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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 2019 through March 2020

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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
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
TCLC	Tan Clay Lower Clay

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

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)

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1.0 INTRODUCTION

This Effectiveness Monitoring Report (EMR) addresses the effectiveness of the Monitored Natural Attenuation (MNA) groundwater remedy at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU) for the period from April 2019 to March 2020. 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 actual 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 and was followed by backfilling of the pit area with clean soil and then capped. 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 remedial action (RA) for the CMP Pits vadose zone in and around Field A. This remedy targeted the contaminated soil at Pit 080-183G that was left in place after the previous soil excavations which included dense non-aqueous phase liquid (DNAPL) that was present in the clay horizons beneath the pits (Figure 2). 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 remedial action 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 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 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 over time. Additionally, 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 installed in 2019, located directly to the southeast of CMP Pits has shown that the GA is contaminated with VOCs above MCLs. This is the first occurrence of GA contamination above MCLs.

Although vadose zone remediations have occurred, there has been forty or more years for contamination to move through the aquifers, resulting in contaminants likely sorbing to clay particles and 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 any 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 can be leaky. As noted above, 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 2019 (4Q2019) 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 74 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 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 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 last observed potentiometric surfaces from the calendar year (CY) 4Q2018 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 2016 – 2019 and the 20-year average. Rainfall during 2019 (total of 44.27 inches) measured less than the 2018 measurements and was slightly below the 20-year average (47.08 inches). The months of June, October, and December were especially wet months. February, May, July, and September were dry months. In general, monitoring wells at higher elevations (not in wetland areas) showed a slight increase in water elevations during 2Q2019 or displayed similar water elevations compared to 2018 measurements. Wetland wells to the northeast displayed very slightly decreased water elevations. Wetland well water elevations are more sensitive to recent rainfall events. There was no significant rain event two weeks prior to the wetland well sampling during 2Q2019. 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) suggest that a component of flow has a south or southwest gradient. Some years display a more pronounced southerly flow gradient than others. The 4Q2019 results show a flatter surface in the CMP Pits area. Additionally, the dry zones may be slightly redirecting groundwater flow around the dry areas slightly to the east.

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 0.12 ft/day on the western side of the CMP Pits and 0.37 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 0.28 ft/day, or 103.98 ft/year. The MAZ is more uniform in its rates and averages at 1.74 ft/day, or 634.08 ft/year. The LAZ's rate is much less than the MAZ near CMP Pits with a rate of 0.20 ft/day, or 74.74 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 1.46 ft/day, or 535.03 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 1.6 feet in elevation across the whole CMP Pits monitored area. Horizontal flow velocity for the GA was calculated as 0.05 ft/day, or 19.72 ft/year and flow direction is towards the south/southeast.

There is a significant downward component to groundwater flow throughout the UTRA. Water level measurements collected from well clusters during 2019 show an average head drop of 10.8 ft (3.3 m) across the TCCZ and an average of 13.5 ft (4.1 m) across the TCLC. There is an average of a 15.2 ft (4.6 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 cluster CMP064BU and CMP064B (both screened in the LAZ) shows a higher water elevation in the lower B screen than the upper BU 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 4.15 ft (1.3 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 term/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 intent 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.

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 74 wells which have been sampled on a semi-annual or annual basis (Table 1, Figure 5). The TZ includes 13 monitoring wells, the MAZ includes 26 monitoring wells, the LAZ includes 29 monitoring wells (including one extra well, CMP 32B), and the GA includes six monitoring wells. Two of the GA wells (CMP010A and CMP055A) were installed in 2019. All wells are used for water level measurements and the majority are sampled for VOCs and/or lindane. Seven surface water stations north of CMP Pits located in the Pen Branch stream were used to monitor any discharge of VOCs to the stream. One of these surface water stations (CMP-SW-22) was added in 2019 and is located between stations CMP-SW-06 and CMP-SW-07 (Figure 5). Surface water station CMP-SW-21 was not sampled during 2019 but will be added to routine sampling in 2020, increasing the number of surface water stations to eight. 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 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 maximum contaminant levels (MCLs) for a minimum of 50 years (~2050) 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 were collected from 66 monitoring wells at CMP Pits mostly during CY 2Q2019 and 4Q2019. This includes additional samples collected from one of the wells that are only used for water level measurements (CMP 15B) and a well that is not currently part of the monitoring network (CMP 32B). SRS proposes to add well CMP 32B to the monitoring network with semiannual sampling for VOCs and annual sampling for 1,4-dioxane. Samples were also collected during CY 1Q2020 at stations CMP010A, CMP055A, CMP066B, and CMP067B. All groundwater results from April 2019 through March 2020 are provided in Table 3. Plumes were drawn based on the maximum concentration from the time period results. 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 46 acres (18.6 hectares) (Figures 10 and 11), and the TCE plumes comprise approximately 45 acres (18.2 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 33). This is also consistent with modeling, as concentrations in the LAZ are predicted to increase over time. Additionally, samples collected from new GA well CMP010A detected PCE and TCE above MCLs. Sixty-four (64) of the 66 monitoring wells were sampled in 2019 for VOCs (two wells are only analyzed for lindane). Thirty-three (33) 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 (83%) show a declining or steady (including consistent non-detects) trend in PCE and TCE over the past 10 years as shown in the time-series plots for all the wells in Appendix B, Figure 33, and summarized below.

The following is a summary of the PCE and TCE contaminant trends by aquifer for the April 2019 through March 2020 reporting period:

Transmissive Zone:

The maximum concentrations of PCE and TCE found in the TZ were 1,940 µg/L for PCE at monitoring well CMP 34D (Figure 10) and 795 µg/L for TCE (Figure 17) 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 2019. 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 10 years have generally declined. Concentrations in well CMP 10D and CMP 11D during 2019 were similar to concentrations during 2018. 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 10 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 32), 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 CMP 35D.

Due to the increases observed at well CMP 35D, PCE and TCE were additionally analyzed at nearby well CMP34D. This well has previously shown high levels of PCE (1,460 µg/L) and TCE (417 µg/L) in 2001. The 2Q2019 results were 1,940 µg/L for PCE and non-detect (<50 µg/L) for TCE. The 4Q2019 sample results decreased to 1,440 µg/L for PCE and non-detect (<50 µg/L) for TCE. 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.

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 and CMP 34D as previously discussed. The high 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 slightly exceeded the MCL during 2019 and displays a slight increasing trend. Concentrations at well CMP 30D were non-detect for PCE, but TCE was detected below the MCL.

PCE and TCE concentrations in the distal plume in the wetlands slightly increased during 2019. 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 and CMP 37D were less than or near MCLs during 2Q2019, but increased during 4Q2019. Concentrations at CMP 38D are usually less variable and were similar to 2018 results. The distal plume initially was

thought to originate from an alternative source from the CMP Pits, as particle track modeling indicates it could be from a potential 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 11 years (2019 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 34D 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 remain 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 555 µg/L for PCE at well CMP 47D (Figure 10), and 144 µg/L for TCE at well CMP 52C (Figure 17), both located north of CMP Pits. The concentration of PCE detected at CMP 47D has increased over the last 3 years and is likely due to the increase in contamination seen north of CMP Pits in the TZ. Concentrations of TCE

detected at CMP 52C in 2019 were similar to monitoring results reported for this location since May 2014.

There are 15 monitoring wells (out of 21 sampled) screened in the MAZ that had PCE concentrations above the MCL in 2019, and 13 monitoring wells had TCE exceedances above the MCL. The majority of the MAZ wells display a steady or decreasing trend in concentrations (Figure 33). Wells CMB 24I and CMP059C display a slight increasing trends as these wells are near others with similar or higher concentrations and is mostly likely due to plume spreading or concentrations from the TZ; however, the overall plume footprint has not increased. Well CMP 44D has shown an increase the last two years. The 2Q2019 groundwater sample for CMP 41D, which is located near Pen Branch on the western edge of the PCE and TCE plume, slightly exceeded the MCL for PCE, but was below the MCL for TCE. Both PCE and TCE concentrations further west at CMP 43D were below their MCLs. 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 11 years (2019 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 50% and the area of higher concentration 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 nine monitoring wells (out of 26 sampled) screened in the LAZ that had PCE concentrations above the MCL in 2019. These nine wells also corresponded to the locations in the LAZ having TCE concentrations above the MCL. The maximum concentrations of PCE and TCE found in the LAZ were 404 µg/L for PCE at well CMP 32C and 202 µg/L for TCE at monitoring well CMP 52BU. These wells are 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 appear to have stabilized over the last three years and CMP 52C has minimally increased over the last three years. CMP064BU is located to the east of well CMP 8B and may indicate a preferential flow path for groundwater or contaminants due to the relatively high concentrations of VOCs (Figure 11). However, concentrations at this well are displaying a slight decreasing trend. Concentrations of PCE at CMP 10C slightly increased in 2019, but TCE decreased.

Concentrations at six wells (CMP 8B, CMP 10B, CMP 13B, CMP 32C, CMP 52BU, and CMP058B) generally display increasing trends over the last 11 years (Appendix B and Figure 33). The majority of these wells are located in the upper 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 slightly increased during 2019. Other wells vertically located mid-plume and deeper remain steady, below MCLs, or non-detect, including additional well CMP 32B (Figure 13).

Upgradient wells CMP062B and CMP063B were non-detect for PCE and TCE during 2019. Downgradient wells CMP060B and CMP061B remains non-detect for PCE and TCE, and well CMP 8B remains below MCLs. During 4Q2019 at well CMP067B, located north of Pen Branch and vertically located mid-LAZ plume (Figures 11 and 12), PCE and TCE were detected below MCLs at concentrations of 1.5 µg/L and 2.47 µg/L, respectively. Well CMP066B results were non-detect. Due to this being the first instance of detections of any VOC north of Pen Branch, samples were also collected in 1Q2020 to confirm the results; however, results from both wells

CMP066B and CMP067B were all non-detect. These two wells will additionally be sampled during 2Q2020.

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 11 years (2019 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 also 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 nine 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) has also decreased. The downgradient wells (CMP060B, CMP061B, and CMP 8B) remain below MCLs. The majority of the 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 six monitoring wells screened within the GA and all were sampled during 2019. Two of these monitoring wells (CMP010A and CMP055A) were installed in September 2019. These wells can be seen on the GA planar maps and in cross sections A-A' and/or C-C'. With the exception of CMP010A, all results were non-detect for both PCE and TCE. New well CMP010A was sampled during 4Q2019 and results indicated that PCE and TCE were above MCLs with concentrations of 188 µg/L for PCE and 87.5 µg/L for TCE. Due to the unexpected results, additional samples were collected during 1Q2020 confirming contamination at CMP010A with

increased concentrations of 287 µg/L for PCE and 114 µg/L for TCE. CMP010A will continue with semi-annual sampling.

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; however, concentrations should decrease with time if this is the case. Based on the vertical contaminant profile as can be 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 only within the last six years, including well CMP 10B. It is plausible that some contamination has migrated along a path vertically from the CMP Pits area to the GCCZ/GA. As mentioned in SRS responses to the United States Environmental Protection Agency (USEPA) comments on the 2019 CMP Pits EMR, further discussion of this new data and a path forward is planned with the Core Team following review of the June 2020 EMR.

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.

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

C-1,2-DCE was detected in five wells in 2019. Concentrations were all low values, with a maximum of 8.89 µg/L at well CMP 36D, well below the 70 µg/L MCL. All 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 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)

During April 2019 through March 2020, all t-1,2-DCE results were non-detect.

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

During April 2019 through March 2020, all 1,1-DCE results were non-detect.

2.2.2.5 Vinyl Chloride (VC)

During April 2019 through March 2020, all monitoring results were non-detect for VC.

2.2.2.6 1,4-Dioxane

1,4-Dioxane is analyzed annually at CMP Pits. There is currently no MCL for 1,4-dioxane, but the current USEPA tap water regional screening level (RSL) is 0.46 µg/L. During the April 2019 through March 2020 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 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 42 of the 63 wells sampled (66%) using the EPA 522 method compared to 16 wells (25%) using the EPA 8260BSIM method. Overall, there was close agreement in the results between the two methods with the EPA 522 results slightly higher. Figure 19 graphically displays the 1,4-dioxane EPA 522 method results versus the EPA 8260BSIM method results.

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 20),

LAZ and GA (Figure 21). The maximum concentration was 92 µg/L at new GA well CMP010A. 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 similar to other contaminant trends for this well.

During 4Q2019 1,4-dioxane was detected above the USEPA tap water RSL at a concentration of 3.9 µg/L using the EPA 8260BSIM method at new GA well CMP055A. However, the result using the EPA 522 method was non-detect. During 1Q2020, GA well CMP055A was resampled for 1,4-dioxane and the EPA 8260BSIM method result was non-detect. Because there is no MCL for 1,4-dioxane, the USEPA tap water RSL is used for contouring plume maps (Figures 20 and 21) and cross-sections (Figures 22, 23, and 24).

There is no SC 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 proposes to continue to utilize the EPA 522 method that can meet the USEPA tap water RSL, in addition to the current SCDHEC approved method. If a lab/method has SC accreditation and can meet the USEPA tap water RSL, then that would be the preferable analyses method used.

2.2.2.7 Carbon Tetrachloride (CCl₄)

CCl₄ was detected in 20 wells during April 2019 through March 2020, but only exceeded the MCL of 5.0 µg/L in six wells: CMP 10D, CMP 10C, CMP010A, CMP 35D, CMP064BU, and CMB 15I with a maximum concentration of 24.0 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 April 2019 through March 2020. None of the results exceeded the MCL of 80 µg/L. The maximum result was at well CMP 35D with a value of 35.0 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 2019 through March 2020, all DCM results were non-detect.

2.2.2.10 Bromodichloromethane

During April 2019 through March 2020, bromodichloromethane was detected at low concentrations in six wells. The maximum result was found at CMP064BU at 1.7 µg/L, below the MCL of 80 µg/L.

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

During April 2019 through March 2020, all 1,1,2-TCA results were non-detect.

2.2.2.12 Lindane

Twenty wells were analyzed for lindane in 2019. The MCL for lindane is 0.2 µg/L and five wells (CMP 10C, CMP 34D, CMP 35D, CMP 44D, and CMP064BU) had lindane concentrations that exceeded this level (Figures 25 and 26). Cross-sections with lindane plumes and concentrations are provided in Figures 27 through 29. Most of the 20 wells monitored for lindane in 2019 show slightly decreasing or steady trends in concentrations as shown in Appendix B and Figures 30, 31 and 33.

The highest lindane concentration for 2019 was 29.8 µg/L found in CMP 35D during 2Q2019, with concentrations decreasing to 10.3 µg/L in 4Q2019. This well has shown fluctuations in concentrations over the years, but it has been increasing since 2013 (Appendix B, page B-57). Factors contributing to this 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 32), 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 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 32 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 six years. Well CMP 10B, which is screened at the bottom of the LAZ (Figure 27), 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 4.6 acres (1.9 hectares) in the UTRA (Figures 25 and 26). The majority of the plume (including the highest concentrations) resides in the TZ. The MAZ concentrations slightly decreased in 2019 with only one well CMP 44D slightly above the MCL. The plume is more diffused and spread out within the MAZ (Figure 25) and overall concentrations appear to be stable to decreasing. In the LAZ, Lindane was detected at well CMP064BU (Upper LAZ) above the 0.2 µg/L MCL at a concentration of 0.224 µg/L during 2Q2019 and dropped to 0.216 µg/L in 4Q2019. Lindane was below the MCL at well CMP064BU in previous years. The VOC solvent plumes have likely mobilized lindane to some degree and/or the contaminant may have originated from a previous alternate dumping spot such as the drainage ditch, if it was used.

A comparison of lindane plume concentrations over the last 11 years (2019 values compared to 2008 values) can be seen in Figures 30 and 31 and Table 5. In the TZ, lindane concentrations above the MCL are currently limited to wells CMP 34D 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 11 years but concentrations continue a downward trend. 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 (Figures 27 and 29). The lindane plumes have minimally increased in extent in the TZ and LAZ, which is believed to be caused by contamination trapped in the vadose zone pore space or capillary fringe, the stratigraphy of the Tan Clay, subsequent dry areas in the TZ and MAZ, and radial groundwater flow. 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 seven locations along the groundwater discharge boundary (Figure 5). Two of these stations were added in 2017 in a tributary leading to Pen Branch (CMP-SW-20 and CMP-SW-21). SRS had proposed to omit CMP-SW-21 in the June 2019 report and did not sample it during 2019. Following review of the 2019 EMR, USEPA requested surface water sampling continue at CMP-SW-21. Surface water station CMP-SW-21 will be added back to the monitoring network starting with 2Q2020 sampling.

The other six surface water stations were sampled semi-annually. 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 show an expected VOC discharge to Pen Branch above MCLs. In 2019, there were no detections of VOCs in surface water. 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-10, with the EPA 522 method at an estimated concentration of 0.101 µg/L, which is below the USEPA tap water RSL of 0.46 µg/L. All other 1,4-dioxane 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 VOC degradation are all contributing factors that reduce the groundwater 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 in past 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. However, SCSU was not awarded a grant for continued sampling during 2019. Future sampling by SCSU or other independent entities will be provided in future EMRs as is available.

3.0 SUMMARY

A CSM figure has been added to aid in the understanding of potential sources of contamination and the subsequent groundwater transport pathways (Figure 3). 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). Although rainfall was below average during 2019, water elevations generally increased slightly (more so in the TZ and MAZ) or remained similar to 2018 levels. However, water elevations in the wetlands area decreased slightly. The areas estimated to be dry in the TZ and MAZ have marginally decreased in size from last year, but dry areas to the northeast in the TZ increased. 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 would 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. 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 2020 indicates that the MNA remedy is working as predicted as the majority of wells display steady or decreasing trends or either remain non-detect. However, recent data in the source area has shown steady increases in PCE, TCE, and /or lindane in well CMP 35D directly north of the CMP Pits since

2012. Elevated PCE was also detected in well CMP 34D. This contamination appears to be related to water elevation rise releasing residual contamination trapped in the vadose zone; however, VOC and lindane concentrations in other nearby wells indicate that the contaminant spread is minimum and is localized north of CMP Pits.

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. Lindane concentrations increased slightly above the MCL at CMP064BU in 2019.

One well located north of Pen Branch, CMP067B, had detections of PCE and TCE below MCLs during 4Q2019; however, results from resampling in 1Q2020 were non-detect. The two wells north of Pen Branch, CMP066B and CMP067B will be sampled semi-annually in 2Q2020 and 4Q2020 for continued monitoring. These detections are not believed to be representative of groundwater conditions, as underflow beneath Pen Branch from a CMP Pit source is highly unlikely.

Two new monitoring wells were installed in the GA in September 2019, CMP010A and CMP055A. Results from CMP010A indicate that the GA is contaminated above MCLs with PCE, TCE, and also has concentrations of 1,4-dioxane above the USEPA tap water RSL. The contaminants in the GA above MCLs were confirmed at CMP010A with resampling results collected in 1Q2020. It is currently unknown if the contamination is a result of drilling activities or is occurring due to complex contaminant transport from CMP Pits.

1,4-Dioxane was analyzed at a majority of the CMP Pits wells and at surface water stations in 2019 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 42 of the 63 wells sampled (66%) using the EPA 522 method compared to 16 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 92 µg/L at new GA well CMP010A. 1,4-Dioxane was detected at one surface station, CMP-SW-10, with the EPA 522 method at an estimated concentration of 0.101 µg/L, which is below the USEPA tap water RSL of 0.46 µg/L. All other 1,4-dioxane results were non-detect. Due to its presence in groundwater, 1,4-dioxane is monitored annually.

There is no SC 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 proposes to utilize the EPA 522 method that can meet the USEPA tap water RSL, in addition to the current SCDHEC approved method. If a lab/method has SC accreditation and can meet the USEPA tap water RSL, then that would be the preferable analyses method used.

Screening level data that is usually presented within this report from SCSU is not available for the 2019 time period. Future sampling done by SCSU or other independent entities will be provided in future EMRs as is available.

Based on the previous SCSU study findings, surface water station CMP-SW-22 was added approximately 150 ft. upstream of surface water station CMP-SW-07 to ensure representative surface water samples are collected near this area of Pen Branch. Surface water monitoring will continue at CMP-SW-07. SRS had previously proposed to omit CMP-SW-21 in the June 2019 report and did not sample it during 2019. Following review of the 2019 EMR, USEPA requested surface water sampling continue at CMP-SW-21. Surface water station CMP-SW-21 will be added back to the monitoring network starting with 2Q2020 sampling.

Additionally, SRS proposes to add well CMP 32B to the monitoring network with semiannual sampling for VOCs and annual sampling for 1,4-dioxane. SRS has been monitoring this well annually for VOCs for the past five years.

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 term RA 10 years ago, many core concentrations continue to decline, and surface water continues to be minimally impacted as concentrations are generally non-detect. VOC biodegradation in the wetlands around Pen Branch are likely reducing the flux of VOCs into Pen Branch.

Although the modeling efforts have predicted that contamination will remain above MCLs for many decades, it would be prudent to discuss the new results and increasing source area trends with the Core Team to determine the need/scope for additional characterization and alternative evaluations. As documented in the SRS responses to USEPA comments on the June 2019 EMR, a Core Team discussion will occur in 2020 following review of this EMR.

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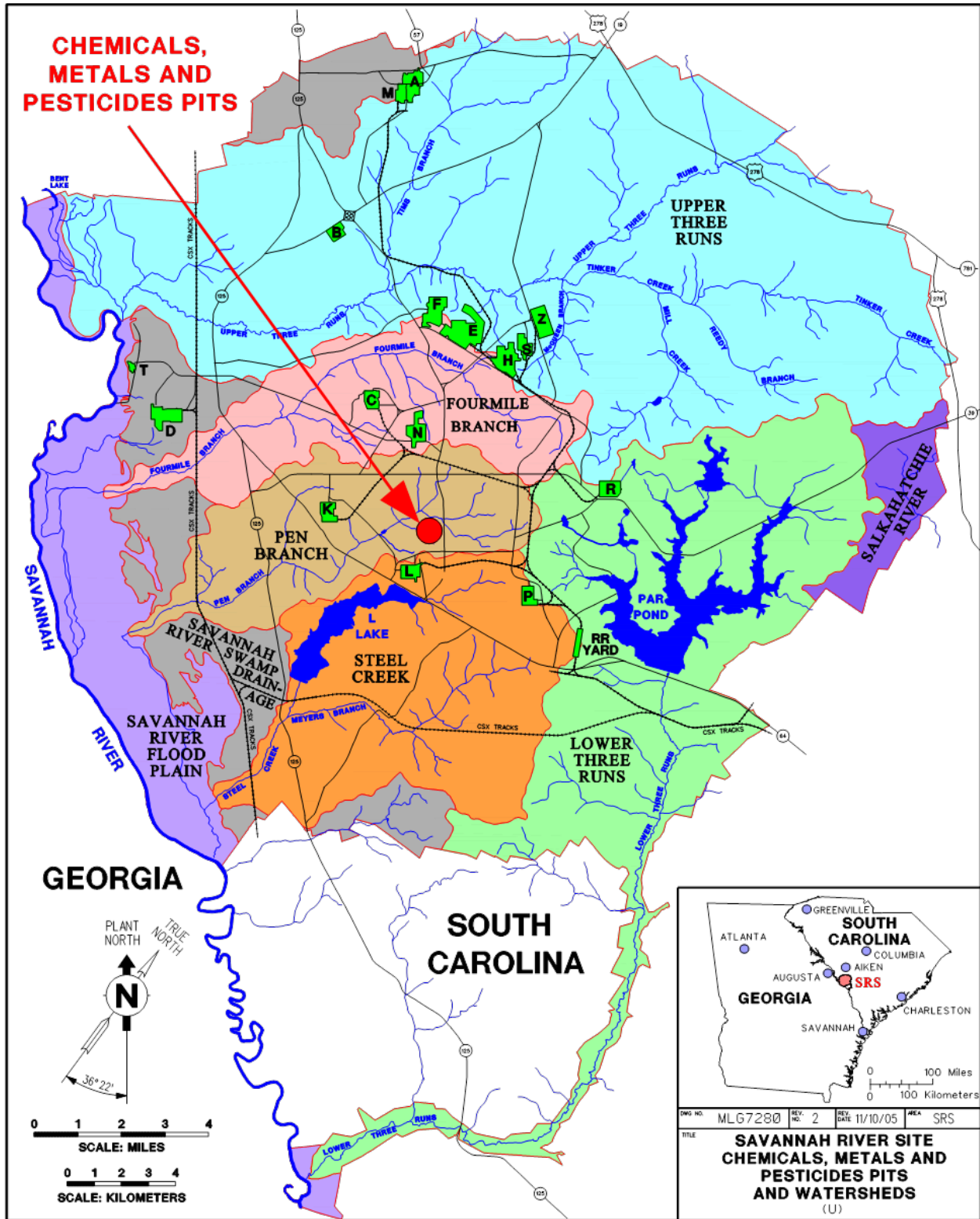


Figure 1. Location of the CMP Pits OU within the Savannah River Site

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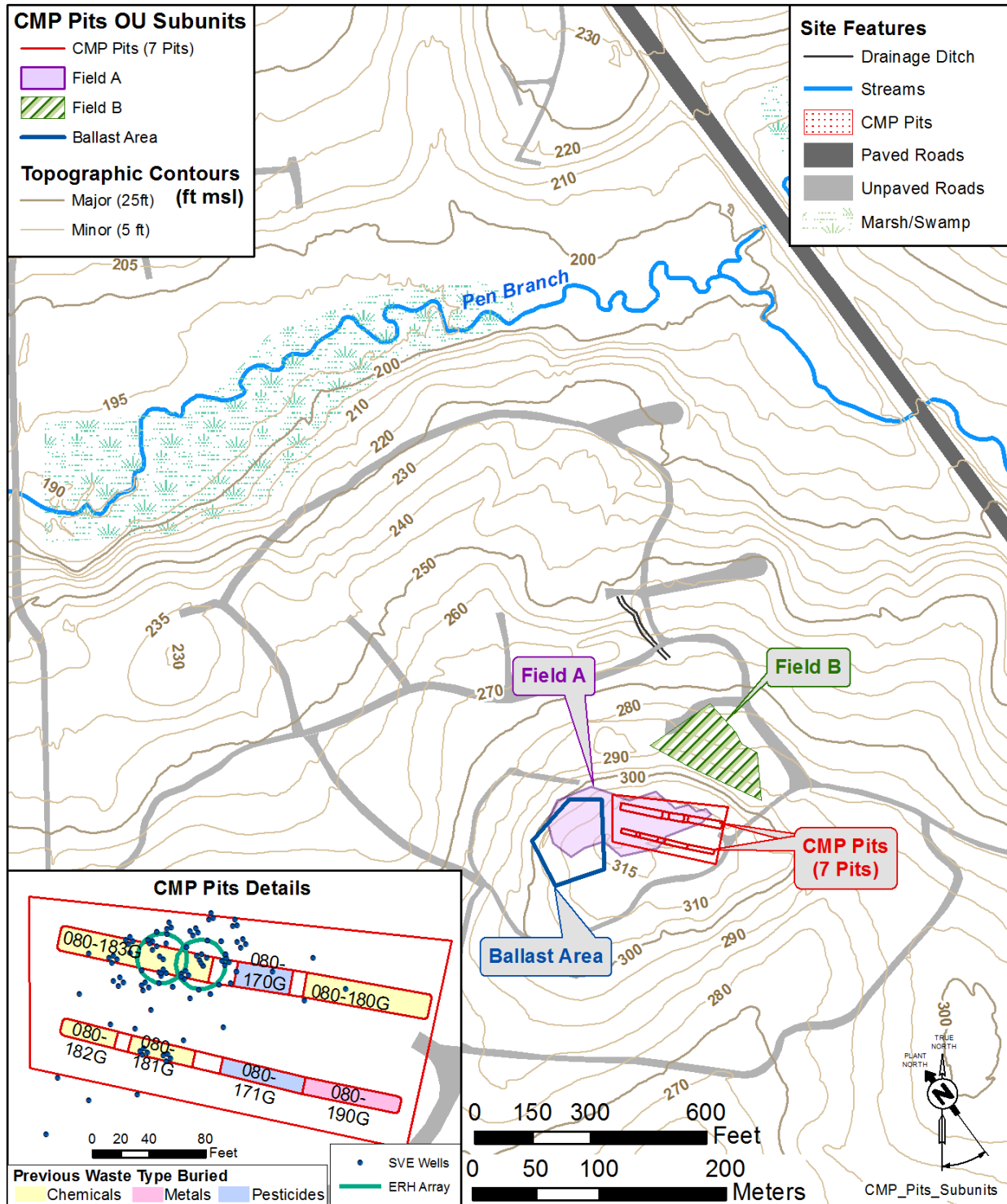


Figure 2. CMP Pits OU Subunits

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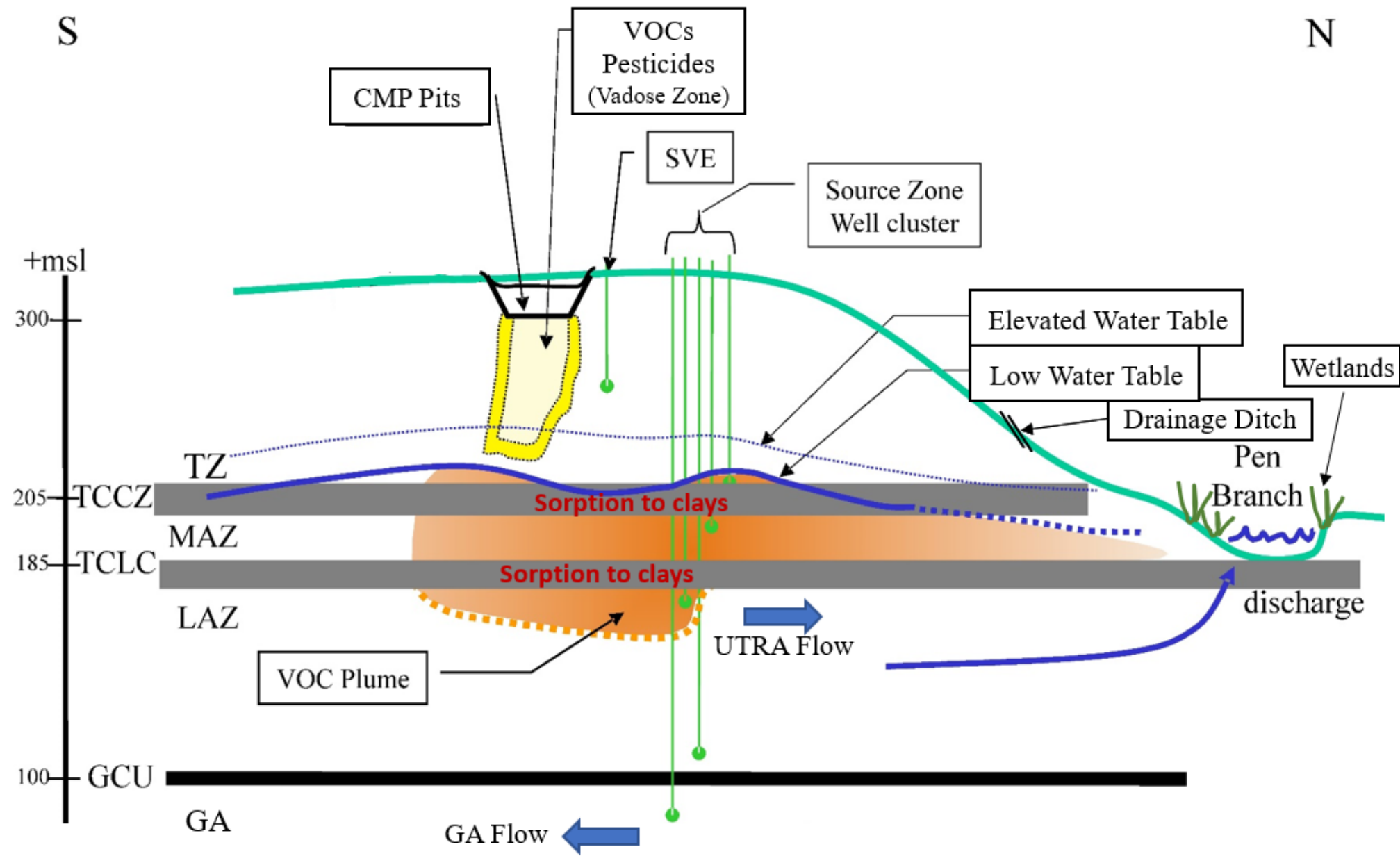


Figure 3. CMP Pits Groundwater OU Conceptual Site Model (CSM)

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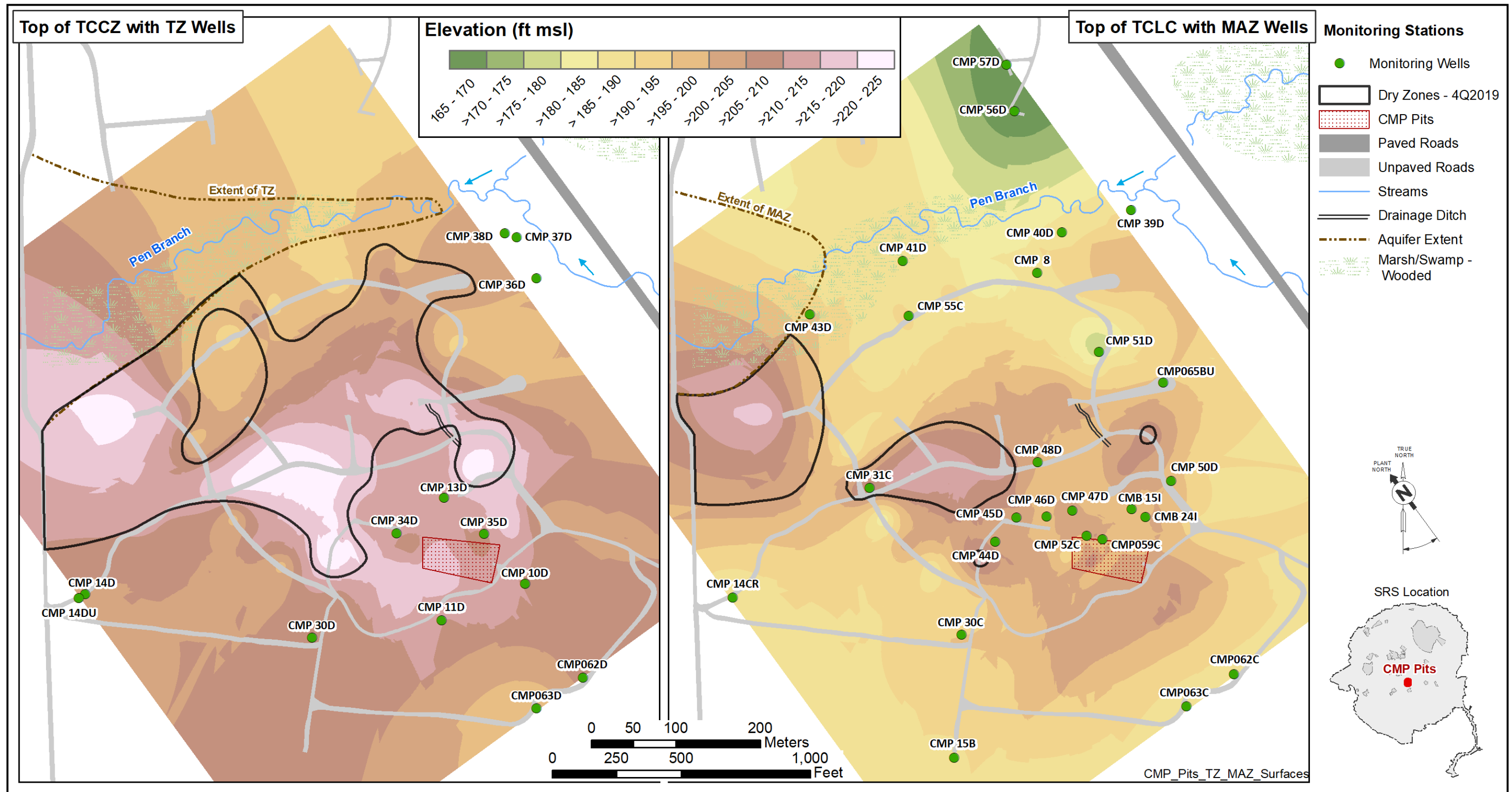


Figure 4. Stratigraphic Surfaces of the TCCZ and TCLC

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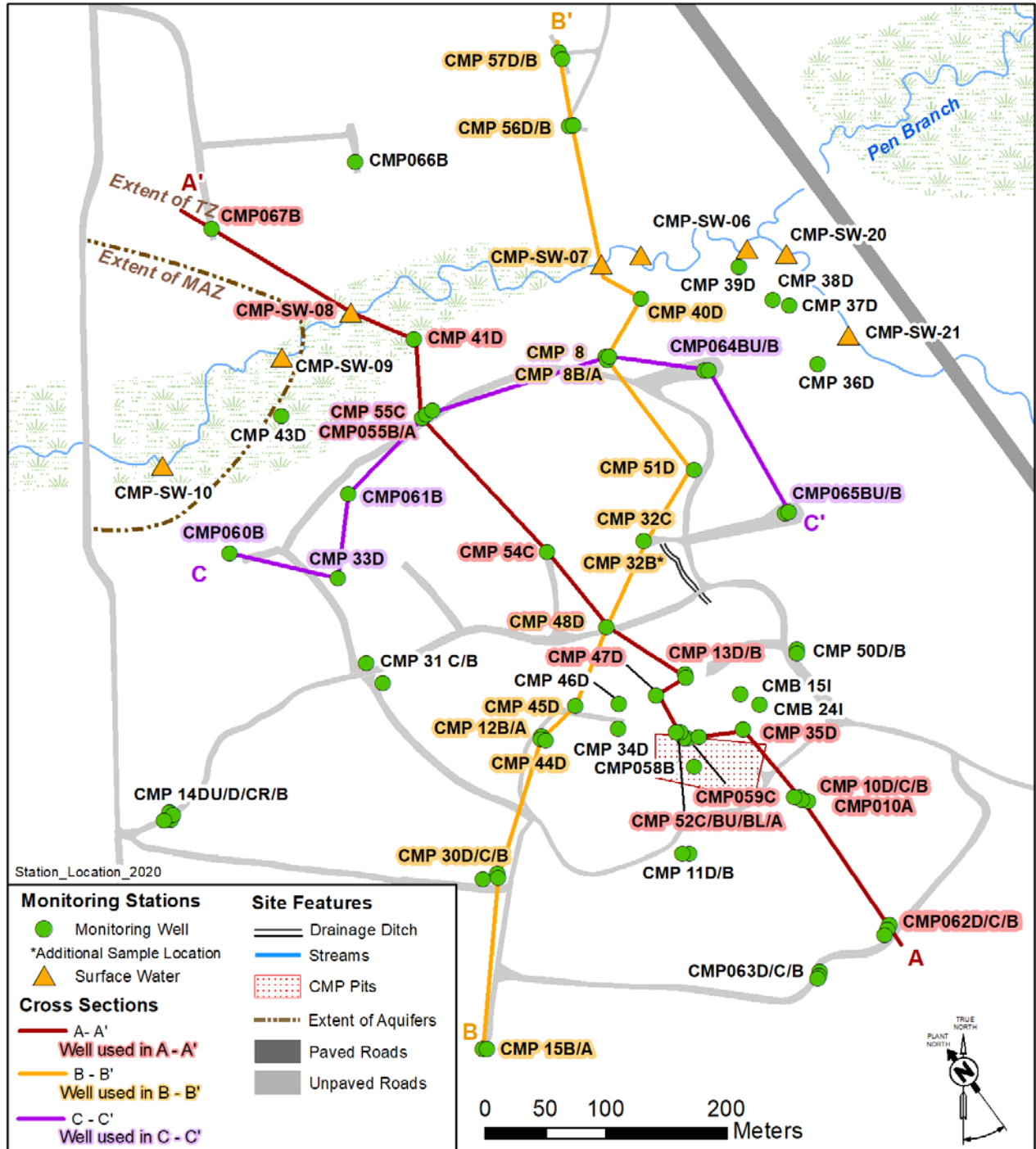


Figure 5. CMP Pits OU Monitoring Network, and Cross Section Lines

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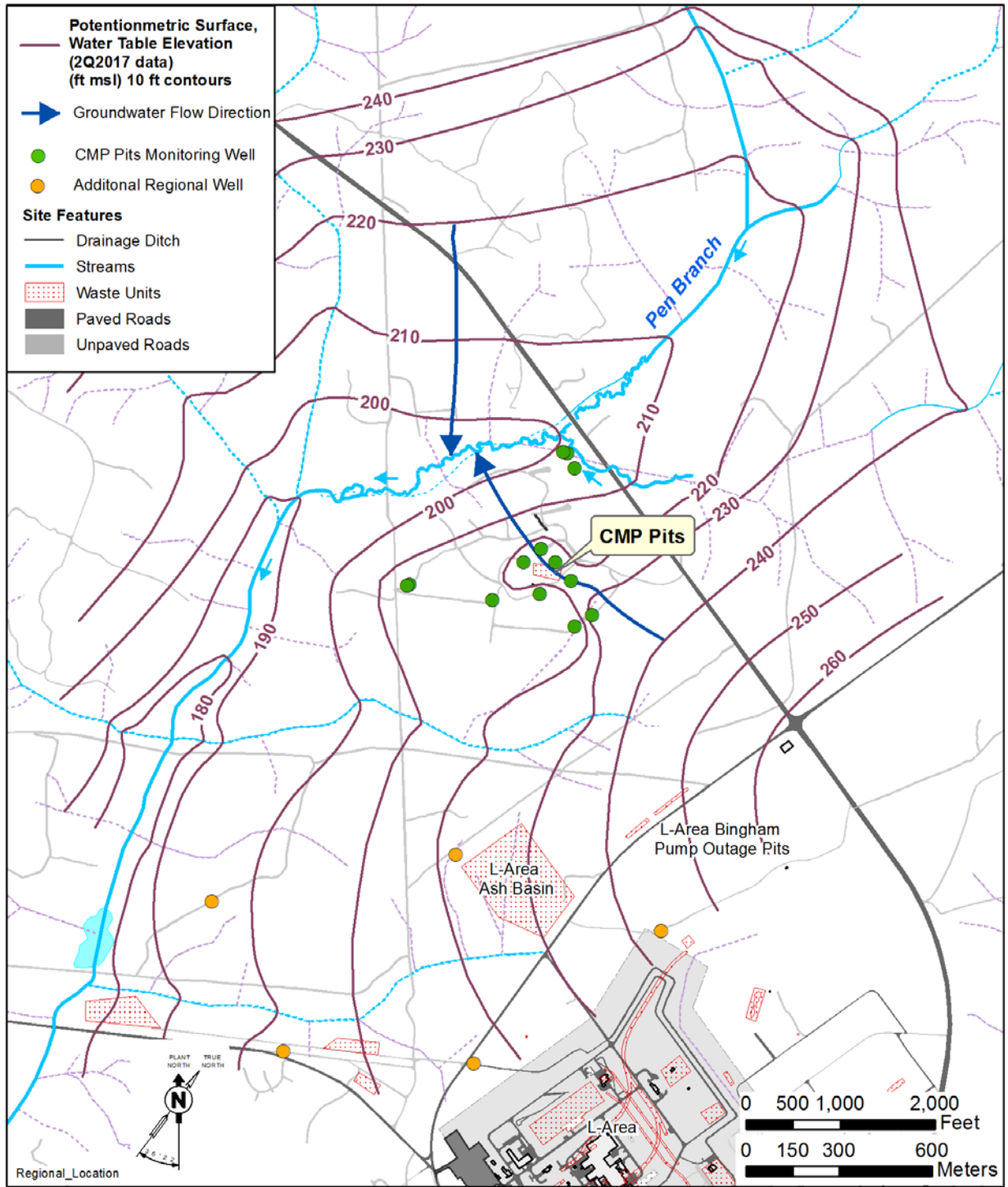


Figure 6. Regional Water Table Potentiometric Surface

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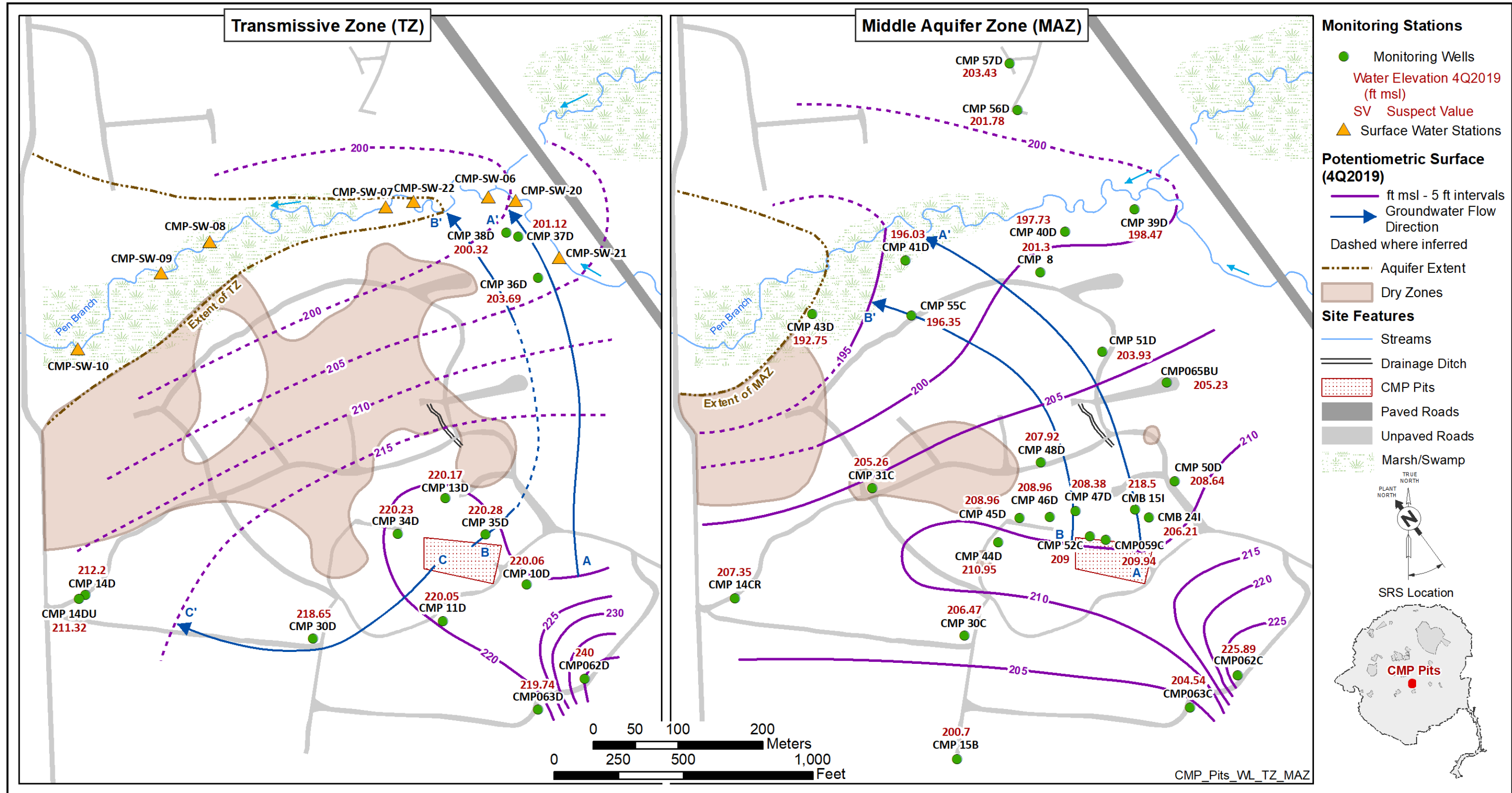


Figure 7. 2019 Potentiometric Surface for the TZ and MAZ

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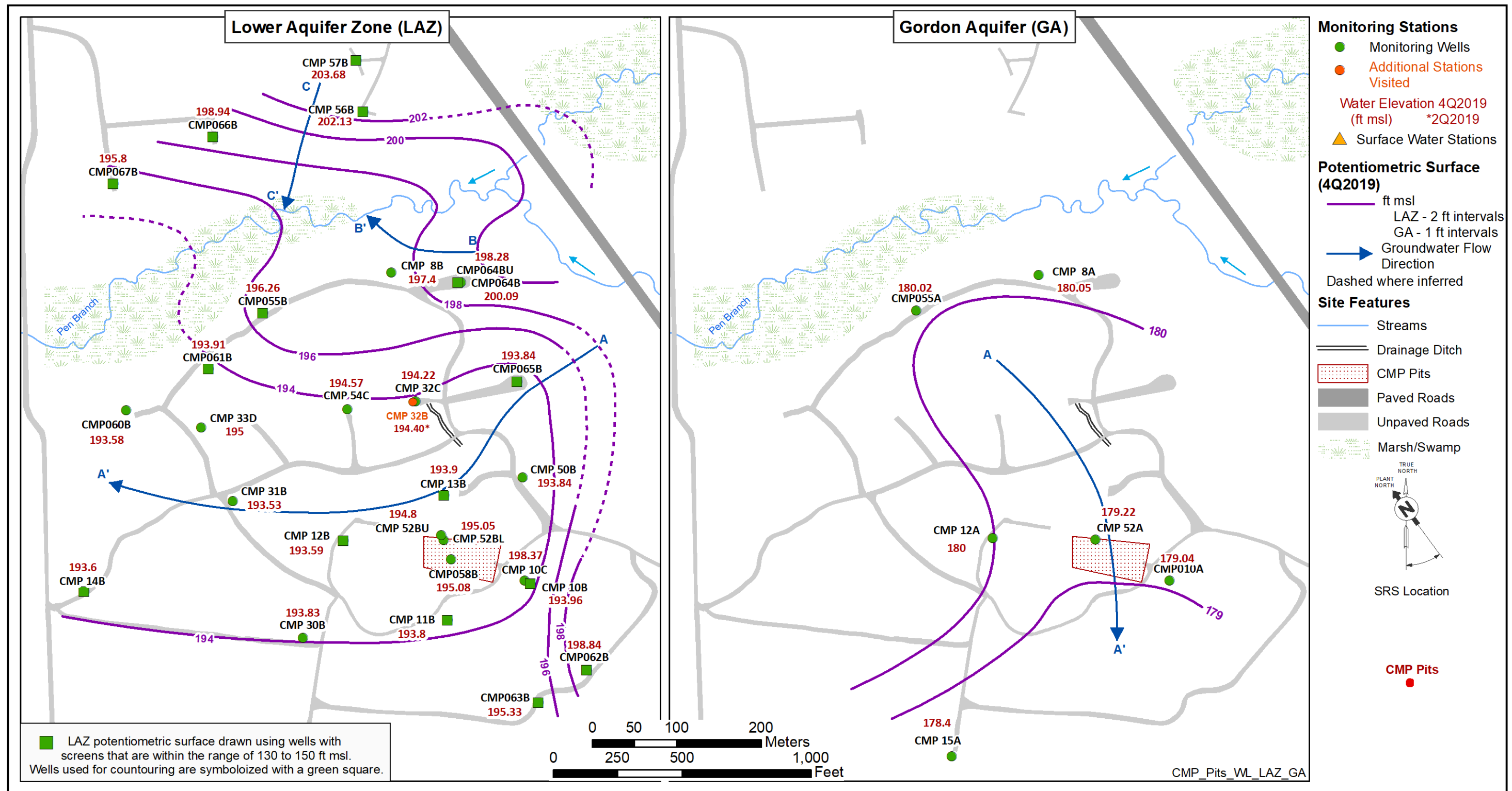


Figure 8. 2019 Potentiometric Surface for the LAZ and GA

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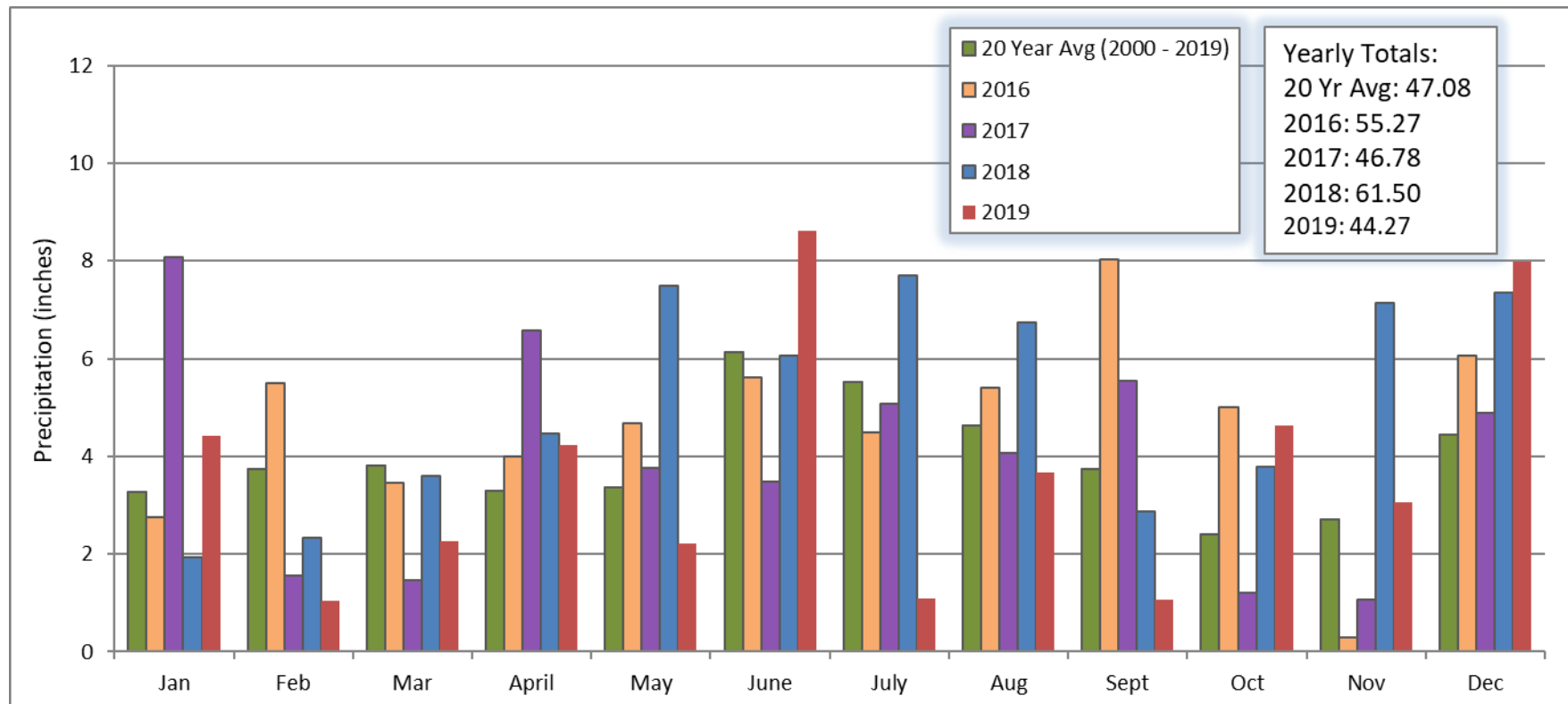


Figure 9. Monthly Rainfall Measurements in L-Area for 2019, 2018, 2017, 2016, and the 20-Year Average

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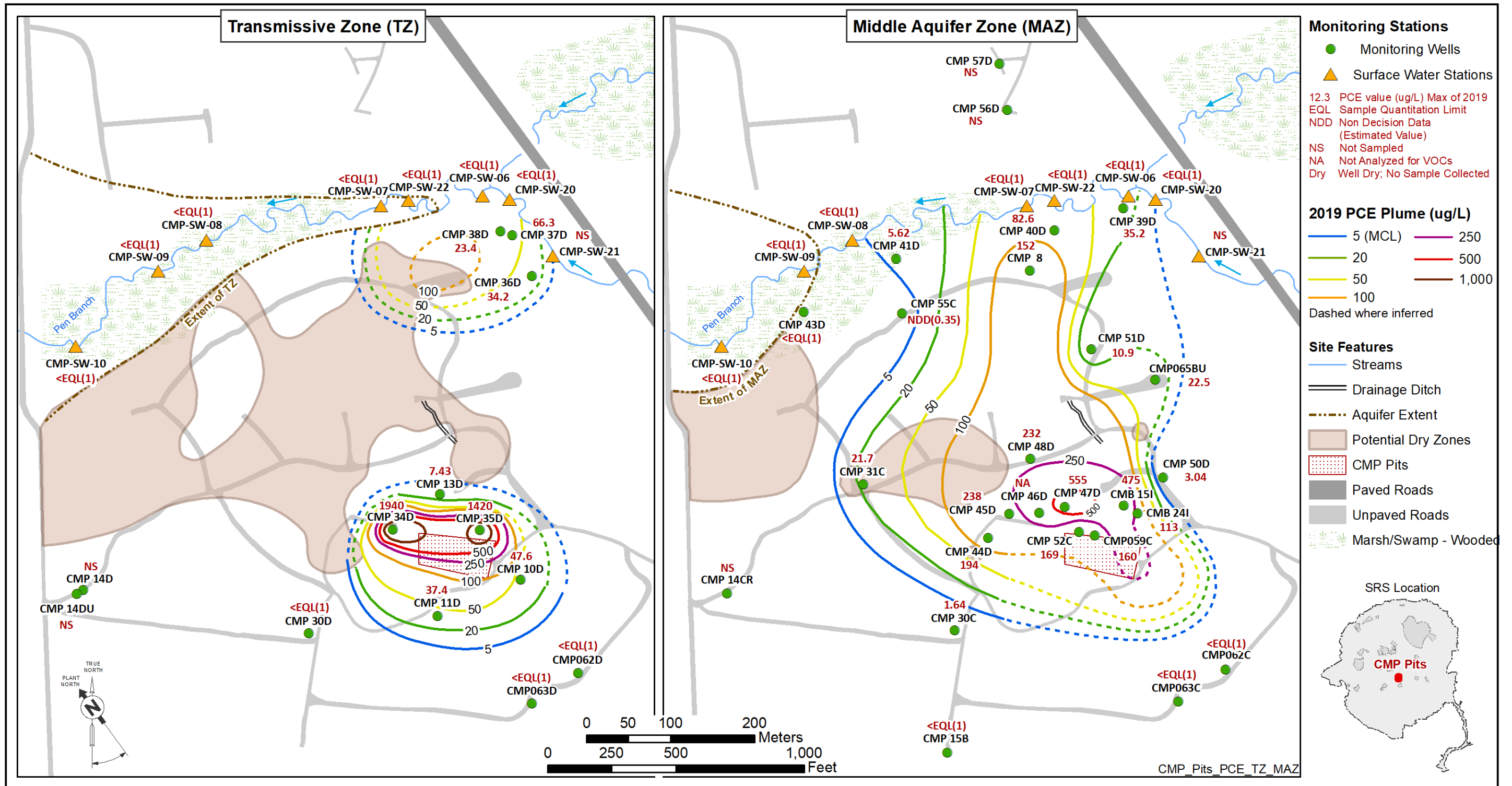


Figure 10. 2019 PCE Plume and Groundwater and Surface Water Results for the TZ and MAZ

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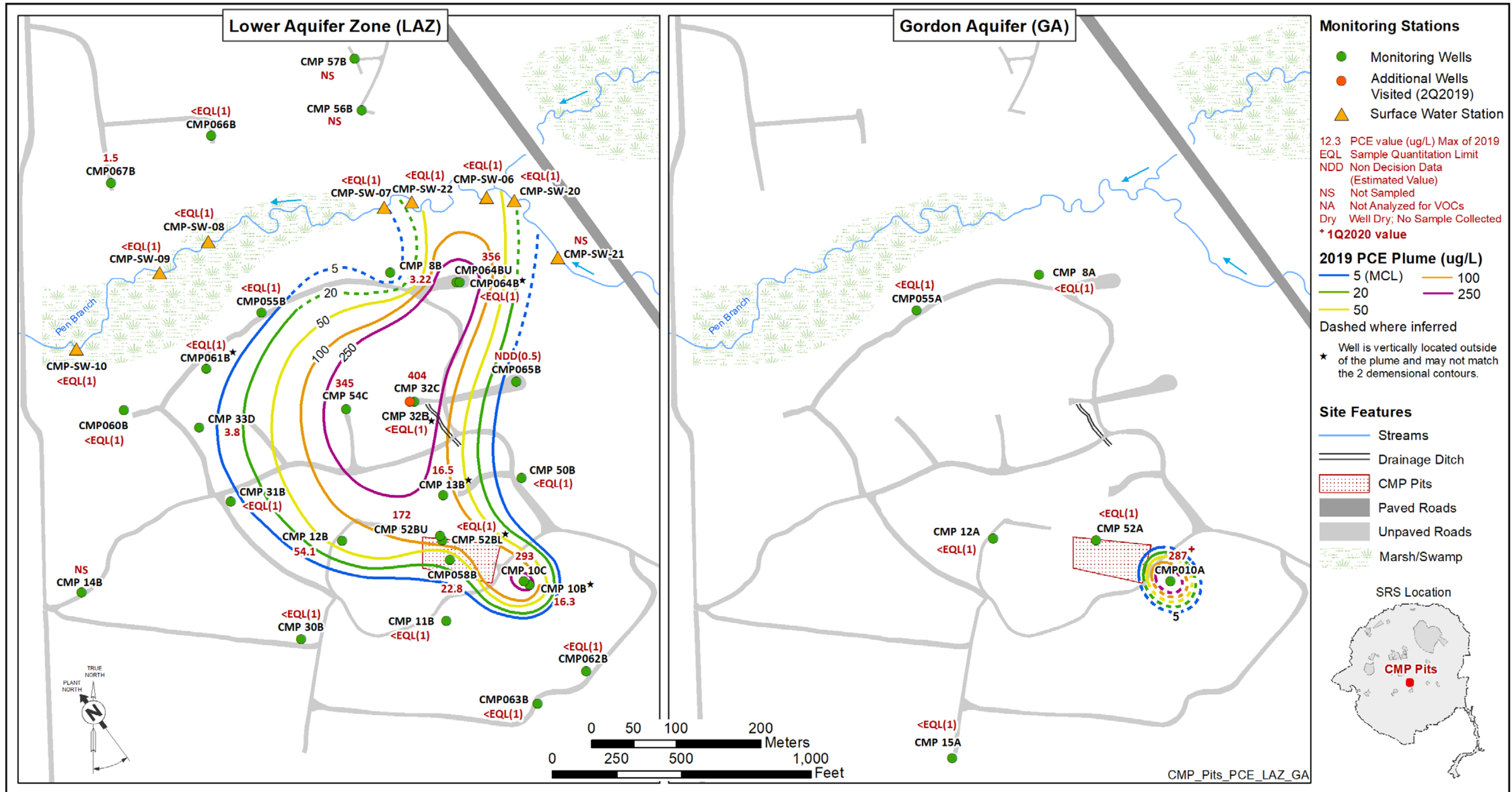
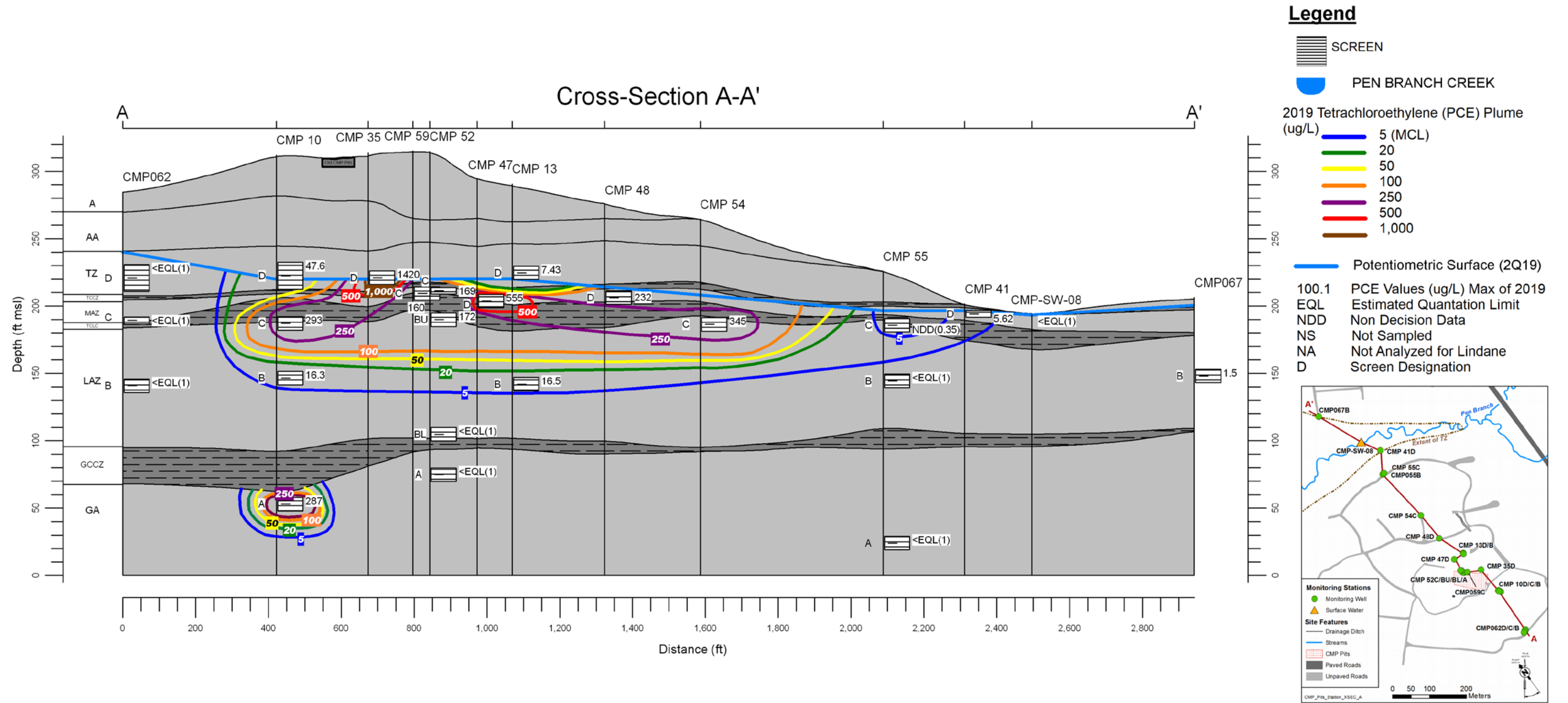


Figure 11. 2019 PCE Plume and Groundwater Results for the LAZ and GA

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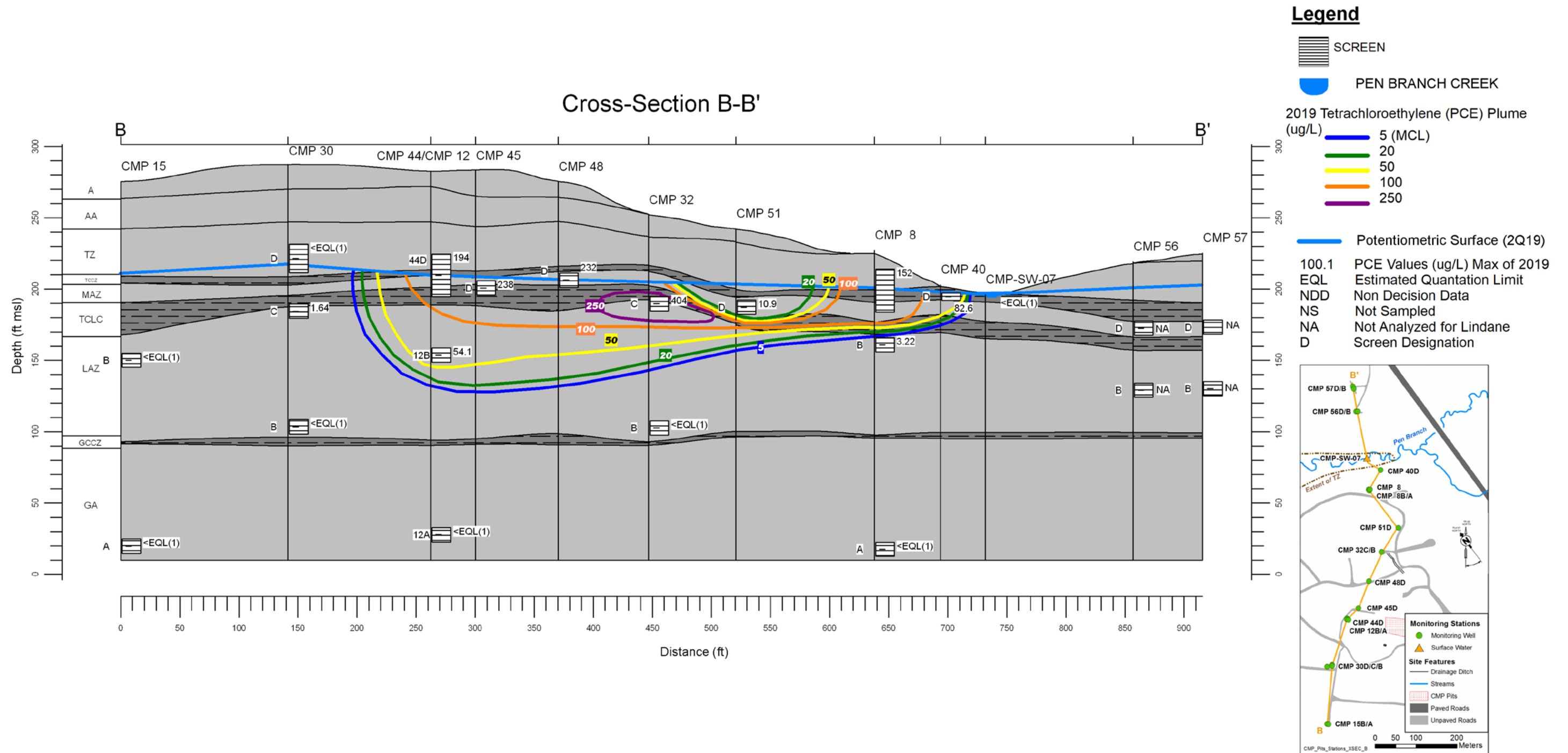


Figure 13. Cross Section B - B' at the CMP Pits OU Area with 2019 PCE Plume and Results

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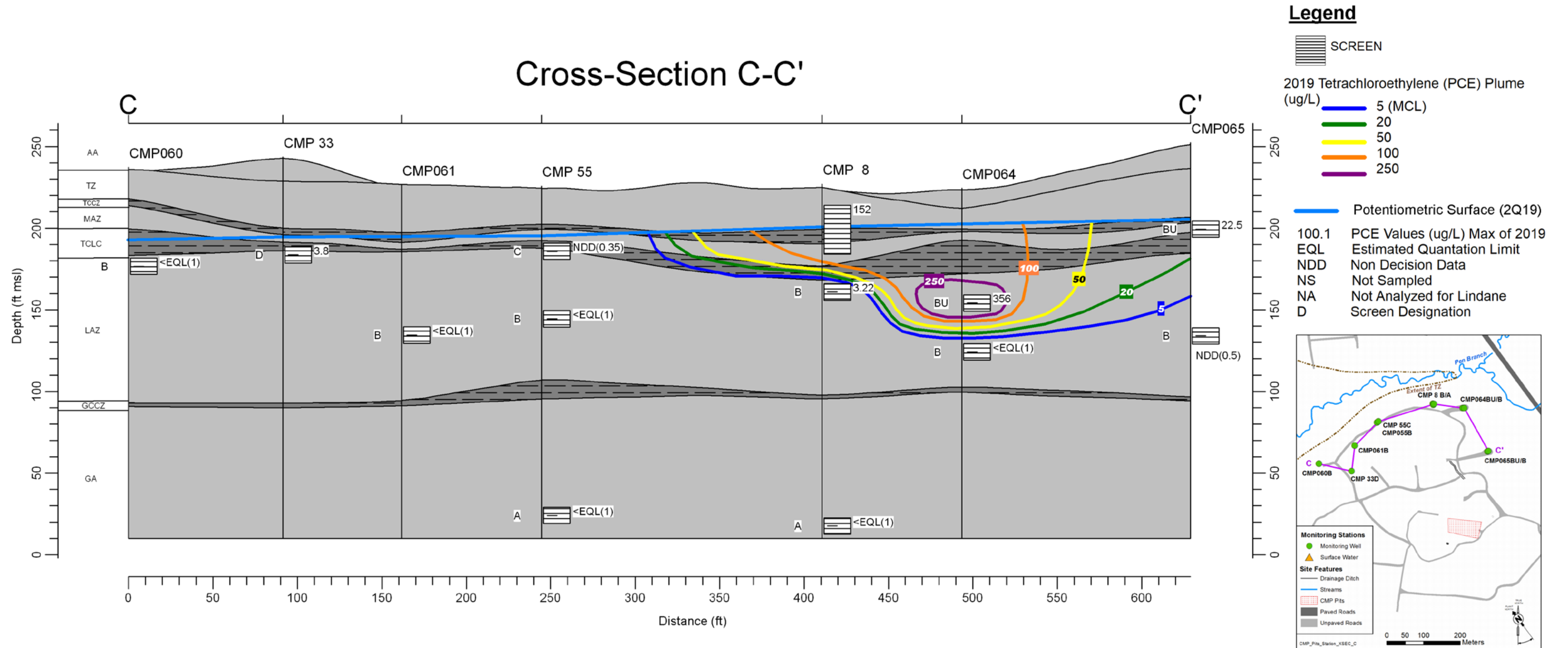


Figure 14. Cross Section C - C' at the CMP Pits OU Area with 2019 PCE Plume and Results

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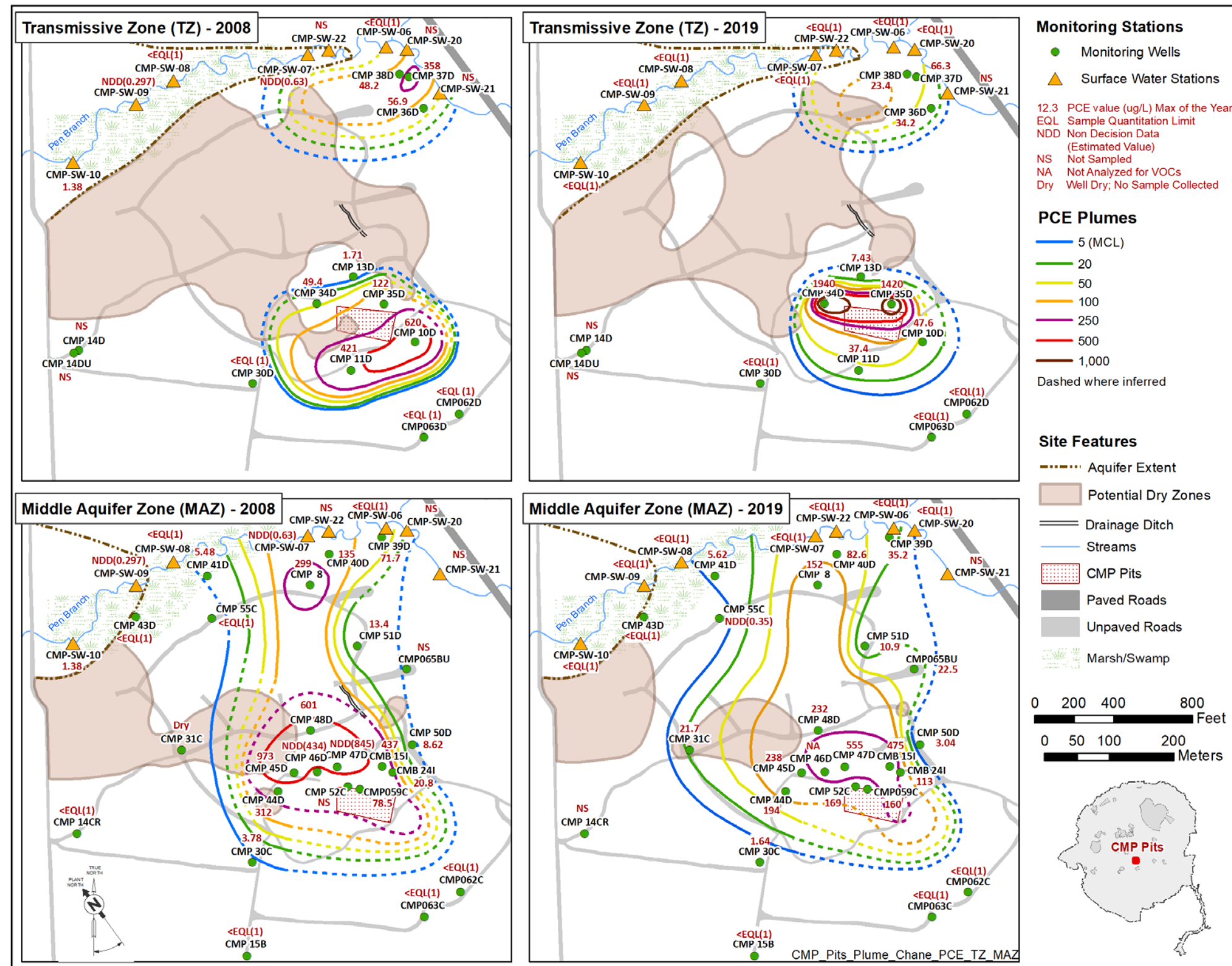


Figure 15. PCE Plume Comparison from 2008 and 2019 in the TZ and MAZ

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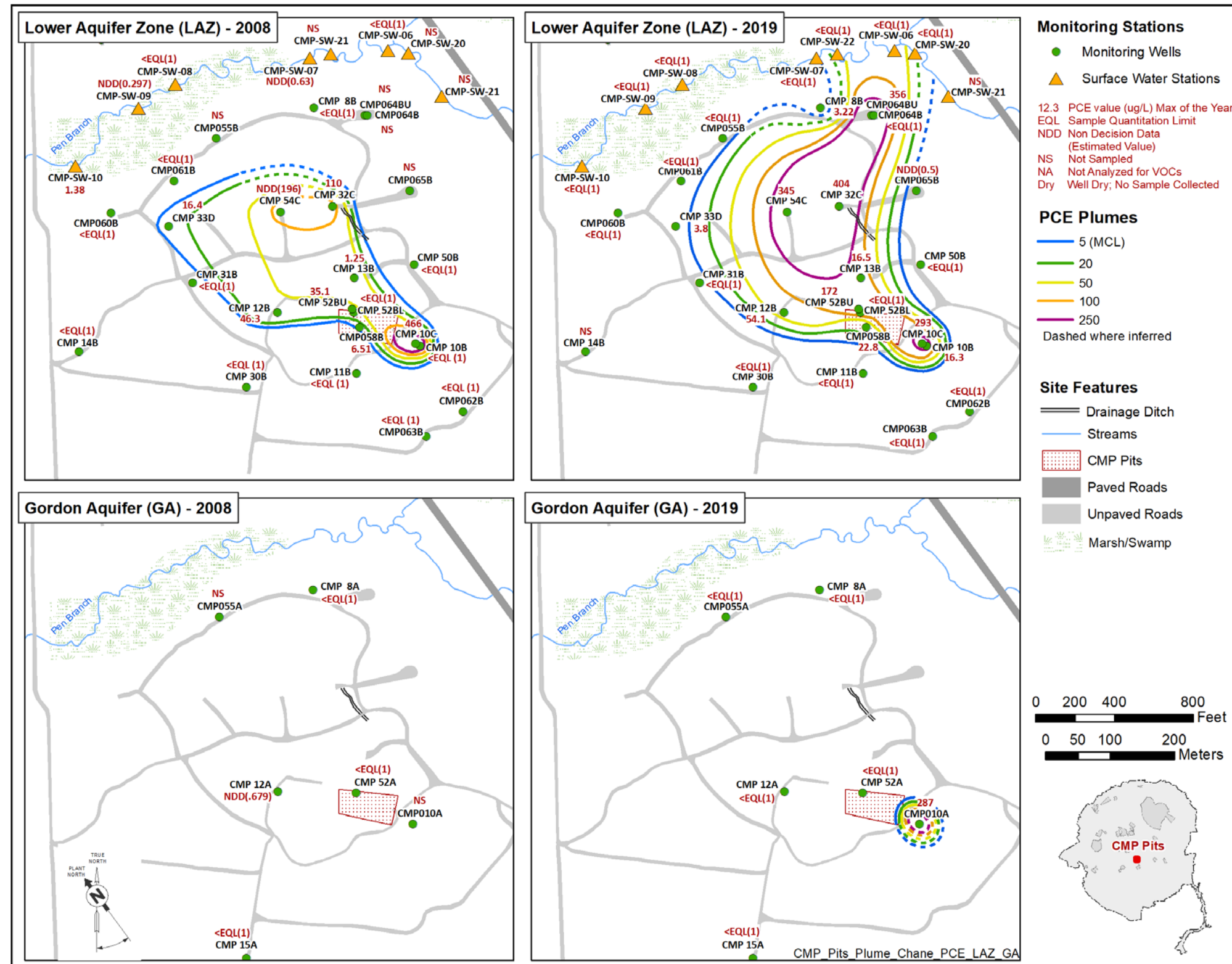


Figure 16. PCE Plume Comparison from 2008 and 2019 in the LAZ and GA

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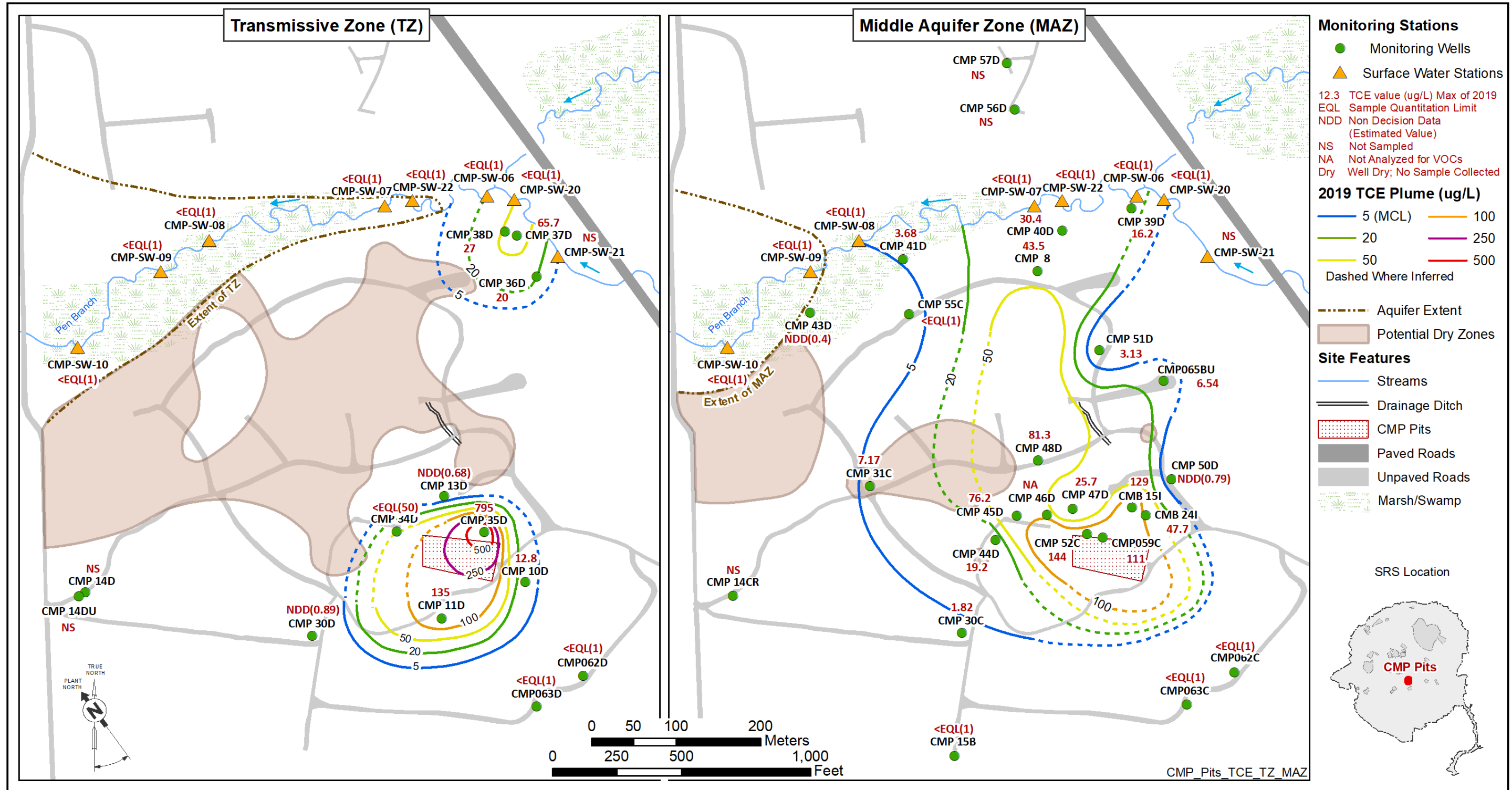


Figure 17. 2019 TCE Plume and Groundwater and Surface Water Results in the TZ and MAZ

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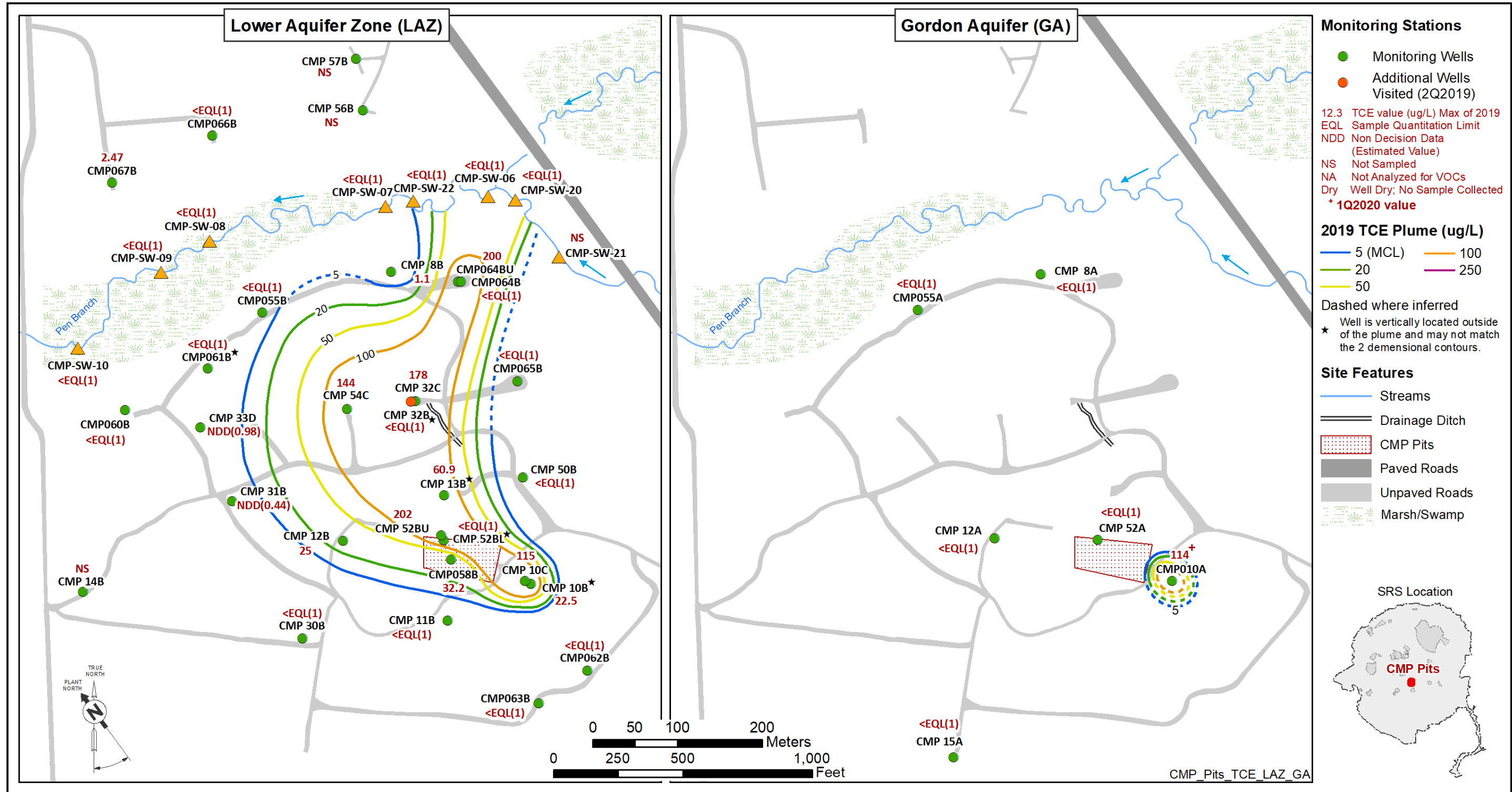


Figure 18. 2019 TCE Plume and Groundwater Results for the LAZ and GA

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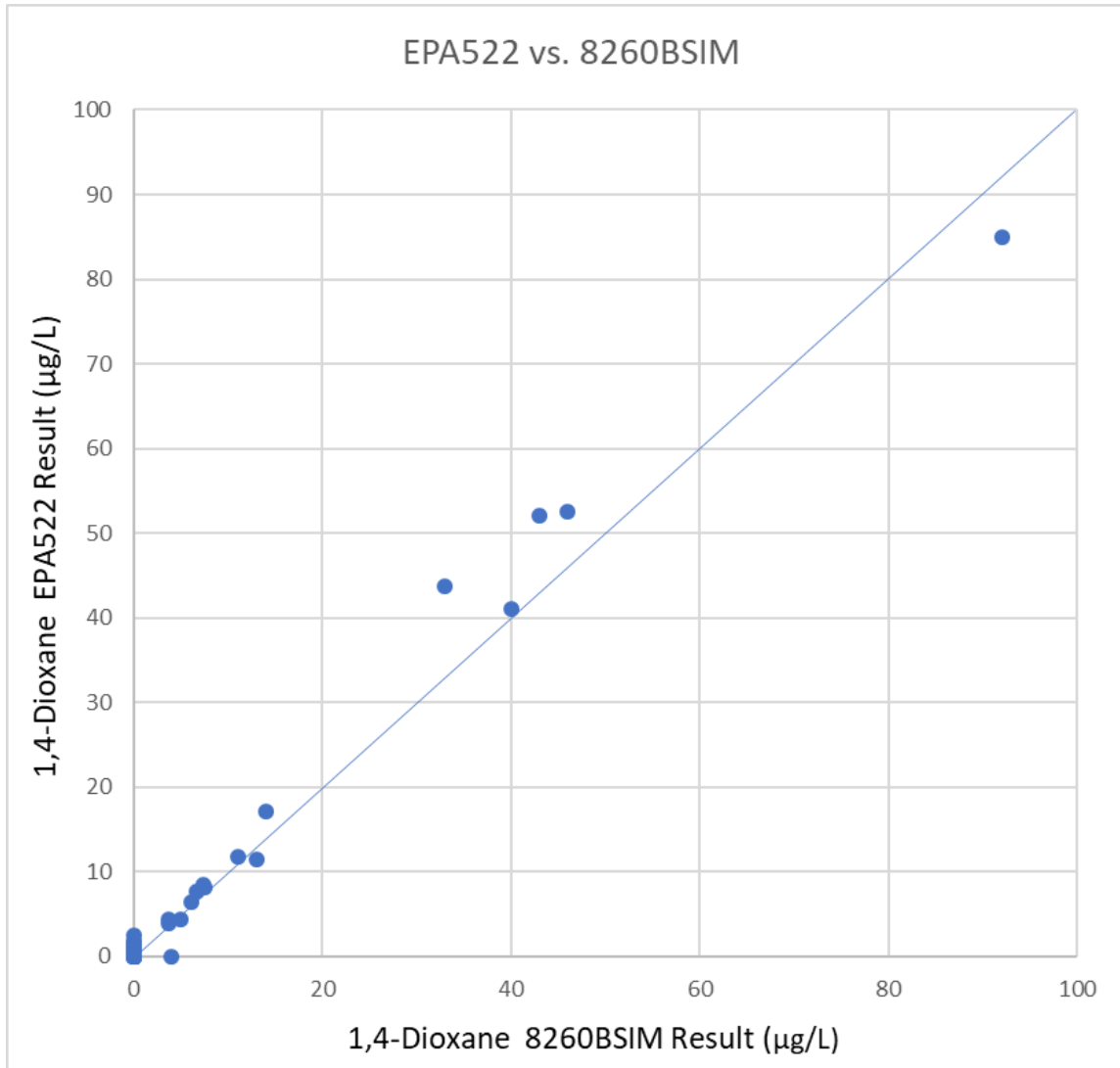


Figure 19. Comparison of 2019 1,4-Dioxane Results Using Method EPA522 and 8260BSIM

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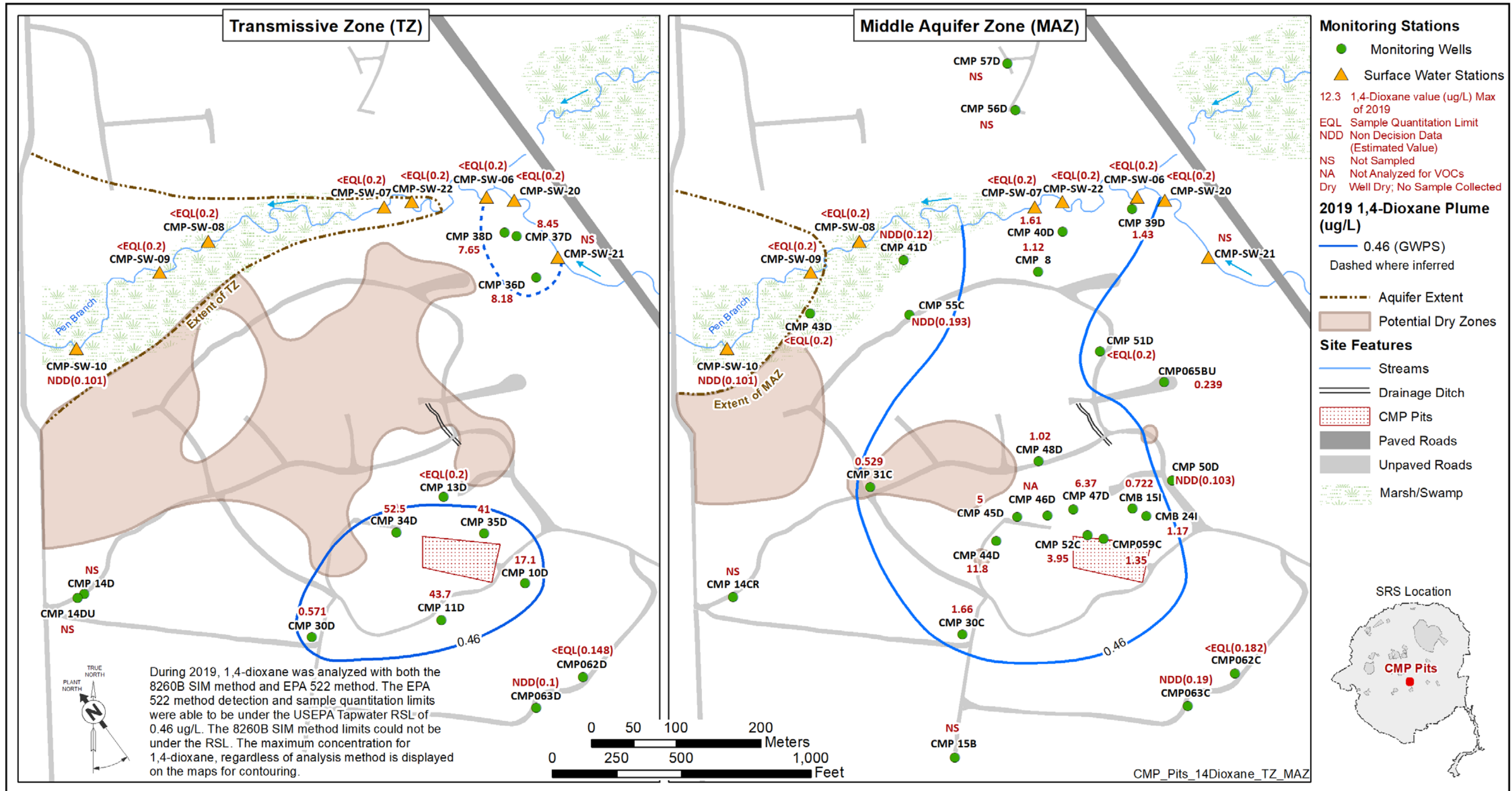


Figure 20. 2019 1,4-Dioxane Plume and Groundwater Results for the TZ and MAZ

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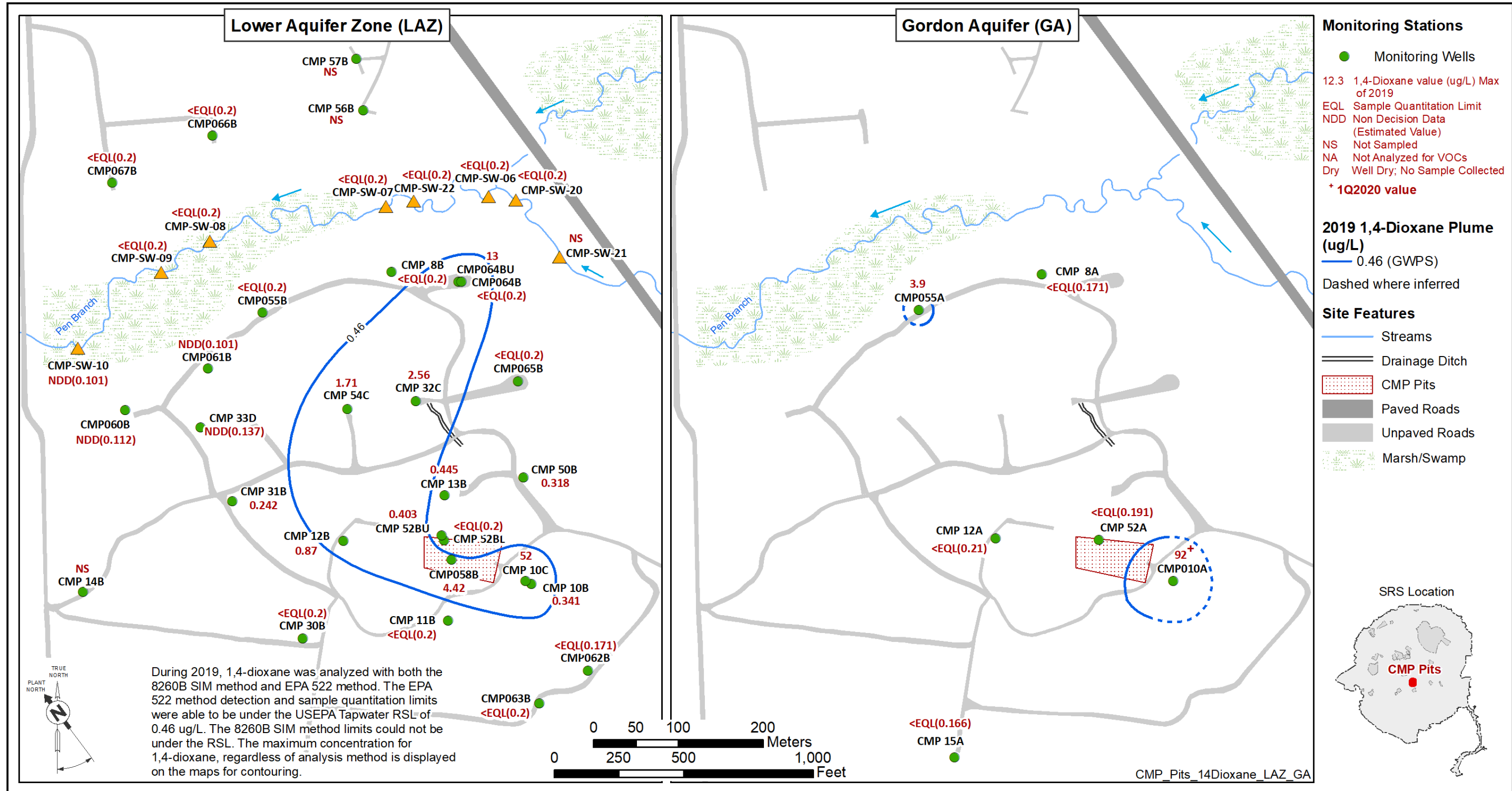


Figure 21. 2019 1,4-Dioxane Plume and Groundwater Results for the LAZ and GA

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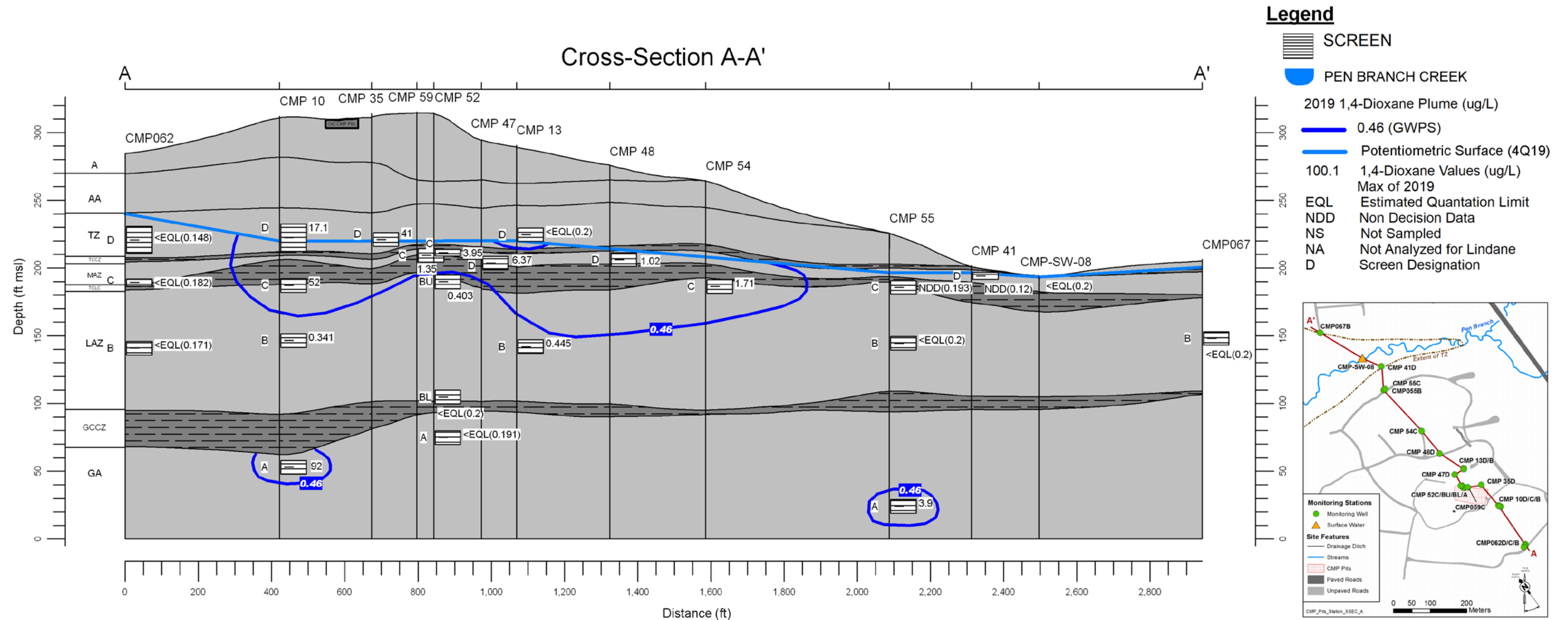


Figure 22. Cross Section A - A' at the CMP Pits OU Area with 2019 1,4-Dioxane Plume and Results

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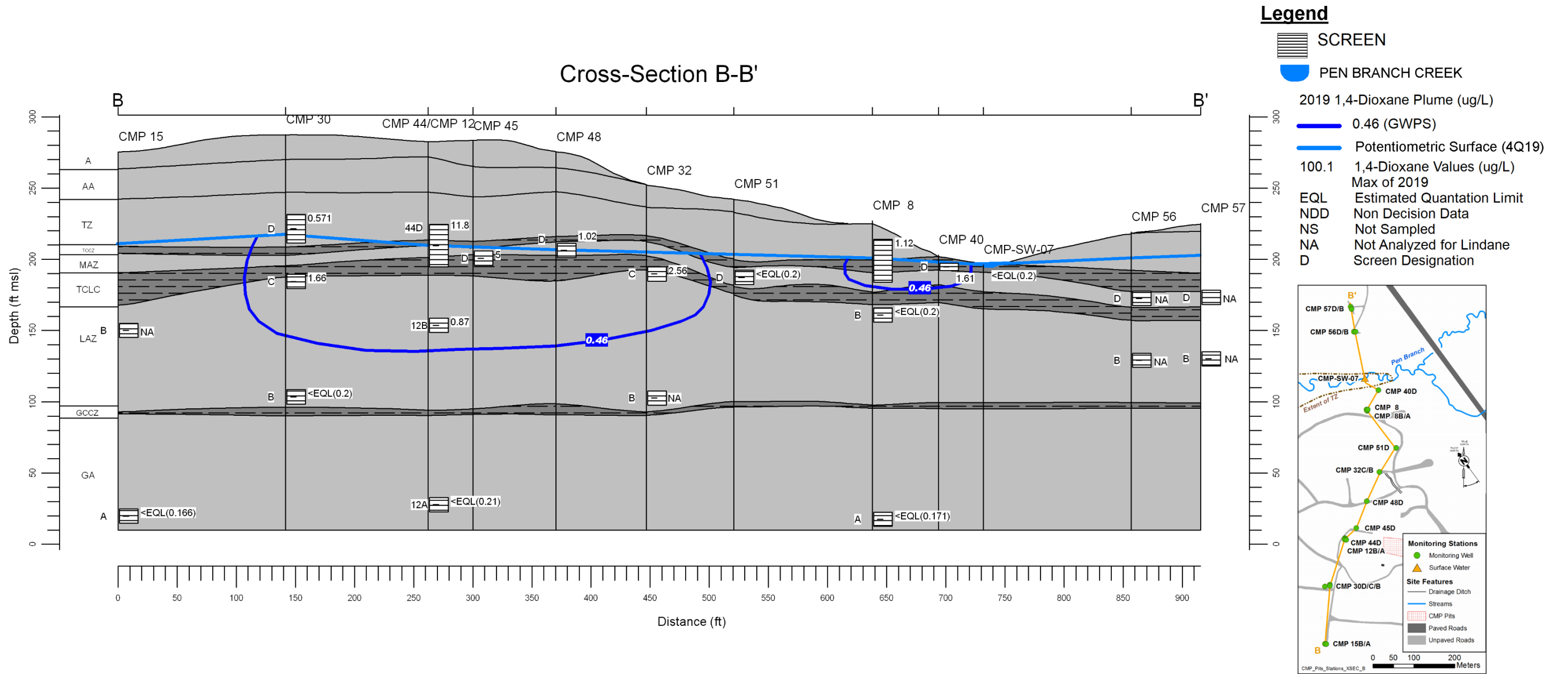


Figure 23. Cross Section B - B' at the CMP Pits OU Area with 2019 1,4-Dioxane Plume and Results

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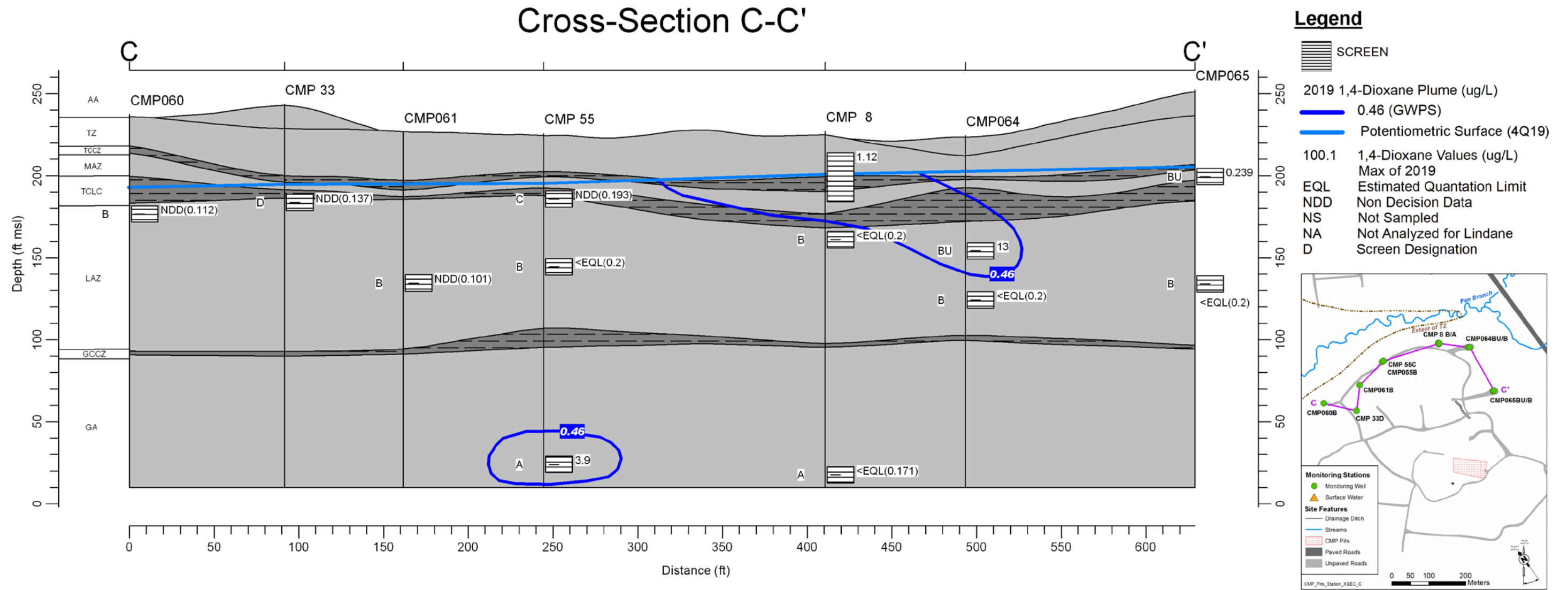


Figure 24. Cross Section C - C' at the CMP Pits OU Area with 2019 1,4-Dioxane Plume and Results

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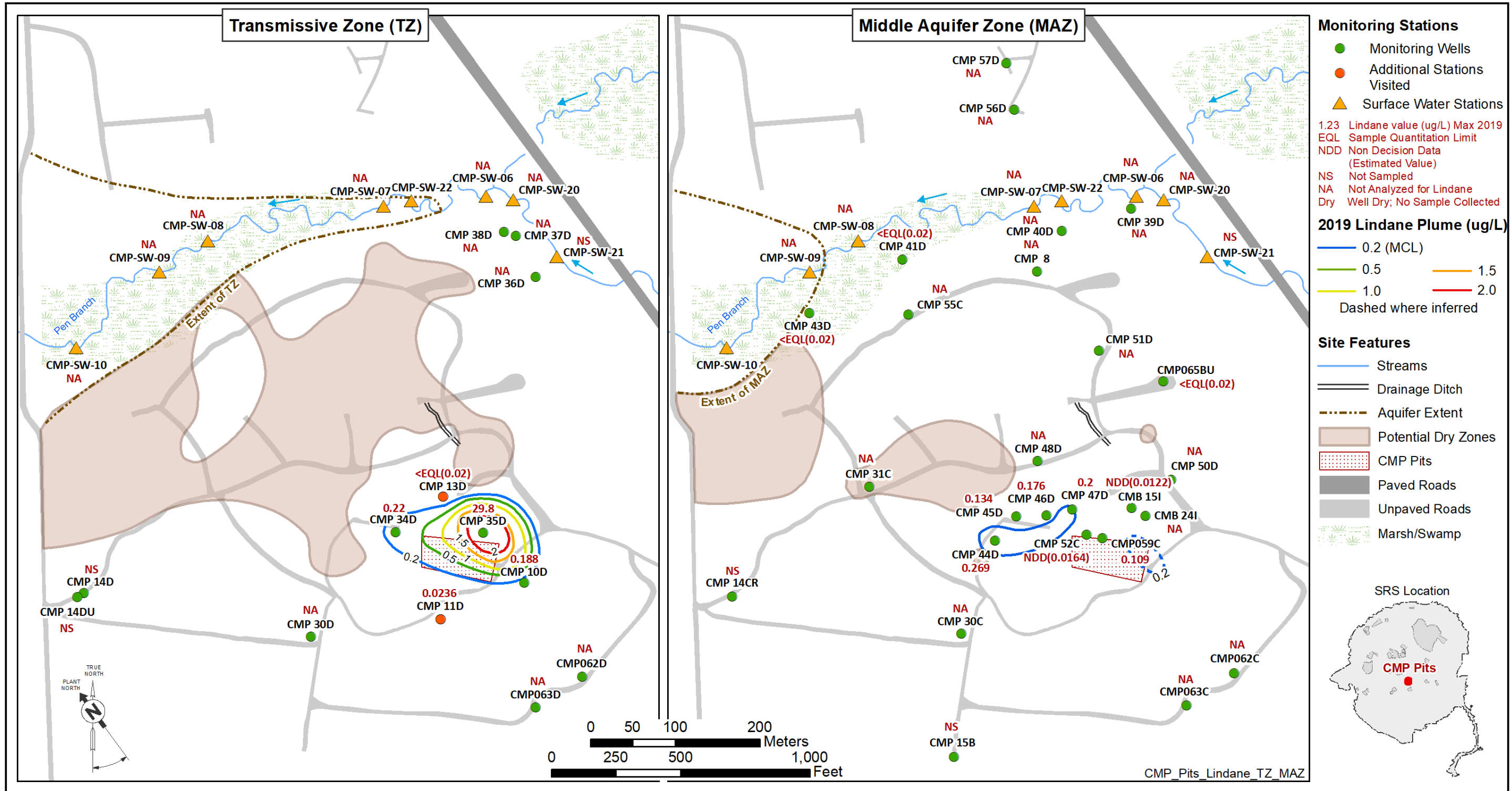


Figure 25. 2019 Lindane Plume and Groundwater Results for the TZ and MAZ

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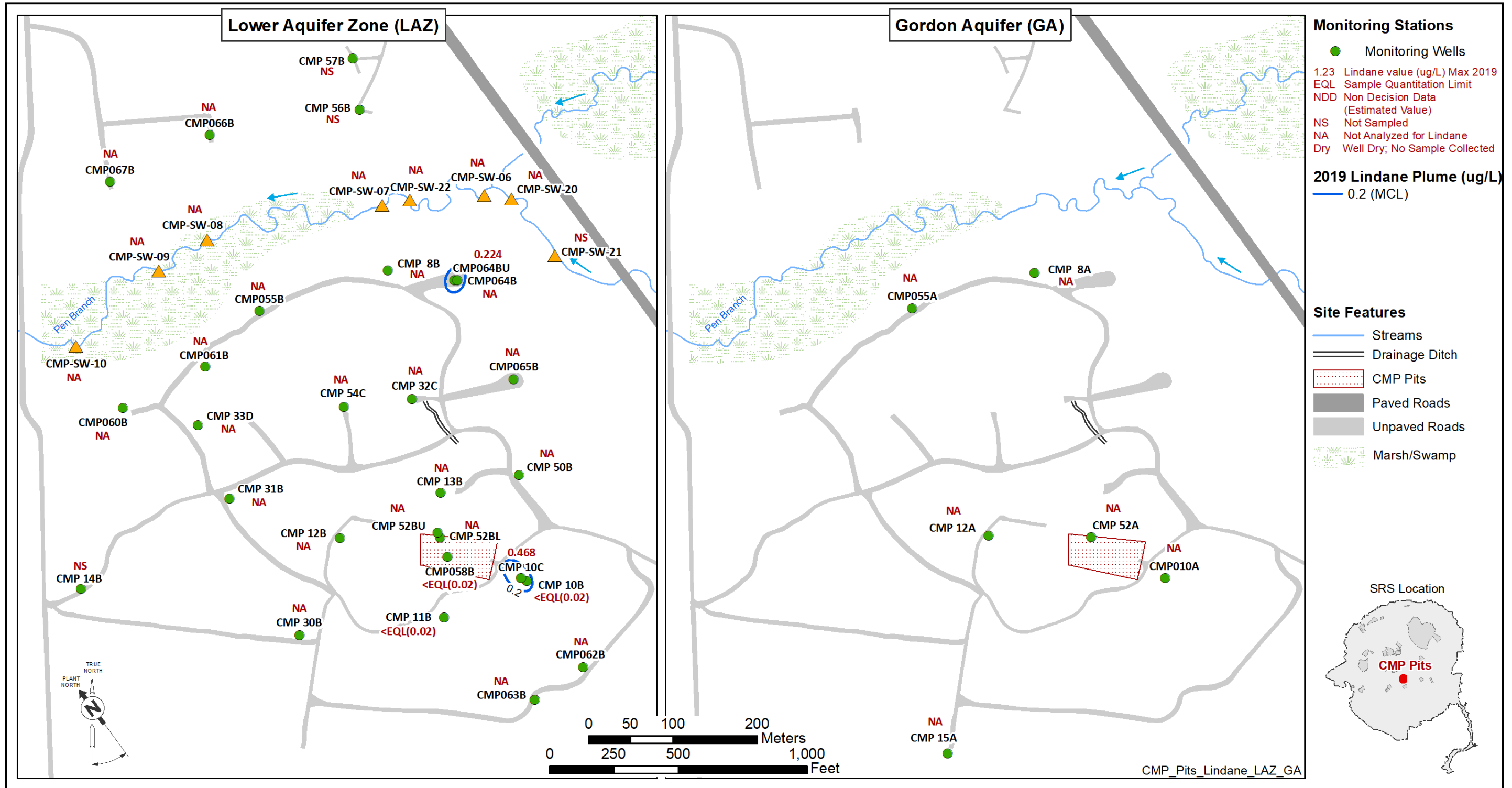


Figure 26. 2019 Lindane Plume and Groundwater Results for the LAZ and GA

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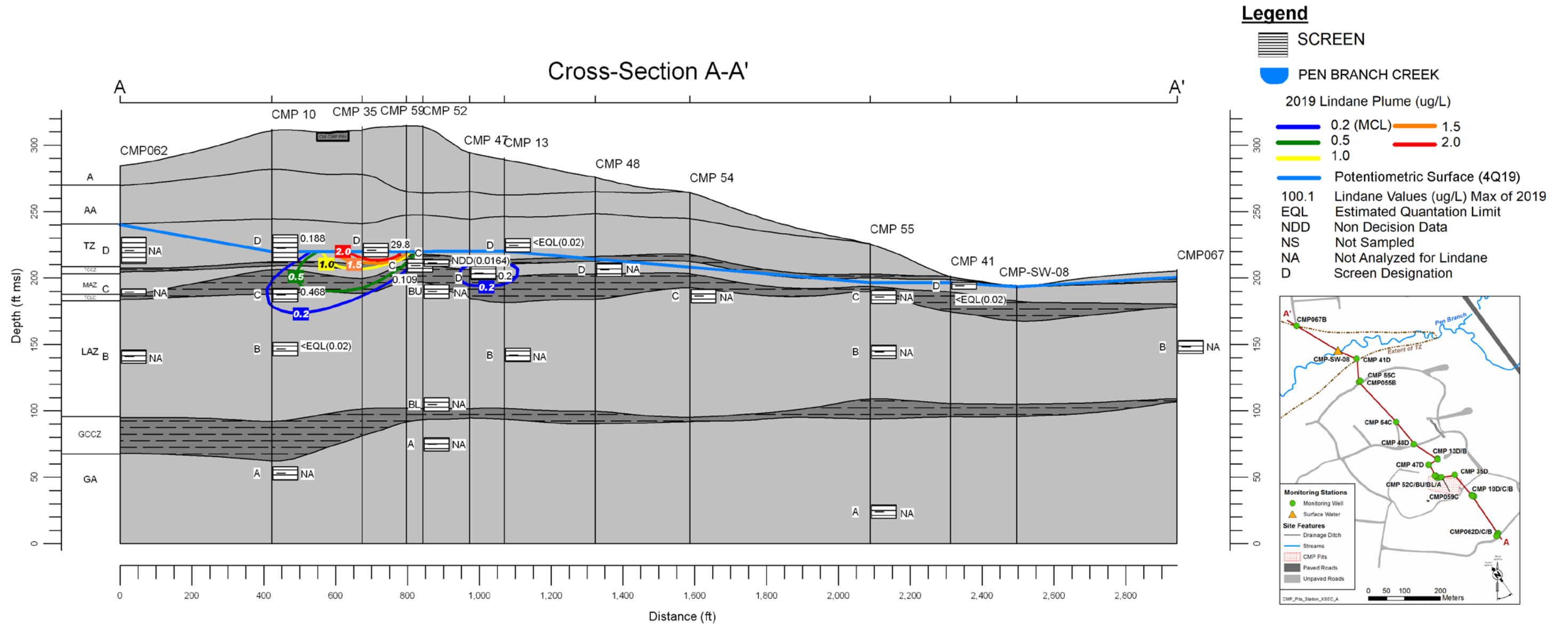


Figure 27. Cross Section A - A' at the CMP Pits OU Area with 2019 Lindane Plume and Results

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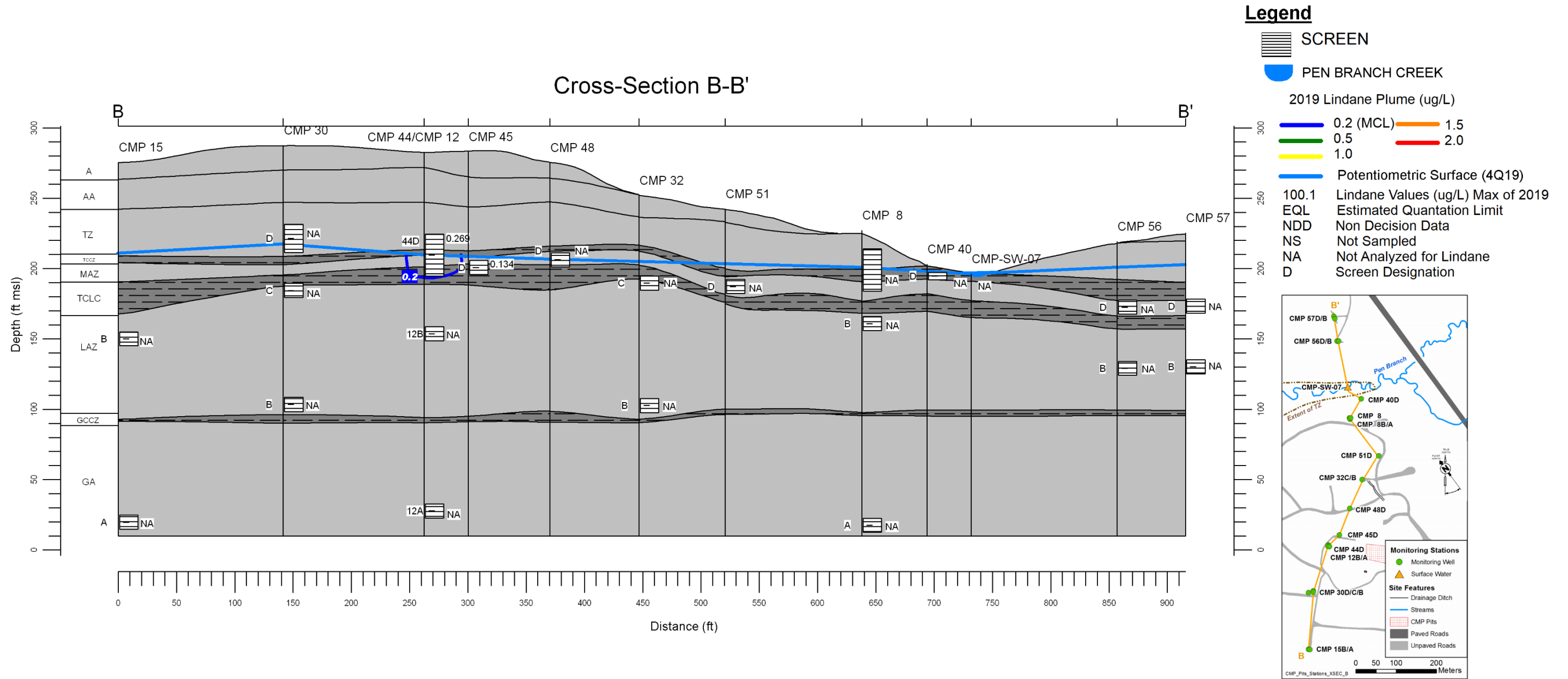
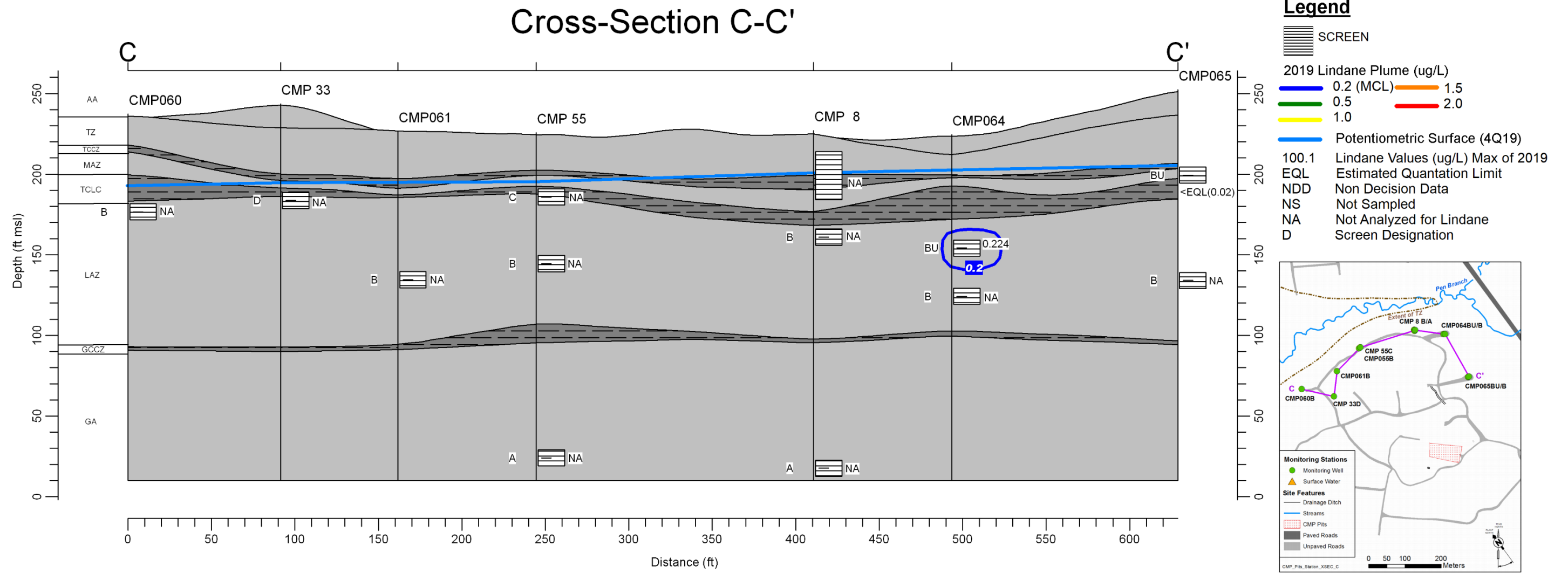


Figure 28. Cross Section B - B' at the CMP Pits OU Area with 2019 Lindane Plume and Results

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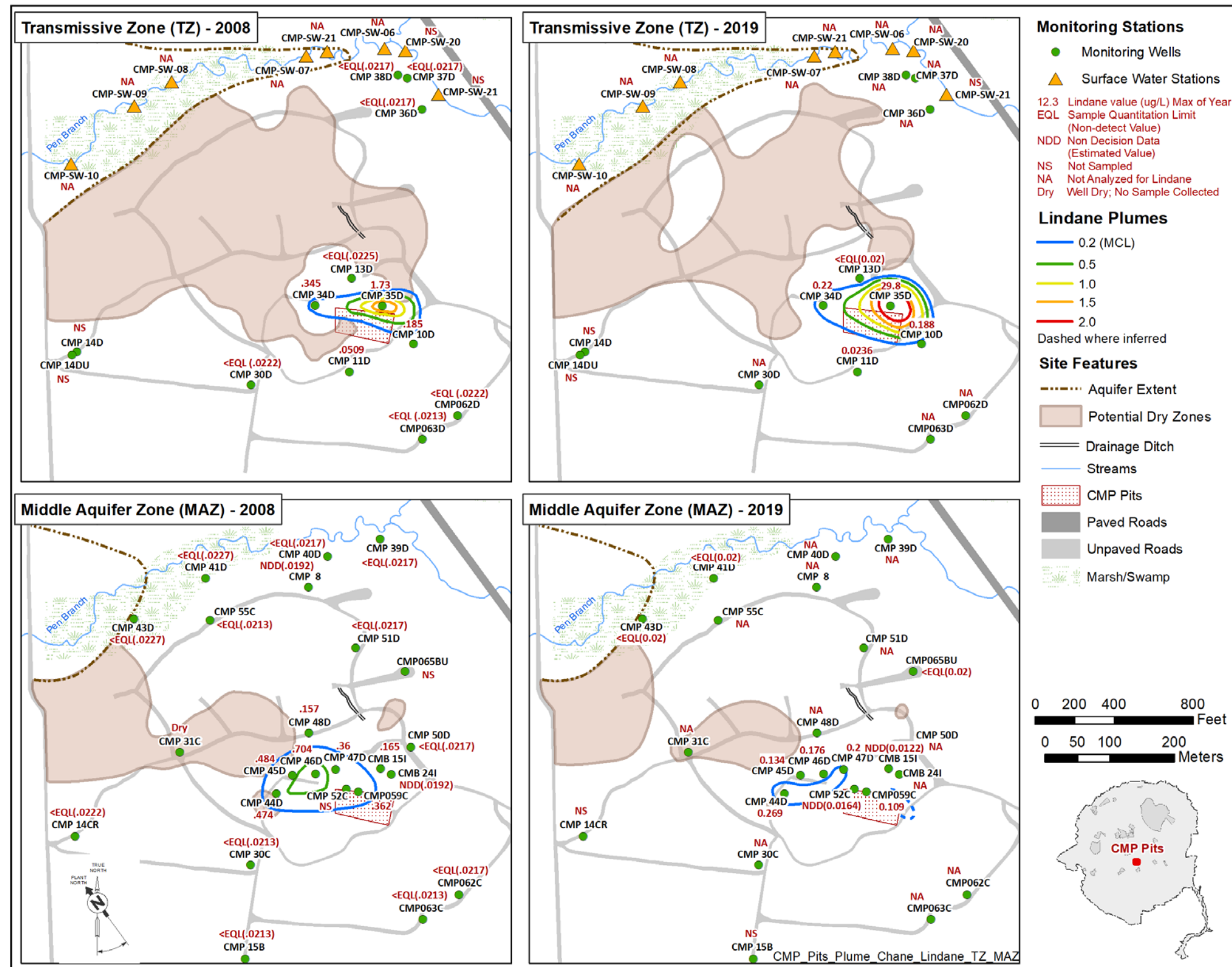


Figure 30. Lindane Plume Comparison from 2008 and 2019 in the TZ and MAZ

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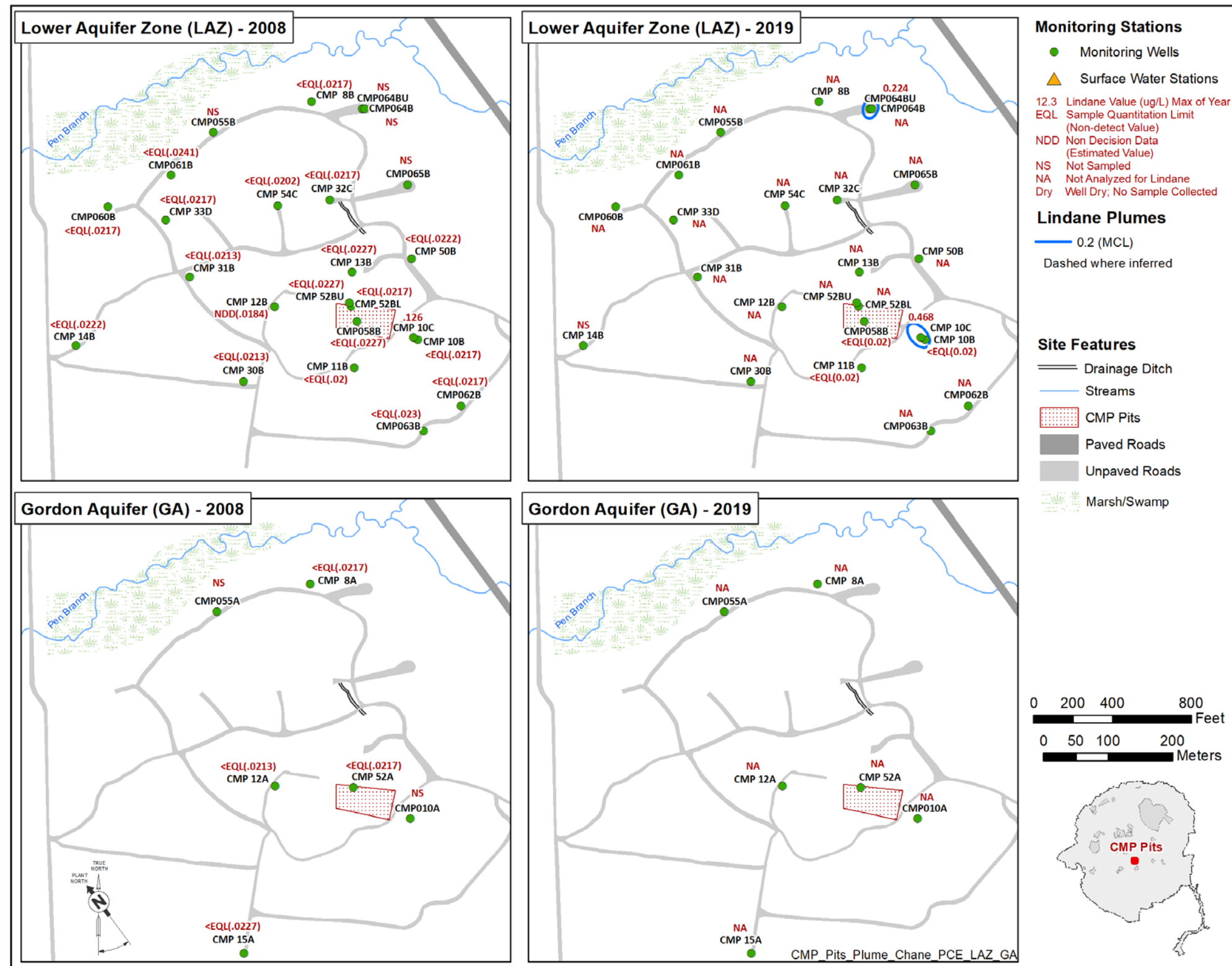


Figure 31. Lindane Plume Comparison from 2008 and 2019 in the LAZ and GA

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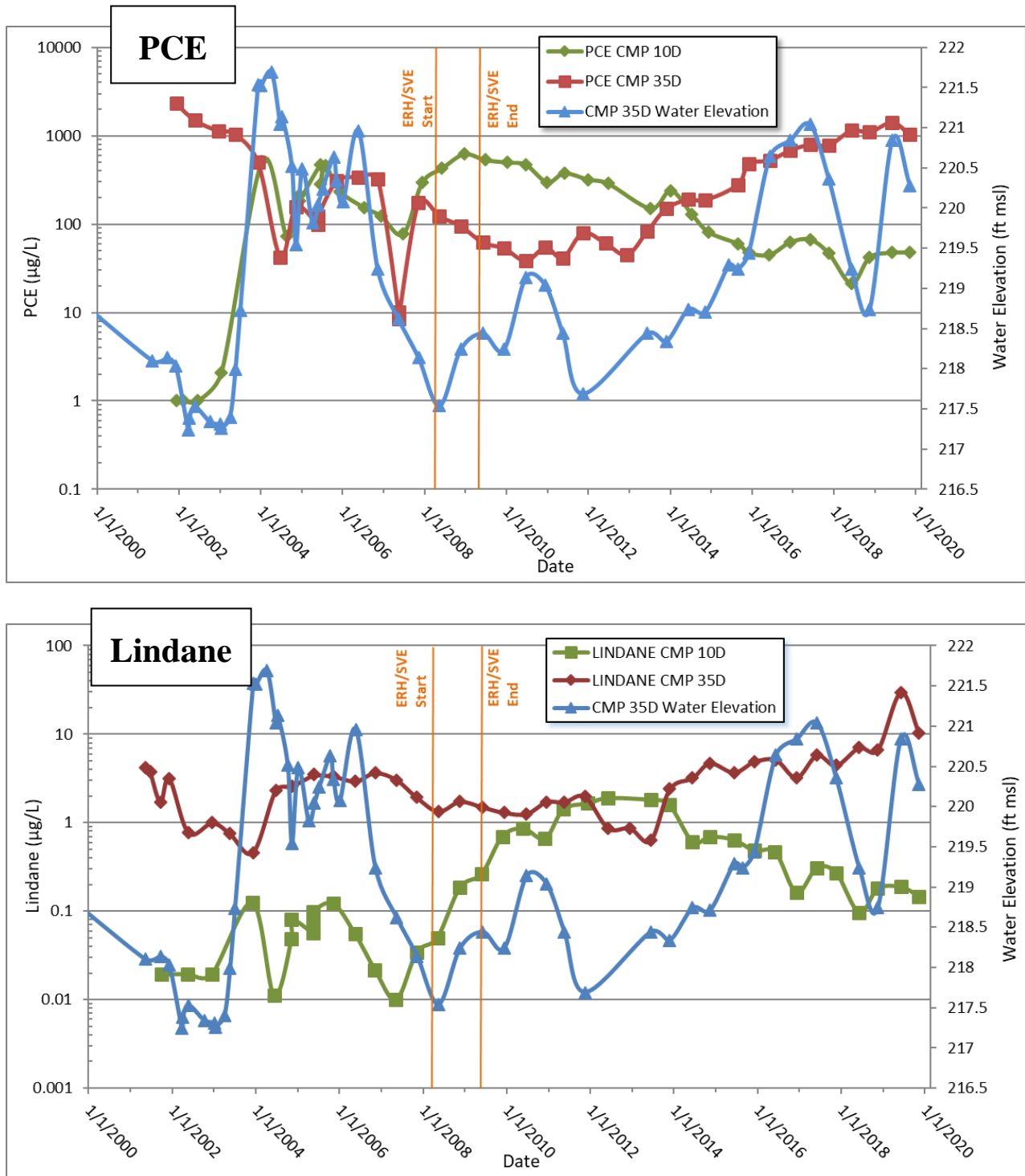
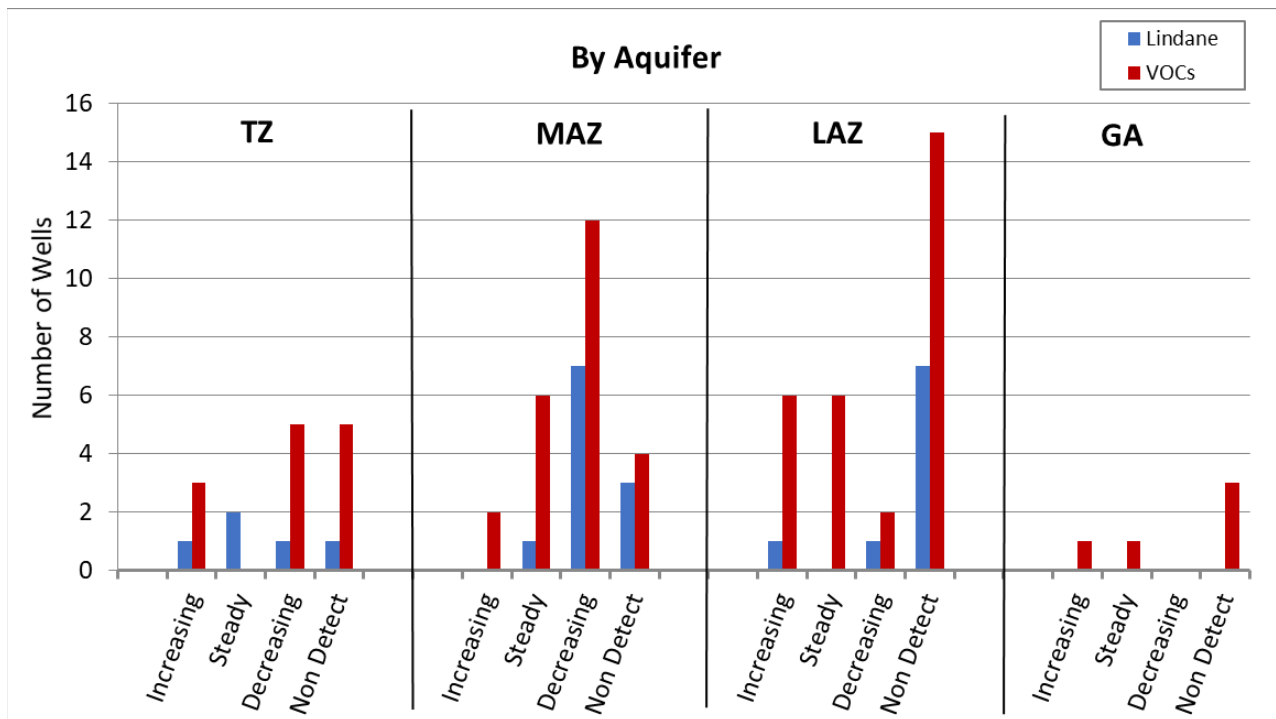
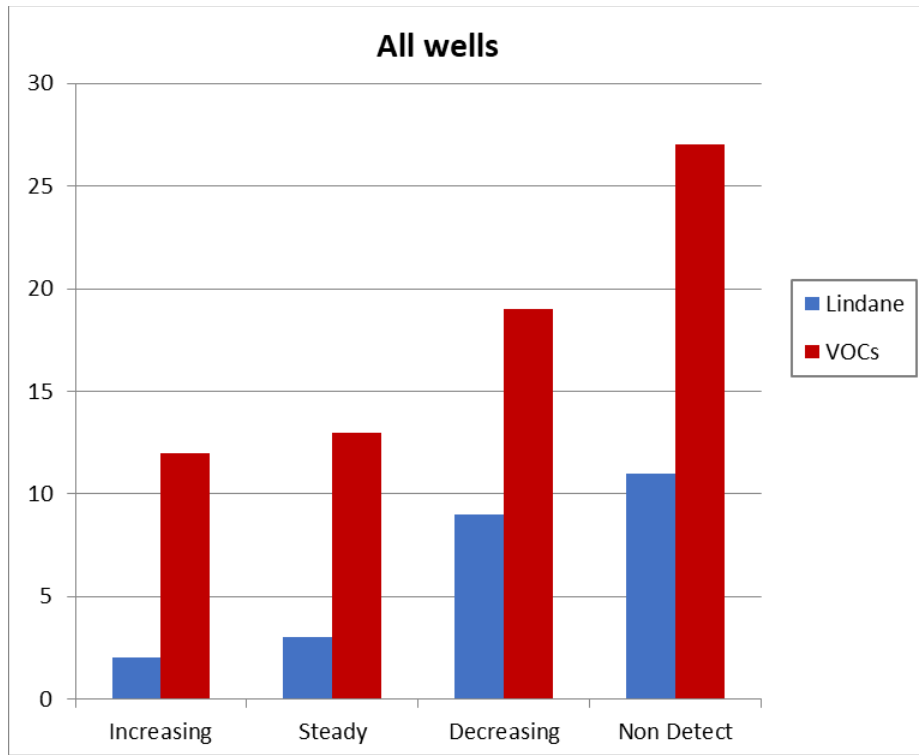


Figure 32. Comparison of PCE and Lindane Trends in CMP 10D and CMP 35D

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Identification of the wells trend type can be found on the “Trends” tab in the Excel file (CMP_EMR_2018) located on the CD supplied with this report.

Figure 33. Contaminant Concentration Well Trends and Well Trends by Aquifer

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
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 ¹	LAZ (Lower)				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
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
CMP 47D	MAZ	2Q, 4Q	4Q	2Q, 4Q	196.37	206.37	10

¹ Well or surface water station is not part of the official monitoring network.

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

Station	Aquifer Unit	Lab Analyses			Screen Zone (ft msl)		Screen Length (ft)
		VOCs	1,4-Dioxane	Lindane	Bottom	Top	
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.)

¹ Well or surface water station is not part of the official monitoring network.

Table 2. CMP Pits OU Horizontal Groundwater Flow Velocities (4Q19)

GW Flow Line	dh	dl	Conductivity	Porosity	Velocity (ft/day)	Velocity (ft/year)
TZ						
A - A'	20	1480	8	0.3	0.36	131.62
B - B'	20.3	1452	8	0.3	0.37	136.17
C - C'	5.1	1125	8	0.3	0.12	44.15
TZ Avg.					0.28	103.98
MAZ						
A - A'	15	1547	50	0.3	1.62	590.26
B - B'	15	1347	50	0.3	1.86	677.90
MAZ Avg.					1.74	634.08
LAZ						
A - A'	4.41	2155	30	0.3	0.20	74.74
B - B'	3	477	30	0.3	0.63	229.72
C - C'	7.5	512	30	0.3	1.46	535.03
LAZ Avg.					0.77	279.83
GA						
A - A'	1	1235	20	0.3	0.05	19.72

Table 3. CMP Pits OU Annual MNA Results, April 2019 through March 2020

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Table 4. CMP Pits OU PCE Max Results from 2008 and 2019 (µg/L)

Station	Aquifer	2008 Max (Pre ERH/SVE)	2019 Max
CMP 10D	TZ	620	47.6
CMP 11D	TZ	421	37.4
CMP 13D	TZ	1.71	7.43
CMP 14D	TZ	NS	NS
CMP 14DU	TZ	NS	NS
CMP 30D	TZ	<EQL(1)	<EQL(1)
CMP 34D	TZ	49.4	1,940
CMP 35D	TZ	122	1,420
CMP 36D	TZ	56.9	34.2
CMP 37D	TZ	358	66.3
CMP 38D	TZ	48.2	23.4
CMP062D	TZ	<EQL(1)	<EQL(1)
CMP063D	TZ	<EQL(1)	<EQL(1)
CMB 15I	MAZ	437	475
CMB 24I	MAZ	20.8	113
CMP 8	MAZ	299	152
CMP 14CR	MAZ	<EQL(1)	NS
CMP 15B	MAZ	<EQL(1)	<EQL(1)
CMP 30C	MAZ	3.78	1.64
CMP 31C	MAZ	NS - Dry	21.7
CMP 39D	MAZ	71.7	35.2
CMP 40D	MAZ	135	82.6
CMP 41D	MAZ	5.48	5.62
CMP 43D	MAZ	<EQL(1)	<EQL(1)
CMP 44D	MAZ	312	194
CMP 45D	MAZ	973	238
CMP 46D	MAZ	NDD(434)	NA
CMP 47D	MAZ	NDD(845)	555
CMP 48D	MAZ	601	232
CMP 50D	MAZ	8.62	3.04
CMP 51D	MAZ	13.4	10.9
CMP 52C	MAZ	NS	169
CMP 55C	MAZ	<EQL(1)	NDD(0.35)
CMP 56D	MAZ	NS	NS
CMP 57D	MAZ	NS	NS
CMP059C	MAZ	78.5	160
CMP062C	MAZ	<EQL(1)	<EQL(1)
CMP063C	MAZ	<EQL(1)	<EQL(1)
CMP065BU	MAZ	NS	22.5
CMP 8B	LAZ	<EQL(1)	3.22
CMP 10B	LAZ	<EQL(1)	16.3

Station	Aquifer	2008 Max (Pre ERH/SVE)	2019 Max
CMP 10C	LAZ	466	293
CMP 11B	LAZ	<EQL(1)	<EQL(1)
CMP 12B	LAZ	46.3	54.1
CMP 13B	LAZ	1.25	16.5
CMP 14B	LAZ	<EQL(1)	NS
CMP 30B	LAZ	<EQL(1)	<EQL(1)
CMP 31B	LAZ	<EQL(1)	<EQL(1)
CMP 32C	LAZ	110	404
CMP 33D	LAZ	16.4	3.8
CMP 50B	LAZ	<EQL(1)	<EQL(1)
CMP 52BL	LAZ	<EQL(1)	<EQL(1)
CMP 52BU	LAZ	35.1	172
CMP 54C	LAZ	NDD(196)	345
CMP055B	LAZ	NS	<EQL(1)
CMP 56B	LAZ	NS	NS
CMP 57B	LAZ	NS	<EQL(1)
CMP058B	LAZ	6.51	22.8
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	356
CMP064B	LAZ	NS	<EQL(1)
CMP065B	LAZ	NS	NDD(.5)
CMP066B	LAZ	NS	<EQL(1)
CMP067B	LAZ	NS	1.5
CMP 8A	GA	<EQL(1)	<EQL(1)
CMP010A	GA	NS	287*
CMP 12A	GA	NDD(0.679)	<EQL(1)
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	NS
CMP-SW-22	SW	NS	<EQL(1)

*1Q2020 value

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 2019 (µg/L)

Station	Aquifer	2008 Max (Pre ERH/SVE)	2019 Max
CMP 10D	TZ	0.185	0.188
CMP 11D	TZ	0.0509	0.0236
CMP 13D	TZ	<EQL(0.0225)	<EQL(.02)
CMP 14D	TZ	NS	NS
CMP 14DU	TZ	NS	NS
CMP 30D	TZ	<EQL(0.0222)	NA
CMP 34D	TZ	0.345	0.22
CMP 35D	TZ	1.73	29.8
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(.0122)
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)	<EQL(.02)
CMP 43D	MAZ	<EQL(1)	<EQL(.02)
CMP 44D	MAZ	0.474	0.269
CMP 45D	MAZ	0.484	0.134
CMP 46D	MAZ	0.704	0.176
CMP 47D	MAZ	0.36	0.2
CMP 48D	MAZ	0.157	NA
CMP 50D	MAZ	<EQL(0.0217)	NA
CMP 51D	MAZ	<EQL(0.0217)	NA
CMP 52C	MAZ	NS	NDD(.0164)
CMP 55C	MAZ	<EQL(0.0213)	NA
CMP 56D	MAZ	NS	NA
CMP 57D	MAZ	NS	NA
CMP059C	MAZ	0.362	0.109
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)	<EQL(.02)

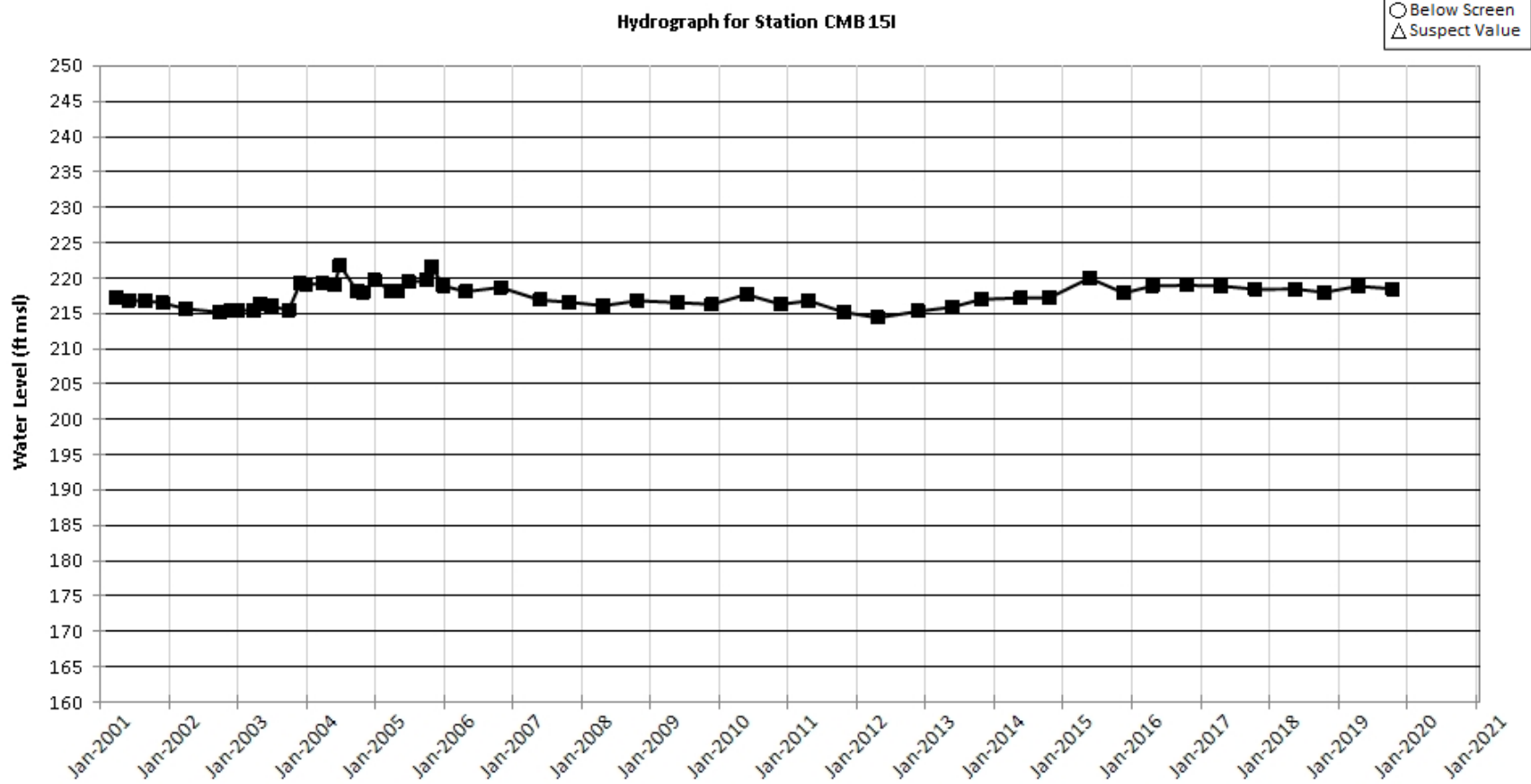
Station	Aquifer	2008 Max (Pre ERH/SVE)	2019 Max
CMP 10C	LAZ	0.126	0.468
CMP 11B	LAZ	<EQL(0.02)	<EQL(.02)
CMP 12B	LAZ	NDD(0.0184)	NA
CMP 13B	LAZ	<EQL(0.0227)	NA
CMP 14B	LAZ	<EQL(0.0222)	NS
CMP 30B	LAZ	<EQL(0.0213)	NA
CMP 31B	LAZ	<EQL(0.0213)	NA
CMP 32C	LAZ	<EQL(0.0217)	NA
CMP 33D	LAZ	<EQL(0.0217)	NA
CMP 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	0.224
CMP065B	LAZ	NS	NA
CMP066B	LAZ	NS	NA
CMP067B	LAZ	NS	NA
CMP 8A	GA	<EQL(0.0217)	NA
CMP010A	GA	NS	NA
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	NS
CMP-SW-22	SW	NS	NA

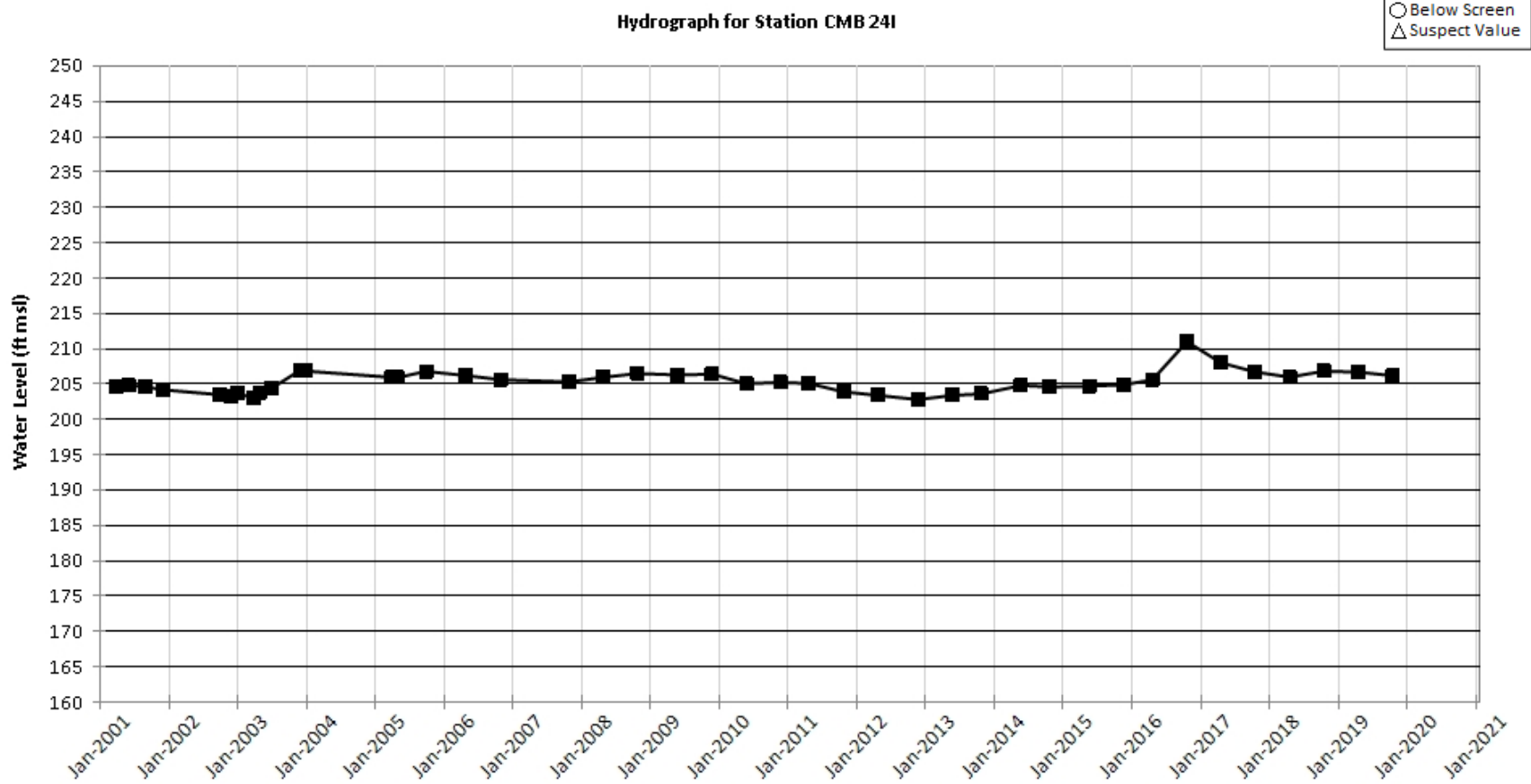
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NA= Not analyzed for lindane

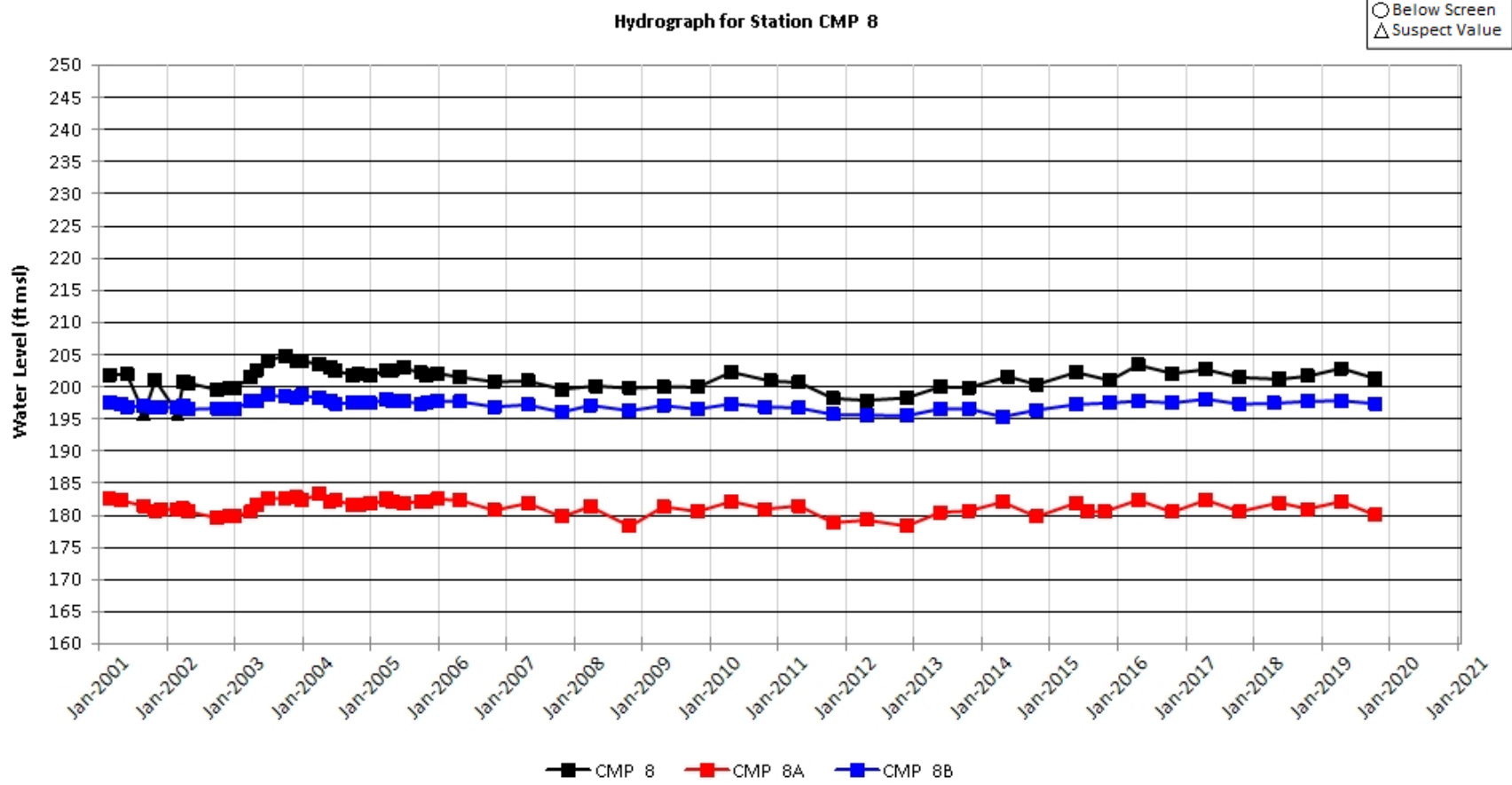
Appendix A

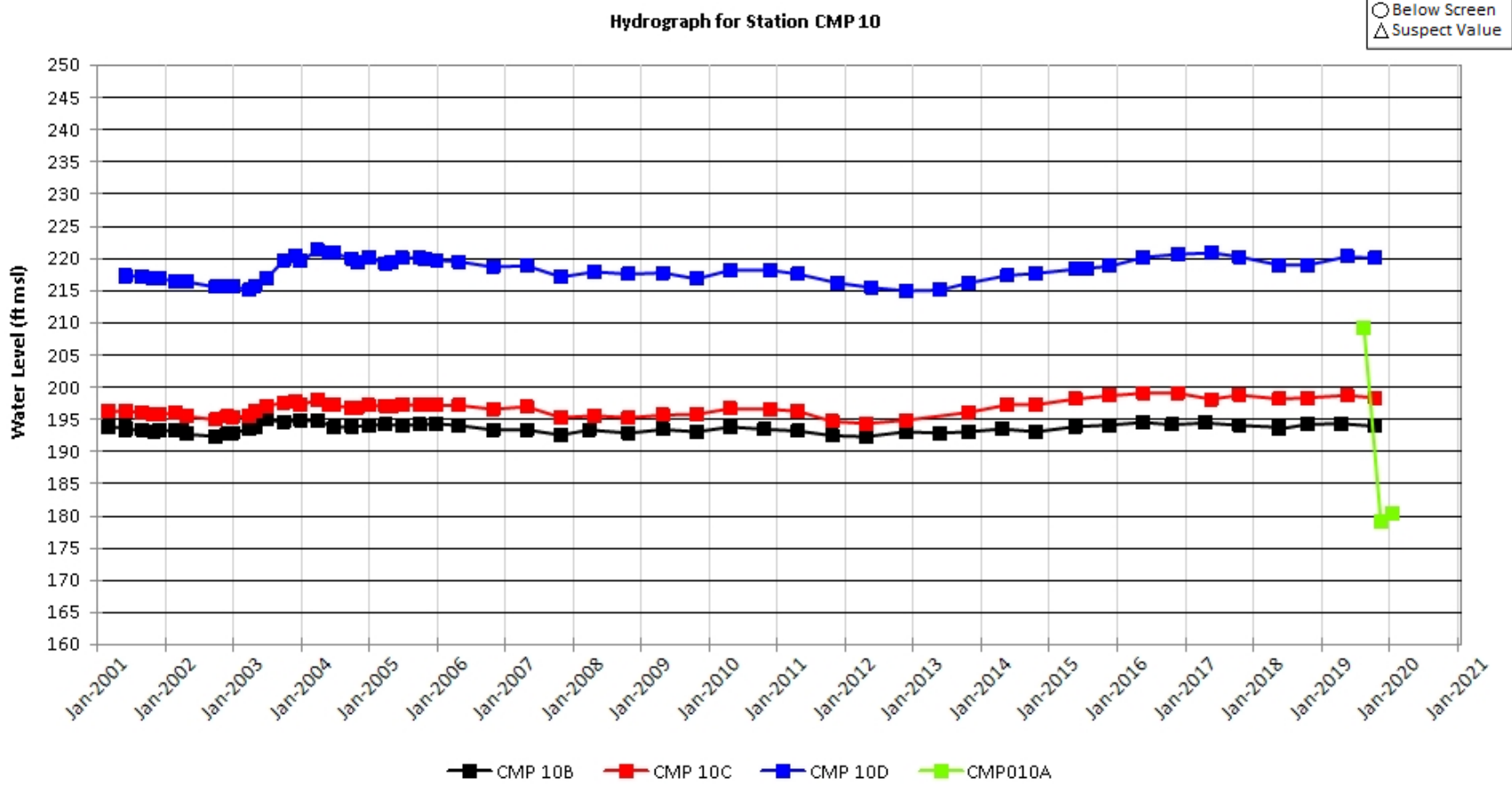
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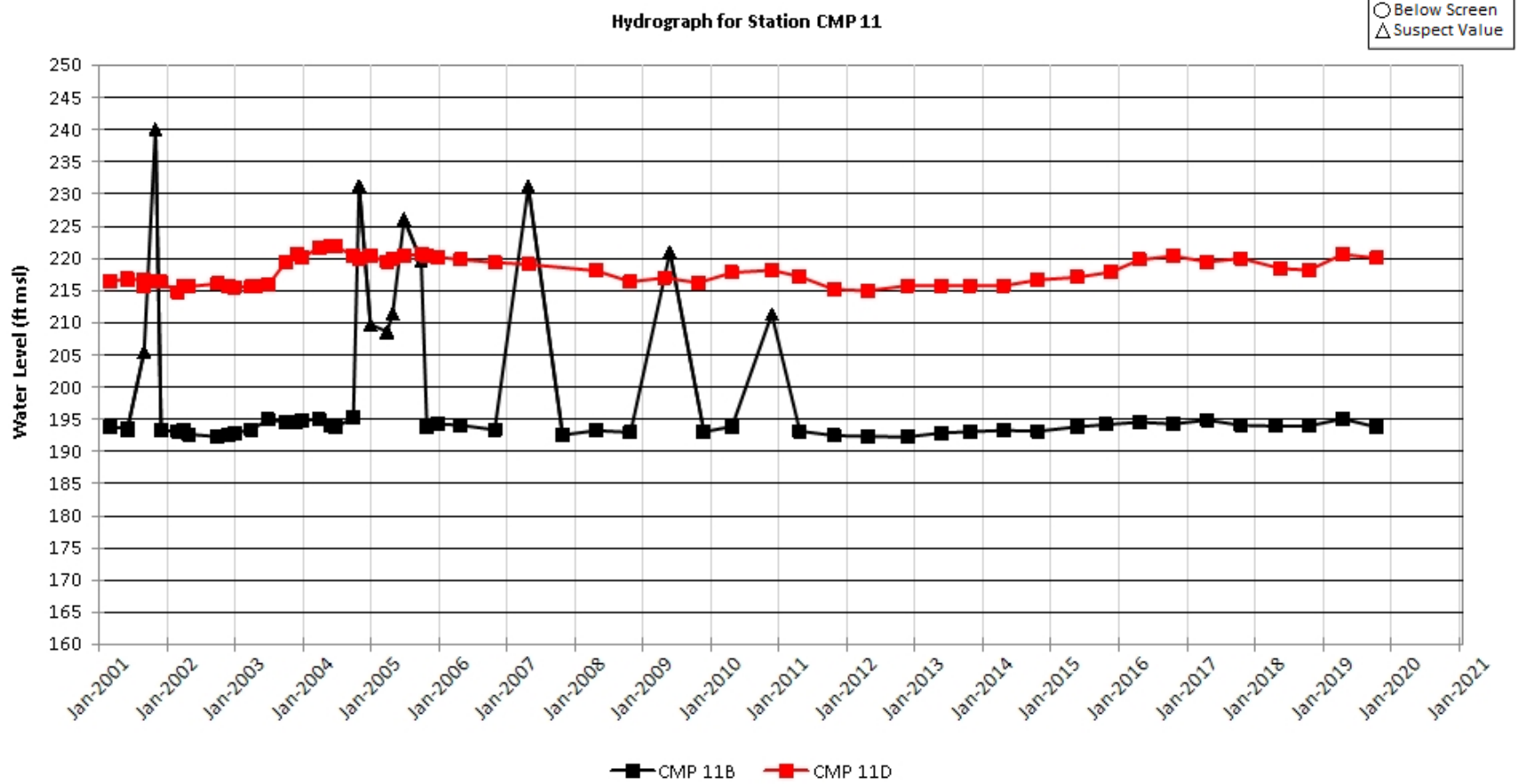
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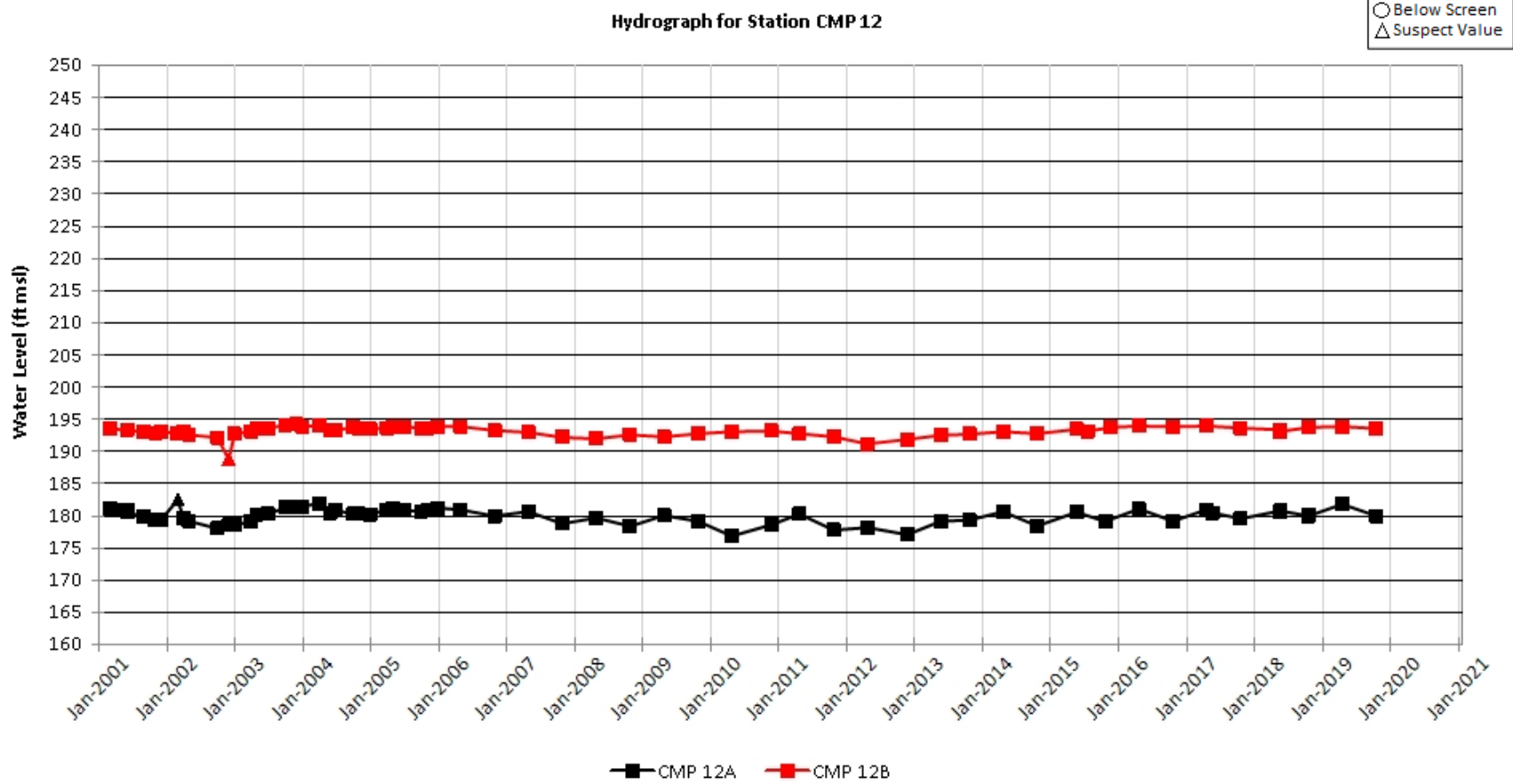


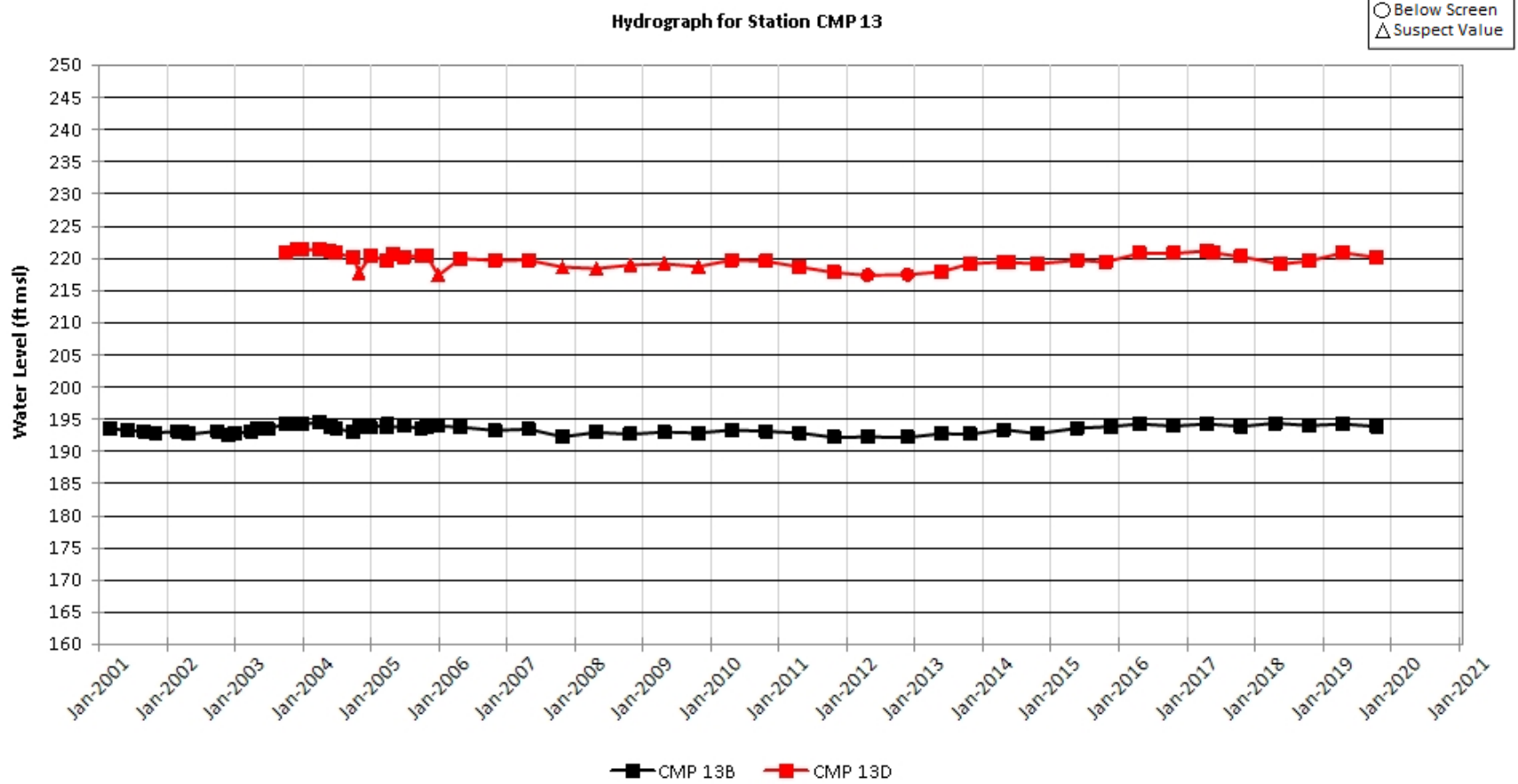


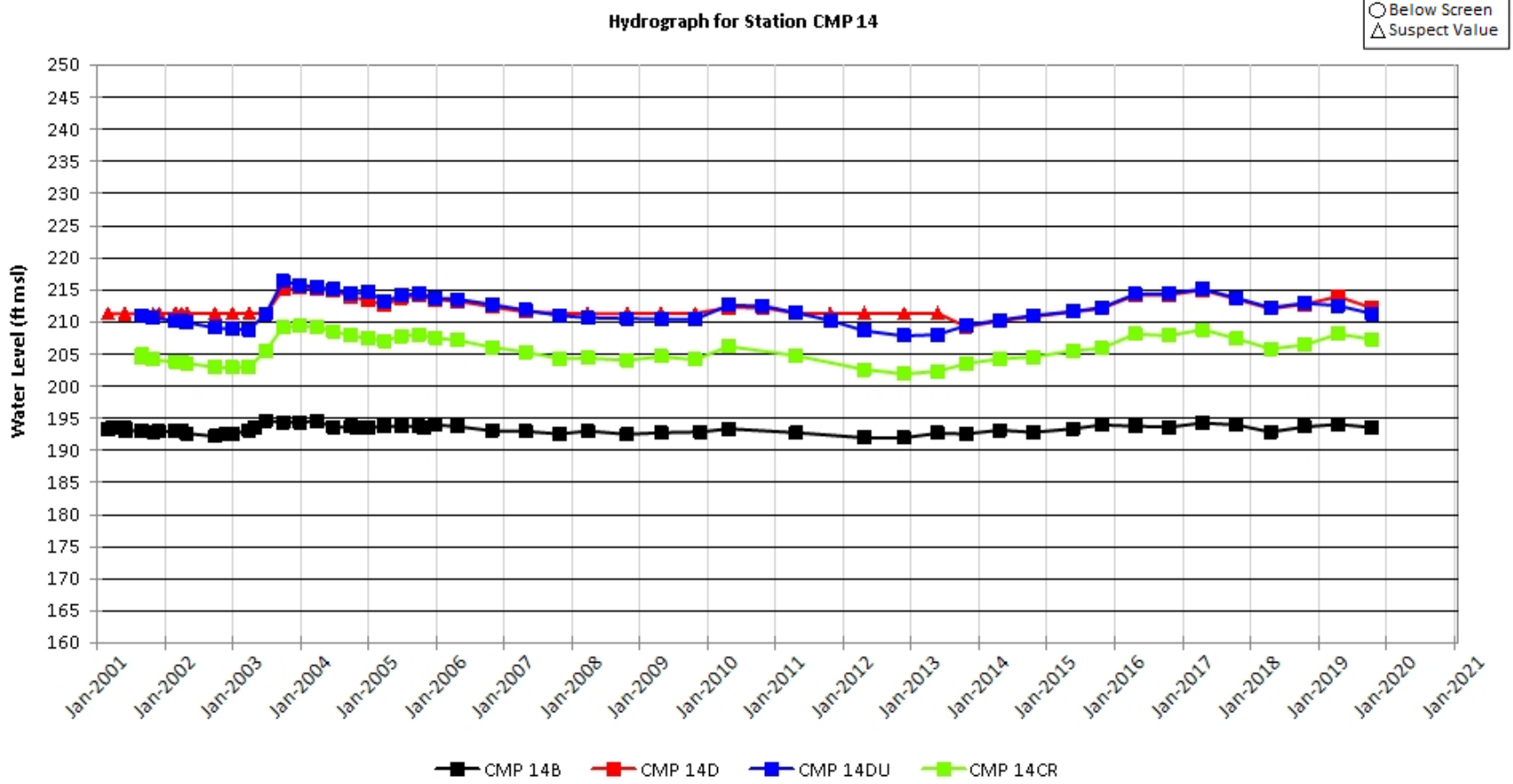


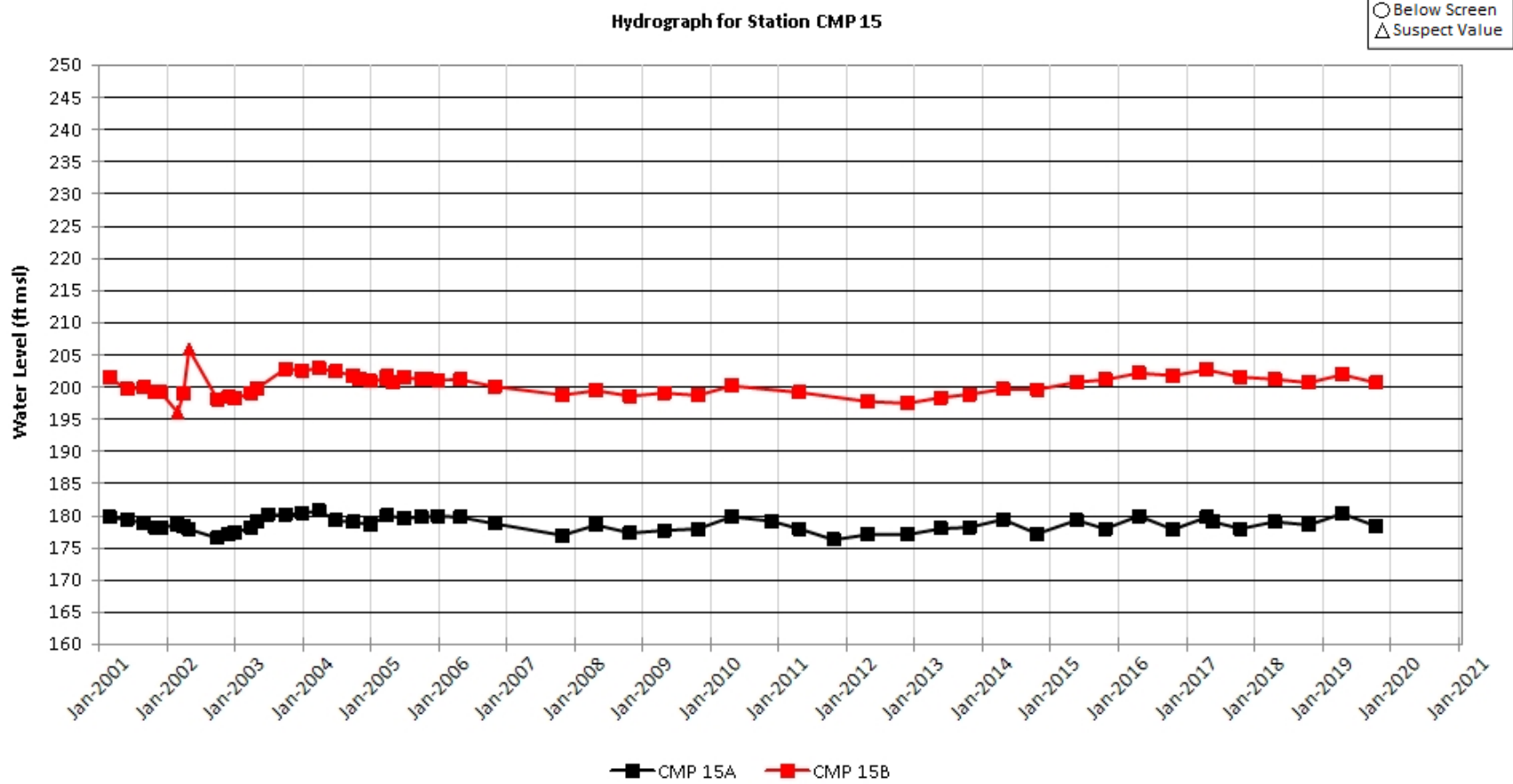


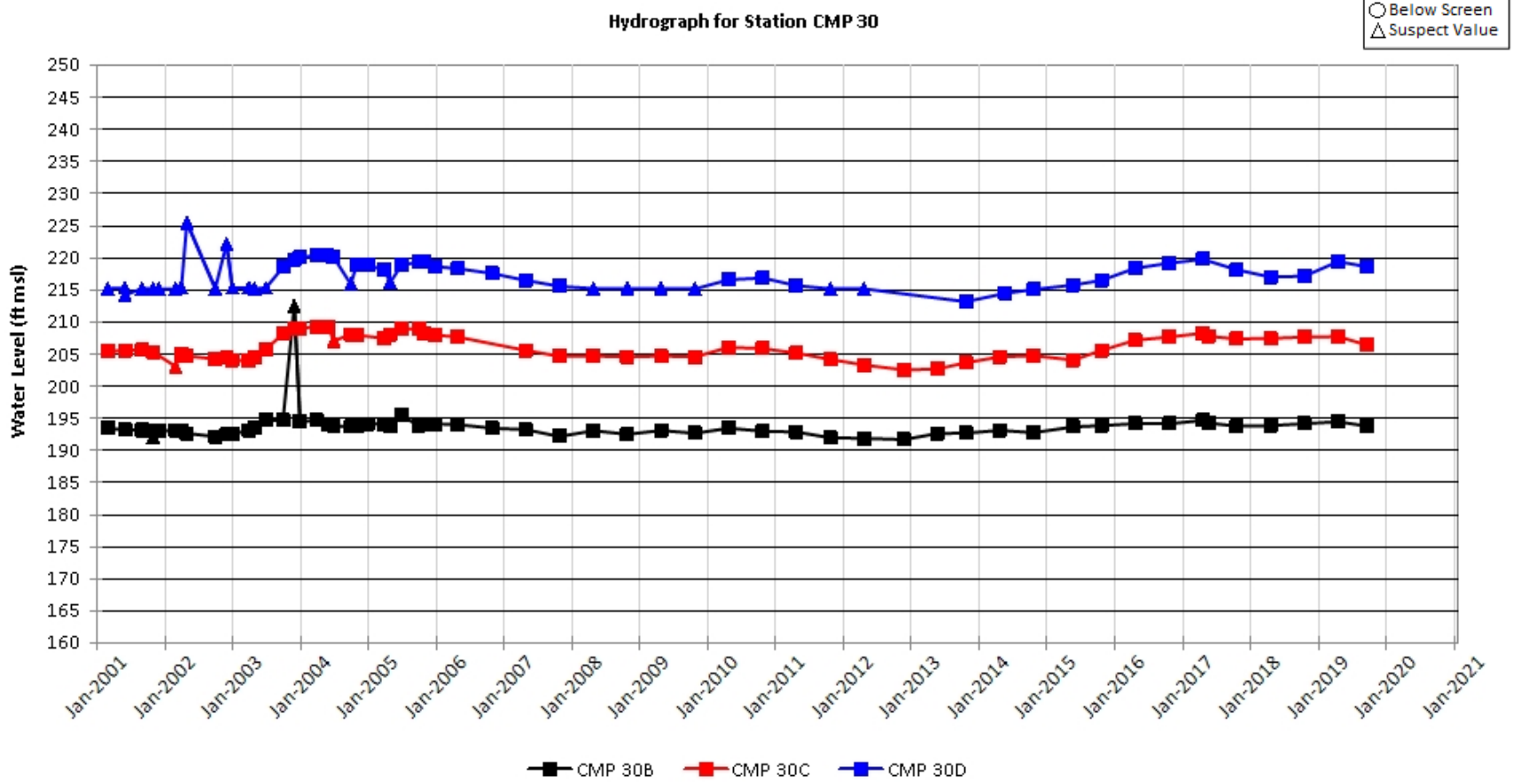


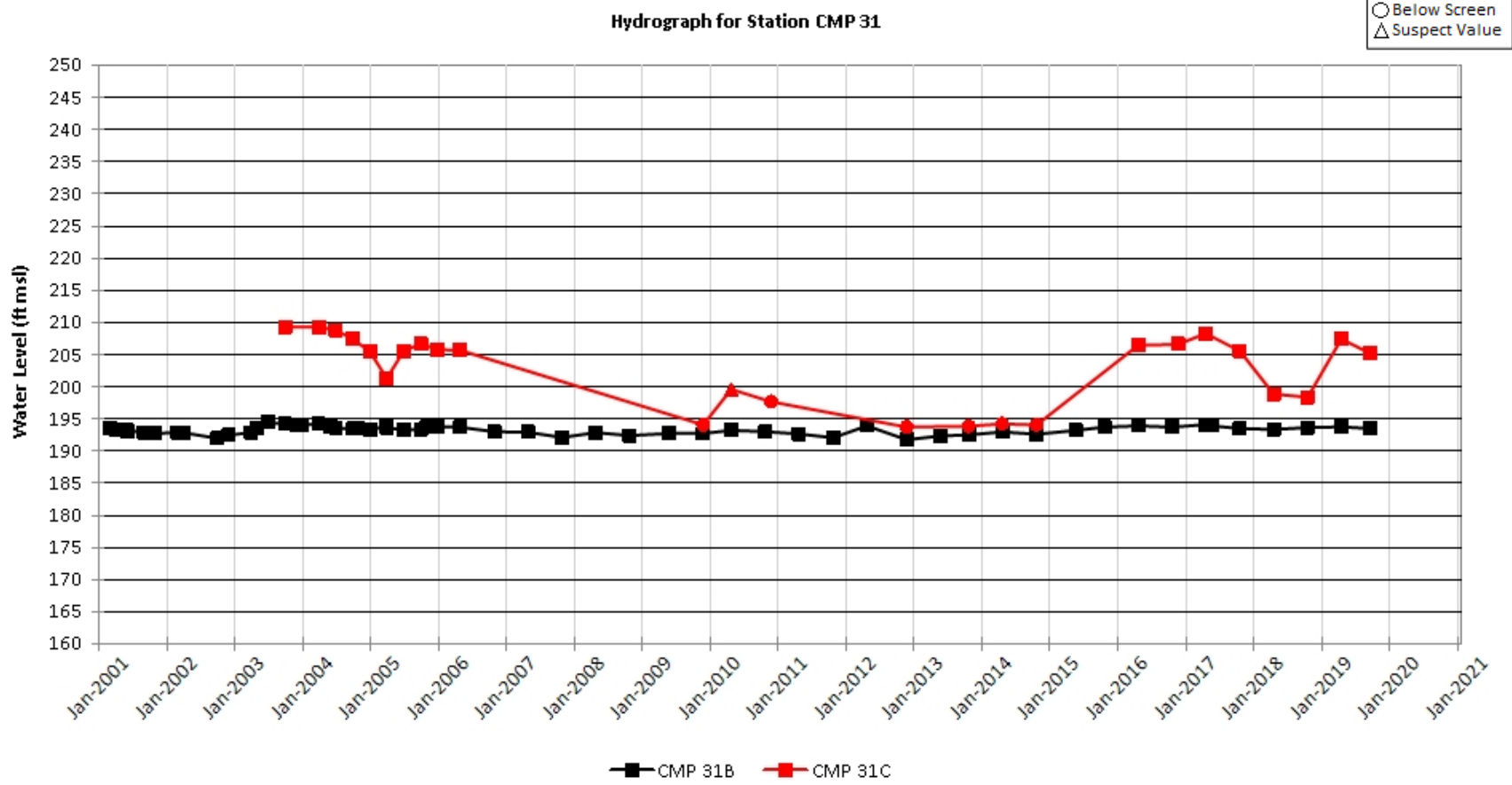


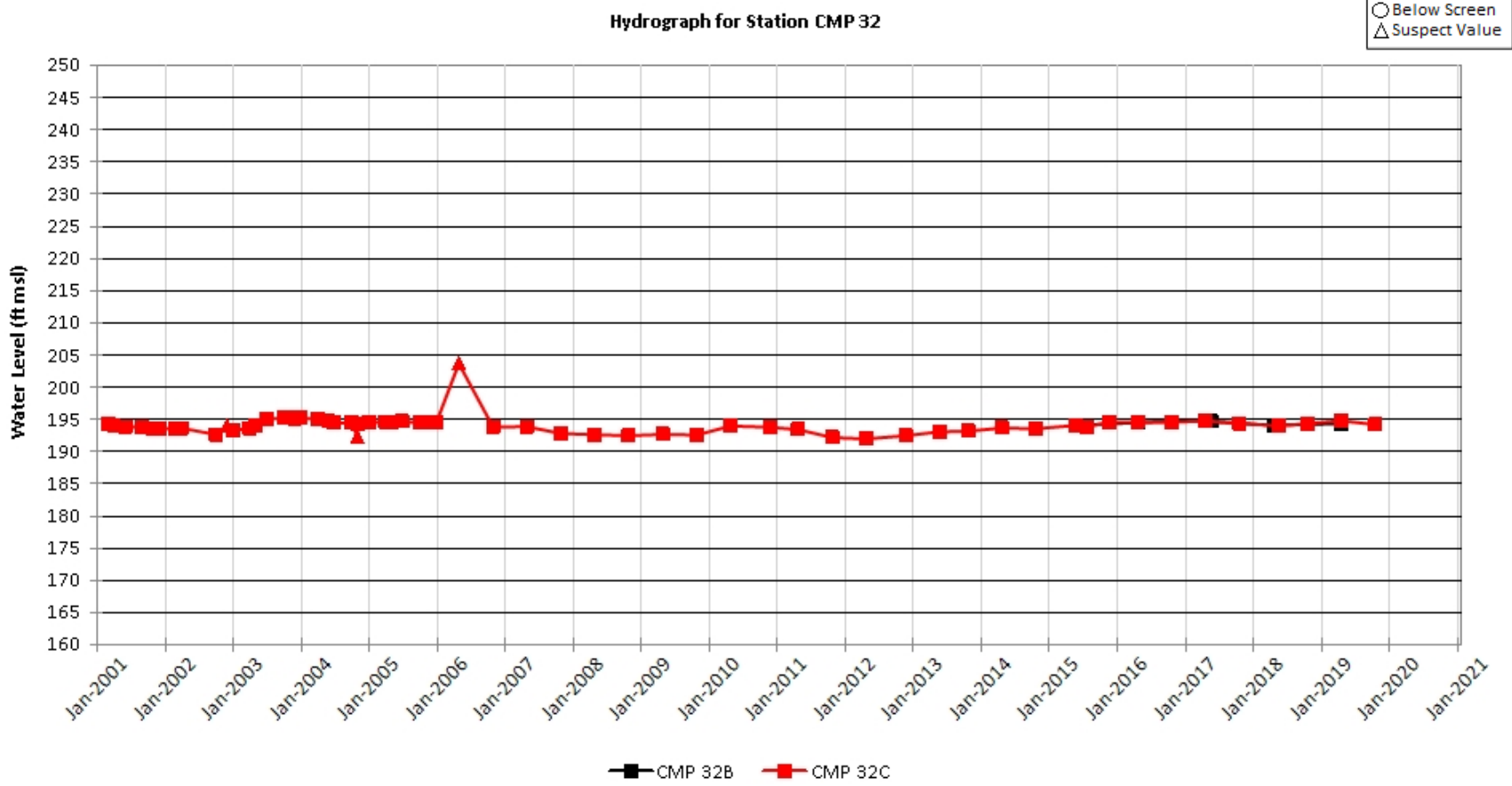


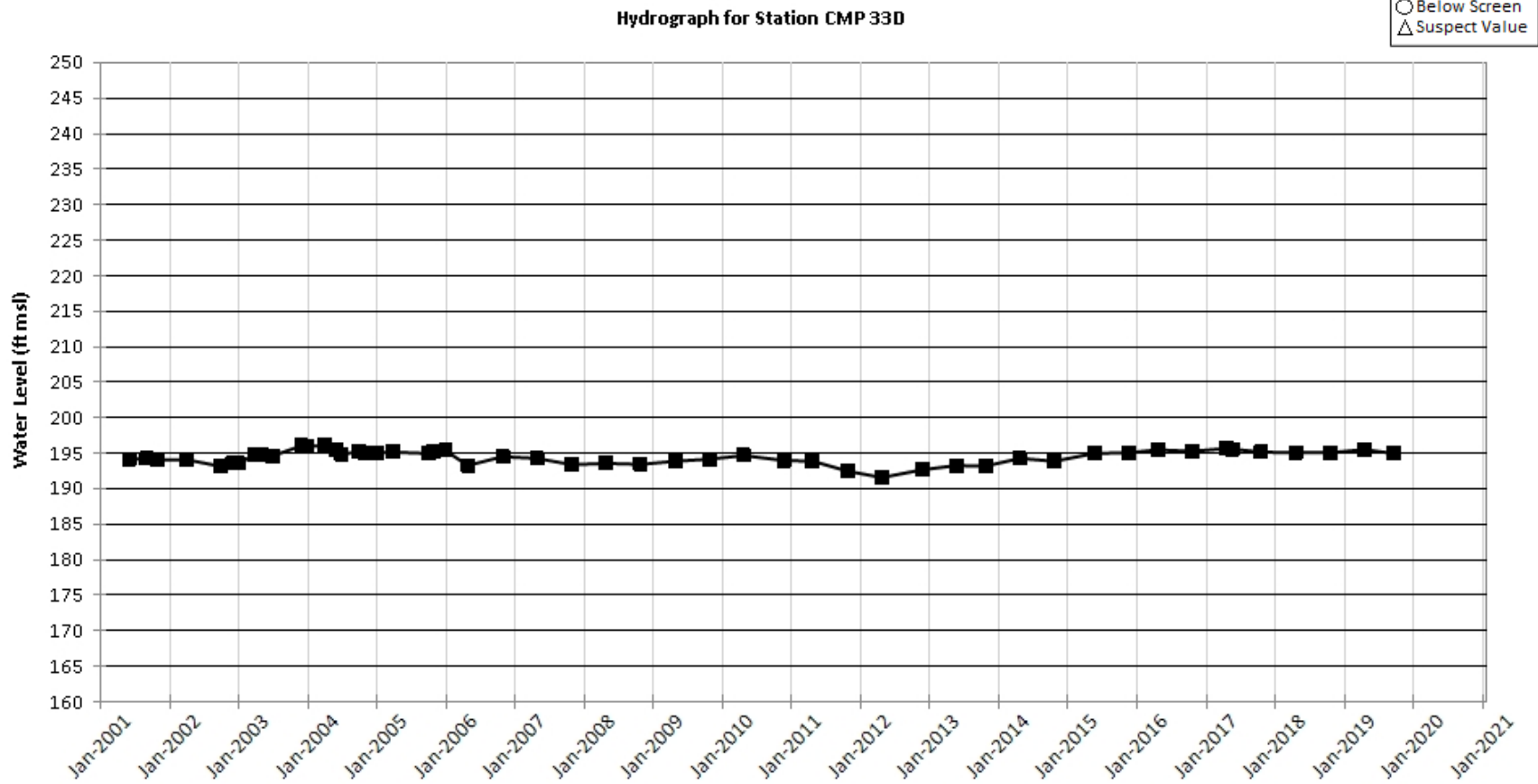


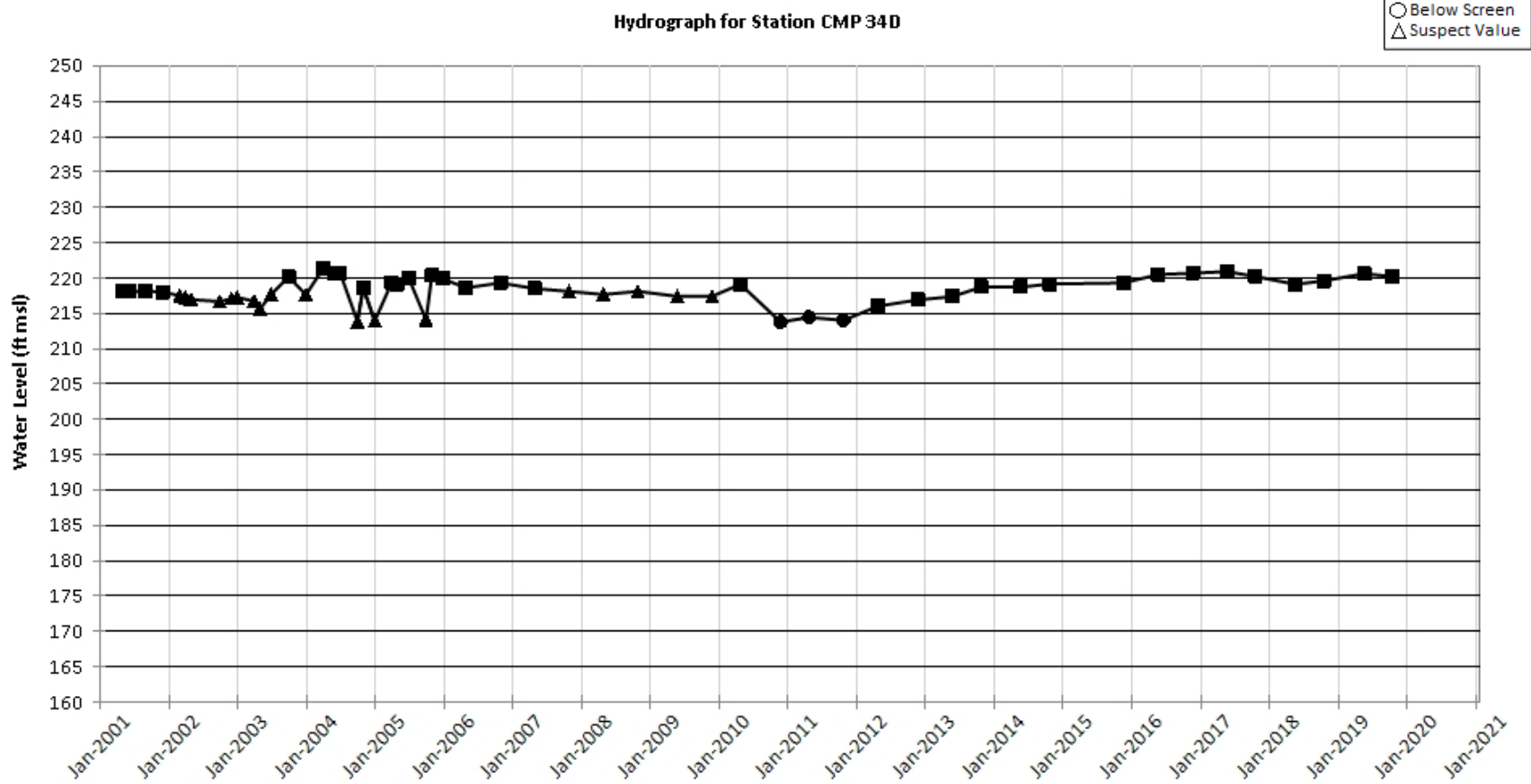


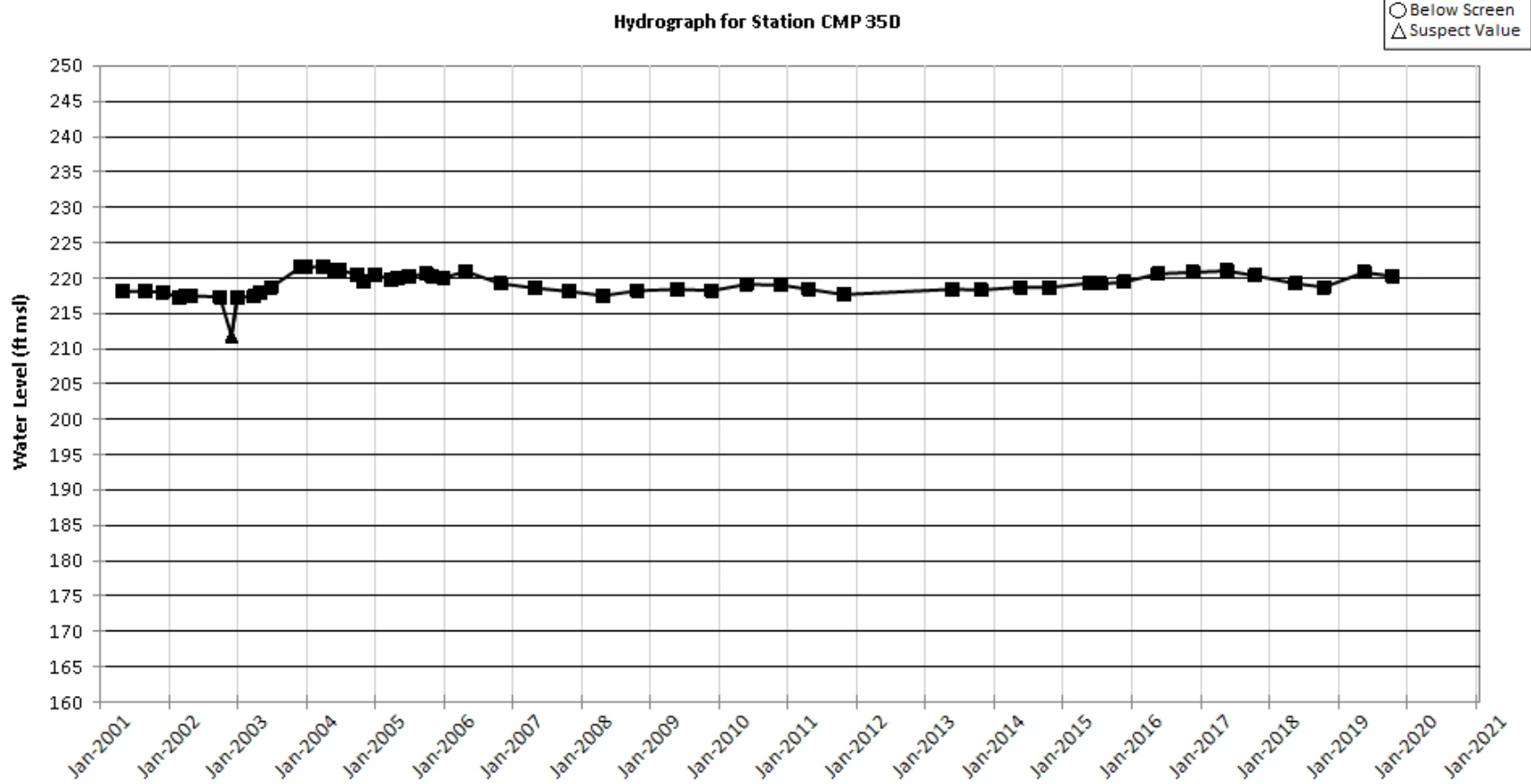


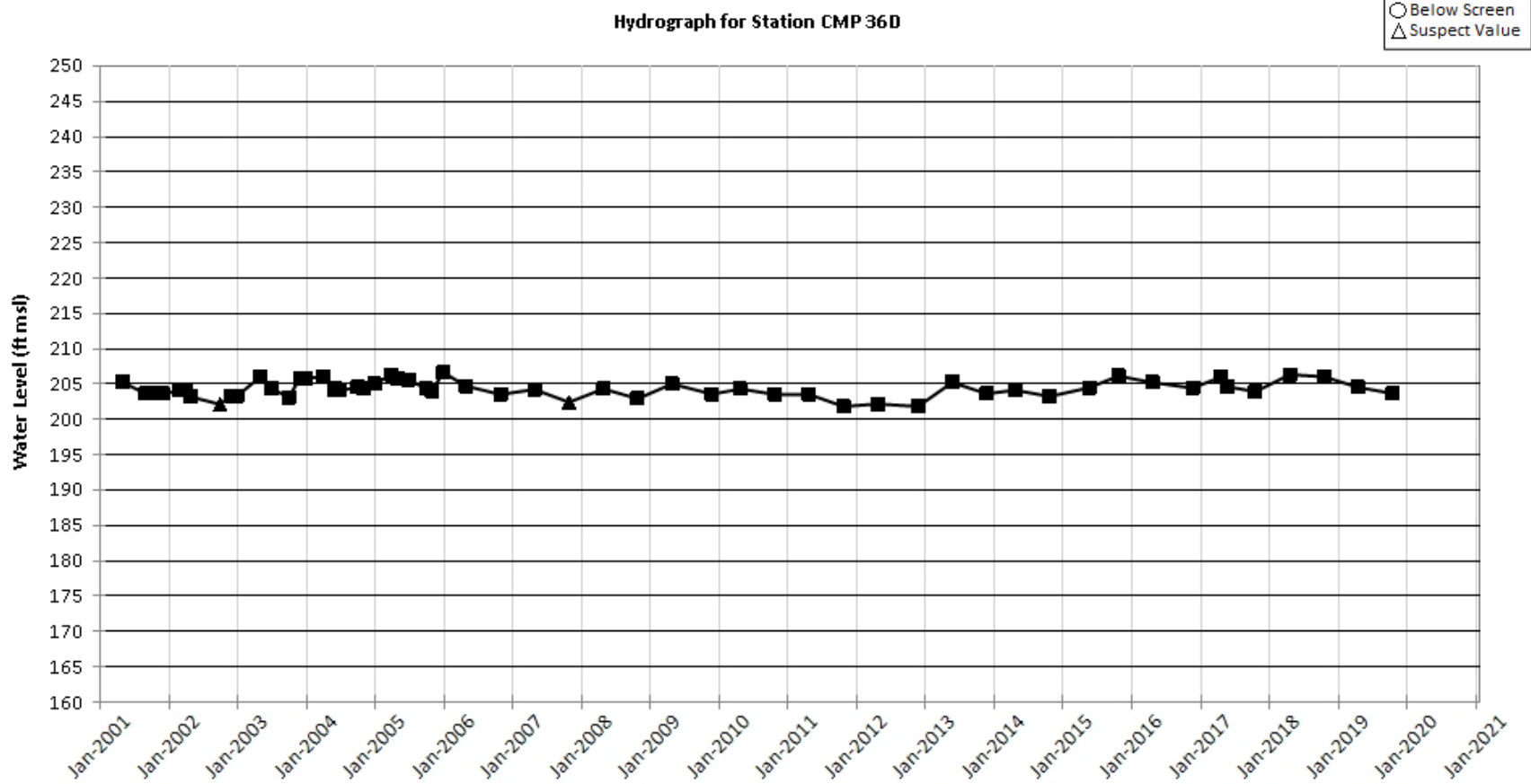


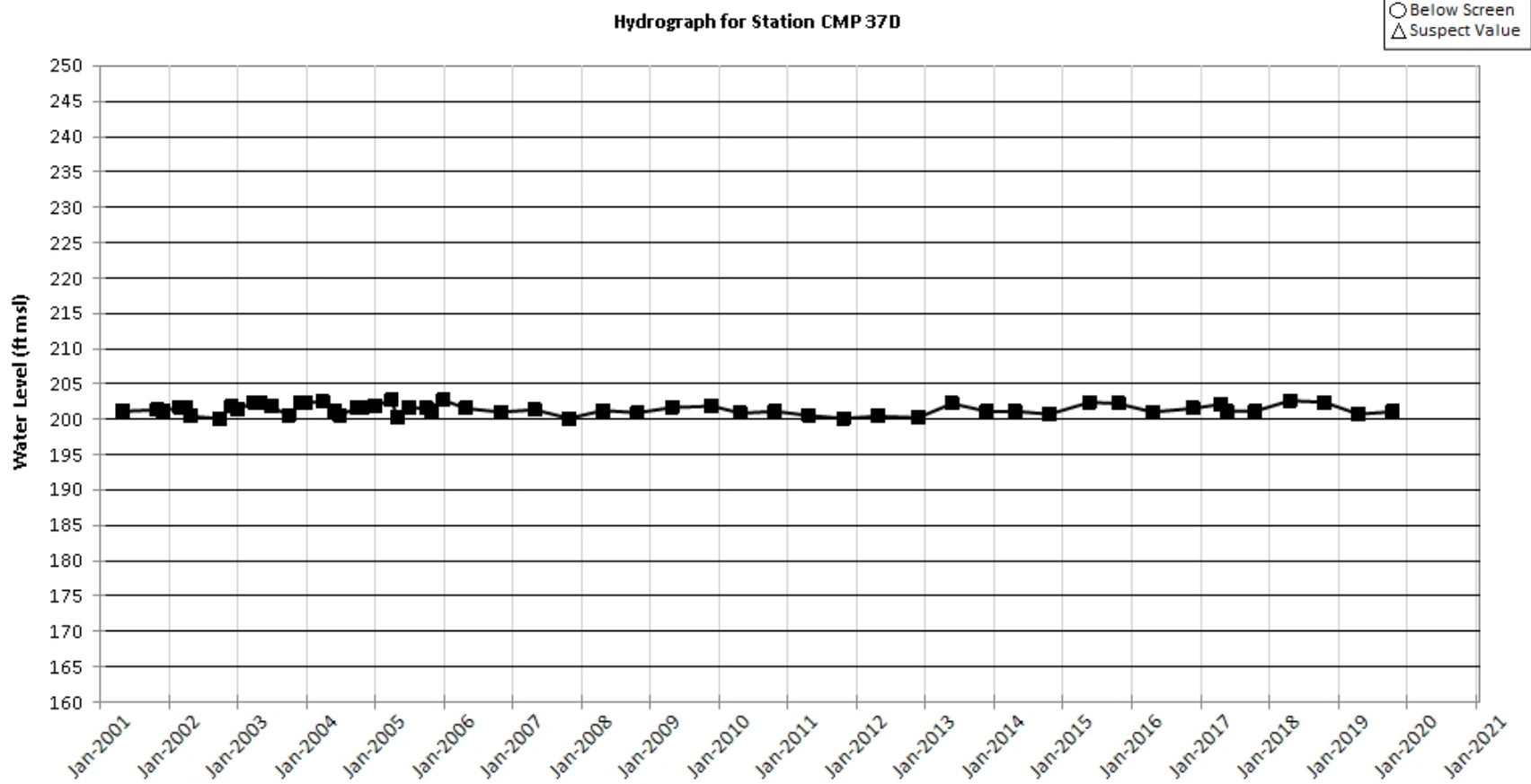


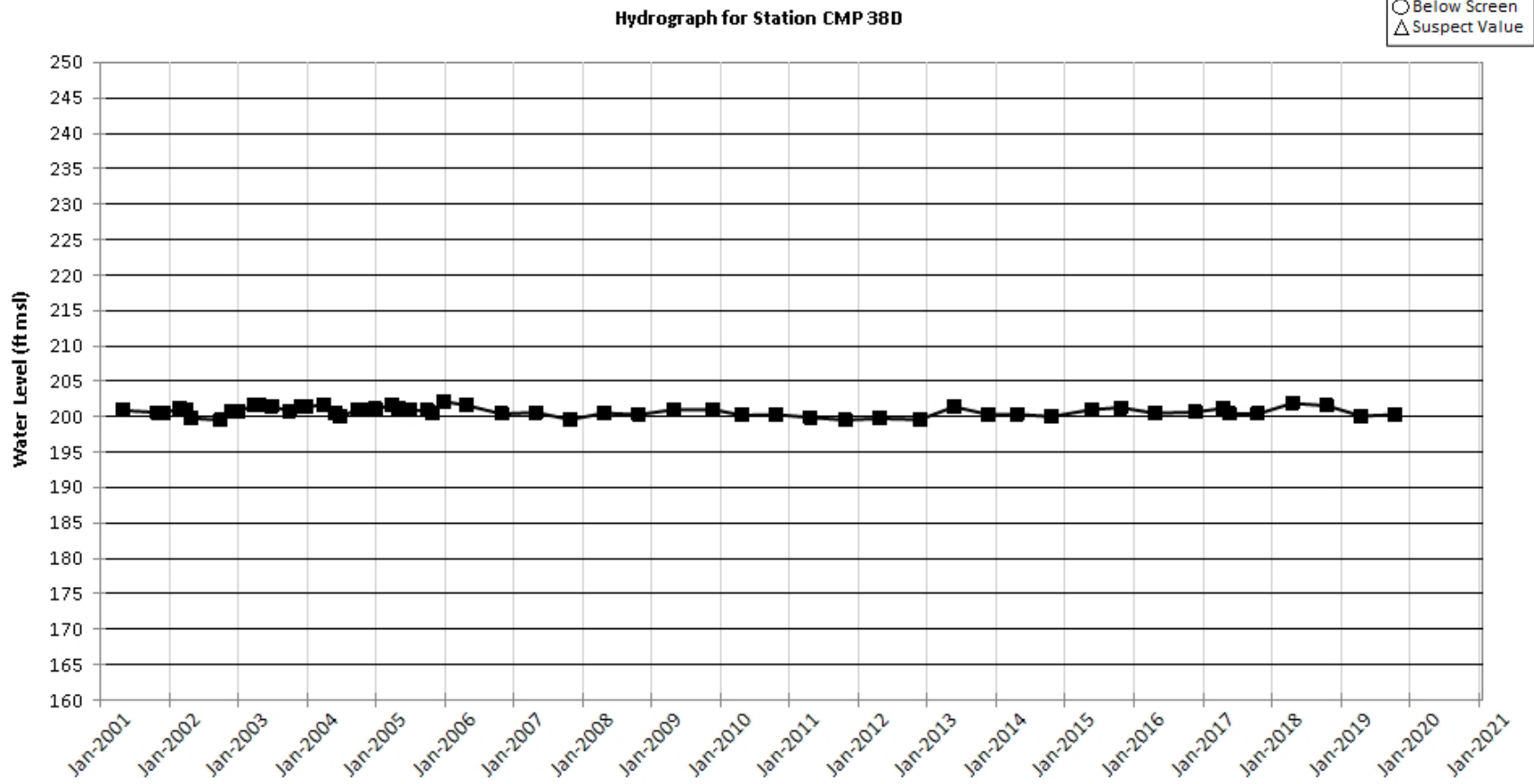


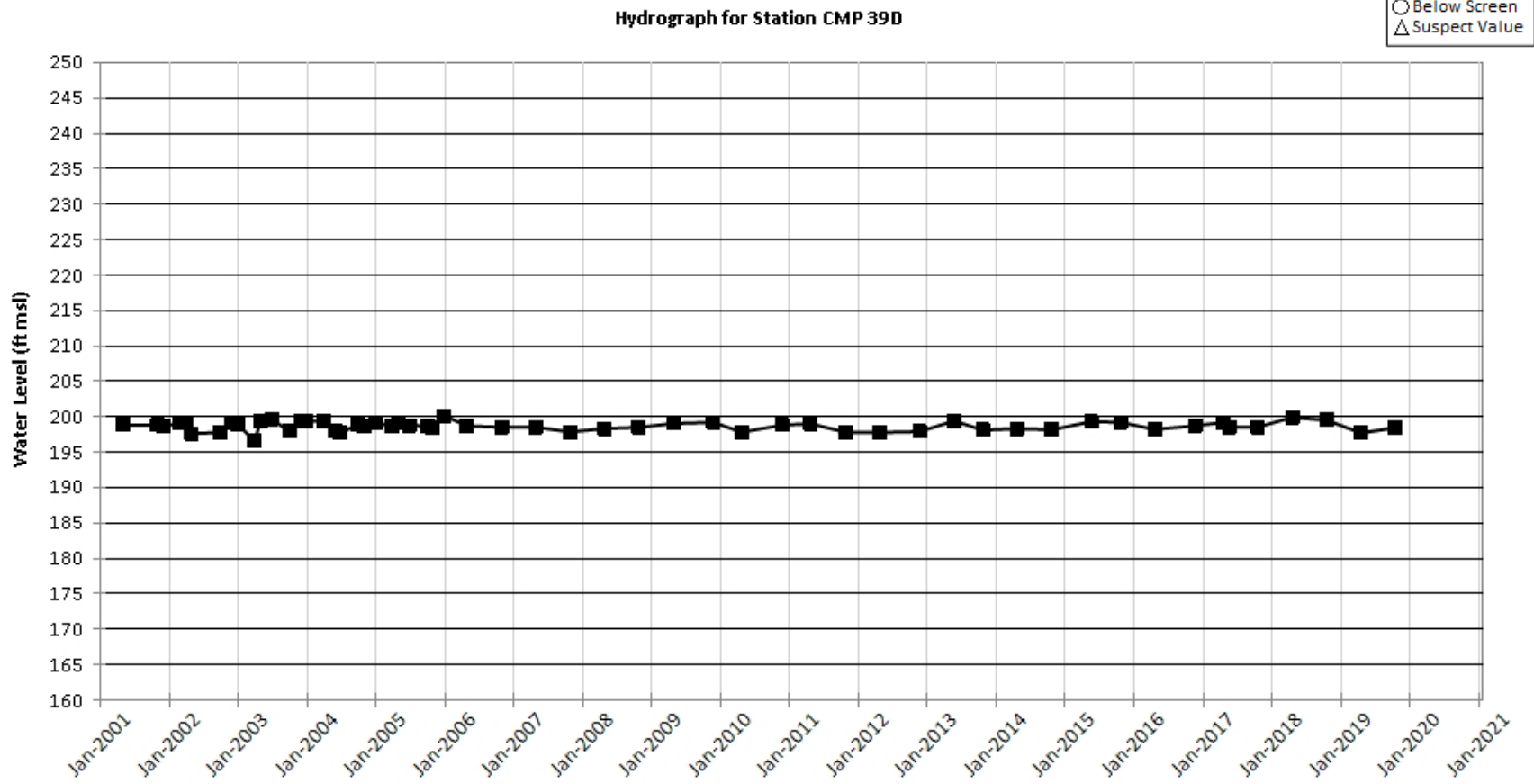


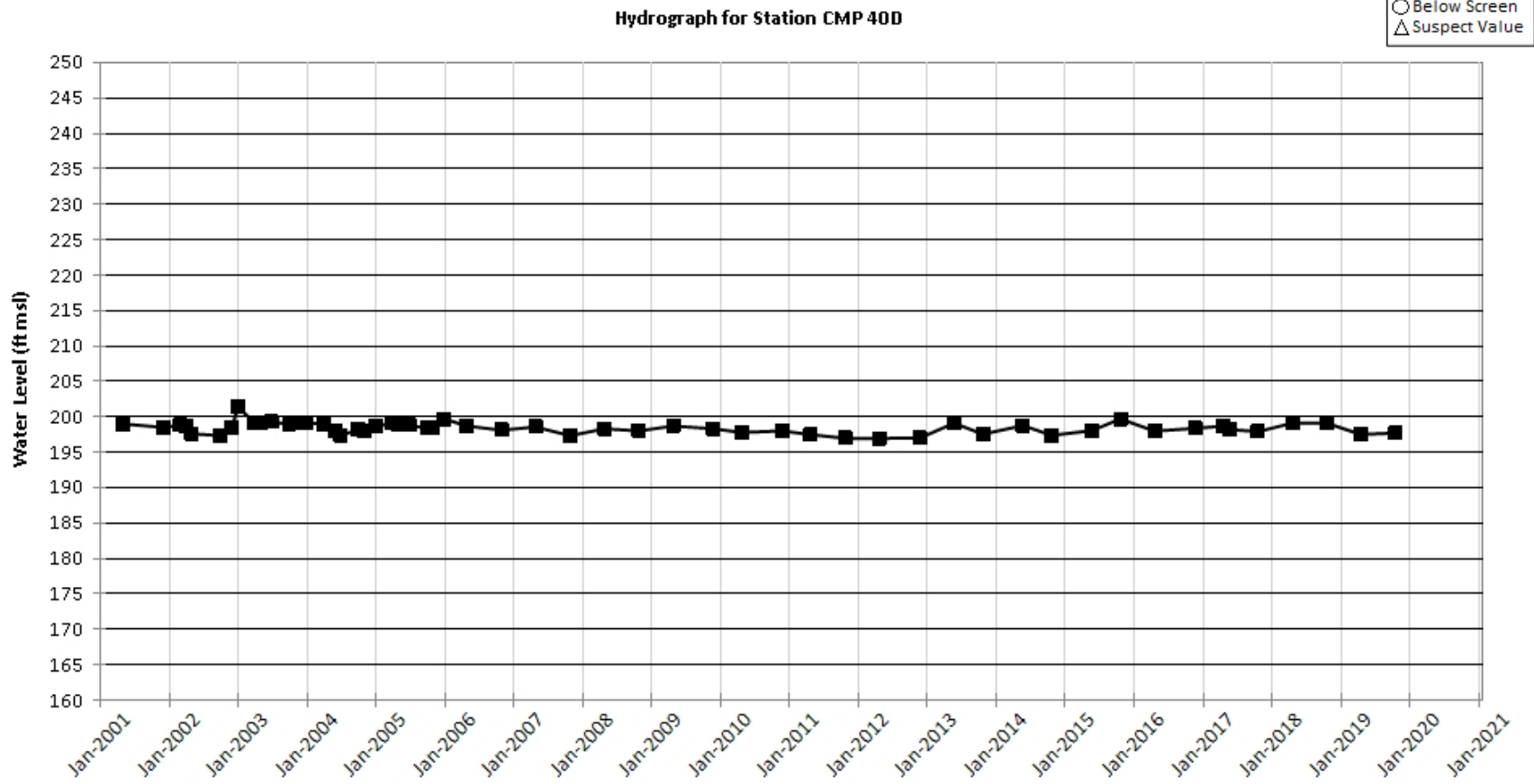


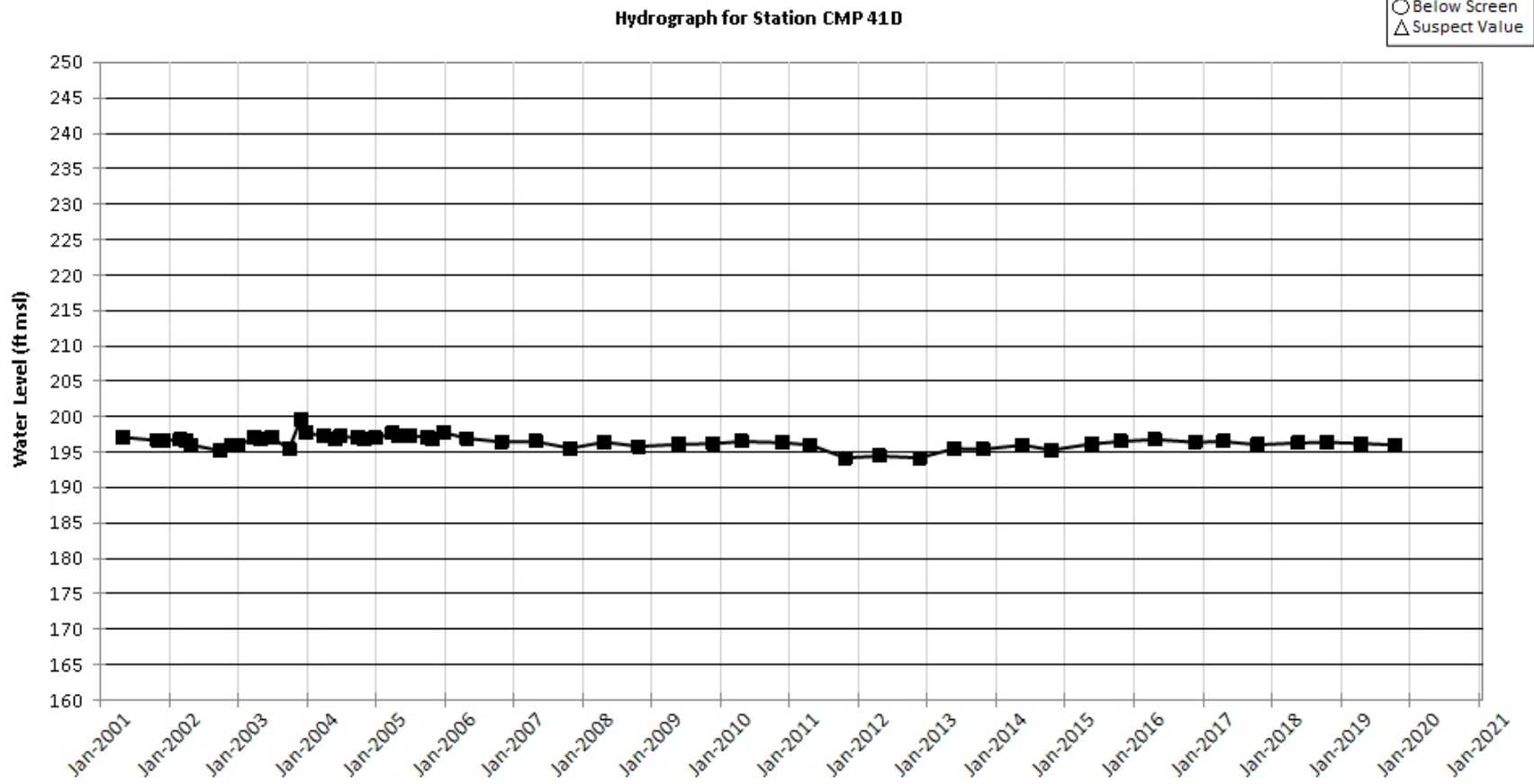


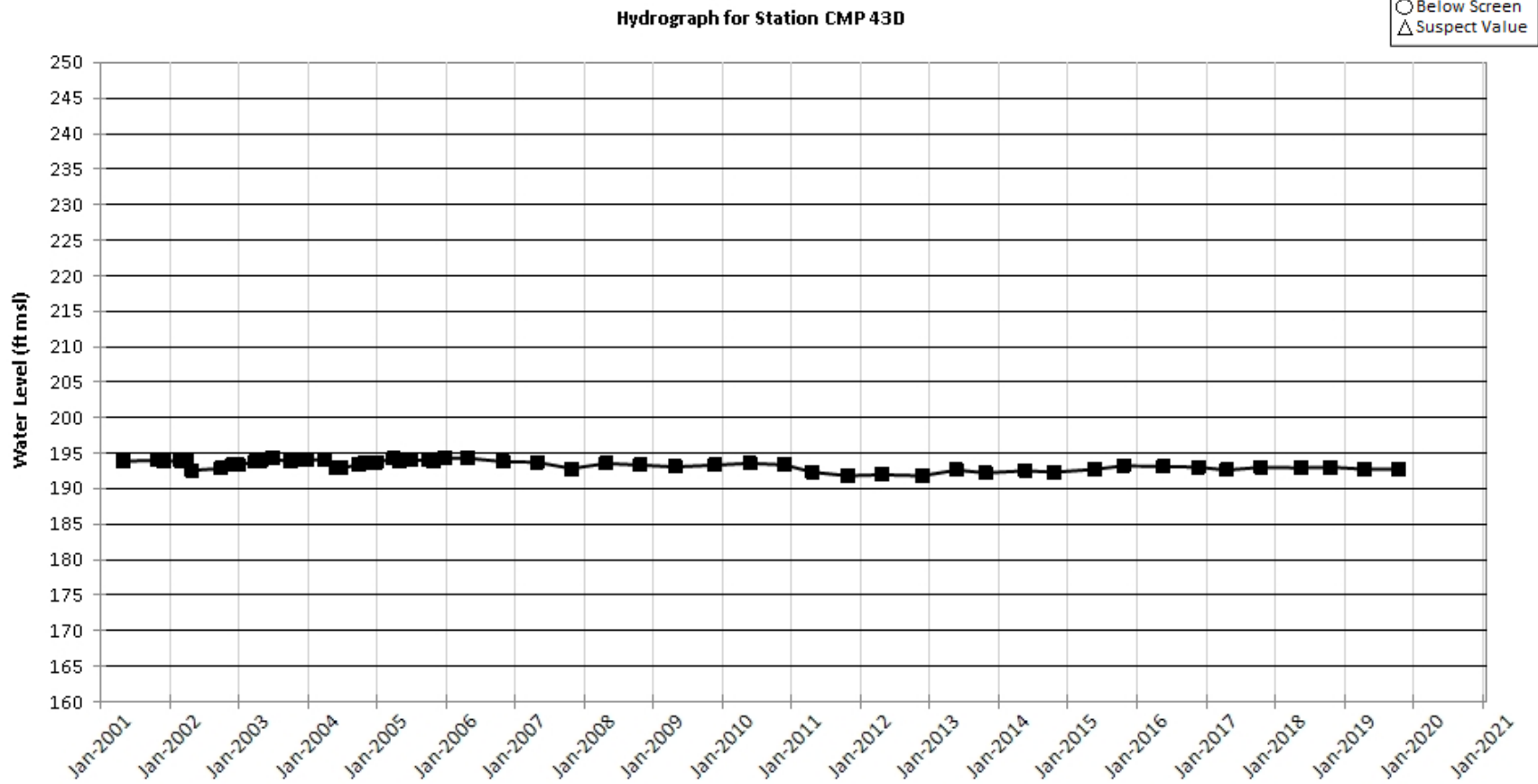


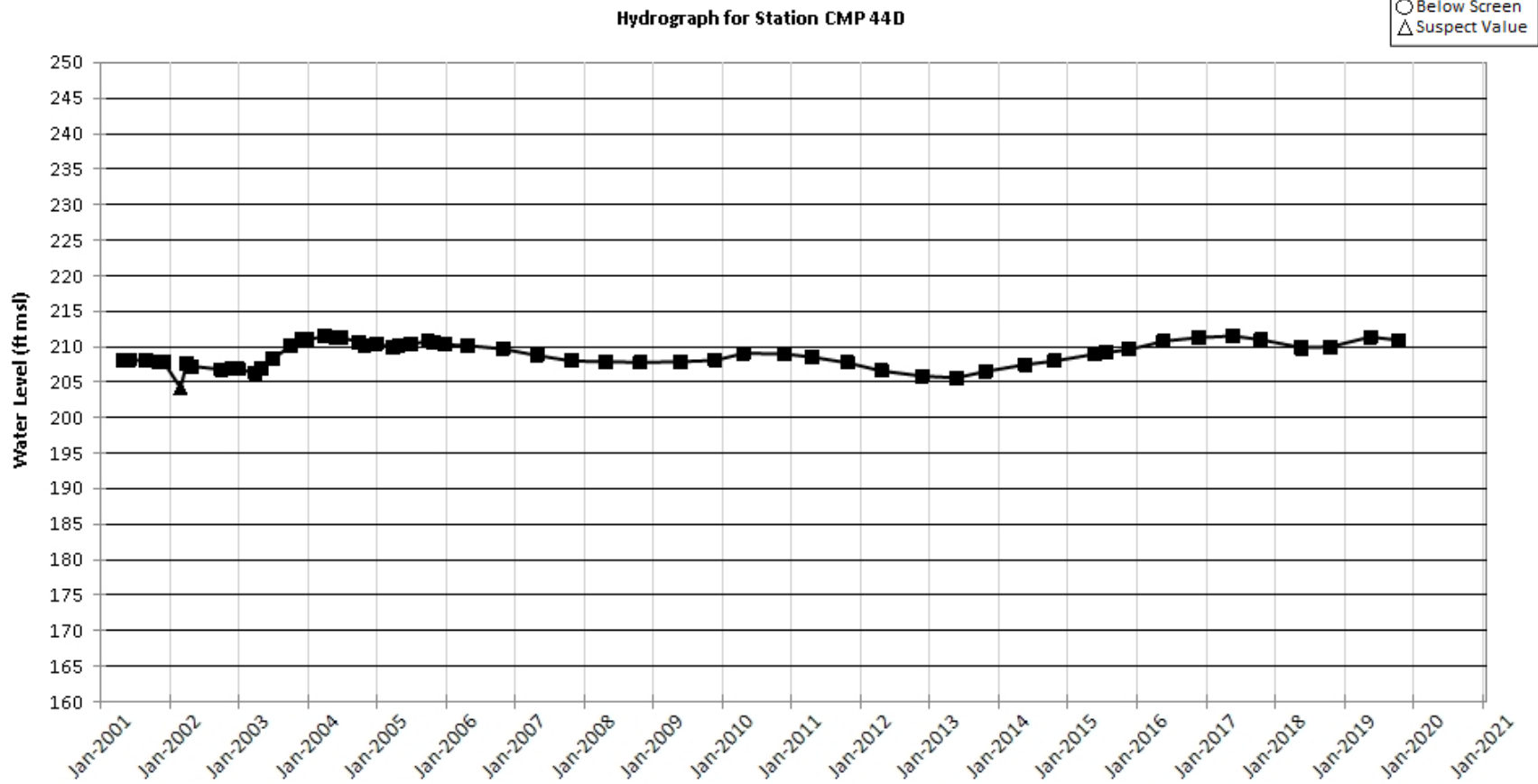


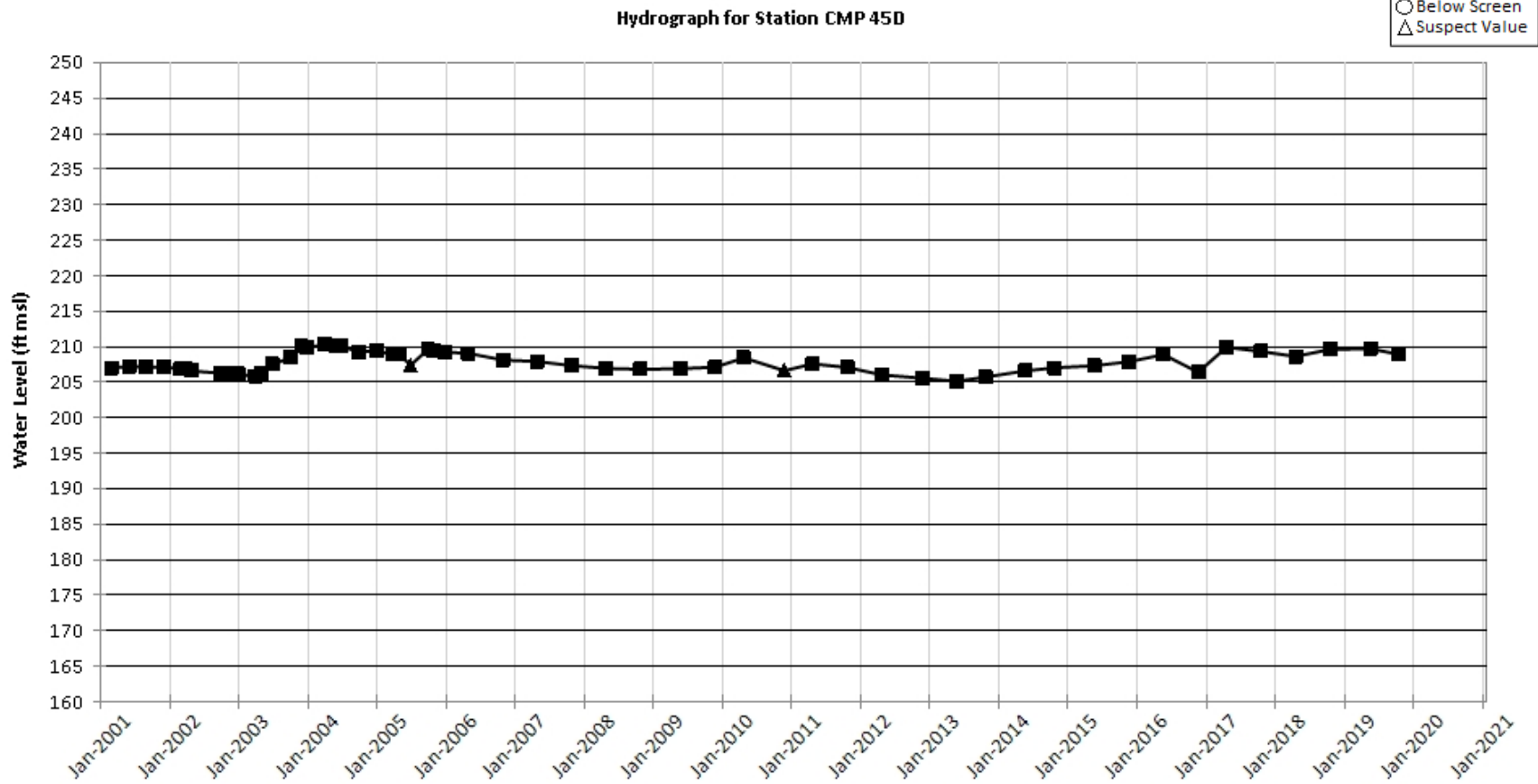


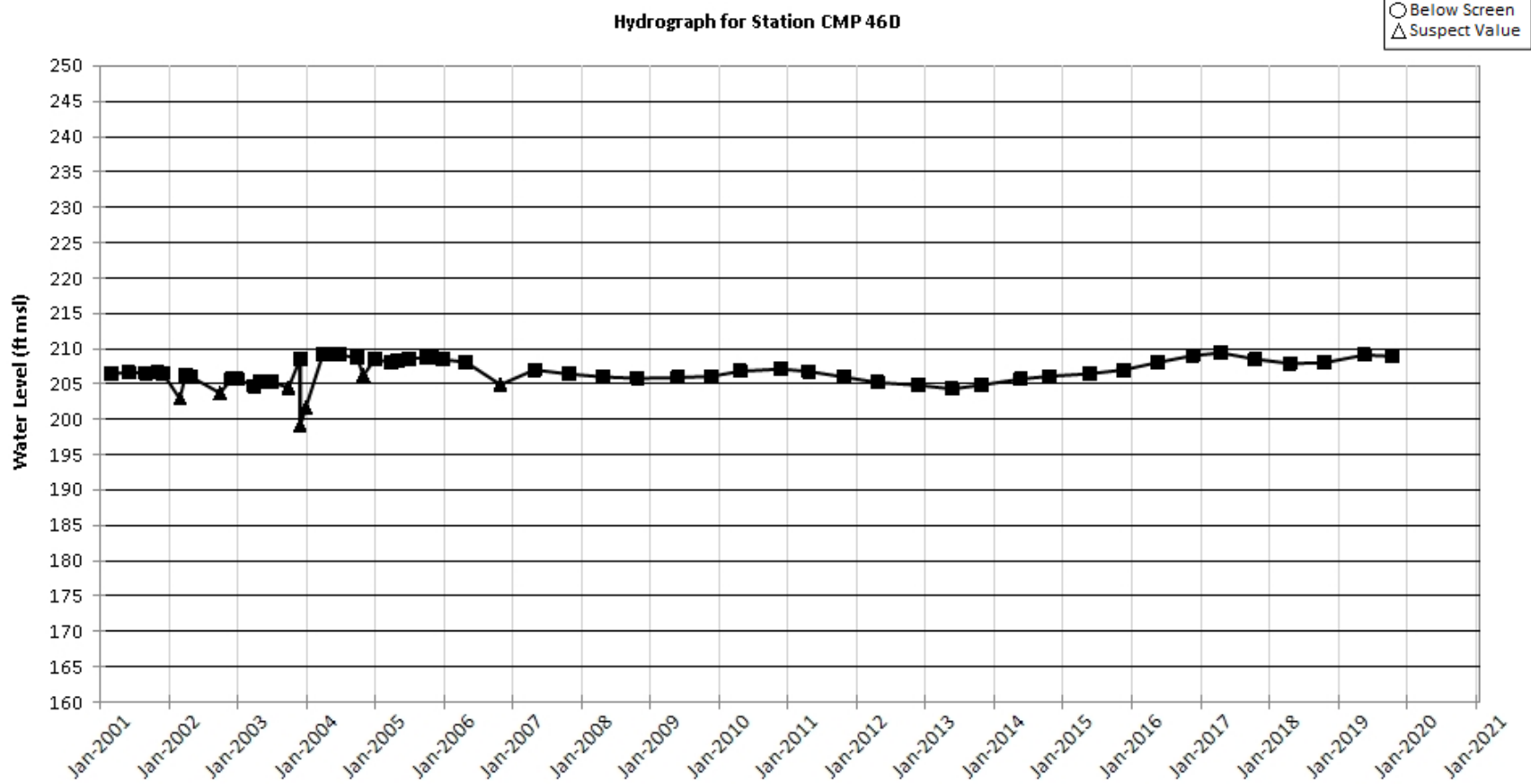


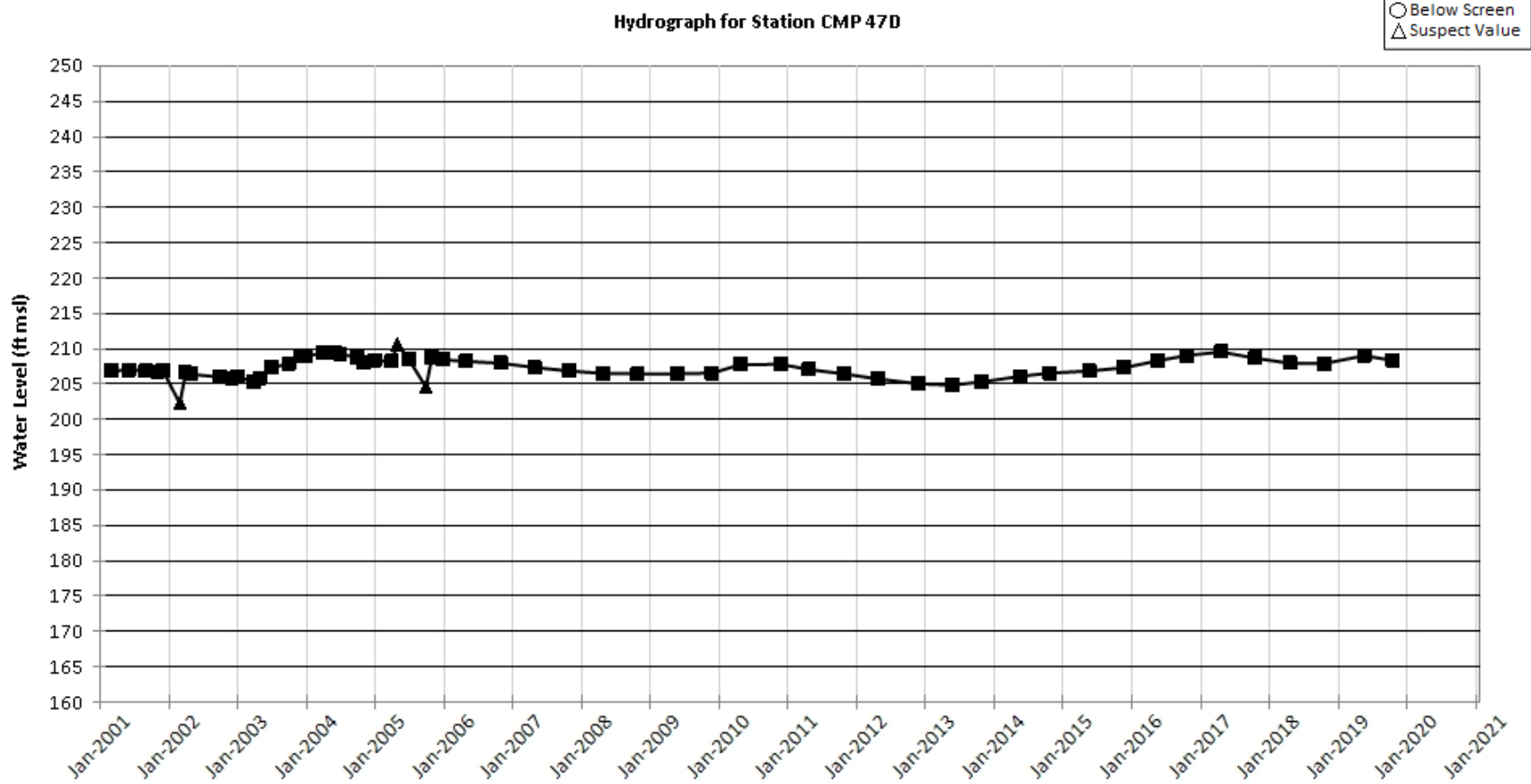


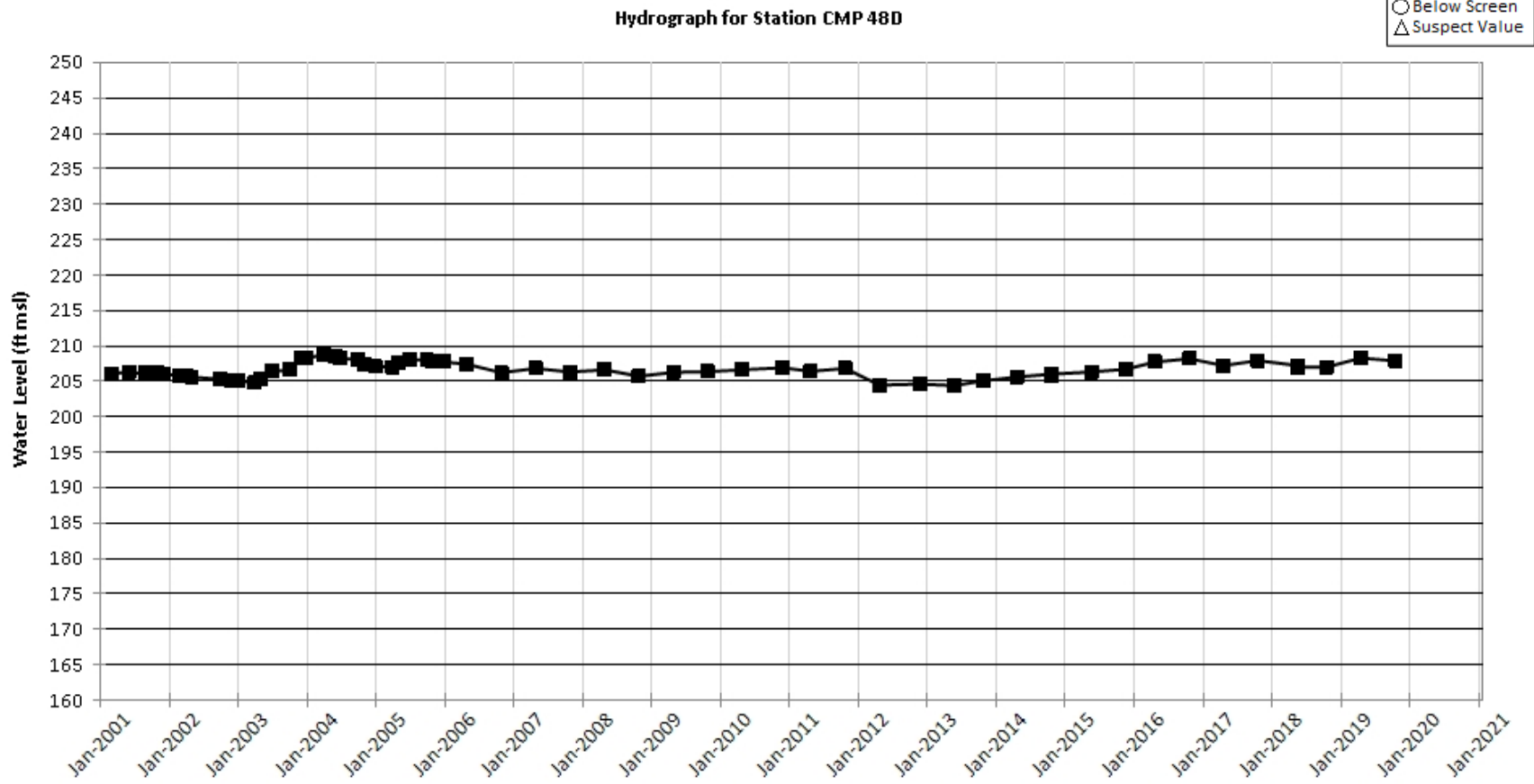


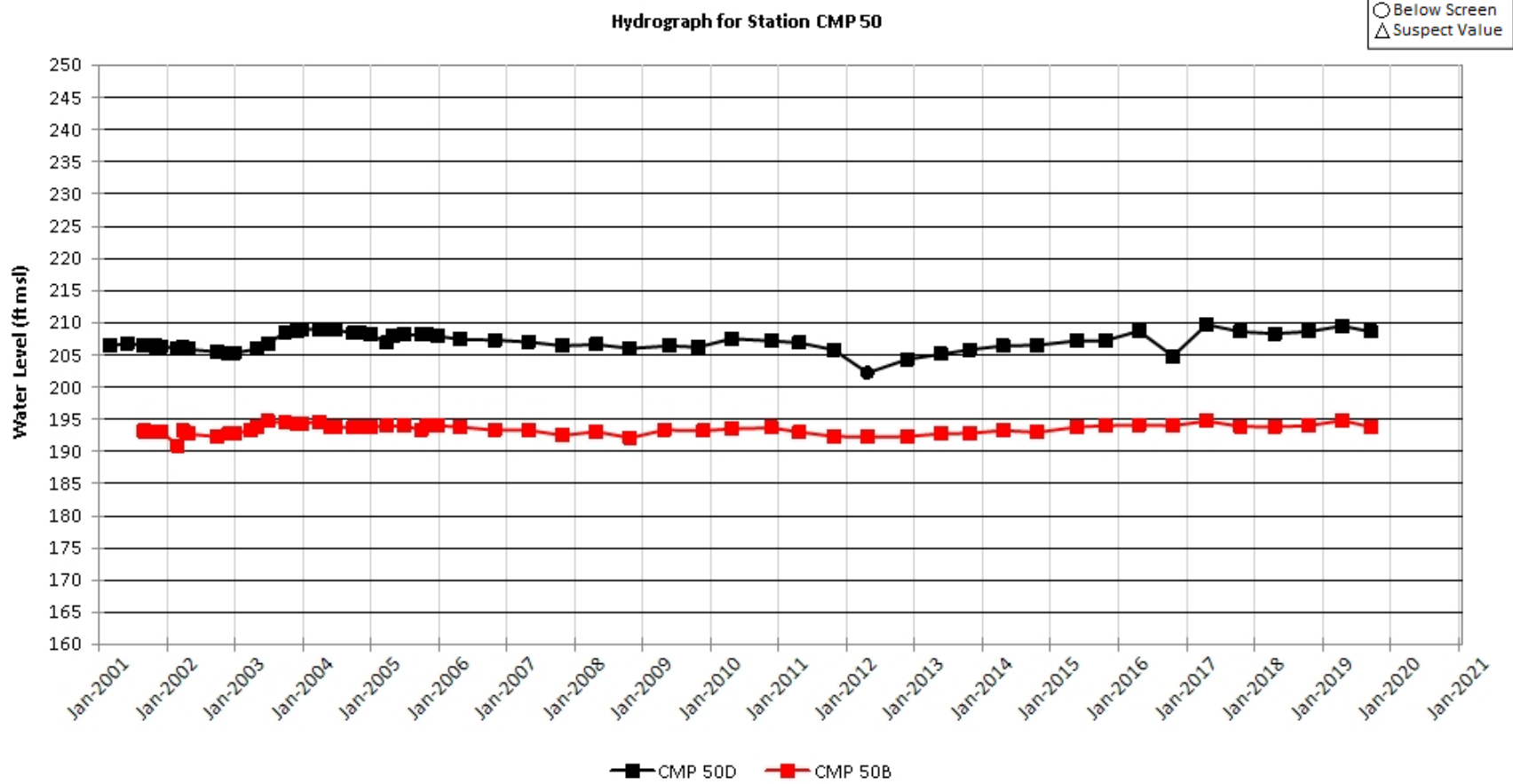


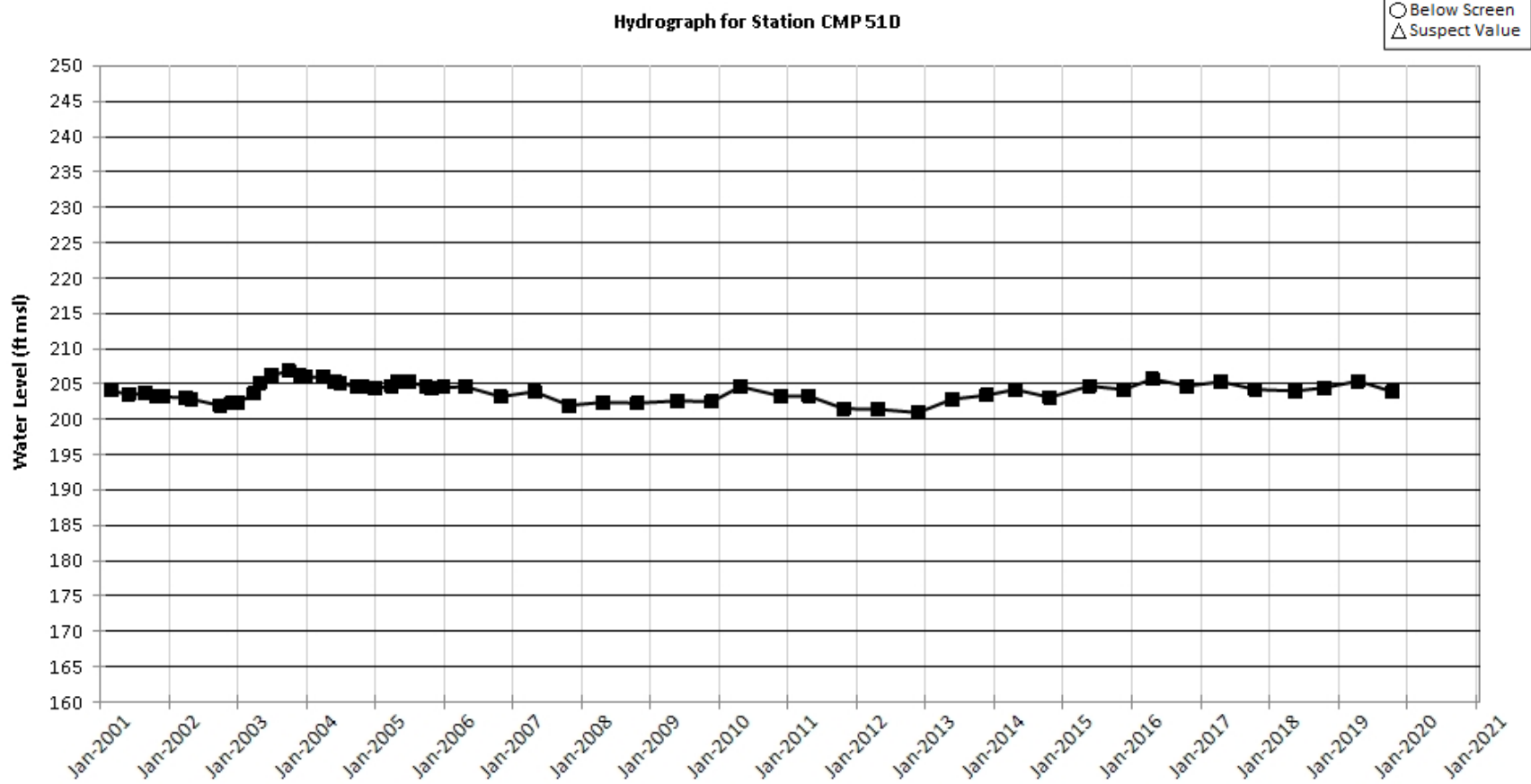


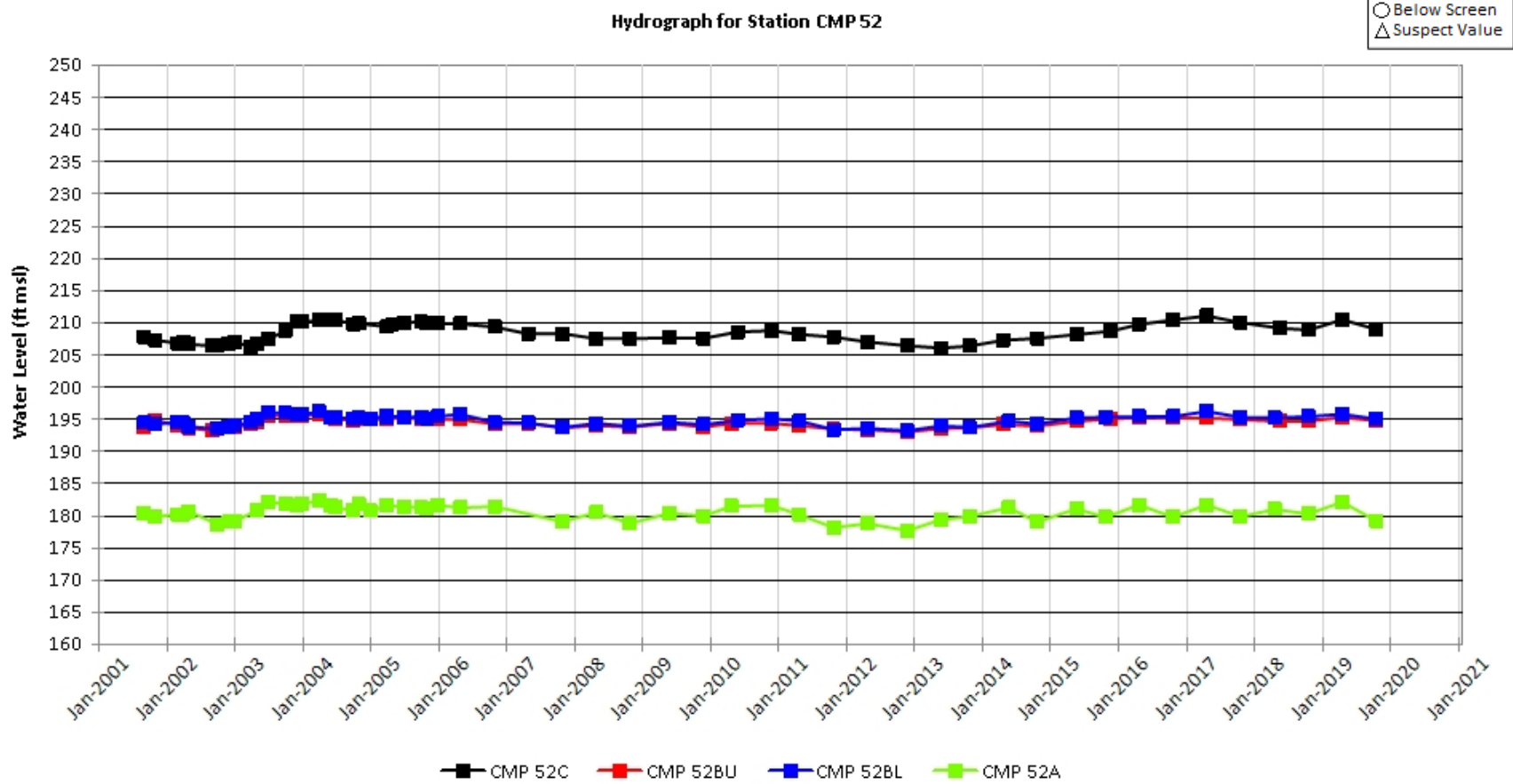


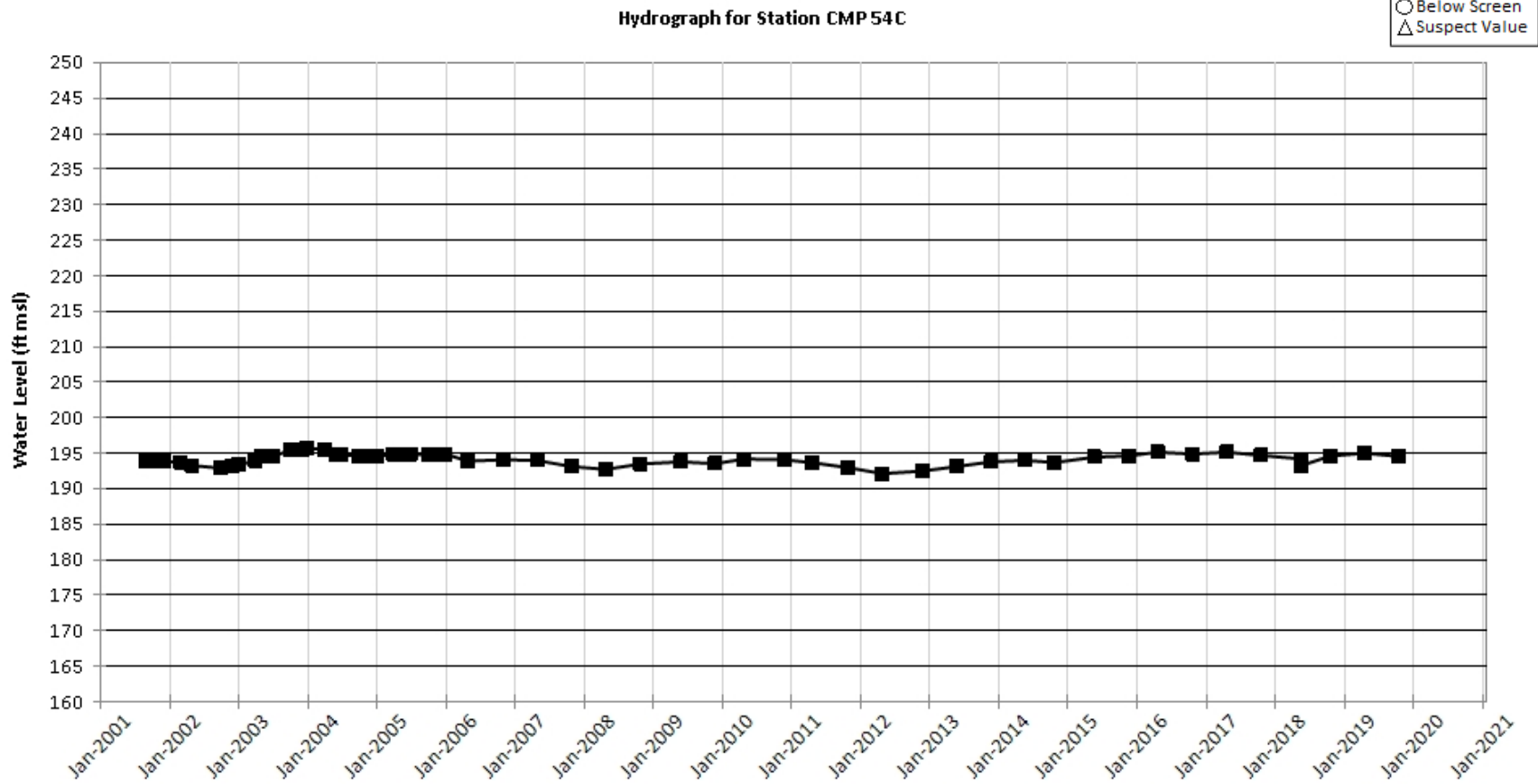


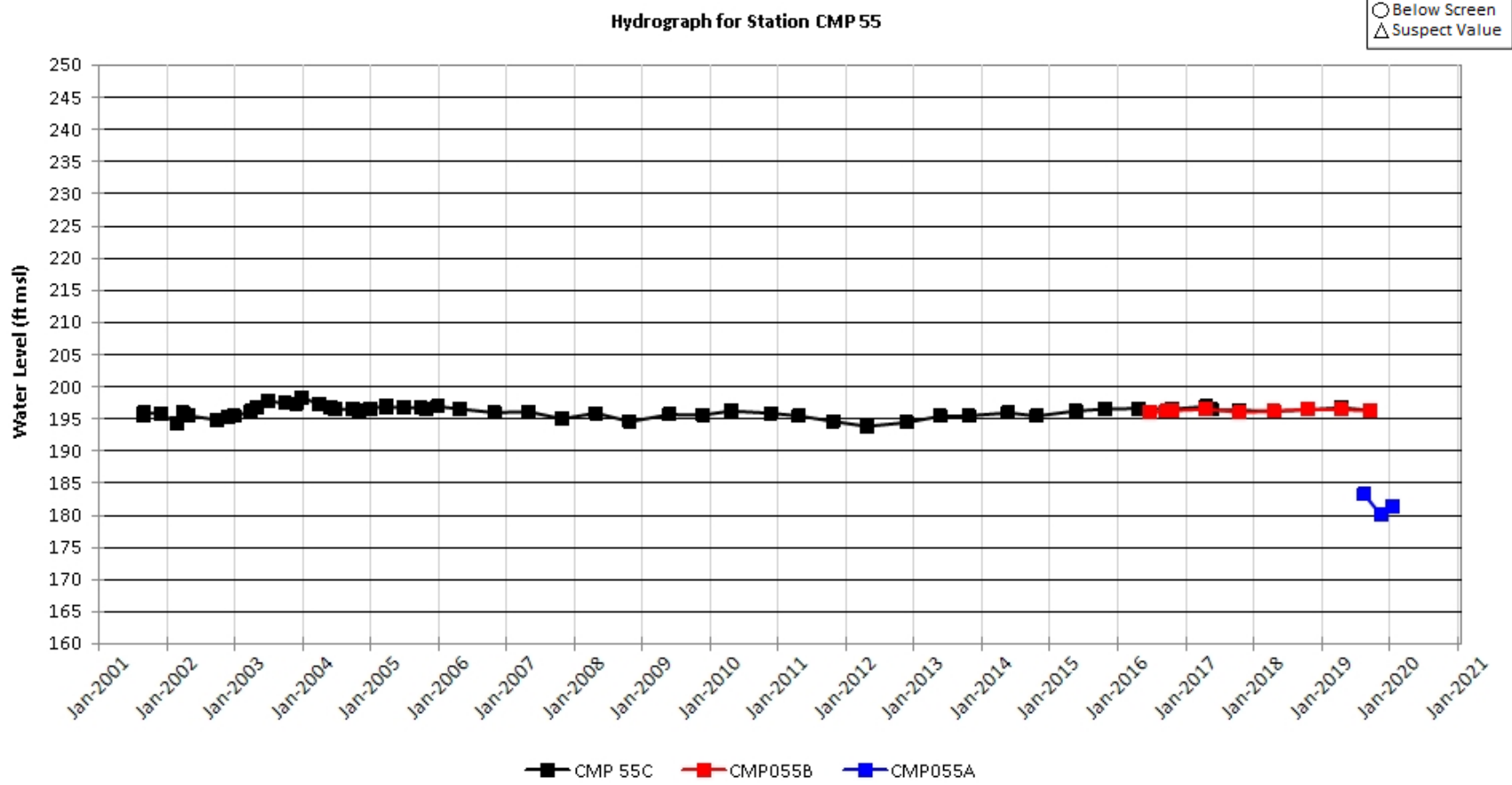


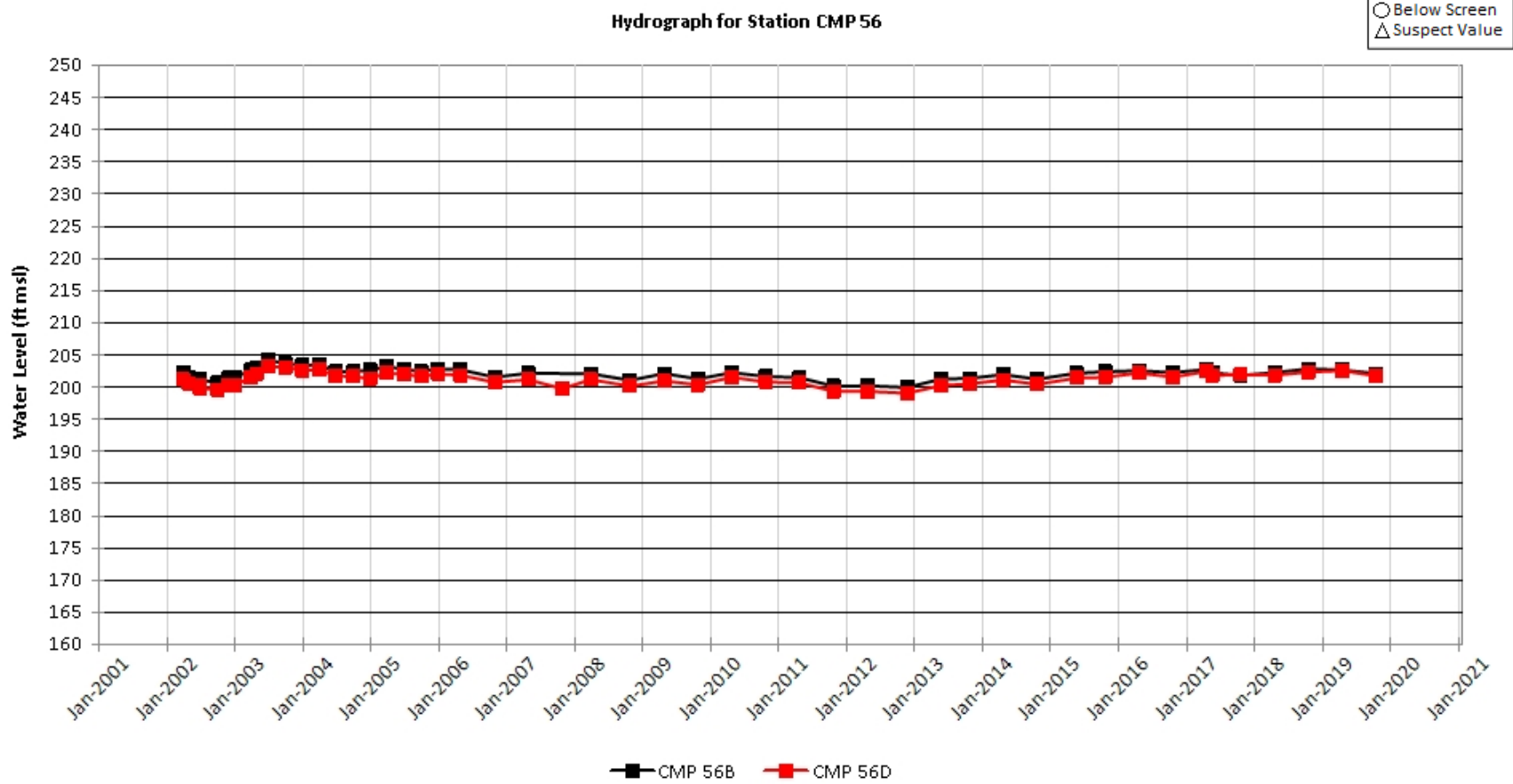


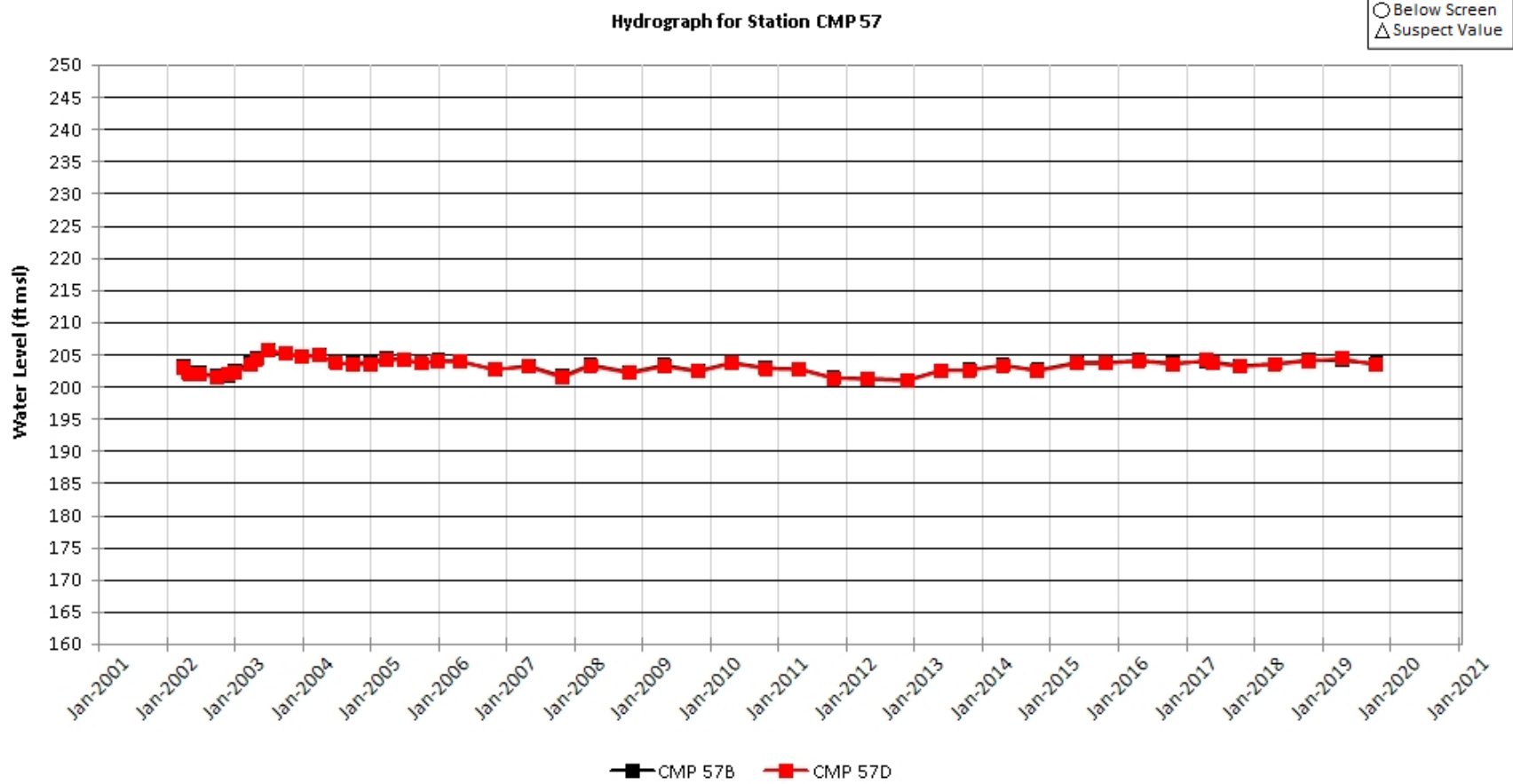


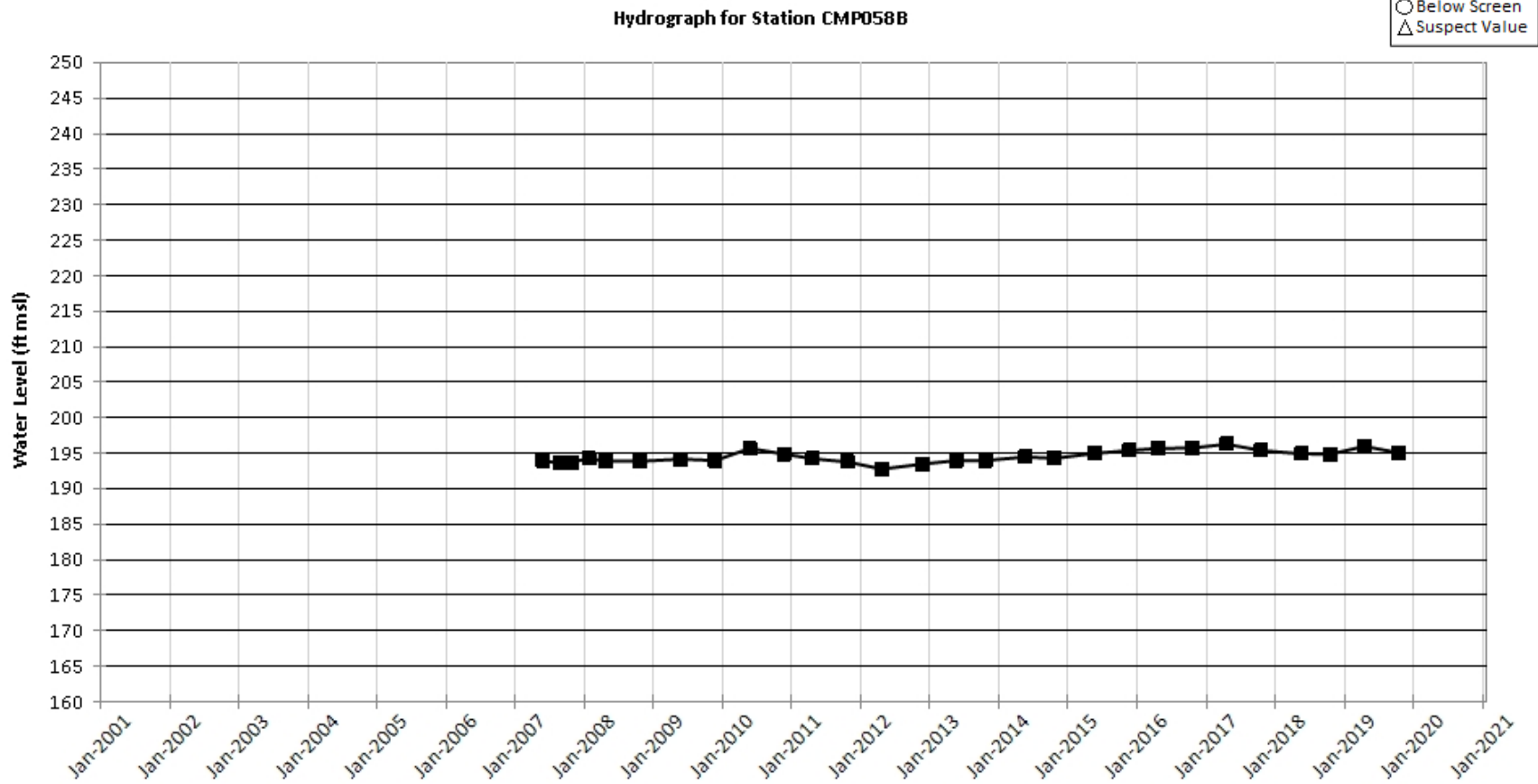


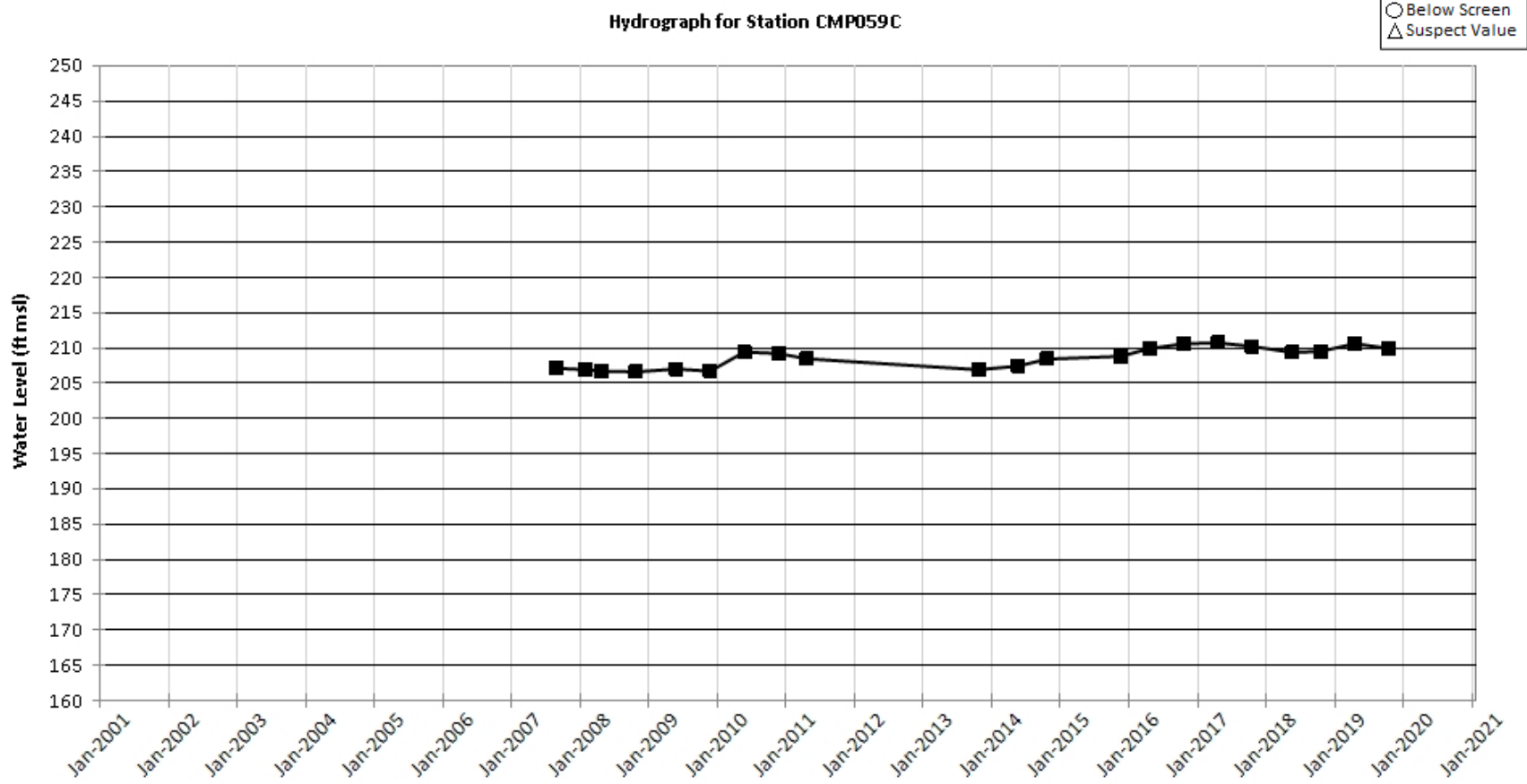


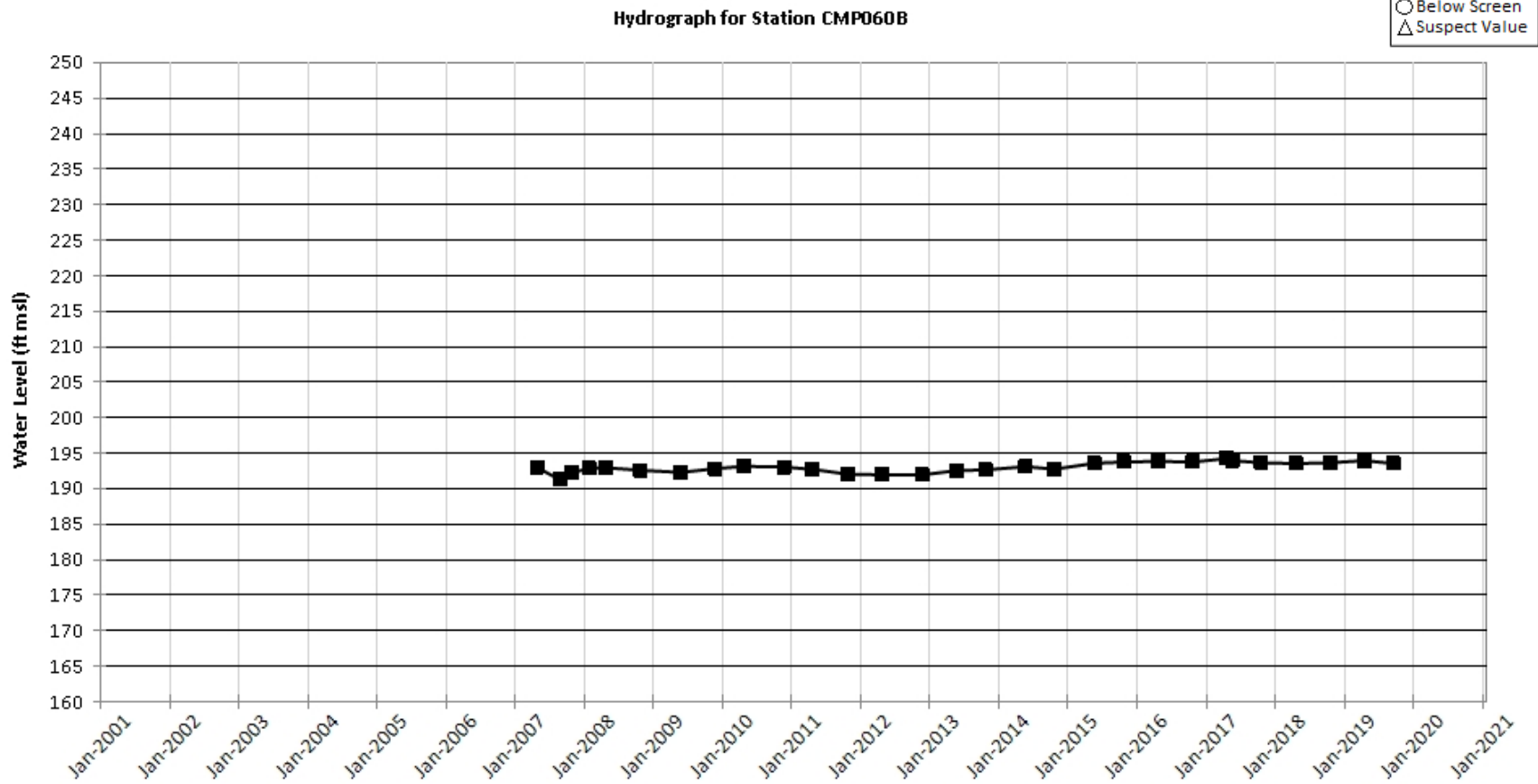


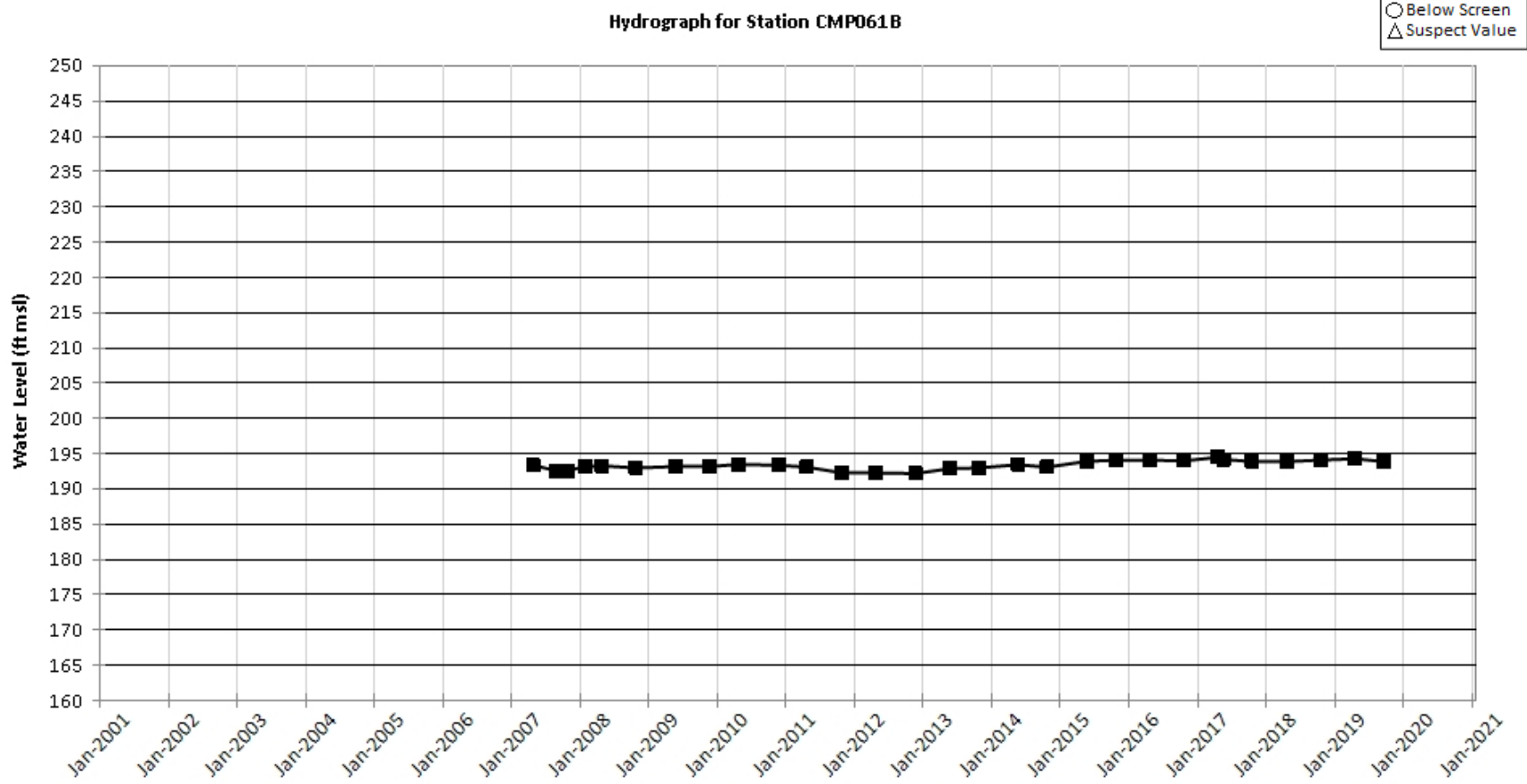


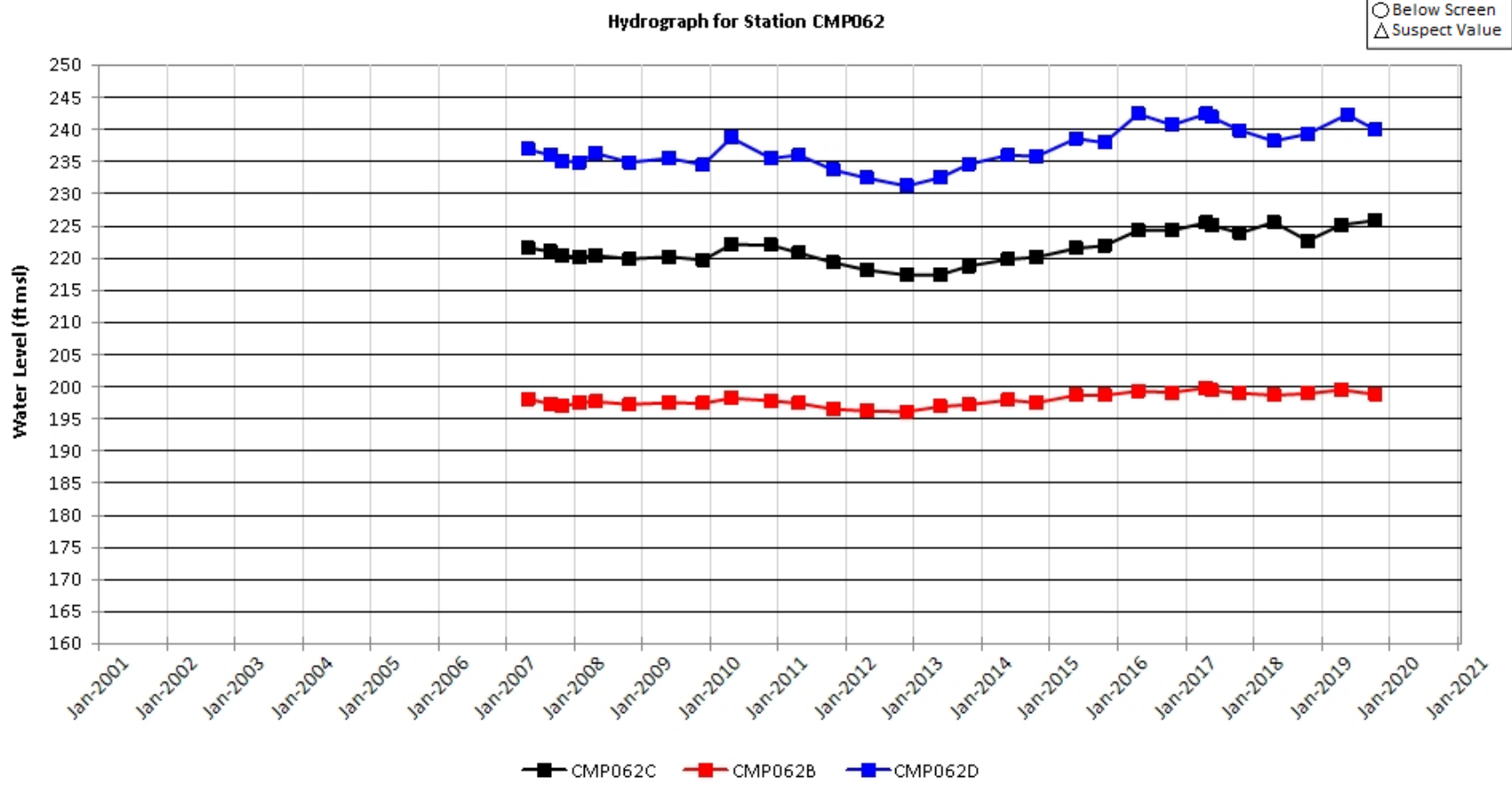


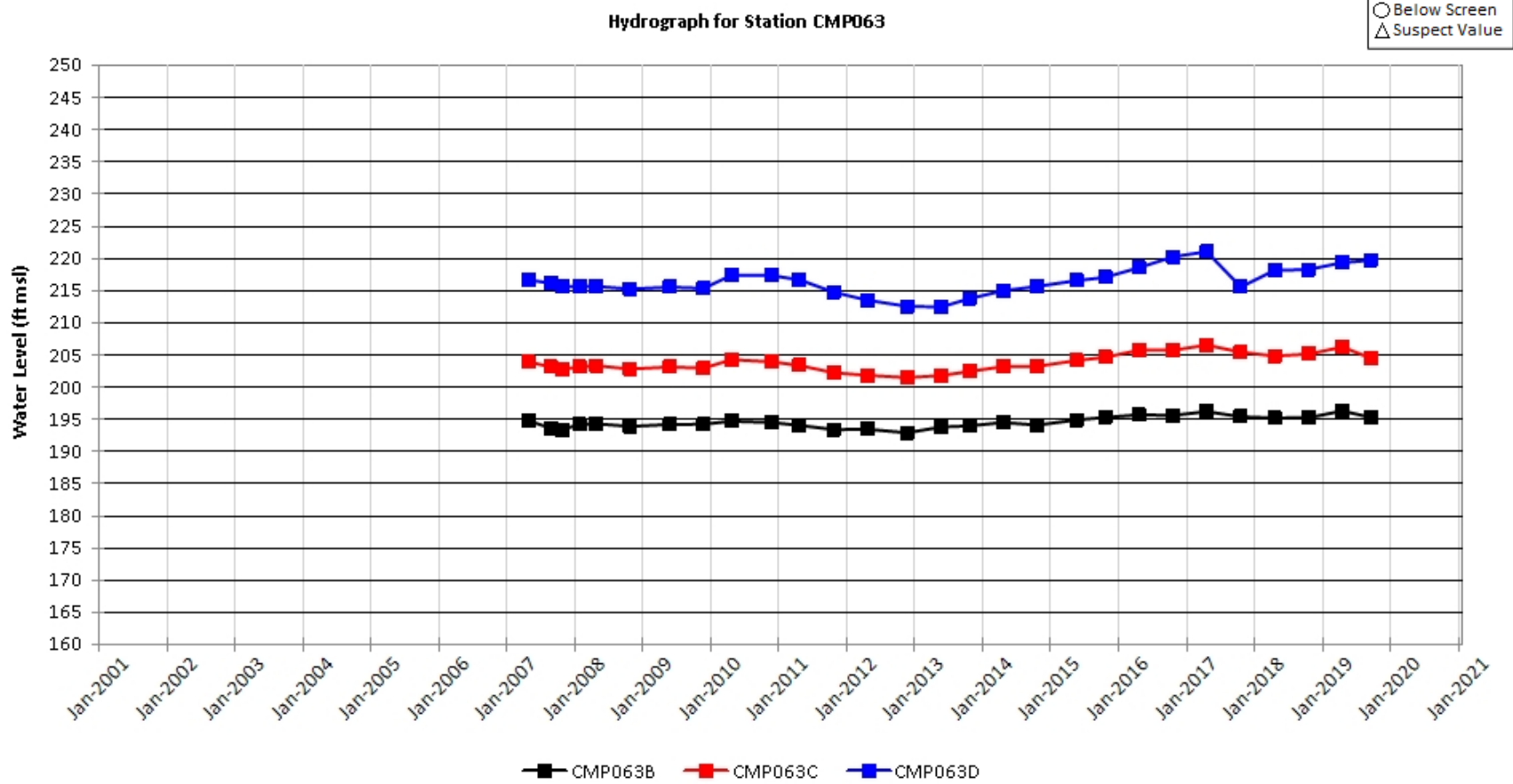


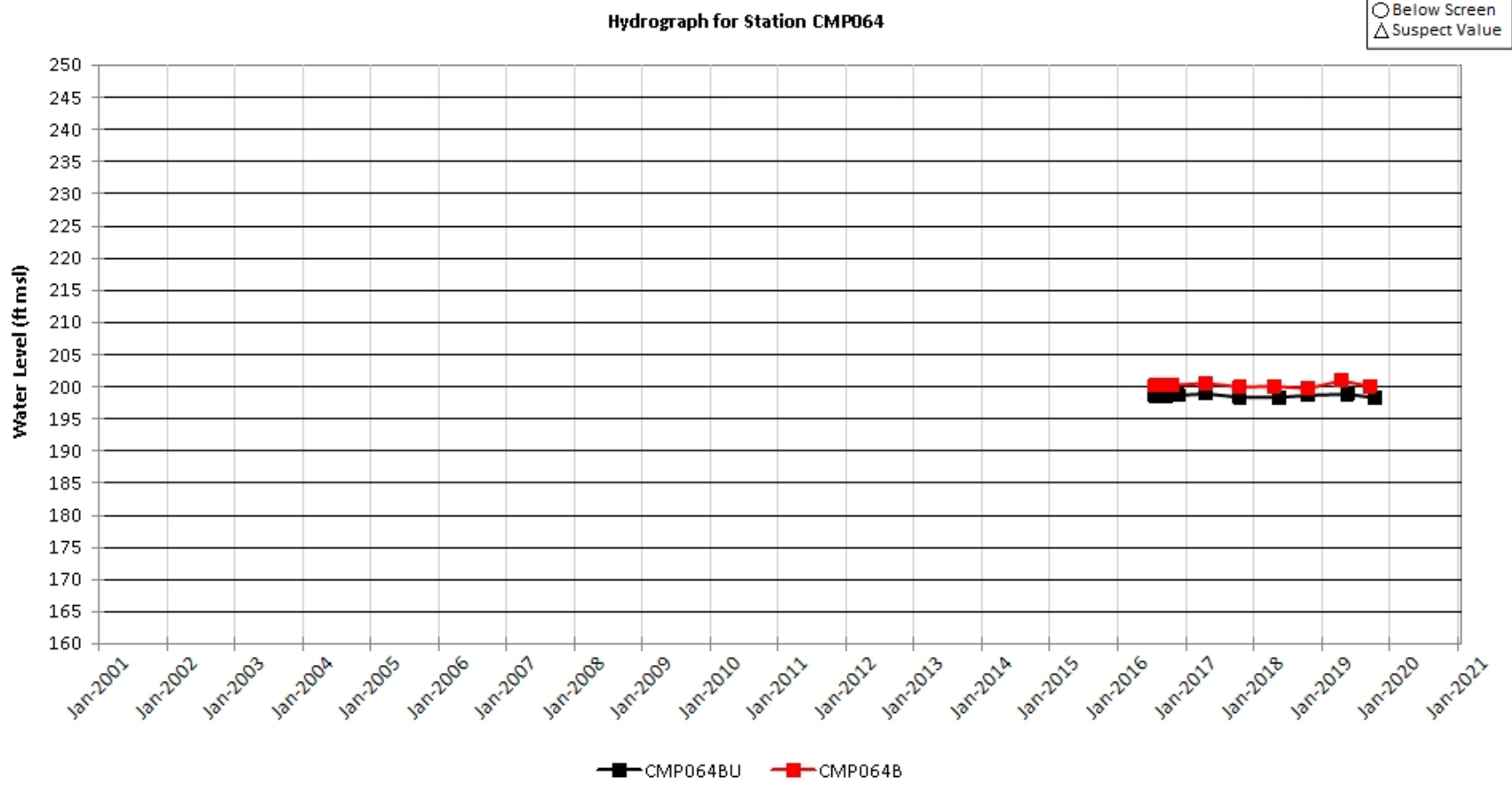


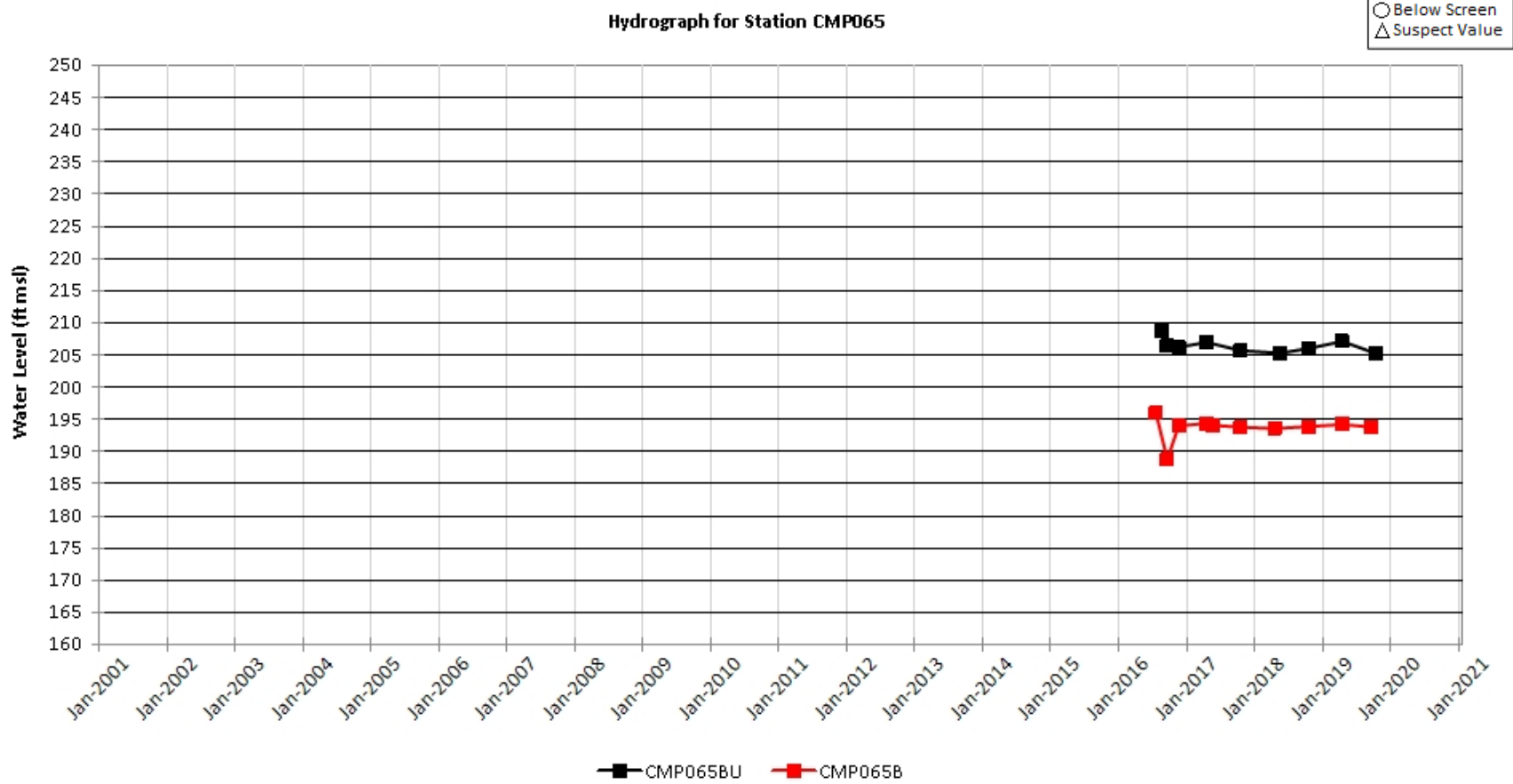


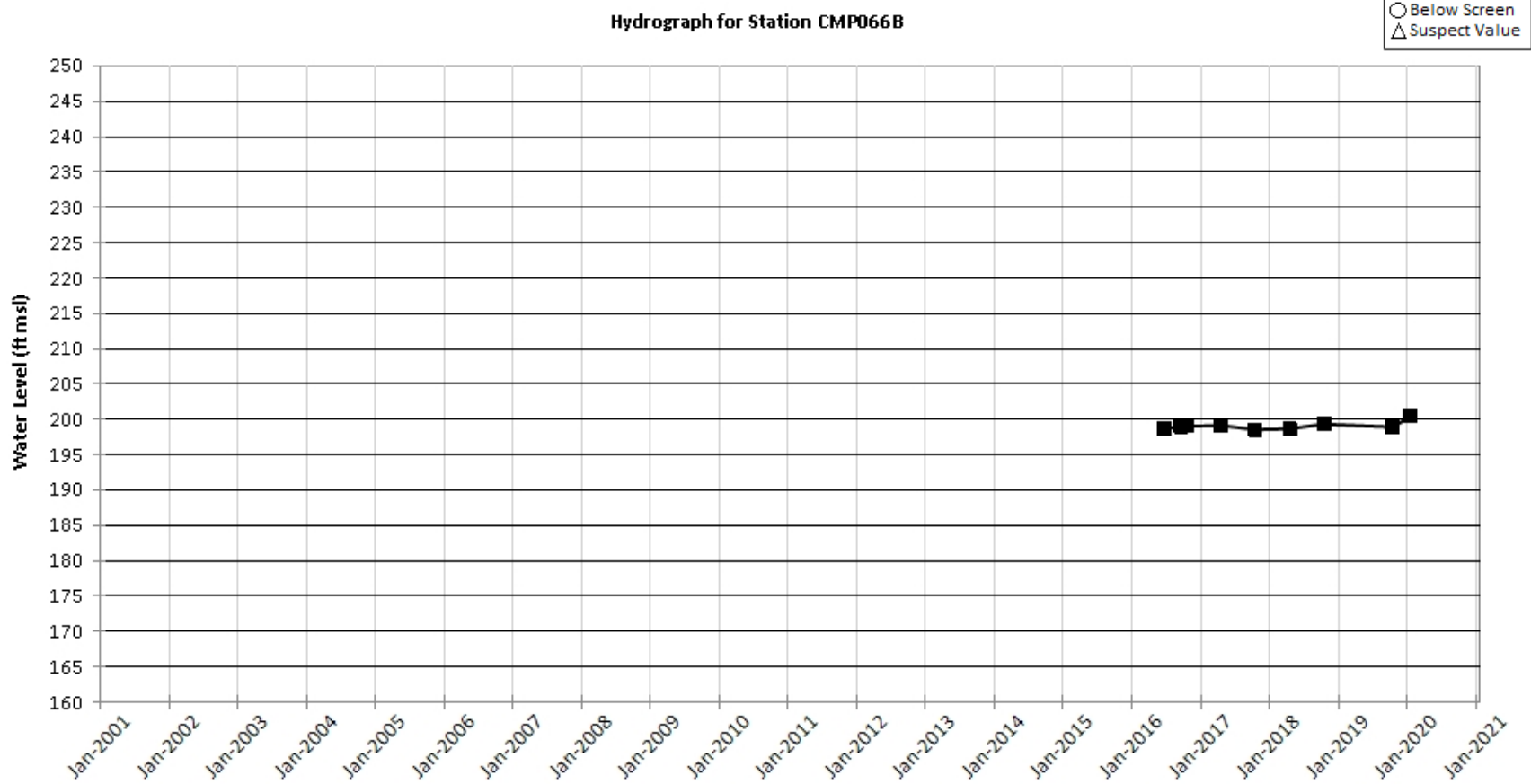


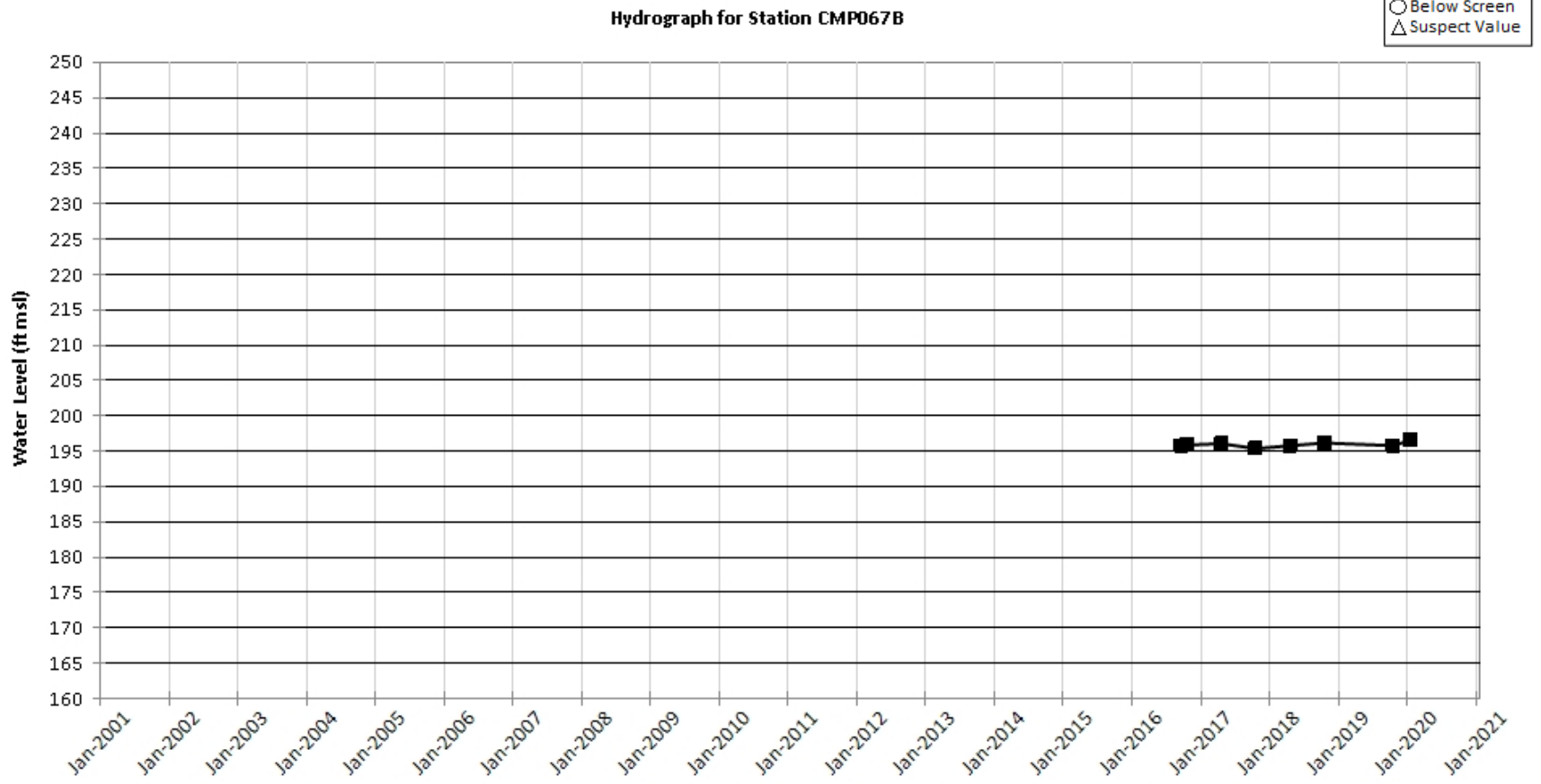












Appendix B

Time-Series Plots

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