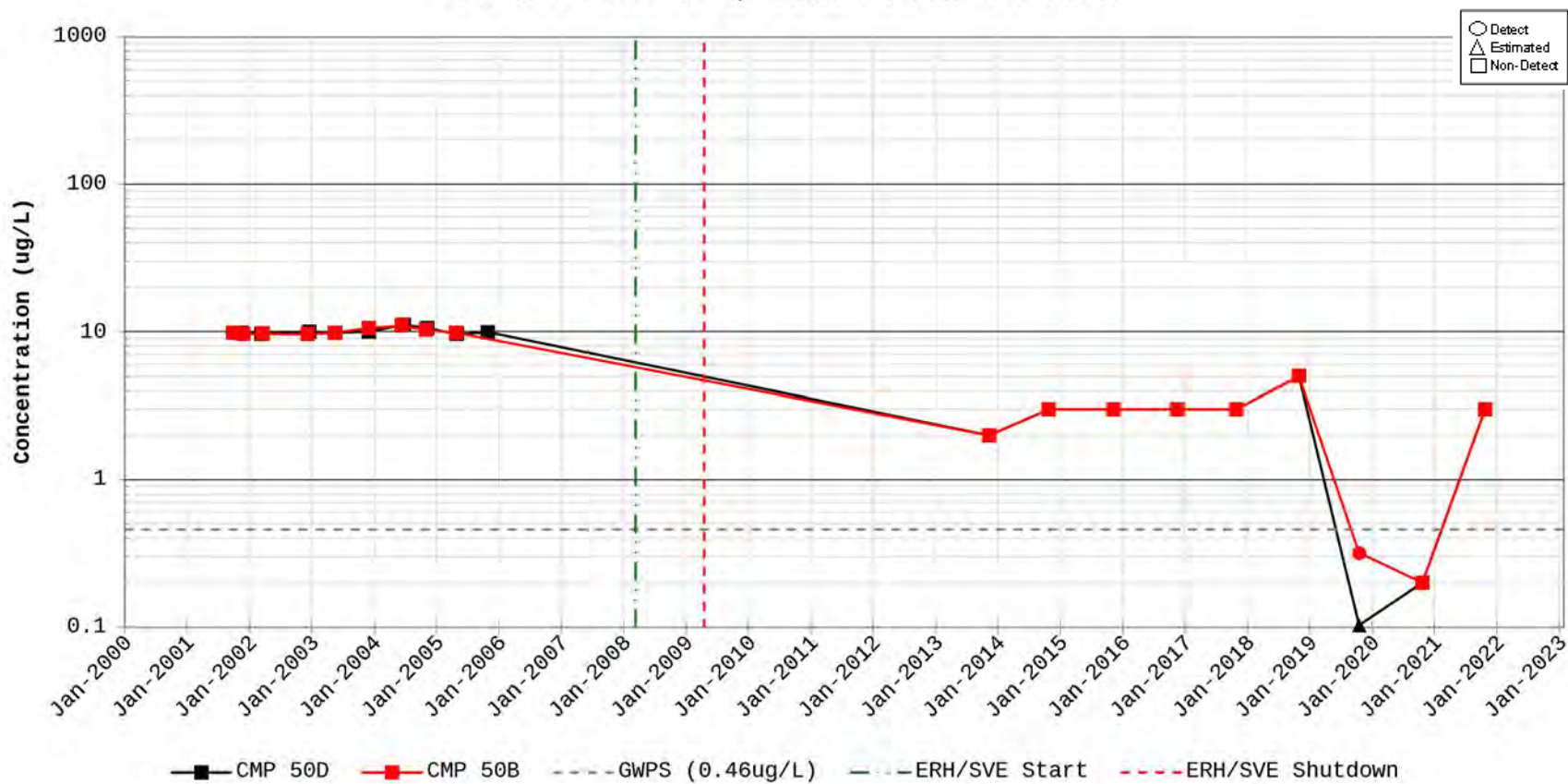
Time Series Plot for 1,4-Dioxane Station for CMP 47



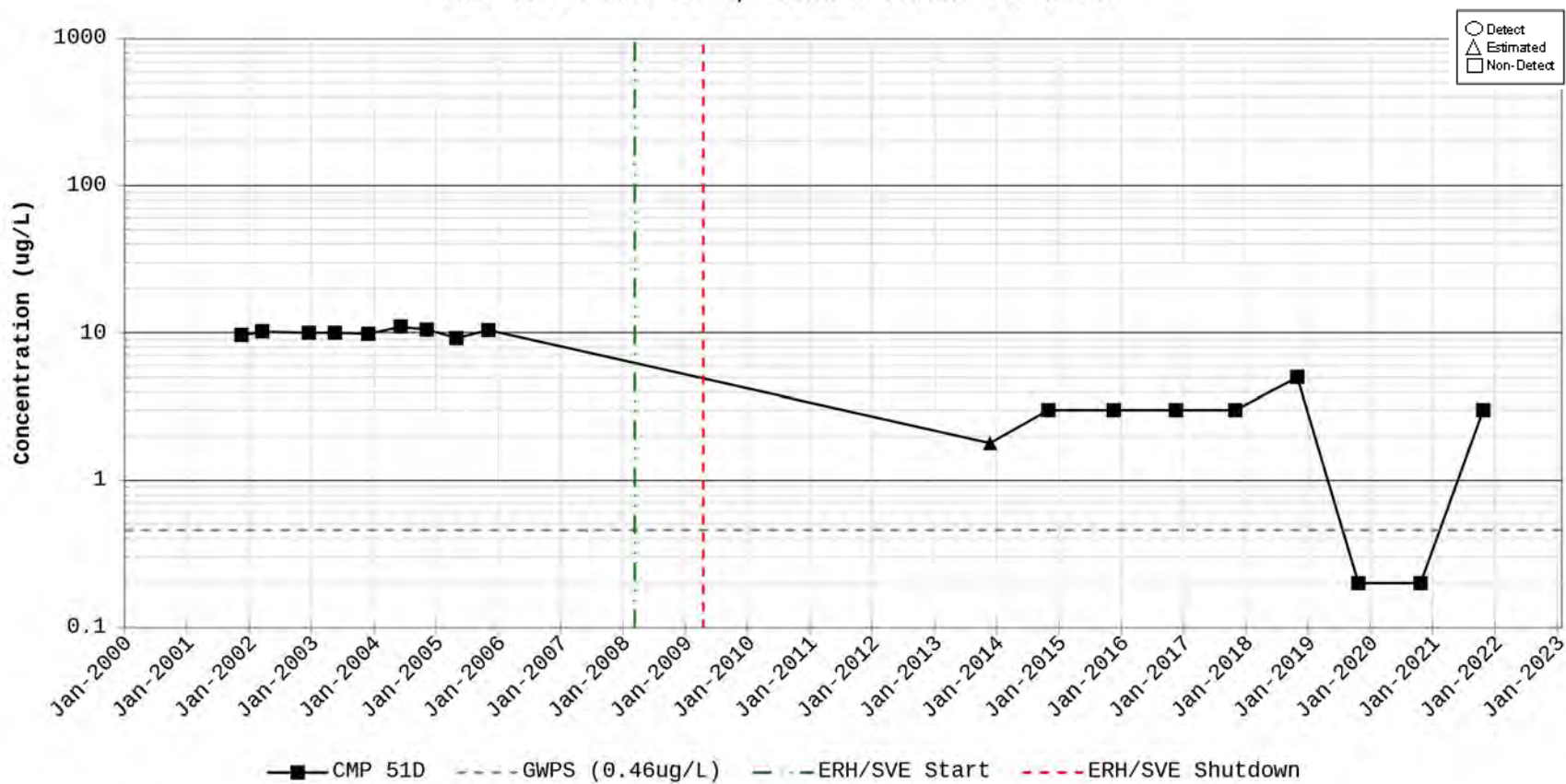
Time Series Plot for 1,4-Dioxane Station for CMP 48

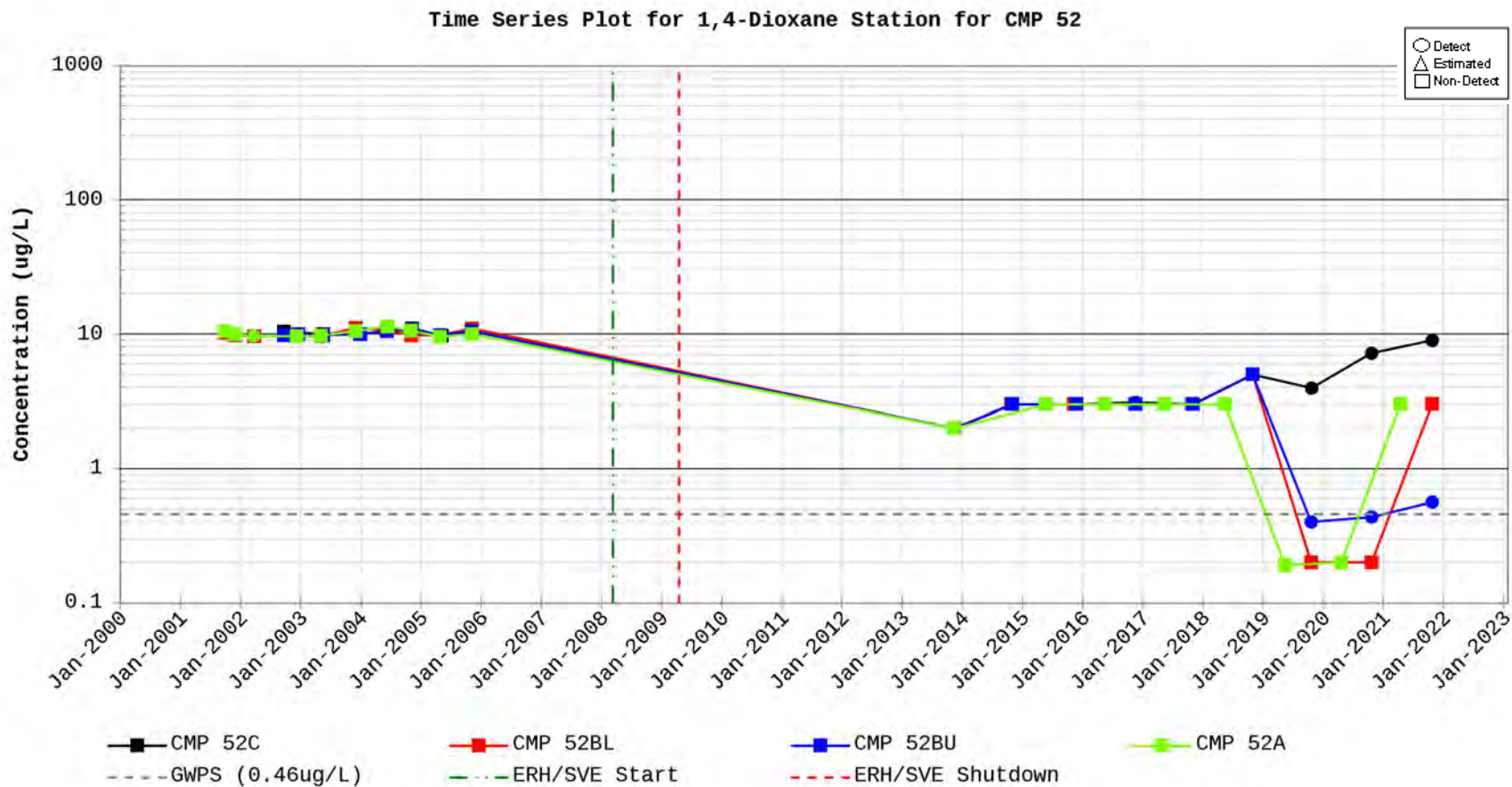


Time Series Plot for 1,4-Dioxane Station for CMP 50

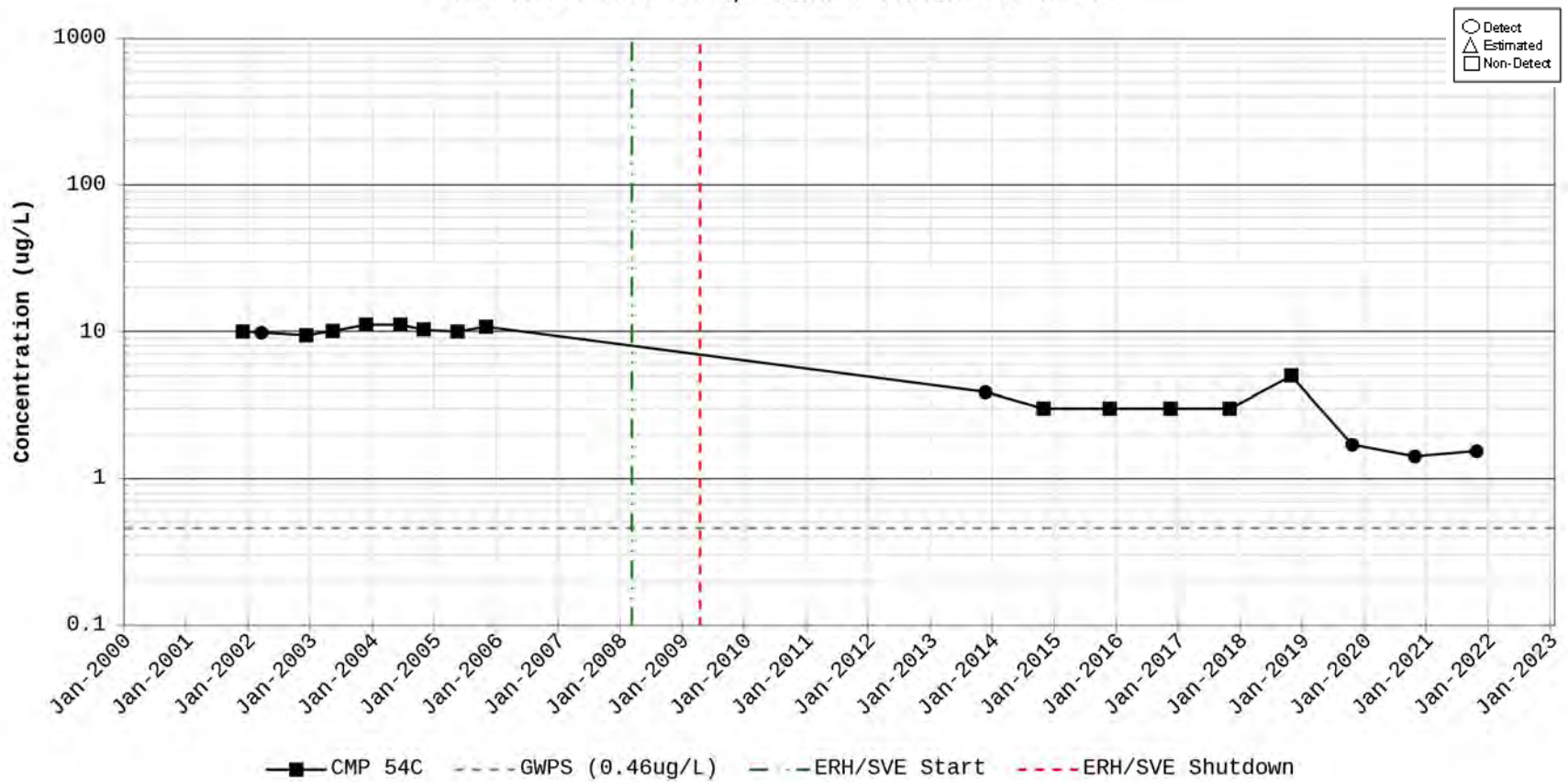


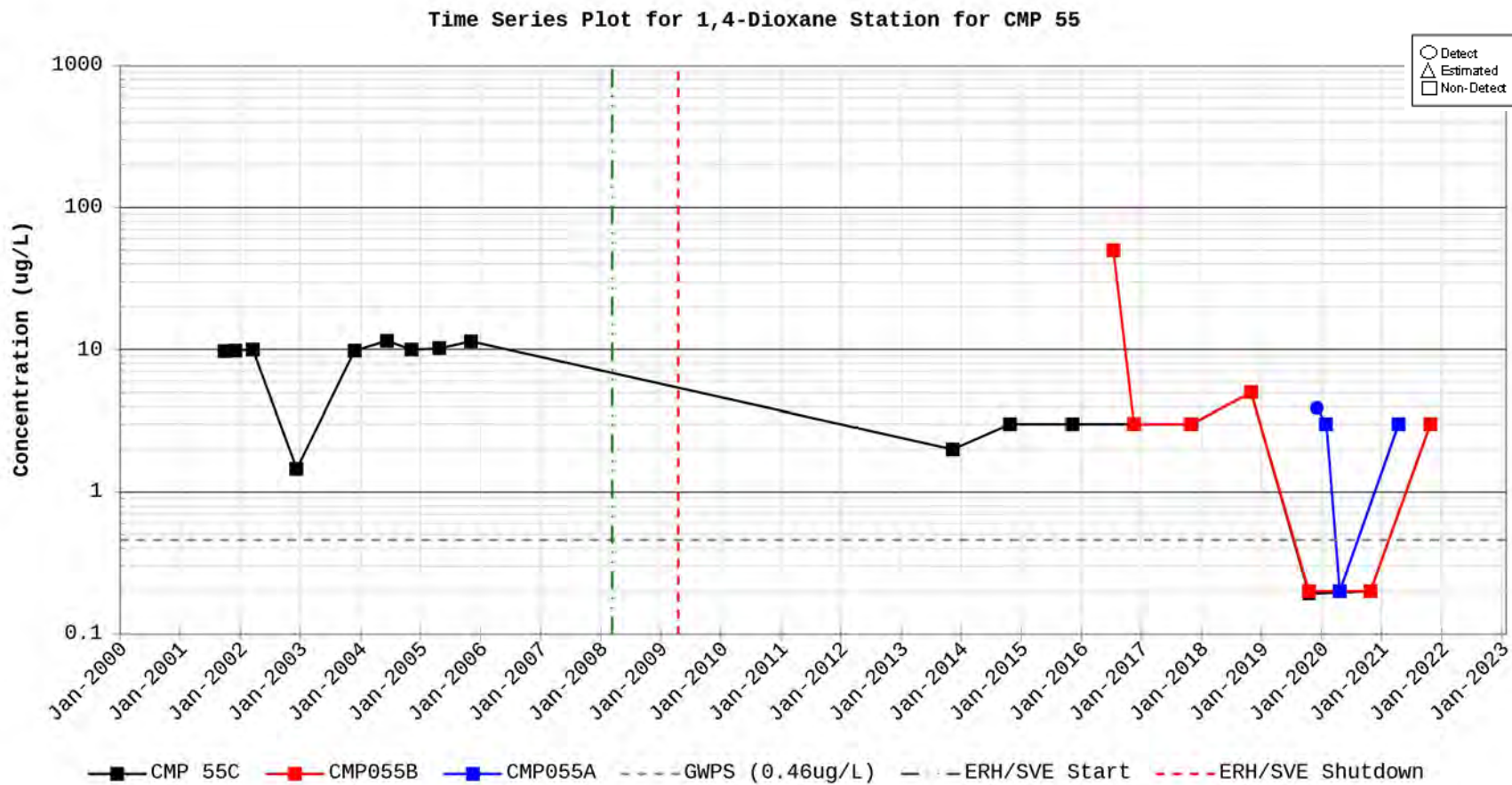
Time Series Plot for 1,4-Dioxane Station for CMP 51

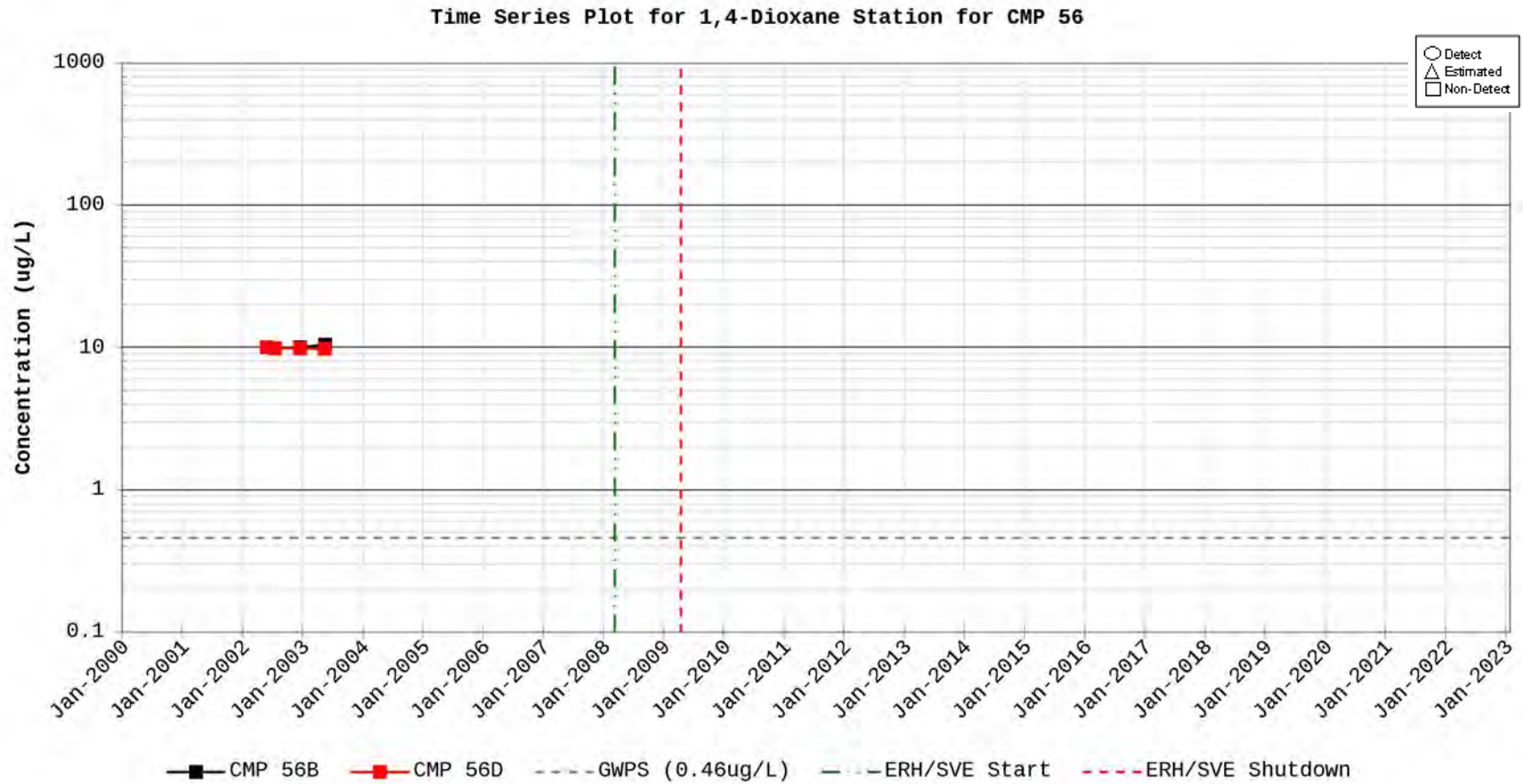


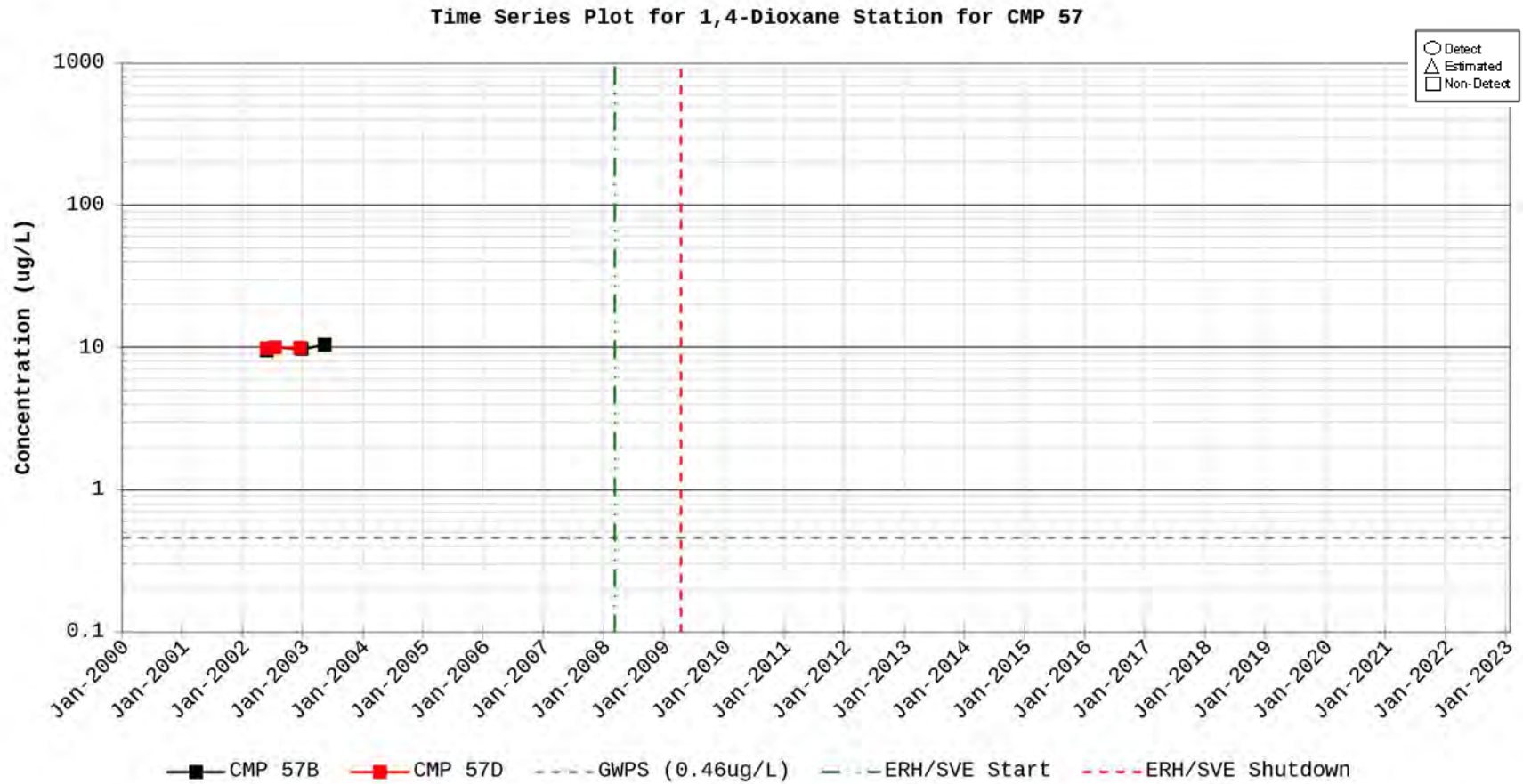


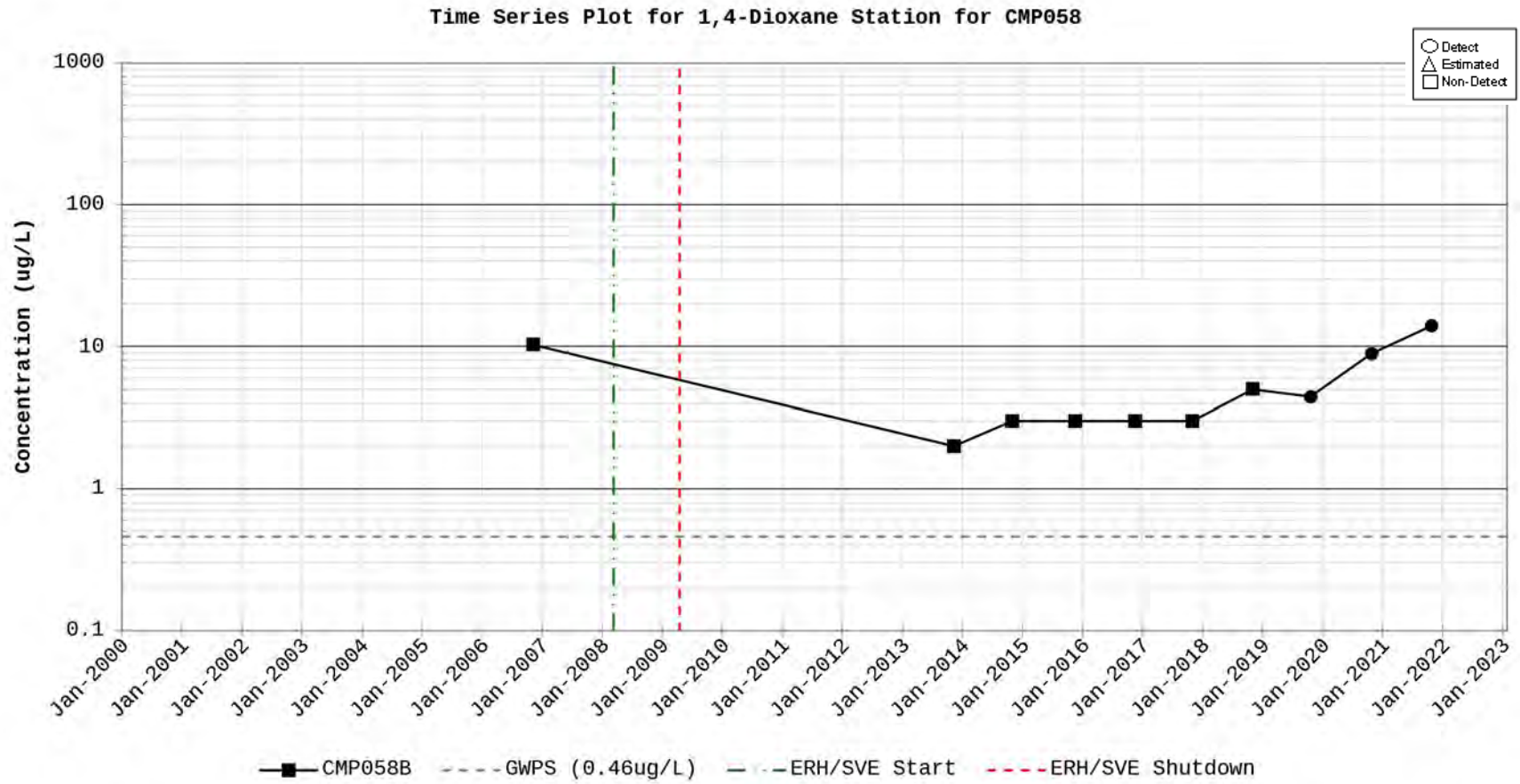
Time Series Plot for 1,4-Dioxane Station for CMP 54

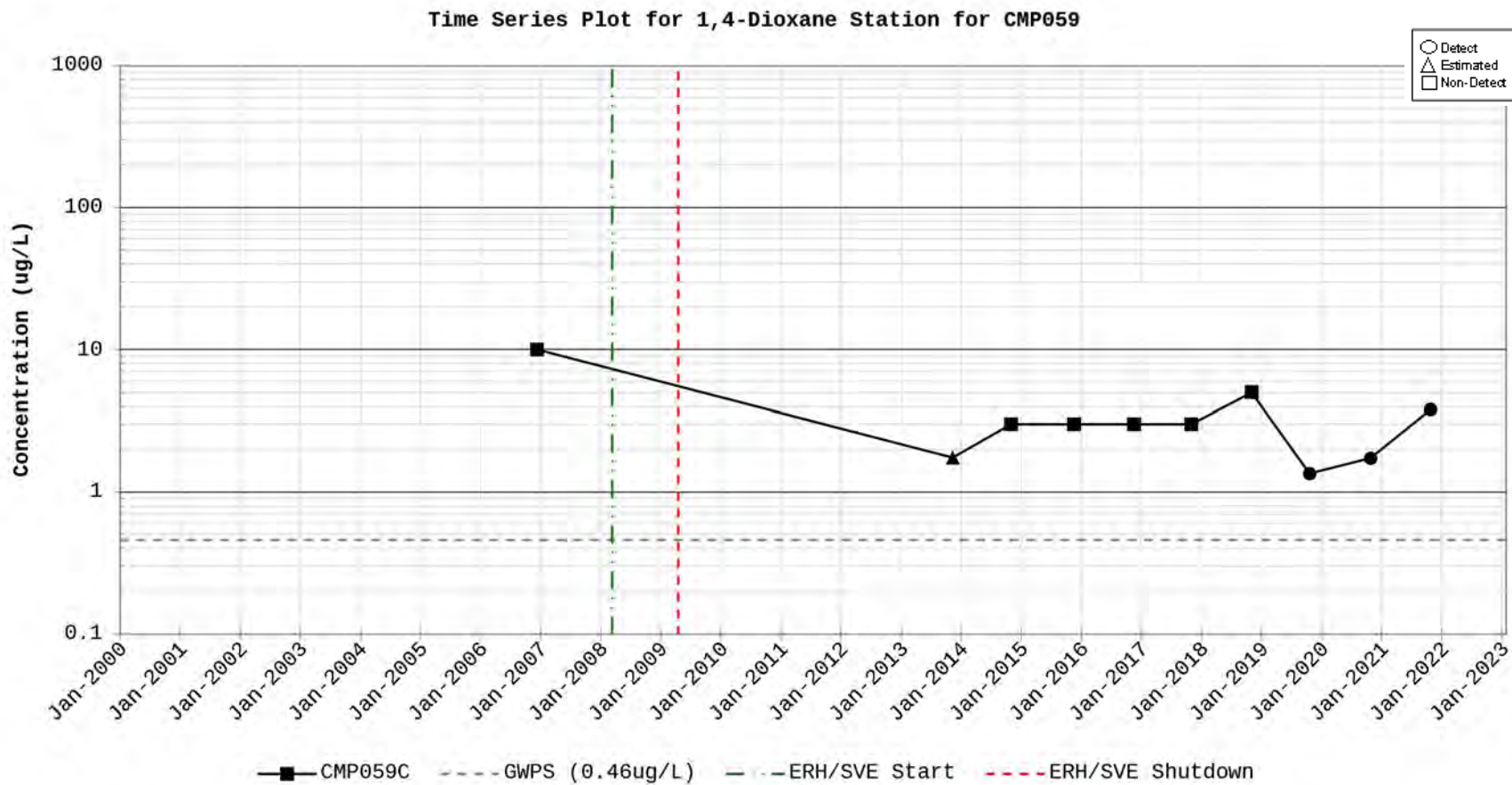


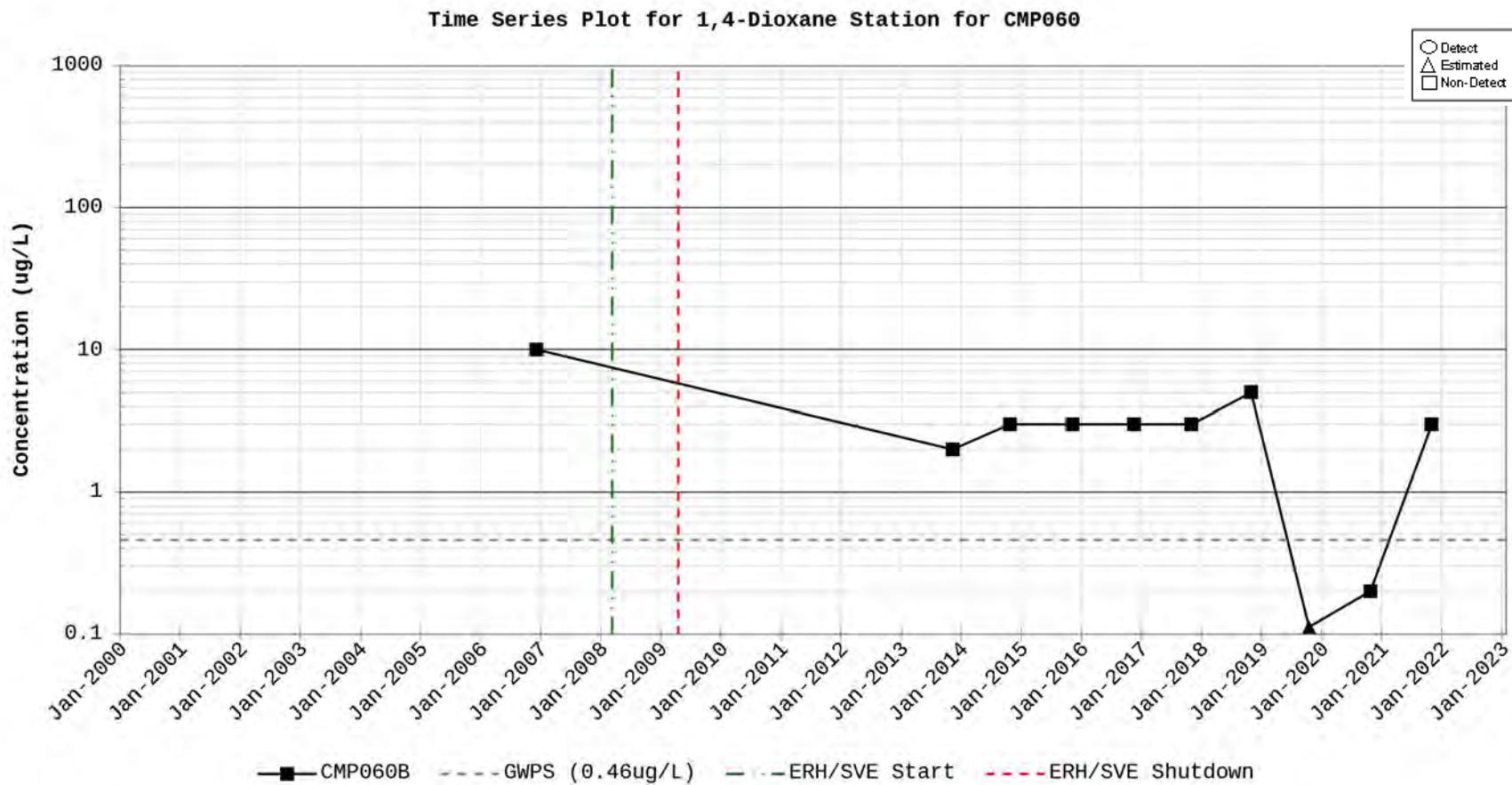


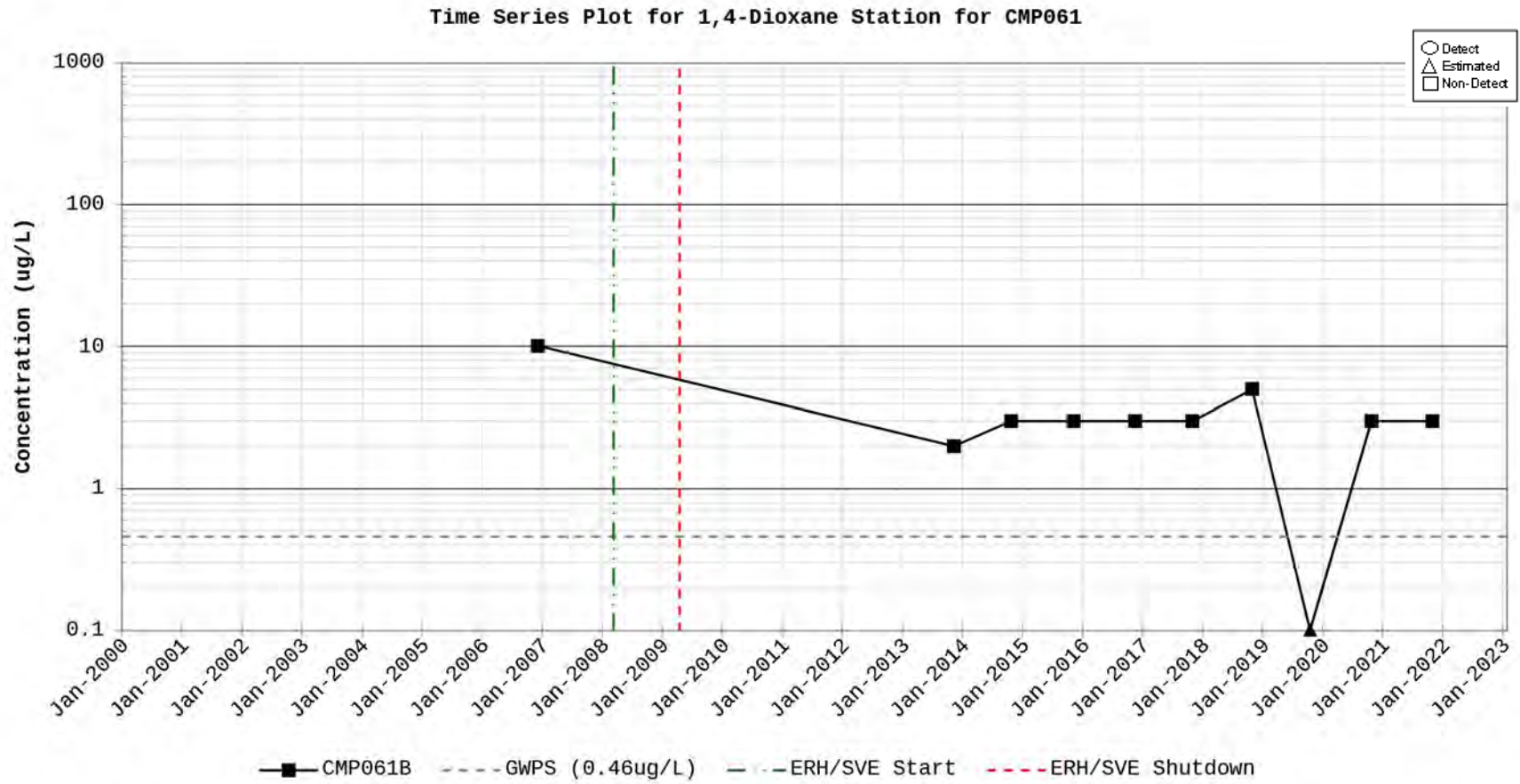


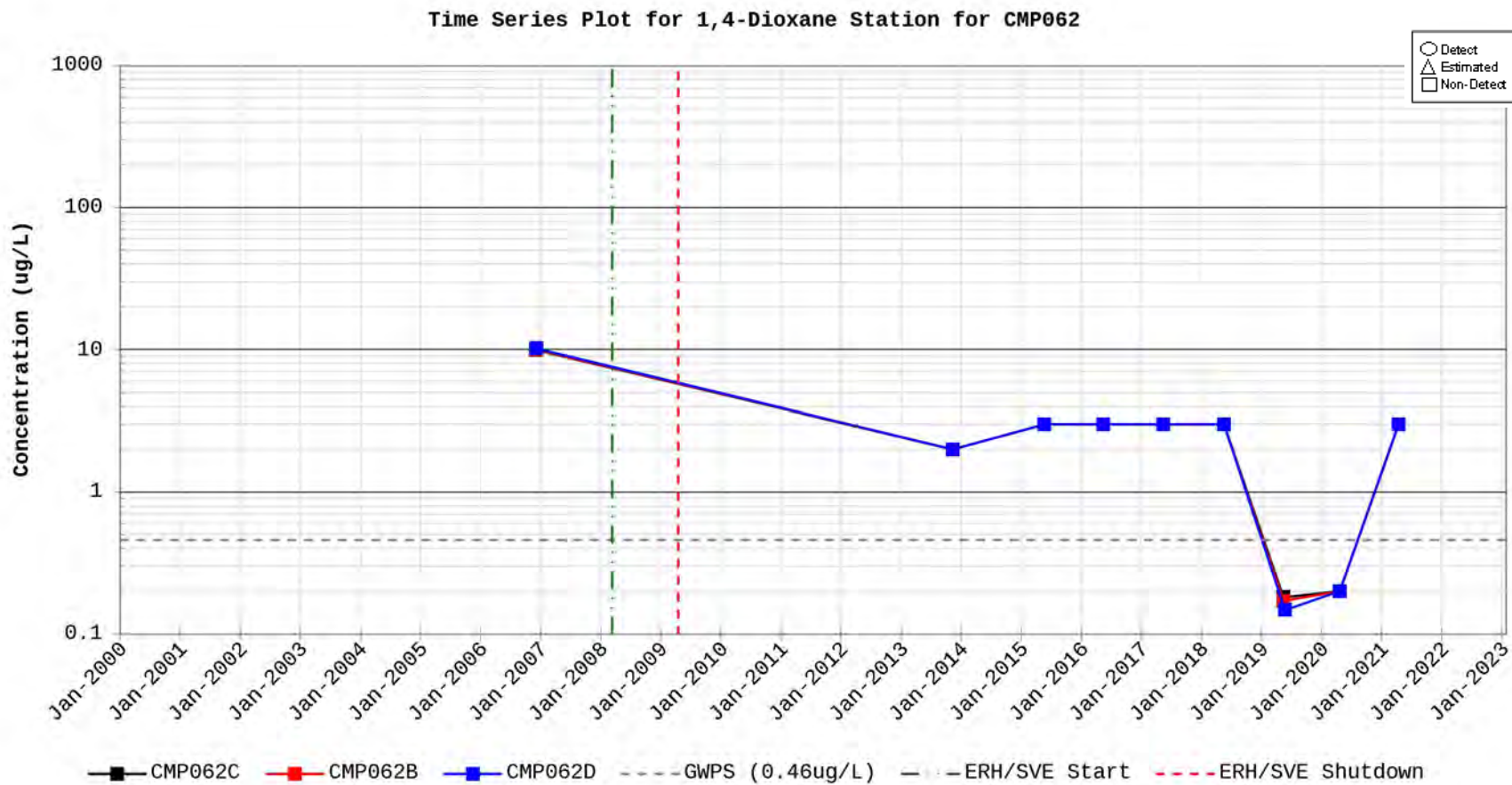


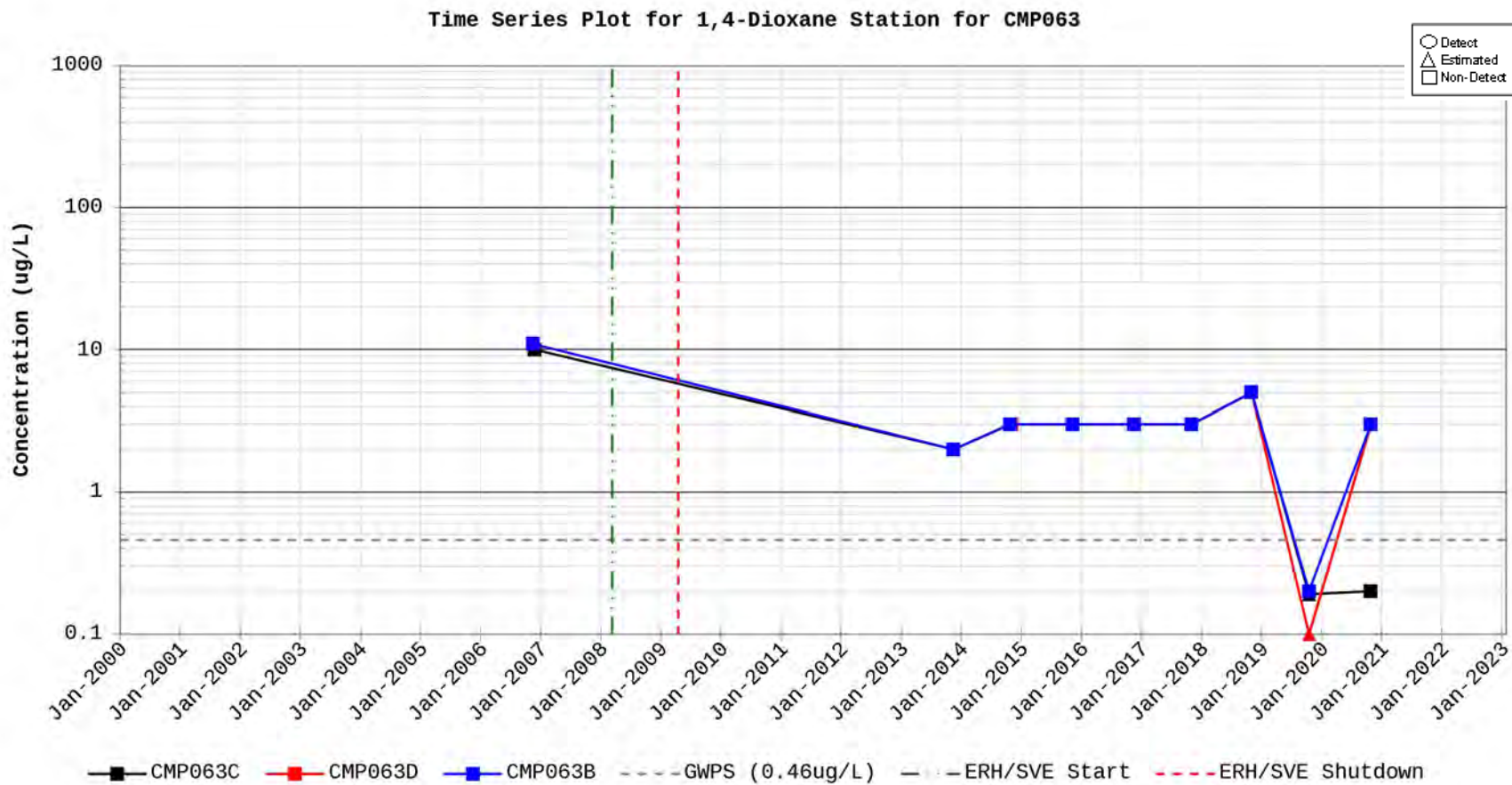


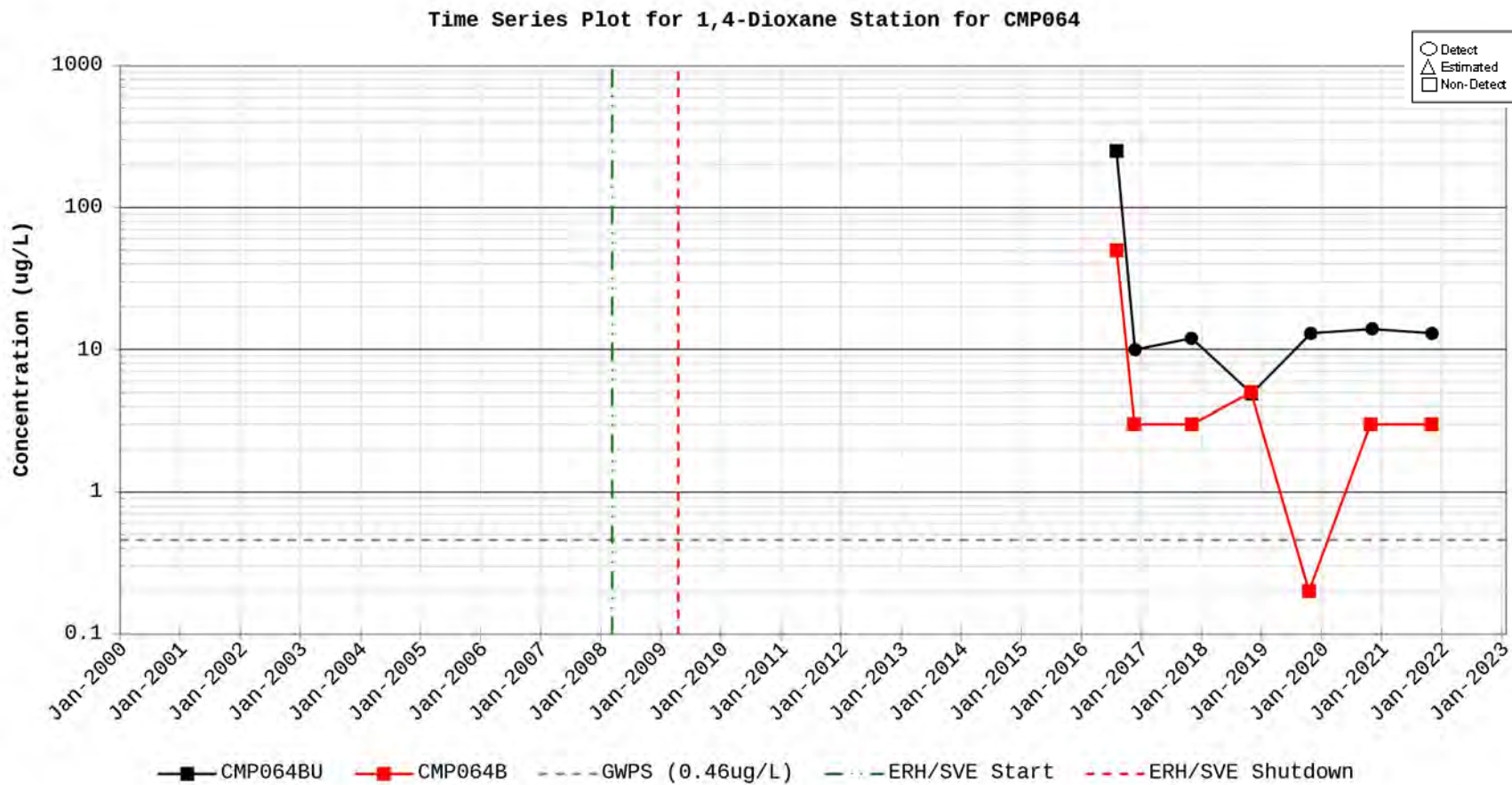


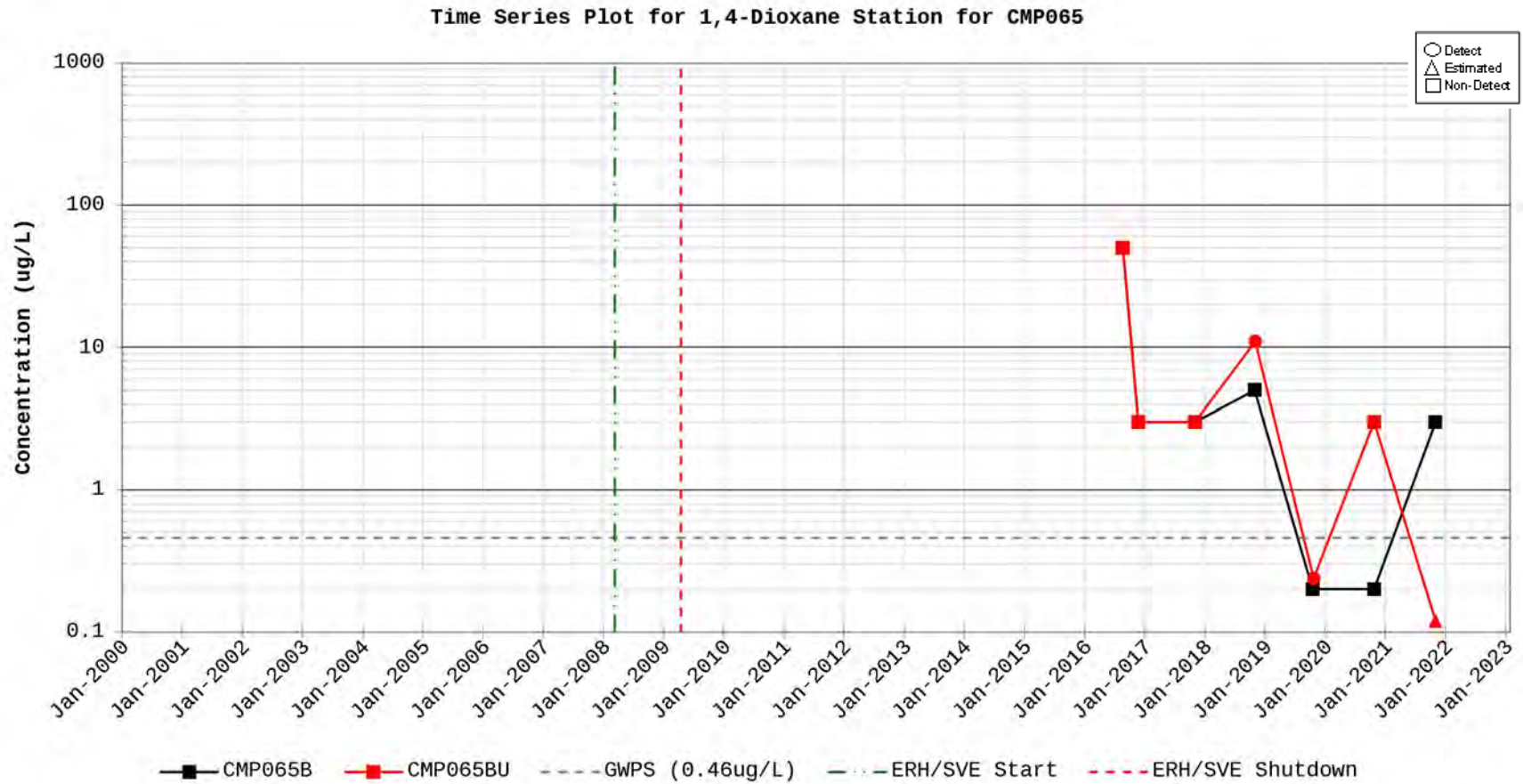


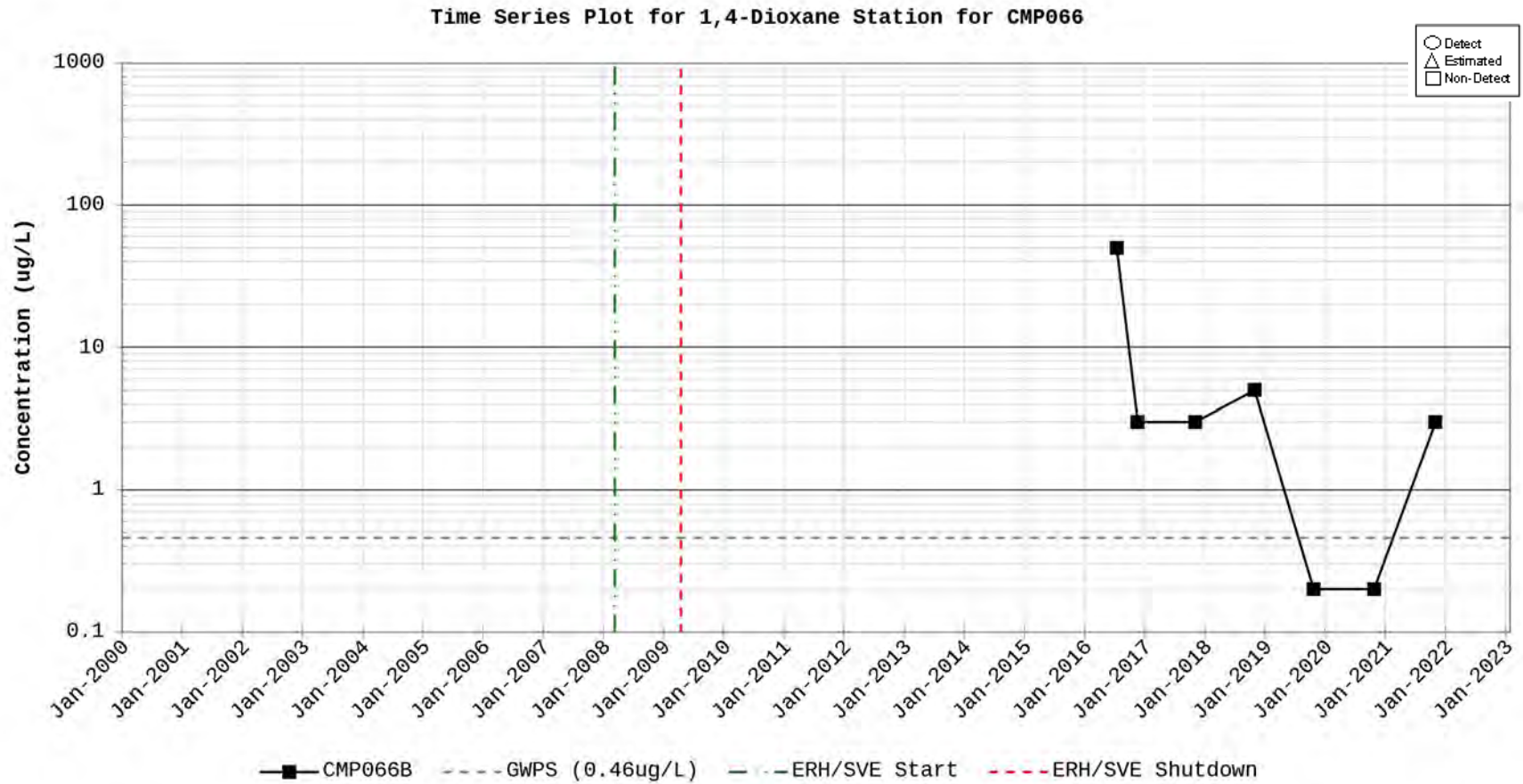


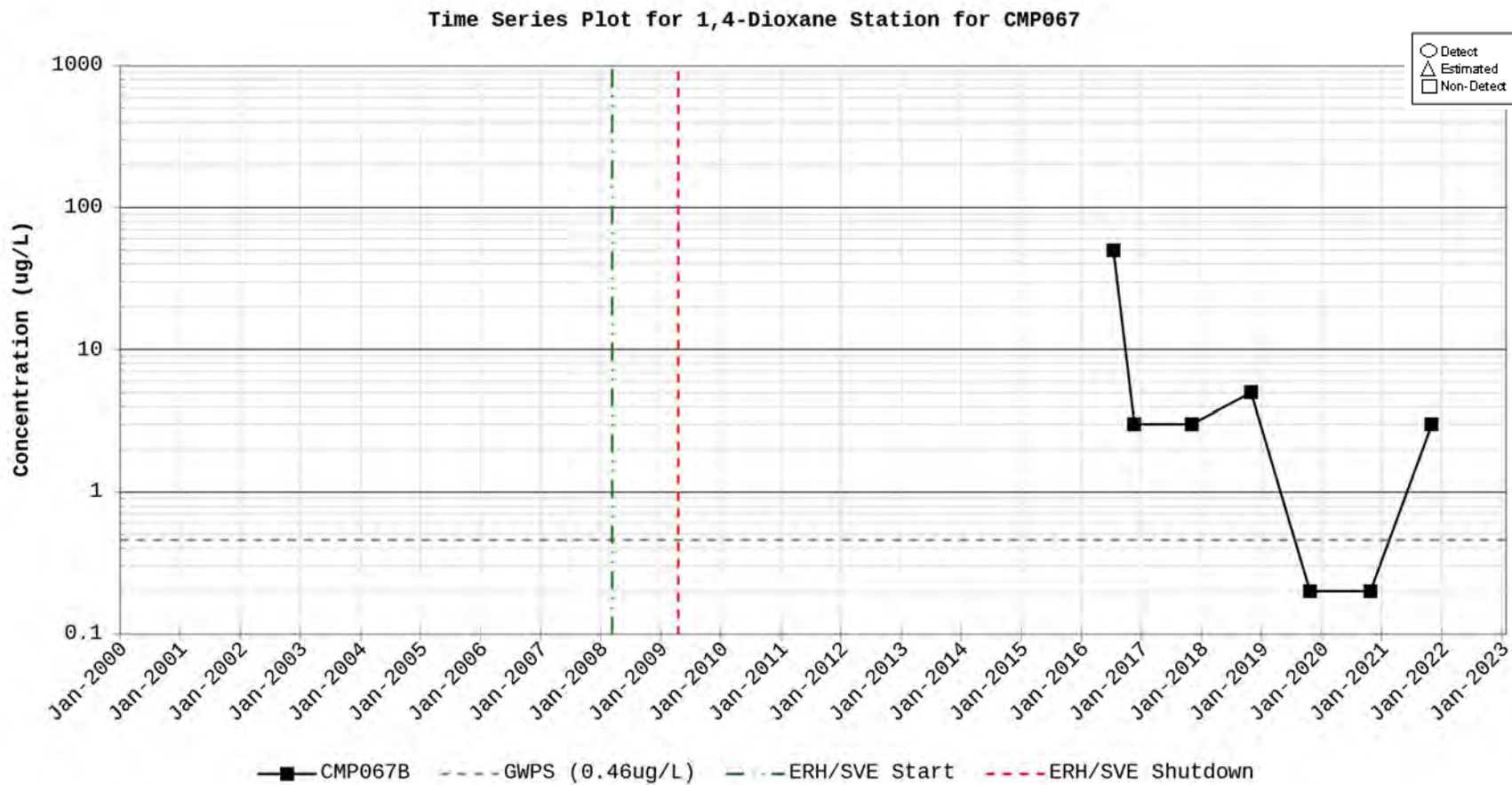


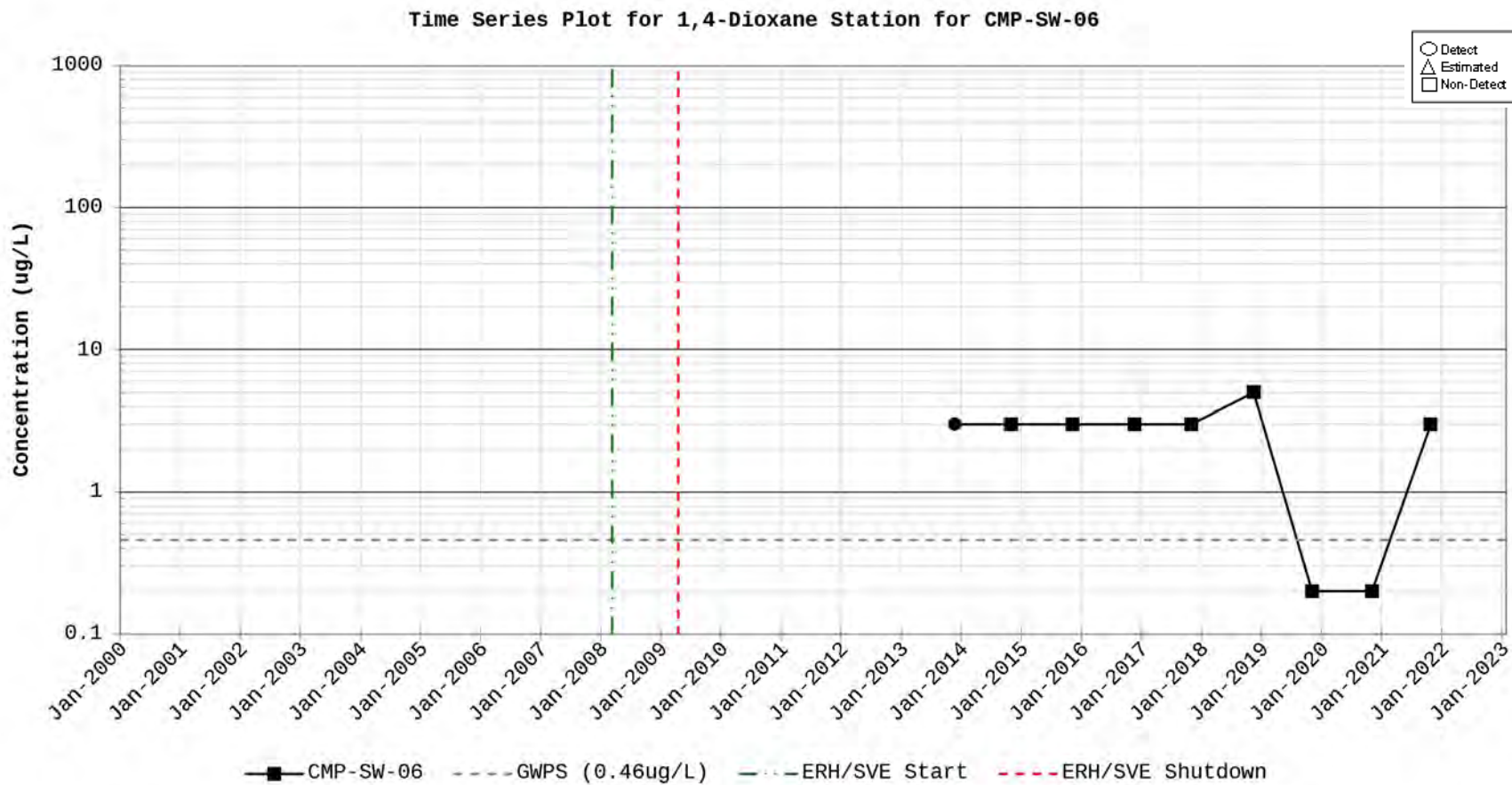


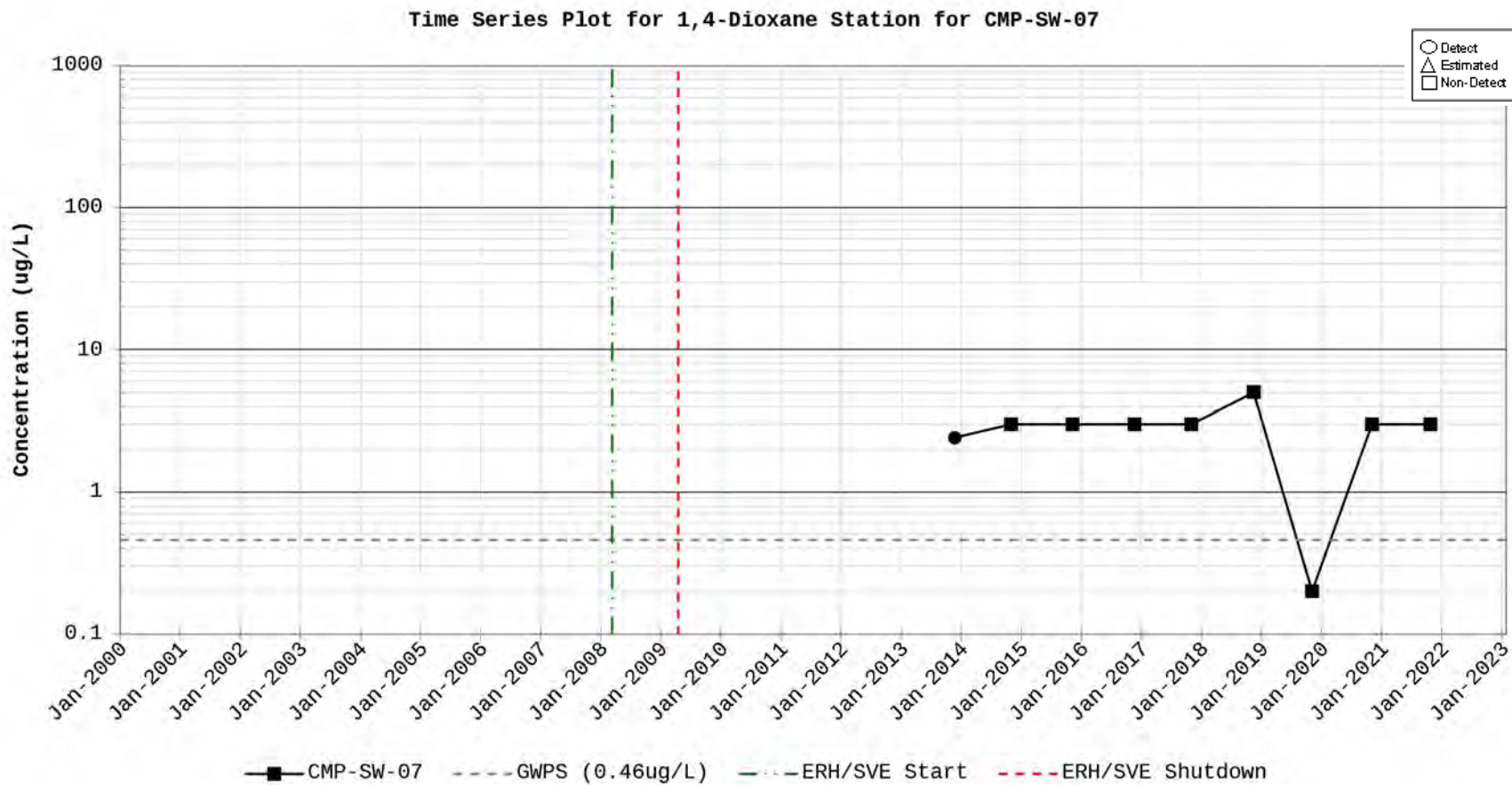


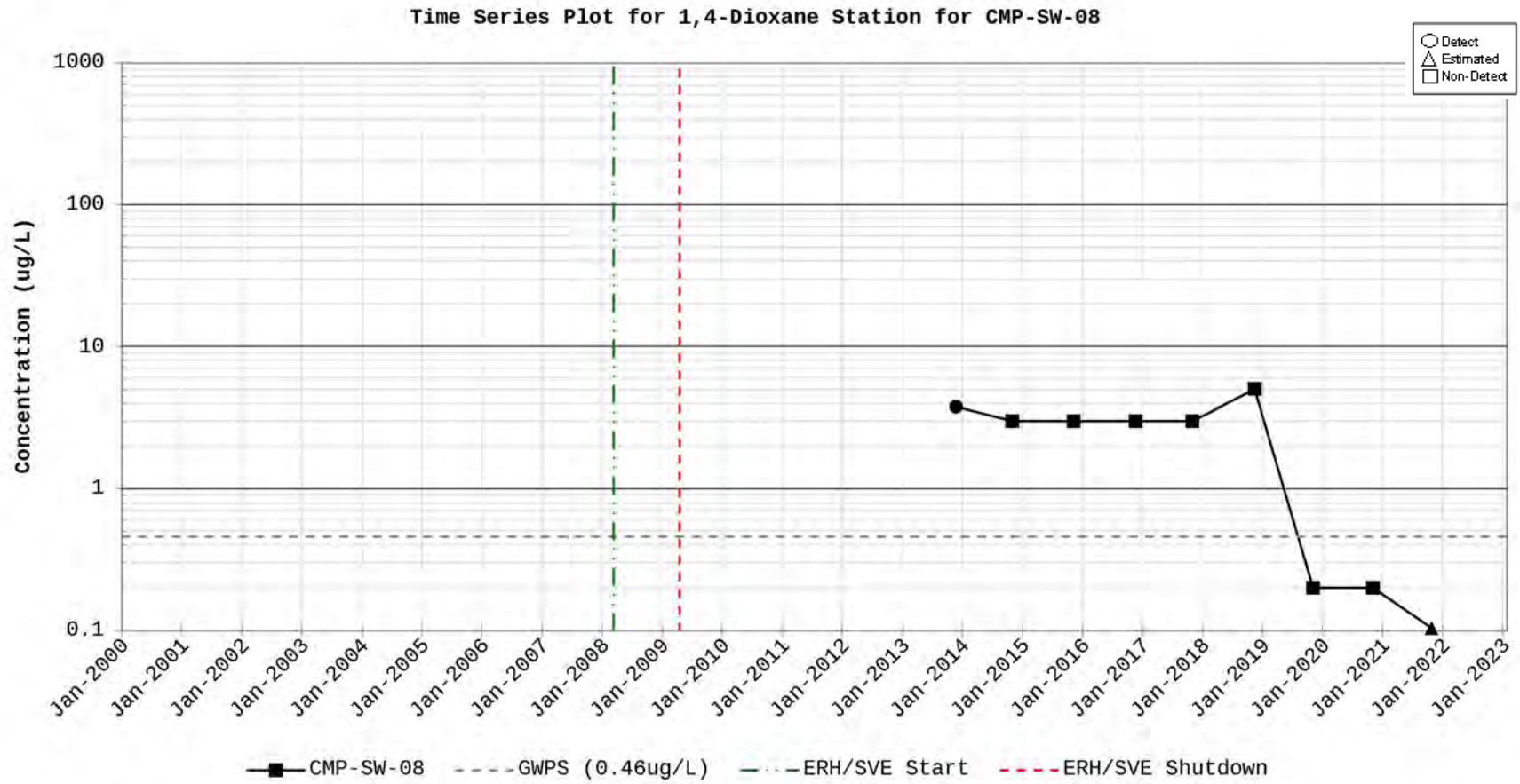


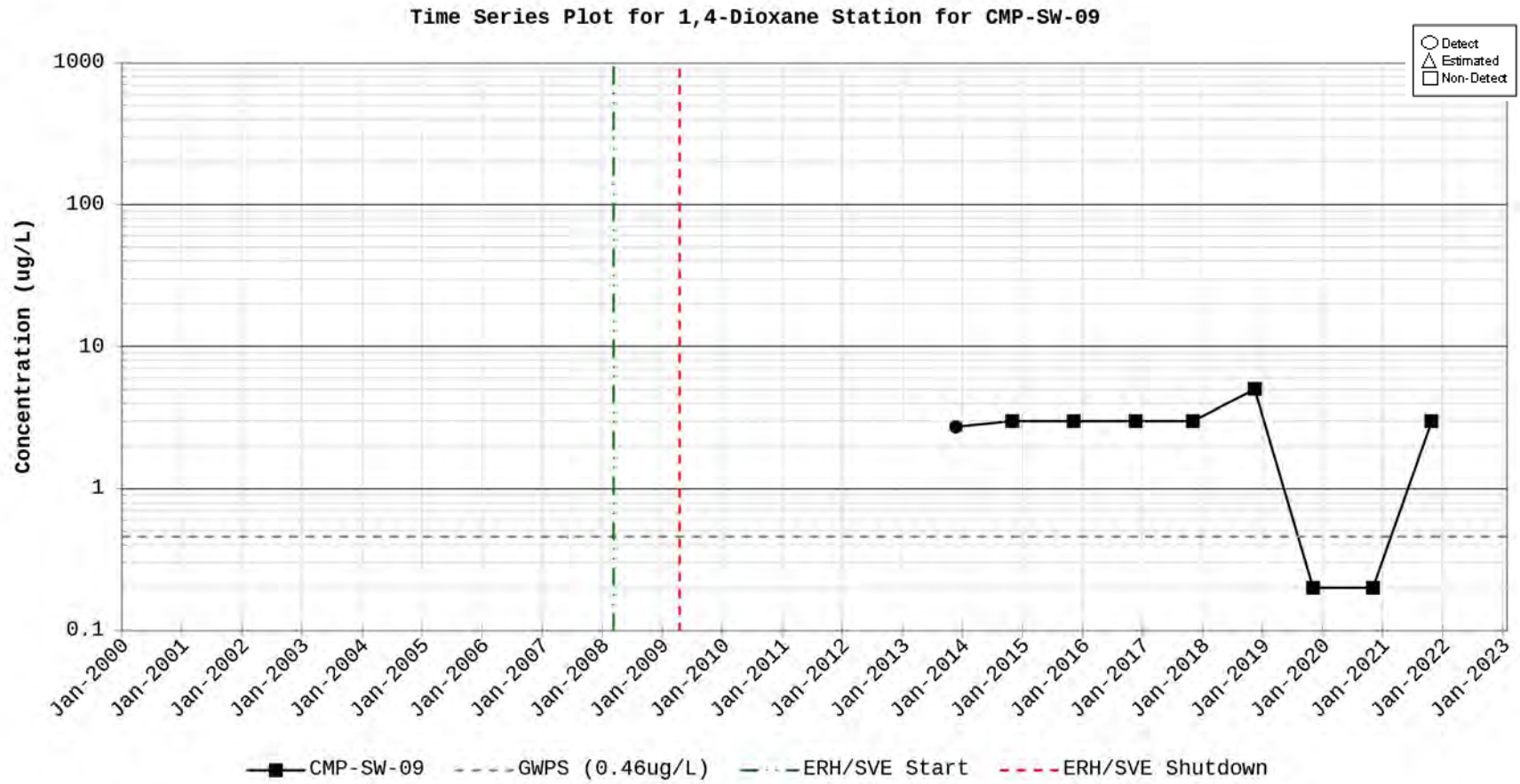


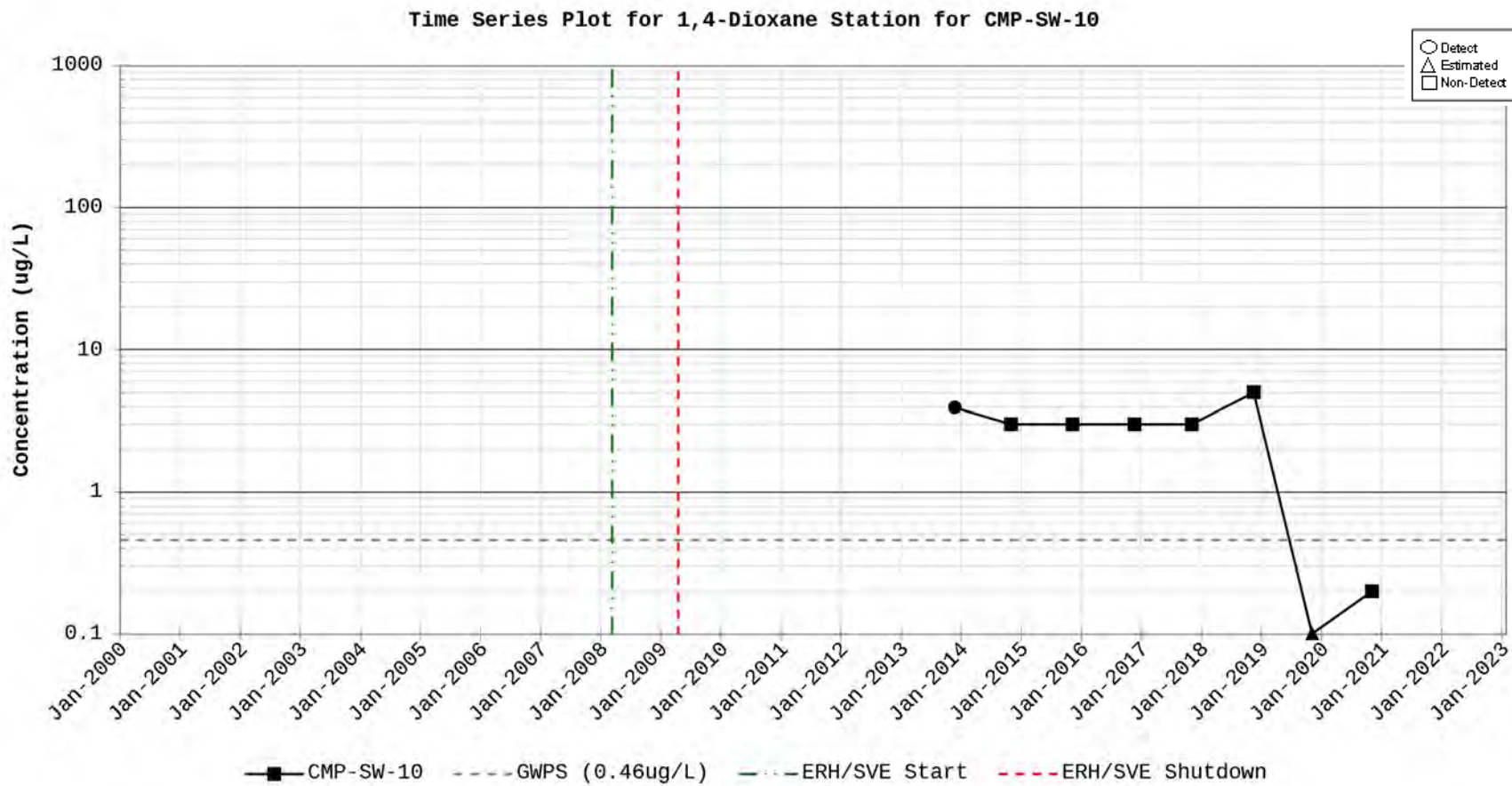


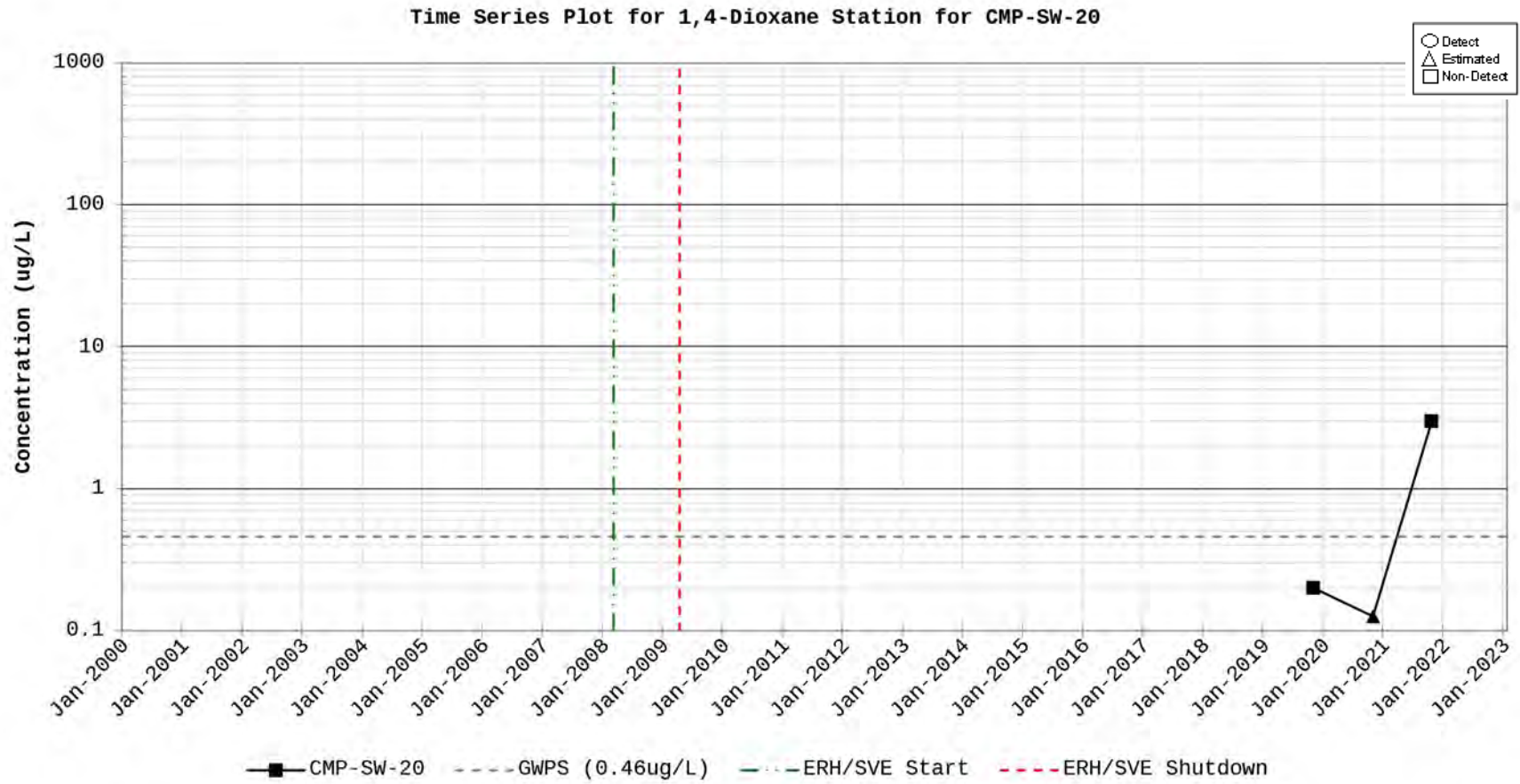


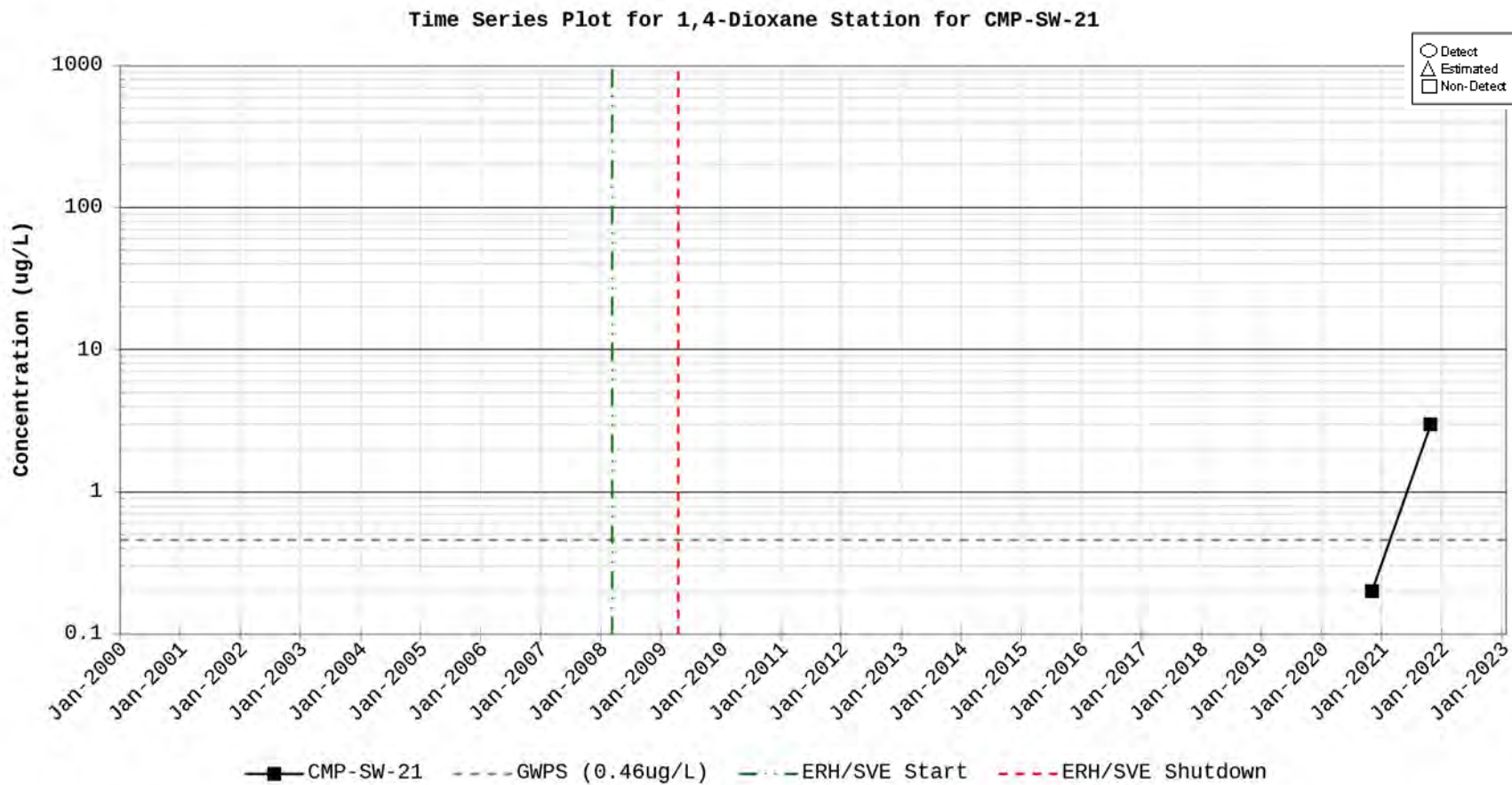


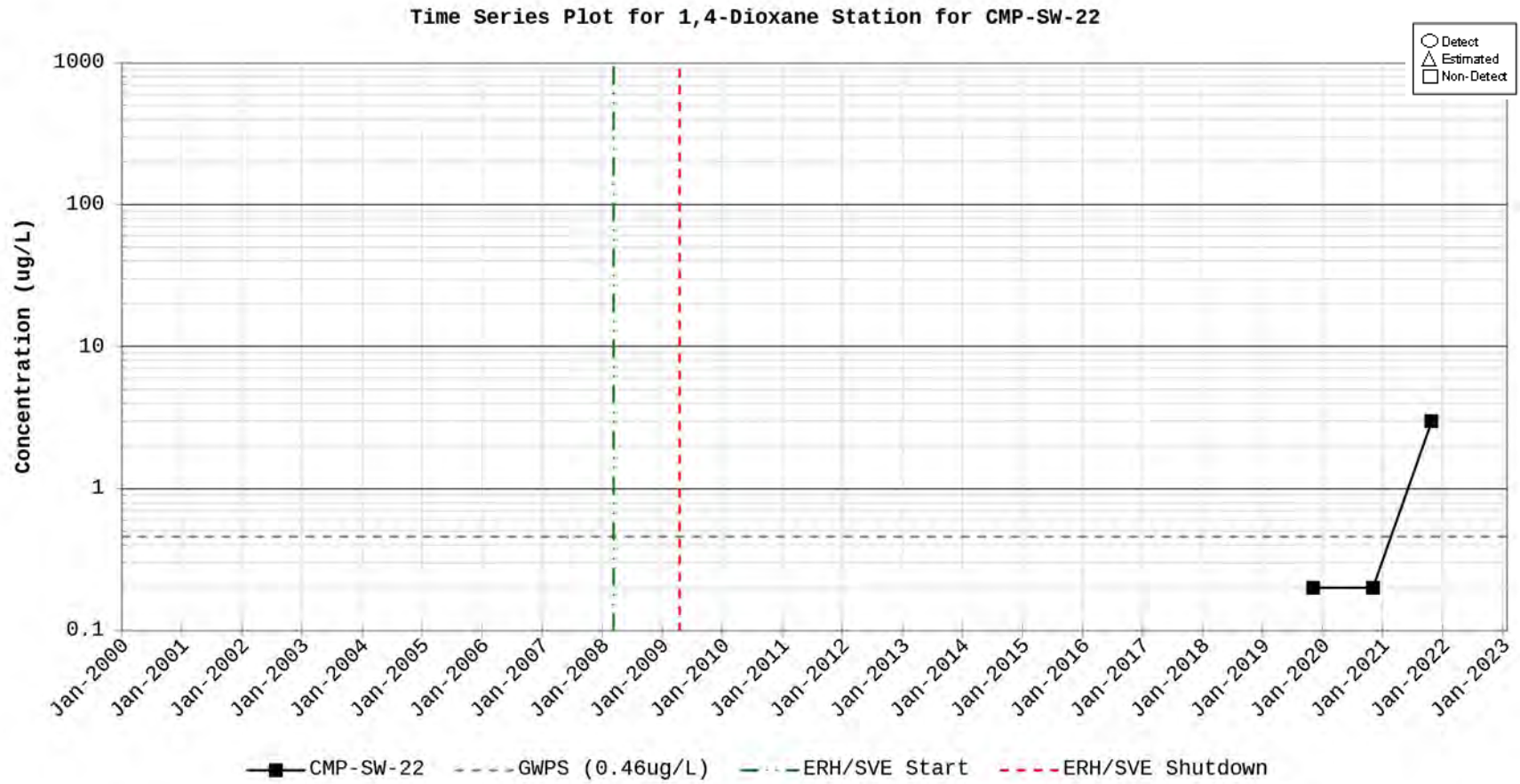


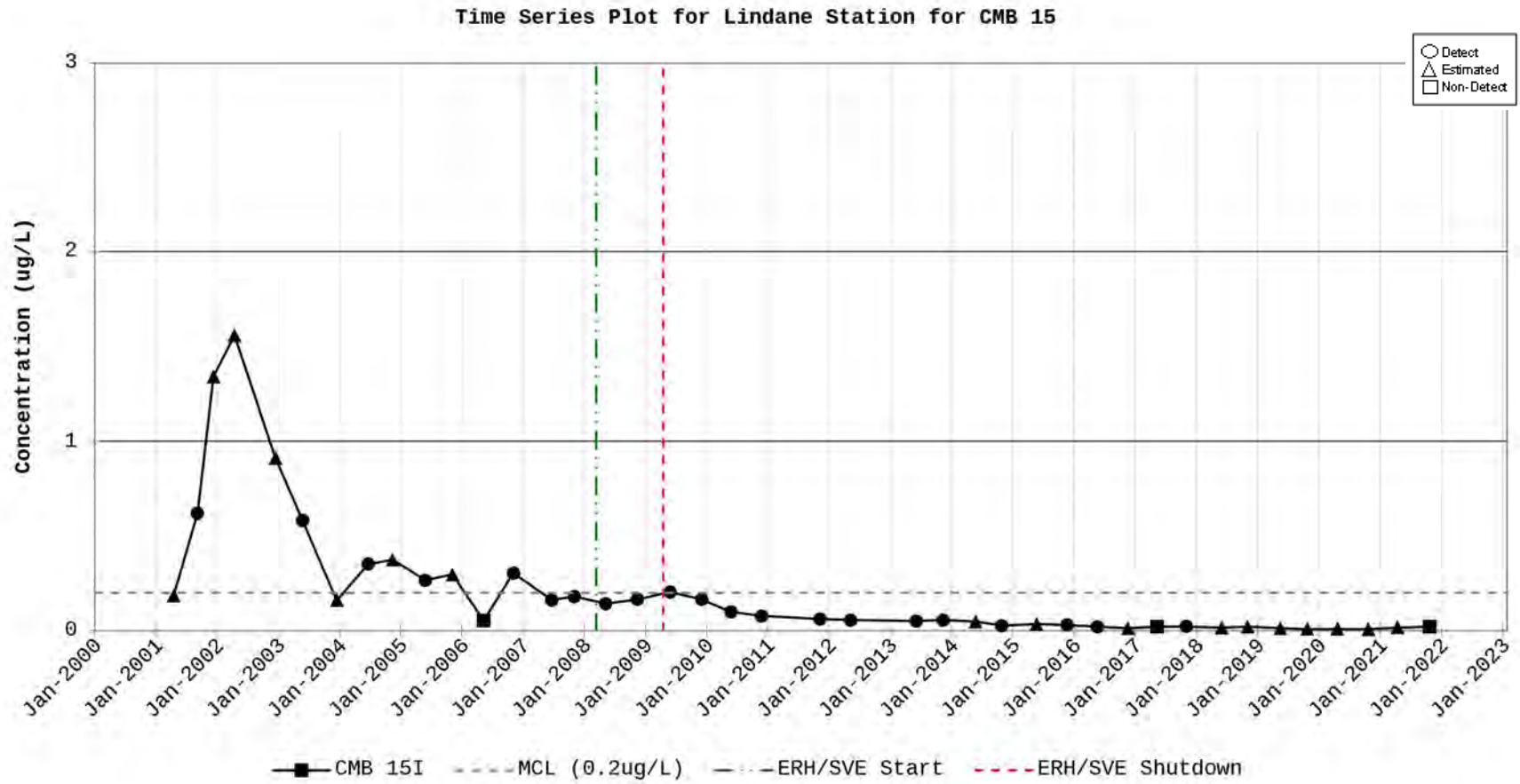


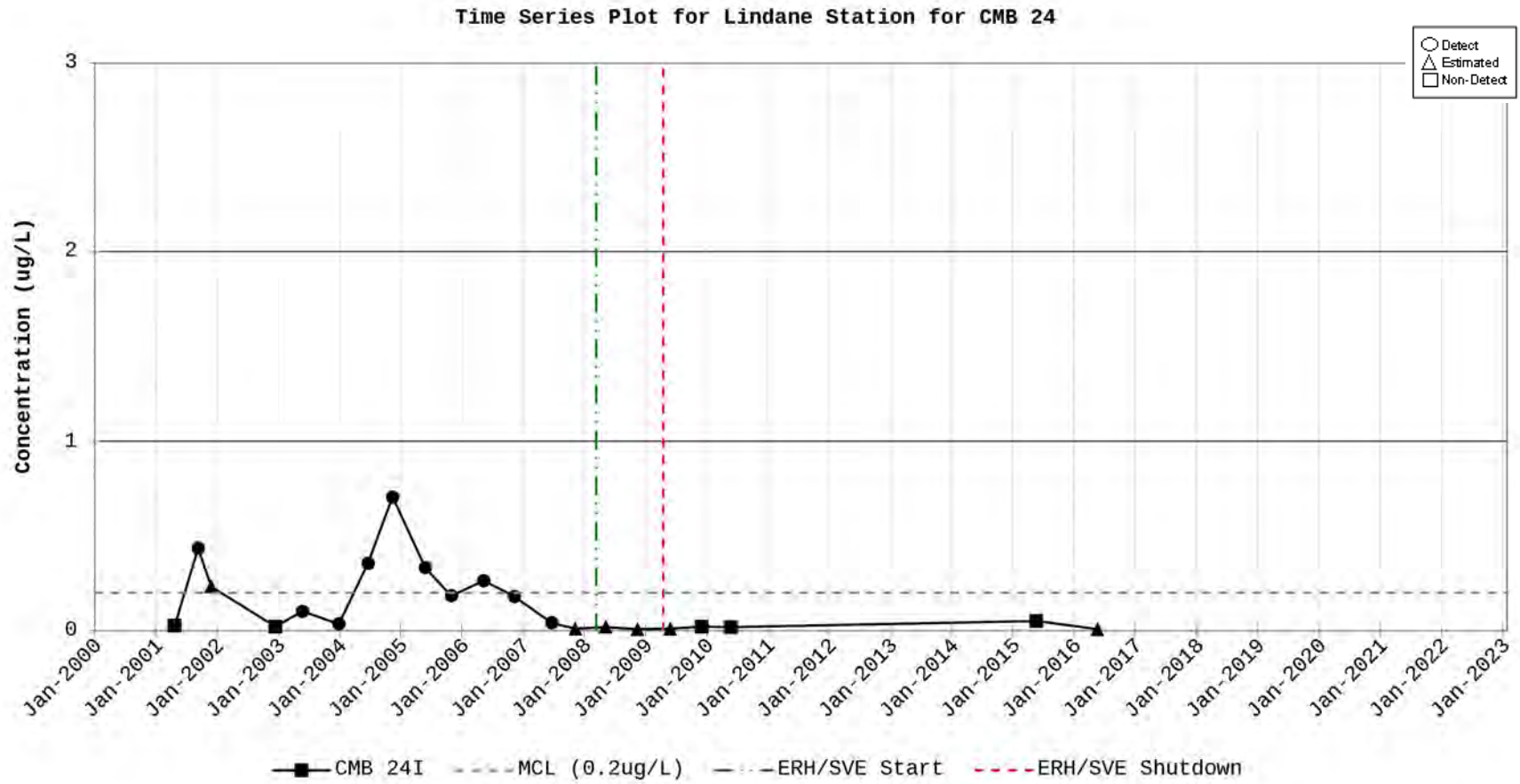


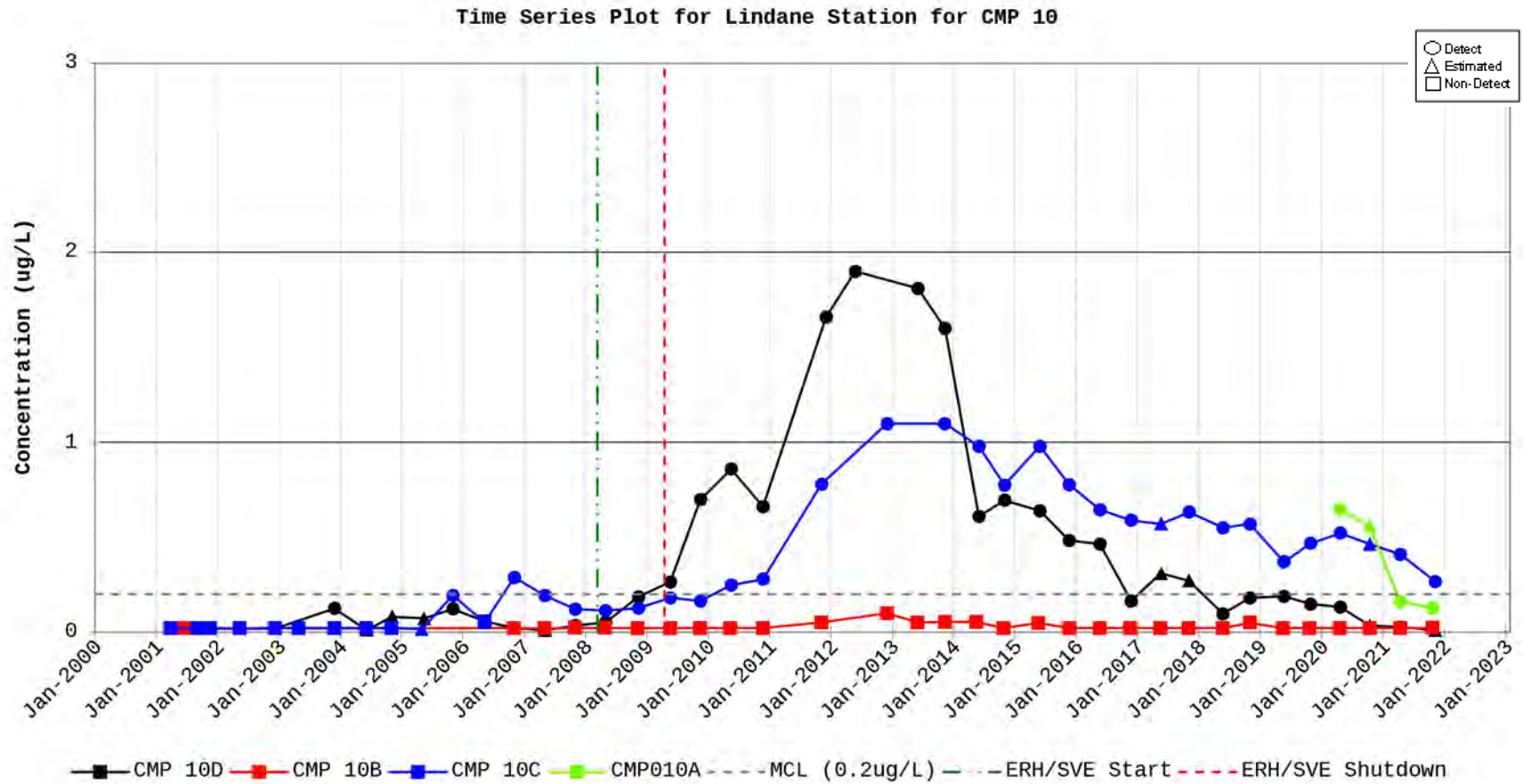


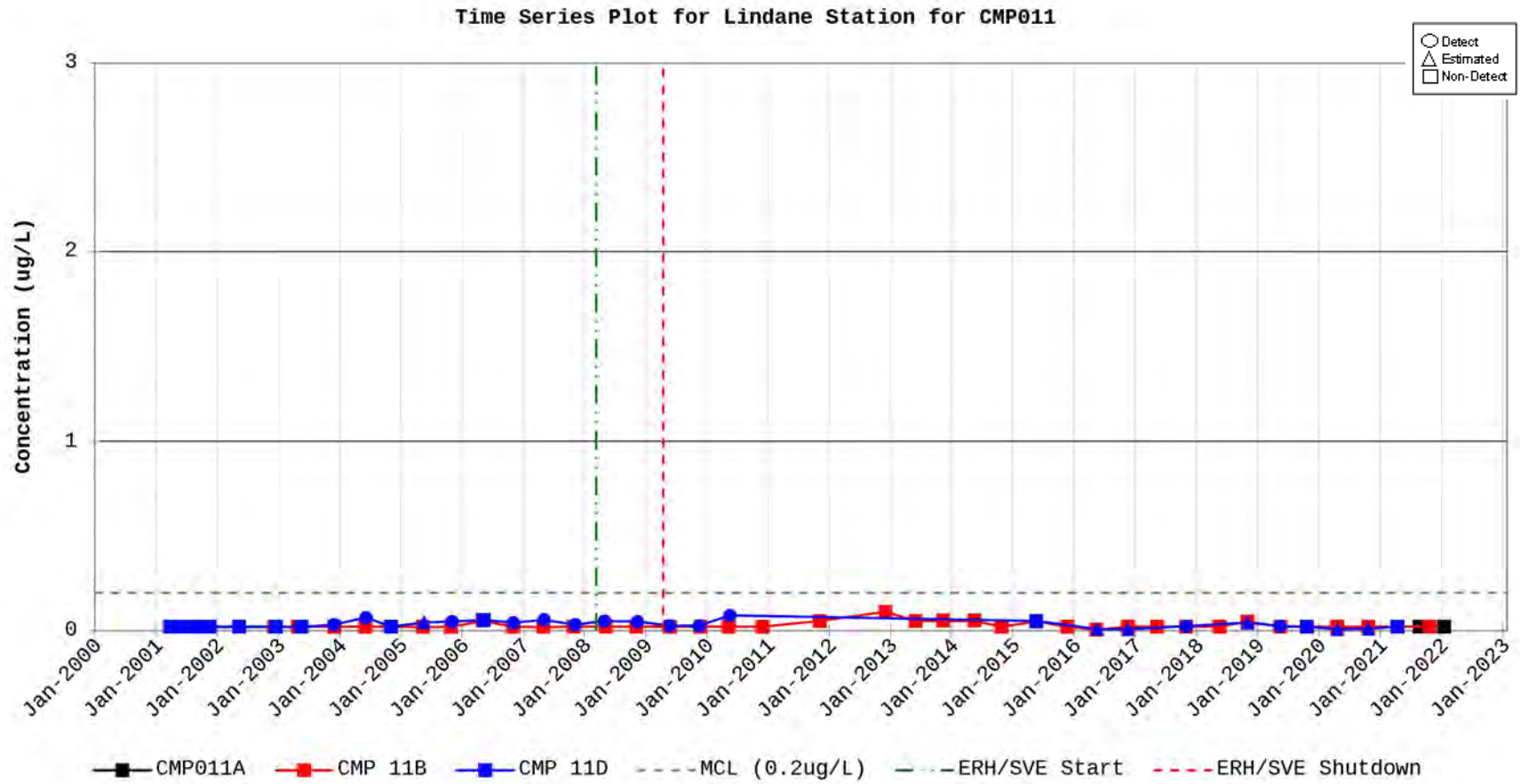


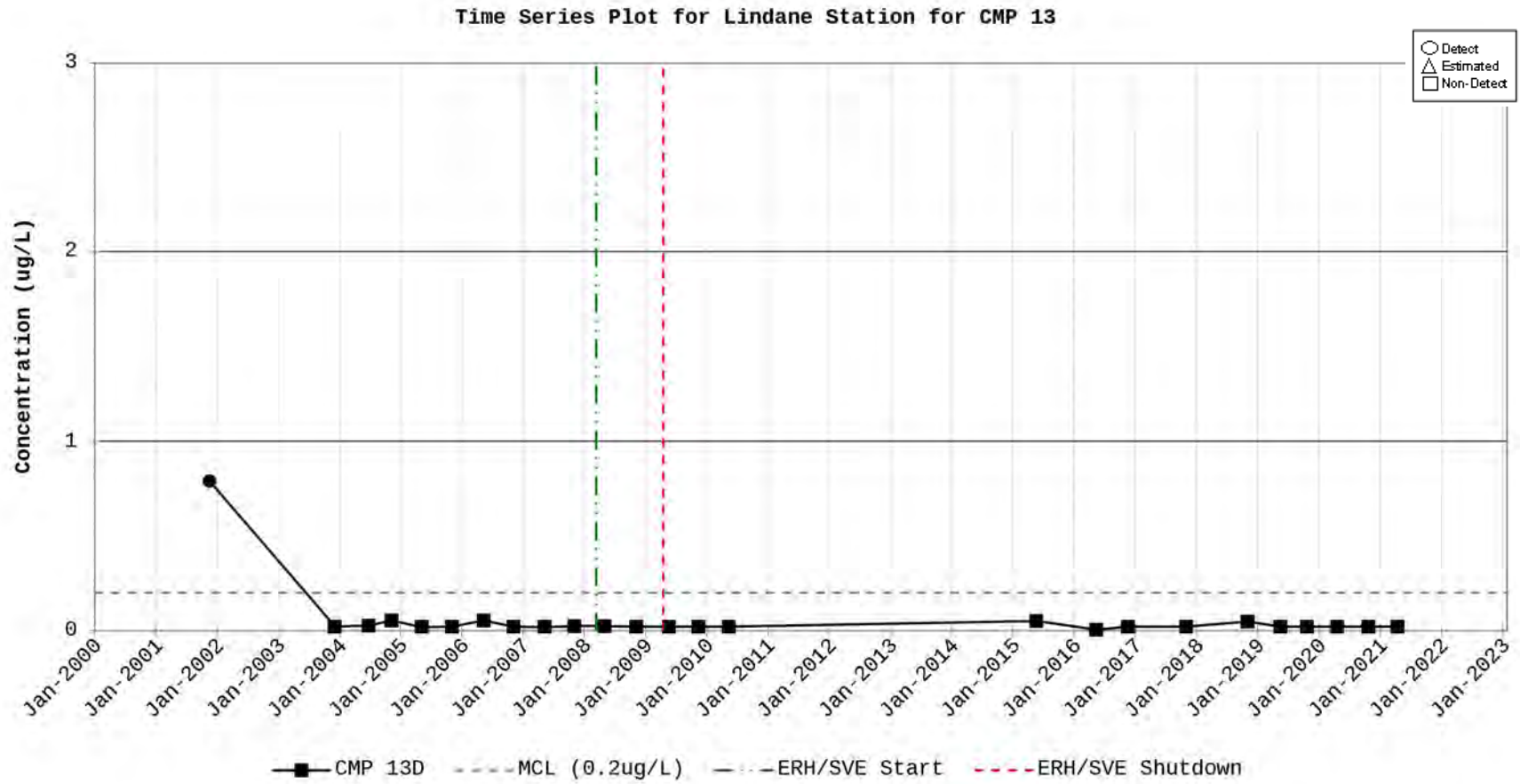


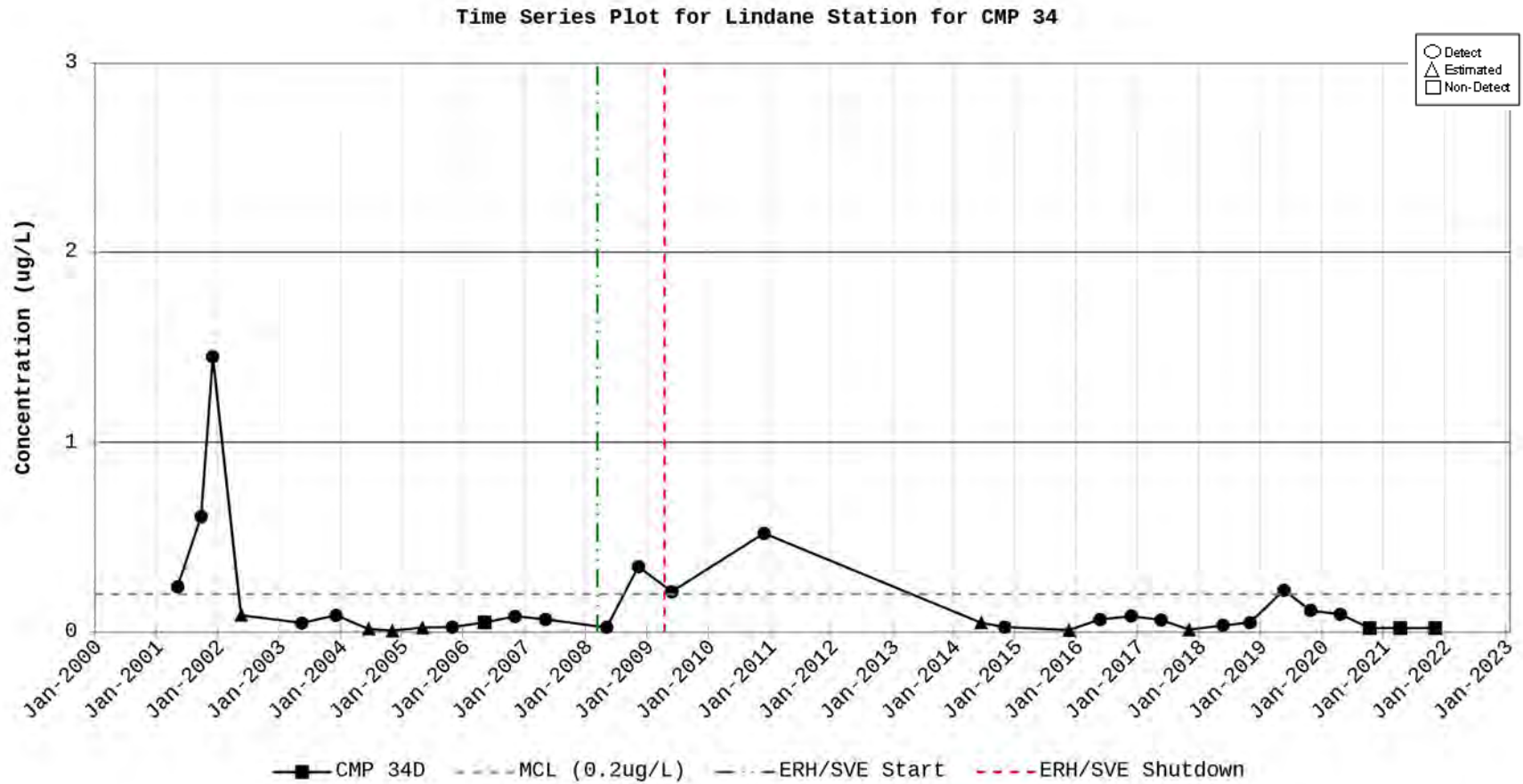


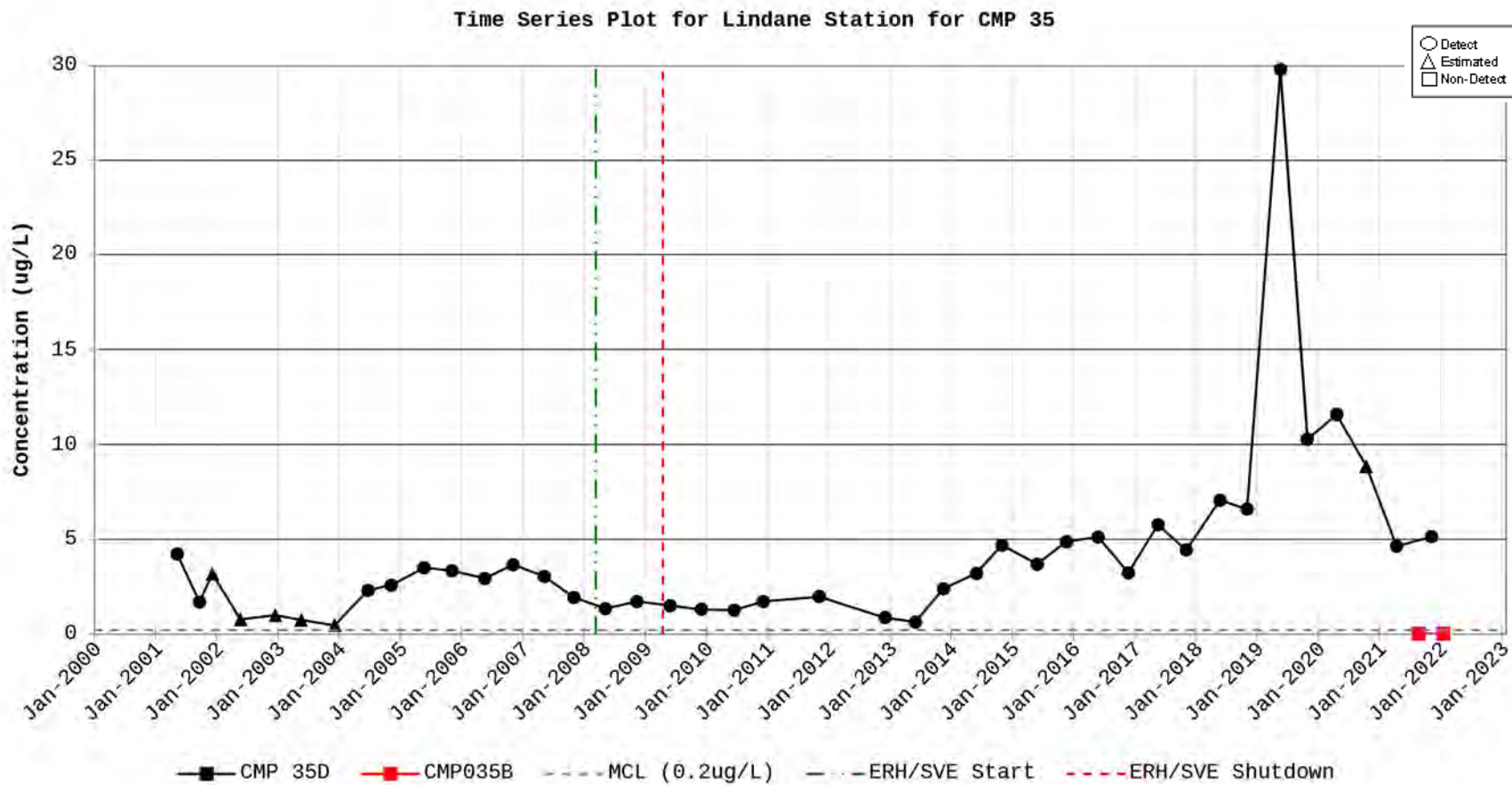


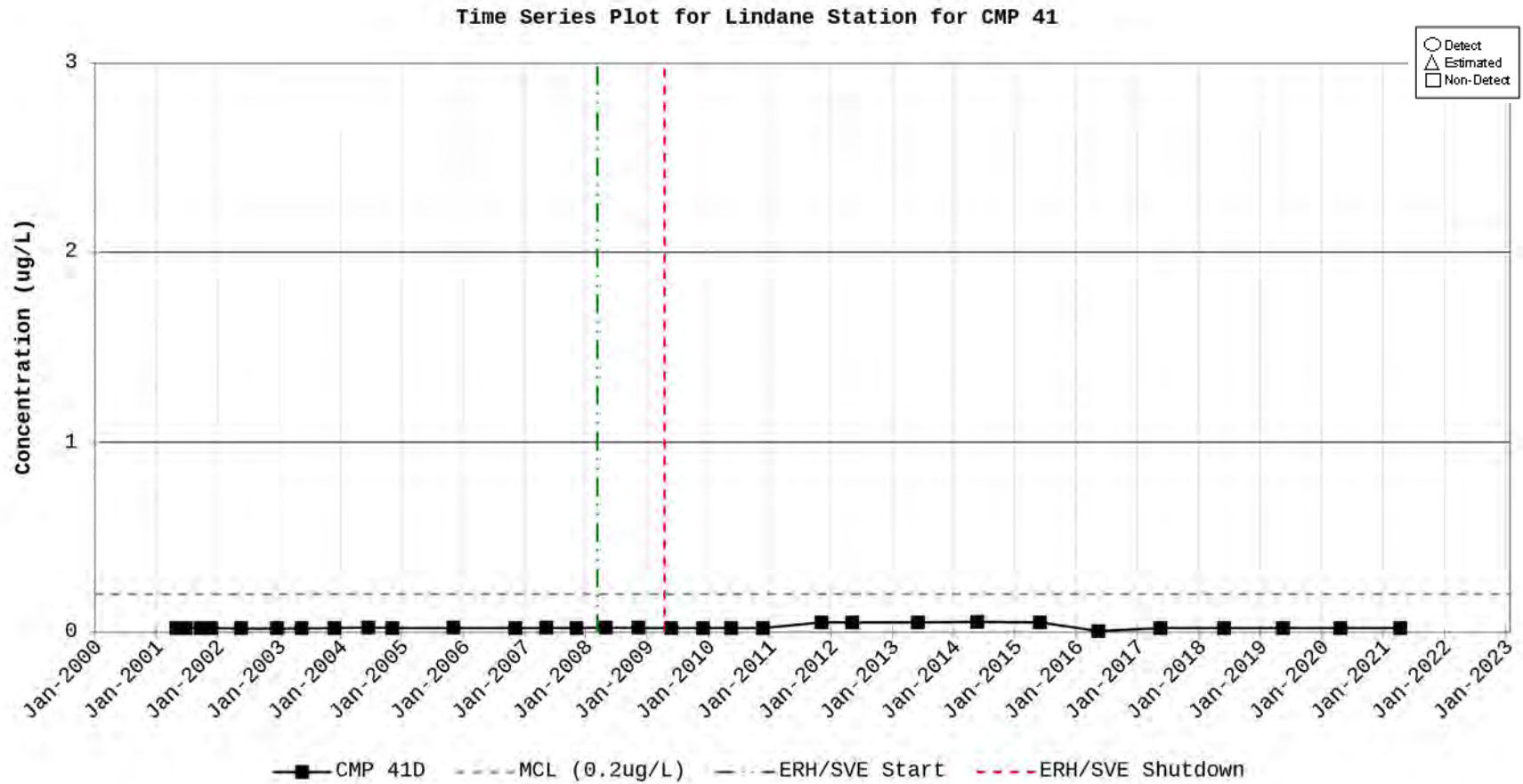


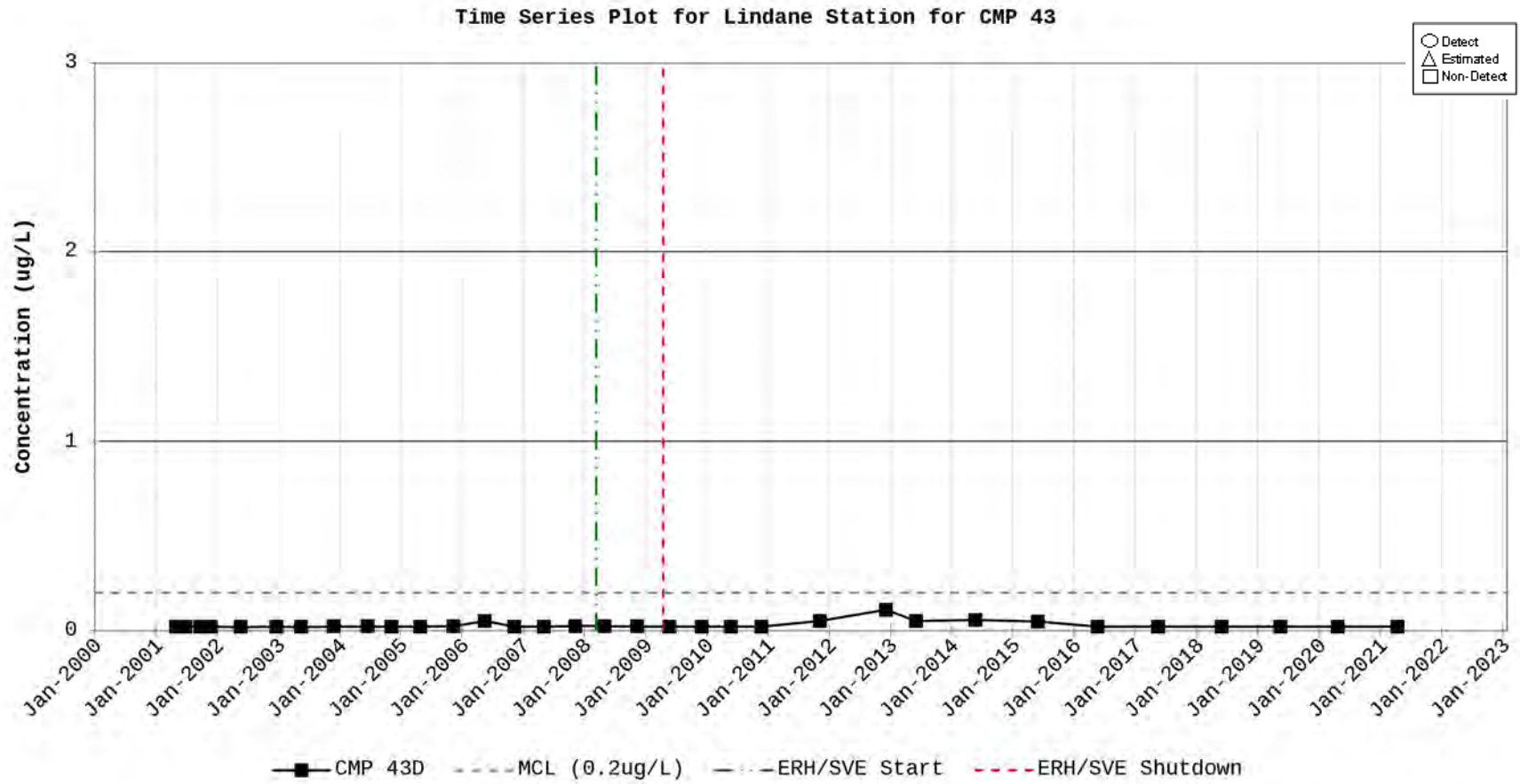


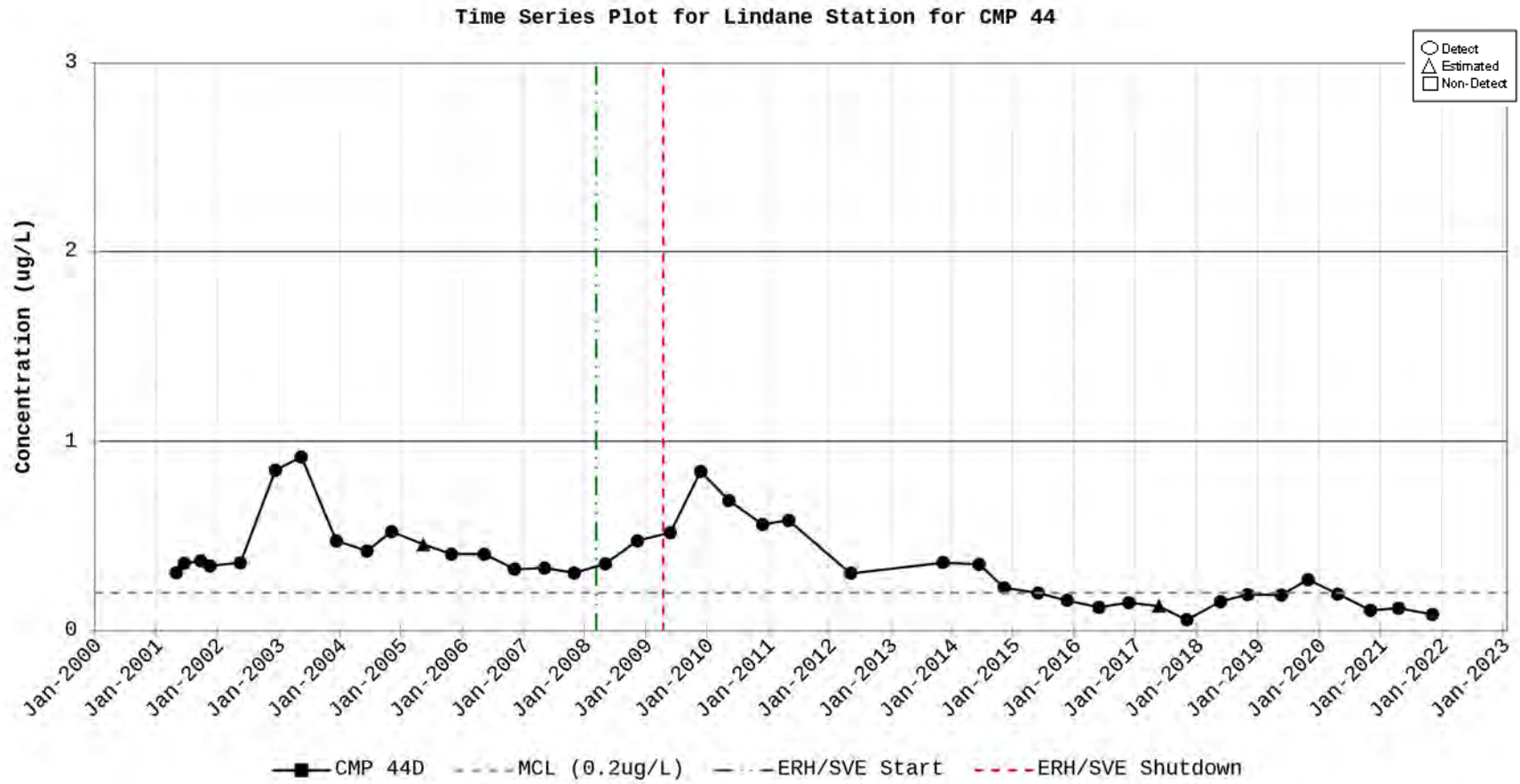


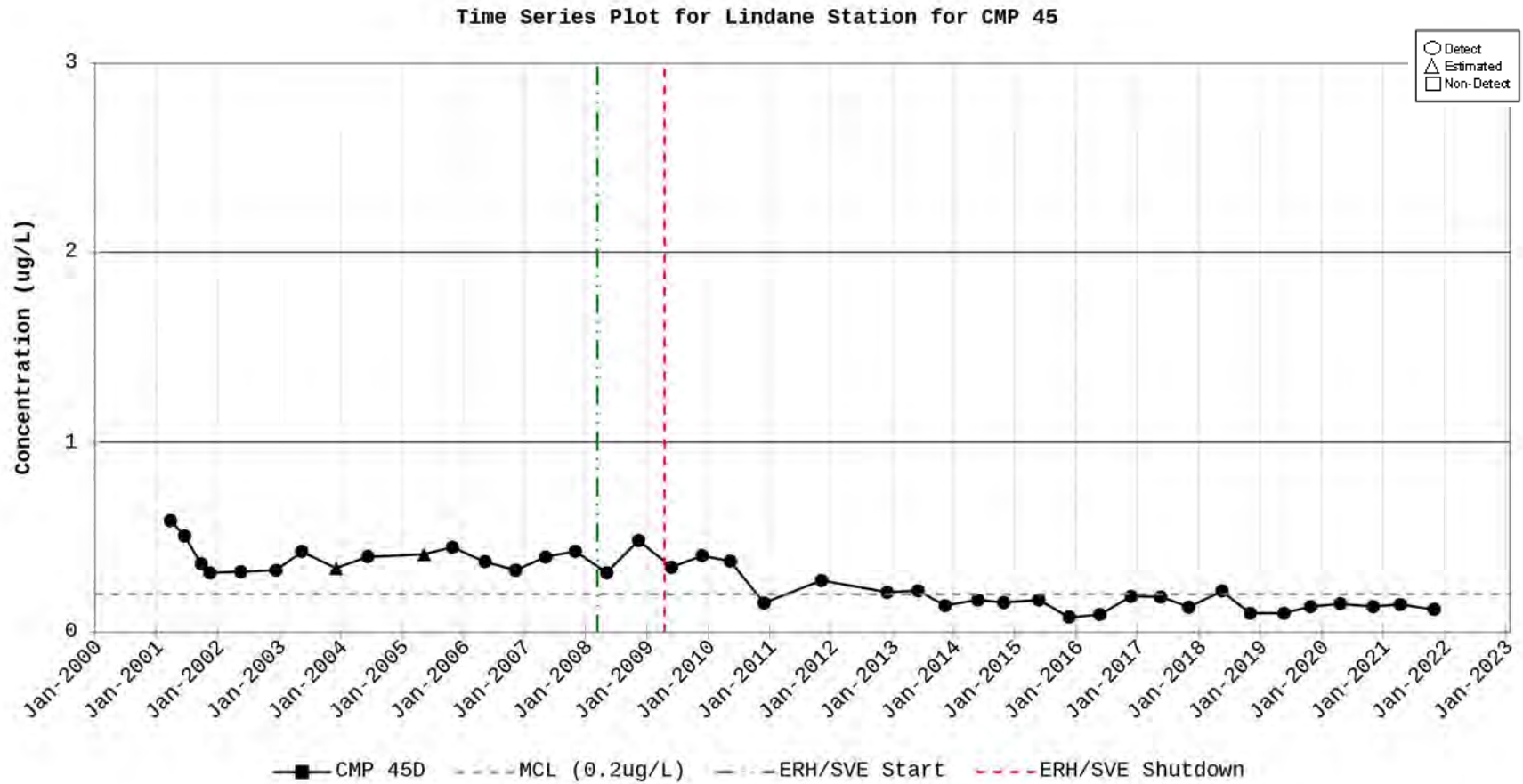


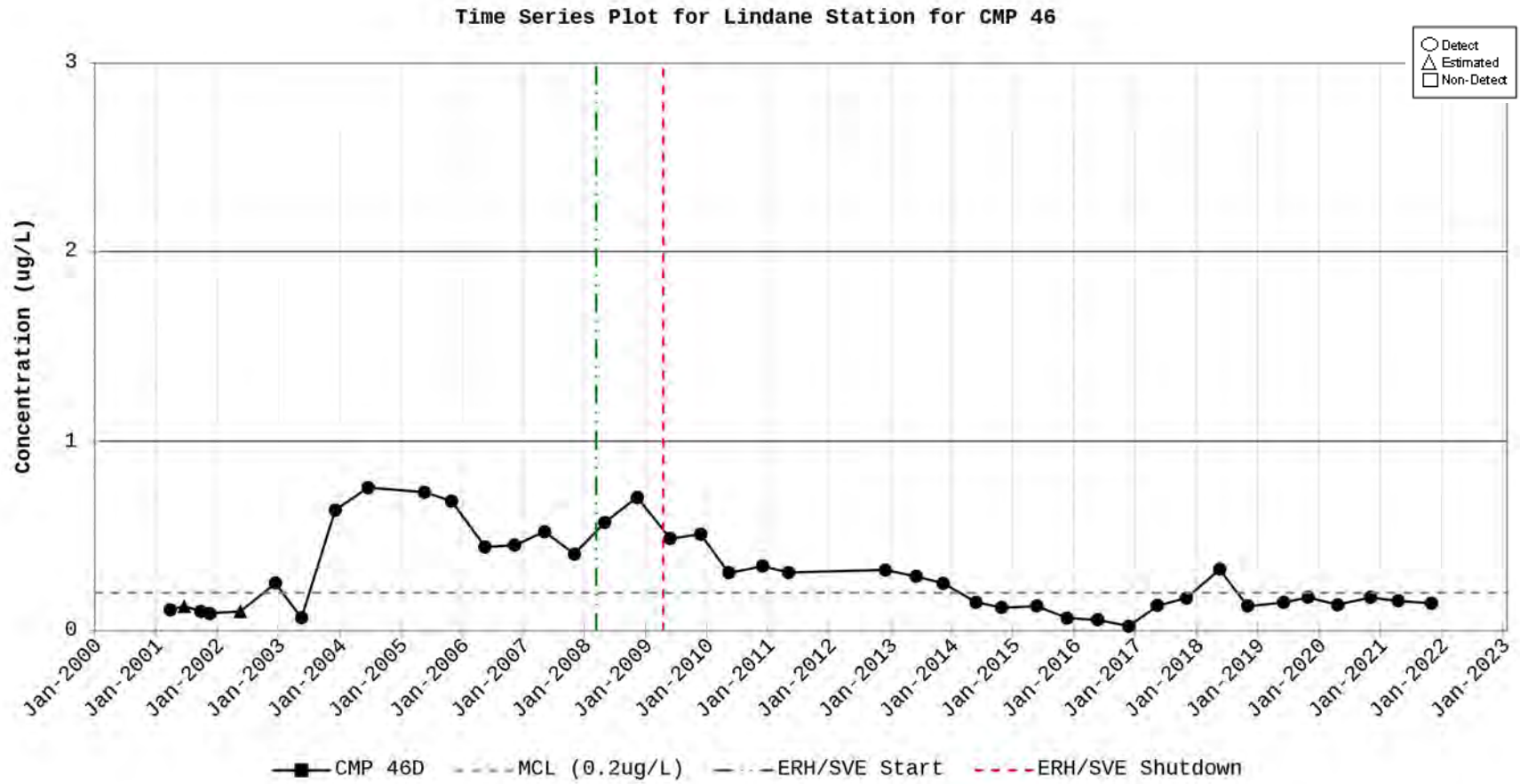


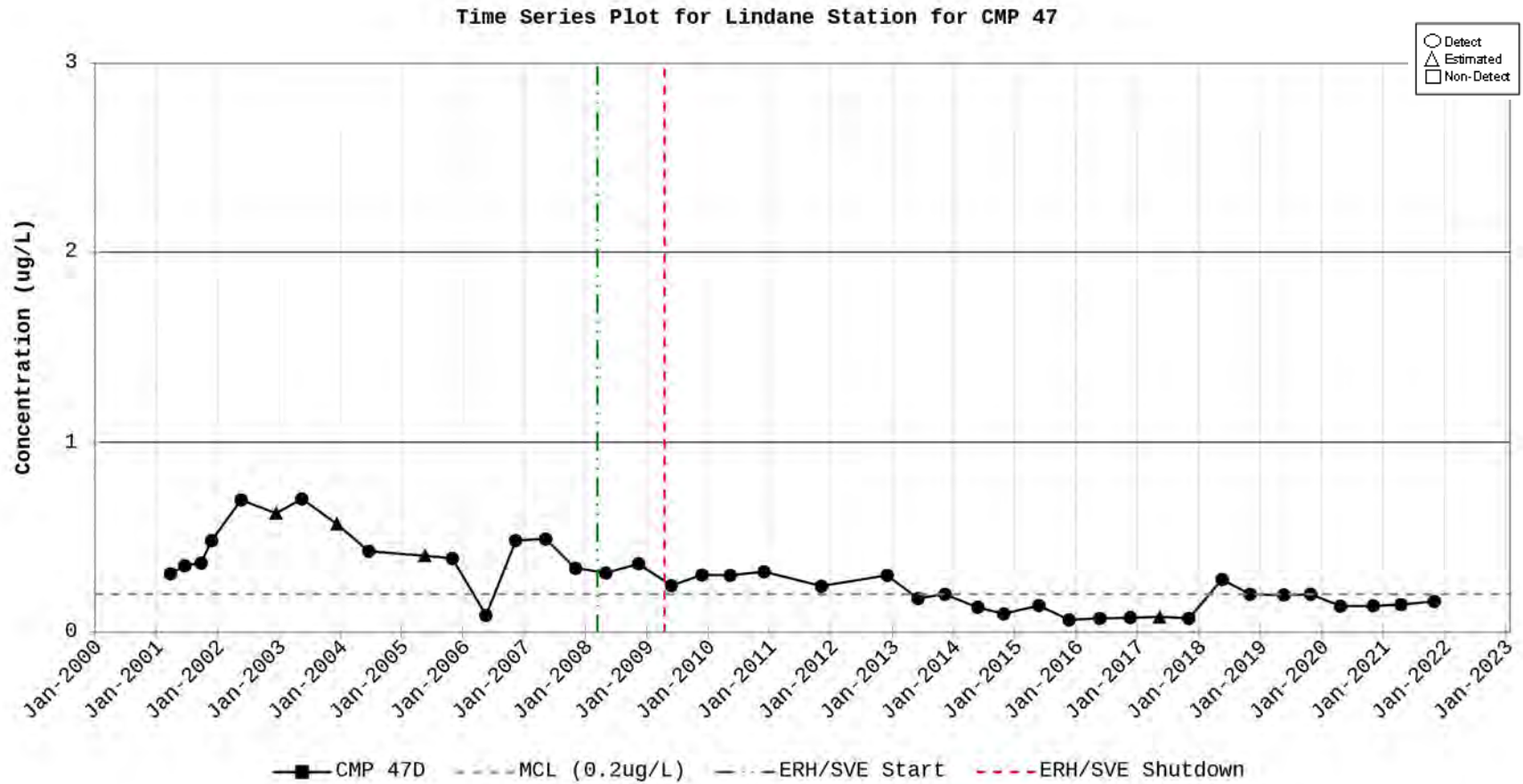


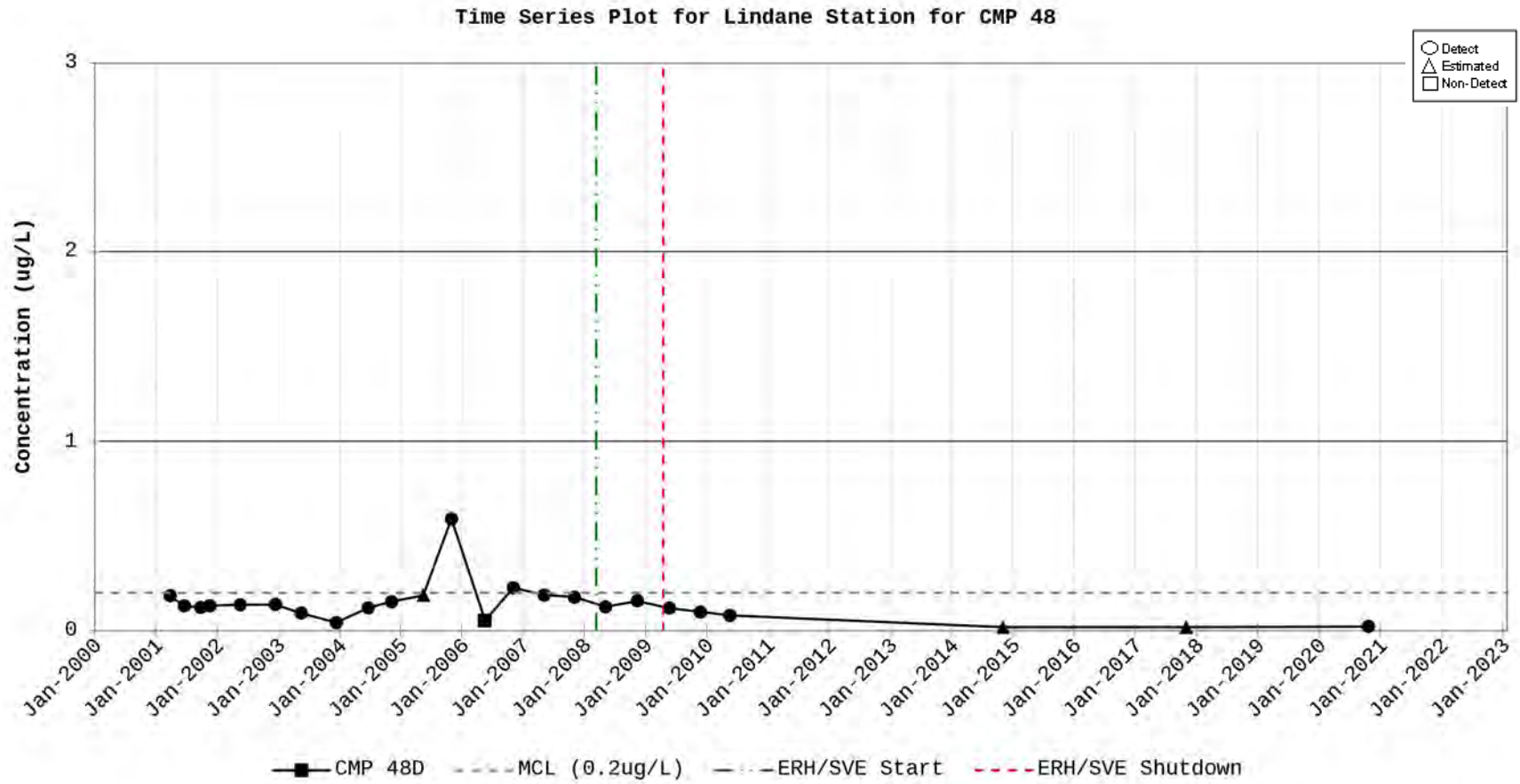


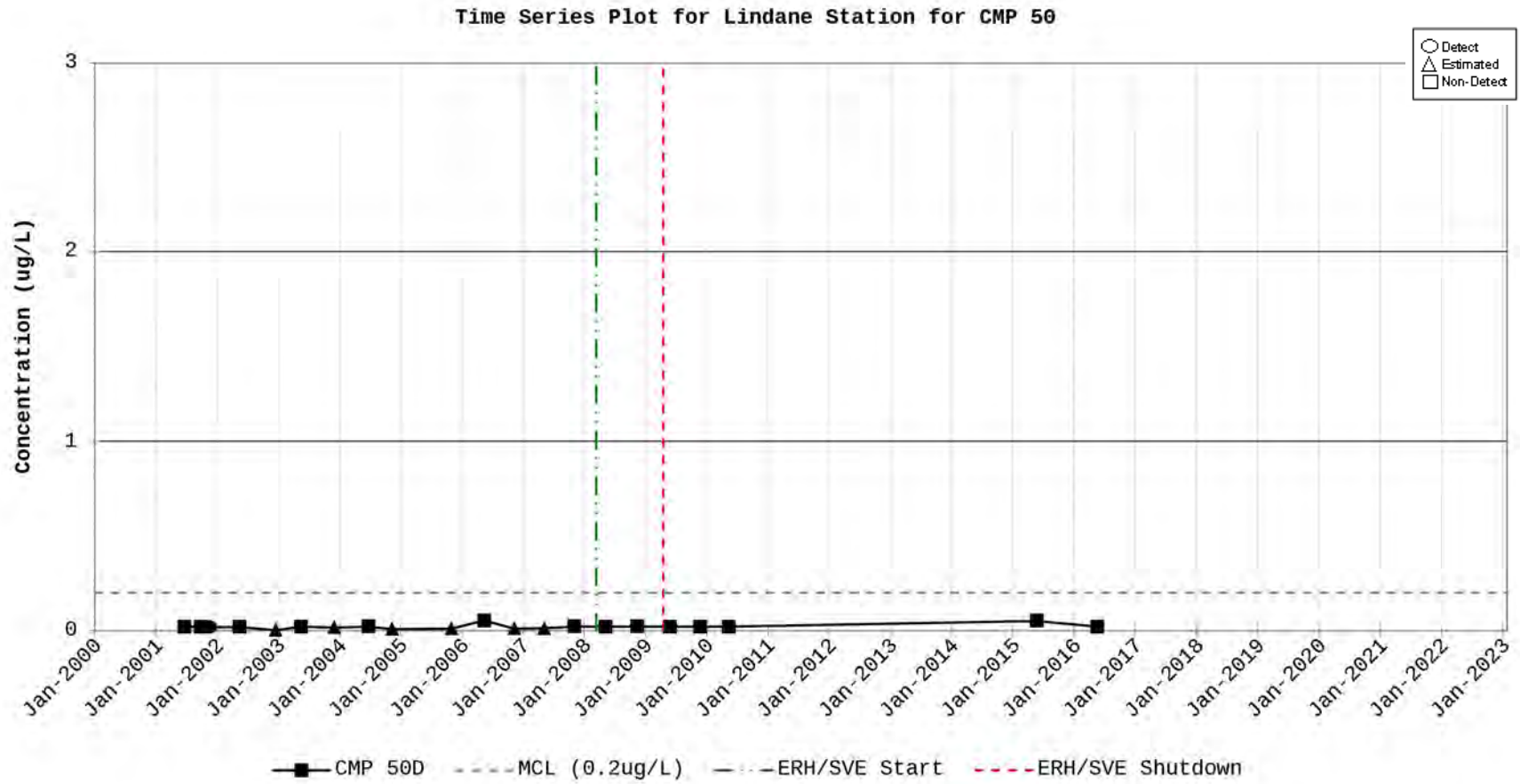


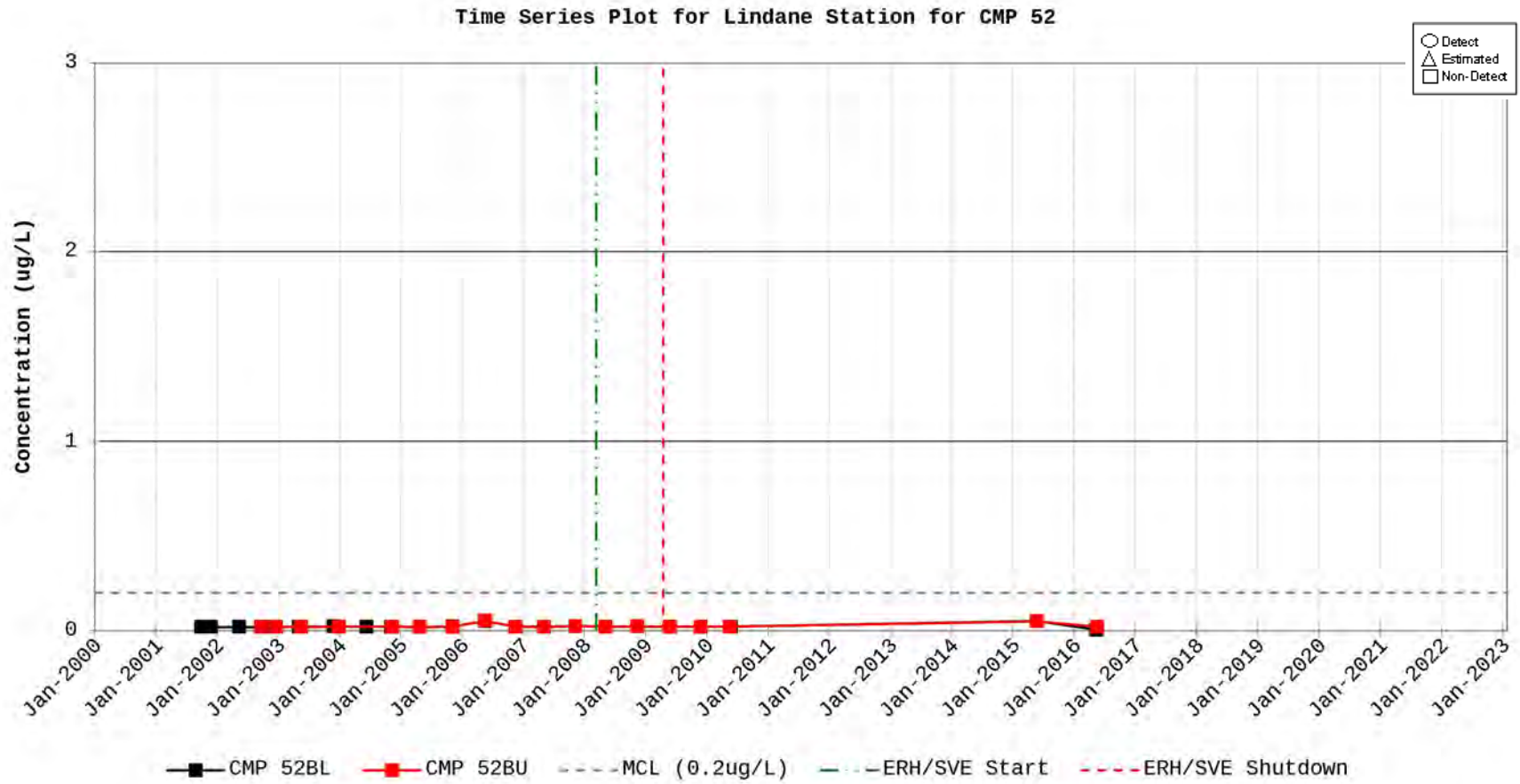


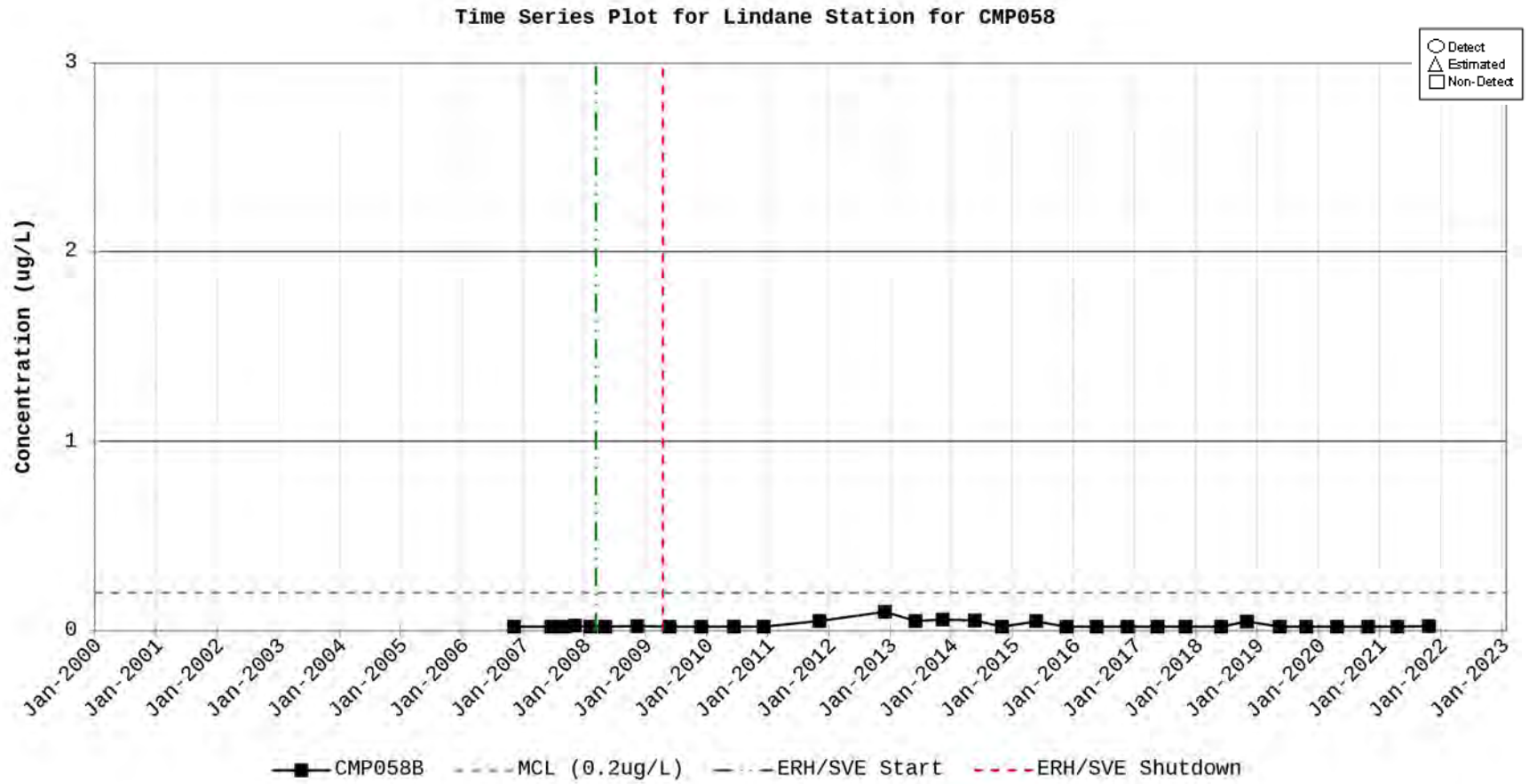


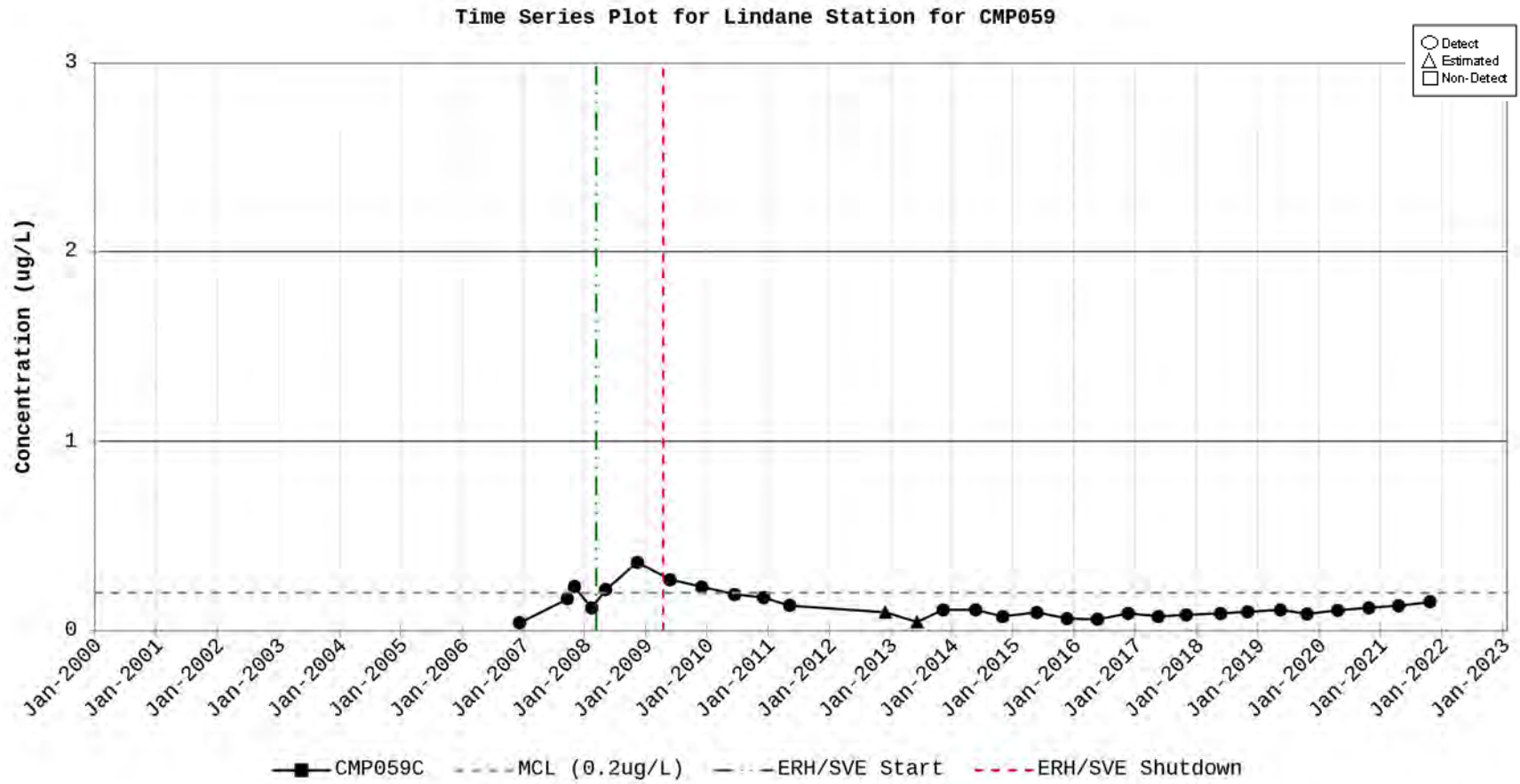


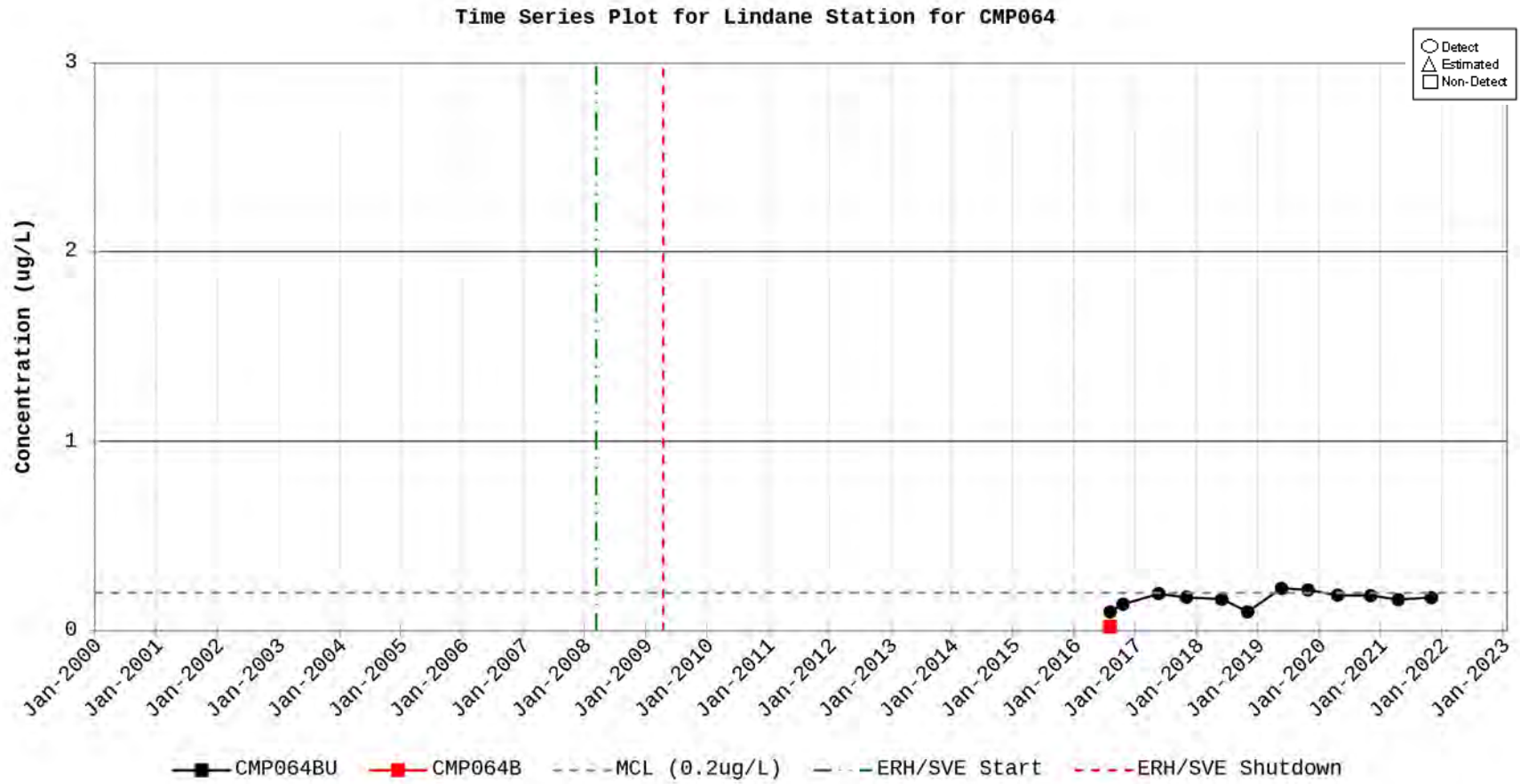


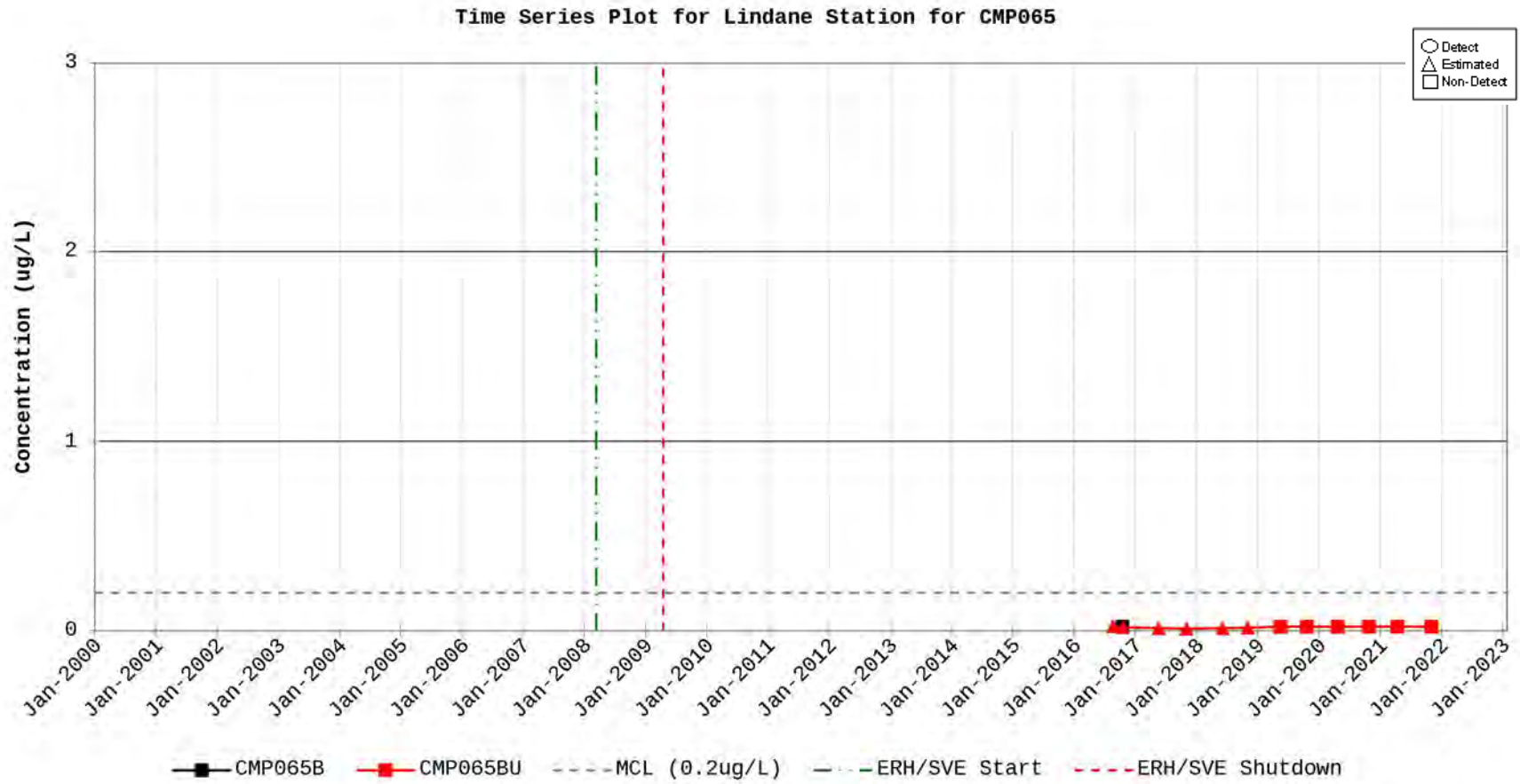












This page is intentionally left blank.

Appendix C

Additional Sampling Efforts

This page is intentionally left blank.

C 1.0 Introduction

During 2021, SRS conducted an additional soil and groundwater investigation due to concerns about increasing contaminant trends in the source area at CMP Pits and contamination detected in GA well CMP010A. This will aid in determining if residual contamination is present within the vadose zone at CMP Pits that is negatively impacting groundwater concentrations in the TZ and around the source area and to provide current vertical and horizontal contaminant trend data. Four (4) borings (CMP-BR-05, CMP-BR-06, CMP-BR-07, and CMP-BR-08) were investigated and included multiple VOC headspace soil samples for determination of vertical and horizontal extent of VOC contamination. Two (2) additional monitoring wells were installed (CMP035B in the LAZ and CMP011A in the GA) to provide further groundwater data and clarity to contamination profiles in the aquifers. During drilling activities, these well locations also included multiple VOC headspace soil samples like the borings. The locations of the borings and wells are shown in Figure C-1.

Additionally, cation and anion analyses were sampled for at a subset of wells to determine if aquifer conditions are distinct for each aquifer zone and if some wells (i.e., CMP010A) display differing characteristics that could be due to aquifer mixing.

C 2.0 VOC Headspace Soil Sampling

VOC headspace soil samples were collected at the four boring locations and the two new monitoring well locations. Samples were collected throughout the vadose zone and UTRA, and at some locations continued into the GA. The data is presented in this Appendix C in tabular form (Table C-1) and graphical form (Figures C-2 through C-7). The graphical figures include the co-located or nearby monitoring well screen locations and the depth intervals of the TCCZ, TCLC, and GCCZ, as applicable. Note that these graphs are in $\mu\text{g}/\text{kg}$ concentration.

Results indicate that the vast majority of the remaining VOC contamination resides in the vadose zone and are associated with clay horizons and/or the TCCZ and TCLC. Minimal detections occurred in deeper depths within the LAZ and none were observed within the GA. The maximum PCE result was 1137.5 $\mu\text{g}/\text{kg}$ at CMP035B at a depth of 60 ft bgs. No results were above the

previous 60 mg/kg (60,000 µg/kg) threshold limit for DNAPL contamination as was identified in the ROD for the remedial action for the CMP Pits Field A. The maximum TCE result was 106.4 µg/kg also at CMP035B at a depth of 92 ft bgs.

Due to the limited vertical extent of contamination seen at CMP-BR-06, located between the CMP Pits and well cluster CMP 10D/C/B/A, it is believed that the recent contamination at new GA well CMP010A may be caused by well drilling activities or previous well installation/abandonment in the vicinity, especially at lower depths and within and near the GA. Additional well development is planned for 2022 at the CMP010A well to further provide information on the potential source of the contamination observed. As discussed in the EMR, concentration trends at CMP010A have been steady or decreased recently.

The VOC headspace soil sampling results displayed similar trends as is seen in the CMP Pits groundwater monitoring wells and plume profiles. Groundwater data for the two (2) new monitoring wells (CMP011A and CMP035B) is provided and discussed in the EMR; however, the groundwater concentrations imitate the VOC headspace data collected at these locations.

C 3.0 Anion/Cation Groundwater Sampling

During the August 2021 Core Team meeting, SRNS proposed performing an evaluation on a select number of wells at the CMP 10 well cluster for cation-anion speciation to aid in evaluating impact to the GAU. Ten (10) wells were identified with at least two wells selected from each of the five aquifer units monitored at the CMP Pits (Table C-2) and their locations shown in Figure C-8. All the wells at the CMP 10 well cluster were selected, however, only four of the aquifer units have wells installed. For comparison, wells at the nearby CMP 52 well cluster were selected. Two additional wells, CMP 35D and 44D, were also selected to provide additional data from the TZ and MAZ, respectively. A cross sectional view of the wells and their lithology is provided in Figure C-9. Each of the 10 wells were sampled and analyzed for cations to include aluminum, calcium, iron, potassium magnesium, manganese, and sodium. Anions include chloride, fluoride, nitrate, carbonate, and sulfate.

To aid in evaluating the cation and anion data, Stiff diagrams were developed to graphically display the data (Figure C-10). Stiff diagrams are created by plotting the equivalent concentration of the cations to the left of the center axis and anions to the right. In determining the equivalent concentration, reported lab concentration data (e.g., mass/volume) are first converted to a standard unit of measure (e.g., mg/L) and then converted to milliequivalents per liter (meq/L). Stiff diagrams were developed using Grapher, a commercial software from Golden Software. The plotted data are connected to form a shape allowing for an evaluation on the different waters sampled. The data can be used to “fingerprint” aquifers in that there is a unique shape for the unit sampled. Impact to groundwater as a result of geochemical changes (e.g., leachate, remedial action, spills, etc.) can be determined. Additionally, impact to deeper aquifer units can also be evaluated for potential impact, especially if there is a prominent vertical component with groundwater flow.

Figure C-10 depicts the Stiff diagrams for each of the 10 wells as related to each of the five sampled aquifer units. For comparison, the right side of the figure depicts data from the CMP 10 well cluster with well CMP 44D included. On the left side of the figure, CMP 52 well cluster along with well CMP 35D are depicted. Stiff diagrams for the TZ and MAZ depict minor similarities between the data but overall, there is insufficient data to determine a fingerprint for these two units without including additional wells for evaluation. However, there appears to be some similarity with Stiff diagrams from CMP 10D (TZ) and CMP 44D (MAZ) which possibly could indicate similar waters unlike as depicted at CMP 52C (MAZ). In the LAZ, the Stiff diagrams indicate a strong fingerprint of the LAZ as shown by the four wells screened in the unit. These fingerprints do not resemble Stiff diagrams from the overlying aquifers or mixing of the waters which might suggest impact association with vertical migration. In the GA, the Stiff diagrams do not resemble each other and therefore there is insufficient data to determine fingerprinting of the GA. The Stiff diagram associated with CMP 52A mostly resembles overlying LAZ groundwater with possibly some mixing of GA groundwater. This likely indicates vertical migration of groundwater into the GAU at this well cluster. At CMP010A, the Stiff diagram does not resemble overlying LAZ groundwater and may be indicative of GAU groundwater.

By using the data presented with the Stiff diagrams, the source of VOCs in the GA as related to vertical migration at or near CMP 10 well cluster do not suggest impact to the GA from vertical migration of the overlying aquifers. As previously mentioned, redevelopment of CMP010A will be conducted in 2022 to provide further information on the potential source of the contamination observed and any contribution from drilling activities.

Well clusters CMP062D/B/C and CMP063D/B/C will include the same cation/anion analyses during the 2Q2022 sampling event. The evaluation of that data will be provided in the CMP Pits EMR which is scheduled to be submitted in June 2023.

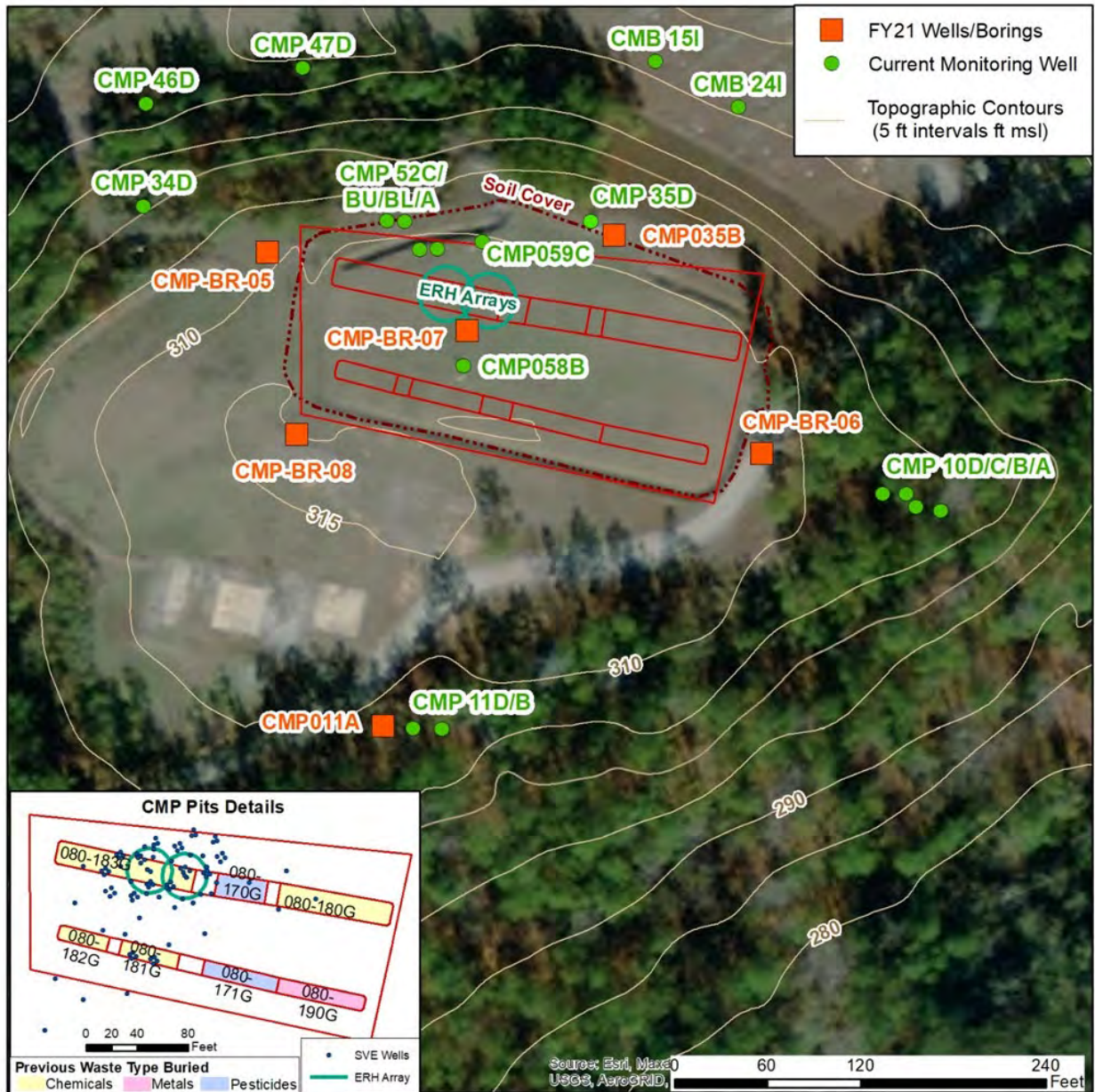


Figure C-1. Locations of New Borings and Monitoring Wells in 2021

This page is intentionally left blank.

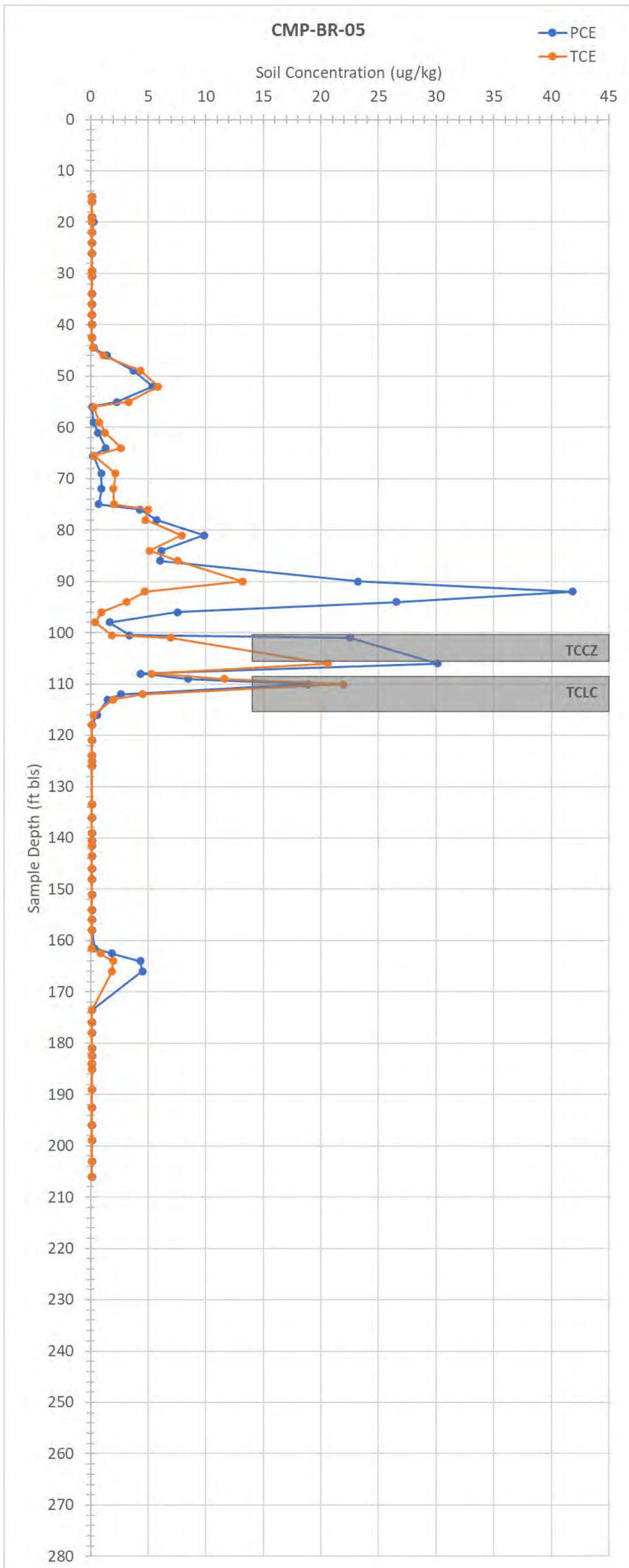


Figure C-2. CMP-BR-05 VOC Headspace Soil Data Results Graph

This page is intentionally left blank.

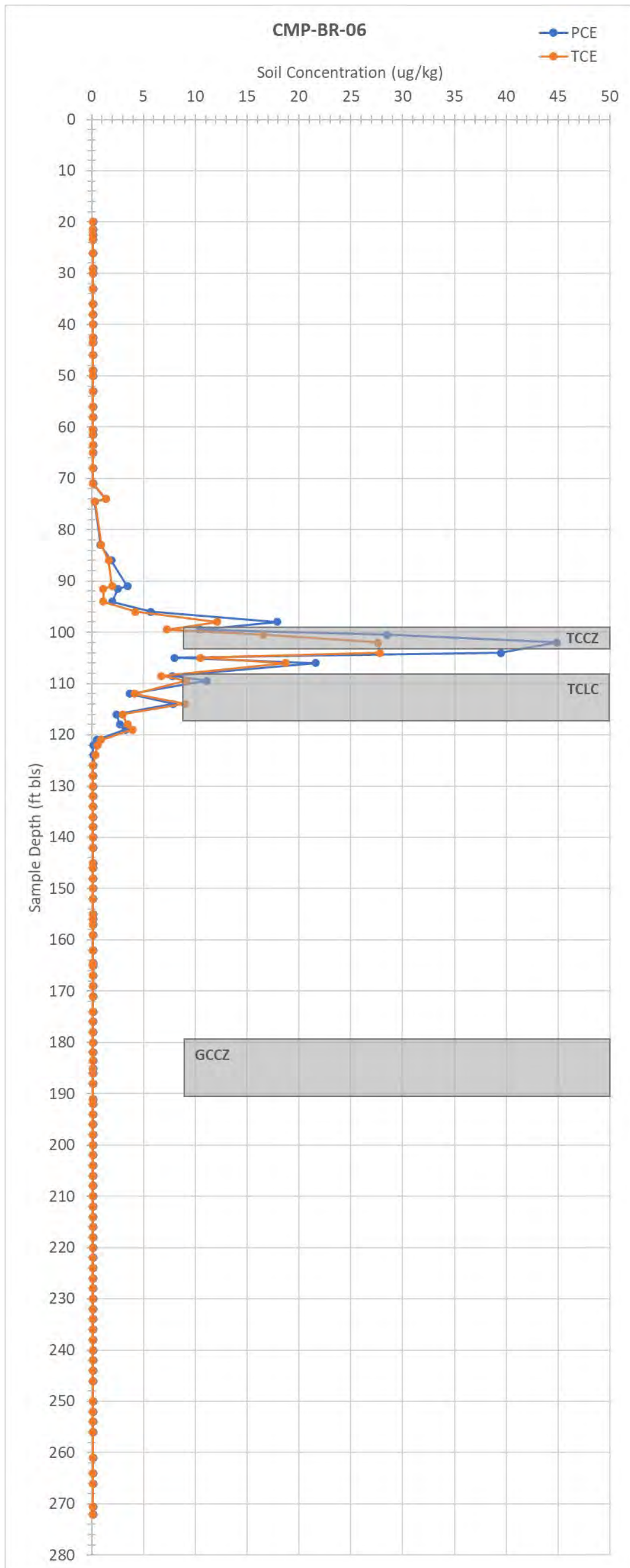


Figure C-3. CMP-BR-06 VOC Headspace Soil Data Results Graph

This page is intentionally left blank.

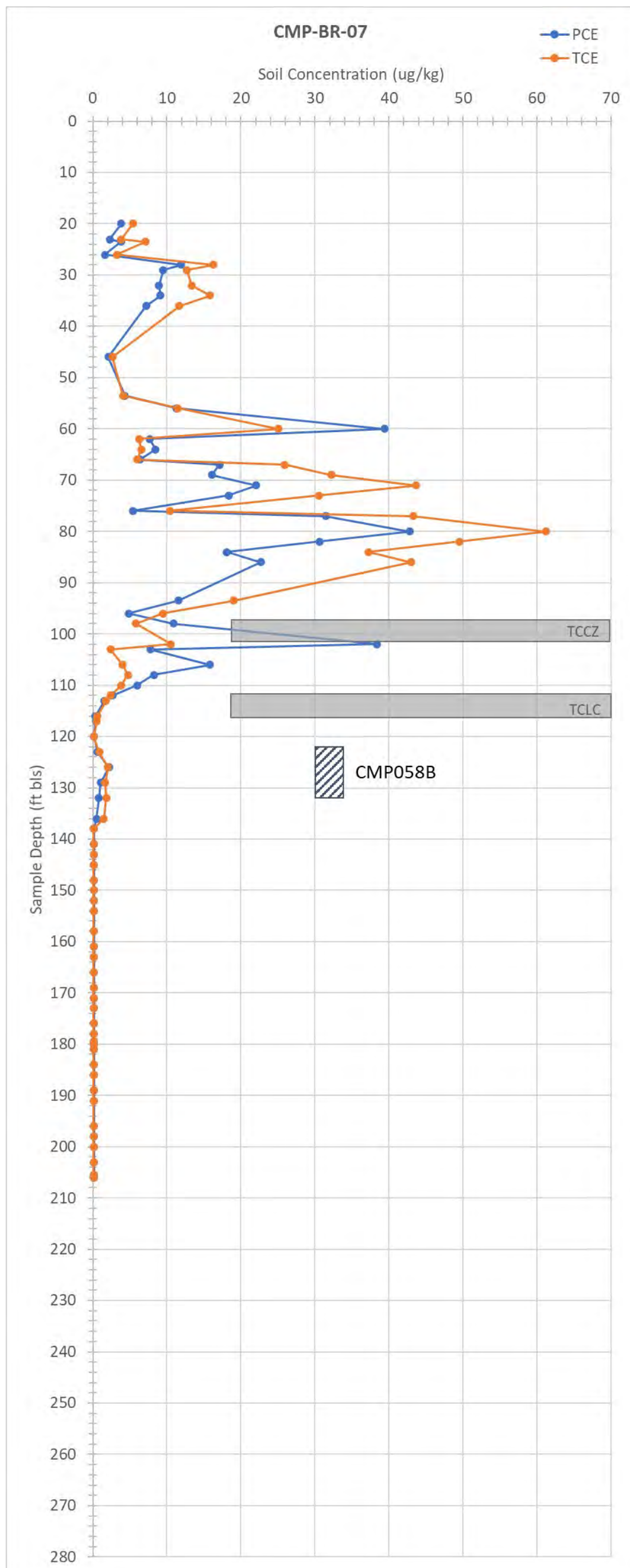


Figure C-4. CMP-BR-07 VOC Headspace Soil Data Results Graph

This page is intentionally left blank.

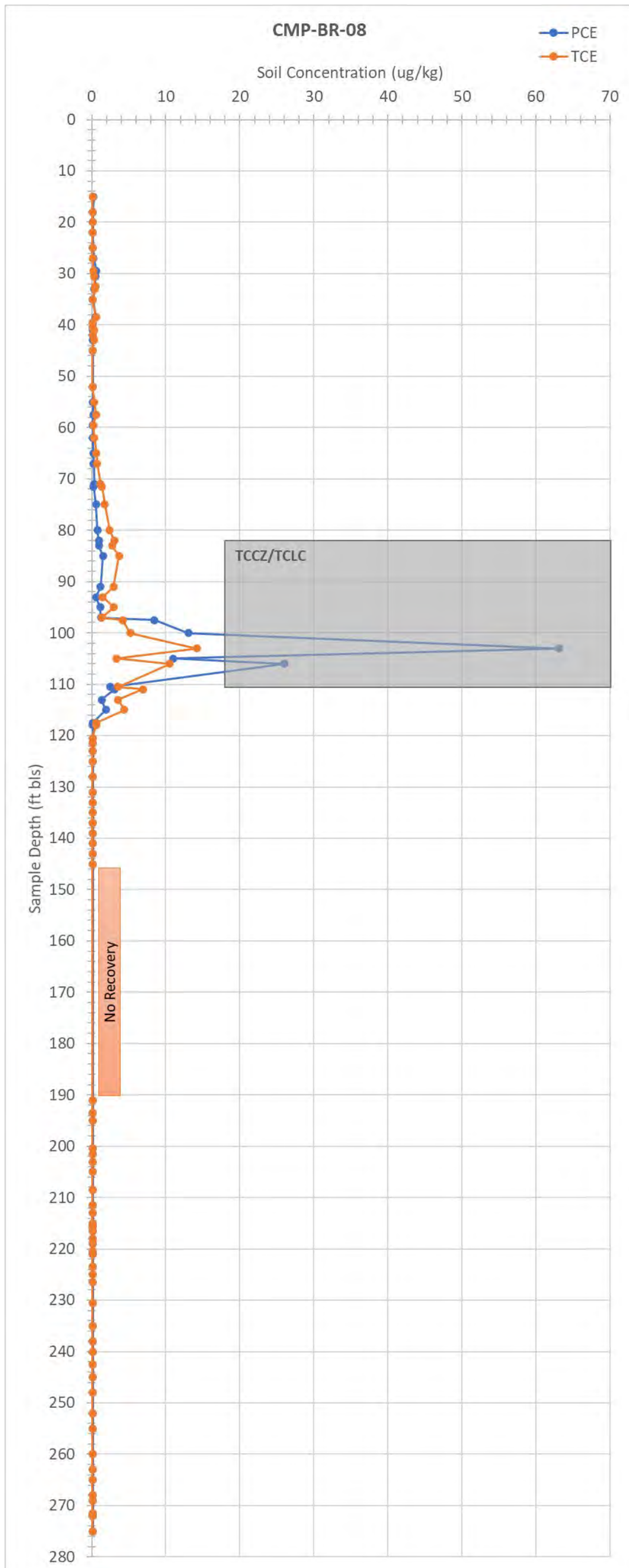


Figure C-5. CMP-BR-08 VOC Headspace Soil Data Results Graph

This page is intentionally left blank.

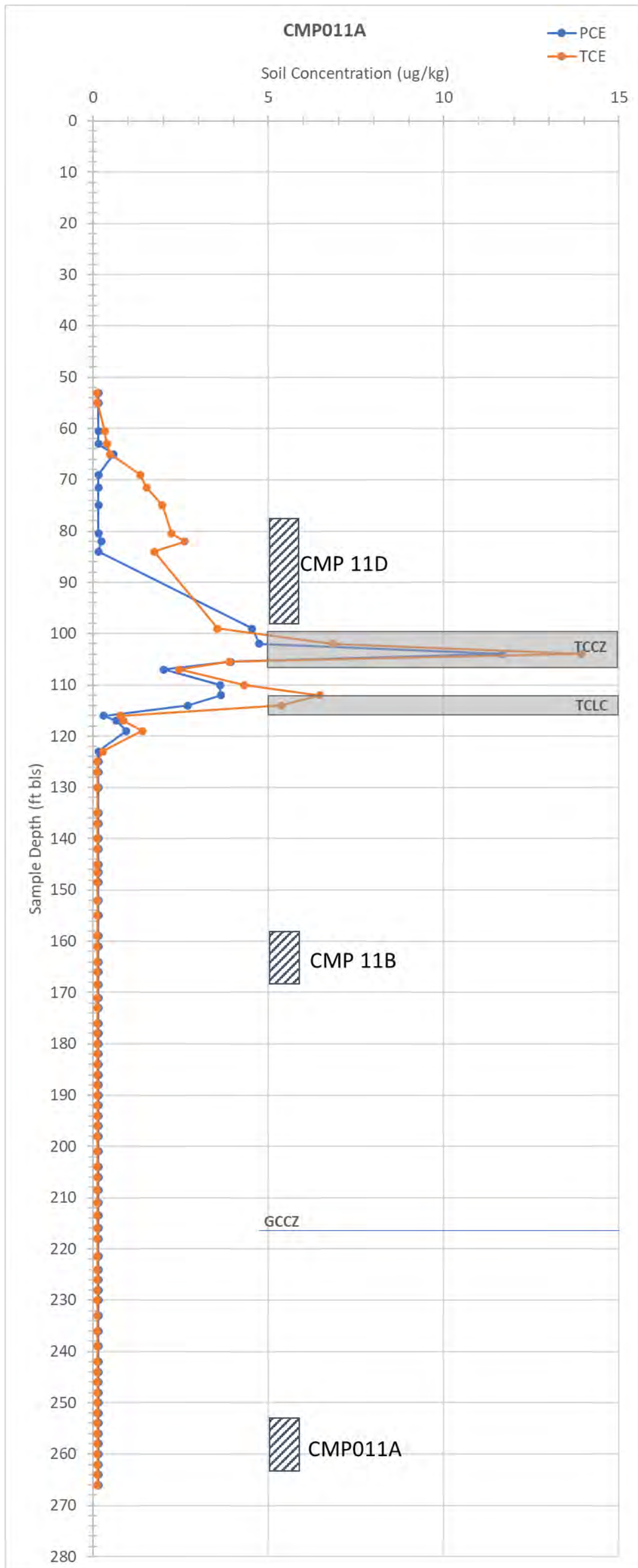


Figure C-6. CMP011A VOC Headspace Soil Data Results Graph

This page is intentionally left blank.

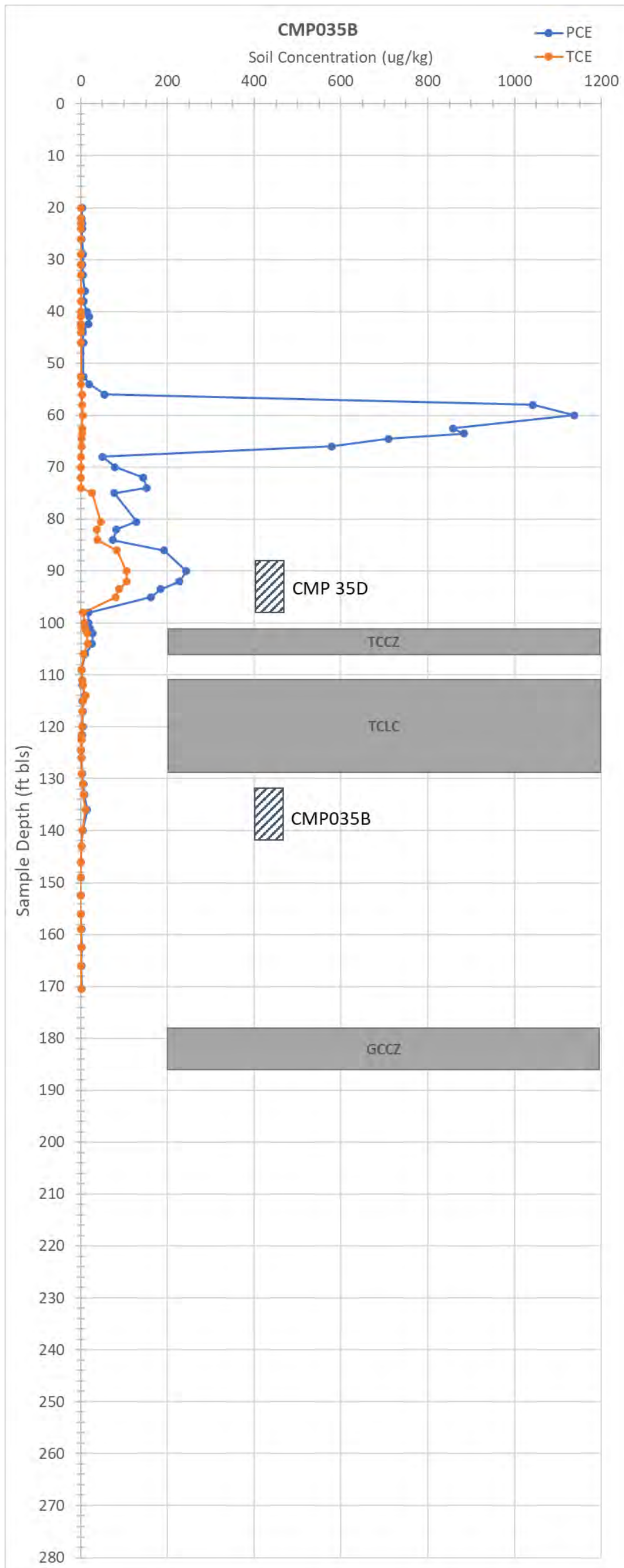


Figure C-7. CMP035B VOC Headspace Soil Data Results Graph

This page is intentionally left blank.

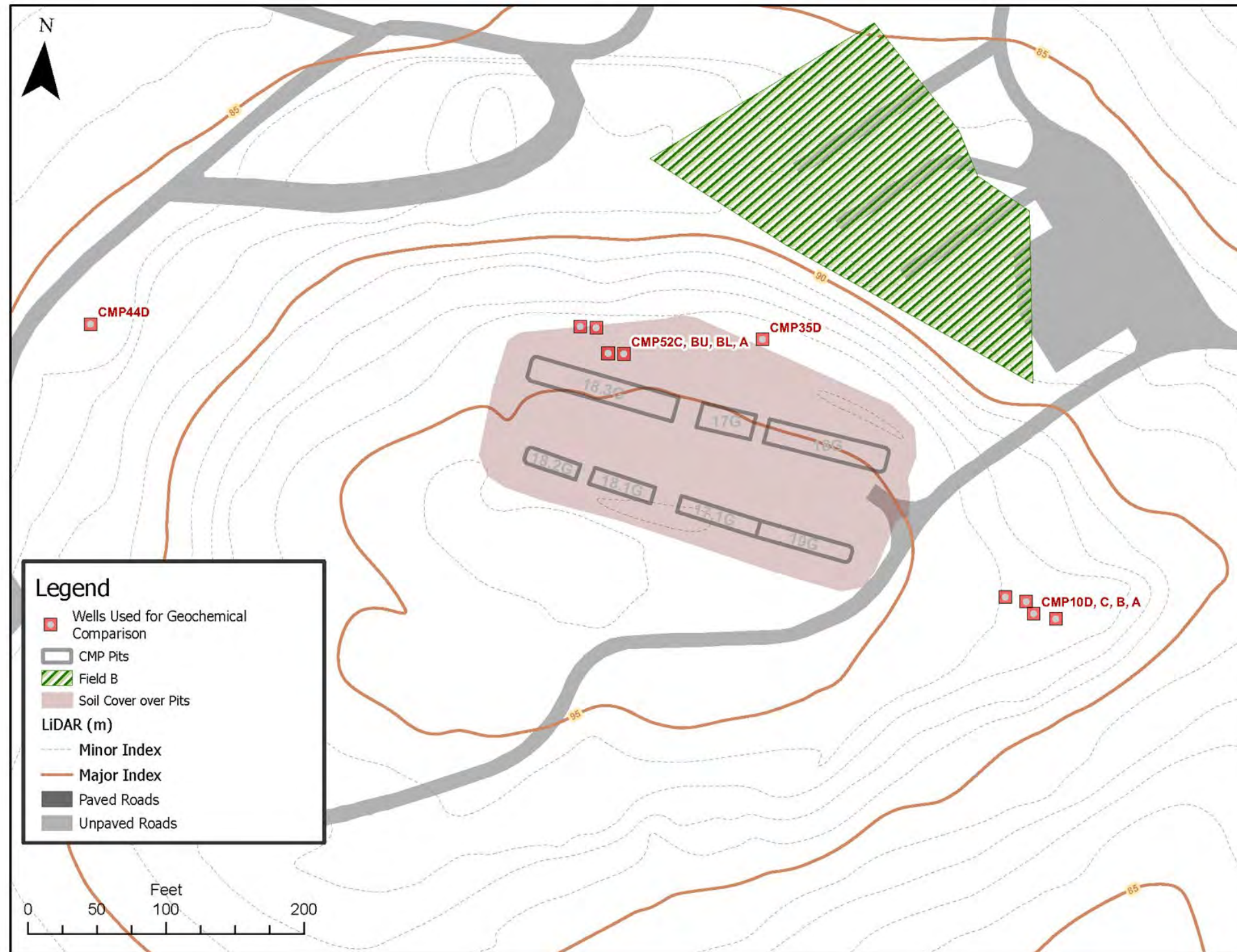


Figure C-8. Location of the Wells Used in the Cation/Anion Analyses

This page is intentionally left blank.

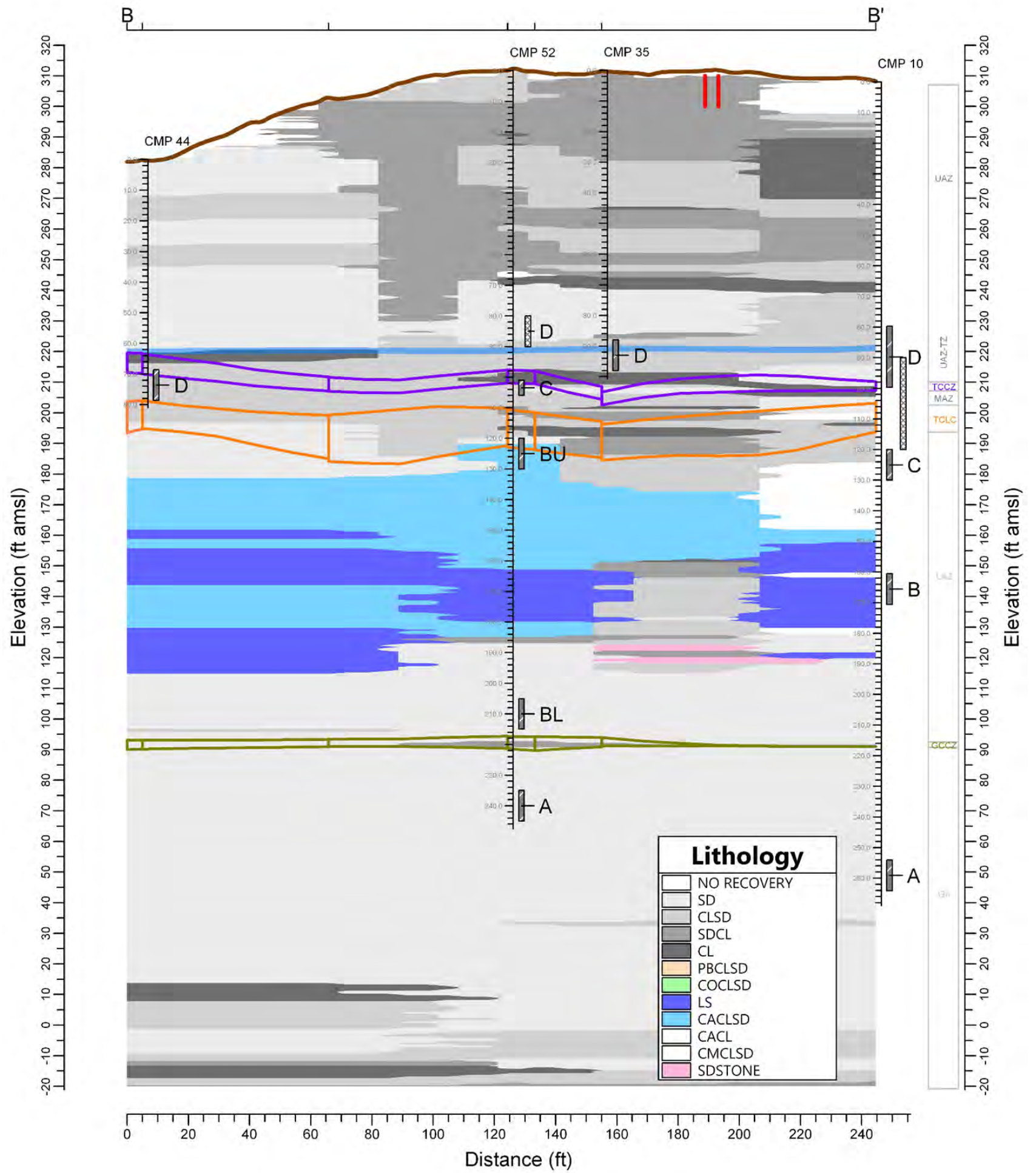


Figure C-9. Lithological Cross Section of the Wells Used for Cation/Anion Analyses

This page is intentionally left blank.

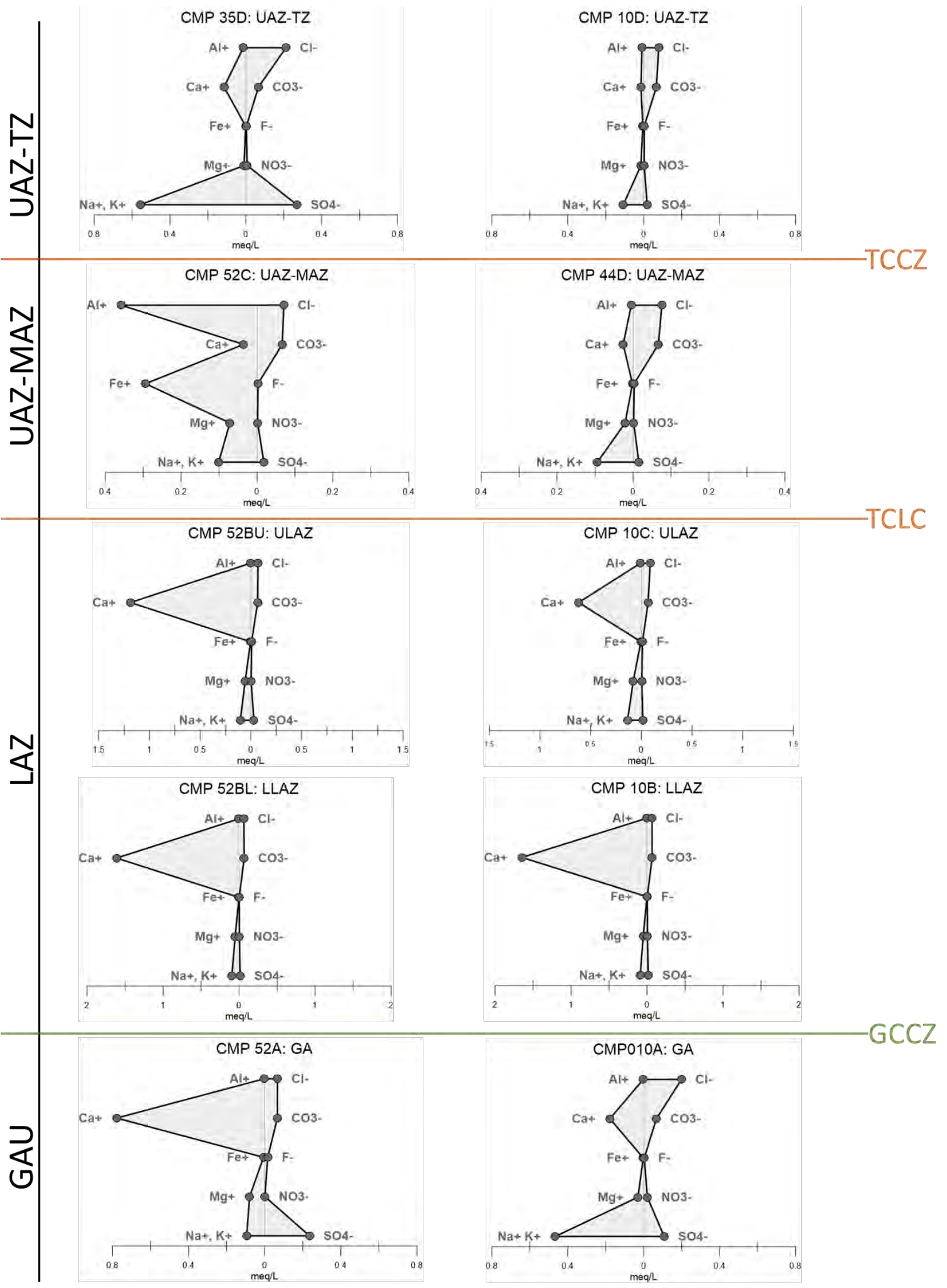


Figure C-10. Stiff Diagrams of the Cation and Anion Analyses

This page is intentionally left blank.

Table C-1. VOC Headspace Soil Sample Results

CMP-BR-05			CMP-BR-06			CMP-BR-06 continued; end			CMP-BR-07		
Depth (ft bgs)	PCE	TCE	Depth (ft bgs)	PCE	TCE	Depth (ft bgs)	PCE	TCE	Depth (ft bgs)	PCE	TCE
15	ND	ND	20	ND	ND	185	ND	ND	20	3.8	5.4
16	ND	ND	21.5	ND	ND	186	ND	ND	23	2.3	3.8
19	ND	ND	22.5	ND	ND	188	ND	ND	23.5	3.8	7.1
20	0.26	ND	23.5	ND	ND	191	ND	ND	26	1.6	3.2
22	ND	ND	26	ND	ND	192	ND	ND	28	12.0	16.3
24	ND	ND	29	ND	ND	194	ND	ND	29	9.5	12.7
26	ND	ND	30	ND	ND	196	ND	ND	32	8.9	13.3
29.5	ND	ND	33	ND	ND	198	ND	ND	34	9.1	15.9
30.5	ND	ND	36	ND	ND	200	ND	ND	36	7.2	11.7
34	ND	ND	38	ND	ND	202	ND	ND	46	2.1	2.7
36	ND	ND	40	ND	ND	204	ND	ND	53.5	4.3	4.1
38	ND	ND	42.5	ND	ND	206	ND	ND	56	11.3	11.5
40	ND	ND	43.5	ND	ND	208	ND	ND	60	39.4	25.1
42.5	ND	ND	46	ND	ND	210	ND	ND	62	7.7	6.2
44.5	0.26	0.20	49	ND	ND	212	ND	ND	64	8.5	6.5
46	1.42	1.10	50	ND	ND	214	ND	ND	66	6.4	6.0
49	3.74	4.36	53	ND	ND	216	ND	ND	67	17.1	25.9
52	5.38	5.86	56	ND	ND	218	ND	ND	69	16.1	32.2
55	2.29	3.29	58	ND	ND	220	ND	ND	71	22.1	43.7
56	ND	0.25	60.5	ND	ND	222	ND	ND	73	18.3	30.5
59	0.27	0.78	61.5	ND	ND	224	ND	ND	76	5.4	10.5
61	0.65	1.27	63.5	ND	ND	226	ND	ND	77	31.4	43.3
64	1.33	2.64	65	ND	ND	228	ND	ND	80	42.8	61.2
65.5	0.22	0.31	68	ND	ND	230	ND	ND	82	30.6	49.5
69	0.94	2.18	71	ND	ND	232	ND	ND	84	18.1	37.2
72	0.96	1.97	74	1.38	1.38	234	ND	ND	86	22.7	43.0
75	0.70	2.01	74.5	0.29	0.31	236	ND	ND	93.5	11.5	19.0
76	4.29	4.99	83	0.85	0.94	238	ND	ND	96	4.9	9.5
78	5.73	4.78	86	1.91	1.64	240	ND	ND	98	10.9	5.8
81	9.84	7.90	91	3.45	1.97	242	ND	ND	102	38.3	10.6
84	6.14	5.15	91.5	2.53	1.14	244	ND	ND	103	7.8	2.4
86	6.05	7.58	94	1.97	1.13	246	ND	ND	106	15.8	4.1
90	23.23	13.20	96	5.70	4.23	250	ND	ND	108	8.2	4.7
92	41.83	4.71	98	17.88	12.13	252	ND	ND	110	6.0	3.8
94	26.52	3.10	99.5	10.40	7.27	254	ND	ND	112	2.7	2.4
96	7.53	0.96	100.5	28.52	16.57	256	ND	ND	113	1.6	1.8
98	1.64	0.41	102	44.88	27.63	261	ND	ND	116	0.4	0.6
100.5	3.38	1.84	104	39.45	27.81	264	ND	ND	117	0.4	0.5
101	22.54	6.93	105	7.96	10.49	266	ND	ND	120	ND	ND
106	30.15	20.60	106	21.59	18.70	270.5	ND	ND	123	0.6	0.9
108	4.35	5.32	108.5	7.78	6.71	272	ND	ND	126	2.2	2.0
109	8.45	11.59	109.5	11.11	9.08				129	1.0	1.7
110	18.87	21.91	112	3.64	4.14				132	0.8	1.8
112	2.67	4.51	114	7.86	8.99				136	0.5	1.5
113	1.51	1.96	116	2.41	2.99				138	ND	ND
116	0.56	0.28	118	2.71	3.44				141	ND	ND
118	ND	ND	119	3.24	3.94				143	ND	ND
121	ND	ND	121	0.50	0.94				145	ND	ND
124	ND	ND	122	ND	0.57				148	ND	ND
125	ND	ND	124	ND	0.36				150	ND	ND
126	ND	ND	126	ND	ND				152	ND	ND
133.5	ND	ND	128	ND	ND				154	ND	ND
136	ND	ND	130	ND	ND				158	ND	ND
139	ND	ND	132	ND	ND				161	ND	ND
140.5	ND	ND	134	ND	ND				163	ND	ND
141.5	ND	ND	136	ND	ND				166	ND	ND
143.5	ND	ND	138	ND	ND				169	ND	ND
146	ND	ND	140	ND	ND				171	ND	ND
148	ND	ND	142	ND	ND				173	ND	ND
151	ND	ND	145	ND	ND				176	ND	ND
154	ND	ND	146	ND	ND				178	ND	ND
156	ND	ND	148	ND	ND				179.5	ND	ND
158	ND	ND	150	ND	ND				180	ND	ND
161.5	0.34	ND	152	ND	ND				181	ND	ND
162.5	1.85	0.86	155	ND	ND				184	ND	ND
164	4.33	1.95	156	ND	ND				186	ND	ND
166	4.51	1.85	157	ND	ND				189	ND	ND
173.5	ND	ND	159	ND	ND				191	ND	ND
176	ND	ND	162	ND	ND				196	ND	ND
178	ND	ND	164.5	ND	ND				198	ND	ND
181	ND	ND	165	ND	ND				200	ND	ND
182.5	ND	ND	167	ND	ND				203	ND	ND
184	ND	ND	169	ND	ND				205.5	ND	ND
185	ND	ND	171	ND	ND				206	ND	ND
189	ND	ND	174	ND	ND						
192.5	ND	ND	176	ND	ND						
196	ND	ND	178	ND	ND						
199	ND	ND	180	ND	ND						
203	ND	ND	182	ND	ND						
206	ND	ND	183.5	ND	ND						

Table C-1. VOC Headspace Soil Sample Results (continued;end)

CMP-BR-08			CMP-BR-08 continued; end			CMP011A			CMP011A continued; end			CMP035B		
Depth (ft bgs)	PCE	TCE	Depth (ft bgs)	PCE	TCE	Depth (ft bgs)	PCE	TCE	Depth (ft bgs)	PCE	TCE	Depth (ft bgs)	PCE	TCE
15	0.27	ND	230.5	ND	ND	53	ND	ND	262	ND	ND	20	3.52	ND
18	ND	ND	235	ND	ND	55	ND	ND	264	ND	ND	22	1.62	ND
20	ND	ND	238	ND	ND	60.5	ND	0.33	266	ND	ND	23	4.03	ND
22	ND	ND	240	ND	ND	63	ND	0.39				24	3.33	ND
25	ND	ND	242.5	ND	ND	65	0.58	0.49				26	2.20	ND
27	0.28	ND	245	ND	ND	69	ND	1.34				29	5.72	ND
29.5	0.65	0.27	248	ND	ND	71.5	ND	1.52				31	3.99	ND
30.5	0.49	0.29	252	ND	ND	75	ND	1.97				33	4.95	0.20
32.5	0.48	0.49	255	ND	ND	80.5	ND	2.24				36	9.22	0.38
33	0.36	0.46	260	ND	ND	82	0.23	2.62				38	6.52	ND
35	ND	ND	263	ND	ND	84	ND	1.74				40	14.63	0.48
38.5	0.53	0.59	265	ND	ND	99	4.53	3.54				41	19.80	0.55
39.5	ND	ND	268	ND	ND	102	4.74	6.84				42.5	18.53	0.53
40.5	ND	ND	269	ND	ND	104	11.66	13.91				43	5.35	ND
41	ND	0.32	271.5	ND	ND	105.5	3.93	3.88				44	4.54	ND
42	ND	ND	272	ND	ND	107	2.02	2.46				46	6.41	0.33
43	ND	0.31	275	ND	ND	110	3.62	4.30				52.5	6.47	0.30
45	ND	ND				112	3.64	6.46				54	19.55	0.68
52	ND	ND				114	2.70	5.36				56	54.83	2.88
55	ND	0.36				116	0.30	0.77				58	1042.11	3.15
57.5	0.21	0.61				117	0.66	0.87				60	1137.45	4.40
59.5	ND	0.23				119	0.95	1.40				62.5	857.46	3.01
62	ND	0.36				123	ND	0.26				63.5	883.14	3.31
65	0.22	0.64				125	ND	ND				64.5	710.30	2.18
67	0.26	0.73				127	ND	ND				66	578.62	1.90
71	0.34	1.20				130	ND	ND				68	49.90	0.88
71.5	0.28	1.38				135	ND	ND				70	79.22	0.84
75	0.59	1.78				137	ND	ND				72	144.03	0.94
80	0.78	2.42				140	ND	ND				74	152.27	1.02
82	0.95	3.04				142	ND	ND				75	77.61	26.49
83	0.97	2.78				145	ND	ND				80.5	128.64	46.56
85	1.53	3.73				146.5	ND	ND				82	82.21	37.30
91	1.22	2.95				148.5	ND	ND				84	74.16	38.84
93	0.59	1.49				152	ND	ND				86	192.17	83.46
95	1.18	3.01				155	ND	ND				90	243.85	105.39
97	1.25	1.34				159	ND	ND				92	226.51	106.36
97.5	8.48	4.19				161	ND	ND				93.5	184.48	87.98
100	13.04	5.22				164	ND	ND				95	162.33	80.60
103	63.11	14.19				166	ND	ND				98	17.59	5.68
105	11.02	3.38				168.5	ND	ND				100	18.39	8.30
106	25.97	10.55				171	ND	ND				101	20.55	10.16
110.5	2.50	3.56				173	ND	ND				102	27.83	13.99
111	3.09	6.92				176	ND	ND				104	26.11	16.02
113	1.37	3.56				178	ND	ND				106	10.01	7.38
115	1.91	4.42				180	ND	ND				109	1.82	2.10
117.5	ND	0.63				182	ND	ND				111	2.72	2.89
118	ND	0.60				184	ND	ND				112	2.98	4.75
120.5	ND	ND				186	ND	ND				114	10.31	11.32
121.5	ND	ND				188	ND	ND				115	3.81	5.35
123	ND	ND				190	ND	ND				117	4.67	3.46
125	ND	ND				192	ND	ND				120	4.29	3.20
128	ND	ND				194	ND	ND				121.5	2.70	2.32
131	ND	ND				196	ND	ND				122.5	2.14	2.10
133	ND	ND				198	ND	ND				124.5	0.71	0.89
135	ND	ND				201	ND	ND				126	1.22	1.24
137	ND	ND				204	ND	ND				129	2.76	2.07
139	ND	ND				206	ND	ND				131	5.98	4.46
141	ND	ND				208.5	ND	ND				133	8.16	6.50
143	ND	ND				211	ND	ND				136	15.18	11.30
145	ND	ND				213.5	ND	ND				140	4.46	3.59
191	ND	ND				216	ND	ND				143	1.14	1.15
193.5	ND	ND				218	ND	ND				146	0.24	0.37
195	ND	ND				221.5	ND	ND				149	ND	ND
200.5	ND	ND				224	ND	ND				152.5	ND	ND
201.5	ND	ND				226	ND	ND				156	ND	ND
203	ND	ND				228	ND	ND				159	1.06	0.86
205	ND	ND				230	ND	ND				162.5	1.86	1.24
208.5	ND	ND				233	ND	ND				166	1.11	0.77
211.5	ND	ND				236	ND	ND				170.5	1.97	1.22
213	ND	ND				239	ND	ND						
215	ND	ND				242	ND	ND						
215.5	ND	ND				244	ND	ND						
216.5	ND	ND				246	ND	ND						
218	ND	ND				248	ND	ND						
219	ND	ND				250	ND	ND						
220.5	ND	ND				252	ND	ND						
221	ND	ND				254	ND	ND						
223.5	ND	ND				256	ND	ND						
225	ND	ND				258	ND	ND						
226.5	ND	ND				260	ND	ND						

Table C-2. Wells Selected for Cation-Anion Analyses

WELL ID	AQUIFER	LITHOLOGY ⁽¹⁾	UAZ-TZ	UAZ-MAZ	ULAZ	LLAZ	GAU
CMP 10D	UAZ-TZ	CLSD-SD	X				
CMP 10C	ULAZ	CLSD-CACLSD			X		
CMP 10B	LLAZ	LS				X	X
CMP010A	GAU	SD					
CMP 44D	UAZ-MAZ	UNKNOWN		X			
CMP 52C	UAZ-MAZ	CLSD		X			
CMP 52BU	ULAZ	CACLSD			X		
CMP 52BL	LLAZ	SD				X	
CMP 52A	GAU	SD					X
CMP 35D	UAZ-TZ	CLSD	X				

⁽¹⁾ CA - CALCAREOUS
 CL - CLAY
 LS - LIMESTONE
 SD - SAND

This page is intentionally left blank.
