# BISC Semi-Annual Monitoring and Performance Report, Rev. 1

July 1 to December 31, 2017

Perchlorate Bioremediation System
Endeavour LLC
Henderson, Nevada

NDEP Facility ID: H-000534

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**BISC Semi-Annual Monitoring and Performance Report, Rev. 1**
**July 1 to December 31, 2017**

Prepared by:
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Revised February 28, 2018

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2/28/18

Jeff Gibson
Authorized Representative

Date

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2/28/18

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Date

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## Executive Summary

Forward flow through the Athens Road/Galleria Drive and Auto Mall area Groundwater Treatment System (AGTS) plant to the effluent line continued in the second half of 2017 (2H2017) averaging approximately 744 gpm. The plant had minimal interruptions of operation. The plant was down for less than an hour on two separate occasions during the reporting period: a thunderstorm induced event in July, 2017 and an area-wide power outage in October, 2017.

Compliance with permit and regulatory action limits was achieved in samples collected during the reporting period. The optimized FBR-based system continued to perform well on a perchlorate mass reduction basis. The total mass of perchlorate destroyed during 2H2017 was approximately 201,800 pounds and the total amount of water treated was approximately 197,194,000 gallons.

The results of Geosyntec's performance analysis and mass capture calculations for the 2H2017 reporting period showed that the total perchlorate loading captured in the shallow water bearing zone (Athens/Galleria area) as a function of the total loading in that groundwater was in the range of 87% to 92% and the total loading captured (groundwater and surface water) was in the range of 59% to 61%. The average loading of perchlorate in the Athens Drainage Channel (ADC) from July to December 2017 was 18.1 lbs/day. The perchlorate captured from the deep water bearing zone was calculated to be approximately 1,012 lbs/day when all AMEWs were operating during the semi-annual sampling event November 2 – 19, 2017.

## 1.0 Introduction

Endeavour LLC has prepared this semi-annual monitoring and performance report for the Nevada Division of Environmental Protection (NDEP) Bureau of Industrial Site Cleanup (BISC) for its perchlorate treatment system at Henderson, Nevada. This report comprises groundwater monitoring and FBR remediation system data collected during the 2H2017 (July 1 through December 31, 2017) and includes results of the annual monitoring well sampling event.

The purpose of this narrative is to provide periodic remediation data to the BISC. The NDEP Facility ID for the project is H-000534.

Supporting information for this report includes a technical memo prepared by Geosyntec on the perchlorate mass capture assessment found in Appendix A, a list of acronyms in Appendix B, definitions of key terms in Appendix C, calculations in support of the groundwater hydraulics and mass capture assessment in Appendix D, and pertinent NDEP correspondence in Appendix E. The Data Validation Summary Report for this reporting period is provided in Appendix F, a copy of the NPDES discharge permit NV0024112 in Appendix G, and electronic copies of laboratory certifications in PDF format are provided in Appendix H.

## 2.0 Objectives

The objectives of the remediation project during this reporting period were to:

- Continue reliable operation of the expanded long-term FBR remediation system that treats groundwater closer to the former perchlorate chemicals manufacturing facility in addition to the Leading Edge (Athens/Galleria extraction area).

- Continue to pursue optimization opportunities of the entire FBR-based remediation system to maximize the contaminant mass removal and groundwater capture.

- Continue groundwater sampling activities per the Rev. 2 Sampling and Analysis Plan (SAP).

- Demonstrate the ability to reduce the perchlorate load in the surface water resulting from groundwater seepage into the Athens drainage channel.

## 3.0 Scope of Work

This report, as with the previous reports, contains information pertinent to the Mitigation System Area (MSA) Work Plan and the approved Rev. 2 SAP. Since the FBR remediation system treated effluent discharges directly into the Las Vegas Wash, Endeavour LLC submits quarterly Discharge Monitoring Reports (DMRs) separately to the Bureau of Water Pollution Control (BWPC) per our National Pollution Discharge Elimination System (NPDES) permit, NV0024112.

Monitoring for the BISC was originally described in the MSA Work Plan and associated documents submitted to NDEP Bureau of Corrective Actions (BCA) in February, 2005. A SAP covering the requirements of the combined BCA and BWPC Underground Injection Control (UIC) programs was submitted to NDEP and approved on September 8, 2010. This was updated after the UIC permit cancellation and submitted to the BCA on March 26, 2013 for conditional approval. BCA approved that Rev. 1 SAP for use in the 2013 annual sampling event in a letter dated April 19, 2013.

A Rev. 2 SAP was prepared per an agreement with NDEP during a meeting held July 18, 2013 and as required under our Administrative Order on Consent (AOC) which became effective on July 1, 2013 and was assigned to, and assumed by, Endeavour LLC in December, 2015. The Rev. 2 SAP was approved by NDEP in a letter dated September 30, 2013.

A Rev. 2 Work Plan for Demonstration of Groundwater Capture was prepared by Geosyntec which concluded that taking water levels from 12 additional wells on a semi-annual basis was necessary to better assess groundwater capture in the shallow WBZ. This was added to an updated Rev. 2 SAP dated September 19, 2014. The updated Rev. 2 SAP also included a change which required that nitrate analyses only be conducted during the annual sampling, which was approved by email correspondence from NDEP on September 4, 2014. Both of these updated plans were officially approved by NDEP in compliance with the AOC in a letter dated October 16, 2014.

The scope of work performed during the reporting period included:

- Operation, maintenance and monitoring of the FBR treatment system.

- Collection of groundwater levels, field parameters and samples from extraction wells, new plant processes, surface water channels, and monitoring wells covered under the BCA's monthly, quarterly, and semi-annual monitoring programs.
- Management of field measurements, plant operational data and laboratory analytical results.
- Preparation of this technical report.

# 4.0 Description of the Groundwater Treatment System

## 4.1 AGTS Plant and Discharge

The AGTS operation is based at a 9,000 square foot building located within a 1.77 acre site at 900 Wiesner Way, Henderson, NV 89011, which is northeast of Boulder Highway and Sunset Road (see Figure 1). The operational controls, offices, chemical storage, and analytical laboratory are located here. There were no material changes to any of these items during the reporting period.

The FBR system began operation in late September 2012 and is designed to remove perchlorate from groundwater extracted from the Valley Auto Mall area (near the source area close to the former PEPCON facility) as well as the shallow groundwater bearing zone along Galleria Drive and the Athens Pen area (the Leading Edge) before it enters the Las Vegas Wash to the north.

The treatment system comprises 14 extraction wells, a water handling and FBR treatment plant, and a discharge system. Five Auto Mall extraction wells (AMEWs) are located within the Valley Auto Mall area of Henderson (see Figure 2), six Athens Road extraction wells (AREWs) are located along the north side of Galleria Drive (formerly Athens Road) west of Wiesner Way, and three Athens Pen extraction wells (APEWs) are located east of Wiesner Way along the private driveway to the treatment plant (see Figure 1).

The target contaminant for the AGTS is perchlorate ($ClO4^-$). During the process, chlorate ($ClO3^-$), nitrate ($NO3^-$), and dissolved oxygen (DO) are also reduced in biologically mediated redox reactions. For purposes of this report, perchlorate, chlorate and nitrate will be often referred to as "electron acceptors."

The AGTS FBR plant consists of two first stage FBRs that contain sand media while a second stage FBR contains granular activated carbon. Internal FBR components include a fluidization flow distribution system, a biomass separator with an in-bed biomass control system, and an effluent collection system. A media separator is included within the first stage. Microorganisms growing as a film on the media and utilizing metabolic pathways reduce the perchlorate, chlorate, nitrate and oxygen in redox reactions resulting in nitrogen, carbon dioxide, water, and minerals. This is accomplished through the precise addition of an electron donor (ethanol), nutrients (di-ammonium phosphate/urea mixture), and other trace elements (micro-nutrients).

Additionally, pH is adjusted through the addition of a 50 percent (by weight) solution of sodium hydroxide.

The treated effluent from the FBRs is aerated in an aeration tank with hydrogen peroxide added to control the formation of sulfides. The treated water then flows from the aeration tank directly to the effluent tank. The dissolved air filtration units (DAFs), sludge digestion, truck loading, and sand filtration components still exist at the site but were taken offline in September, 2013 with approval by NDEP. The layout of the AGTS facility showing these process components is provided on Figure 3.

Effluent is pumped from the effluent tank to the Las Vegas Wash via one or two 8-inch HDPE pipelines. The first 7,700 feet of effluent line from the plant consists of an 8-inch HDPE pipe that was installed in 2006 and used during the ISB operation. It feeds into a maintenance vault at the former re-injection area. Dual 8-inch HDPE pipelines extend out from the mixing vault approximately 6,200 feet to the discharge point within the Las Vegas Wash where those lines recombine to one line immediately prior to discharge. In the maintenance vault, effluent can be switched from one pipe to the other, or to both simultaneously, based on a set schedule or as necessary if line maintenance is required. Discharge into the Las Vegas Wash is subject to a NPDES permit (NV0024112, dated December 29, 2011) and quarterly DMRs are submitted to NDEP under this permit (see Appendix G). Permit NV0024112 expired on December 29, 2016 and a new draft permit has yet to be issued by NDEP. Endeavour submitted a permit renewal application on June 21, 2016 which was before the required deadline of six months prior to expiration. The renewal application fee was paid via check in conjunction with the renewal application.

## 4.2 Plant Systems and Control

The components of the AGTS are managed through the Human Machine Interface (HMI). The HMI is located within a desktop PC and provides process graphics, alarms for process parameters, and trending data. Several key data points of the HMI are captured in a Microsoft Access data log system. Those data include influent and effluent flow rates, extraction well flow rates and water levels, and FBR system operational data.

## 4.3 Groundwater Extraction Systems

Groundwater containing perchlorate is extracted through a series of extraction wells as described above in Section 4.1. The primary function of the AMEWs is to extract a higher volume of perchlorate-contaminated groundwater near the former PEPCON manufacturing site area, principally groundwater from the deep water-bearing zone (Deep WBZ), thus reducing the overall duration of the remediation project. The purpose of the AREWs is to intercept groundwater containing perchlorate from the shallow water-bearing zone (Shallow WBZ), lowering the groundwater elevation broadly, before it can enter (seep into) the Athens Drainage Channel (ADC) and thereby become surface water. The other function of the AREW's is to reduce the flux of perchlorate moving in the aquifer below the ADC that moves down-gradient towards the Las Vegas Wash.

The APEW-1 and APEW-2 wells are located down-gradient of the AREWs and have therefore been used solely to remove perchlorate mass from the Shallow WBZ. APEW-3 is located furthest to the east of all the extraction wells, close to the AGTS building and screened in the shallow alluvium east of a ridge of clayey siltstone of the Muddy Creek formation. The function of APEW-3 is to provide capture of the relatively small flux of perchlorate in the Shallow WBZ east of the "Muddy Creek High."

# 5.0 Remediation and Monitoring Activities

## 5.1 Remediation Operation & Maintenance

Forward flow through the plant to the effluent line continued in the third and fourth quarters of 2017, averaging approximately 744 gpm (1.071 MGD). The effluent pipeline was pigged on a regular basis during the reporting period to maintain appropriate line pressure at the desired flow rates. The most significant issues affecting operations were two separate power outages that occurred in July and October, 2017. Further details are provided in the bullets in Section 5.1.1 below.

### 5.1.1 Maintenance and Repairs

The following list presents the notable maintenance and repair activities that occurred during the reporting period.

- On July 19, 2017 between 7:30 and 8:15 am, the plant experienced several brief power outages during a thunderstorm that included heavy rainfall. Extraction wells APEW-1 and AREW-4 lost power and operations staff were unable to get the pumps in those wells to come back on. After troubleshooting with our electrical contractor on July 21, 2017, it was discovered that the issue was likely within the PLC. The same day, our PLC consultant was able to trace the programming issue to code that needed to be fixed that allowed the power to be restored to those wells. APEW-1 and AREW-4 were back in service at around 12:30 pm on July 21, 2017.
- On October 12, 2017 at 2:00 am, the plant lost power due to an area wide outage. NV Energy was contacted as soon as operations staff arrived at the facility at approximately 2:15 am. NV Energy restored power at 2:45 am and the plant was back up and running in forward-flow mode at 3:00 am. No issues with any electrical or mechanical components were encountered after power was restored.

### 5.1.2 Plant Optimization

There was no optimization activities performed on the AGTS plant during the reporting period.

## 5.2 Groundwater and Surface Water Monitoring Procedures

Groundwater samples are collected in accordance with the SAP and Endeavour internal procedures included in SOP-02 Water and Soil Sample Collection. Samples are collected by qualified personnel on a monthly, quarterly, semi-annual and annual basis as referenced in the aforementioned documents.

Short summaries of methods used to collect samples and take field measurement readings can be found in sections 5.2.1 and 5.2.2, respectively. A brief synopsis of the major sampling events of 2H2017 in reference to location and analyte can be found below in sections 5.2.3 through 5.2.5.

### 5.2.1 Well and Surface Water Collection Procedure

Monitoring wells are purged and samples collected using a peristaltic pump, a submersible pump or bailers according to the physical constraints of the well. Surface waters are not purged and do not require pumps or specialized equipment. New, unused, pre-labeled bottles are rinsed with groundwater or surface water from the location sampled prior to collection unless a sample preservative is used. The sample is collected and the bottles are placed in individual sealed bags (to minimize possible cross contamination) and stored in a cooler with ice, blue ice or some other cooling block until they are delivered to AGTS. At the AGTS, samples are placed in a designated refrigerator to maintain sample preservation requirements, if needed. Chain of Custody (COC) forms are completed, signed and accompany samples that are shipped to a laboratory for analyses.

### 5.2.2 Procedure for Taking Field Measurements

Field measurements (parameters) consist of temperature, pH, conductivity, Oxidation-Reduction Potential (ORP) and Dissolved Oxygen (DO). These are taken at the time of sample collection subsequent to the monitoring well having been purged (not applicable for active extraction wells). Sample measurements are taken using field meters that are calibrated to NIST traceable standards, if available. Samples are collected in a cup or bottle, briefly stirred and once stabilized a reading is taken and recorded on a paper and/or tablet form. Water level readings are also taken in the field using a sounder prior to the purging of the well. The field measurement data is uploaded to an electronic spreadsheet then transferred to a data warehouse which is backed up daily.

### 5.2.3 AGTS Plant Influent and Effluent Sampling Activities

During the reporting period, samples are collected on a daily basis per the NPDES permit as well as for operational purposes. Influent samples (INF) are obtained daily at a sample port immediately before the FBR vessels with weekly composites analyzed for perchlorate. Effluent water (EFF) is also sampled daily with weekly composites analyzed for perchlorate. These samples are also analyzed monthly and quarterly under the NPDES permit for total dissolved solids (TDS), sulfide, total inorganic nitrogen (TIN), ammonia, phosphorus, major anions, and total suspended solids (TSS).

### 5.2.4 Extraction Well Area Sampling Activities

AREW and APEW samples are collected in order to analyze perchlorate mass loading from each extraction well. Groundwater drawdown levels relative to static levels are measured in order to confirm reduced infiltration into the ADC via the lowering of the groundwater below the bottom of the ADC structure. The samples are collected on a quarterly basis for electron acceptors and field measurements.

### 5.2.5 Surface Water Sampling Activities

The subsurface and surface flood channels which transect the mitigation system area are monitored monthly during the reporting period to provide additional input for the system performance assessment and mass capture calculations. They are analyzed on a monthly basis for electron acceptors per the Rev. 2 SAP. The sample locations and parameters monitored include:

- Flow rate and concentration of perchlorate in waters flowing from the EGSD entering the ADC from the southwest at Boulder Highway and Galleria Drive.
- Athens Channel North-South (ACNS) for perchlorate to provide information on loss or gain of perchlorate along the AREWs.
- Concentrations of perchlorate in the French Drain (F6) which de-waters the residential area west of Wiesner Way (South Valley Ranch Subdivision).
- Total loading of the ADC (measured at ACMain), located east of Wiesner Way downstream of where the ACNS and F6 flows merge for perchlorate concentrations and flow rate.

These surface water sample locations are shown on Figure 1.

## 5.3 Data Assimilation

Geosyntec was retained by Endeavour LLC to provide an assessment of perchlorate mass captured by the AGTS system during the reporting period. All data from the reporting period used in the assessment were provided to Geosyntec by Endeavour LLC.

The mass captured by the combined shallow and deep WBZ extraction wells was assessed as follows:

- Shallow WBZ extraction system at Athens Road/Galleria Drive area: the system is designed to cut off the flow of perchlorate-impacted groundwater that is being transported in this WBZ toward the Las Vegas Wash area and other down-gradient discharge points, and therefore perchlorate percent capture (perchlorate mass capture compared to perchlorate mass not captured) is evaluated as the metric of effectiveness, and
- Deep WBZ extraction system in the Auto Mall area: the system is designed to reduce perchlorate mass in the deep WBZ that would otherwise contribute to an upward flux of perchlorate into the adjacent shallow WBZ and therefore the area of hydraulic containment and the perchlorate mass captured by deep WBZ wells (AMEWs) are evaluated as metrics of effectiveness.

# 6.0 Performance Data, Field Measurements, and Analytical Results

## 6.1 System Performance Data

As described in Section 5.1 above, the system flow rate averaged approximately 744 gpm during the 2H2017 reporting period. The following monthly performance breakdown is based on the first and second quarter data presented in the NPDES DMRs.

| Month | Average System Flow Rate (gpm) | Average Influent $ClO_4$ Concentration (mg/L) | Average $ClO_4$ Destruction (pounds/day) | Total $ClO_4$ Destruction (pounds/month) |
|---|---|---|---|---|
| July | 741 | 131.6 | 1,170 | 36,261 |
| August | 745 | 123.2 | 1,102 | 34,168 |
| September | 745 | 123.3 | 1,103 | 33,083 |
| October | 746 | 118.7 | 1,063 | 32,940 |
| November | 745 | 120.0 | 1,073 | 32,191 |
| December | 743 | 120.0 | 1,070 | 33,180 |

Approximate total perchlorate destroyed July – December, 2017: **201,800 pounds**
Approximate total gallons treated July – December, 2017: **197,194,000 gallons**

Average monthly perchlorate concentrations and average monthly flow for each of the AREWs, APEWs, and AMEWs for the reporting period is shown on Tables 1 (a,b), 2 (a,b), and 3 (a,b) respectively. The monthly average mass removal and the cumulative mass removal by the AREW and APEW extraction wells are also depicted in graphical form in Figures 4a and 5a respectively. Figures 4b and 5b pertain to the AMEWs. These figures were prepared by Geosyntec as part of the mass capture analysis of the Athens drainage area which is presented in Section 6.4 below.

## 6.2 Groundwater and Surface Water Monitoring Results

Groundwater monitoring data including level measurements, field parameters and laboratory analytical results for the reporting period are summarized in Sections 6.2.1 through 6.2.4 below. Samples collected in the field were transported via overnight express service to American Pacific's Nevada-certified analytical laboratory in Cedar City, Utah. The full laboratory analytical data reports are provided in electronic format in Appendix H. The data presented in these sections was used by Geosyntec to create the figures used in their assessment of groundwater hydraulics and mass capture presented in Section 6.3 and in Appendix A.

### 6.2.1 Monthly Monitoring Results

Monthly electron acceptor results for AC Main, Athens Channel North-South, Eastgate Storm Drain, and F6 French Drain surface water sample points are presented in Table 4.

### 6.2.2 Quarterly Monitoring Results

Quarterly sampling results for perchlorate, chlorate and other data are presented in Table 5. These include the nine AREWs and APEWs, and 13 monitoring wells. The sample locations are shown on Figures 1 and 2.

#### 6.2.2.1 Historical Quarterly Perchlorate Results

Selected historical quarterly sampling results for perchlorate are provided for the AREWs, APEWs, and AMEWs. Selected quarterly historical perchlorate results for the AREWs and APEWs are presented in Table 6 and Figure 6, and Table 7 and Figure 7, respectively. Similar historical perchlorate results for the AMEWs are presented in Table 8 and Figure 8.

### 6.2.3 Semi-Annual Monitoring Results

Semi-annual sampling for perchlorate, chlorate and field parameters for twelve monitoring wells that are in addition to the quarterly sampling points was performed during the reporting period as required per the Rev. 2 SAP. These are commonly referred to as the semi-annual samples and are presented in Table 9.

### 6.2.4 Surface Water Monitoring Results

Surface water along the Athens Drainage Channel was sampled monthly during this period and analyzed for two electron acceptors (perchlorate and chlorate) at four locations noted on Table 4 and Figure 1 (Monthly Samples). The locations are further described above in Section 5.2.5.

Flow measurements were recorded at the AC Main and EGSD sampling locations and provided to Geosyntec for use in their assessment of groundwater hydraulics and mass capture. The results of Geosyntec's analysis are presented in Section 6.3 below and in Appendix A.

## 6.3 Groundwater Hydraulics and System Performance Assessment

Prior to 2012, the groundwater extraction system included pumping only from the Shallow Water Bearing Zone (WBZ) in the Athens Road/Galleria Drive area and treatment by in situ biodegradation. During the second half of 2012 (2H2012), there was an expansion of the extraction system to include five Deep WBZ extraction wells in the Valley Auto Mall Area and a change in the groundwater treatment system to a fluidized bed reactor system. The newer treatment system has enabled treatment of the higher loading from the Deep WBZ wells in the Auto Mall area as well as higher pumping rates from the Shallow WBZ wells in the Athens Road/Galleria Drive area.

After a period of system startup, the pumping rates began to stabilize toward the later stages of the first half of 2013 (1H2013). The remainder of 2013 was still considered a "transitional period" with varying flow rates and operational durations. Since 2014, the extraction well pumping rates have been relatively stable, with the following notes on significant and modest changes:

- APEW-1 was started on May 28, 2015. The extraction rate remained stable for a period at around 14 gpm. In 2H2015, maintenance work and adjustments of the FBR system resulted in extraction wells being turned on and off intermittently. Since 1H2016, the extraction rate remained stable at around 15 gpm. In 2H2017, the extraction rate increased to around 18 gpm.

- APEW-2 had variable flow during 2014 and 2015, including a 9.5-week shutdown in 1H2014. In December 2015, the extraction rate was increased from 12 gpm to 27 gpm. In 1H2017, the extraction rate remained stable around 29 gpm. In 2H2017, the extraction rate decreased to 26 gpm.
- In 2H2016, the extraction rate at AREW-4 increased from 9 to 16 gpm, and in 1H2017 the extraction rate remained stable at around 16 gpm. In 2H2017, the extraction rate increased to around 20 gpm.
- In 1H2017, the extraction rate at AMEW-1 increased from 250 to 275 gpm. In 2H2017, the extraction rate remained stable around 277 gpm.
- In 2H2017, the extraction rate at AMEW-2 increased from 61 to 64 gpm.
- In 2H2017, the extraction rate at AMEW-4 decreased from 39 to 32 gpm.

This section assesses the mass captured by the combined Shallow and Deep WBZ extraction wells, assessed as follows.

- Shallow WBZ extraction system at Athens Road/Galleria Drive area: the system is designed to cut off the flow of perchlorate-impacted groundwater that is being transported in this WBZ toward the Las Vegas Wash area and other down-gradient discharge points, and therefore perchlorate percent capture (perchlorate mass capture compared to perchlorate mass not captured) is evaluated as the metric of effectiveness, and

- Deep WBZ extraction system in the Auto Mall area: the system is designed to remove perchlorate mass in the Deep WBZ that would otherwise contribute to longer-term persistence of perchlorate in the Shallow WBZ and therefore the area of hydraulic containment and the perchlorate mass capture by Deep WBZ wells are evaluated as metrics of effectiveness.

For purposes of this analysis, the following definitions are used:

**Perchlorate loading** (in units of pounds per day [lbs/day]) refers to the mass of perchlorate per unit time in groundwater moving across a given cross-sectional area.

**Perchlorate mass capture** (also lbs/day) refers the mass of perchlorate per unit time that is withdrawn from the sub-surface and treated by the AGTS.

**Perchlorate percent capture** refers to perchlorate mass loading capture as a percentage of the total perchlorate loading estimated at the extraction well locations.

### 6.3.1 Approach and Methodology

#### 6.3.1.1 Calculation of Perchlorate Percent Capture in Shallow WBZ

The approach to evaluating perchlorate capture in the Shallow WBZ used the following steps:

- Delineate the capture zone(s) of the extraction wells using numerical and analytical methods;
- Quantify the perchlorate loading in:
  - o surface water in the Athens Drainage Channel (ADC) (i.e., non-captured surface water perchlorate loading);
  - o groundwater in the influent to the extraction system (i.e. perchlorate loading in extraction wells)
  - o groundwater outside of the extraction wells capture zone (i.e., non-captured groundwater perchlorate loading).
- Sum the perchlorate loading in groundwater and surface water (i.e., the total perchlorate loading);
- Divide the perchlorate loading in the extraction wells by the total perchlorate loading to quantify the perchlorate percent capture.

The details of these calculations are provided below and are based on data collected during the semi-annual sampling event performed November 2 - 19, 2017. The following sections present the quantification of the three components of perchlorate loading that are used in the perchlorate percent mass capture calculation.

<u>Perchlorate Loading in Surface Water (Not Captured)</u>

The perchlorate loading in surface water is measured monthly in the Athens Drain Channel (ADC) at a location downstream of where groundwater seeps into the ADC but upstream of where the surface water re-infiltrates to the groundwater system (see Section II of the 2007 One Year Performance and Operations Optimization Program Report). The average loading of perchlorate in the ADC from July to December 2017 was 18.1 pounds per day (lbs/day) (Figure 9). The ADC perchlorate loading data derived from field and analytical measurements on November 8, 2017 was 18.6 lbs/day, which is the value used in the mass capture calculation presented in Section 6.3.2 below.[1]

Perchlorate loading was also monitored in the Eastgate Storm Drain (EGSD) that is upgradient and connects to the ADC. The monthly perchlorate loading in the EGSD is presented in Figure 10 and the average perchlorate loading from July to December 2017 was 14.6 lbs/day.

Perchlorate loading was noted to have increased in 1H2017 compared to 2016, likely due to increasing water levels in the vicinity of the ESGD, resulting in increasing groundwater infiltration into the EGSD and increasing flow, while the perchlorate concentrations remained stable. Perchlorate loading was relatively stable in 2H2017 compared to 1H2017.

<u>Perchlorate Loading in Shallow Groundwater Captured by the AGTS</u>

The groundwater volumetric flow rate and perchlorate loading captured by the extraction system are based on directly measurable quantities of flow and concentration. The approximate perchlorate mass capture rates for the shallow extraction wells operating when the site-wide

[1] The perchlorate loading at ADC Main measured in November, 2016 coincides with the monitoring and sampling event (November 2 – 19, 2017) that is used for estimating perchlorate loading in groundwater and perchlorate mass capture by the extraction system.

perchlorate groundwater samples were collected November 2 - 19, 2017, are presented in the following table (see Figure 1 for shallow extraction well locations).

| Well | Average Operating Rate for 2H2017 Measurement Period (gpm) | Average Perchlorate Concentration for 2H2017 Measurement Period (mg/L) | Average Perchlorate Mass Removal Rate for 2H2017 Measurement Period (lbs/day) |
|---|---|---|---|
| APEW-1 | 18 | 0.5 | 0.1 |
| APEW-2 | 26 | 10 | 3.0 |
| APEW-3 | 8 | 10 | 0.9 |
| AREW-1 | 12 | 0.58 | 0.1 |
| AREW-2 | 36 | 1.0 | 0.4 |
| AREW-3 | 24 | 0.74 | 0.2 |
| AREW-4 | 20 | 2.3 | 0.6 |
| AREW-5 | 103 | 11 | 13.6 |
| AREW-6 | 24 | 51 | 14.7 |
| **Total** | **271** | - | **33.6** |

During this period, the total mass removal rate by the Athens Road/Galleria Drive Extraction Wells was approximately 34 lbs/day of perchlorate. The approximate mass removal rates and cumulative mass removed for all of the individual extraction wells operating intermittently from initial pumping in October 2012 to December 31, 2017 are presented in Figures 4a and 5a, respectively.

Perchlorate Loading in Shallow Groundwater Not Captured by the AGTS

The perchlorate loading in groundwater that is not captured by the extraction system cannot be estimated based on directly measured quantities, but rather requires analysis of interpreted subsurface data. The loading in non-captured groundwater was estimated by establishing the capture zone of the Athens Road/Galleria Drive Extraction Wells and estimating the perchlorate loading in groundwater outside of this zone. The evaluation included the following steps:

- Estimation of the capture zone(s) of the extraction system following the multiple lines of evidence approach described in USEPA, 2008[2]
  - Use of the program KT3D-H2O[3] to create a potentiometric surface using linear-log kriging methodology, and calculate capture zones around extraction wells using particle tracking methodology (numerical method); and calculation of capture zones around extraction wells using particle tracking methodology.

[2] U.S. EPA, 2008. A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems – Final Project Report, Office of Research and Development. EPA 600/R-08/003. January. http:/www.epa.gov/ord."

[3] http://www.sspa.com/software/kt3d_h2o.html; Karanovic, M., Tonkin, M., and Wilson, D., 2009. KT3D_H2O: A Program for Kriging Water Level Data using Hydrologic Drift Terms. *Ground Water*, Vol. 47, No. 4, pp. 580-586.

- o Export of a raster surface representing the interpolated potentiometric surface and vector datasets representing the equipotential contours on a 5-foot elevation interval, and calculated capture zones.
- o Use of the equations detailed in Javandel and Tsang[4] to estimate the width of hydraulic capture achieved by each extraction well or extraction well series based on groundwater hydraulics analysis and using input parameters consistent with the current Endeavour numerical groundwater flow model.

- Estimate of perchlorate loading outside of the capture zone:

  - o Use of the potentiometric surface map to develop a map of hydraulic gradients and convert gradients to groundwater volumetric flow rates by multiplying by aquifer transmissivity.
  - o Generation of a map of perchlorate loading in groundwater by multiplying groundwater volumetric flow by the perchlorate concentration at each node of a grid that encompasses the region.
  - o Overlay of the delineated capture zones from the numerical model to determine the perchlorate loading outside of the capture zone (the numerical method).

The above steps were accomplished by using a fixed grid for each of the mapped features (e.g. potentiometric head, transmissivity, gradient, etc.) such that the appropriate arithmetic operations could be applied to each cell of the grid. The specific procedures for accomplishing the above steps are described below.

Figure 11 shows the Shallow WBZ potentiometric surfaces generated by the KT3D-H2O software using data from Shallow WBZ monitoring wells and extraction well pumping rates during the measurement period. Contours were modified using professional judgment to better represent hydraulic interaction with the ADC and the presence of the “Muddy Creek High” zone.

Capture zones associated with the operating Athens Road Extraction Wells calculated using the numerical method are presented on Figure 11 as well as on Figure 13 (see discussion below). Figure 11 shows the particle tracks generated by the KT3D-H2O software from the Shallow WBZ potentiometric surfaces. KT3D-H2O is a simplified analytical approach; therefore the lack of flow in the “Muddy Creek High” zone cannot be included in the evaluation using KT3D-H2O, which explains the apparent “gap” observed in the particle tracks showed in Figure 11. Additional refinements of the current groundwater flow model were performed by Geosyntec to better represent the groundwater flow in the shallow zone and the interaction with the Las Vegas Wash. Based on this refined model, the groundwater in the apparent “gap” flows very slowly towards the north.[5]

Capture zone widths (in feet) associated with each operating extraction well were calculated using the two methods shown below.

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[4] Javandel, I. and C.F. Tsang, 1986. Capture-Zone Type Curves: A Tool for Aquifer Cleanup, Ground Water, Vol. 24, No. 5, pp. 616-625.

[5] Geosyntec, 2017. Shallow Zone Capture Assessment – Revision 1, Endeavour, Henderson, NV, dated 23 March 2017 and sent to NDEP in an email dated 30 March 2017.

| Extraction Well | Operating Rate (gpm) | KT3D-H2O Method Capture Zone Width (ft.) Measured at 1,625 ft. msl | KT3D-H2O Method Capture Zone Width (ft.) Measured at 1,645 ft msl | Analytical Method Maximum Upgradient Capture Zone Width (ft) |
|---|---|---|---|---|
| APEW-3 | 8 | 45 | 45 | 80 |
| APEW-1 | 18 | 2,300 | 3,500 | 90 |
| APEW-2 | 26 | | | 130 |
| AREW-1 | 12 | | | 570 |
| AREW-2 | 36 | | | 1,730 |
| AREW-3 | 24 | | | 120 |
| AREW-4 | 20 | | | 100 |
| AREW-5 | 103 | | | 500 |
| AREW-6 | 24 | | | 120 |
| **Total** | **271** | **2,345** | **3,545** | **3,440** |

Figure 12 presents a map of perchlorate concentrations in the extraction area in the Shallow WBZ during the 2H2017 period.

Figure 13 presents a map of perchlorate loading per unit width in the shallow groundwater north of Warm Springs Road. Perchlorate loading in groundwater is a function of the chemical concentration and the volumetric flow rate of the water in which it is dissolved. Perchlorate loading in shallow groundwater that is not captured by the extraction wells is calculated by adding up the perchlorate loading linearly along equipotentials that are outside of the capture zones. In order to accomplish this, Figure 13 was generated by performing the following calculations, with each [parameter] shown in brackets representing a map of parameter values on a grid spacing of 10 feet by 10 feet.

1) [Saturated thickness (ft)] = [Potentiometric surface (ft)] – [Top of Middle WBZ formation (ft)]

2) [Transmissivity (ft$^2$/day)] = [Saturated thickness (ft)] * [Hydraulic conductivity (ft/day)]

3) [Volumetric flow/width (ft$^3$/day/ft)] = [Transmissivity (ft$^2$/day)]*[Gradient (ft/ft)]

4) [Loading/width (lbs/day/ft)] = [Volumetric flow/width (ft$^3$/day/ft)]*[Concentration (mg/L)]*CF

Where,

$CF = (2.2 \times 10^{-6}\ lbs/mg)*(28.3\ L/ft^3) = 6.2 \times 10^{-5}\ lbs*L/mg/ft^3$

Top of Middle WBZ and Hydraulic conductivity distribution are obtained from the calibrated current Endeavour numerical groundwater flow model.[6]

And the gridded parameter values are presented in the following figures,

[Potentiometric surface (ft)] - Figure 11

[Concentration (µg/L)] – Figure 12

[Loading/width (lbs/day/ft)] - Figure 13

The gradient term was calculated at each cell in the grid using a slope analysis.

The perchlorate loading per unit width map for the Shallow WBZ (Figure 13) is presented in units of lbs/day/ft since the values represent loading per width perpendicular to flow. Therefore, a value of perchlorate loading in units of lbs/day can be generated by establishing a cross-sectional width along any potentiometric contour and multiplying the cross-sectional width by the average value in lbs/day/ft (equivalent to integrating the loading term along the line of section). The cross-section locations used for this calculation where chosen to be the 1,625 and 1,645 ft mean sea level [msl] potentiometric contours, as shown on Figure 13.

The range in perchlorate loading not captured in shallow groundwater using these methods are shown in Section 6.3.2. Very few changes have been observed in the estimated perchlorate loading per unit width map north of the Shallow extraction system. The perchlorate mass located in this area in the Shallow WBZ is estimated in Section 6.3.2. Additional refinements of the current groundwater flow model were performed by Geosyntec to better represent the groundwater flow in the shallow zone and the interaction with the Las Vegas Wash. Based on this refined model, and assessment of groundwater flow in the shallow zone north of the extraction system, additional evaluation of this area is pending publication of the NERT Downgradient Investigation Study.[7]

#### 6.3.1.2 Calculation of Perchlorate Mass Capture and Hydraulic Containment in Deep WBZ

The approach to evaluating perchlorate mass capture in the Deep WBZ depends on whether the evaluation coincides with an annual or semi-annual monitoring period. The complete set of Deep WBZ wells used to estimate the extent of the perchlorate groundwater concentration contours is sampled on an annual basis. The approaches to evaluating perchlorate mass capture in the Deep WBZ for both the annual and semi-annual sampling reporting periods are described herein using the following steps:

[6] Geosyntec, 2016. Groundwater Flow Model Update Henderson, Nevada. 13 September 2016.
[7] Geosyntec, 2017. Shallow Zone Capture Assessment – Revision 1, Endeavour, Henderson, NV, dated 23 March 2017 and sent to NDEP in an email dated 30 March 2017.

- Quantify the perchlorate mass capture in groundwater in the influent to the extraction system (i.e. perchlorate loading in extraction wells);
- Delineate the capture zone(s) of the extraction wells using the numerical method (as above); and
- Quantify the total mass of perchlorate in the Deep WBZ within the 700 parts per billion (ppb) contour (completed for annual reporting period only).

As this section presents the data from a semi-annual reporting period (2H2017), the total mass of perchlorate in the Deep WBZ within the 700 ppb contour is not calculated. The details of the calculations that were completed are provided below and are based on data collected during the site-wide water level survey performed November 2 - 19, 2017.

The following sections present the quantification of the perchlorate loading used in the perchlorate mass capture calculation.

<u>Perchlorate Loading in Deep Groundwater Captured by the AGTS</u>

The groundwater volumetric flow rate and perchlorate loading captured by the extraction system are based on directly measurable quantities of flow and concentration. The approximate perchlorate mass capture rates for the deep zone extraction wells operating when the site-wide perchlorate groundwater samples were collected (November 2 – 19, 2017) were calculated and are presented in the following table (see Figure 14 for deep extraction well (AMEW) locations).

| **Well** | **Average Operating Rate for 2H2017 Measurement Period (gpm)** | **Average Perchlorate Concentration for 2H2017 Measurement Period (mg/L)** | **Average Perchlorate Mass Removal Rate for 2H2017 Measurement Period (lbs/day)** |
|---|---|---|---|
| AMEW-1 | 277 | 200 | 670 |
| AMEW-2 | 64 | 240 | 180 |
| AMEW-3 | 50 | 130 | 78 |
| AMEW-4 | 33 | 85 | 34 |
| AMEW-5 | 46 | 90 | 50 |
| **Total** | **470** | **-** | **1,012** |

During this period, the total perchlorate mass removal rate by the Auto Mall Extraction Wells (Deep WBZ) when all wells were operational was approximately 1,012 lbs/day. The approximate daily mass removal rates and cumulative mass removed for all of the individual extraction wells operating intermittently from initial pumping in October, 2012 to December 31, 2017 are presented in Figures 4b and 5b, respectively. The total extraction rate by the Auto Mall Extraction Wells has increased from 358 gpm (1H2014) to 452 gpm (2H2016) to 471 gpm (1H2017) and remained stable at 470 gpm in 2H2017. The total perchlorate mass capture is slightly lower in 2H17 due to lower influent perchlorate concentrations while the extraction rates remained the same as 1H2017 (Section 6.3.3). Given the higher flow rates and perchlorate concentrations when compared with the Shallow WBZ extraction wells, these Deep WBZ extraction wells provide the bulk of the perchlorate mass treated in the FBR-based AGTS.

Hydraulic Containment of Perchlorate in Deep Groundwater by the AGTS

Figure 14 shows a map of the potentiometric surface generated by the current Endeavour numerical groundwater flow model using data from Deep WBZ monitoring wells and extraction well pumping rates during the measurement period. Capture zones associated with the operating AMEWs were calculated using the numerical groundwater flow model.

Capture zone widths (in feet) associated with each operating extraction well were assessed using the numerical groundwater flow model and are shown below.

<table>
<tr><th>Extraction Well</th><th>Operating Rate (gpm)</th><th>Capture Width (ft) Measured at 1,815 ft msl equipotential</th><th>Capture Width (ft) Measured at 1,830 ft msl equipotential</th></tr>
<tr><td>AMEW-1</td><td>277</td><td rowspan="5">5,175</td><td rowspan="5">5,000</td></tr>
<tr><td>AMEW-2</td><td>64</td></tr>
<tr><td>AMEW-3</td><td>50</td></tr>
<tr><td>AMEW-4</td><td>33</td></tr>
<tr><td>AMEW-5</td><td>46</td></tr>
<tr><td>Total</td><td>470</td><td>5,175</td><td>5,000</td></tr>
</table>

The calculated capture zones are similar to those previously estimated in 1H2017, reflecting the stabilization of the extraction rates in 2017.

### 6.3.2 Perchlorate Mass Capture and Removal

#### 6.3.2.1 Shallow WBZ Perchlorate Capture and Removal

The components of Shallow WBZ perchlorate loading described above can be combined to estimate the percentage of perchlorate mass captured by the shallow extraction system in 2H2017. The table below summarizes the perchlorate loading components, with cumulative ranges between the two equipotential measuring points (1,625 and 1,645 ft msl) used in the numerical calculations:

| Perchlorate Loading | Groundwater | Surface Water (ADC) | Total |
|---|---|---|---|
| Captured (lbs/day) | 34 | 0 | 34 |
| Not Captured (lbs/day) | 3 – 5 | 18.6 | 21.6 – 23.6 |
| Total (lbs/day) | 37 – 39 | 18.6 | 55.6 – 57.6 |
| Fraction of Loading Captured (%) | 87 – 92 | 0 | 59 – 61 |

Thus, the total perchlorate loading captured as a function of the total loading in groundwater is in the range of 90%. The total loading captured (i.e., groundwater and surface water) is in the range of 60%.

An estimate of the total perchlorate mass in the Shallow WBZ within the 700 ppb contour was calculated based on the perchlorate contours (Figure 12**)** and an estimate of the Shallow WBZ thickness (20 ft) and of the porosity range (0.10 – 0.25). The mass within the 700 ppb contour was calculated as the product of:

- the volume of the Shallow WBZ between each contour and the next greater contour; and
- the geometric mean of the measured concentrations above 100,000 ppb for the mass within the 100,000 contour; or
- the concentration at half of the logarithmic scale between the two delineating contours for the lesser contours.

The calculated perchlorate masses are presented below:

| **Shallow WBZ Contour (ppb)** | **Perchlorate Concentration (ppb)** | **Area (square feet)** | **Mass within contour (lbs)** Effective Porosity 0.1 | 0.25 |
|---|---|---|---|---|
| 700 | 837 | 11,580,000 | 1,200 | 3,000 |
| 1,000 | 3,160 | 16,879,000 | 6,700 | 16,600 |
| 10,000 | 31,600 | 37,049,000 | 146,200 | 365,400 |
| 100,000 | 110,000 | 1,822,000 | 25,000 | 62,600 |
| **TOTAL** | | **67,330,000** | **179,100** | **447,600** |

The mass estimate in the Shallow WBZ decreased slightly compared to 1H2017, due to reshaping of the 10,000 and 1,000 contours around extraction well APEW-3.

In addition, an estimate of the perchlorate mass in the Shallow WBZ in the area located north of the shallow extraction system was calculated using the method outlined above. The mass in this area was estimated to be between 10,000 and 25,200 lbs, for effective porosities of 0.1 and 0.25 respectively. This mass corresponds to approximately 6 percent of the total mass estimate in the Shallow WBZ. The shallow zone plume north of the extraction system has been stable over time, as documented in the semi-annual monitoring reports, but increasing perchlorate concentrations have previously been observed at monitoring well MW-S. The perchlorate concentration stabilized at monitoring well MW-S in 1H2017 (see Figure 21). This well is sampled on an annual basis and therefore was not sampled during the 2H2017 semi-annual reporting period. Additional evaluation of the concentration trend at this well will be performed in future monitoring events.

#### 6.3.2.2 Deep WBZ Perchlorate Capture and Removal

As in the past, an estimate of the total perchlorate mass in the Deep WBZ within the 700 ppb contour will be calculated in the next annual report when the complete suite of perchlorate analyses (i.e., all annually sampled wells) is available.

The perchlorate capture rate from the Deep WBZ was approximately 1,012 lbs/day.

A summary of Shallow and Deep WBZ mass capture for 2H2017 is presented below:

| Zone | Total Extraction Well Flow Rate (gpm) | Total Perchlorate Mass Removal Rate (lbs/day) |
|---|---|---|
| Shallow WBZ | 271 | 34 |
| Deep WBZ | 470 | 1,012 |
| **Total** | **741** | **1,046** |

As a result of adding the Deep WBZ extraction wells and installing the FBR system, the total flux of groundwater extracted and treated has increased from approximately 150 gpm (2H2011), when only the Shallow WBZ wells were operating) to almost 750 gpm (an increase by a factor of almost 5 since 2H2011). The total mass captured and treated has increased from about 36 lbs/day to over 1,000 lbs/day (an increase by a factor of over 30 since 2H2011).

The mass removed by the Deep WBZ extraction wells decreased from approximately 1,600 lbs/day in 1H2013 to approximately 1,012 lbs/day in 2H2017, while the extraction rates increased from 360 to 470 gpm in the same period. The decrease in mass removal is due to decreasing influent concentrations at the extraction wells (AMEW-1, AMEW-2 and AMEW-4 in Figure 28), reflecting the decreasing perchlorate mass in the Deep WBZ. The total extraction rates remained stable in 2H2017 compared to 1H2017, while the influent concentrations have decreased. It is anticipated that this trend will continue as perchlorate mass decreases in the Deep WBZ. This metric will continue to be tracked in the following monitoring periods to assess the trend.

The uncertainties associated with the method for mass capture and perchlorate loading estimate include the following:

a. These methods rely on interpolation of concentration and water levels, and the interpolated values can be expected to have decreased confidence with distance from measurement points;

b. The hydraulic gradient is calculated at each cell in the grid, so sharp changes in equipotential direction might yield erroneous gradients in certain cells; and

c. These methods assume the hydraulic conductivities assigned to each conductivity zone are constant across those zones, when in fact they may vary.

The uncertainties associated with the methods for mass estimate include the following:

a. These methods rely on interpolation of concentration and the interpolated values can be expected to have decreased confidence with distance from measurement points; and
b. The mass estimate is based on an estimated value for porosity in the Shallow WBZ.

### 6.3.3 Remediation Tracking

Remediation tracking was conducted for the Shallow WBZ as outlined in the Work Plan for Demonstration of Groundwater Capture. Remediation tracking metrics for the Deep WBZ are calculated annually (corresponding with the greater number of wells sampled on an annual basis), and are included in the table below. Several metrics are used to track the progress of the AGTS. Many of these metrics will need to be refined following more months of consistent operation. They are stated here as a basis for future comparisons.

The estimation of the concentration at which 90% and 99% capture is achieved is limited to the precision at which concentration contours can be reasonably drawn on the available data.

| Metric | Metric Value | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2H17** | **1H17** | **2H16** | **1H16** | **2H15** | **1H15** | **2H14** | **1H14** | **2H13** | **1H13** | **2H12** |
| **Shallow Water Bearing Zone** | | | | | | | | | | | |
| Total mass of perchlorate within 700 ppb contour (lbs) | 179,100 - 447,600 | 183,000 - 460,000 | 175,000 - 440,000 | 175,000 - 440,000 | 200,000 - 505,000 | 200,000 - 510,000 | 210,000 - 510,000 | 210,000 - 510,000 | 210,000 - 510,000 | 210,000 - 500,000 | 210,000 - 530,000 |
| Estimated Concentration at which 90% capture is achieved (Shallow WBZ) (ppb) | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | n/a |
| Estimated Concentration at which 99% capture is achieved (Shallow WBZ) (ppb) | >700 | >700 | >700 | >700 | >700 | >700 | >700 | >700 | >700 | >700 | n/a |
| Estimated Coordinates of the Centroid* of the Perchlorate Contours (Shallow WBZ) 700 ppb contour | E 823,225 N 26,723,676 | E 823,230 N 26,723,710 | E 823,200 N 26,723,700 | E 823,200 N 26,723,700 | E 823,100 N 26,723,700 | E 823,100 N 26,723,700 | E 822,900 N 26,723,600 | E 822,900 N 26,723,600 | E 822,900 N 26,723,700 | E 822,900 N 26,723,700 | E 820,700 N 26,718,400 |
| Estimated Coordinates of the Centroid* of the Perchlorate Contours (Shallow WBZ) 1,000 ppb contour | E 823,348 N 26,723,409 | E 823,380 N 26,723,650 | E 823,300 N 26,723,700 | E 823,300 N 26,723,700 | E 823,300 N 26,723,600 | E 823,300 N 26,723,600 | E 823,000 N 26,723,600 | E 823,000 N 26,723,600 | E 823,000 N 26,723,700 | E 823,000 N 26,723,600 | E 823,000 N 26,723,000 |
| Estimated Coordinates of the centroid* of the Perchlorate Contours (Shallow WBZ) 10,000 ppb contour | E 823,186 N 26,723,035 | E 823,310 N 26,723,200 | E 823,300 N 26,723,700 | E 823,300 N 26,723,300 | E 823,300 N 26,723,200 | E 823,300 N 26,723,300 | E 823,200 N 26,723,100 | E 823,200 N 26,723,100 | E 823,200 N 26,723,000 | E 823,100 N 26,722,900 | E 823,100 N 26,722,600 |
| Estimated Coordinates of the Centroid* of the Perchlorate Contours (Shallow WBZ) 100,000 ppb contour | E 819,960 N 26,717,906 | E 819,950 N 26,717,910 | E 820,000 N 26,717,900 | E 820,000 N 26,717,900 | E 820,100 N 26,718,200 | E 820,100 N 26,718,200 | E 820,300 N 26,718,200 | E 820,300 N 26,718,300 | E 820,300 N 26,718,300 | E 820,300 N 26,718,300 | E 823,100 N 26,722,300 |
| Average Daily Perchlorate Capture Rate (lbs/day) (Shallow WBZ) | 34 | 36 | 38 | 38 | 38 | 41 | 42 | 50 | 60 | 62 | 36 |
| Estimated Perchlorate Loading Not Captured by AGTS at Athens/Galleria Extraction Area (lbs/day) | 22 - 24 | 23 - 24 | 16 - 17 | 13 - 15 | 13 - 14 | 20 - 21 | 9 - 10 | 18 - 19 | 10 - 12 | 17 - 18 | n/a |
| **Deep Water Bearing Zone** | | | | | | | | | | | |
| Total mass of perchlorate within 700 ppb contour (lbs) | n/a | 430,000 - 1,070,000 | n/a | 460,000 - 1,160,000 | n/a | 430,000 - 1,080,000 | n/a | 500,000 - 1,240,000 | n/a | 670,000 - 1,670,000 | 830,000 - 2,090,000 |
| Rounded Average Daily Perchlorate Capture Rate (lbs/day) (Deep WBZ) | 1,000 | 1,100 | 1,100 | 1,100 | 1,200 | 1,200 | 1,200 | 1,200 | 1,400 | 1,600 | n/a |

* Centroid coordinates based on Nevada State Plane NAD83 South System, Feet

### 6.4 Monitoring Well Trend Analysis

Figures 15 through 30 show historical perchlorate and groundwater elevation trends in select wells within each of the shallow, middle, and deep WBZs. Figures 15 through 24 show shallow WBZ wells, Figures 25 through 27 are middle WBZ, and Figures 28 through 30 are deep WBZ. Some noteworthy observations of the trends in each of the WBZs as depicted in these figures are discussed in the paragraphs below.

Deep WBZ

As discussed in previous reports, the following wells indicate a continued decreasing perchlorate concentration trend as these were sampled during the 2H2017 semi-annual reporting period: monitoring wells AMOW-3-165 and DX-161 located in the Auto Mall South Area (Figure 28), monitoring wells MW-D2D and MW-C located in the Auto Mall East Area (Figure 29). These decreasing trends are consistent with the significant mass removal, over 1,000 lbs/day, achieved with the AMEWs and the estimated mass decrease in the Deep WBZ.

Data for extraction wells AMEW-1, AMEW-2 and AMEW-4 (Figure 28) also present a decreasing perchlorate concentration trend, following the initial increase observed after start-up in late 2012, while extraction wells AMEW-3 and AMEW-5 (Figure 28) present a stable perchlorate concentration trend, following the initial increase observed after start-up.

There was an increase in perchlorate concentrations during the 2H2017 reporting period in two wells that typically show a decreasing or stable perchlorate concentration trend: monitoring wells DY-169 and ADX-156 located in the Auto Mall South Area (Figure 28). These monitoring wells are located close to extraction wells AMEW-2 and AMEW-4, respectively, and the increase in perchlorate concentrations is likely related to the change in flow field and perchlorate distribution in the vicinity of the extraction well.

Monitoring wells AK-204, AMX-166, ADYX-165, and AFX-195 located in the Auto Mall West Area (Figure 30) presented an increase in perchlorate concentrations in 1H2017. These wells are sampled on an annual basis and therefore additional data will be necessary to re-assess the perchlorate concentration trend at these locations. Monitoring well MW-AX-72 (located in the Auto Mall East Area, Figure 29) presents an increasing trend between 2005 and 2012, a more significant increasing trend following startup of the AMEWs between 2012 and 2015, and a decreasing trend starting in 2015. This well is sampled on an annual basis and therefore additional data will be necessary to confirm the decreasing perchlorate concentration trend at that location.

Monitoring well AEX-166 (located in the Auto Mall South Area, Figure 28) presents an increasing trend between 2005 and 2012, a decreasing trend following startup of the nearby AMEWs between 2012 and 2015, an increasing trend starting in 2015, and concentration fluctuations in 2017. Well AEX-166 is located in the vicinity of extraction well AMEW-5 with perchlorate concentrations around 100,000 µg/L, and the perchlorate concentration fluctuations at AEX-166 are likely related to the change in flow field and perchlorate distribution in the vicinity of the extraction well.

Monitoring well DX-350 (located in the Auto Mall East Area, Figure 29) presents a fluctuating perchlorate concentration trend. This trend is most probably related to the change in flow field and perchlorate distribution, following start-up of the Deep extraction system. Well DX-350 is located in the vicinity of extraction well AMEW-1 with perchlorate concentrations around 220,000 µg/L. AMEW-1 is screened to 235 feet below ground surface (bgs), while DX-350 is screened between 350 and 370 feet bgs. Prior to start-up of AMEW-1, DX-350 perchlorate concentrations increased from approximately 400 µg/L in 2005 to 3,000 µg/L in 2012 and since startup, the perchlorate concentrations have fluctuated between 1,300 and 3,000 µg/L, but there has not been an increase in concentration relative to that observed prior to start-up. This well is sampled on an annual basis and the perchlorate concentration in 1H2017 (1,900 µg/L) confirmed the concentration fluctuations at that location, due to the proximity of the extraction well AMEW-1.

All monitoring wells located in Auto Mall West Area (Figure 30) present perchlorate concentrations below 100 micrograms per liter (µg/L), except AFX-148, which was right at 100 µg/L during 1H2017 monitoring event, and AFX-195, which had increasing perchlorate concentrations from 4 µg/L in 1H2014 to 260 µg/L in 1H2017. Well AFX-195 is located at the eastern edge of the perchlorate Deep WBZ where there are likely significant spatial variations in perchlorate concentrations. These wells are sampled on an annual basis and therefore were not sampled during the 2H2017 semi-annual reporting period. The graphs for these wells will be updated for the next reporting period.

Middle WBZ

The effect of the operating AMEWs on the groundwater elevations is significant in monitoring wells DX-75, ADX-112, DX-121, located in Auto Mall South Area (Figure 25) and AMX-98, AGX-160, DY-106, and AK-86 located in Auto Mall East Area (Figure 26).

All monitoring wells located in Auto Mall West Area (Figure 30) present perchlorate concentrations below 100 µg/L, except AFX-148, which was as noted above, right at 100 µg/L during 1H2017 monitoring event, and AFX-195, which had increasing perchlorate concentrations from 4 µg/L in 1H2014 to 260 µg/L in 1H2017. Well AFX-195 is located at the eastern edge of the perchlorate Deep WBZ where there are likely significant spatial variations in perchlorate concentrations. These wells are sampled on an annual basis and therefore were not sampled during the 2H2017 semi-annual reporting period. The graphs for these wells will be updated for the next reporting period.

Shallow WBZ

South of Warm Springs Road, several shallow monitoring wells listed below show a decreasing perchlorate concentration trend or changed from an increasing trend to a stable trend, likely in response to start-up of the AMEWs in late 2012 and the intended reduction in perchlorate mass flux from the deep to the shallow WBZ. MW-AD and AEX-35 were sampled during the 2H2017 period and their trend graph has been updated accordingly, while the other monitoring wells are sampled on an annual basis and their trend graphs will be updated in the next monitoring report.

- Monitoring well MW-AD, MW-D2S (this well is monitored on an annual basis and was dry in 1H2017), DX-24 and DZ-15, located in Auto Mall East Area (Figure 15),
- MW-AHX and AK-25, and AEX-35 located in Auto Mall East Area (Figure 16), and
- ACY-15 and ZX-11, located in Warm Springs/Eastgate Area (Figure 17).

In contrast, AGX-50 and AMOW-3-52 located in the Auto Mall West Area (Figure 16) show an increasing perchlorate concentration trend. AGX-50 shows a decreasing trend starting in 2015, while AMOW-3-52 shows a stabilization of perchlorate concentration since 2014. These wells are sampled on an annual basis and therefore were not sampled during the 2H2017 semi-annual reporting period. Their graphs will be updated for the next reporting period.

In the vicinity of the AREWs/APEWs (shallow groundwater extraction system), the monitoring wells showed a decreasing trend in groundwater elevations which coincides with the gradual increase in drawdown effects and reduction in flow from the extraction wells. The following wells show a decreasing perchlorate trend since the start-up of the AREWs/APEWs in 2006-2007.

- Monitoring wells NX-17, NY-15, OX-16, and OY-8, located in Boulder/Galleria Area (Figure 20),
- TWE-33 located in AGTS Area (Figure 21), and
- AAX-15, APX-2-P101, APX-7-14, MW-AA, and SBMW-4-4, located in the Wiesner/Sam Boyd Area (Figure 22).

In contrast, monitoring wells MW-S, APX-4-20, and MW-K1 located in the AGTS Plant Area (Figure 21), present an increasing perchlorate concentration trend. Potential causes for the increased trend in perchlorate concentration at the monitoring wells:

- MW-K1 is located close to the eastern edge of the perchlorate impacted groundwater. The Nevada Environmental Response Trust (NERT) Athens Road Well Field is located northeast of MW-K1 and the Shallow WBZ potentiometric surface in this area suggests that the NERT well field might cause an easterly shift in the direction of groundwater flow in this area. Because of the presence of higher concentrations on the west side of MW-K1, a slight change of the groundwater flow field to a more easterly direction will result in increasing perchlorate concentrations at MW-K1.
- APX-4-20 is located in the vicinity of the Muddy Creek High, between extraction wells APEW-2 and APEW-3. The perchlorate concentrations at APX-4-20 have been increasing since 2007 and the startup of the AREWs/APEWs in that timeframe. These increasing concentrations are likely the result of perchlorate leaching from the low permeability Muddy Creek High. The concentrations at the other monitoring wells located in the vicinity of APX-4-20 (APX-5-7, which has been increasing between 2007 and 2012 but stable since 2012, and APX-5-16 in Figure 21 and APX-2-45 in Figure 22) have been stable.

- MW-S is located north of the AREWs/APEWs. The perchlorate concentrations at MW-S increased between 1997 and 2006 and have been increasing again since 2013. These increasing concentrations are likely indicating that higher than expected perchlorate mass was present north of the AREWs/APEWs. The perchlorate concentrations stabilized between 1H2016 and 1H2017, and additional data will be necessary to confirm this stabilization in perchlorate concentration at that location.

# 7.0 Summary and Conclusions

Forward flow through the plant to the effluent line continued in 2H2017 averaging approximately 744 gpm (1.071 MGD). Interruption of operations were minimal as the plant was down for less than an hour on two separate occasions during unplanned power outages in July and October, 2017.

Compliance with permit and regulatory action limits was achieved in samples collected during the reporting period. The optimized FBR-based system continued to perform well on a perchlorate mass reduction basis. The total mass of perchlorate destroyed during 2H2017 was approximately 201,800 pounds and the total amount of water treated was approximately 197,194,000 gallons.

In looking at perchlorate concentration trends in Figures 15 – 30, several monitoring and extraction wells in the deep WBZ showed a continued decreasing perchlorate concentration trend during the 2H2017. In the shallow WBZ several wells show a decreasing perchlorate concentration trend or changed from an increasing trend to a stable trend, likely in response to start-up of the AMEWs and the intended reduction in perchlorate mass flux from the deep to the shallow WBZ. A couple of wells, however, show an increasing trend. Most of the wells shown on Figures 15 - 30 are sampled in the annual event in April-May and therefore those graphs will have more updated data in the next reporting period.

The results of Geosyntec's performance analysis and mass capture calculations for the 2H2017 reporting period showed that the total perchlorate loading captured in the shallow water bearing zone (Athens/Galleria area) as a function of the total loading in that groundwater was in the range of 87% to 92% and the total loading captured (groundwater and surface water) was in the range of 59% to 61%. The average loading of perchlorate in the Athens Drainage Channel (ADC) from July to December 2017 was 18.1 lbs/day. The perchlorate captured from the deep water bearing zone was calculated to be approximately 1,012 lbs/day when all AMEWs were operating during the semi-annual sampling event November 2 – 19, 2017.

# 8.0 Plan and Recommendations

Endeavour LLC will continue operation of the FBR perchlorate treatment system 24 hours per day, 7 days per week. The first stage FBRs have shown steady performance during the 2H2017 reporting period. Bioassays will continue to be conducted on the FBR biomass/media on a regular basis in the foreseeable future to monitor performance. Also, communication and information exchanges with Dr. John Coates of UC Berkeley will continue.

Drawdown effects of the AMEWs will continue to be observed and hydraulic balancing in the FBRs will be appropriately managed with any increase in flow. Additional optimization measures, including potential alternatives for surface water capture, will be explored for the entire system during the next reporting period. Monitoring and evaluation of the perchlorate loading in the ADC will continue on a monthly basis.

## 9.0 Limitations

The conclusions and recommendations presented herein are based on analytical data, field measurements, survey data and results of previous environmental assessment and/or treatment activities. The results reported herein are applicable to the time the sampling occurred. Changes in site conditions may occur as a result of rainfall, snowmelt, water usage, or other factors. Endeavour LLC exercised due diligence in selecting consultants and laboratories.

This report is not a legal opinion. The tasks performed by and for Endeavour LLC have been conducted in a manner consistent with the level of care ordinarily exercised by members of the environmental profession currently practicing under similar conditions.

The use of the word "certify" in this document constitutes an expression of professional opinion regarding those facts or findings which are the subject of the certification and does not constitute a warranty or guarantee, either expressed or implied.

| Table 1a - Athens Road Extraction Wells (AREW) Average Monthly Perchlorate (mg/L) | | | | | | |
|---|---|---|---|---|---|---|
| **Date** | **AREW-1** | **AREW-2** | **AREW-3** | **AREW-4** | **AREW-5** | **AREW-6** |
| January 2013 | 0.8 | 2.1 | 2.5 | 9.3 | 21 | 43 |
| February 2013 | 0.9 | 2.0 | 1.5 | 7.3 | 19 | 52 |
| March 2013 | 1.7 | 1.8 | 1.6 | 5.5 | 21 | 63 |
| April 2013 | 0.9 | 1.2 | 1.4 | 5.1 | 21 | 45 |
| May 2013 | 1.1 | 1.4 | 1.8 | 7.3 | 20 | 50 |
| June 2013 | 1.2 | 1.5 | 2.0 | 8.1 | 23 | 54 |
| July 2013 | 1.5 | 2.0 | 1.7 | 7.1 | 21 | 47 |
| August 2013 | 1.1 | 1.4 | 2.0 | 10.0 | 22 | 50 |
| September 2013 | 1.0 | 1.3 | 1.8 | 6.3 | 18 | 49 |
| October 2013 | 1.0 | 1.5 | 1.6 | 5.6 | 22 | 50 |
| November 2013 | 1.1 | 1.6 | 1.8 | 5.2 | 18 | 53 |
| December 2013 | 1.1 | 1.6 | 1.8 | 5.2 | 18 | 53 |
| January 2014 | 1.0 | 1.9 | 1.5 | 4.7 | 16 | 52 |
| February 2014 | 0.9 | 1.7 | 1.2 | 4.5 | 17 | 48 |
| March 2014 | 0.9 | 1.3 | 1.3 | 4.4 | 17 | 47 |
| April 2014 | 1.0 | 1.4 | 1.7 | 5.1 | 17 | 44 |
| May 2014 | 1.0 | 1.2 | 2.2 | 5.3 | 18 | 49 |
| June 2014 | 0.9 | 1.1 | 1.6 | 5.0 | 18 | 45 |
| July 2014 | 0.9 | 1.1 | 1.5 | 4.7 | 17 | 44 |
| August 2014 | 0.9 | 1.0 | 1.6 | 4.4 | 17 | 42 |
| September 2014 | 0.9 | 1.1 | 1.6 | 4.7 | 18 | 46 |
| October 2014 | 0.8 | 1.1 | 1.6 | 4.5 | 16 | 42 |
| November 2014 | 0.9 | 1.2 | 1.3 | 3.9 | 15 | 44 |
| December 2014 | 0.8 | 1.4 | 1.6 | 2.4 | 16 | 43 |
| January 2015 | 0.9 | 2.0 | 1.7 | 5.0 | 15 | 46 |
| February 2015 | 0.9 | 1.9 | 1.7 | 5.1 | 15 | 45 |
| March 2015 | 0.8 | 1.4 | 1.6 | 4.9 | 14 | 45 |
| April 2015 | 0.8 | 1.1 | 1.5 | 4.6 | 15 | 44 |
| May 2015 | 0.9 | 1.2 | 1.5 | 4.5 | 15 | 50 |
| June 2015 | 0.9 | 1.0 | NS | 3.6 | 15 | 47 |
| July 2015 | 0.9 | 1.0 | 1.9 | 3.7 | 13 | 43 |
| August 2015 | 0.8 | 1.0 | 1.3 | 3.7 | 16 | 49 |
| September 2015 | 0.8 | 1.0 | 1.3 | 3.5 | 14 | 46 |
| October 2015 | 0.8 | 0.9 | 1.1 | NS | 11 | 43 |
| November 2015 | 1.0 | 1.4 | 1.3 | 3.4 | 14 | 44 |
| December 2015 | NS | NS | NS | NS | NS | NS |
| January 2016 | 0.7 | 1.3 | 1.1 | 3.0 | 12 | 41 |
| February 2016 | 0.8 | 1.1 | 1.1 | 3.0 | 13 | 46 |
| March 2016 | 0.8 | 1.0 | 1.2 | 3.2 | 13 | 44 |
| April 2016 | 0.8 | 0.9 | 1.1 | 3.0 | 13 | 43 |
| May 2016 | NS | NS | NS | NS | NS | NS |
| June 2016 | 0.8 | 1.0 | 1.1 | 3.4 | 14 | 45 |
| July 2016 | 0.8 | 0.9 | 1.0 | 2.8 | 13 | 42 |
| August 2016 | 0.7 | 0.8 | 0.9 | 2.5 | 13 | 43 |
| September 2016 | 0.7 | 0.8 | 0.9 | 2.5 | 13 | 47 |
| October 2016 | NS | NS | NS | NS | NS | NS |
| November 2016 | 0.7 | 0.8 | 0.8 | 2.8 | 13 | 46 |
| December 2016 | NS | NS | NS | NS | NS | NS |
| January 2017 | 0.66 | 1.6 | 0.94 | 2.5 | 12 | 47.0 |
| February 2017 | 0.66 | 1.2 | 0.80 | 2.1 | 11 | 46 |
| March 2017 | NS | NS | NS | NS | NS | NS |
| April 2017 | 0.59 | 0.97 | 0.80 | 2.1 | 12 | 46 |
| May 2017 | NS | NS | NS | NS | NS | NS |
| June 2017 | 0.63 | 0.89 | 0.82 | 2.2 | 12 | 47 |
| July 2017 | NS | NS | NS | NS | NS | NS |
| August 2017 | 0.61 | 0.73 | 0.79 | 2.2 | 12 | 45 |
| September 2017 | 0.58 | 0.80 | 0.81 | 1.6 | 10 | 41 |
| October 2017 | 0.60 | 0.84 | 0.81 | 1.8 | 9.7 | 43 |
| November 2017 | 0.58 | 1.0 | 0.74 | 2.3 | 11 | 51 |
| December 2017 | 0.63 | 1.5 | 0.80 | 2.6 | 11 | 42 |
| | | | | | | |
| **Screen Interval (feet bgs)** | 25-35 | 25-40 | 25-35 | 24-34 | 30-45 | 25-40 |
| **Lithological Classification** | Qal/xMCf | Qal/xMCf | Qal/xMCf | Qal/xMCf | Qal/xMCf | Qal/xMCf |
| **Water Bearing Zone** | Shallow | Shallow | Shallow | Shallow | Shallow | Shallow |
| **Approx. Operating Depth to Water (feet)** | 30.4 | 32.6 | 29 | 32 | 28.5 | 31 |

| Table 1b - Athens Road Extraction Wells (AREW) Average Monthly Flow (GPM) | | | | | | |
|---|---|---|---|---|---|---|
| **Date** | **AREW-1** | **AREW-2** | **AREW-3** | **AREW-4** | **AREW-5** | **AREW-6** |
| January 2013 | 0.0 | 52.1 | 15.7 | 23.4 | 41.6 | 25.5 |
| February 2013 | 0.0 | 56.8 | 0.0 | 23.8 | 134 | 24.6 |
| March 2013 | 0.0 | 55.4 | 0.0 | 23.8 | 132 | 24.3 |
| April 2013 | 0.0 | 57.8 | 8.7 | 24.9 | 89.7 | 25.1 |
| May 2013 | 18.2 | 55.2 | 23.9 | 24.3 | 80.9 | 23.4 |
| June 2013 | 24.4 | 55.8 | 24.4 | 24.8 | 101 | 1.66 |
| July 2013 | 24.3 | 55.8 | 24.4 | 24.9 | 101 | 0.0 |
| August 2013 | 10.0 | 57.4 | 24.7 | 25.6 | 39.9 | 15.2 |
| September 2013 | 9.6 | 55.8 | 24.4 | 24.8 | 95.5 | 24.8 |
| October 2013 | 14.4 | 54.4 | 24.0 | 24.0 | 103 | 23.1 |
| November 2013 | 13.3 | 55.4 | 24.3 | 24.5 | 105 | 24.7 |
| December 2013 | 0.0 | 57.2 | 24.7 | 25.0 | 107 | 9.12 |
| January 2014 | 21.1 | 55.0 | 24.3 | 24.6 | 105 | 20.9 |
| February 2014 | 30.6 | 53.9 | 24.2 | 24.3 | 104 | 24.5 |
| March 2014 | 30.5 | 53.7 | 24.1 | 24.2 | 104 | 24.4 |
| April 2014 | 30.3 | 53.3 | 24.0 | 23.2 | 104 | 24.2 |
| May 2014 | 30.3 | 53.1 | 23.9 | 19.9 | 104 | 24.1 |
| June 2014 | 30.2 | 53.2 | 23.9 | 18.9 | 105 | 23.9 |
| July 2014 | 29.6 | 52.8 | 24.0 | 17.2 | 105 | 23.9 |
| August 2014 | 29.6 | 52.4 | 24.0 | 16.3 | 105 | 23.9 |
| September 2014 | 17.0 | 53.2 | 24.3 | 16.5 | 107 | 22.4 |
| October 2014 | 29.4 | 51.3 | 23.8 | 15.6 | 106 | 23.7 |
| November 2014 | 19.7 | 34.2 | 24.3 | 16.6 | 110 | 24.0 |
| December 2014 | 29.7 | 51.6 | 24.1 | 15.1 | 108 | 24.0 |
| January 2015 | 29.8 | 51.4 | 24.1 | 14.1 | 109 | 24.0 |
| February 2015 | 29.6 | 51.5 | 24.2 | 13.7 | 103 | 23.9 |
| March 2015 | 29.4 | 51.1 | 23.9 | 13.7 | 100 | 23.6 |
| April 2015 | 26.7 | 49.5 | 23.7 | 11.8 | 102 | 23.8 |
| May 2015 | 24.1 | 46.6 | 23.5 | 10.1 | 102 | 23.7 |
| June 2015 | 21.3 | 46.9 | 6.3 | 10.2 | 102 | 23.5 |
| July 2015 | 20.1 | 42.7 | 24.1 | 8.3 | 101 | 23.3 |
| August 2015 | 18.9 | 40.4 | 24.2 | 7.6 | 101 | 23.5 |
| September 2015 | 17.9 | 39.1 | 24.2 | 7.5 | 101 | 23.5 |
| October 2015 | 18.2 | 28.0 | 24.4 | 3.9 | 102 | 23.4 |
| November 2015 | 17.6 | 44.3 | 24.3 | 10.0 | 101 | 19.4 |
| December 2015 | 17.0 | 42.2 | 24.3 | 9.4 | 101 | 23.4 |
| January 2016 | 16.1 | 38.4 | 24.2 | 8.3 | 101 | 23.3 |
| February 2016 | 15.4 | 36.4 | 23.7 | 8.2 | 99 | 22.8 |
| March 2016 | 14.0 | 33.3 | 24.1 | 7.3 | 100 | 23.3 |
| April 2016 | 13.0 | 30.7 | 24.0 | 6.6 | 100 | 23.2 |
| May 2016 | 13.1 | 30.6 | 24.0 | 7.2 | 100 | 23.1 |
| June 2016 | 13.6 | 31.3 | 23.8 | 8.1 | 99 | 23.1 |
| July 2016 | 12.3 | 32.9 | 23.9 | 9.1 | 100 | 23.5 |
| August 2016 | 12.2 | 33.1 | 24.1 | 10.4 | 101 | 23.4 |
| September 2016 | 12.2 | 34.4 | 23.9 | 11.9 | 101 | 23.2 |
| October 2016 | 13.5 | 34.9 | 24.3 | 12.9 | 102 | 23.4 |
| November 2016 | 15.8 | 37.3 | 23.7 | 16.7 | 76 | 22.8 |
| December 2016 | 12.6 | 38.1 | 24.3 | 16.1 | 102 | 23.3 |
| January 2017 | 12.0 | 38.0 | 24.4 | 16.5 | 103 | 23.3 |
| February 2017 | 12.0 | 37.9 | 24.4 | 16.8 | 102 | 23.2 |
| March 2017 | 12.1 | 35.9 | 24.5 | 17.3 | 104 | 23.4 |
| April 2017 | 12.0 | 41.8 | 24.3 | 16.9 | 103 | 19.2 |
| May 2017 | 12.0 | 38.7 | 24.3 | 16.2 | 103 | 24.2 |
| June 2017 | 12.0 | 37.2 | 24.3 | 15.6 | 103 | 24.1 |
| July 2017 | 11.9 | 36.5 | 24.2 | 14.7 | 103 | 24.2 |
| August 2017 | 11.9 | 36.7 | 24.2 | 17.2 | 103 | 24.3 |
| September 2017 | 11.9 | 36.7 | 24.3 | 18.3 | 102 | 24.2 |
| October 2017 | 11.9 | 37.4 | 24.3 | 19.7 | 103 | 24.0 |
| November 2017 | 11.9 | 35.8 | 24.3 | 20.1 | 103 | 23.9 |
| December 2017 | 11.9 | 34.8 | 24.3 | 20.3 | 103 | 23.8 |
| | | | | | | |
| **Screen Interval (feet bgs)** | 25-35 | 25-40 | 25-35 | 24-34 | 30-45 | 25-40 |
| **Lithological Classification** | Qal/xMCf | Qal/xMCf | Qal/xMCf | Qal/xMCf | Qal/xMCf | Qal/xMCf |
| **Water Bearing Zone** | Shallow | Shallow | Shallow | Shallow | Shallow | Shallow |
| **Approx. Operating Depth to Water (feet)** | 30.4 | 32.6 | 29 | 32 | 28.5 | 31 |

## Table 2a - Athens Pen Extraction Wells (APEW) Average Monthly Perchlorate (mg/L)

| Date | APEW-1 | APEW-2 | APEW-3 |
|---|---|---|---|
| January 2013 | 1.2 | 20 | 47 |
| February 2013 | NS | 30 | 34 |
| March 2013 | NS | 24 | 58 |
| April 2013 | NS | 19 | 56 |
| May 2013 | NS | 18 | 52 |
| June 2013 | NS | 18 | 56 |
| July 2013 | NS | 21 | 60 |
| August 2013 | NS | 21 | 59 |
| September 2013 | NS | 19 | 52 |
| October 2013 | NS | 19 | 54 |
| November 2013 | NS | 18 | 53 |
| December 2013 | NS | 18 | 53 |
| January 2014 | NS | NS | 54 |
| February 2014 | NS | 15 | 50 |
| March 2014 | NS | 16 | 50 |
| April 2014 | NS | 14 | 48 |
| May 2014 | NS | 16 | 55 |
| June 2014 | NS | 15 | 57 |
| July 2014 | NS | 14 | 50 |
| August 2014 | NS | 13 | 49 |
| September 2014 | NS | 13 | 54 |
| October 2014 | NS | 13 | 47 |
| November 2014 | NS | 12 | 53 |
| December 2014 | NS | 11 | 50 |
| January 2015 | NS | 11 | 53 |
| February 2015 | NS | 11 | 52 |
| March 2015 | NS | 14 | 50 |
| April 2015 | NS | 11 | 54 |
| May 2015 | NS | 13 | 57 |
| June 2015 | 0.6 | 10 | 58 |
| July 2015 | 0.61 | 12 | 50 |
| August 2015 | 0.58 | 12 | 58 |
| September 2015 | 0.59 | 12 | 54 |
| October 2015 | 0.58 | 9.9 | 51 |
| November 2015 | 0.7 | 11 | 49 |
| December 2015 | NS | NS | NS |
| January 2016 | 0.60 | 11 | 52 |
| February 2016 | 0.64 | 11 | 53 |
| March 2016 | 0.67 | 12 | 54 |
| April 2016 | 0.61 | 12 | 54 |
| May 2016 | NS | NS | NS |
| June 2016 | 0.66 | 13 | 57 |
| July 2016 | 0.62 | 12 | 53 |
| August 2016 | 0.57 | 11 | 53 |
| September 2016 | 0.58 | 12 | 54 |
| October 2016 | NS | NS | NS |
| November 2016 | 0.54 | 11 | 54 |
| December 2016 | NS | NS | NS |
| January 2017 | 0.79 | 11 | 55 |
| February 2017 | 0.59 | 10 | 55 |
| March 2017 | NS | NS | NS |
| April 2017 | 0.66 | 10 | 54 |
| May 2017 | NS | NS | NS |
| June 2017 | 0.44 | 11 | 56 |
| July 2017 | NS | NS | NS |
| August 2017 | 0.55 | 11 | 56 |
| September 2017 | 0.51 | 9 | 60 |
| October 2017 | 0.51 | 9 | 59 |
| November 2017 | 0.50 | 9.5 | 10 |
| December 2017 | 0.55 | 9.4 | 54 |

| | | | |
|---|---|---|---|
| **Screen Interval (feet bgs)** | 20-40 | 20-30 | 10-30 |
| **Lithological Classification** | Qal/xMCf | Qal/xMCf | Qal/xMCf |
| **Water Bearing Zone** | Shallow | Shallow | Shallow |
| **Approx. Operating Depth to Water (feet)** | 17.9 | 18.2 | 14.8 |

NS- Not Sampled

## Table 2b - Athens Pen Extraction Wells (APEW) Average Monthly Flow (GPM)

| Date | APEW-1 | APEW-2 | APEW-3 |
|---|---|---|---|
| January 2013 | 0.0 | 54.3 | 7.2 |
| February 2013 | 0.0 | 29.0 | 3.5 |
| March 2013 | 0.0 | 58.2 | 6.7 |
| April 2013 | 0.0 | 59.3 | 7.0 |
| May 2013 | 0.0 | 58.2 | 6.7 |
| June 2013 | 0.0 | 56.2 | 6.8 |
| July 2013 | 0.0 | 54.0 | 7.0 |
| August 2013 | 0.0 | 56.4 | 7.2 |
| September 2013 | 0.0 | 59.6 | 7.3 |
| October 2013 | 0.0 | 56.0 | 7.2 |
| November 2013 | 0.0 | 60.7 | 7.2 |
| December 2013 | 0.0 | 22.4 | 7.2 |
| January 2014 | 0.0 | 0.21 | 7.1 |
| February 2014 | 0.0 | 33.1 | 7.1 |
| March 2014 | 0.0 | 56.4 | 7.0 |
| April 2014 | 0.0 | 53.1 | 7.0 |
| May 2014 | 0.0 | 48.2 | 6.8 |
| June 2014 | 0.0 | 47.6 | 6.9 |
| July 2014 | 0.0 | 45.5 | 7.2 |
| August 2014 | 0.0 | 44.1 | 7.1 |
| September 2014 | 0.0 | 44.3 | 7.2 |
| October 2014 | 0.0 | 38.3 | 7.1 |
| November 2014 | 0.0 | 22.0 | 7.2 |
| December 2014 | 0.0 | 22.0 | 7.2 |
| January 2015 | 0.0 | 22.1 | 7.2 |
| February 2015 | 0.0 | 22.1 | 7.1 |
| March 2015 | 0.0 | 22.4 | 7.0 |
| April 2015 | 0.0 | 22.1 | 7.1 |
| May 2015 | 1.6 | 21.8 | 7.1 |
| June 2015 | 14.3 | 20.5 | 7.1 |
| July 2015 | 14.2 | 20.5 | 7.1 |
| August 2015 | 14.3 | 20.6 | 7.2 |
| September 2015 | 14.4 | 20.7 | 7.2 |
| October 2015 | 11.4 | 20.6 | 5.7 |
| November 2015 | 14.5 | 20.9 | 7.4 |
| December 2015 | 14.8 | 22.6 | 7.3 |
| January 2016 | 15.8 | 27.5 | 7.3 |
| February 2016 | 15.5 | 27.0 | 7.2 |
| March 2016 | 15.8 | 28.4 | 7.4 |
| April 2016 | 15.9 | 27.5 | 7.4 |
| May 2016 | 15.9 | 28.1 | 7.4 |
| June 2016 | 15.8 | 27.8 | 7.3 |
| July 2016 | 12.9 | 28.7 | 7.5 |
| August 2016 | 15.5 | 28.9 | 7.5 |
| September 2016 | 15.4 | 28.8 | 7.4 |
| October 2016 | 15.7 | 29.3 | 7.6 |
| November 2016 | 15.3 | 28.4 | 7.4 |
| December 2016 | 15.6 | 29.1 | 7.6 |
| January 2017 | 15.7 | 29.2 | 7.6 |
| February 2017 | 15.7 | 29.2 | 7.6 |
| March 2017 | 15.7 | 29.3 | 7.6 |
| April 2017 | 15.7 | 29.2 | 7.6 |
| May 2017 | 15.7 | 29.3 | 7.6 |
| June 2017 | 15.7 | 28.5 | 7.5 |
| July 2017 | 15.5 | 25.8 | 7.5 |
| August 2017 | 18.3 | 25.9 | 7.5 |
| September 2017 | 18.3 | 26.0 | 7.6 |
| October 2017 | 18.3 | 26.0 | 7.5 |
| November 2017 | 18.4 | 26.1 | 7.5 |
| December 2017 | 18.4 | 26.1 | 7.5 |

| | | | |
|---|---|---|---|
| **Screen Interval (feet bgs)** | 20-40 | 20-30 | 10-30 |
| **Lithological Classification** | Qal/xMCf | Qal/xMCf | Qal/xMCf |
| **Water Bearing Zone** | Shallow | Shallow | Shallow |
| **Approx. Operating Depth to Water (feet)** | 19.3 | 19.9 | 15.9 |

| Table 3a - Auto Mall Extraction Wells (AMEW) Average Monthly Perchlorate (mg/L) | | | | | |
|---|---|---|---|---|---|
| **Historical Monthly Averages** | **AMEW-1** | **AMEW-2** | **AMEW-3** | **AMEW-4** | **AMEW-5** |
| January 2013 | 490 | 630 | 140 | 350 | 37.0 |
| February 2013 | NS | NS | NS | NS | NS |
| March 2013 | 470 | 660 | 140 | 280 | 53.0 |
| April 2013 | 510 | 630 | 150 | 280 | 39.0 |
| May 2013 | 490 | 610 | 130 | 300 | 68.0 |
| June 2013 | 410 | 580 | 120 | 260 | 78.0 |
| July 2013 | 390 | 590 | 94 | 210 | 83.0 |
| August 2013 | 380 | 610 | 140 | 210 | 110 |
| September 2013 | 380 | 570 | 130 | 220 | NS |
| October 2013 | 370 | 560 | 140 | 240 | 120 |
| November 2013 | 390 | 590 | 140 | 230 | 110 |
| December 2013 | 330 | 530 | 130 | 190 | 100 |
| January 2014 | 420 | 630 | 140 | 220 | 110 |
| February 2014 | 350 | 590 | 130 | 200 | 110 |
| March 2014 | 350 | 540 | 140 | 190 | 120 |
| April 2014 | 310 | 490 | 130 | 180 | 99 |
| May 2014 | 350 | 530 | 140 | 190 | 120 |
| June 2014 | 320 | 480 | 130 | 210 | 110 |
| July 2014 | 340 | 480 | 120 | 180 | 120 |
| September 2014 | 330 | 460 | 140 | 180 | 130 |
| October 2014 | 270 | 450 | 130 | 170 | 110 |
| November 2014 | 300 | 410 | 120 | 140 | 120 |
| December 2014 | 270 | 380 | 130 | 140 | 180 |
| January 2015 | NS | 400 | 130 | 120 | 120 |
| February 2015 | 270 | 380 | 120 | 140 | 83 |
| March 2015 | 270 | 380 | 140 | 120 | 130 |
| April 2015 | 250 | 370 | 120 | 130 | 110 |
| May 2015 | 280 | 390 | 140 | 150 | 130 |
| June 2015 | 260 | 440 | 130 | 150 | 110 |
| July 2015 | 270 | 360 | 150 | 130 | 120 |
| August 2015 | 290 | 37 | 160 | 140 | 120 |
| September 2015 | 280 | 250 | 140 | 140 | 120 |
| October 2015 | 250 | 340 | 130 | 120 | NS |
| November 2015 | 240 | 360 | 110 | 180 | 110 |
| December 2015 | NS | NS | NS | NS | NS |
| January 2016 | 240 | 340 | 130 | 120 | 110 |
| February 2016 | 260 | 330 | 130 | 120 | 110 |
| March 2016 | 250 | 330 | 140 | 120 | 120 |
| April 2016 | NS | NS | NS | NS | NS |
| May 2016 | 240 | 300 | 130 | 98 | 99 |
| June 2016 | 270 | 250 | 130 | 120 | 110 |
| July 2016 | 240 | 310 | 130 | 100 | 110 |
| August 2016 | 240 | 280 | 130 | 110 | 110 |
| September 2016 | 240 | 310 | 140 | 120 | 100 |
| October 2016 | NS | NS | NS | NS | NS |
| November 2016 | 220 | 280 | 130 | 91 | 91 |
| December 2016 | NS | NS | NS | NS | NS |
| January 2017 | 230 | 300 | 141 | 97 | 98 |
| February 2017 | 200 | 270 | 68 | 93 | 100 |
| March 2017 | 230 | 287 | 137 | 98 | 104 |
| April 2017 | 220 | 280 | 140 | 95 | 99 |
| May 2017 | NS | NS | NS | NS | NS |
| June 2017 | 230 | 283 | 144 | 96 | 100 |
| July 2017 | NS | NS | NS | NS | NS |
| August 2017 | 220 | 250 | 140 | 270 | 210 |
| September 2017 | 209 | 260 | 136 | 86 | 94 |
| October 2017 | 221 | 272 | 147 | 89 | 100 |
| November 2017 | 200 | 240 | 130 | 85 | 90 |
| December 2017 | 206 | 242 | 132 | 86 | 94 |

| | | | | | |
|---|---|---|---|---|---|
| **Screen Interval (feet bgs)** | 145-235 | 175-215 | 169-199 | 151-186 | 165-200 |
| **Lithological Classification** | UMCf | UMCf | UMCf | UMCf | UMCf |
| **Water Bearing Zone** | Deep | Deep | Deep | Deep | Deep |
| ***Approx. Operating Depth to Water (feet)** | 145 | 174 | 161 | 153 | 156 |

*Does not include days with no flow

## Table 3b - Auto Mall Extraction Wells (AMEW) Average Monthly Flow (GPM)

| Date | AMEW-1 | AMEW-2 | AMEW-3 | AMEW-4 | AMEW-5 |
|---|---|---|---|---|---|
| January 2013 | 58.8 | 32.5 | 64.5 | 53.4 | 0.0 |
| February 2013 | 151.8 | 12.9 | 31.8 | 38.2 | 0.0 |
| March 2013 | 152.1 | 46.0 | 59.7 | 0.0 | 2.2 |
| April 2013 | 122.7 | 42.8 | 54.1 | 7.6 | 9.3 |
| May 2013 | 114.1 | 37.0 | 53.4 | 40.4 | 47.5 |
| June 2013 | 160.1 | 4.1 | 52.9 | 44.4 | 47.8 |
| July 2013 | 160.1 | 19.3 | 53.2 | 28.5 | 48.1 |
| August 2013 | 159.2 | 21.1 | 50.6 | 0.9 | 35.9 |
| September 2013 | 147.5 | 12.1 | 51.2 | 46.9 | 1.0 |
| October 2013 | 158.1 | 31.4 | 52.2 | 45.1 | 1.6 |
| November 2013 | 159.7 | 29.7 | 52.9 | 43.1 | 26.4 |
| December 2013 | 160.5 | 0.0 | 54.6 | 15.8 | 0.0 |
| January 2014 | 33.1 | 0.0 | 53.1 | 39.8 | 38.8 |
| February 2014 | 171.4 | 32.3 | 53.9 | 47.4 | 0.0 |
| March 2014 | 170.6 | 56.4 | 53.7 | 47.3 | 0.0 |
| April 2014 | 171.1 | 55.9 | 53.4 | 46.1 | 12.2 |
| May 2014 | 179.7 | 55.4 | 50.8 | 39.6 | 46.9 |
| June 2014 | 179.1 | 55.6 | 50.6 | 38.9 | 47.2 |
| July 2014 | 186.9 | 54.5 | 50.9 | 38.9 | 47.6 |
| August 2014 | 187.1 | 54.3 | 50.9 | 39.0 | 46.0 |
| September 2014 | 176.2 | 42.4 | 52.2 | 41.2 | 10.4 |
| October 2014 | 180.7 | 46.0 | 51.6 | 41.6 | 14.2 |
| November 2014 | 144.9 | 57.2 | 51.7 | 28.6 | 36.3 |
| December 2014 | 204.4 | 60.5 | 50.1 | 39.2 | 47.7 |
| January 2015 | 140.0 | 53.9 | 51.5 | 39.1 | 46.6 |
| February 2015 | 194.7 | 46.6 | 54.0 | 41.0 | 47.6 |
| March 2015 | 216.1 | 60.2 | 51.3 | 40.6 | 47.2 |
| April 2015 | 223.0 | 60.5 | 52.1 | 40.8 | 47.4 |
| May 2015 | 230.4 | 60.4 | 51.4 | 40.8 | 46.8 |
| June 2015 | 234.1 | 60.3 | 51.1 | 42.2 | 48.6 |
| July 2015 | 232.4 | 57.2 | 46.0 | 36.4 | 43.9 |
| August 2015 | 236.5 | 38.5 | 50.8 | 42.5 | 46.5 |
| September 2015 | 237.4 | 0.0 | 51.7 | 42.7 | 47.6 |
| October 2015 | 165.9 | 38.6 | 51.5 | 32.4 | 34.6 |
| November 2015 | 168.2 | 62.2 | 50.3 | 38.1 | 39.1 |
| December 2015 | 249.9 | 49.9 | 40.3 | 36.2 | 34.3 |
| January 2016 | 253.3 | 62.0 | 48.5 | 47.0 | 40.9 |
| February 2016 | 247.5 | 59.5 | 48.5 | 44.1 | 44.7 |
| March 2016 | 252.0 | 60.8 | 49.9 | 42.7 | 46.4 |
| April 2016 | 252.0 | 60.7 | 50.9 | 42.5 | 49.0 |
| May 2016 | 260.4 | 60.6 | 51.0 | 42.4 | 49.3 |
| June 2016 | 264.1 | 60.4 | 51.2 | 42.0 | 49.4 |
| July 2016 | 261.8 | 60.3 | 52.7 | 41.8 | 51.6 |
| August 2016 | 263.3 | 62.0 | 53.7 | 41.6 | 45.4 |
| September 2016 | 260.0 | 62.4 | 53.4 | 41.1 | 39.4 |
| October 2016 | 129.2 | 12.7 | 48.6 | 28.7 | 38.0 |
| November 2016 | 254.2 | 58.5 | 52.9 | 41.8 | 43.8 |
| December 2016 | 236.1 | 61.3 | 52.8 | 41.7 | 39.3 |
| January 2017 | 254.2 | 51.9 | 44.8 | 41.5 | 44.8 |
| February 2017 | 219.3 | 32.5 | 0.0 | 42.7 | 48.7 |
| March 2017 | 247.3 | 60.0 | 36.7 | 41.4 | 46.7 |
| April 2017 | 275.1 | 60.7 | 49.8 | 39.8 | 47.7 |
| May 2017 | 275.0 | 60.8 | 50.5 | 40.4 | 25.8 |
| June 2017 | 276.1 | 64.4 | 49.8 | 37.9 | 50.6 |
| July 2017 | 276.0 | 66.0 | 50.2 | 36.7 | 51.2 |
| August 2017 | 276.2 | 65.9 | 50.1 | 35.3 | 46.9 |
| September 2017 | 276.5 | 65.8 | 50.1 | 33.6 | 45.1 |
| October 2017 | 276.7 | 64.5 | 50.1 | 32.0 | 45.3 |
| November 2017 | 277.1 | 64.0 | 50.2 | 32.9 | 48.3 |
| December 2017 | 277.0 | 63.9 | 50.1 | 32.9 | 51.8 |

| | | | | | |
|---|---|---|---|---|---|
| **Screen Interval (feet bgs)** | 145-235 | 175-215 | 169-199 | 151-186 | 165-200 |
| **Lithological Classification** | UMCf | UMCf | UMCf | UMCf | UMCf |
| **Water Bearing Zone** | Deep | Deep | Deep | Deep | Deep |
| ***Approx. Operating Depth to Water (feet)** | 145 | 174 | 161 | 153 | 156 |

*Does not include days with no flow.

## Table 4 - Flow Rate and Monthly Sampling Results

| Location | Date Sampled | Flow Rate ($ft^3$/sec) | Flow Rate, gpm | Chlorate (mg/L) | Perchlorate (mg/L) |
|---|---|---|---|---|---|
| Athens Main | 7/6/2017 | 0.44 | 197 | 1.8 | 5.9 |
| | 8/2/2017 | 0.40 | 180 | 2.6 | 6.9 |
| | 9/5/2017 | 0.50 | 224 | 1.9 | 5.0 |
| | 10/3/2017 | 0.49 | 220 | 2.6 | 7.2 |
| | 11/8/2017 | 0.40 | 180 | 3.0 | 8.7 |
| | 12/20/2017 | 0.44 | 197 | 5.7 | 12 |
| | | | | | |
| Athens North South | 7/6/2017 | NA | NA | 2.0 | 6.9 |
| | 8/2/2017 | NA | NA | 3.2 | 8.8 |
| | 9/5/2017 | NA | NA | 2.6 | 7.7 |
| | 10/3/2017 | NA | NA | 3.3 | 8.9 |
| | 11/8/2017 | NA | NA | 3.2 | 9.1 |
| | 12/6/2017 | NA | NA | 3.1 | 7.4 |
| | | | | | |
| Eastgate Drain | 7/6/2017 | 0.20 | 90 | 4.5 | 14 |
| | 8/2/2017 | 0.23 | 103 | 2.8 | 8.9 |
| | 9/5/2017 | 0.23 | 103 | 7.5 | 19 |
| | 10/3/2017 | 0.22 | 99 | 4.2 | 12 |
| | 11/8/2017 | 0.19 | 85 | 4.4 | 13 |
| | 12/20/2017 | 0.25 | 112 | 2.8 | 7.6 |
| | | | | | |
| F6 French Drain | 7/6/2017 | NA | NA | 0.47 | 0.18 |
| | 8/2/2017 | NA | NA | 0.62 | 0.24 |
| | 9/5/2017 | NA | NA | 0.77 | 0.15 |
| | 10/3/2017 | NA | NA | 0.93 | 0.17 |
| | 11/8/2017 | NA | NA | 0.84 | 0.17 |
| | 12/6/2017 | NA | NA | 0.82 | 0.17 |

**Weir Calculation:** **2.5 x (Feet measured using Weir)$^{2.5}$ = flow rate in $ft^3$/sec**

**Nitrate as N is sampled annually (April/May)**

| Table 5 - Quarterly Analytes and Field Measurements | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Location | Date Sampled | Chlorate (mg/L) | Perchlorate (mg/L) | Ref Elev (ft) | DTW (ft) | GW Elev (ft) | Temp (°F) | pH (S.U.) | Conductivity (µS/cm) | DO (mg/L) | ORP (mV) |
| ADX-112 | 8/13/2017 | 0.50 | 3.1 | 1807.70 | 62.31 | 1,745.39 | 78.7 | 7.44 | 1478 | 2.49 | 209.5 |
| | 11/12/2017 | 0.68 | 3.1 | 1807.70 | 61.25 | 1,746.45 | 75.7 | 7.77 | 1386 | 6.74 | 174.4 |
| ADX-156 | 8/13/2017 | 0.33 | 1.6 | 1808.10 | 77.70 | 1,730.40 | 84.7 | 7.63 | 1426 | 10.56 | 205.9 |
| | 11/12/2017 | 2.6 | 10 | 1808.10 | 75.75 | 1,732.35 | 74.2 | 7.63 | 1489 | 7.42 | 174.9 |
| AEX-166 | 8/13/2017 | 1.7 | 64 | 1783.30 | 92.29 | 1,691.01 | 89.2 | 7.80 | 1438 | 7.00 | 186.5 |
| | 11/6/2017 | 1.9 | 76 | 1783.30 | 90.84 | 1,692.46 | 76.7 | 7.76 | 1472 | 7.24 | 199.3 |
| AEX-35 | 8/13/2017 | 35 | 130 | 1782.70 | 37.03 | 1,745.67 | 81.9 | 7.47 | 3544 | 6.83 | 193.6 |
| | 11/6/2017 | 34 | 9.6 | 1782.70 | 37.89 | 1,744.81 | 76.2 | 7.42 | 3728 | 7.29 | 204.4 |
| AMEW-1 | 8/9/2017 | 71 | 220 | 1832.55 | 154.40 | 1,678.15 | 78.9 | 7.64 | 3279 | 6.21 | 212.9 |
| | 11/6/2017 | 67 | 200 | 1832.55 | 153.00 | 1,679.55 | 76.5 | 7.63 | 3396 | 6.79 | 206.9 |
| AMEW-2 | 8/20/2017 | 54 | 250 | 1802.62 | 184.44 | 1,618.18 | 78.5 | 7.56 | 3675 | 6.91 | 253.6 |
| | 11/5/2017 | 53 | 240 | 1802.62 | 179.19 | 1,623.43 | 77.2 | 7.51 | 3642 | 7.51 | 241.5 |
| AMEW-3 | 8/20/2017 | 29 | 140 | 1782.11 | 153.71 | 1,628.40 | 78.7 | 7.85 | 2328 | 7.46 | 256.8 |
| | 11/5/2017 | 29 | 130 | 1782.11 | 154.80 | 1,627.31 | 78.0 | 7.82 | 2413 | 7.87 | 138.3 |
| AMEW-4 | 8/13/2017 | 24 | 270 | 1808.06 | 162.84 | 1,645.22 | 79.2 | 7.65 | 2027 | 9.49 | 255.6 |
| | 11/12/2017 | 25 | 85 | 1808.06 | 159.09 | 1,648.97 | 78.5 | 7.69 | 1964 | 8.00 | 172.4 |
| AMEW-5 | 8/13/2017 | 24 | 210 | 1784.53 | 120.00 | 1,664.53 | 80.0 | 7.73 | 2002 | 7.19 | 205.9 |
| | 11/6/2017 | 24 | 90 | 1784.53 | 156.50 | 1,628.03 | 79.0 | 7.71 | 2057 | 7.62 | 206.6 |
| AMOW-3-165 | 8/20/2017 | 0.014 | 0.13 | 1780.00 | 70.65 | 1,709.35 | 84.0 | 7.69 | 1413 | 9.31 | 229.6 |
| | 11/6/2017 | 0.03 | 0.19 | 1780.00 | 69.50 | 1,710.50 | 71.0 | 7.84 | 1437 | 7.74 | 202.0 |
| AMOW-3-52 | 8/20/2017 | 11 | 55 | 1779.70 | 34.27 | 1,745.43 | 81.5 | 7.45 | 3707 | 2.96 | 223.1 |
| | 11/5/2017 | 12 | 55 | 1779.70 | 34.89 | 1,744.81 | 77.0 | 7.44 | 4001 | 5.13 | 133.0 |
| APEW-1 | 8/7/2017 | 0.19 | 0.55 | 1620.25 | NR | NR | 76.9 | 7.32 | 5542 | 5.37 | 238.0 |
| | 11/2/2017 | 0.24 | 0.50 | 1620.25 | 15.90 | 1,604.35 | 77.0 | 7.27 | 5622 | 5.50 | 197.6 |
| APEW-2 | 8/7/2017 | 2.1 | 11 | 1621.00 | NR | NR | 77.4 | 7.38 | 5171 | 5.99 | 208.4 |
| | 11/2/2017 | 2.3 | 9.5 | 1621.00 | 14.58 | 1,606.42 | 76.5 | 7.36 | 5363 | 6.58 | 212.8 |
| APEW-3 | 8/7/2017 | 8.8 | 56 | 1614.50 | NR | NR | 79.4 | 7.21 | 6567 | 2.75 | 197.8 |
| | 11/2/2017 | 9.2 | 10 | 1614.50 | 19.10 | 1,595.40 | 80.5 | 7.21 | 6666 | 4.50 | 223.4 |
| AREW-1 | 8/8/2017 | 0.22 | 0.61 | 1649.49 | 25.62 | 1,623.87 | 77.7 | 7.33 | 5478 | 7.04 | 183.6 |
| | 11/19/2017 | 0.28 | 0.58 | 1649.49 | 25.55 | 1,623.94 | 76.9 | 7.25 | 5595 | 7.48 | 205.1 |
| AREW-2 | 8/8/2017 | 0.29 | 0.73 | 1644.20 | 31.28 | 1,612.92 | 77.4 | 7.33 | 5339 | 9.72 | 185.5 |
| | 11/19/2017 | 0.49 | 1.0 | 1644.20 | 28.80 | 1,615.40 | 76.4 | 7.27 | 5432 | 11.09 | 143.0 |
| AREW-3 | 8/8/2017 | 0.29 | 0.79 | 1642.97 | 25.30 | 1,617.67 | 77.7 | 7.37 | 5290 | 7.07 | 206.5 |
| | 11/19/2017 | 0.40 | 0.74 | 1642.97 | 24.10 | 1,618.87 | 76.5 | 7.20 | 5472 | 6.87 | 154.6 |
| AREW-4 | 8/8/2017 | 0.57 | 2.2 | 1641.78 | NR | NR | 77.9 | 7.26 | 5145 | 9.24 | 216.1 |
| | 11/19/2017 | 0.78 | 2.3 | 1641.78 | 29.94 | 1,611.84 | 76.7 | 7.24 | 5254 | 9.40 | 157.4 |
| AREW-5 | 8/8/2017 | 2.6 | 12 | 1640.74 | 24.87 | 1,615.87 | 78.0 | 7.31 | 4656 | 6.21 | 232.6 |
| | 11/19/2017 | 2.8 | 11 | 1640.74 | 24.60 | 1,616.14 | 77.4 | 7.27 | 4697 | 6.50 | 164.0 |
| AREW-6 | 8/8/2017 | 7.8 | 45 | 1638.86 | 27.10 | 1,611.76 | 77.5 | 7.27 | 5816 | 6.20 | 237.0 |
| | 11/19/2017 | 8.2 | 51 | 1638.86 | 26.19 | 1,612.67 | 77.0 | 7.26 | 5963 | 7.53 | 198.5 |
| DX-161 | 8/9/2017 | 13 | 45 | 1830.10 | 70.56 | 1,759.54 | 81.7 | 7.56 | 1754 | 5.99 | 171.9 |
| | 11/6/2017 | 6.0 | 25 | 1830.10 | 70.04 | 1,760.06 | 75.5 | 7.55 | 1613 | 6.71 | 193.6 |
| DX-30 | 8/9/2017 | 20 | 120 | 1830.20 | 7.38 | 1,822.82 | 81.7 | 7.43 | 6847 | 6.04 | 209.5 |
| | 11/6/2017 | 21 | 110 | 1830.20 | 27.39 | 1,802.81 | 77.0 | 7.40 | 7140 | 6.75 | 214.5 |
| DX-75 | 8/9/2017 | 67 | 300 | 1830.10 | 25.27 | 1,804.83 | 83.9 | 7.58 | 2917 | 5.42 | 198.8 |
| | 11/6/2017 | 62 | 260 | 1830.10 | 24.94 | 1,805.16 | 75.7 | 7.50 | 2981 | 6.48 | 210.6 |
| DY-106 | 8/20/2017 | 0.014 | 0.003 | 1800.40 | 13.84 | 1,786.56 | 79.7 | 7.82 | 1380 | 6.34 | 267.8 |
| | 11/5/2017 | 0.014 | 0.01 | 1800.40 | 14.00 | 1,786.40 | 77.4 | 7.79 | 1396 | 6.65 | 75.0 |
| DY-169 | 8/20/2017 | 0.054 | 0.44 | 1800.40 | 36.56 | 1,763.84 | 78.5 | 7.68 | 1300 | 4.42 | 299.8 |
| | 11/5/2017 | 0.06 | 2.8 | 1800.40 | 35.50 | 1,764.90 | 78.0 | 7.68 | 1311 | 4.34 | 255.9 |
| DY-26 | 8/20/2017 | 17 | 82 | 1800.60 | 21.10 | 1,779.50 | 79.5 | 7.23 | 7191 | 4.83 | 322.3 |
| | 11/5/2017 | 16 | 80 | 1800.60 | 22.19 | 1,778.41 | 78.0 | 7.20 | 7291 | 4.87 | 275.1 |
| MW-AD | 8/13/2017 | 8.2 | 22 | 1807.30 | 29.75 | 1,777.55 | 80.7 | 7.42 | 3080 | 6.98 | 216.3 |
| | 11/12/2017 | 7.9 | 20 | 1807.30 | 29.94 | 1,777.36 | 76.4 | 7.38 | 3005 | 7.51 | 185.5 |

**NR- Not Recorded**
**Nitrate as N is sampled annually (April/May)**

| Table 6 - Selected History of Perchlorate Concentrations in Athens Road Extraction Wells (mg/L) | | | | | | |
|---|---|---|---|---|---|---|
| **Date Sampled** | **AREW-1** | **AREW-2** | **AREW-3** | **AREW-4** | **AREW-5** | **AREW-6** |
| **November 2009** | 0.9 | 1.4 | 1.4 | 5.6 | 16 | 37 |
| **February 2010** | 0.8 | 1.2 | 1.2 | 2.0 | 15 | 43 |
| **May 2010** | 0.9 | 1.2 | 1.3 | 3.0 | 18 | 47 |
| **August 2010** | 1.0 | 1.4 | 1.4 | 2.4 | 18 | 49 |
| **November 2010** | 1.0 | 1.6 | 1.2 | 3.1 | 19 | 51 |
| **February 2011** | 0.9 | 1.9 | 1.5 | 8.0 | 19 | 46 |
| **May 2011** | 0.9 | 3.7 | 1.2 | 2.6 | 17 | 49 |
| **August 2011** | 1.0 | 1.3 | 1.3 | 2.5 | 18 | 51 |
| **November 2011** | 0.9 | 1.9 | 1.2 | 2.5 | 18 | 49 |
| **February 2012** | 1.0 | 1.7 | 2.5 | 10 | 24 | 53 |
| **May 2012** | 1.0 | 1.3 | 4.0 | 10 | 23 | 49 |
| **August 2012** | 0.8 | 1.1 | 1.8 | 9.6 | 48 | 47 |
| **November 2012** | 0.9 | 2.1 | 3.0 | 13 | 26 | 83 |
| **February 2013** | 0.9 | 2.0 | 1.5 | 7.3 | 19 | 52 |
| **May 2013** | 1.1 | 1.4 | 1.8 | 7.3 | 20 | 50 |
| **August 2013** | 1.1 | 1.4 | 2.0 | 10 | 22 | 50 |
| **November 2013** | 1.1 | 1.6 | 1.8 | 5.2 | 18 | 53 |
| **February 2014** | 0.9 | 1.7 | 1.2 | 4.5 | 17 | 48 |
| **May 2014** | 1.0 | 1.2 | 2.2 | 5.3 | 18 | 49 |
| **August 2014** | 0.9 | 1.0 | 1.6 | 4.4 | 17 | 42 |
| **November 2014** | 0.9 | 1.2 | 1.3 | 3.9 | 15 | 44 |
| **February 2015** | 0.9 | 1.9 | 1.7 | 5.1 | 15 | 45 |
| **May 2015** | 0.9 | 1.2 | 1.5 | 4.5 | 15 | 50 |
| **August 2015** | 0.8 | 1.0 | 1.3 | 3.7 | 16 | 49 |
| **November 2015** | 1.0 | 1.4 | 1.3 | 3.4 | 14 | 44 |
| **February 2016** | 0.8 | 1.1 | 1.1 | 3.0 | 13 | 46 |
| **May 2016** | 0.8 | 0.9 | 1.1 | 3.0 | 13 | 43 |
| **August 2016** | 0.7 | 0.8 | 0.9 | 2.5 | 13 | 43 |
| **November 2016** | 0.7 | 0.8 | 0.8 | 2.8 | 13 | 46 |
| **February 2017** | 0.66 | 1.20 | 0.80 | 2.1 | 11 | 46 |
| **May 2017** | 0.59 | 0.97 | 0.79 | 2.1 | 12 | 45 |
| **August 2017** | 0.61 | 0.73 | 0.79 | 2.2 | 12 | 45 |
| **November 2017** | 0.58 | 1.0 | 0.74 | 2.3 | 11 | 51 |

Note: the data for AREW-5 for August 2012 and AREW-6 for November 2012 are shown here but not plotted on Figure 6. The results are incorrect due to sample handling and/or laboratory error.

| Table 7 - Selected History of Perchlorate Concentrations in Athens Pen Extraction Wells (mg/L) | | | |
|---|---|---|---|
| **Date Sampled** | **APEW-1** | **APEW-2** | **APEW-3** |
| **November 2009** | | 21 | 52 |
| **February 2010** | | 17 | 50 |
| **May 2010** | | 17 | 53 |
| **August 2010** | | 21 | 57 |
| **November 2010** | | 21 | 58 |
| **February 2011** | | 20 | 54 |
| **May 2011** | | 21 | 57 |
| **August 2011** | | 21 | 56 |
| **November 2011** | | 20 | 52 |
| **February 2012** | | 31 | 56 |
| **May 2012** | | 23 | 55 |
| **August 2012** | | 0.9 | 32 |
| **November 2012** | | 34 | 41 |
| **February 2013** | | 30 | 34 |
| **May 2013** | | 18 | 52 |
| **August 2013** | | 21 | 59 |
| **November 2013** | | 18 | 53 |
| **February 2014** | | 15 | 50 |
| **May 2014** | | 16 | 55 |
| **August 2014** | | 13 | 49 |
| **November 2014** | | 12 | 53 |
| **February 2015** | | 11 | 52 |
| **May 2015** | | 13 | 57 |
| **August 2015** | 0.6 | 12 | 58 |
| **November 2015** | 0.7 | 11 | 49 |
| **February 2016** | 0.6 | 11 | 53 |
| **May 2016** | 0.6 | 12 | 54 |
| **August 2016** | 0.6 | 11 | 53 |
| **November 2016** | 0.5 | 11 | 54 |
| **February 2017** | 0.59 | 10 | 55 |
| **May 2017** | 0.66 | 10 | 54 |
| **August 2017** | 0.55 | 11 | 56 |
| **November 2017** | 0.50 | 9.5 | 10 |

Notes: APEW-1 was started on May 28, 2015. Also, the data for APEW-2 for August 2012 and APEW-3 for August and November 2012, and February 2013 are shown here but not plotted on Figure 7. The results are incorrect due to sample handling and/or laboratory error. Additionally APEW-3 for November 2017.

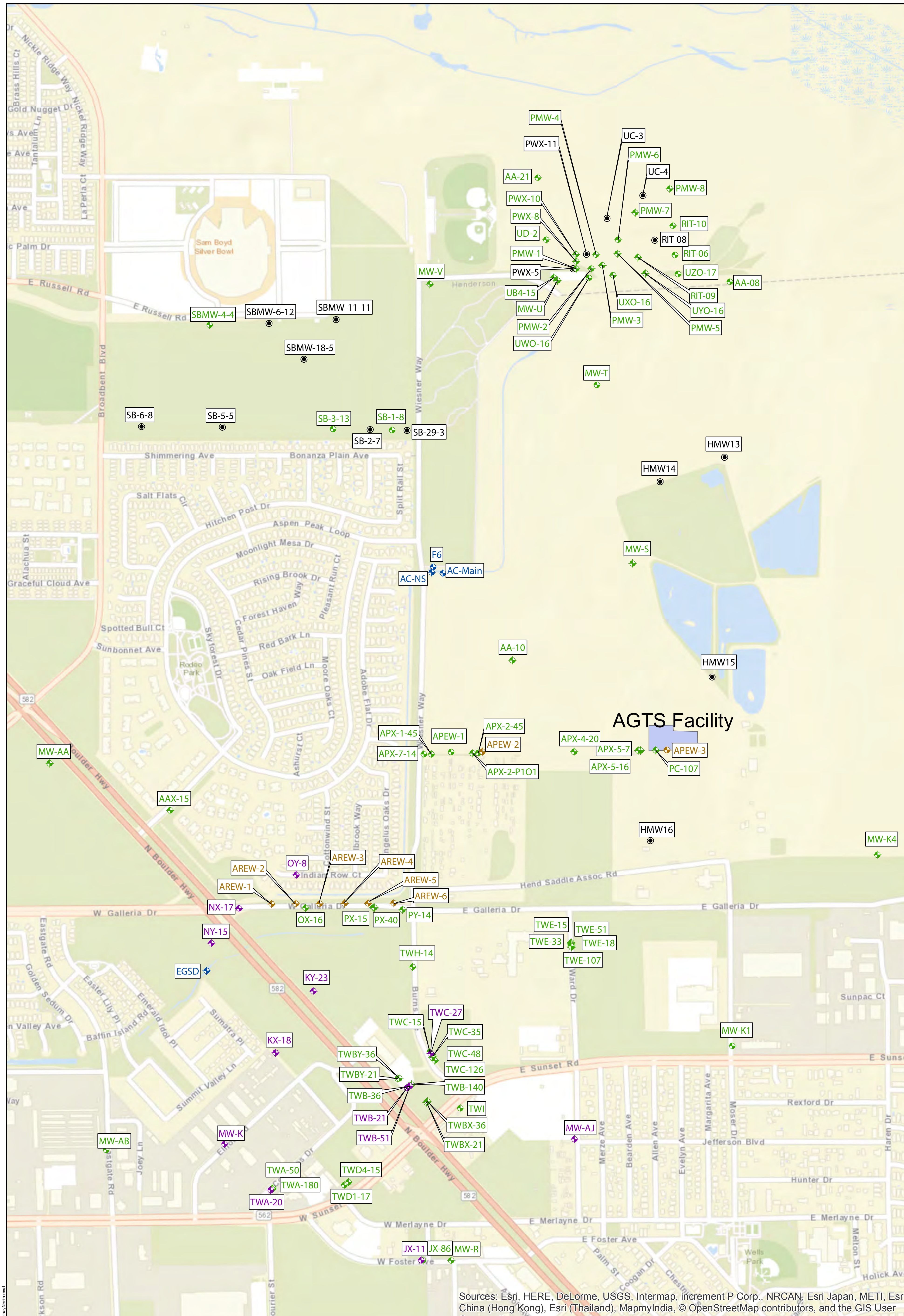
| Table 8 - Selected History of Perchlorate Concentrations in Auto Mall Extraction Wells (mg/L) | | | | | |
|---|---|---|---|---|---|
| **Date Sampled** | **AMEW-1** | **AMEW-2** | **AMEW-3** | **AMEW-4** | **AMEW-5** |
| **December 2012** | 540 | 700 | 65 | 400 | 66 |
| **January 2013** | 490 | 630 | 140 | 350 | 37 |
| **March 2013** | 470 | 660 | 140 | 280 | 53 |
| **May 2013** | 490 | 610 | 130 | 300 | 68 |
| **August 2013** | 380 | 610 | 140 | 210 | 110 |
| **November 2013** | 390 | 590 | 140 | 230 | 110 |
| **Februrary 2014** | 350 | 590 | 130 | 200 | 110 |
| **May 2014** | 350 | 530 | 140 | 190 | 120 |
| **August 2014** | 310 | 440 | 130 | 170 | 120 |
| **November 2014** | 300 | 410 | 120 | 140 | 120 |
| **Februrary 2015** | 270 | 380 | 120 | 140 | 83 |
| **May 2015** | 280 | 390 | 140 | 150 | 130 |
| **August 2015*** | 290 | 37 | 160 | 140 | 120 |
| **November 2015** | 240 | 360 | 110 | 180 | 110 |
| **February 2016** | 260 | 330 | 130 | 120 | 110 |
| **May 2016** | 240 | 300 | 130 | 98 | 99 |
| **August 2016** | 240 | 280 | 130 | 110 | 110 |
| **November 2016** | 220 | 280 | 130 | 91 | 91 |
| **February 2017** | 200 | 270 | 68 | 93 | 100 |
| **May 2017** | 220 | 280 | 140 | 95 | 99 |
| **August 2017*** | 220 | 250 | 140 | 270 | 210 |
| **November 2017** | 200 | 240 | 130 | 85 | 90 |

* AMEW-2 was not running during sampling in August 2015 and the well was not purged enough to get a representative sample result. AMEWs 4 and 5 results erroneously high in August 2017 but not re-ran. Outliers not plotted in Figure 8.

| Table 9 - Semi-Annual Analytes and Field Measurements | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location** | **Date Sampled** | **Chlorate (mg/L)** | **Perchlorate (mg/L)** | **Ref Elevation (ft)** | **DTW (ft)** | **GW Elev** | **Temp (° F)** | **pH (S.U.)** | **EC (µS/cm)** | **DO (mg/L)** | **ORP (mV)** |
| JX-11 | 11/8/2017 | 5.4 | 58 | 1669.13 | 13.10 | 1656.03 | 79.0 | 6.91 | 5751 | 1.57 | 190.5 |
| KX-18 | 11/8/2017 | 4.5 | 20 | 1657.40 | 26.19 | 1631.21 | 77.4 | 7.23 | 4662 | 5.92 | 165.4 |
| KY-23 | 11/8/2017 | 3.7 | 17 | 1653.60 | 27.60 | 1626.00 | 77.5 | 7.31 | 4519 | 6.63 | 155.5 |
| MW-AJ | 11/7/2017 | 11 | 52 | 1649.80 | 8.30 | 1641.50 | 76.0 | 7.24 | 6034 | 3.18 | 226.0 |
| MW-K | 11/8/2017 | 0.27 | 1.2 | 1668.60 | 17.10 | 1651.50 | 77.0 | 7.27 | 3486 | 6.16 | 160.8 |
| NX-17 | 11/12/2017 | 0.24 | 0.50 | 1648.47 | 21.19 | 1627.28 | 75.7 | 7.17 | 5469 | 7.53 | 194.9 |
| NY-15 | 11/8/2017 | 0.19 | 0.53 | 1651.90 | 20.60 | 1631.30 | 75.2 | 7.13 | 5412 | 6.90 | 209.6 |
| OY-8 | 11/2/2017 | 0.25 | 0.56 | 1629.10 | 10.10 | 1619.00 | 79.5 | 7.14 | 5570 | 4.90 | 209.5 |
| TWA-20 | 11/8/2017 | 2.3 | 9.6 | 1670.90 | 20.19 | 1650.71 | 77.2 | 7.29 | 4416 | 6.79 | 202.6 |
| TWB-21 | 11/7/2017 | 12 | 68 | 1654.60 | 13.55 | 1641.05 | 78.2 | 7.08 | 6861 | 1.59 | 193.9 |
| TWB-51 | 11/7/2017 | 0.014 | 0.024 | 1654.90 | 14.69 | 1640.21 | 77.5 | 7.48 | 3557 | 1.53 | -71.5 |
| TWC-27 | 11/7/2017 | 0.028 | 6.6 | 1650.06 | 12.65 | 1637.41 | 78.7 | 7.40 | 5334 | 1.53 | 198.6 |
| AA-10[1] | 11/13/2017 | NM | NM | 1615.35 | 20.05 | 1595.30 | NM | NM | NM | NM | NM |
| AAX-15[1] | 11/2/2017 | NM | NM | 1644.30 | 16 | 1628.30 | NM | NM | NM | NM | NM |
| APX-2-45[1] | 11/2/2017 | NM | NM | 1621.10 | 16.65 | 1604.45 | NM | NM | NM | NM | NM |
| APX-4-20[1] | 11/2/2017 | NM | NM | 1618.20 | 10.6 | 1607.60 | NM | NM | NM | NM | NM |
| APX-5-16[1] | 11/19/2017 | NM | NM | 1613.90 | 8.45 | 1605.45 | NM | NM | NM | NM | NM |
| APX-7-14[1] | 11/2/2017 | NM | NM | 1624.70 | 16.95 | 1607.75 | NM | NM | NM | NM | NM |
| MW-S[1] | 11/13/2017 | NM | NM | 1606.20 | 24.19 | 1582.01 | NM | NM | NM | NM | NM |
| OX-16[1] | 11/12/2017 | NM | NM | 1643.25 | 22.3 | NM | NM | NM | NM | NM | NM |
| PC-107[1] | 11/2/2017 | NM | NM | 1616.94 | 10.1 | 1606.84 | NM | NM | NM | NM | NM |
| PX-15[1] | 11/12/2017 | NM | NM | 1640.19 | 23.85 | 1616.34 | NM | NM | NM | NM | NM |
| PY-14[1] | 11/12/2017 | NM | NM | 1639.08 | 23.5 | 1615.58 | NM | NM | NM | NM | NM |

**NM- Not Measured**
**OR- Out of Range**
**Nitrate as N is sampled annually (April/May)**

[1] These wells received DTW measurements only to better assess groundwater capture at the shallow zone extraction system on a semi-annual basis.




Sampling Frequency

- Monthly
- Quarterly
- Semi-Annually
- Annually Only
- (Removed from SAP April 2013)

N

500 0 500 1,000 Feet

Not shown: HMW-8 (Removed from SAP) and MW-K5 (sampled annually)

**Sample Locations and Frequency (North)**

Endeavour LLC

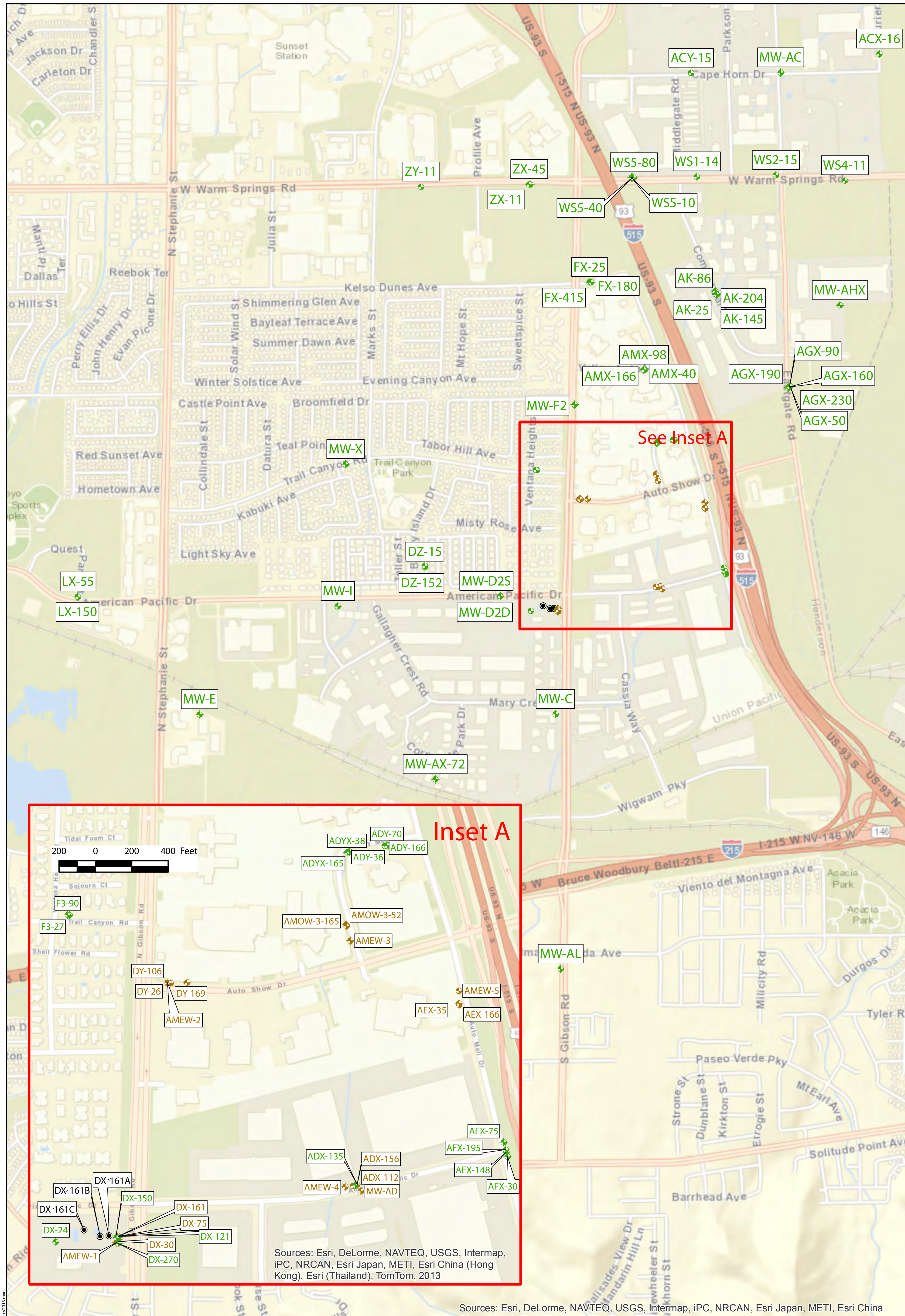
Geosyntec consultants

Guelph

23-Jan-2018

Figure 1

Path: P:\PRJ\Projects\TR0195_FullScale\GIS_SAP_FrequencyNorth.mxd




800 0 800 1,600 Feet

N

Sampling Frequency
- Monthly
- Quarterly
- Semi-Annually
- Annually Only
- (Removed from SAP April 2013)

Not shown: BHE1-10, sampled annually

**Sample Locations and Frequency (South)**

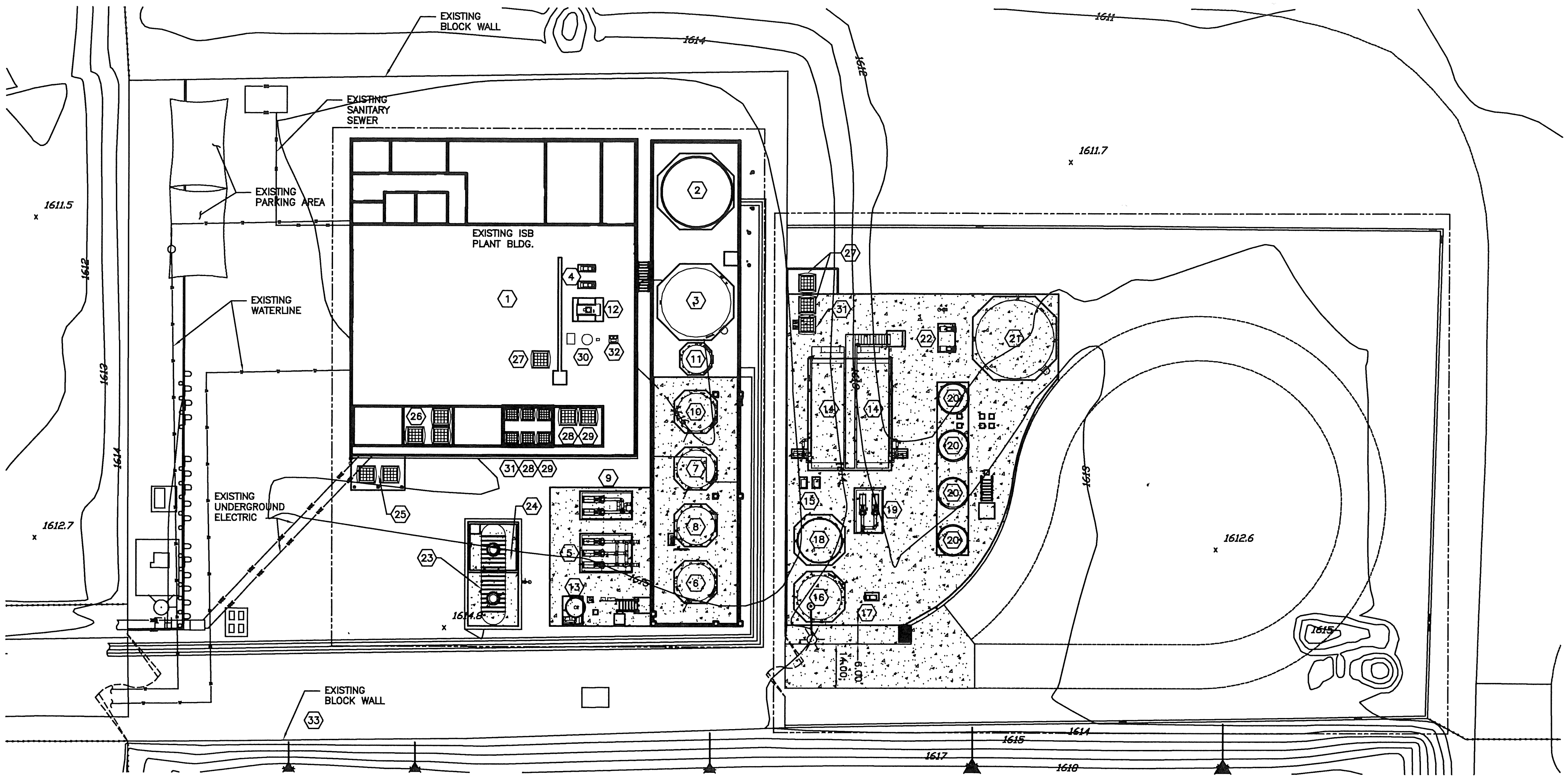
**Endeavour LLC**

Geosyntec consultants

Guelph | 23-Jan-2018

**Figure 2**

Path: P:\PRJ\Projects\TR0195_FullScale\GIS\SAP_Frequency2013.mxd




LEGEND

1615 — EXISTING CONTOUR

CMU WALL, BY OTHERS

PROPOSED CONCRETE

GENERAL NOTES:

1. THIS SITE CONTAINS SEVERAL CHEMICALS THAT COULD DEVELOP A HAZARDOUS SITUATION IF INADVERTENTLY MIXED. THE LIST BELOW ARE CHEMICALS THAT HAVE BEEN IDENTIFIED IN A RISK ASSESSMENT AS NEEDING TO BE KEPT SEGREGATED.

25 HYDROGEN PEROXIDE——ETHANOL 23 24

27 FERRIC CHLORIDE——HYDROGEN PEROXIDE 25

28 DI-AMMONIUM PHOSPHATE—— SODIUM HYDROXIDE 26

34 CATIONIC POLYMER——HYDROGEN PEROXIDE 25

28 UREA——SODIUM HYDROXIDE 26

28 UREA——HYDROGEN PEROXIDE 25

## OVERALL SITE PLAN

1"=20'-0"

REFERENCE TABLE

| REF. # | PROCESS EQUIPMENT | EQUIPMENT TAG |
|---|---|---|
| 1 | NOT IN USE | |
| 2 | INFLUENT EQUALIZATION TANK #1 | T-110 |
| 3 | INFLUENT EQUALIZATION TANK #2 | T-120 |
| 4 | INFLUENT PUMPS | P-110A, P-110B |
| 5 | FIRST STAGE FBR PUMP SKID | P-130, P-135, P-140 |
| 6 | 1ST STAGE FLUIDIZED BED REACTOR #1 | FBR-130 |
| 7 | 1ST STAGE FLUIDIZED BED REACTOR #2 | FBR -140 |
| 8 | MEDIA SEPARATOR | SEP-130 |
| 9 | SECOND STAGE FBR PUMP SKID | P-210A, P-210B |
| 10 | 2ND STAGE FLUIDIZED BED REACTOR | FBR-210 |
| 11 | AERATION TANK | T-220 |
| 12 | PACKAGE BLOWERS | B-220A, B-220A |
| 13 | BIOFILTER ODOR SCRUBBER | T-600, T-601, B-600 |
| 14 | DISSOLVED AIR FLOTATION TANKS | D-300, D-310 |
| 15 | DISSOLVED AIR FLOTATION PUMPS | P-300, P-310 |
| 16 | SLUDGE STORAGE TANK | T-410 |
| 17 | MIXING/AERATION PUMP | P-410 |
| 18 | CLARIFIED WATER TANK | T-400 |
| 19 | CLARIFIED WATER PUMPS | P-400A, P-400B |
| 20 | SAND FILTERS | SF-610, SF-620, SF-630, SF-640 |
| 21 | EFFLUENT EQUALIZATION TANK | T-130 |
| 22 | EFFLUENT PUMPS | P-300A, P-300B |
| 23 | UNDERGROUND ETHANOL TANK | T-720, 10,000 GAL |
| 24 | ELECTRON DONOR SYSTEM/ ETHANOL | P-720, P-721, P-722, P-723 |
| 25 | HYDROGEN PEROXIDE FEED SYSTEM | 2 - 270 GAL TOTES |
| 26 | pH FEED SYSTEM/ SODIUM HYDROXIDE | 3 - 270 GAL TOTES |
| 27 | COAGULANT FEED SYSTEM/ FERRIC CHLORIDE | 2 - 270 GAL TOTES OUTSIDE 1 - TOTE INSIDE |
| 28 | NUTRIENT FEED SYSTEM (DI-AMMONIUM PHASPHATE/UREA) | 3 - 270 GAL TOTES |
| 29 | MICRO NUTRIENT FEED SYSTEM (MET SOURCE AN) | 3 - 270 GAL TOTES |
| 30 | AIR SUPPLY SYSTEM | COMPRESSOR, TANK, DESSICANT AIR DRYER |
| 31 | DAF POLYMER (ICS 2835B) FEED SYSTEM | 1 - 270 GAL TOTE OUTSIDE 2 - TOTES INSIDE |
| 32 | OXYGEN GENERATOR | 0-400 |
| 33 | HCl STORAGE | 2 - 15 GAL CONTAINERS |

ENDEAVOUR, LLC

| | | | | | |
|---|---|---|---|---|---|
| 1 | 07-31-12 | REMOVED FIND NUMBERS | RGS | FWF | GAC |
| 0 | 07-19-12 | NEW DRAWING FOR AGTS | RGS | FWF | GAC |
| REV | DATE | DESCRIPTION | DWN | CHK | APPR |

GROUNDWATER TREATMENT SYSTEM
(AGTS)
HENDERSON, NV

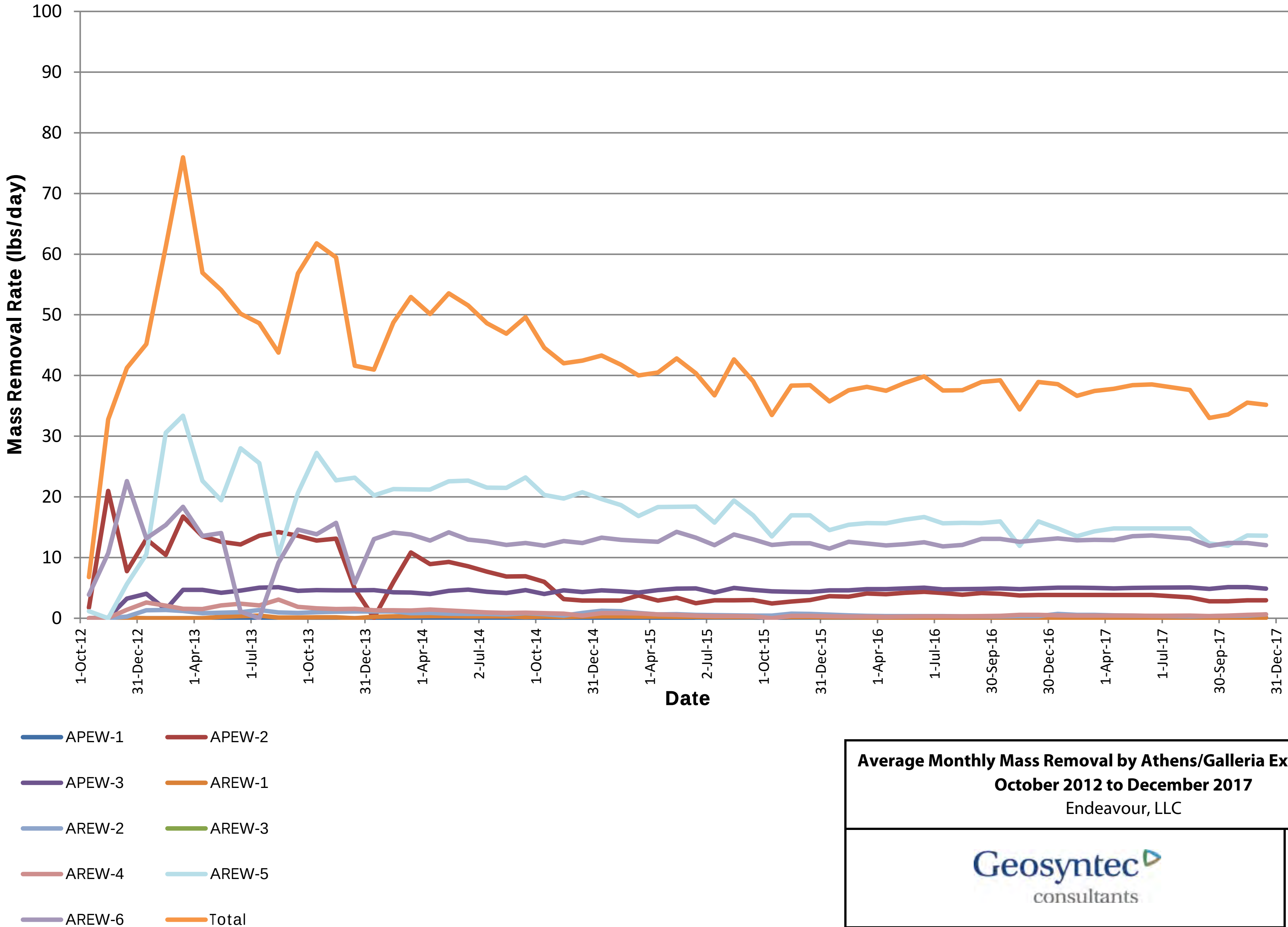
FIGURE 3
SITE PLAN

0 1" 2"

FILENAME 400-G-002-1.dwg

SCALE 1"=20'

SHEET 400-G-002-1

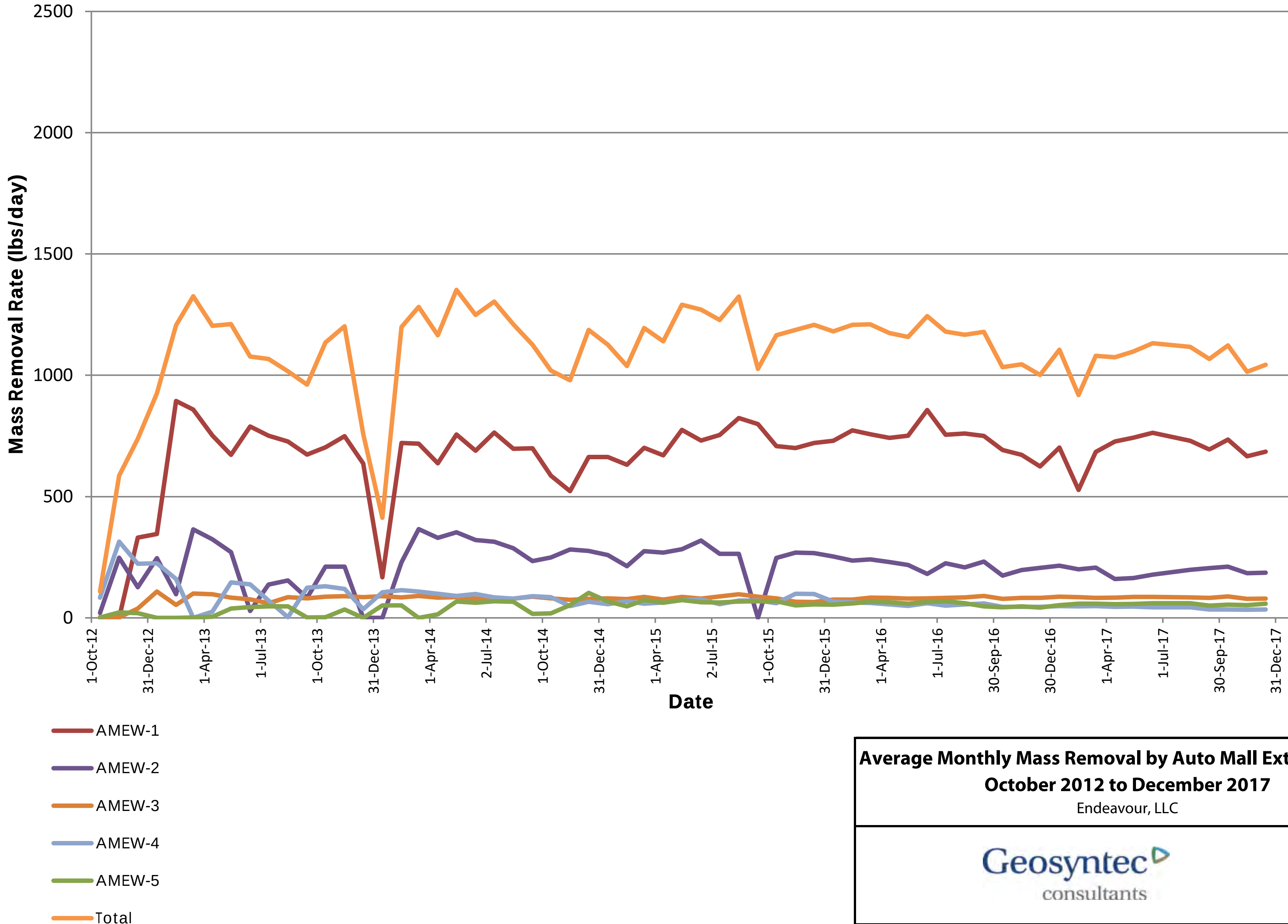



**Average Monthly Mass Removal by Athens/Galleria Extraction Well**
**October 2012 to December 2017**
Endeavour, LLC

Geosyntec consultants

Figure **4a**

Guelph | 2-Feb-18

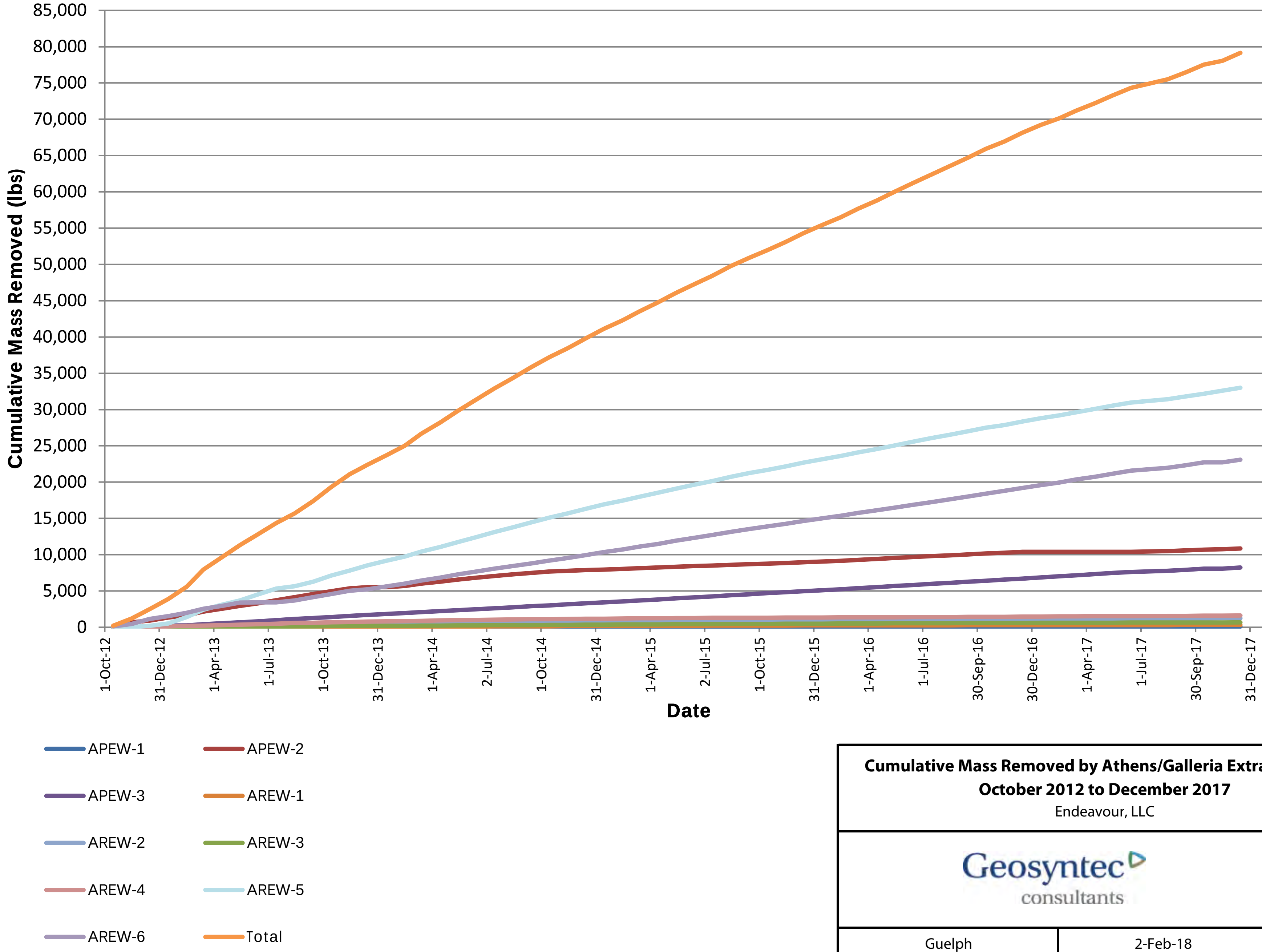



**Average Monthly Mass Removal by Auto Mall Extraction Well**
**October 2012 to December 2017**
Endeavour, LLC

Geosyntec consultants

Figure **4b**

Guelph | 2-Feb-18




**Cumulative Mass Removed by Athens/Galleria Extraction Well**
**October 2012 to December 2017**

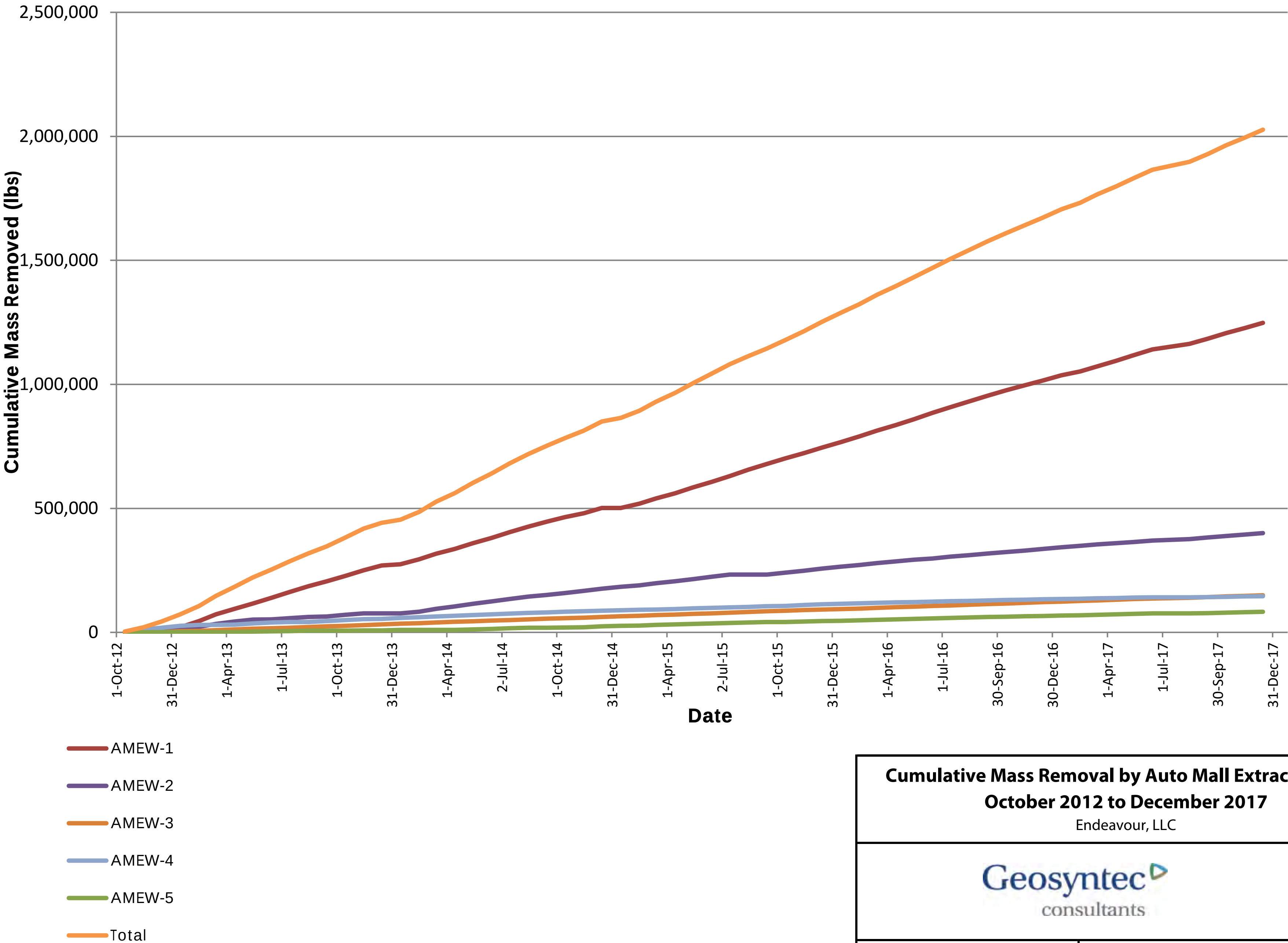
Endeavour, LLC

Geosyntec consultants

Figure **5a**

Guelph | 2-Feb-18

\\Oakland-01\data\PRJ2003REM\Endeavour\53. Reports\Monitoring Reports\2H2017\Figures\[Figure 4ab, 5ab - MassRemovalByEW_MonthlyData_2H17.xlsx]Fig5b-cum.mass.rem.b




**Cumulative Mass Removal by Auto Mall Extraction Well**
**October 2012 to December 2017**
Endeavour, LLC

Geosyntec consultants

Figure **5b**

Guelph | 2-Feb-18

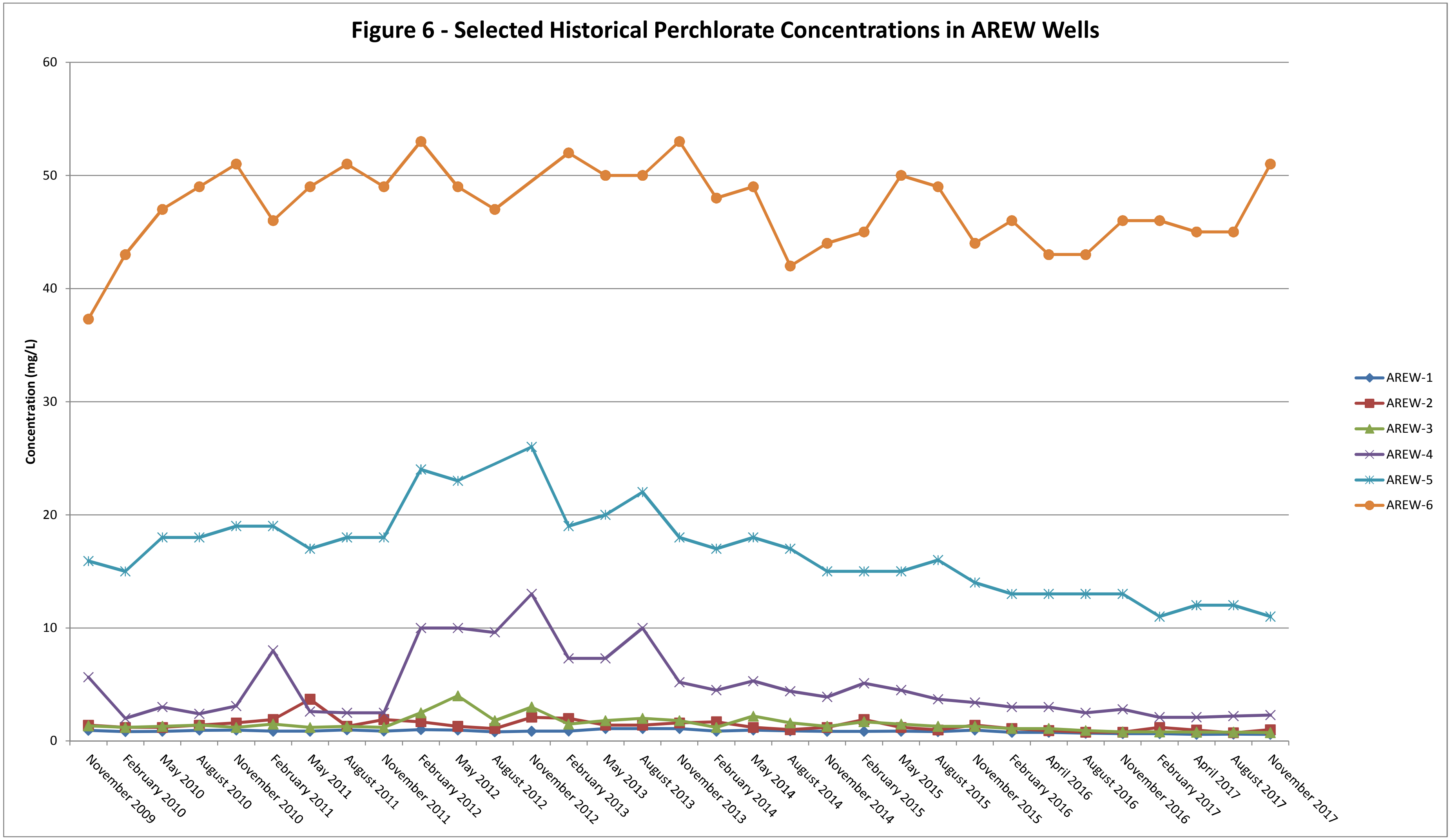


Figure 6 - Selected Historical Perchlorate Concentrations in AREW Wells
Concentration (mg/L)
60
50
40
30
20
10
0
November 2009
February 2010
May 2010
August 2010
November 2010
February 2011
May 2011
August 2011
November 2011
February 2012
May 2012
August 2012
November 2012
February 2013
May 2013
August 2013
November 2013
February 2014
May 2014
August 2014
November 2014
February 2015
May 2015
August 2015
November 2015
February 2016
April 2016
August 2016
November 2016
February 2017
April 2017
August 2017
November 2017
AREW-1
AREW-2
AREW-3
AREW-4
AREW-5
AREW-6

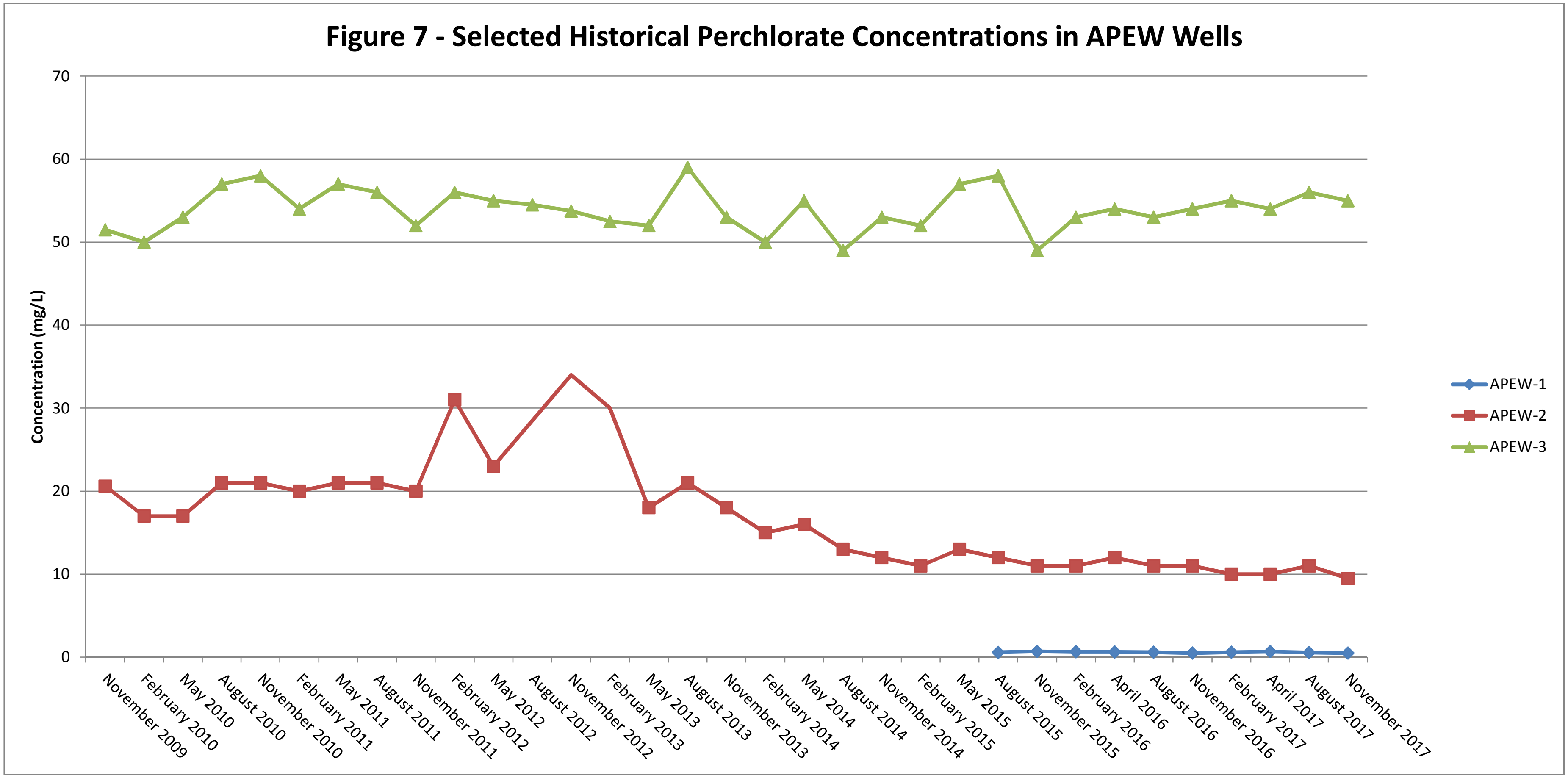


Figure 7 - Selected Historical Perchlorate Concentrations in APEW Wells
Concentration (mg/L)
70
60
50
40
30
20
10
0
November 2009
February 2010
May 2010
August 2010
November 2010
February 2011
May 2011
August 2011
November 2011
February 2012
May 2012
August 2012
November 2012
February 2013
May 2013
August 2013
November 2013
February 2014
May 2014
August 2014
November 2014
February 2015
May 2015
August 2015
November 2015
February 2016
April 2016
August 2016
November 2016
February 2017
April 2017
August 2017
November 2017
APEW-1
APEW-2
APEW-3

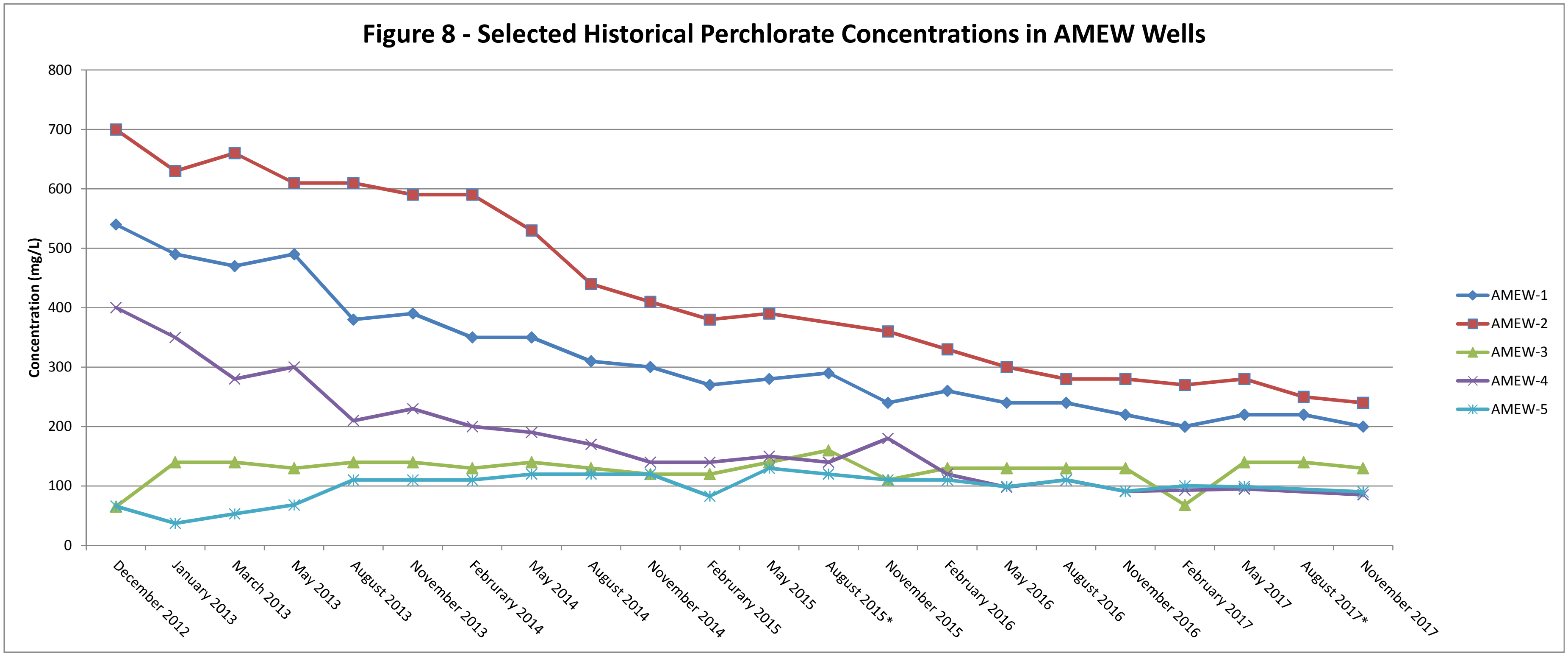
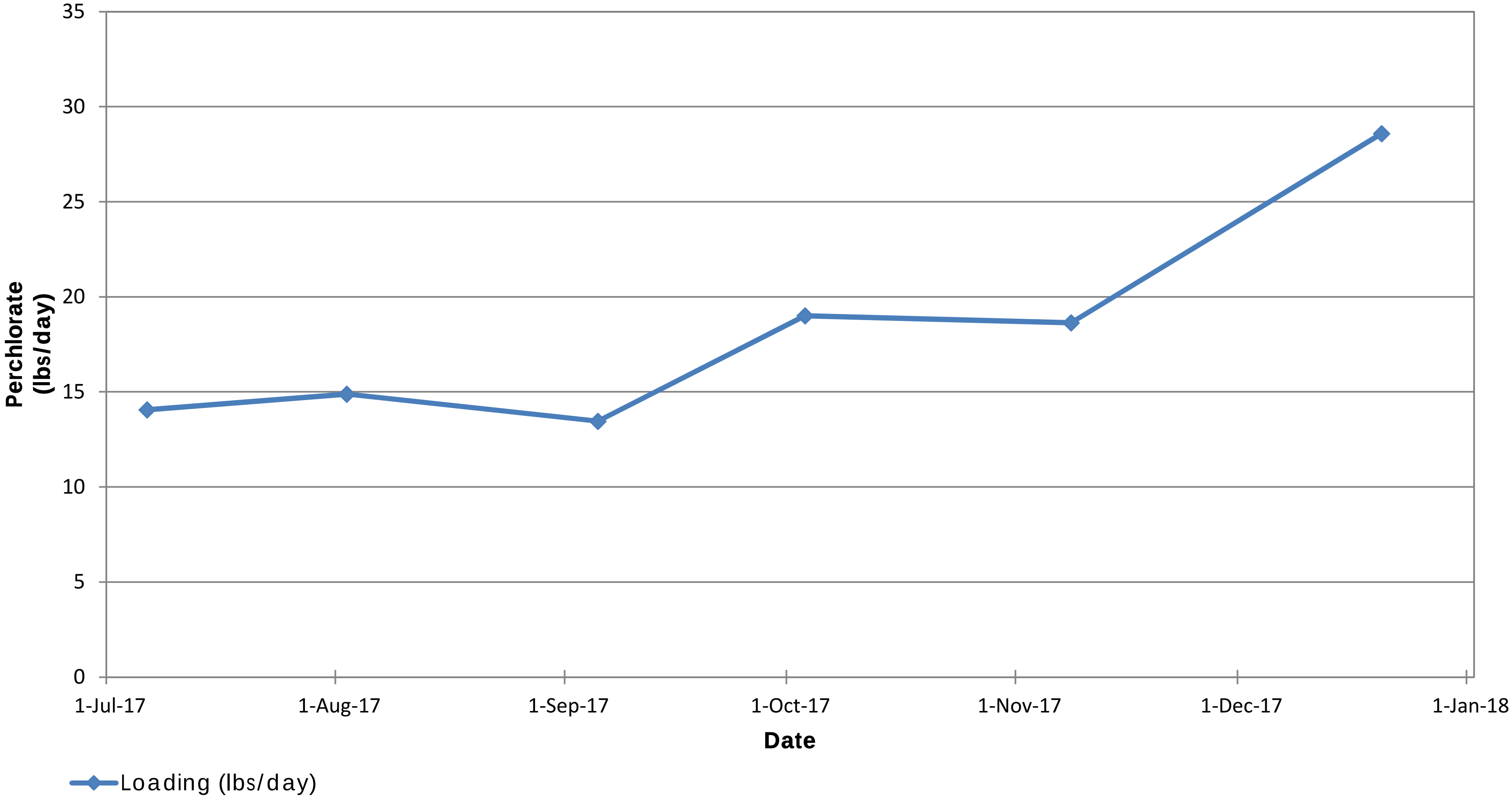


Figure 8 - Selected Historical Perchlorate Concentrations in AMEW Wells
Concentration (mg/L)
800
700
600
500
400
300
200
100
0
AMEW-1
AMEW-2
AMEW-3
AMEW-4
AMEW-5
December 2012
January 2013
March 2013
May 2013
August 2013
November 2013
Februrary 2014
May 2014
August 2014
November 2014
Februrary 2015
May 2015
August 2015*
November 2015
Februrary 2016
May 2016
August 2016
November 2016
Februrary 2017
May 2017
August 2017*
November 2017



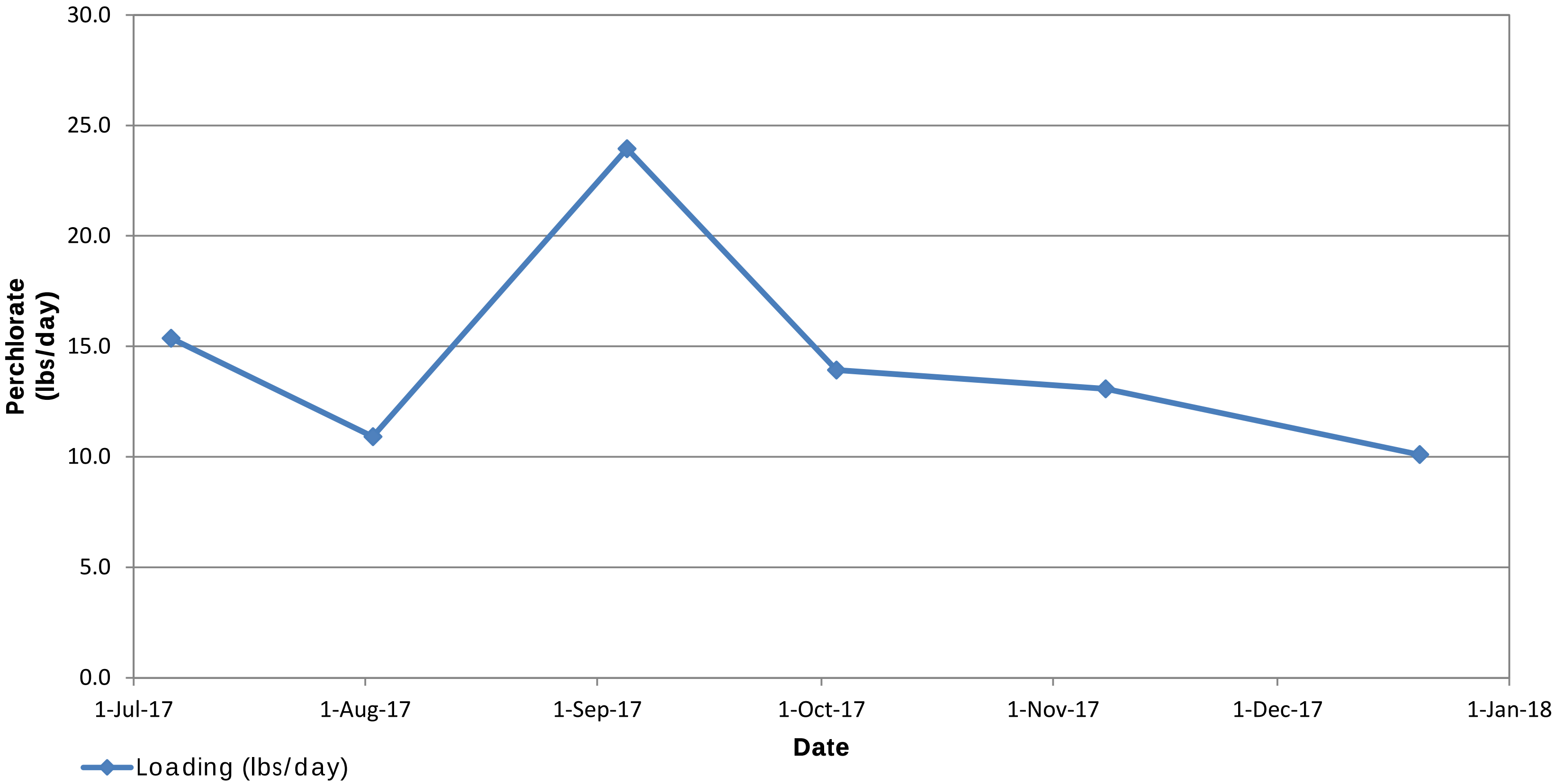

Notes:
lbs/day - pounds per day
Flow measurement on 8/2/2017 estimated due to too much debris in channel.

**Monthly Perchlorate Loading in AC Main**
**July 1 to December 31, 2017**
Endeavour LLC

Geosyntec consultants

Figure **9**

Oakland | January 2018



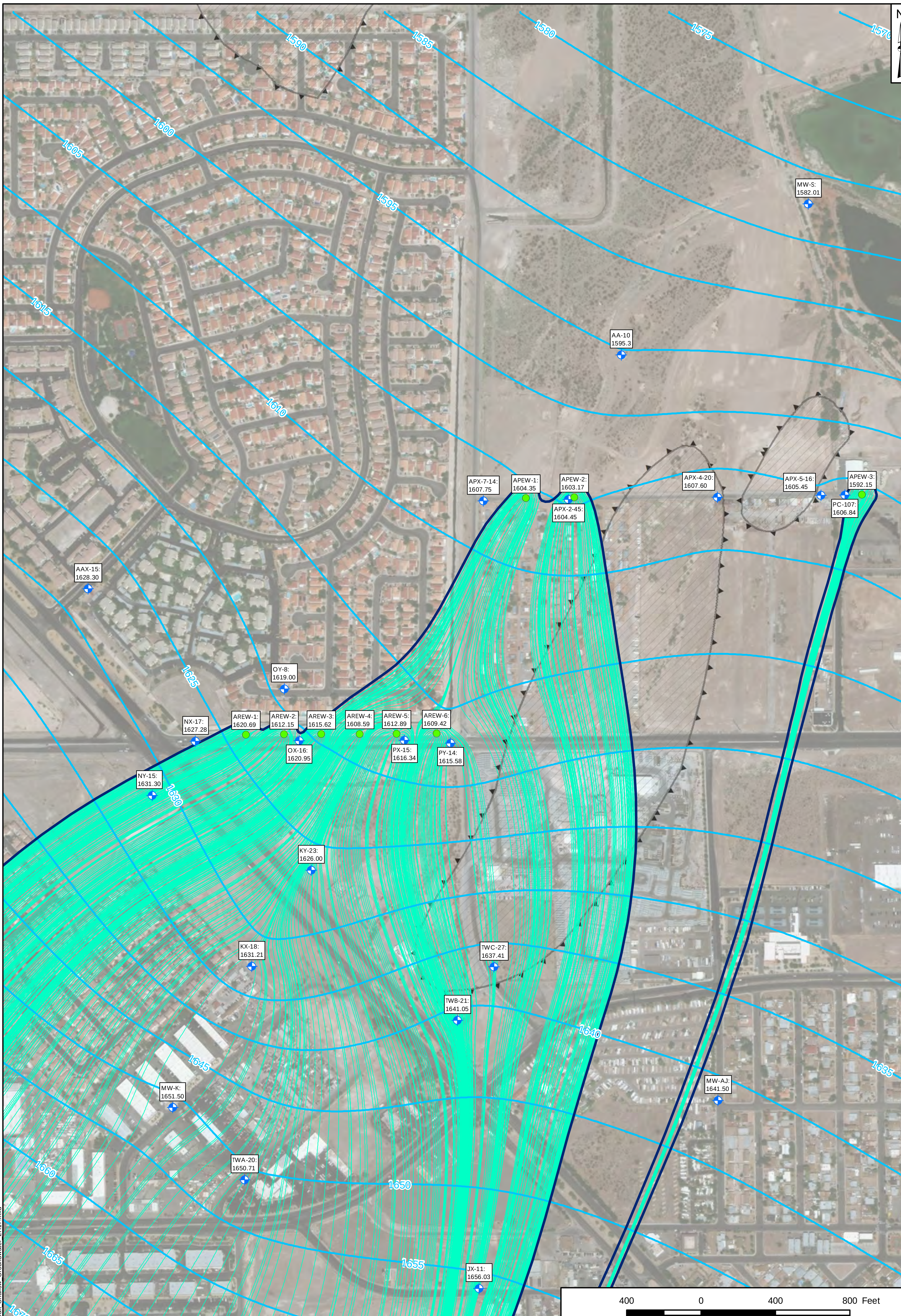

Note:
lbs/day - pounds per day

**Monthly Perchlorate Loading in Eastgate Storm Drain**
**July 1 to December 31, 2017**
Endeavour LLC

Geosyntec consultants

Figure **10**

Guelph | January 2018




- Operating Extraction Well
- Groundwater Elevation at Monitoring Well (ft msl)
- Capture Zone (numerical method)
- Groundwater Equipotential (ft msl) - 5 Feet
- Particle Tracking
- "Muddy Creek High"

Notes:
ft msl - feet above mean sea level
Water levels measured in extraction wells not used for contouring
Aerial Photograph courtesy of Microsoft Corporation

Groundwater Equipotentials in Shallow Water Bearing Zone, Athens/Galleria Extraction Area
November 2, 2017 to November 19, 2017
Endeavour LLC

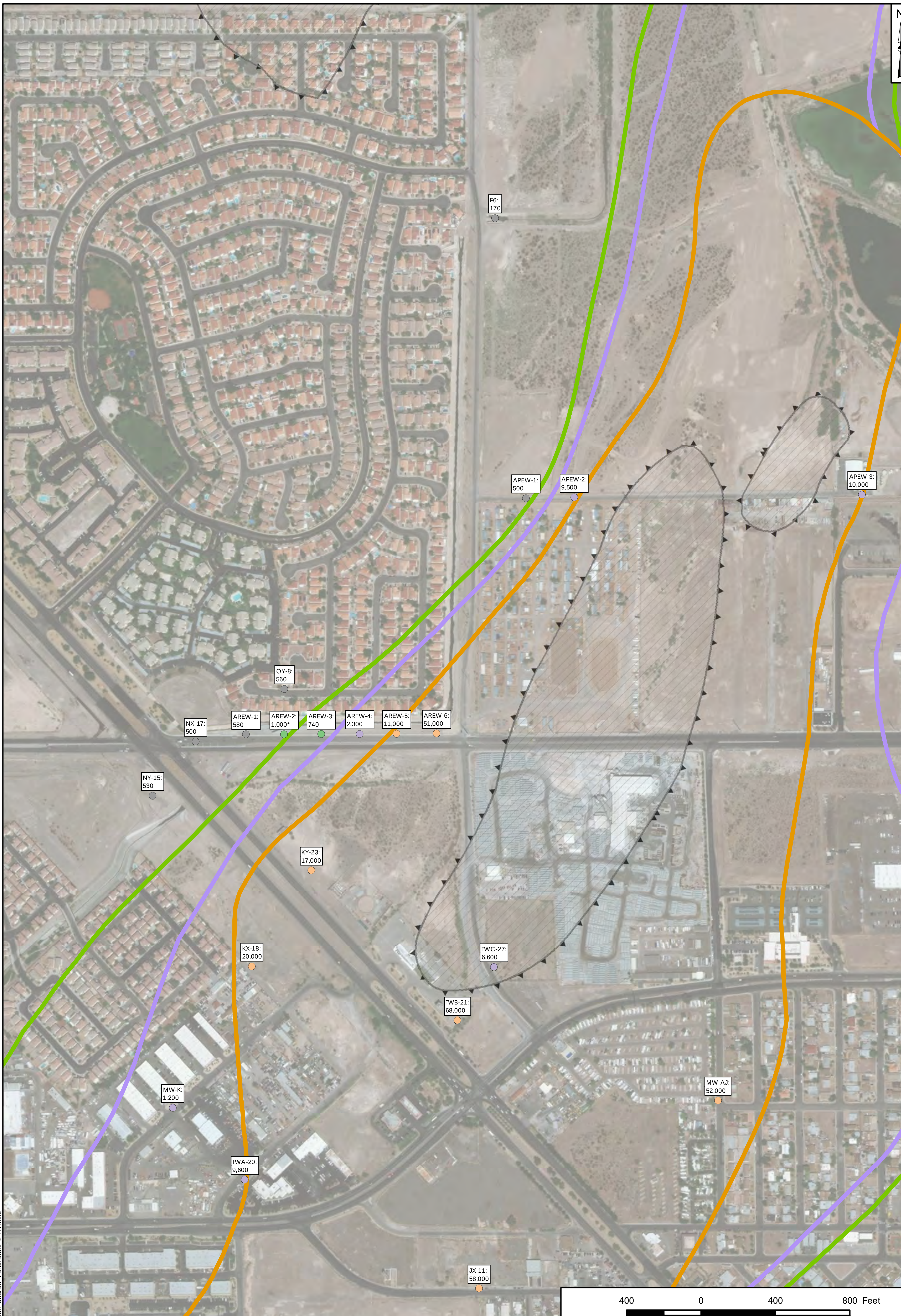
Geosyntec consultants

Figure 11

Guelph

23-Jan-2018

Path: P:\GIS\Endeavour\2H17\MXD\Endeavour_Tabloid_Portrait_Shallow_Groundwater_2H17.mxd




Measured Concentration (µg/L)
- >10,000
- >1,000 - 10,000
- >700 - 1,000
- ≤700

Isoconcentration Contour (µg/L)
- 10,000
- 1,000
- 700

"Muddy Creek High"

Notes:
µg/L - Micrograms per Liter
All concentrations in µg/L
* - Value not contoured
Aerial Photograph courtesy of Microsoft Corporation

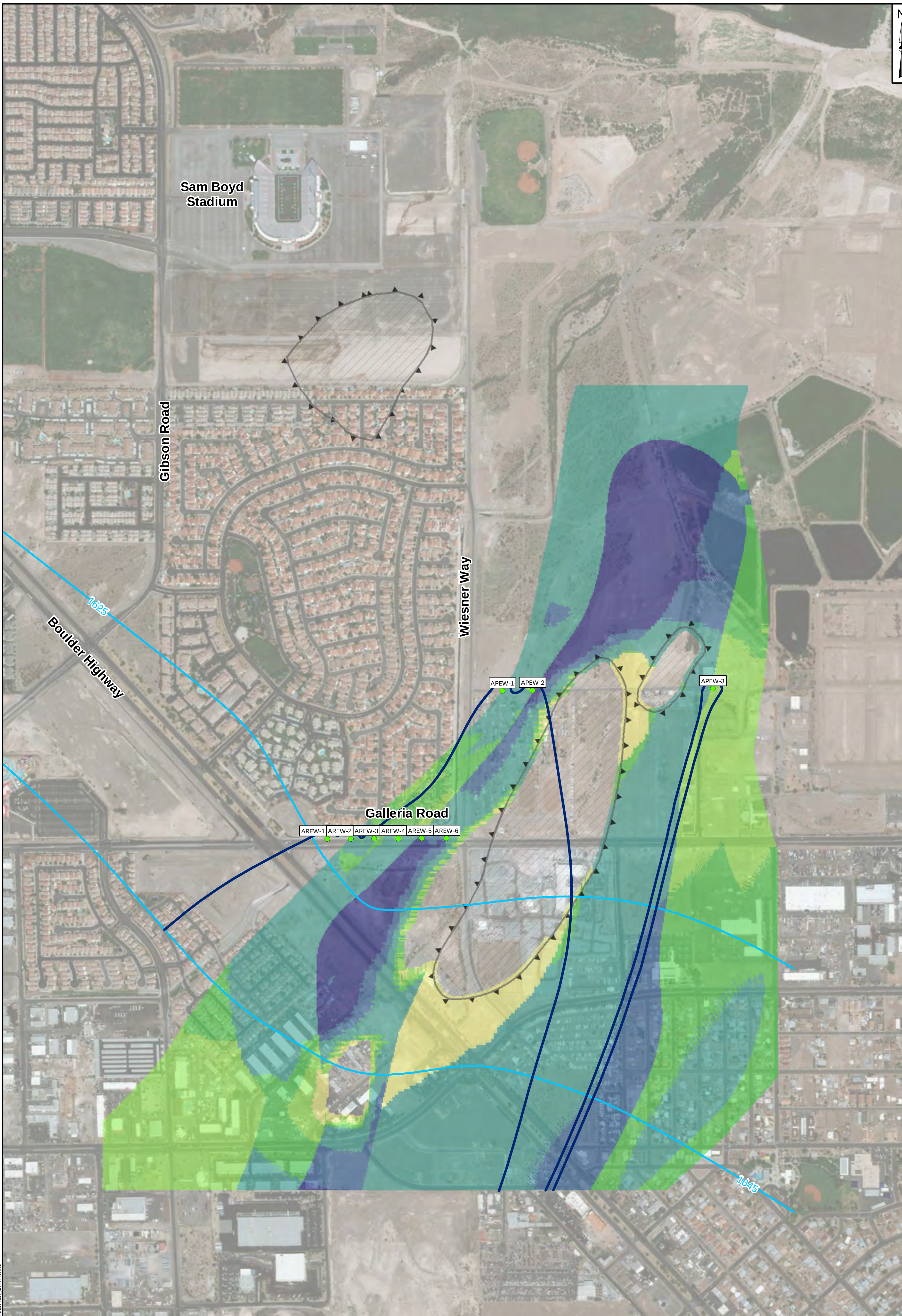
Path: P:\GIS\Endeavour\2H17\MXD\Endeavour_Tabloid_Portrait_Shallow_Perchlorate_2H17.mxd

Perchlorate in Shallow Water Bearing Zone,
Athens/Galleria Extraction Area
November 2, 2017 to November 19, 2017
Endeavour LLC

Geosyntec
consultants

Figure
12

Guelph
17-Jan-2018




Operating Extraction Well

Capture Zone (numerical method)

Groundwater Equipotential (ft msl)

"Muddy Creek High"

Mass Flux per Unit Width
(lbs/day/ft)

≤0.0001

>0.0001 - 0.0005

>0.0005 - 0.001

>0.001 - 0.005

>0.005 - 0.01

>0.01

400 0 400 800 Feet

Notes:
ft msl - feet above mean sea level
lbs/day/ft - pounds per day per foot
Aerial Photograph courtesy of Microsoft Corporation

Perchlorate Loading per Width
in Shallow Water Bearing Zone
November 2, 2017 to November 19, 2017

Endeavour LLC

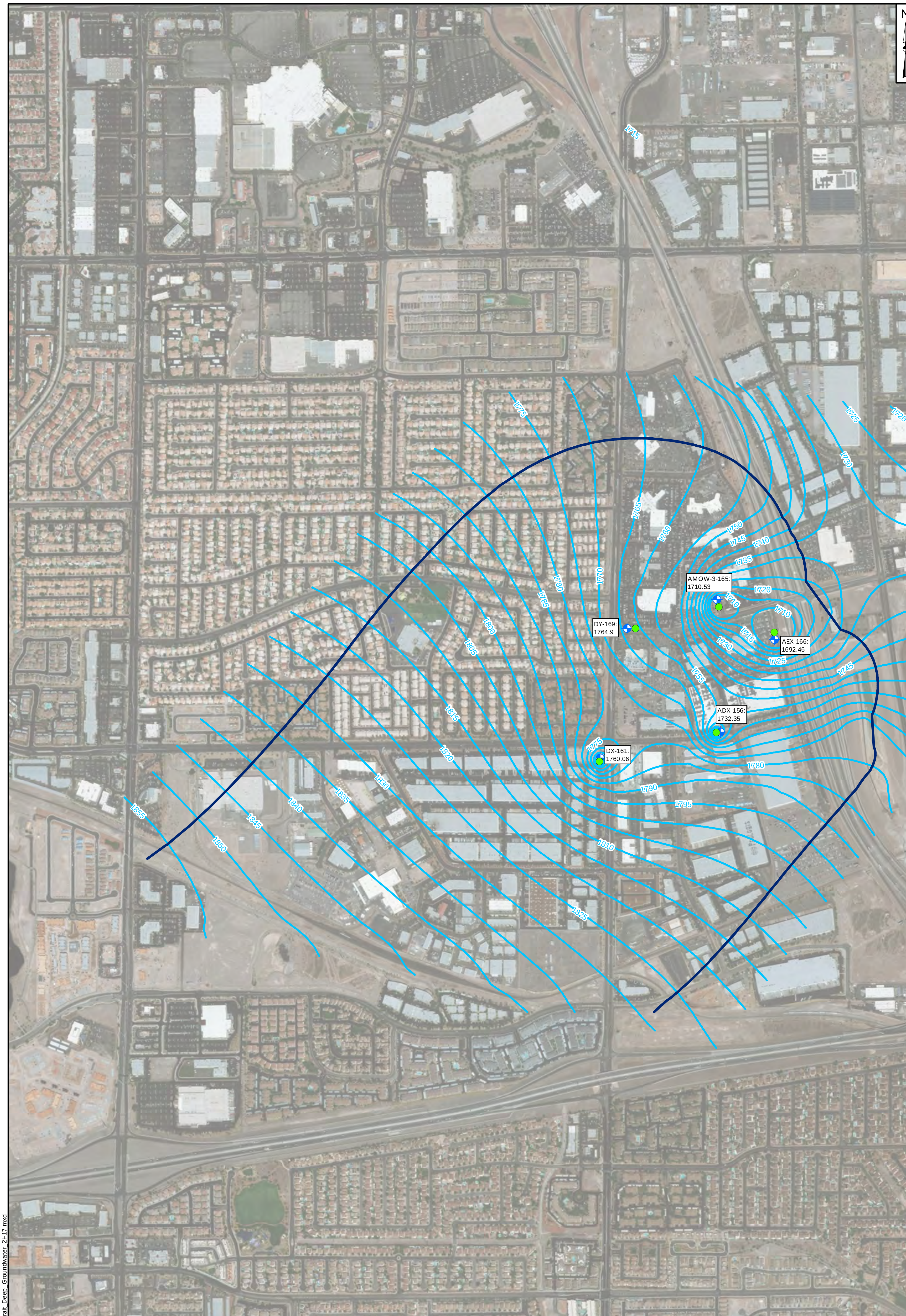
Geosyntec
consultants

Figure
13

Guelph

23-Jan-2018

Path: P:\GIS\Endeavour\2H17\MXD\Endeavour_Tabloid_Portrait_MassFlux_2H17.mxd




Operating Extraction Well

Groundwater Elevation at Monitoring Well (ft msl)

Groundwater Equipotential (ft msl) - 5 Feet

Capture Zone (numerical method)

500 0 500 1,000 Feet

Notes:
ft msl - feet mean sea level
Aerial photograph courtesy of Microsoft Corporation

**Groundwater Equipotentials in Deep Water Bearing Zone, Auto Mall Extraction Area**
**November 5, 2017 to November 12, 2017**

Endeavour, LLC

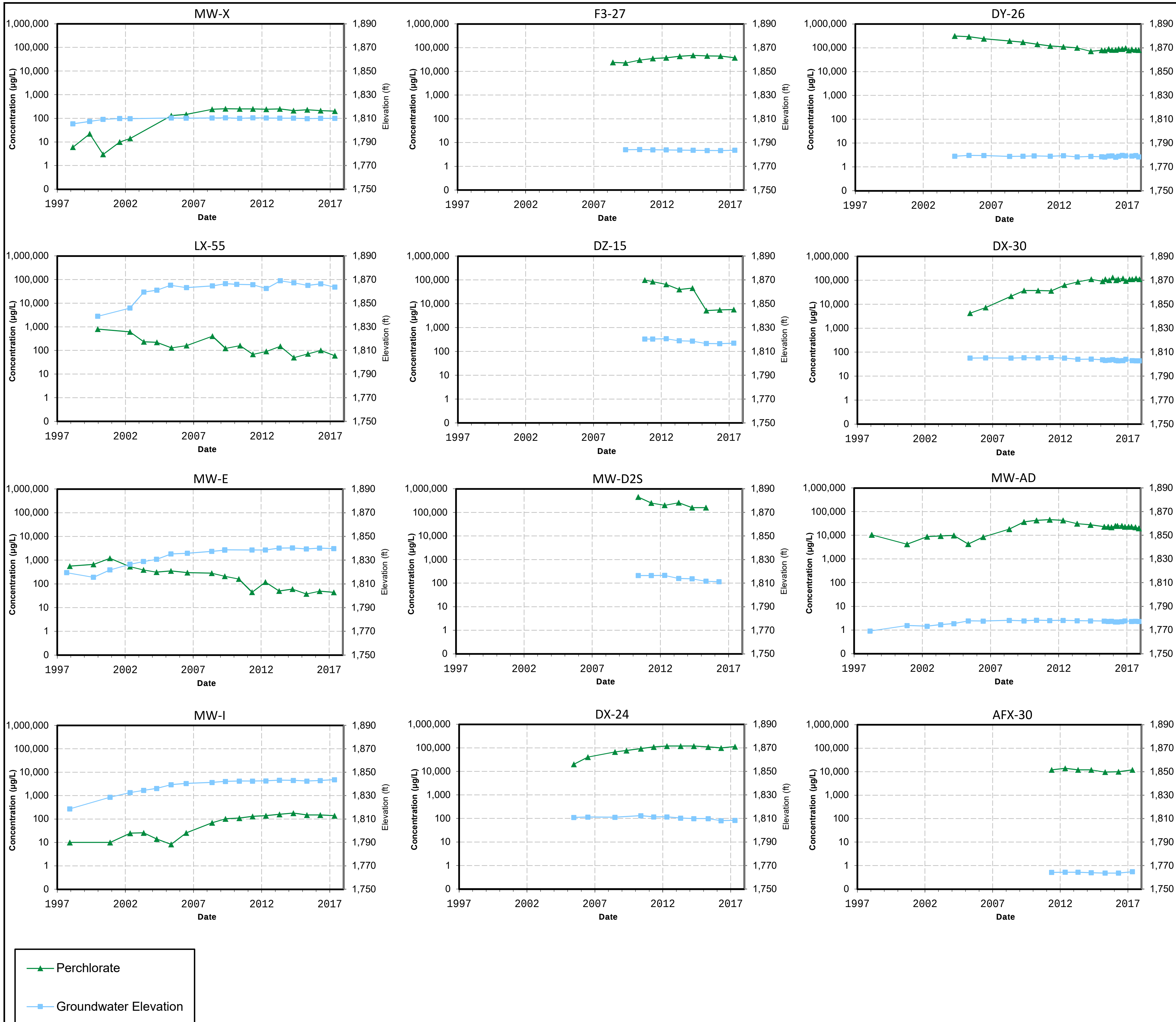
Geosyntec consultants

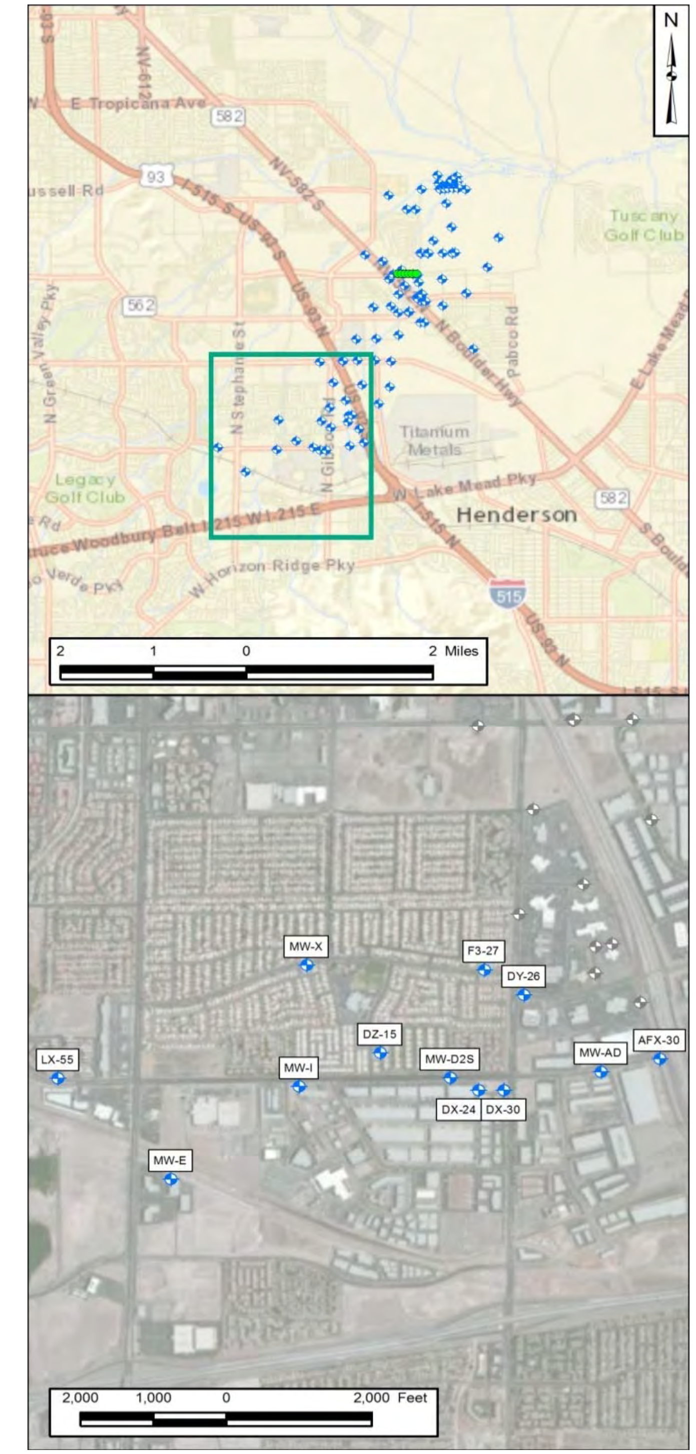
Guelph

12-Jan-2018

**Figure 14**

Path: P:\GIS\Endeavour\2H17\MXD\Endeavour_Tabloid_Portrait_Deep_Groundwater_2H17.mxd




MW-X Monitoring Well

APEW-1 Extraction Well

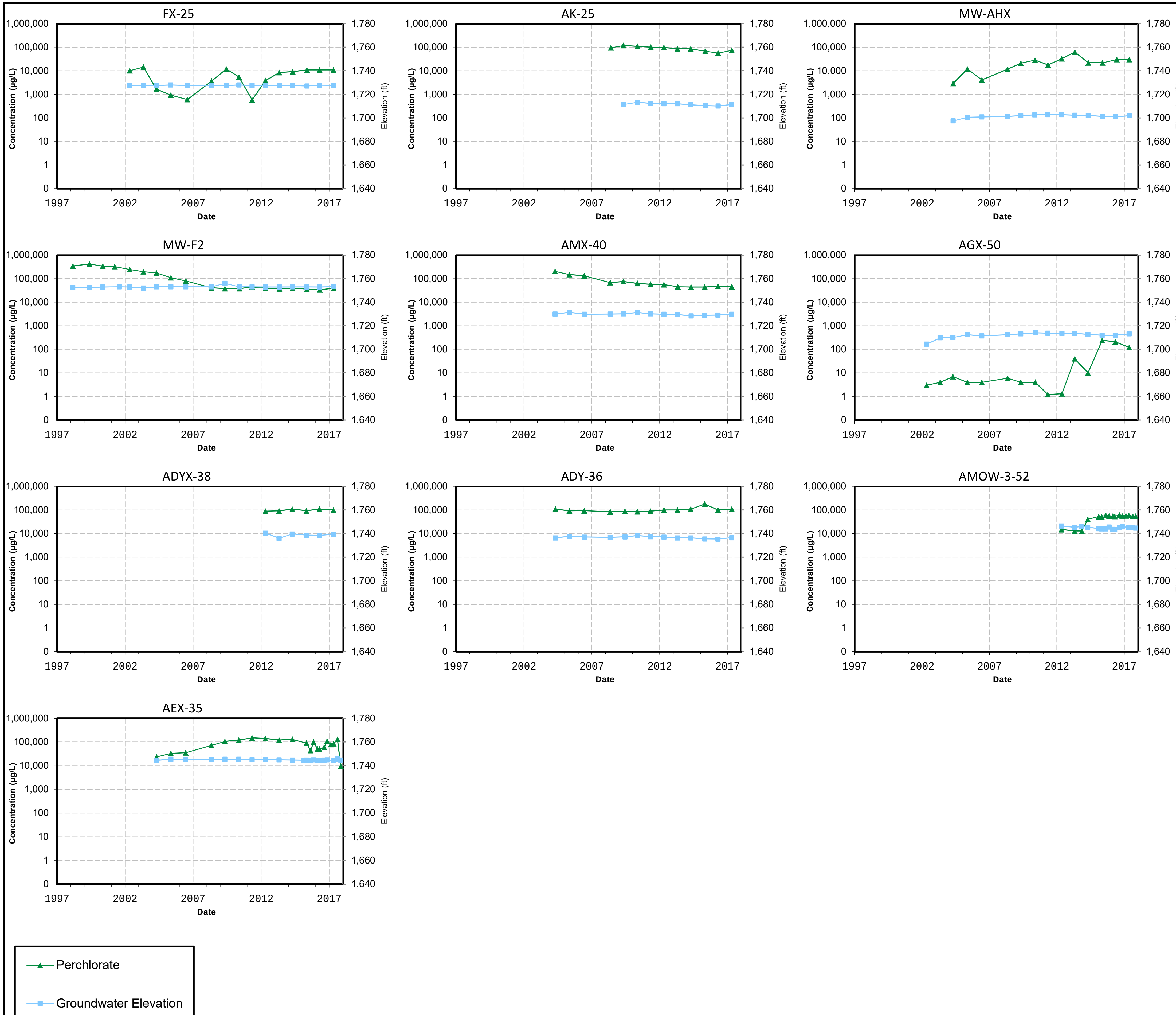
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, Auto Mall West**
Endeavour LLC
Henderson, Nevada

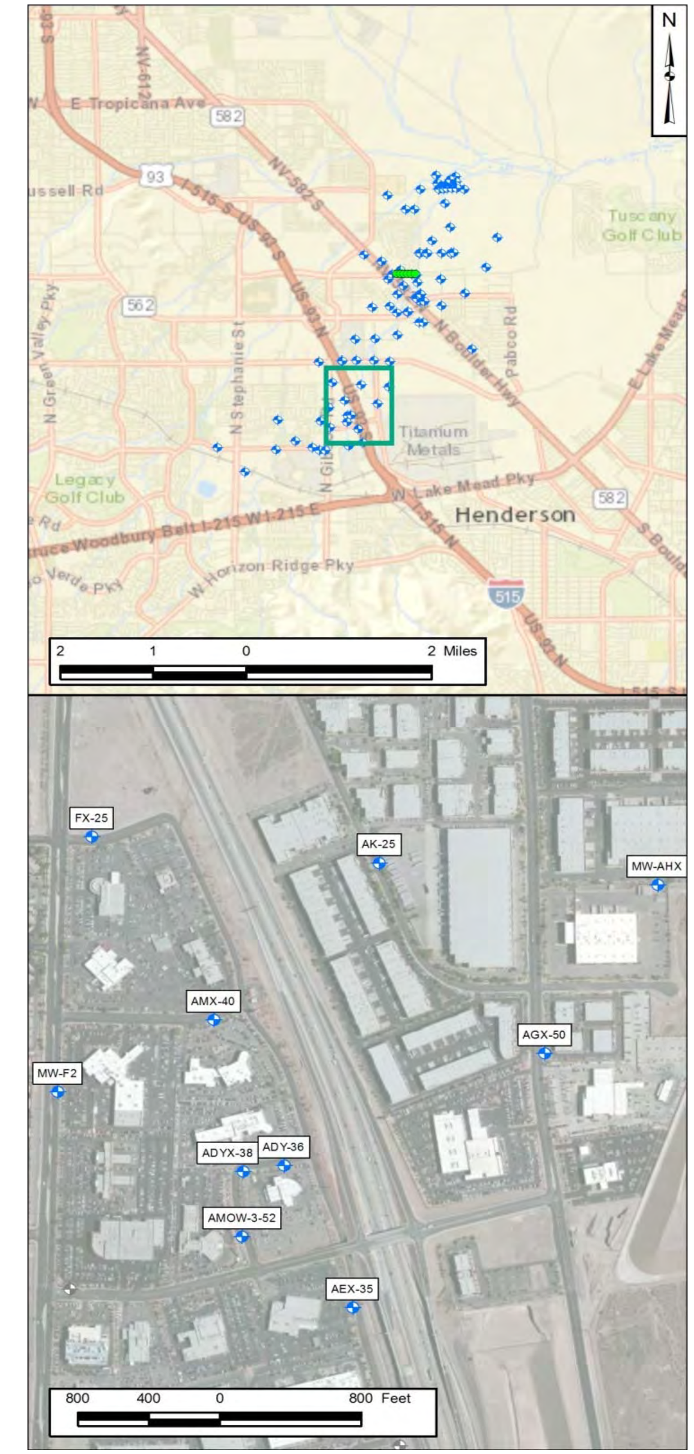
Geosyntec consultants

Figure **15**

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow1_TimeSeries_13Charts.xlsx




FX-25 Monitoring Well

APEW-1 Extraction Well

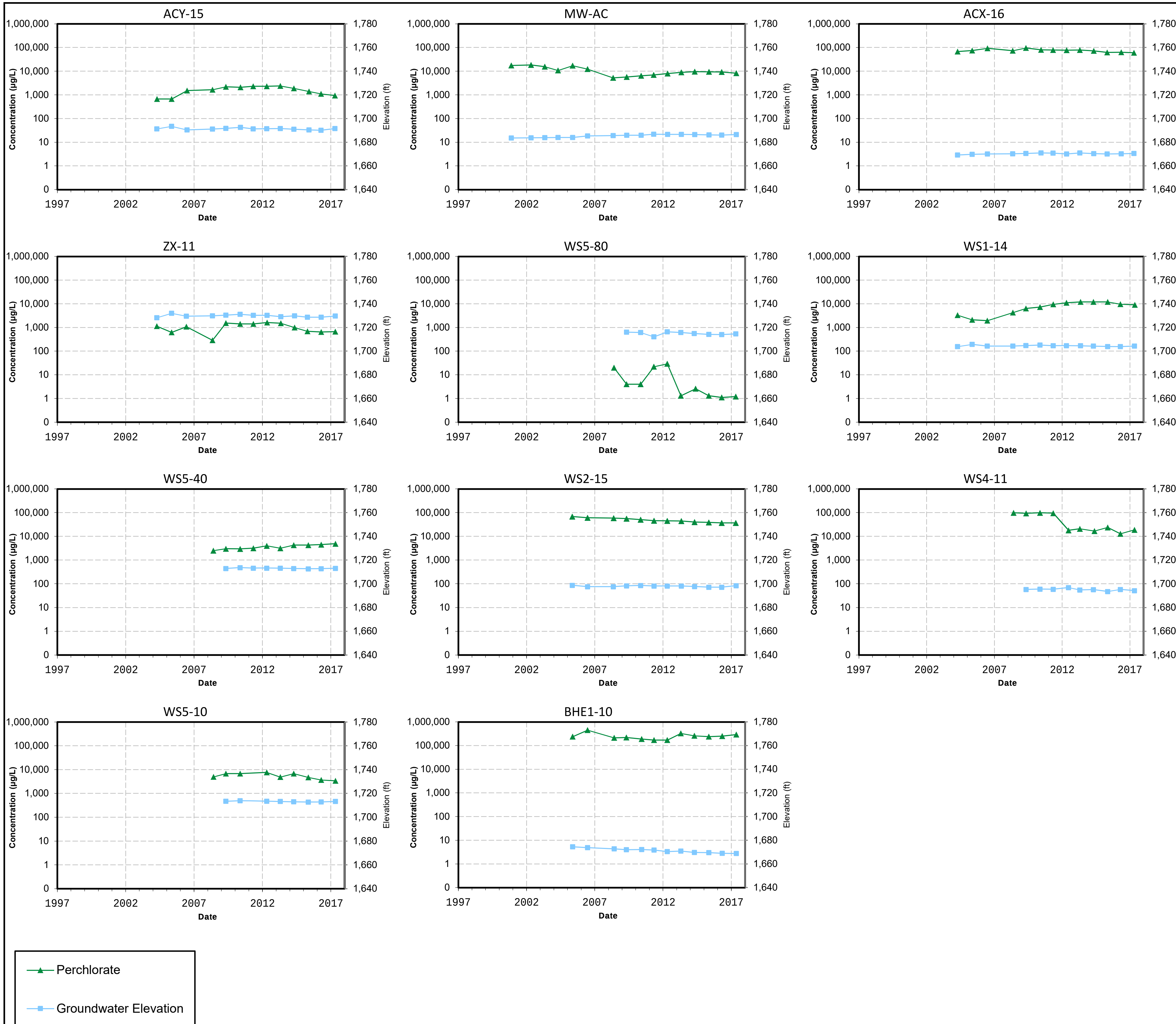
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, Auto Mall East**
Endeavour LLC
Henderson, Nevada

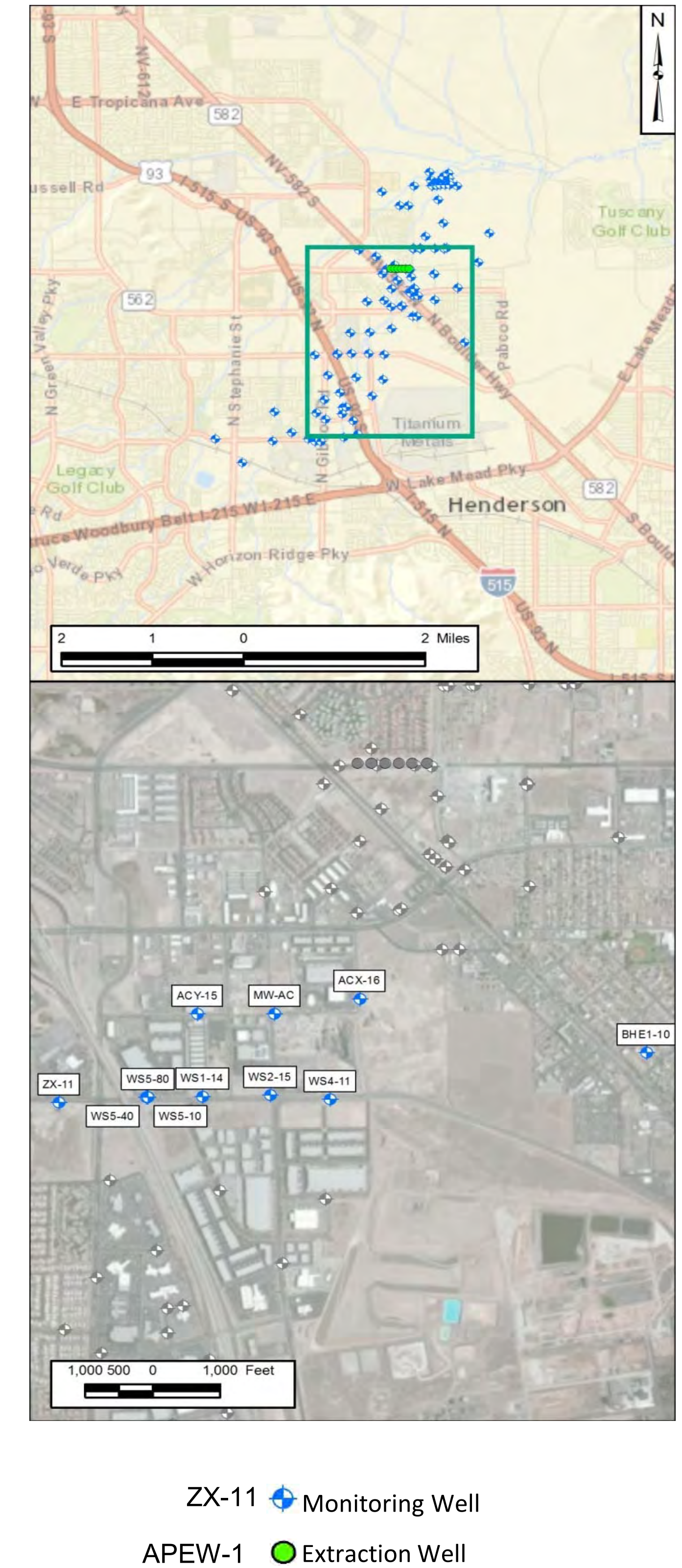
Geosyntec consultants

Figure 16

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow2_TimeSeries_11Charts.xlsx



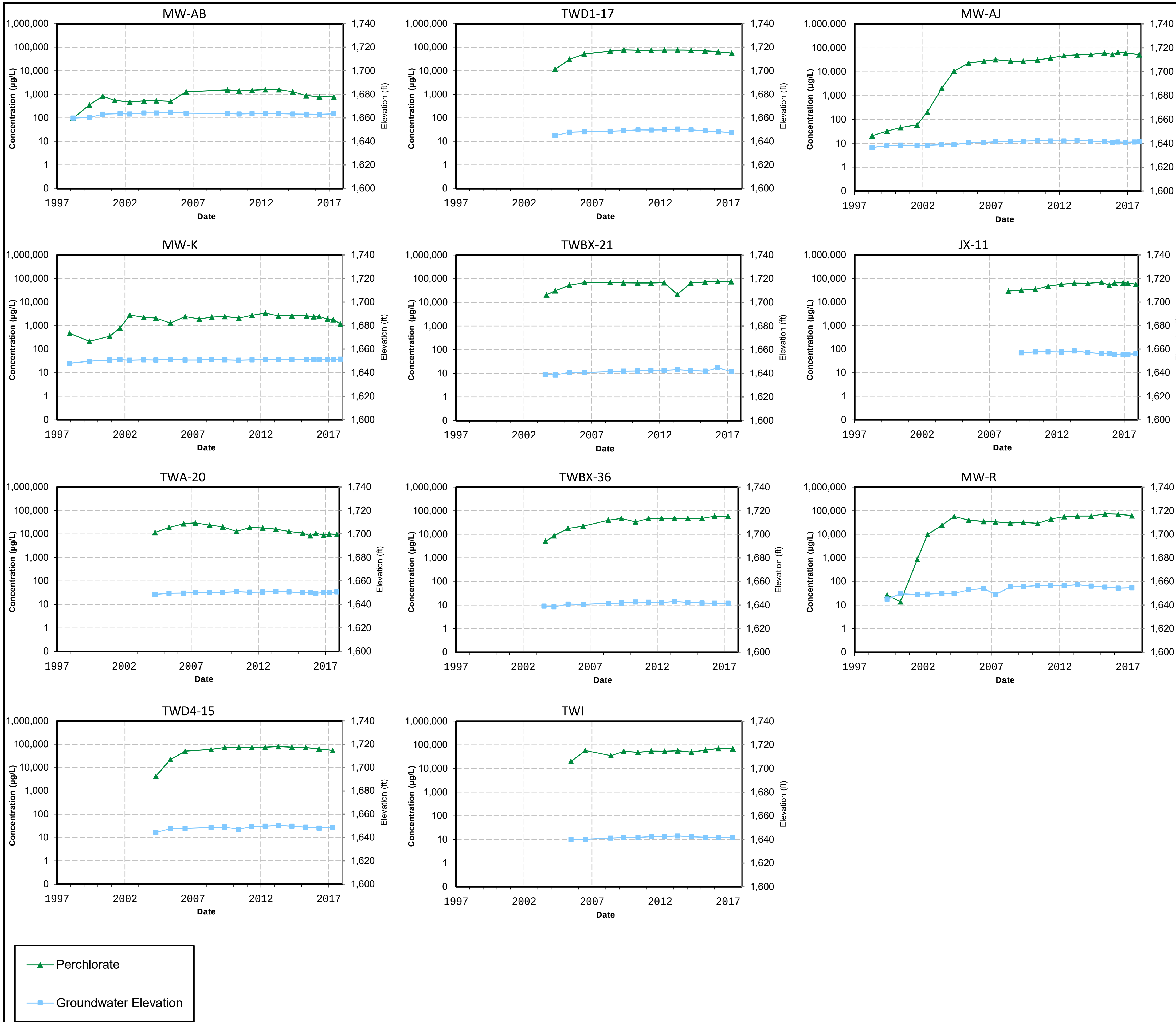

**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, Warm Springs/Eastgate**
Endeavour LLC
Henderson, Nevada

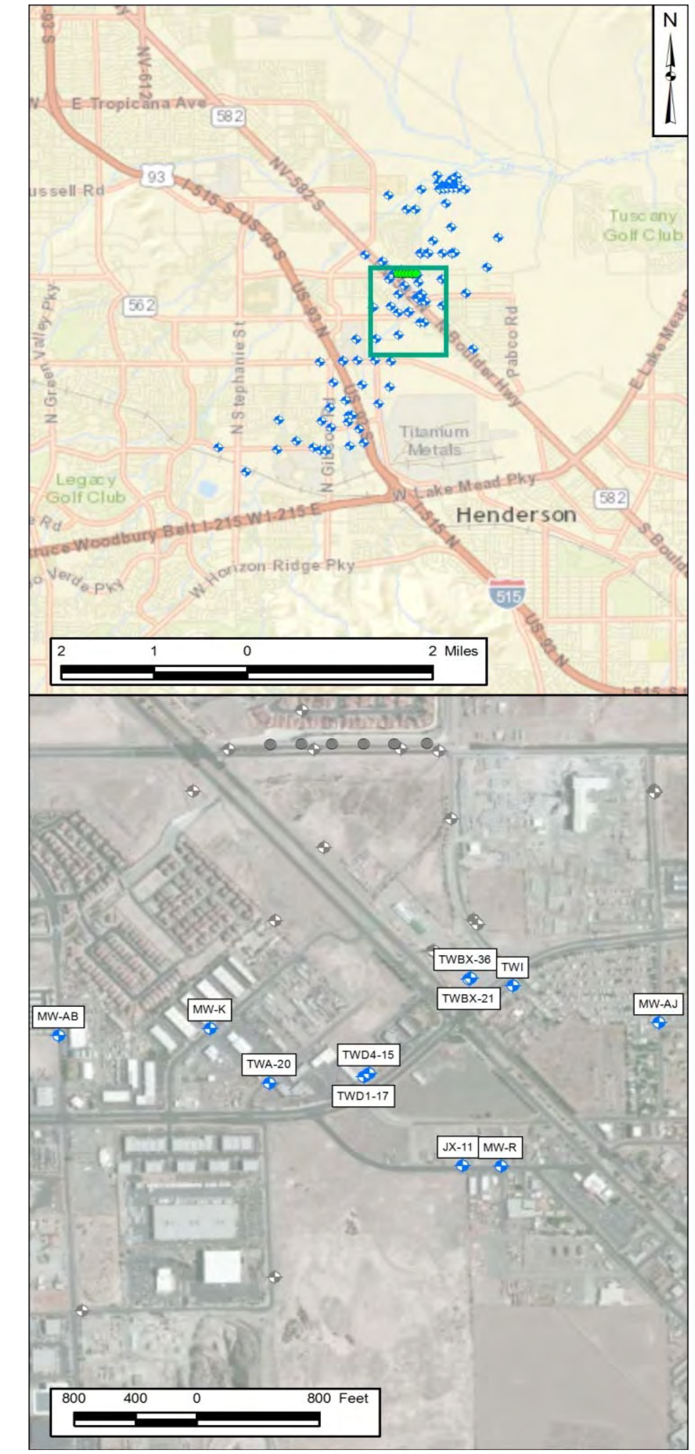
Geosyntec consultants

Figure **17**

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow3_TimeSeries_12Charts.xlsx




MW-AB Monitoring Well

APEW-1 Extraction Well

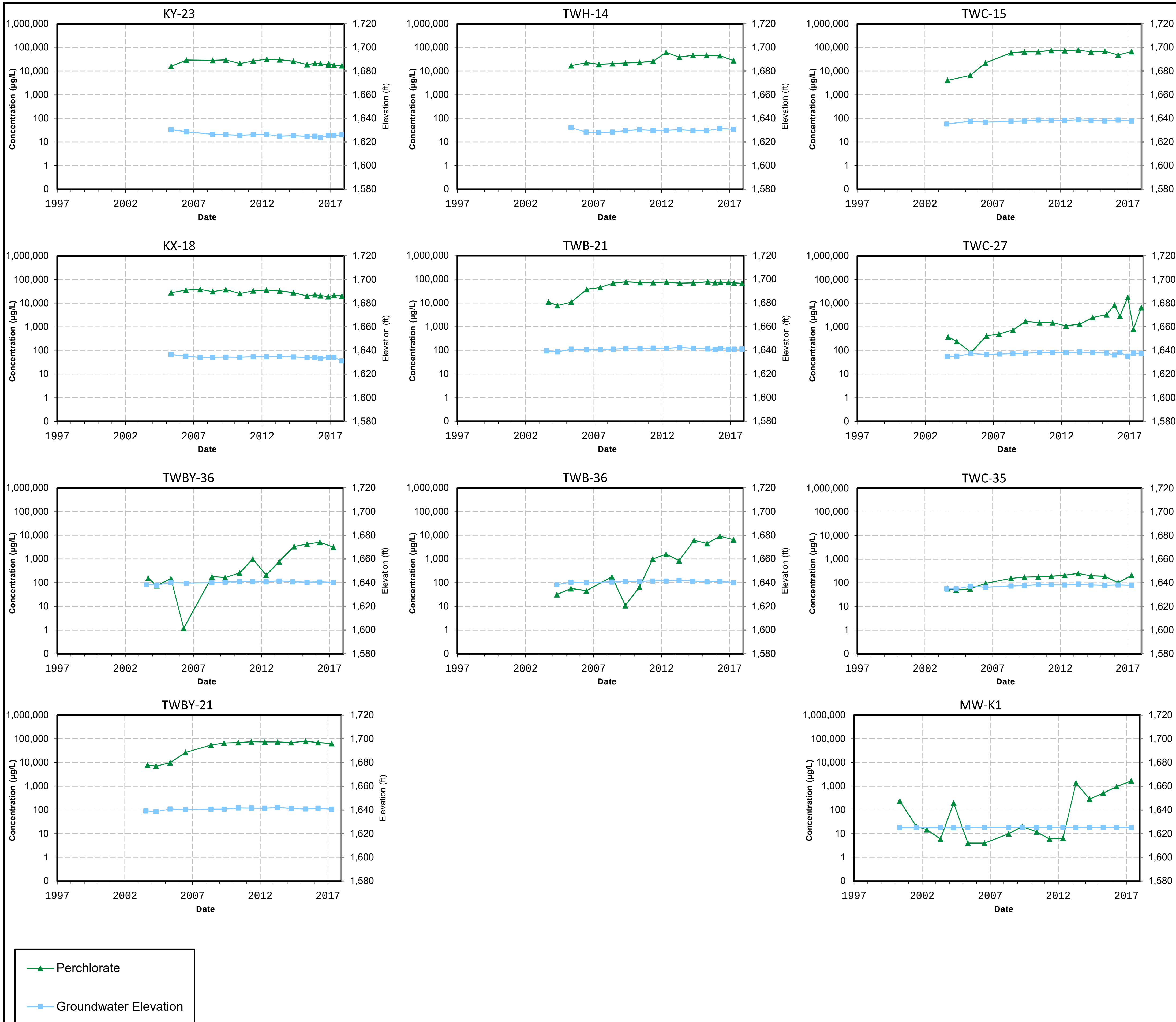
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, Sunset/Boulder West**
Endeavour LLC
Henderson, Nevada

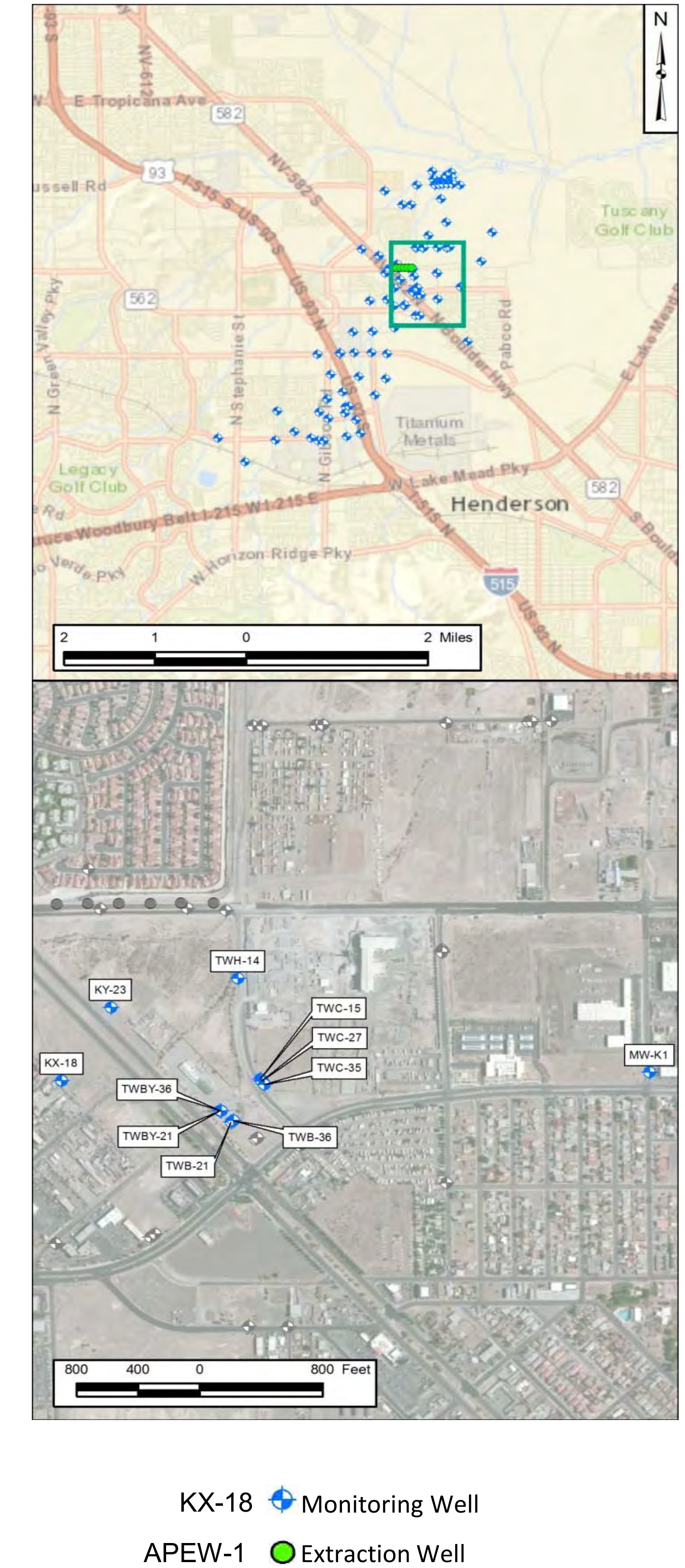
Geosyntec consultants

Figure **18**

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow4_TimeSeries_12Charts.xlsx



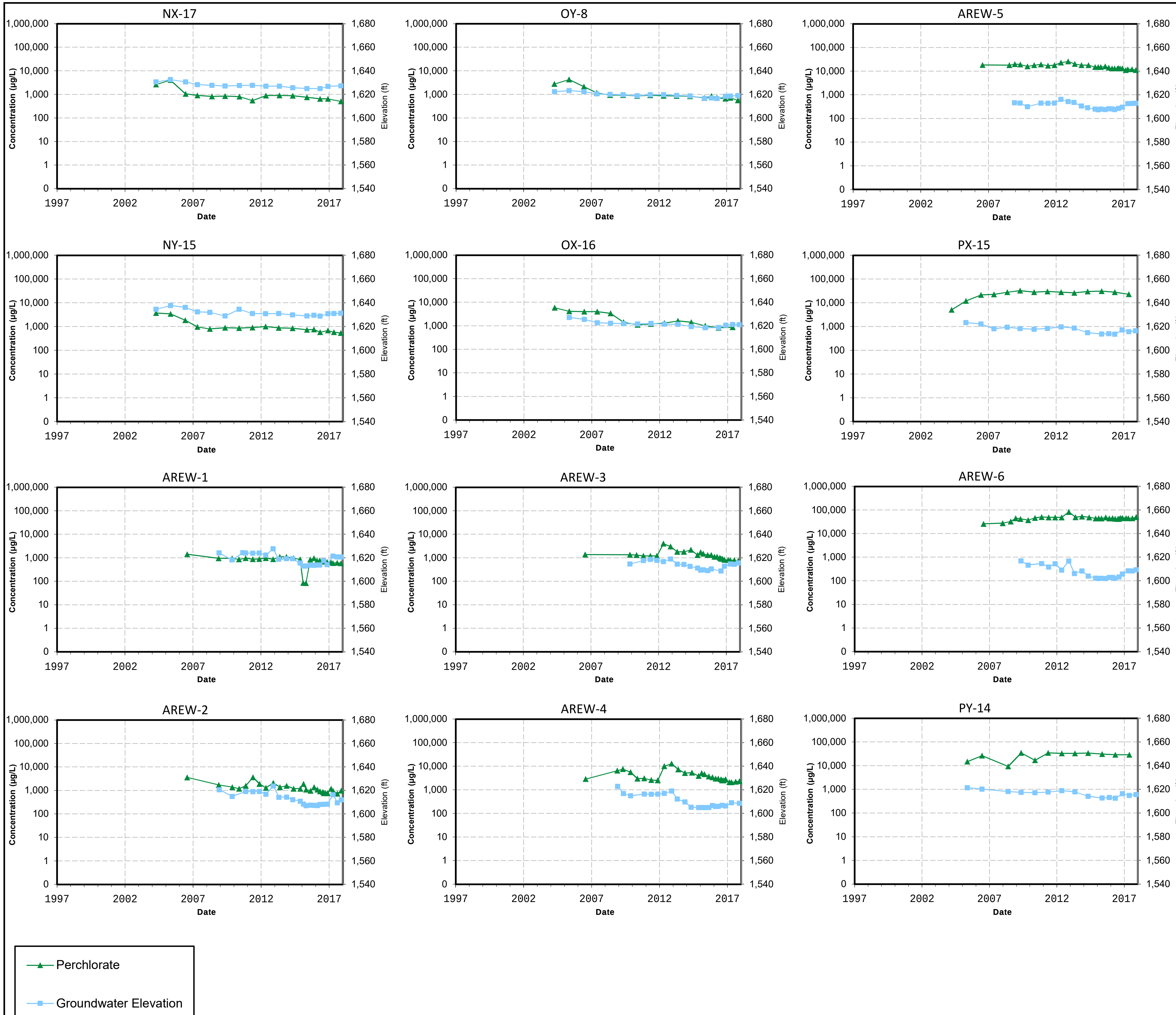




**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, Sunset/Boulder East**
Endeavour LLC
Henderson, Nevada

Geosyntec consultants

| Oakland | January 2018 | Figure 19 |
|---|---|---|

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow5_TimeSeries_12Charts.xlsx





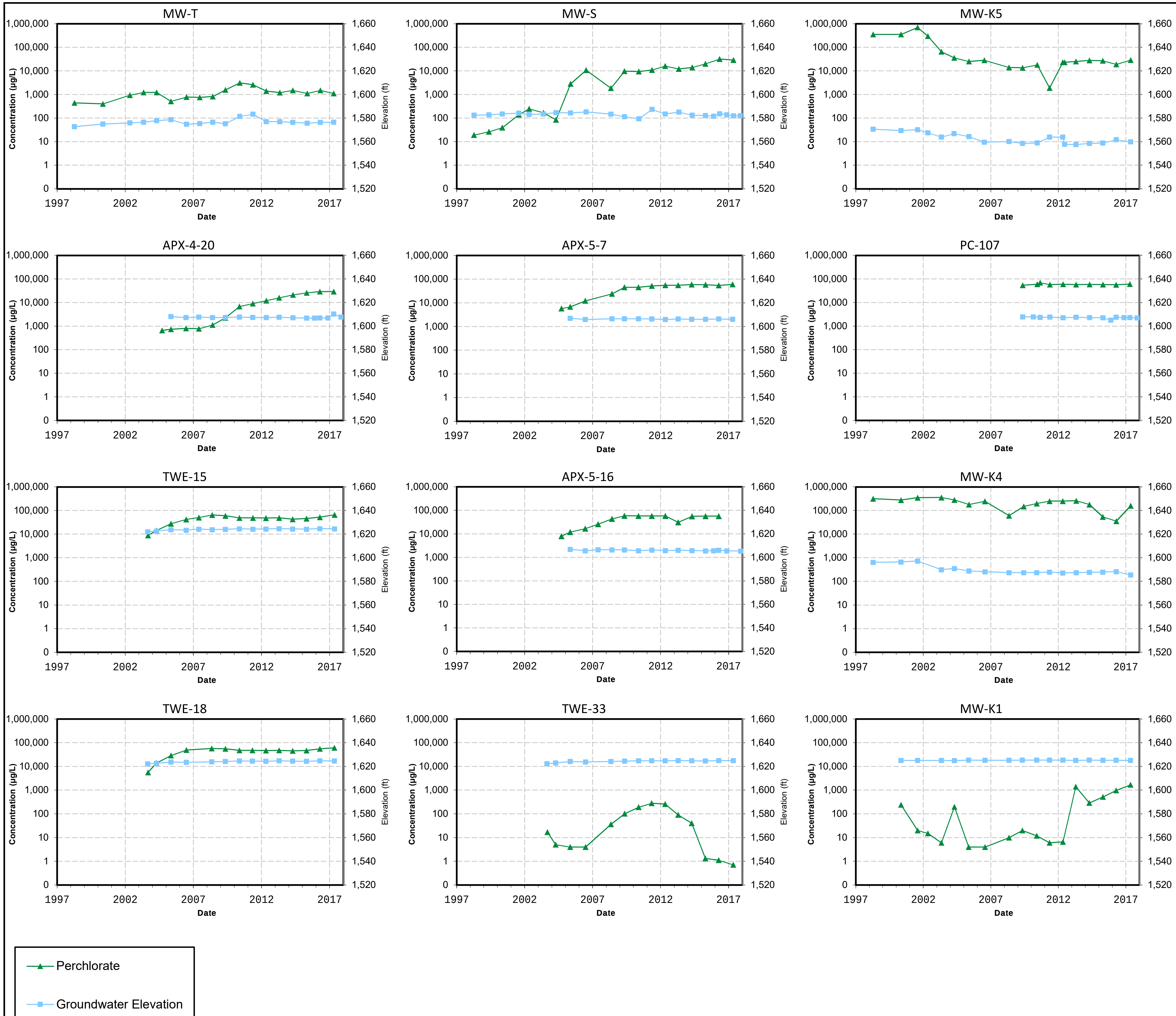
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, Boulder/Galleria**
Endeavour LLC
Henderson, Nevada

Geosyntec consultants

Figure **20**

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow6_TimeSeries_13Charts.xlsx





**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, AGTS Plant Area**

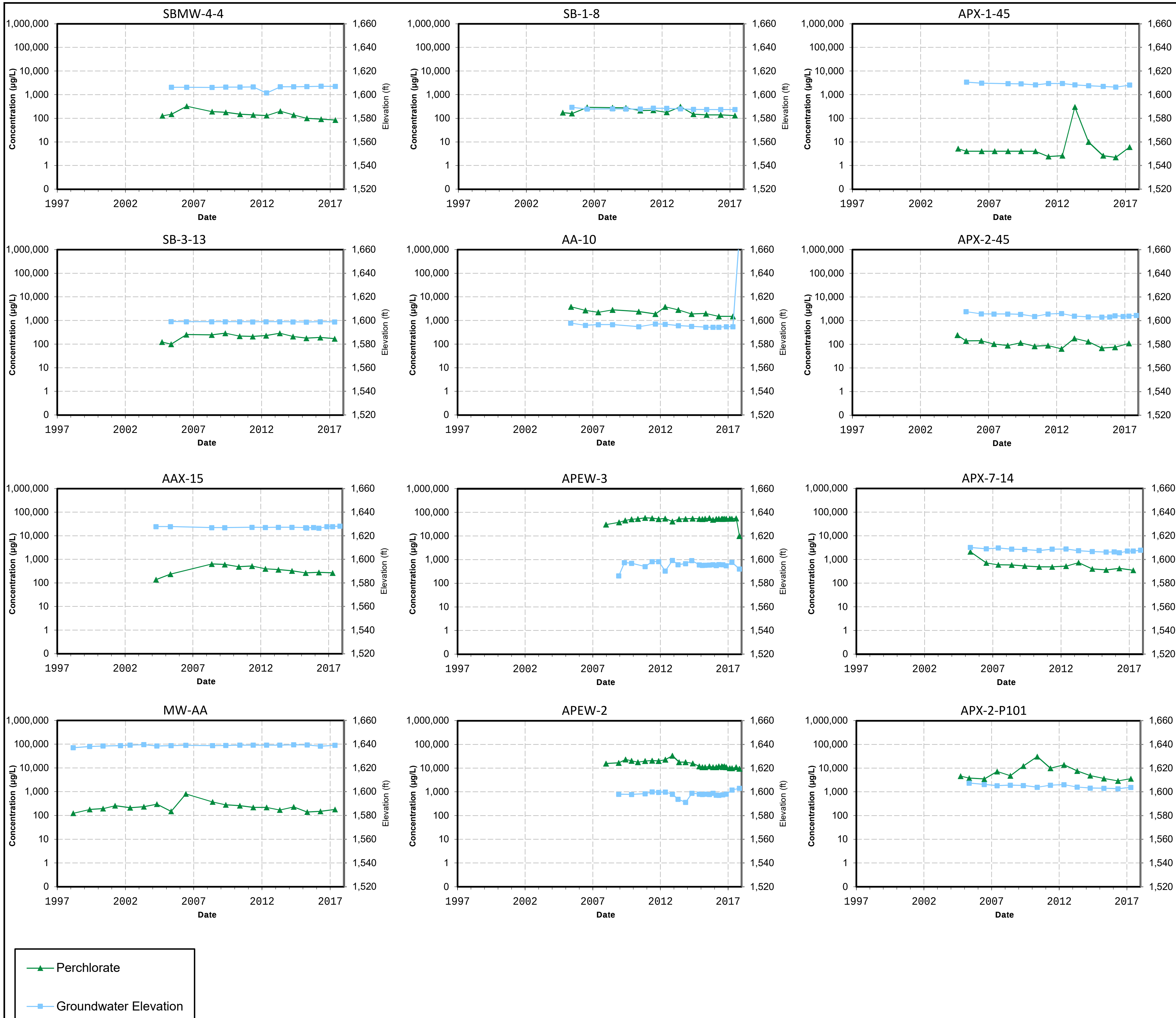
Endeavour LLC
Henderson, Nevada

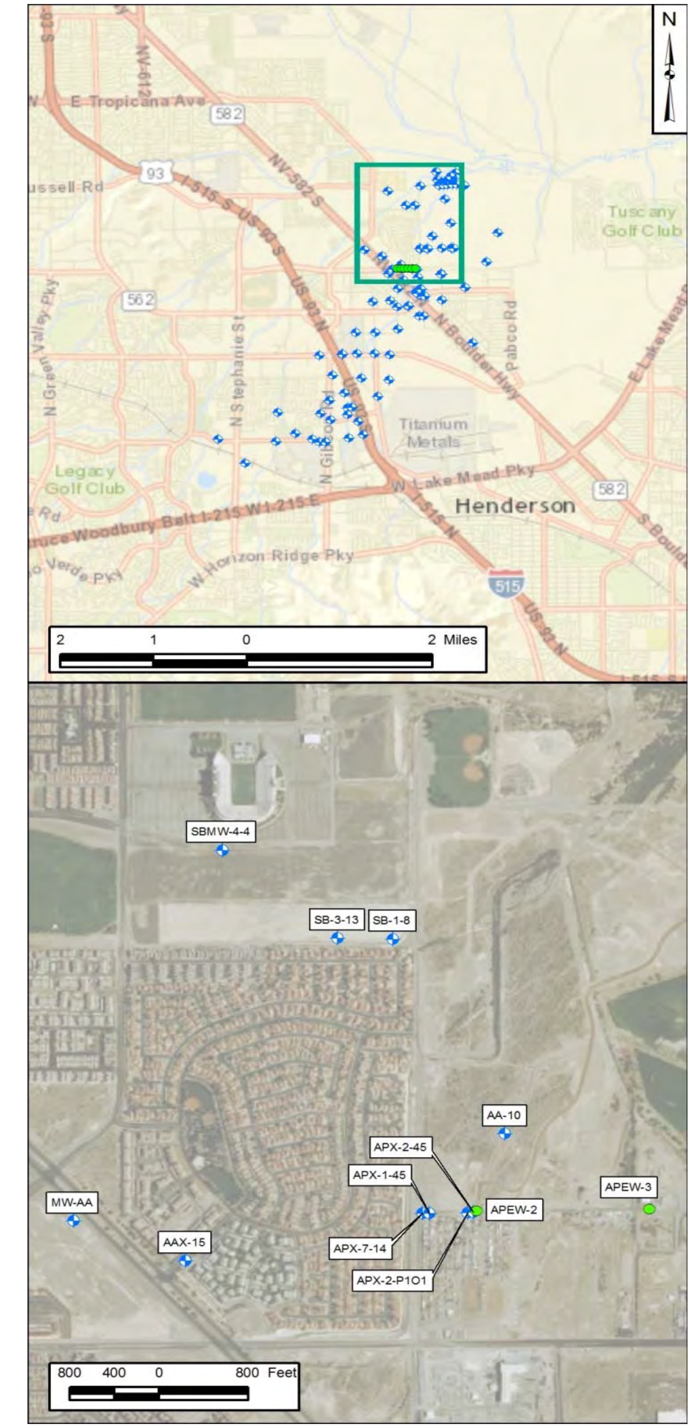
Geosyntec consultants

Figure **21**

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow7_TimeSeries_13Charts.xlsx




MW-AA Monitoring Well

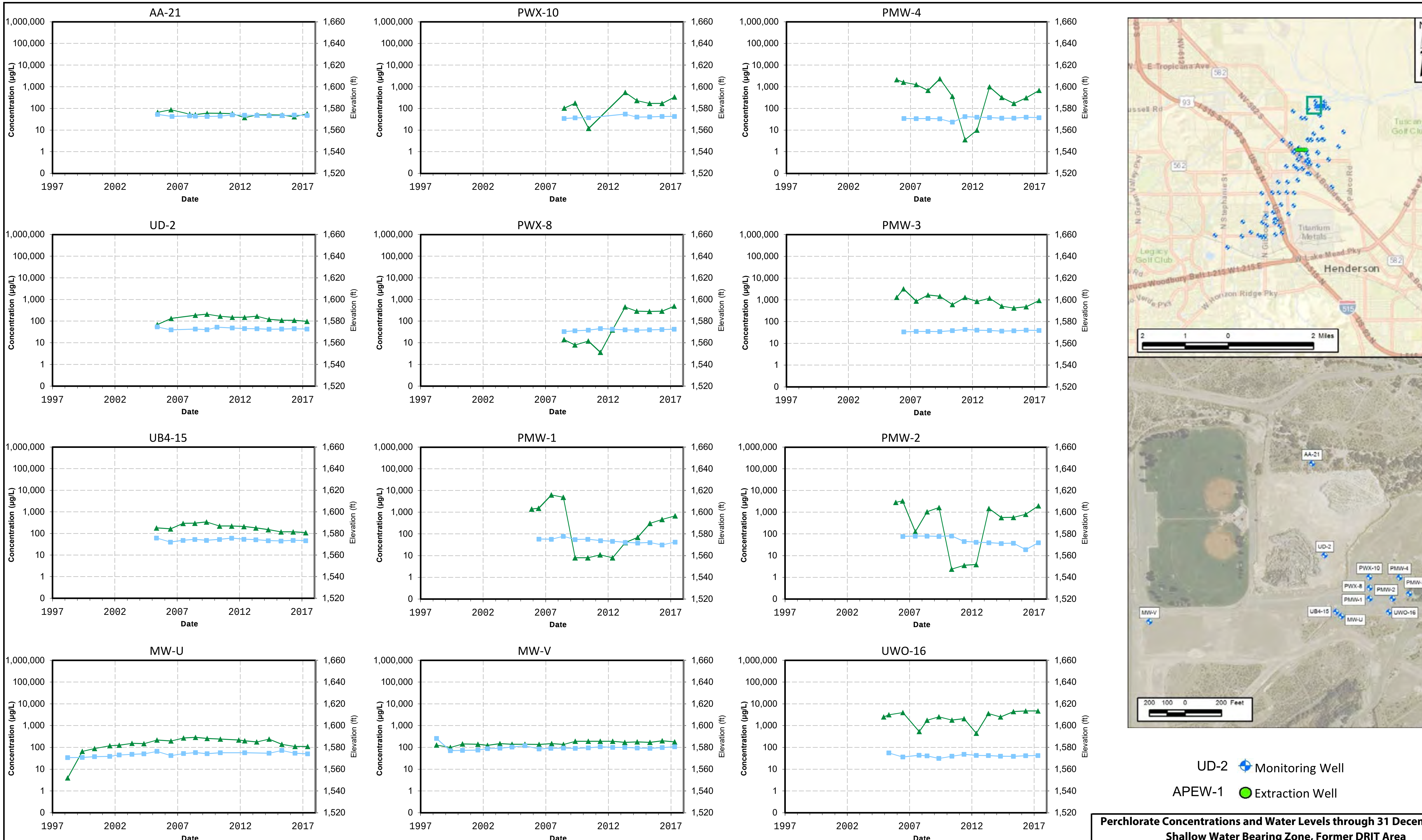
APEW-1 Extraction Well

**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, Wiesner/Sam Boyd**

Endeavour LLC
Henderson, Nevada

| | | |
|---|---|---|
| Geosyntec consultants | | Figure 22 |
| Oakland | January 2018 | |

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow8_TimeSeries_13Charts.xlsx




UD-2 Monitoring Well

APEW-1 Extraction Well

Perchlorate

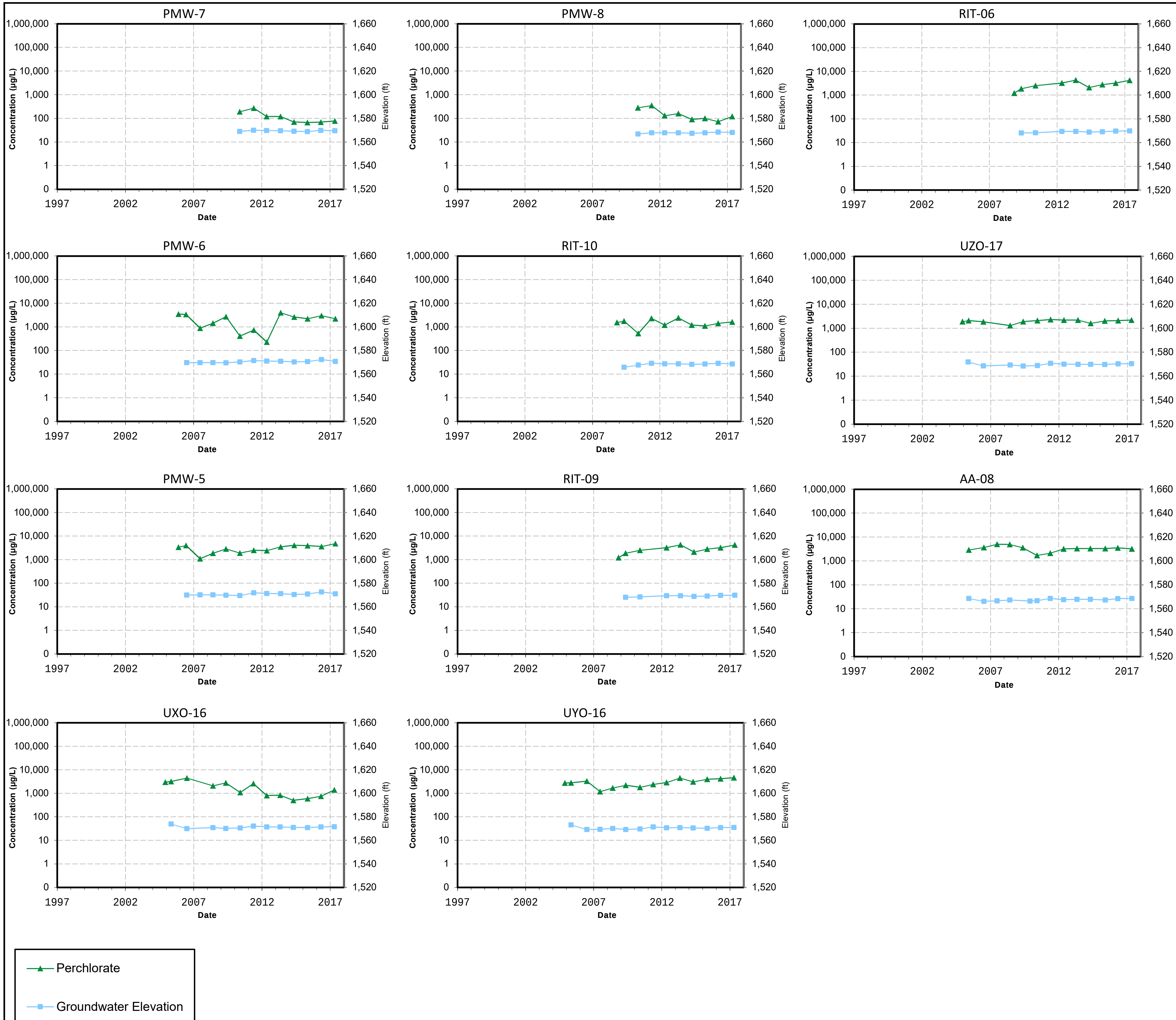
Groundwater Elevation

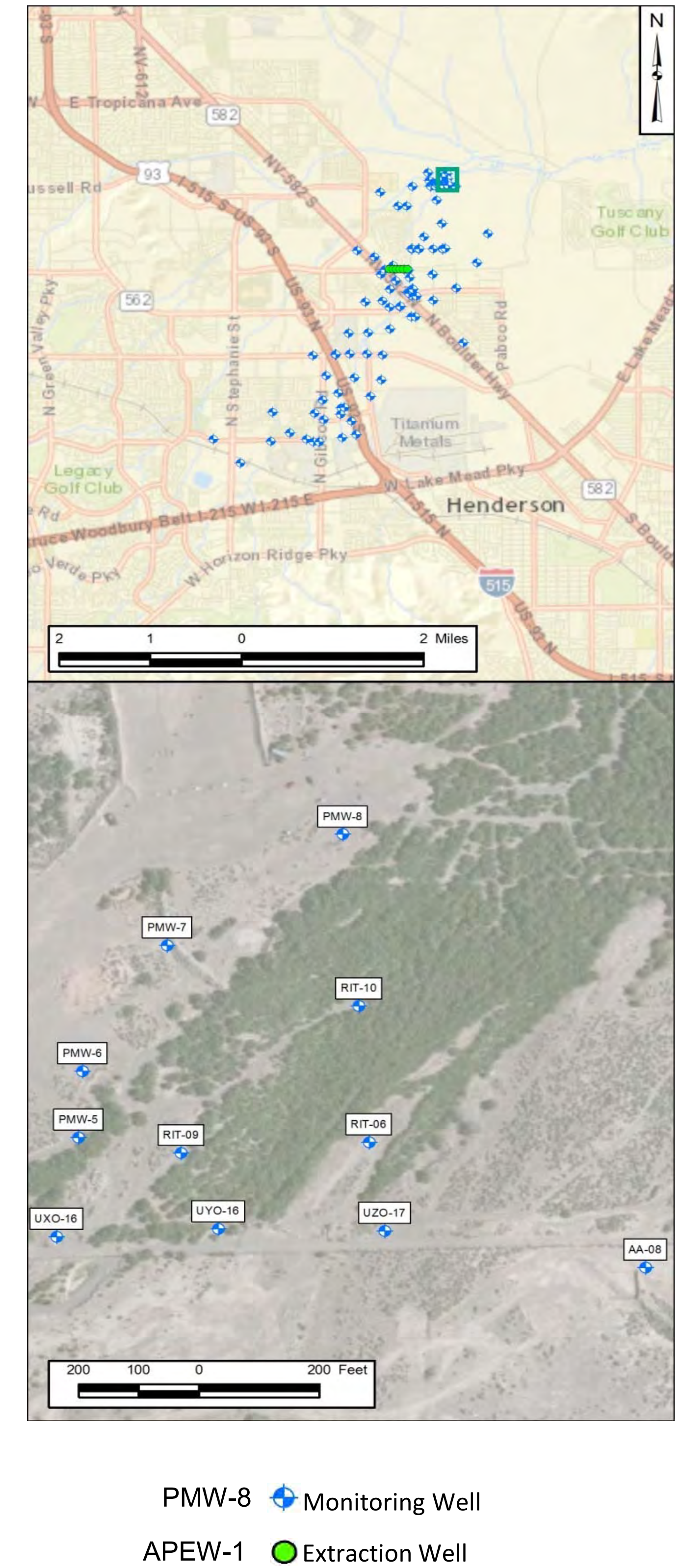
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, Former DRIT Area**
Endeavour LLC
Henderson, Nevada

Geosyntec consultants

Figure **23**

Oakland | January 2018



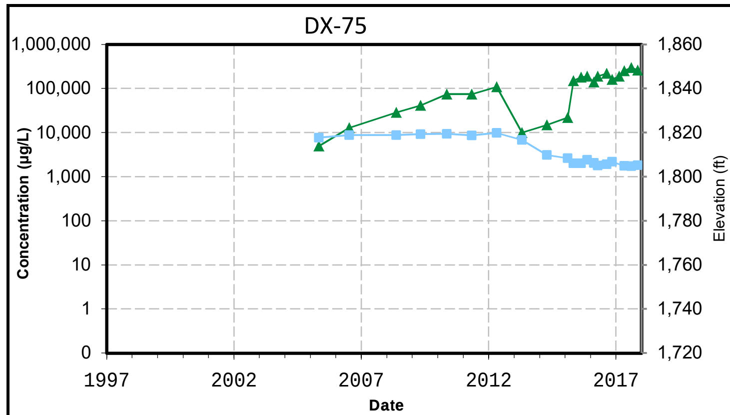

**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Shallow Water Bearing Zone, DRIT East**
American Pacific Corporation
Henderson, Nevada

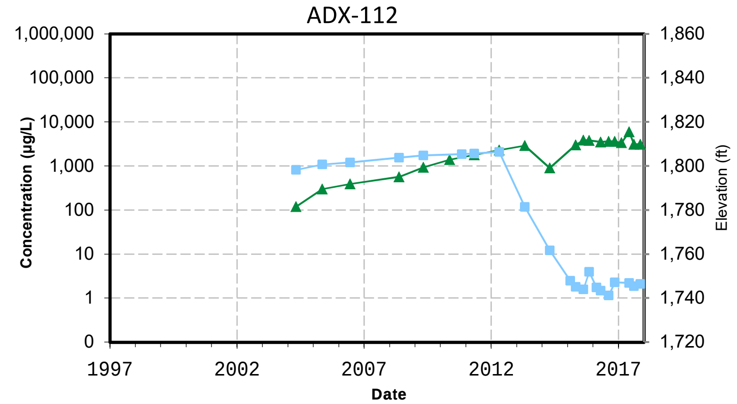
Geosyntec consultants

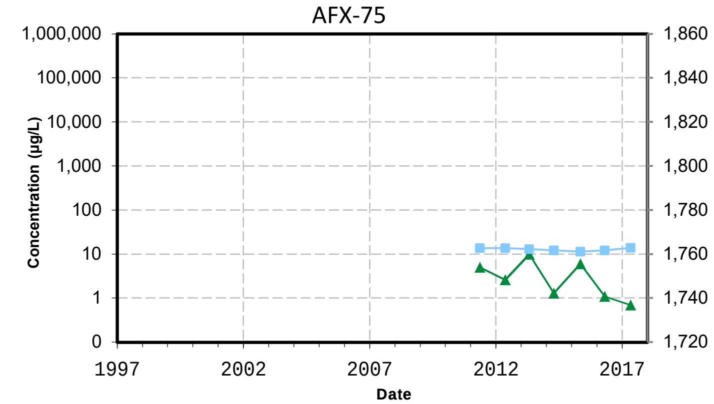
Figure 24

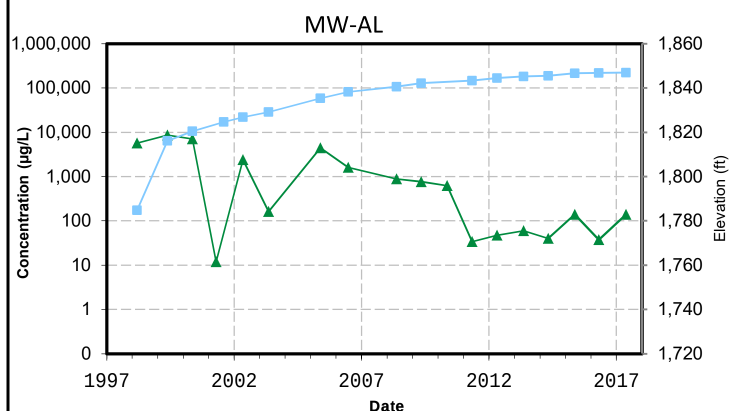
Oakland | January 2018

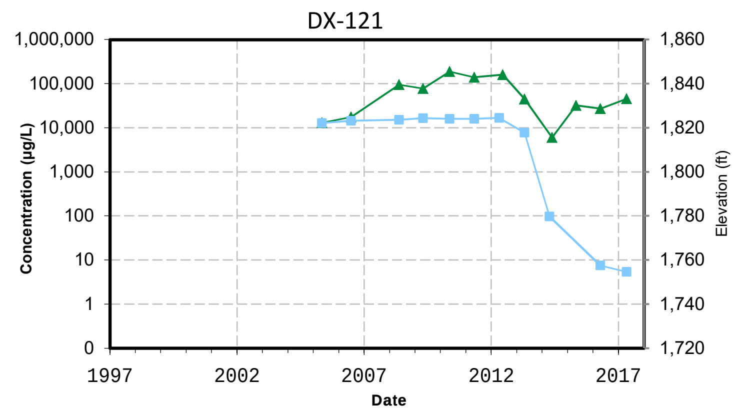
\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Shallow10_TimeSeries_10Charts.xlsx

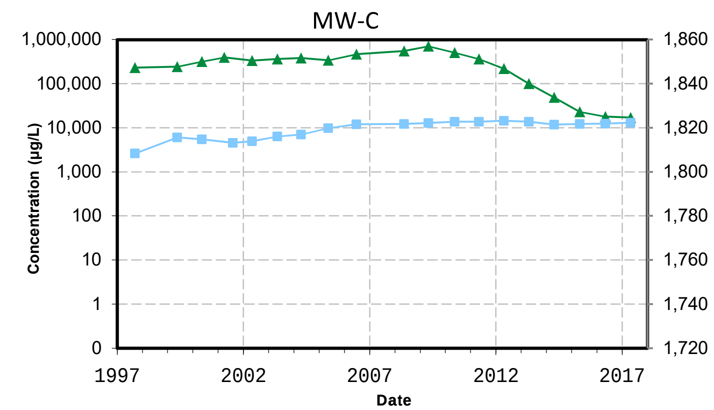


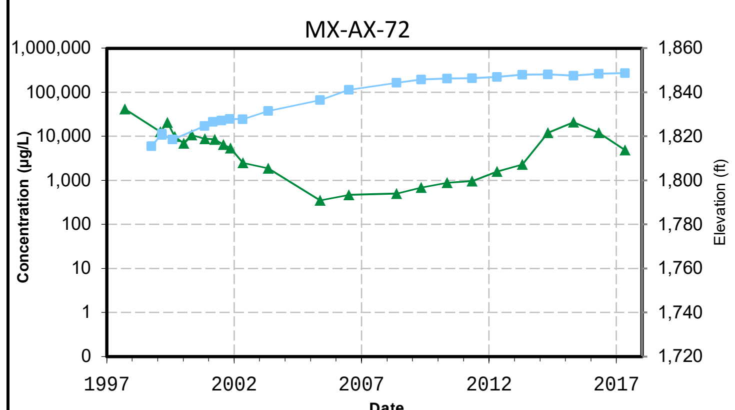



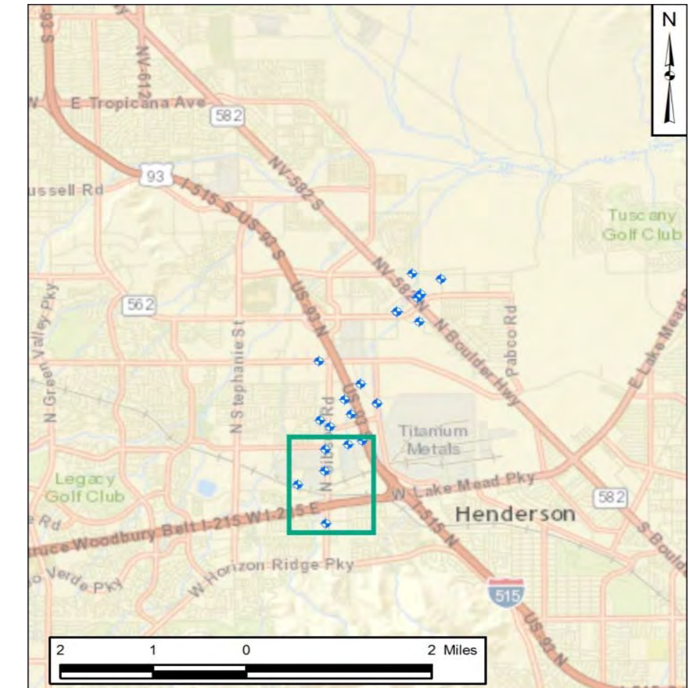




Data prior to 2005 are from well MW-A, which was destroyed in 2003 and was replaced by MW-AX-72.





MW-C Monitoring Well

APEW-1 Extraction Well

Perchlorate

Groundwater Elevation

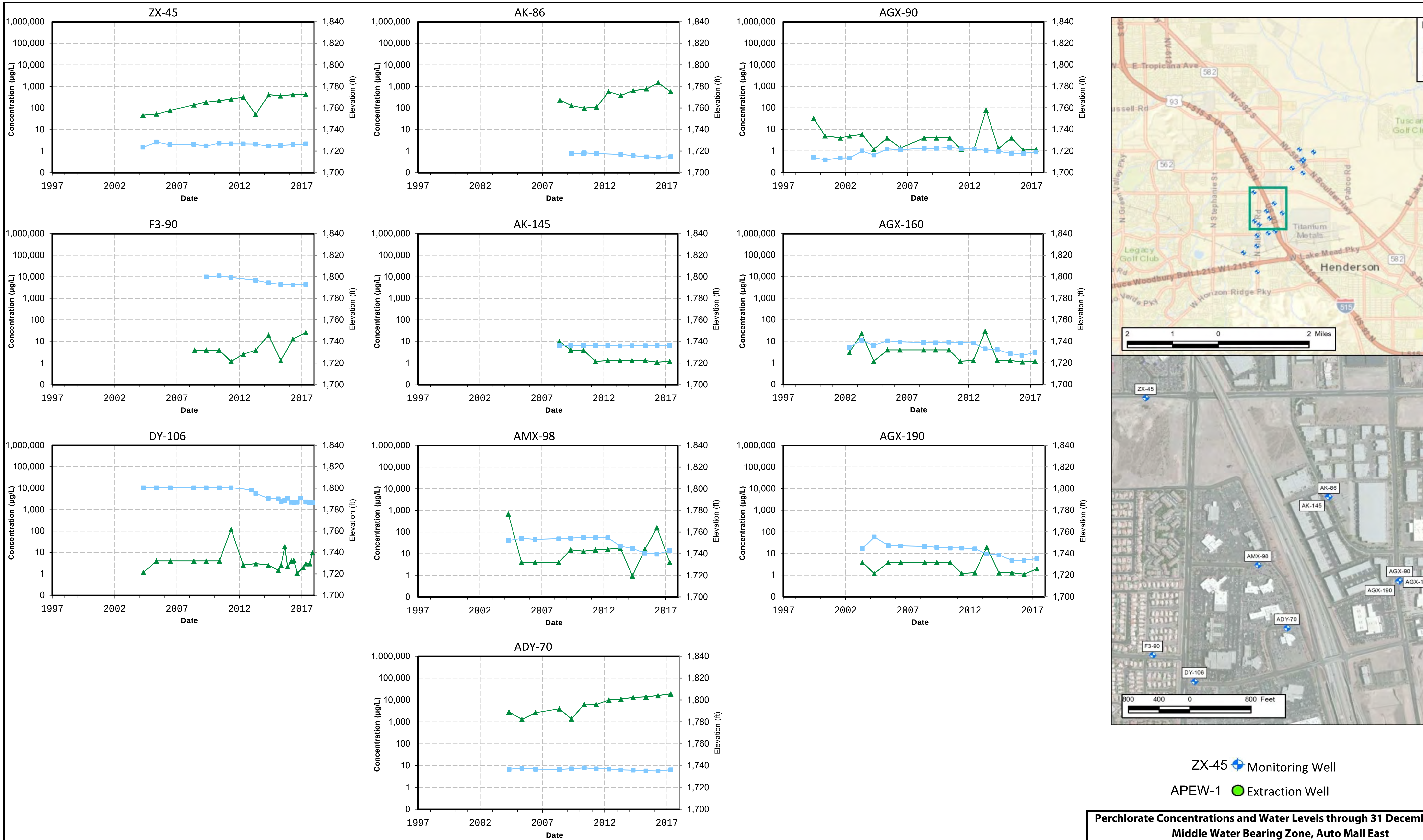
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Middle Water Bearing Zone, Auto Mall South**
Endeavour LLC
Henderson, Nevada

Geosyntec consultants

Figure **25**

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Middle1_TimeSeries_8Charts.xlsx




Perchlorate

Groundwater Elevation

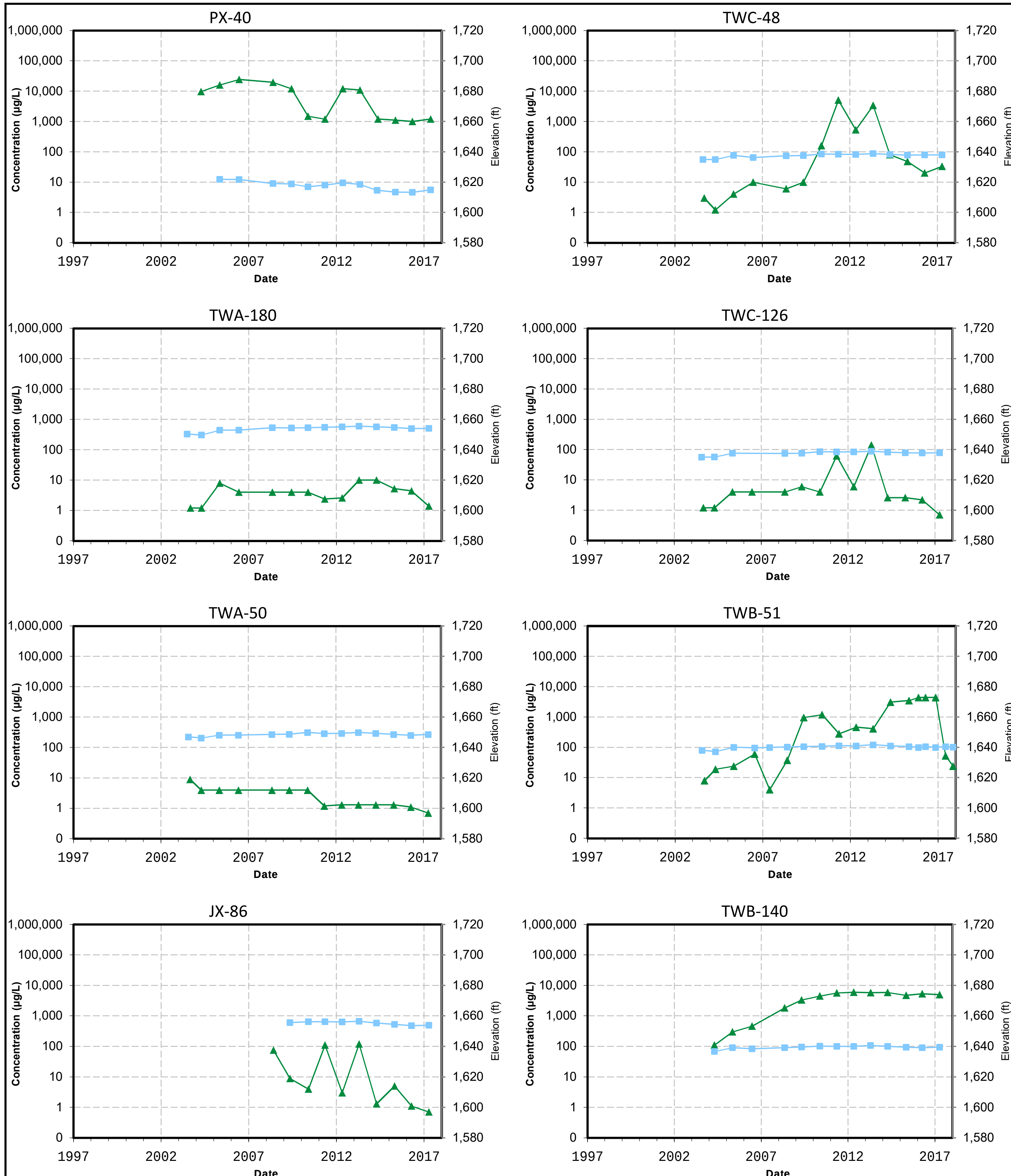
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Middle Water Bearing Zone, Auto Mall East**
Endeavour LLC
Henderson, Nevada

Geosyntec consultants

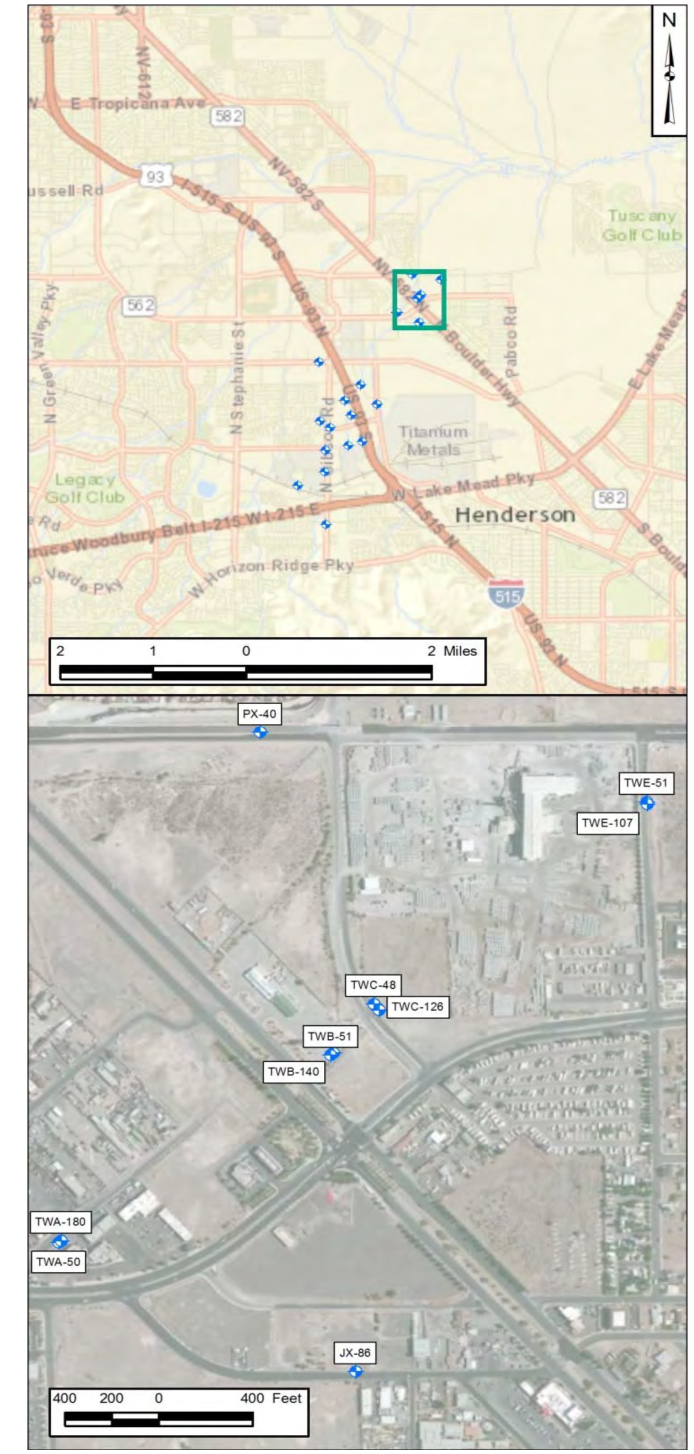
Oakland | January 2018

Figure 26

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Middle2_TimeSeries_11Charts.xlsx




Perchlorate
Groundwater Elevation




PX-40 Monitoring Well
APEW-1 Extraction Well

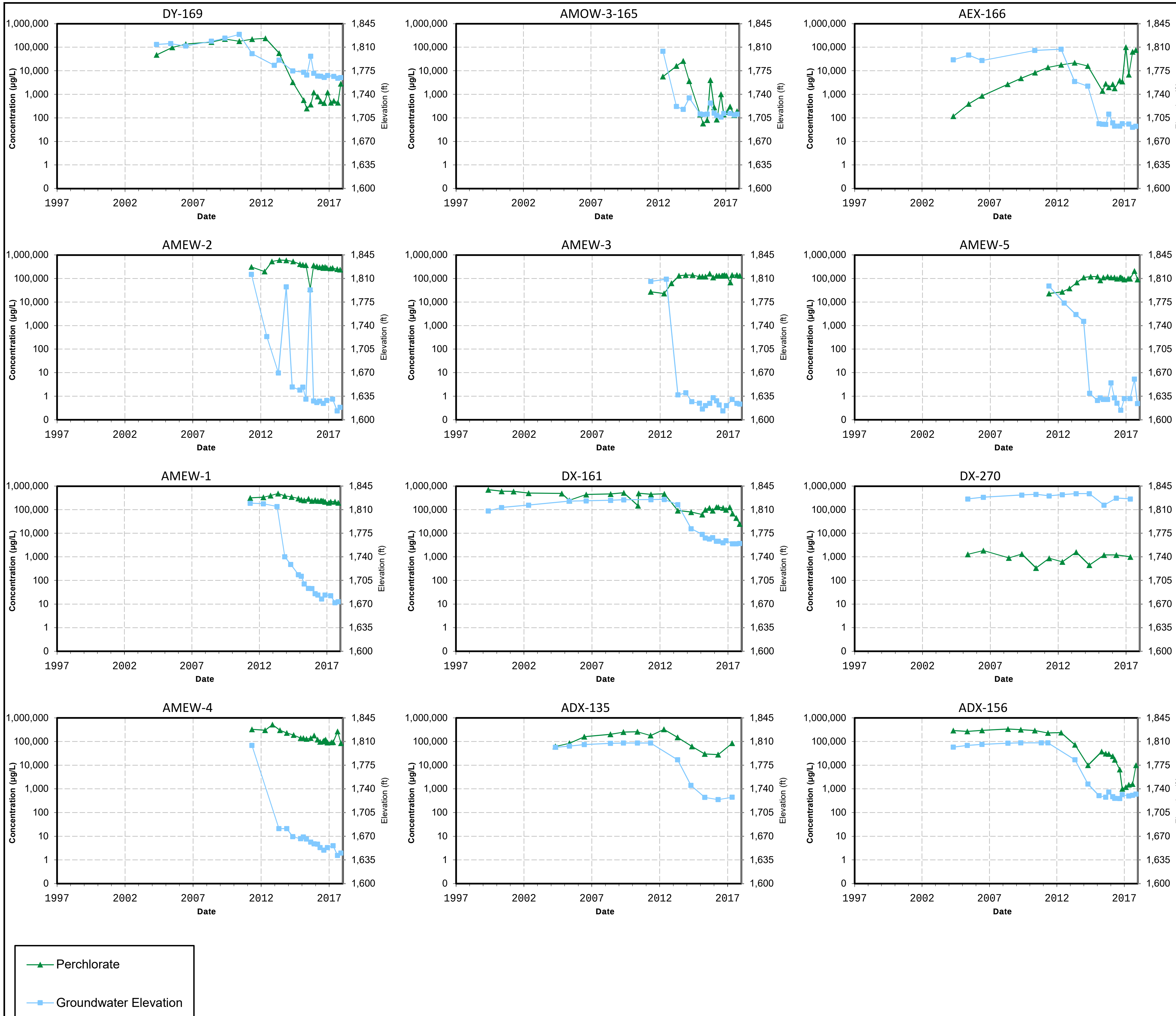
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Middle Water Bearing Zone, Sunset/Boulder**
Endeavour LLC
Henderson, Nevada

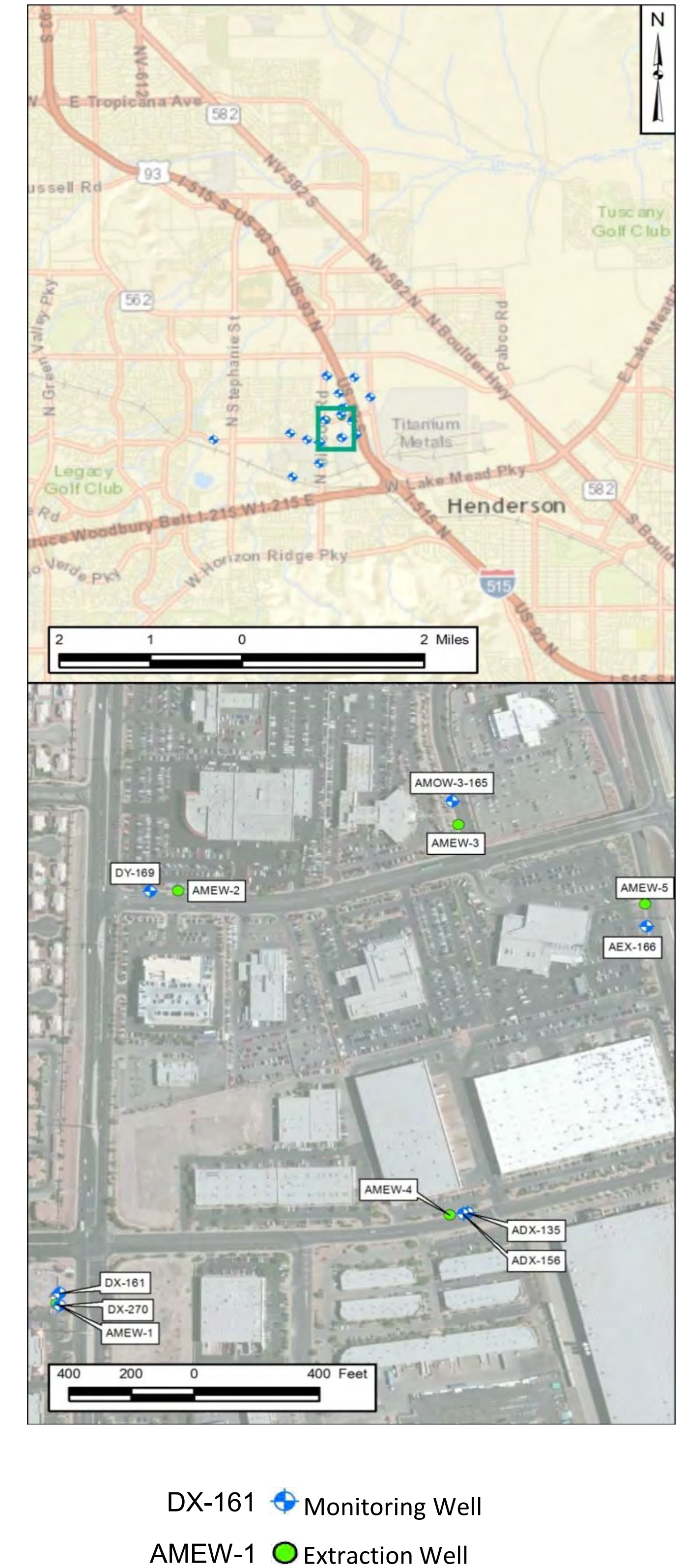
Geosyntec consultants

Oakland | January 2018

Figure **27**

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Middle3_TimeSeries_11Charts.xlsx



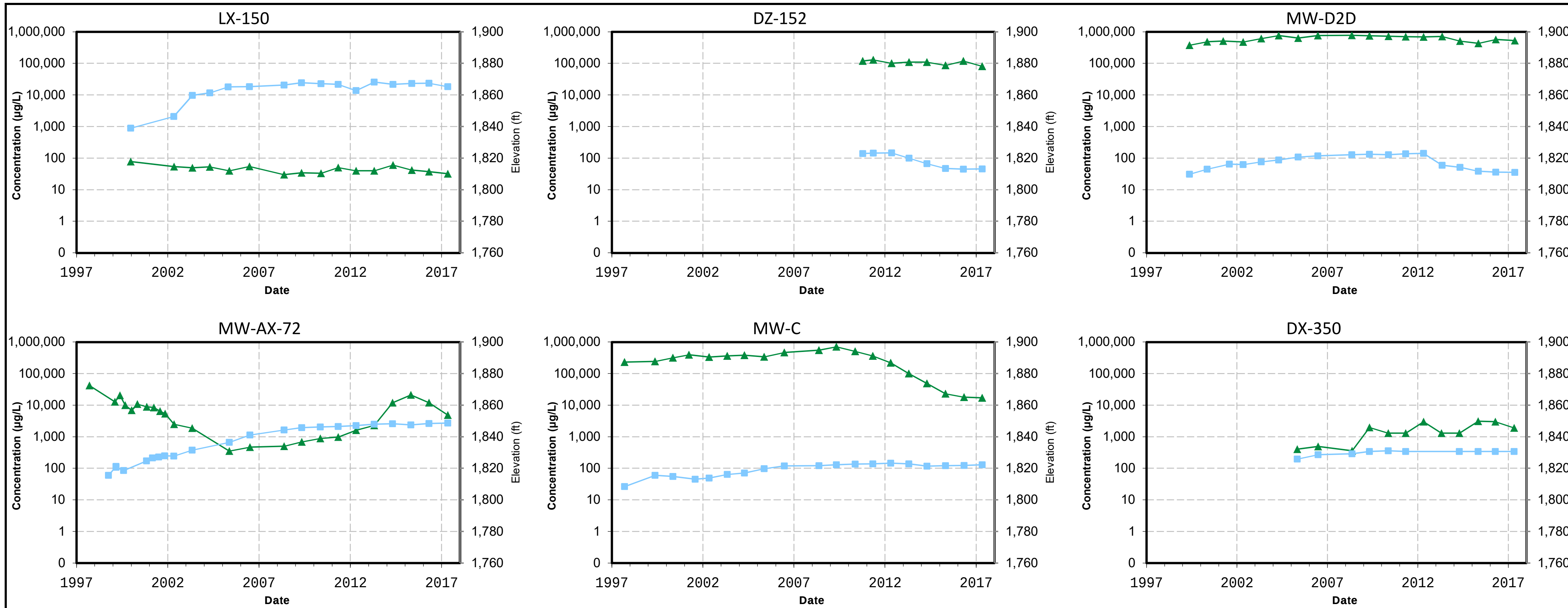

**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Deep Water Bearing Zone, Auto Mall South**
Endeavour LLC
Henderson, Nevada

Geosyntec consultants

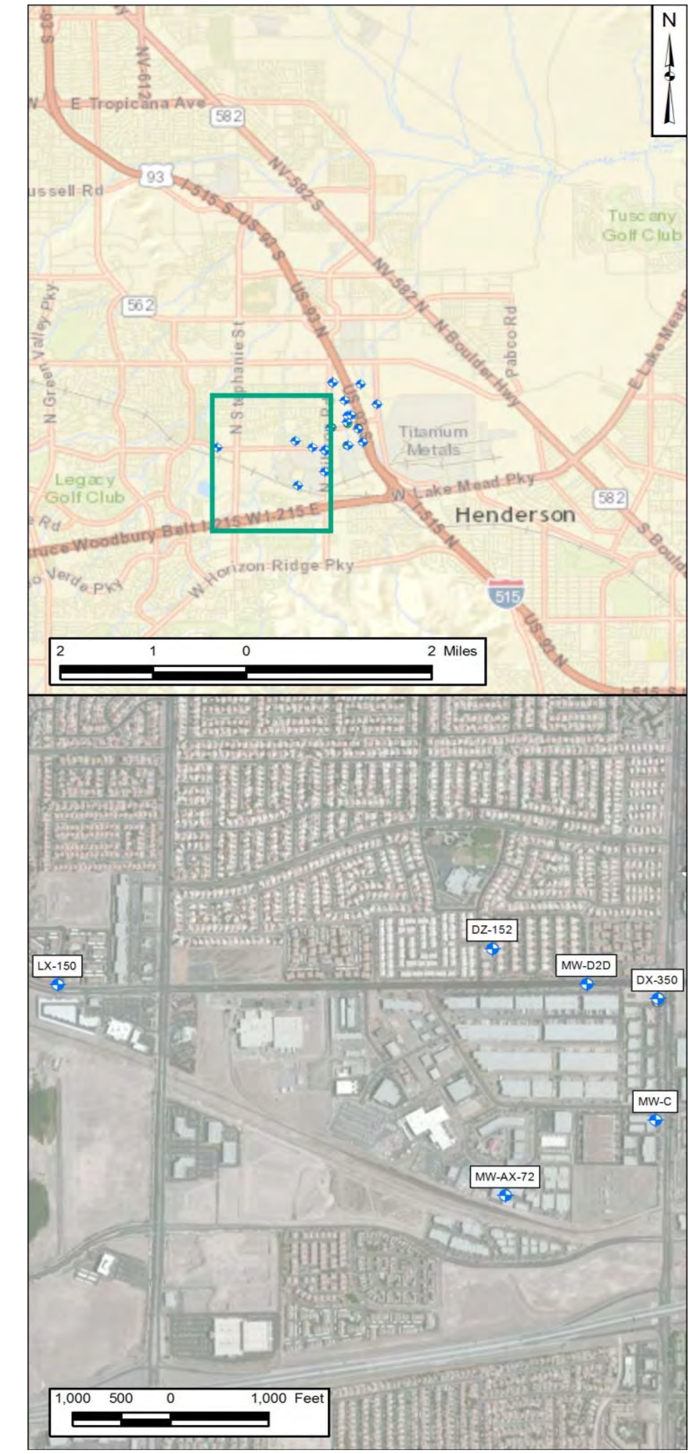
Figure
**28**

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Deep1_TimeSeries_13Charts.xlsx




Data prior to 2005 are from well MW-A, which was destroyed in 2003 and was replaced by MW-AX-72.




LX-150 Monitoring Well

AMEW-1 Extraction Well

Perchlorate

Groundwater Elevation

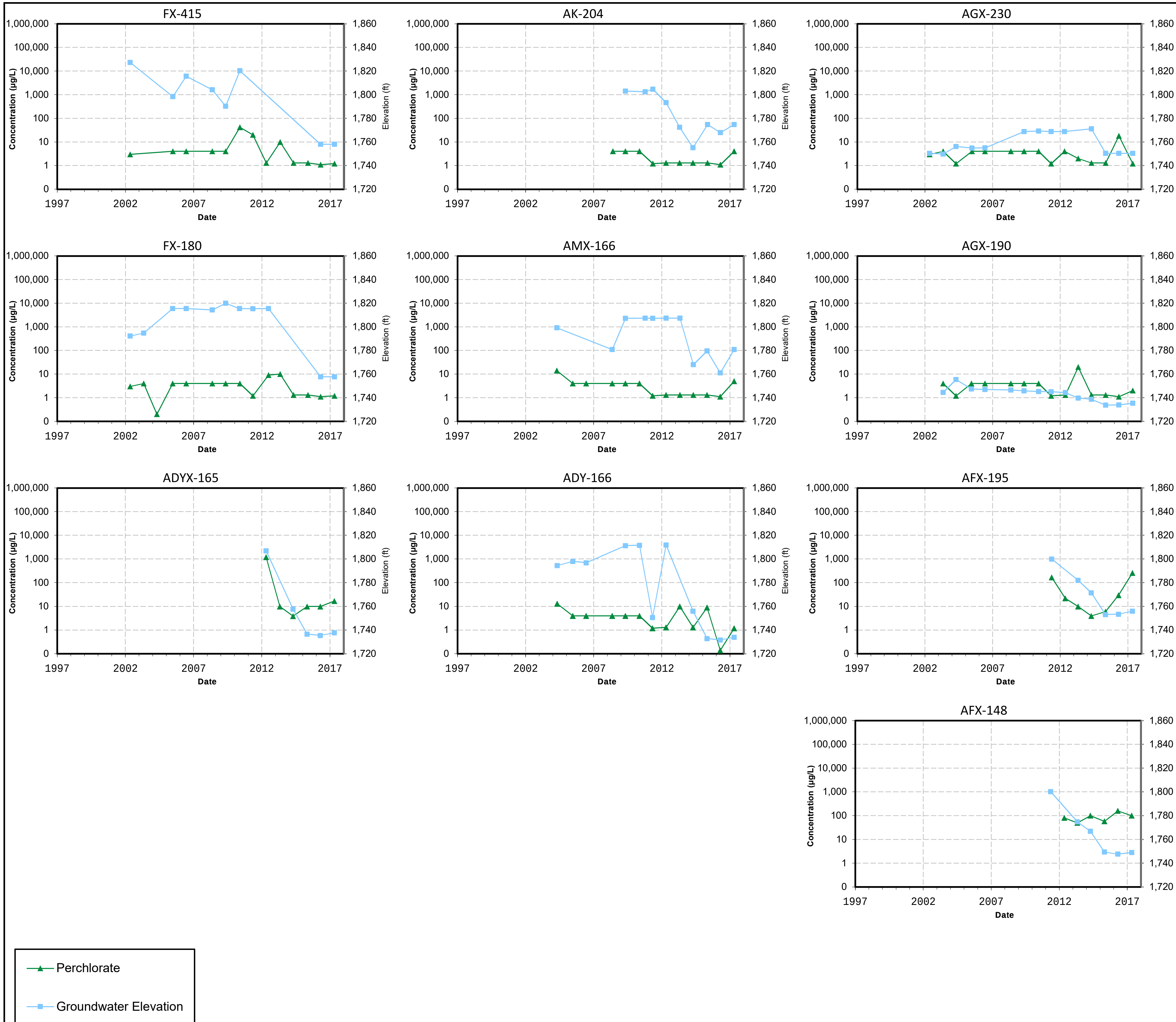
**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Deep Water Bearing Zone, Auto Mall West**
Endeavour LLC
Henderson, Nevada

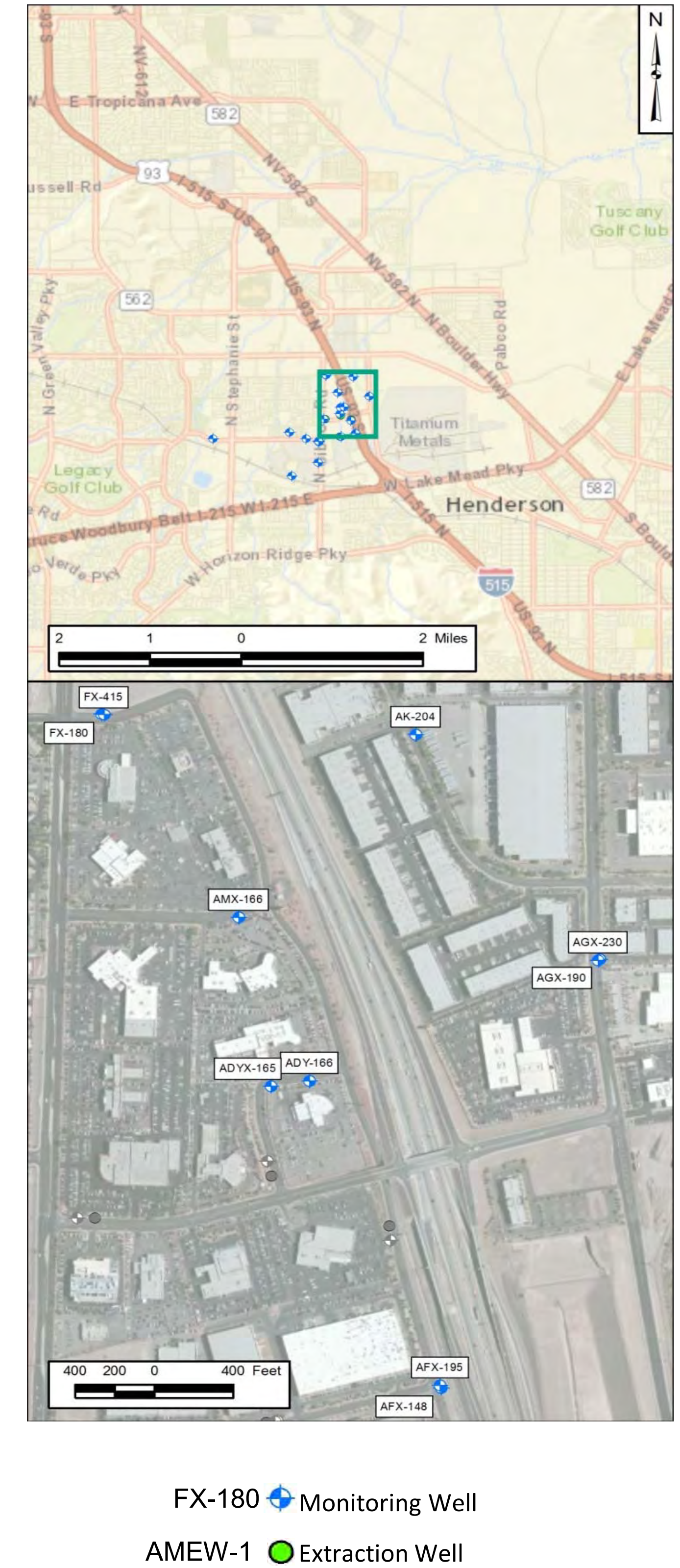
Geosyntec consultants

Figure **29**

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Deep2_TimeSeries_7Charts.xlsx




**Perchlorate Concentrations and Water Levels through 31 December 2017**
**Deep Water Bearing Zone, Auto Mall East**
Endeavour LLC
Henderson, Nevada

Geosyntec consultants

Figure
30

Oakland | January 2018

\\Oakland-01\data\GIS\ampac\excel\2018-01-AnalyticalGraphs\[Deep3_TimeSeries_11Charts.xlsx

# APPENDIX A

# Geosyntec Technical Memo

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Oakland, California 94607
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FAX 510.836.3036
www.geosyntec.com

# MEMORANDUM

Date: 23 February 2018

To: Jeff Gibson and Gary Carter; Endeavour

From: Julie Chambon and John Gallinatti; Geosyntec Consultants

Subject: Annual Mass Capture Assessment (Second Half 2017)
Groundwater Extraction System
Henderson, Nevada

## 1. INTRODUCTION

On behalf of Endeavour, LLC (Endeavour), Geosyntec Consultants, Inc. (Geosyntec) performed a semi-annual assessment of perchlorate mass capture by the Endeavour combined Athens Road/Galleria Drive Area and Auto Mall Area Groundwater Treatment System (AGTS).

This memorandum was prepared for inclusion in the 2H17 semi-annual monitoring report to be prepared by Endeavour for submittal to the Nevada Division of Environmental Protection (NDEP). The Figures attached to this memorandum are numbered as appropriate for inclusion in the Endeavour report and therefore are referenced herein non-sequentially.

### 1.1 Operations Summary

Prior to 2012, the groundwater extraction system included pumping only from the Shallow Water Bearing Zone (WBZ) in the Athens Road/Galleria Drive area and treatment by in situ biodegradation. During the second half of 2012 (2H12), there was an expansion of the extraction system to include five Deep WBZ extraction wells in the Valley Auto Mall Area and a change of the groundwater treatment system to a fluidized bed reactor (FBR) system. The newer treatment system not only allows for treatment of the higher loading from the Deep WBZ wells in the Auto

Mall area, it also accommodates higher pumping rates from the Shallow WBZ wells in the Athens Road/Galleria Drive area.

After a period of system startup, the pumping rates began to stabilize toward the later stages of the first half of 2013 (1H13). The remainder of 2013 was still considered a “transitional period” with varying flow rates and operational durations. Since 2014, the extraction well pumping rates have been relatively stable with the following notes on significant and modest changes:

- The previously unused APEW-1 was started on May 28, 2015. The extraction rate remained stable for a period at around 14 gpm. In 2H15, maintenance work and adjustments of the FBR system resulted in extraction wells being turned on and off intermittently. Since 1H16, the extraction rate remained stable around 15 gpm. In 2H17, the extraction rate increased to around 18 gpm.

- APEW-2 had variable flow during 2014 and 2015, including a 9.5-week shutdown in 1H14. In December 2015, the extraction rate was increased from 12 gpm to 27 gpm. In 1H17, the extraction rate remained stable around 29 gpm. In 2H17, the extraction rate decreased to 26 gpm.

- In 2H16, the extraction rate at AREW-4 increased from 9 to 16 gpm, and in 1H17 the extraction rate remained stable at around 16 gpm. In 2H17, the extraction rate increased to around 20 gpm.

- In 1H17, the extraction rate at AMEW-1 increased from 250 to 275 gpm. In 2H17, the extraction rate remained stable around 277 gpm.

- In 2H17, the extraction rate at AMEW-2 increased from 61 to 64 gpm.

- In 2H17, the extraction rate at AMEW-4 decreased from 39 to 32 gpm.

## 1.2 Summary of Mass Capture Analysis

This memorandum assesses the mass captured by the combined Shallow and Deep WBZ extraction wells as follows.

- Shallow WBZ extraction system at Athens Road/Galleria Drive area: the system is designed to cut off the flow of perchlorate-impacted groundwater that is being transported in this WBZ toward the Las Vegas Wash area and other down-gradient discharge points, and therefore **perchlorate percent capture** (perchlorate mass capture compared to perchlorate mass not captured) is evaluated as the metric of effectiveness; and
- Deep WBZ extraction system in the Auto Mall area: the system is designed to reduce perchlorate mass in the Deep WBZ that is contributing to an upward flux of perchlorate-containing water and persistence of perchlorate in the downgradient Shallow WBZ. Therefore, the **area of hydraulic containment** and the **perchlorate mass capture by Deep WBZ** wells are evaluated as metrics of effectiveness.

All data used in the assessment were provided to Geosyntec by Endeavour.

For purposes of this Memorandum, the following definitions are used:

**Perchlorate loading** (in units of pounds per day [lbs/day]) refers to the mass of perchlorate per unit time in groundwater moving across a given cross-sectional area.

**Perchlorate mass capture** (also in lbs/day) refers to the mass of perchlorate per unit time that is withdrawn from the sub-surface and treated by the AGTS.

**Perchlorate percent capture** refers to perchlorate mass capture as a percentage of the total perchlorate loading estimated at various extraction well locations.

## 2. APPROACH AND METHODOLOGY

### 2.1 Calculation of Perchlorate Percent Capture in Shallow WBZ

The approach to evaluating perchlorate percent capture in the Shallow WBZ used the following steps:

- Delineate the capture zone(s) of the extraction wells using numerical and analytical methods;
- Quantify the perchlorate loading in:
  - surface water in the Athens Drainage Channel (ADC) (i.e., non-captured surface water perchlorate loading);
  - groundwater in the influent to the extraction system (i.e. perchlorate capture in extraction wells); and
  - groundwater outside of the extraction wells capture zone (i.e., non-captured groundwater perchlorate loading).
- Sum the perchlorate loading in groundwater and surface water (i.e., the total perchlorate loading); and
- Divide the perchlorate capture in the extraction wells by the total perchlorate loading to quantify the perchlorate percent capture.

The details of these calculations are provided below and are based on data collected during the site-wide monitoring performed November 2, 2017 through November 19, 2017.

The following sections present the quantification of the three components of perchlorate loading that are used in the perchlorate percent mass capture calculation.

<u>Perchlorate Loading in Surface Water (Not Captured)</u>

The perchlorate loading in surface water is measured monthly in the Athens Drain Channel (ADC) at a location downstream of where groundwater seeps into the ADC but upstream of where the surface water re-infiltrates to the groundwater system (see Section II of the 2007 One

Year Performance and Operations Optimization Program Report). The average loading of perchlorate in the ADC from July to December 2017 was 18.1 pounds per day (lbs/day) (**Figure 9**). The ADC perchlorate loading data derived from field and analytical measurements on November 8, 2017 was 18.6 lbs/day and is the value used in the mass capture calculation presented in Section 3 below.[1]

Perchlorate loading was also monitored in the Eastgate Storm Drain (EGSD) that is upgradient and connects to the ADC. The monthly perchlorate loading in the EGSD is presented in **Figure 10** and the average perchlorate loading from July to December 2017 was 14.6 lbs/day.

Perchlorate loading was noted to have increased in 1H17 compared to 2016, likely due to increasing water levels in the vicinity of the ESGD, resulting in increasing groundwater infiltration into the EGSD and increasing flow, while the perchlorate concentrations remained stable. Perchlorate loading was relatively stable in 2H17 compared to 1H17.

Perchlorate Loading in Shallow Groundwater Captured by the AGTS

The groundwater volumetric flow rate and perchlorate loading captured by the extraction system are based on directly measurable quantities of flow and concentration. The approximate perchlorate mass capture rates for the shallow extraction wells operating when the site-wide perchlorate groundwater samples were collected (November 2, 2017 to November 19, 2017), are presented in the following table (see **Figure 1** for shallow extraction well locations).

[1] The perchlorate loading at ADC Main measured in November 2017 coincides with the monitoring and sampling event (November 2 through November 19) that is used for estimating perchlorate loading in groundwater and perchlorate mass capture by the extraction system.

| Well | Average Operating Rate for 2H17 Measurement Period (gpm) | Perchlorate Concentration for 2H17 Measurement Period (mg/L) | Average Perchlorate Mass Capture Rate for 2H17 Measurement Period (lbs/day) |
|---|---|---|---|
| APEW-3 | 8 | 10 | 0.9 |
| APEW-1 | 18 | 0.50 | 0.1 |
| APEW-2 | 26 | 10 | 3.0 |
| AREW-1 | 12 | 0.58 | 0.1 |
| AREW-2 | 36 | 1 | 0.4 |
| AREW-3 | 24 | 0.74 | 0.2 |
| AREW-4 | 20 | 2.3 | 0.6 |
| AREW-5 | 103 | 11 | 13.6 |
| AREW-6 | 24 | 51 | 14.7 |
| **Total** | **271** | **-** | **33.6** |

During this period, the total mass capture rate by the Athens Road/Galleria Drive Extraction Wells was approximately 34 lbs/day of perchlorate. The average mass capture rates and cumulative mass captured for all the individual extraction wells from October 2012 to December 31, 2017 are presented in **Figures 4a** and **5a**, respectively.

<ins>Perchlorate Loading in Shallow Groundwater Not Captured by the AGTS</ins>

The perchlorate loading in groundwater that is not captured by the extraction system cannot be estimated based on directly measured quantities, but rather requires analysis of interpreted subsurface data. The loading in non-captured groundwater was estimated by establishing the capture zone of the Athens Road/Galleria Drive Extraction Wells and estimating the perchlorate loading in groundwater outside of this zone. The evaluation included the following steps:

- Estimation of the capture zone(s) of the extraction system following the multiple lines of evidence approach described in United States Environmental Protection Agency (USEPA), 2008[2]
  - Use of the program KT3D-H2O[3] to create a potentiometric surface using linear-log kriging methodology, and calculation of capture zones around extraction wells using particle tracking methodology.
  - Export of a raster surface representing the interpolated potentiometric surface and vector datasets representing the equipotential contours on a 5-foot elevation interval, and calculated capture zones.
  - Use of the equations detailed in Javandel and Tsang[4] to estimate the width of hydraulic capture achieved by each extraction well or extraction well series based on groundwater hydraulics analysis and using input parameters consistent with the current Endeavour numerical groundwater flow model.
- Estimate of perchlorate loading outside of the capture zone:
  - Use of the potentiometric surface map to develop a map of hydraulic gradients and convert gradients to groundwater volumetric flow rates by multiplying by aquifer transmissivity.
  - Generation of a map of perchlorate loading in groundwater by multiplying groundwater volumetric flow by the perchlorate concentration at each node of a grid that encompasses the region.

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[2] USEPA, 2008. A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems – Final Project Report, Office of Research and Development. EPA 600/R-08/003. January. http:/www.epa.gov/ord."

[3] http://www.sspa.com/software/kt3d_h2o.html; Karanovic, M., Tonkin, M., and Wilson, D., 2009. KT3D_H2O: A Program for Kriging Water Level Data using Hydrologic Drift Terms. *Ground Water*, Vol. 47, No. 4, pp. 580-586.

[4] Javandel, I. and C.F. Tsang, 1986. Capture-Zone Type Curves: A Tool for Aquifer Cleanup, Ground Water, Vol. 24, No. 5, pp. 616-625.

- o Overlay of the delineated capture zones from the numerical model to determine the perchlorate loading outside of the capture zone (the numerical method).

The above steps were accomplished by using a fixed grid for each of the mapped features (e.g. potentiometric head, transmissivity, gradient, etc.) such that the appropriate arithmetic operations could be applied to each cell of the grid. The specific procedures for accomplishing the above steps are described below.

**Figure 11** shows the Shallow WBZ potentiometric surfaces generated by the KT3D-H2O software using data from Shallow WBZ monitoring wells and extraction well pumping rates during the measurement period. Contours were modified using professional judgment to better represent hydraulic interaction with the ADC and the presence of the "Muddy Creek High" zone.

Capture zones associated with the operating Athens Road Extraction Wells calculated using the KT3D-H2O software are presented on **Figure 11** as well as on **Figure 13** (see discussion below). **Figure 11** shows the particle tracks generated by the KT3D-H2O software from the Shallow WBZ potentiometric surfaces. KT3D-H2O is a simplified analytical approach, therefore the lack of flow in the "Muddy Creek High" zone cannot be included in the evaluation using KT3D-H2O, which explains the apparent "gap" observed in the particle tracks showed in **Figure 11**. Additional refinements of the current groundwater flow model were performed by Geosyntec to better represent the groundwater flow in the shallow zone and the interaction with the Las Vegas Wash. Based on this refined model, the groundwater in the apparent "gap" flows very slowly towards the north.[5]

[5] Geosyntec, 2017. Shallow Zone Capture Assessment – Revision 1, Endeavour, Henderson, NV, dated 23 March 2017 and sent to NDEP in an email dated 30 March 2017.

Capture zone widths (in feet) associated with each operating shallow zone extraction well were calculated using the two methods shown below:

| Extraction Well | Operating Rate (gpm) | KT3D-H2O Method Capture Zone Width (ft) Measured at 1,625 ft msl | KT3D-H2O Method Capture Zone Width (ft) Measured at 1,645 ft msl | Analytical Method Maximum Upgradient Capture Zone Width (ft) |
|---|---|---|---|---|
| APEW-3 | 8 | 45 | 45 | 80 |
| APEW-1 | 18 | 2,300 | 3,500 | 90 |
| APEW-2 | 26 | | | 130 |
| AREW-1 | 12 | | | 570 |
| AREW-2 | 36 | | | 1,730 |
| AREW-3 | 24 | | | 120 |
| AREW-4 | 20 | | | 100 |
| AREW-5 | 103 | | | 500 |
| AREW-6 | 24 | | | 120 |
| **Total** | **271** | **2,345** | **3,545** | 3,440 |

**Figure 12** presents a map of perchlorate concentrations in the extraction area in the Shallow WBZ during the 2H17 period.

**Figure 13** presents a map of perchlorate loading per unit width in the shallow groundwater north of Warm Springs Road. Perchlorate loading in groundwater is a function of the chemical concentration and the volumetric flow rate of the water in which it is dissolved. Perchlorate loading in shallow groundwater that is not captured by the extraction wells is calculated by adding up the perchlorate loading linearly along equipotentials that are outside of the capture zones. To accomplish this, **Figure 13** was generated by performing the following calculations, with each [parameter] shown in brackets representing a map of parameter values on a grid spacing of 10 feet by 10 feet.

1) [Saturated thickness (ft)] = [Potentiometric surface (ft)] – [Top of Middle WBZ formation (ft)]

2) [Transmissivity ($ft^2$/day)] = [Saturated thickness (ft)] * [Hydraulic conductivity (ft/day)]

3) [Volumetric flow/width ($ft^3$/day/ft)] = [Transmissivity ($ft^2$/day)]*[Gradient (ft/ft)]

4) [Loading/width (lbs/day/ft)] = [Volumetric flow/width ($ft^3$/day/ft)]*[Concentration (mg/L)]*CF

Where,

CF = (2.2 x $10^{-6}$ lbs/mg)*(28.3 L/$ft^3$) = 6.2 x $10^{-5}$ lbs*L/mg/$ft^3$

Top of Middle WBZ and Hydraulic conductivity distribution are obtained from the calibrated current Endeavour numerical groundwater flow model.[6]

And the gridded parameter values are presented in the following figures,

[Potentiometric surface (ft)] - **Figure 11**

[Concentration (µg/L)] – **Figure 12**

[Loading/width (lbs/day/ft)] - **Figure 13**

The gradient term was calculated at each cell in the grid using a slope analysis.

The perchlorate loading per unit width map for the Shallow WBZ (**Figure 13**) is presented in units of lbs/day/ft since the values represent loading per width perpendicular to flow. Therefore, a value of perchlorate loading in units of lbs/day can be generated by establishing a cross-sectional width along any potentiometric contour and multiplying the cross-sectional width by the average value in lbs/day/ft (equivalent to integrating the loading term along the line of section). The cross-section locations used for this calculation where chosen to be the 1,625 and 1,645 ft mean sea level [msl] potentiometric contours, as shown on **Figure 13**.

[6] Geosyntec, 2016. Groundwater Flow Model Update Henderson, Nevada. 13 September 2016.

The range in perchlorate loading not captured in shallow groundwater using these methods are shown in Section 3. Very few changes have been observed in the estimated perchlorate loading per unit width map north of the Shallow extraction system. The perchlorate mass located in this area in the Shallow WBZ is estimated in Section 3. Additional refinements of the current groundwater flow model were performed by Geosyntec to better represent the groundwater flow in the shallow zone and the interaction with the Las Vegas Wash. Based on this refined model, and assessment of groundwater flow in the shallow zone north of the extraction system, additional evaluation of this area is pending publication of the NERT Downgradient Investigation Study.[7]

## 2.2 Calculation of Perchlorate Mass Capture and Hydraulic Containment in Deep WBZ

The approach to evaluating perchlorate mass capture in the Deep WBZ depends on whether the evaluation coincides with an annual or semi-annual monitoring period. The complete set of Deep WBZ wells used to estimate the extent of the perchlorate groundwater concentration contours is sampled on an annual basis. The approaches to evaluating perchlorate mass capture in the Deep WBZ for both the annual and semi-annual sampling reporting periods are described herein using the following steps:

- Quantify the perchlorate mass capture in groundwater in the influent to the extraction system (i.e. perchlorate loading in extraction wells);
- Delineate the capture zone(s) of the extraction wells using the numerical method (as above); and
- Quantify the total mass of perchlorate in the Deep WBZ within the 700 part per billion (ppb) contour (completed for annual reporting period only).

[7] Geosyntec, 2017. Shallow Zone Capture Assessment – Revision 1, Endeavour, Henderson, NV, dated 23 March 2017 and sent to NDEP in an email dated 30 March 2017.

As this memo presents the data from a semi-annual reporting period (2H17), the total mass of perchlorate in the Deep WBZ within the 700 ppb contour is not calculated. The details of the calculations that were completed are provided below and are based on data collected during the site-wide water level survey performed November 2, 2017 through November 19, 2017. The following sections present the quantification of the perchlorate loading used in the perchlorate mass capture calculation.

Perchlorate Loading in Deep Groundwater Captured by the AGTS

The groundwater volumetric flow rate and perchlorate loading captured by the extraction system are based on directly measurable quantities of flow and concentration. The approximate perchlorate mass capture rates for the deep zone extraction wells operating when the site-wide perchlorate groundwater samples were collected (November 2, 2017 to November 19, 2017) were calculated and are presented in the following table (see **Figure 14** for deep (AMEW) extraction well locations).

| Well | Average Operating Rate for 2H17 Measurement Period (gpm) | Perchlorate Concentration for 2H17 Measurement Period (mg/L) | Average Perchlorate Mass Capture Rate for 2H17 Measurement Period (lbs/day) |
|---|---|---|---|
| AMEW-1 | 277 | 200 | 670 |
| AMEW-2 | 64 | 240 | 180 |
| AMEW-3 | 50 | 130 | 78 |
| AMEW-4 | 33 | 85 | 34 |
| AMEW-5 | 46 | 90 | 50 |
| **Total** | **470** | **-** | **1,012** |

During this period, the total mass capture rate by the Auto Mall Extraction Wells (Deep WBZ) when all wells were operational was approximately 1,012 lbs/day of perchlorate. The approximate daily mass capture rates and cumulative mass captured for all the individual extraction wells operating from initial pumping in October 2012 to December 31, 2017 are presented in **Figures 4b** and **5b**, respectively. The total extraction rate by the Auto Mall Extraction Wells increased from 358 gpm (1H14) to 452 gpm (2H16) to 471 gpm (1H17) and remained stable at 470 gpm in 2H17. The total perchlorate mass capture is slightly lower in 2H17 due to lower influent perchlorate concentrations while the extraction rates remained the same as 1H17 (Section 4). Given the higher flow rates and perchlorate concentrations when compared with the Shallow WBZ extraction wells, these Deep WBZ extraction wells provide the bulk of the perchlorate mass treated in the FBR-based AGTS.

Hydraulic Containment of Perchlorate in Deep Groundwater by the AGTS

**Figure 14** shows a map of the potentiometric surface generated by the current Endeavour numerical groundwater flow model using data from Deep WBZ monitoring wells and extraction well pumping rates during the measurement period. Capture zones associated with the operating Auto Mall Extraction Wells were calculated using the numerical groundwater flow model.

Capture zone widths (in feet) associated with each operating extraction well were calculated numerically and are shown below:

| Extraction Well | Operating Rate (gpm) | Capture Width (ft) Measured at 1,815 ft msl equipotential | Capture Width (ft) Measured at 1,830 ft msl equipotential |
|---|---|---|---|
| AMEW-1 | 277 | 5,175 | 5,000 |
| AMEW-2 | 64 | | |
| AMEW-3 | 50 | | |
| AMEW-4 | 33 | | |
| AMEW-5 | 46 | | |
| Total | **470** | **5,175** | **5,000** |

The calculated capture zones are similar to those previously estimated in 1H17, reflecting the stabilization of the extraction rates in 2017.

## 3. PERCHLORATE MASS CAPTURE

Shallow WBZ Perchlorate Capture

The components of Shallow WBZ perchlorate loading described above can be combined to estimate the percentage of perchlorate mass captured by the shallow extraction system in 2H17. The table below summarizes the perchlorate loading components, with cumulative ranges between the two equipotential measuring points (1,625 and 1,645 ft msl) used in the numerical calculations:

| Perchlorate Loading | Groundwater | Surface Water (ADC) | Total |
|---|---|---|---|
| Captured (lbs/day) | 34 | 0 | 34 |
| Not Captured (lbs/day) | 3 – 5 | 18.6 | 21.6 – 23.6 |
| Total (lbs/day) | 37 – 39 | 18.6 | 55.6 – 57.6 |
| Fraction of Loading Captured (%) | 87 – 92 | 0 | 59 – 61 |

Thus, the total perchlorate loading captured as a function of the total loading in groundwater is in the range of 90%. The total loading captured (i.e., groundwater and surface water) is in the range of 60%.

An estimate of the total perchlorate mass in the Shallow WBZ within the 700 ppb contour was calculated based on the perchlorate contours (**Figure 12)** and an estimate of the Shallow WBZ thickness (20 ft) and of the porosity range (0.10 – 0.25). The mass within the 700 ppb contour was calculated as the product of:

- the volume of the Shallow WBZ between each contour and the next greater contour; and

- the geometric mean of the measured concentrations above 100,000 ppb for the mass within the 100,000 contour; or
- the concentration at half of the logarithmic scale between the two delineating contours for the lesser contours.

The calculated perchlorate masses are presented below:

| Shallow WBZ Contour (ppb) | Perchlorate Concentration (ppb) | Area (square feet) | Mass within contour (lbs) | |
|---|---|---|---|---|
| | | | Effective Porosity | |
| | | | 0.1 | 0.25 |
| 700 | 837 | 11,580,000 | 1,200 | 3,000 |
| 1,000 | 3,160 | 16,879,000 | 6,700 | 16,600 |
| 10,000 | 31,600 | 37,049,000 | 146,200 | 365,400 |
| 100,000 | 110,000 | 1,822,000 | 25,000 | 62,600 |
| **TOTAL** | | **67,330,000** | **179,100** | **447,600** |

The mass estimate in the Shallow WBZ decreased slightly compared to 1H17, due to reshaping of the 10,000 and 1,000 contours around extraction well APEW-3.

In addition, an estimate of the perchlorate mass in the Shallow WBZ in the area located north of the Shallow extraction system was calculated using the method outlined above. The mass in this area was estimated to be between 10,000 and 25,200 lbs, for effective porosities of 0.1 and 0.25 respectively. This mass corresponds to approximately 6% of the total mass estimate in the Shallow WBZ. The shallow zone plume north of the extraction system has been stable over time, as documented in the semi-annual monitoring reports, but increasing perchlorate concentrations have previously been observed at monitoring well MW-S. The perchlorate concentration stabilized at monitoring well MW-S in 1H17 (**Figure 21**). This well is sampled on an annual basis and therefore was not sampled during the 2H2017 semi-annual reporting period. Additional evaluation of the concentration trend at this well will be performed in future monitoring events.

Deep WBZ Perchlorate Capture

An estimate of the total perchlorate mass in the Deep WBZ within the 700 ppb contour will be calculated in the next annual report when the complete suite of perchlorate analyses (i.e., all annually sampled wells) is available.

The perchlorate capture rate from the Deep WBZ was approximately 1,012 lbs/day.

A summary of Shallow and Deep WBZ mass capture for 2H17 is presented below:

| Zone | Total Extraction Well Flow Rate (gpm) | Total Perchlorate Mass Capture Rate (lbs/day) |
|---|---|---|
| Shallow WBZ | 271 | 34 |
| Deep WBZ | 470 | 1,012 |
| **Total** | **741** | **1,046** |

As a result of adding the Deep WBZ extraction wells and installing the FBR system, the total flux of groundwater extracted and treated has increased from approximately 150 gpm (in the second half of 2011 (2H11), when only the Shallow WBZ wells were operating) to almost 750 gpm (an increase by a factor of almost 5 since 2H11). The total mass captured and treated has increased from about 36 lbs/day to over 1,000 lbs/day (an increase by a factor of over 30 since 2H11).

The mass removed by the Deep WBZ extraction wells decreased from approximately 1,600 lbs/day in 1H13 to approximately 1,012 lbs/day in 2H17, while the extraction rates increased from 360 to 470 gpm in the same period. The decrease in mass removal is due to decreasing influent concentrations at the extraction wells (AMEW-1, AMEW-2 and AMEW-4 in **Figure**

**28**), reflecting the decreasing perchlorate mass in the Deep WBZ. The total extraction rates remained stable in 2H17 compared to 1H17, while the influent concentrations have decreased. It is anticipated that this trend will continue as perchlorate mass decreases in the Deep WBZ. This metric will continue to be tracked in the following monitoring periods to assess the trend.

The uncertainties associated with the method for mass capture and perchlorate loading estimate include the following:

a. These methods rely on interpolation of concentration and water levels, and the interpolated values can be expected to have decreased confidence with distance from measurement points;
b. The hydraulic gradient is calculated at each cell in the grid, so sharp changes in equipotential direction might yield erroneous gradients in certain cells; and
c. These methods assume the hydraulic conductivities assigned to each conductivity zone are constant across those zones, when in fact they may vary.

The uncertainties associated with the methods for mass estimate include the following:

a. These methods rely on interpolation of concentration and the interpolated values can be expected to have decreased confidence with distance from measurement points; and
b. The mass estimate is based on an estimated range for porosity in the Shallow and Deep WBZs.

## 4. REMEDIATION TRACKING

Remediation tracking was conducted for the Shallow WBZ as outlined in the Work Plan for Demonstration of Groundwater Capture.[8] Remediation tracking metrics for the Deep WBZ are calculated annually (corresponding with the greater number of wells sampled on an annual basis), and are included in the table below. Several metrics are used to track the progress of the AGTS. Many of these metrics will need to be refined following more months of consistent operation. They are stated here as a basis for future comparisons.

The estimation of the concentration at which 90% and 99% capture is achieved is limited to the precision at which concentration contours can be reasonably drawn on the available data.

[8] Geosyntec, 2013. Work Plan for Demonstration of Groundwater Capture. Groundwater Extraction Systems Henderson, Nevada. September 18, 2013.

Geosyntec consultants

| **Metric** | **Metric Value** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2H17** | **1H17** | **2H16** | **1H16** | **2H15** | **1H15** | **2H14** | **1H14** | **2H13** | **1H13** | **2H12** |
| **Shallow Water Bearing Zone** | | | | | | | | | | | |
| Total mass of perchlorate within 700 ppb contour (lbs) | 179,100 - 447,600 | 183,000 - 460,000 | 175,000 - 440,000 | 175,000 - 440,000 | 200,000 - 505,000 | 200,000 - 510,000 | 210,000 - 510,000 | 210,000 - 510,000 | 210,000 - 510,000 | 210,000 - 500,000 | 210,000 - 530,000 |
| Estimated Concentration at which 90% capture is achieved (Shallow WBZ) (ppb) | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | >1,000 | n/a |
| Estimated Concentration at which 99% capture is achieved (Shallow WBZ) (ppb) | >700 | >700 | >700 | >700 | >700 | >700 | >700 | >700 | >700 | >700 | n/a |
| Estimated Coordinates of the Centroid* of the Perchlorate Contours (Shallow WBZ) 700 ppb contour | E 823,225 N 26,723,676 | E 823,230 N 26,723,710 | E 823,200 N 26,723,700 | E 823,200 N 26,723,700 | E 823,100 N 26,723,700 | E 823,100 N 26,723,700 | E 822,900 N 26,723,600 | E 822,900 N 26,723,600 | E 822,900 N 26,723,700 | E 822,900 N 26,723,700 | E 820,700 N 26,718,400 |
| Estimated Coordinates of the Centroid* of the Perchlorate Contours (Shallow WBZ) 1,000 ppb contour | E 823,348 N 26,723,409 | E 823,380 N 26,723,650 | E 823,300 N 26,723,700 | E 823,300 N 26,723,700 | E 823,300 N 26,723,600 | E 823,300 N 26,723,600 | E 823,000 N 26,723,600 | E 823,000 N 26,723,600 | E 823,000 N 26,723,700 | E 823,000 N 26,723,600 | E 823,000 N 26,723,000 |
| Estimated Coordinates of the centroid* of the Perchlorate Contours (Shallow WBZ) 10,000 ppb contour | E 823,186 N 26,723,035 | E 823,310 N 26,723,200 | E 823,300 N 26,723,700 | E 823,300 N 26,723,300 | E 823,300 N 26,723,200 | E 823,300 N 26,723,300 | E 823,200 N 26,723,100 | E 823,200 N 26,723,100 | E 823,200 N 26,723,000 | E 823,100 N 26,722,900 | E 823,100 N 26,722,600 |
| Estimated Coordinates of the Centroid* of the Perchlorate Contours (Shallow WBZ) 100,000 ppb contour | E 819,960 N 26,717,906 | E 819,950 N 26,717,910 | E 820,000 N 26,717,900 | E 820,000 N 26,717,900 | E 820,100 N 26,718,200 | E 820,100 N 26,718,200 | E 820,300 N 26,718,200 | E 820,300 N 26,718,300 | E 820,300 N 26,718,300 | E 820,300 N 26,718,300 | E 823,100 N 26,722,300 |
| Average Daily Perchlorate Capture Rate (lbs/day) (Shallow WBZ) | 34 | 36 | 38 | 38 | 38 | 41 | 42 | 50 | 60 | 62 | 36 |
| Estimated Perchlorate Loading Not Captured by AGTS at Athens/Galleria Extraction Area (lbs/day) | 22 - 24 | 23 - 24 | 16 - 17 | 13 - 15 | 13 - 14 | 20 - 21 | 9 - 10 | 18 - 19 | 10 - 12 | 17 - 18 | n/a |
| **Deep Water Bearing Zone** | | | | | | | | | | | |
| Total mass of perchlorate within 700 ppb contour (lbs) | n/a | 430,000 - 1,070,000 | n/a | 460,000 - 1,160,000 | n/a | 430,000 - 1,080,000 | n/a | 500,000 - 1,240,000 | n/a | 670,000 - 1,670,000 | 830,000 - 2,090,000 |
| Rounded Average Daily Perchlorate Capture Rate (lbs/day) (Deep WBZ) | 1,000 | 1,100 | 1,100 | 1,100 | 1,200 | 1,200 | 1,200 | 1,200 | 1,400 | 1,600 | n/a |

* Centroid coordinates based on Nevada State Plane NAD83 South System, Feet

# APPENDIX B

# ACRONYMS

| | |
|---|---|
| ACNS | The section of the ADC that runs North and South |
| ADC | Athens Drainage Channel |
| AGTS | Athens Road/Galleria Drive and Auto Mall area Groundwater Treatment System |
| AMEW | Auto Mall Extraction Well |
| AOC | Administrative Order on Consent |
| APEW | Athens Pen Extraction Well |
| AREW | Athens Road (now Galleria Road) Extraction Well |
| BCA | Bureau of Corrective Actions |
| BISC | Bureau of Industrial Site Cleanup |
| EGSD | Eastgate Storm Drain |
| fbgs | Feet Below Ground Surface |
| FBR | Fluidized Bed Reactor |
| DAF | Dissolved Air Floatation |
| DMR | Discharge Monitoring Report |
| DO | Dissolved Oxygen |
| DRIT | Deep Re-injection Trench |
| EGSD | Eastgate Storm Drain |
| gpm | Gallons per Minute |
| ISB | In-Situ Bioremediation |
| MSA | Mitigation System Area |
| NDEP | Nevada Division of Environmental Protection |
| NPDES | National Pollution Discharge Elimination System |
| µg/L | Microgram per liter (parts per billion) |
| mg/L | Milligrams per liter (parts per million) |
| msl | Mean Sea Level |
| $Q_{al}$ | Quaternary Alluvium lithological unit |
| SAP | Sampling and Analysis Plan |
| SWS | South of Warm Springs Road |
| TRM | Total Recoverable Metals |
| TSS | Total Suspended Solids |
| UIC | Underground Injection Control |
| WBZ | Water Bearing Zone |
| WI | Work Instruction |

# APPENDIX C

# DEFINITIONS

Influent Perchlorate - The total amount of perchlorate extracted from the Auto Mall, Athens Road, and Athens Pen extraction wells.

Loading - The amount of mass per unit time and has units of mass per time (e.g. mass*time-1 or lbs*day-1).

Mass Flux - The mass that crosses a surface area over unit time and has units of mass per time per area (mass*time-1*area-1 or lbs*day-1*($ft^2$)-1).

Perchlorate Loading - The amount of mass of perchlorate per unit time in groundwater moving across a given cross-sectional area.

Perchlorate mass capture - refers to the mass of perchlorate per unit time that is withdrawn from the sub-surface and treated by the AGTS.

Perchlorate percent capture - refers to perchlorate mass loading capture as a percentage of the total perchlorate loading estimated at the extraction well locations.

Volumetric Flux - the volume that crosses a surface area per time (e.g. volume*time-1*area-1 or $ft^3$*day-1*($ft^2$)-1).

# APPENDIX D

# CALCULATIONS

Influent Concentration (lbs) = [(Flow (L/day) ] x [Perchlorate Concentration (g/L)] / [454 (g/lb)]

Loading/width (lbs/day/ft) = [Volumetric flow/width ($ft^3$/day/ft)] x [Concentration (mg/L)] x CF
Where, Conversion Factor (CF) = (2.2 x $10^{-6}$ lbs/mg)*(28.3 L/$ft^3$) = 6.2 x $10^{-5}$ lbs x L/mg/$ft^3$

Saturated thickness (ft) = [Potentiometric surface (ft)] – [Top of Middle WBZ formation (ft)]

Transmissivity ($ft^2$/day) = [Saturated thickness (ft)] x [Hydraulic conductivity (ft/day)]

Volumetric flow/width ($ft^3$/day/ft) = [Transmissivity ($ft^2$/day)] * [Gradient (ft/ft)]

Triangular (V-notch) Weirs Flow ($ft^3$/sec) = 2.5 x $H^{2.5}$
Where, height (H) is the distance from the bottom point to the water surface

# APPENDIX E

September 27, 2017

Mr. Alan Pineda
Bureau of Industrial Site Cleanup
NDEP-Las Vegas City Office
2030 E. Flamingo Road, Suite 230
Las Vegas, NV 89119

**Re: Responses to NDEP's August 21, 2017 Comments on Semi-Annual/Annual Monitoring Report (for the period January 1 – June 30, 2017) Dated August 14, 2017, Endeavour, LLC, Henderson NV, Facility ID H-000534**

Dear Mr. Pineda:

Please find below Endeavour's responses to the specific comments made on Semi-Annual/ Annual Monitoring Report in your August 21, 2017 letter. The report covered the period between January 1 and June 30, 2017. A revised report (Rev 1) is enclosed incorporating the comments found below which will include in Appendix E a copy of this response-to-comments.

Specific Comments:

1. Section 6.2.3 Semi-Annual Monitoring Results: This section states that semi-annual sampling was performed for eleven monitoring wells and one extraction well, as presented in Table 9. However, Table 9 lists twelve monitoring wells (eleven of which were sampled) and no extraction wells. Please clarify.

   **Response: Text has been modified in this section to indicate twelve monitoring wells (no extraction well) and also text has been added explaining why NX-17 was not sampled due to construction.**

2. Table 10 – Annual Sampling Field Measurements: The given depth to water for wells AK-204 and AMX-166 is -39.27 and -19.63, respectively. Please double-check the accuracy of these values and make any necessary corrections.

   **Response: These negative values represent the head pressure in feet above the top of casing as these are artesian wells. The values are converted from psi gauge pressure readings in the field. A footnote has been added to the bottom of Table 10 explaining this.**

3. Section 6.3 Blind Duplicate and Split Sample Results: This section states that seven blind duplicate samples were taken, as presented in Table 12. However, Table 12 only lists six blind duplicates. Please clarify and correct as necessary.

   **Response: Table 12 has been corrected to include all seven blind duplicates. The bottom of the table was inadvertently cut-off when setting the print area.**

4. Page 15, Table for Calculation of Capture Zone Widths, Column 4: The total for *KT3D-H2O Method Capture Zone Width (ft.) Measured at 1,645 ft msl* is given as 3,575. The sum of 45 and 3,520 is 3,565. Please explain or correct as necessary.

   **Response: The sum has been changed to 3,565 in this table and the corresponding table in Appendix A.**

5. Section 6.4.1, Approach and Methodology, Perchlorate Loading in Surface Water (Not Captured): This section states that 17.7 lbs/day is the value used in the mass capture calculation presented in Section 6.4.2. However, Section 6.4.2 uses a value of 16.5 lbs/day for the mass capture calculation. For consistency with previously submitted semi-annual/annual monitoring and performance reports, please use 17.7 lbs/day in lieu of 16.5 lbs/day for the mass capture calculation. Additionally, please make all other corrections that may become necessary as a result of this change, which may include but are not limited to:
   a. Section 6.4.2.1: Percentage of total loading captured in table and text.
   b. Table on Page 23 of the Report: Estimated Perchlorate Loading Not Captured by AGTS at Athens/Galleria Extraction Area (lbs/day) for 1H17.
   c. Section 7.0, Summary and Conclusions, Final Paragraph: Range of total loading captured.
   d. Appendix A: Geosyntec Technical Memo.

   **Response: This value has been changed to 17.7 in this section and all related corrections have been made throughout the text and Appendix A.**

6. Section 6.4.2.1, Shallow WBZ Perchlorate Capture and Removal: This section states that the total perchlorate mass was calculated based on a porosity value of 0.15. However, a subsequent table in this section uses porosity values of 0.1 and 0.25 for the total perchlorate mass calculation. Please clarify and correct as necessary.

   **Response: The text in this section has been modified to reflect that both porosities are used in the mass calculation, thus matching the way it is presented in the corresponding table.**

7. Section 6.4.2.1, Shallow WBZ Perchlorate Capture and Removal: The Fraction of Loading Captured (%) presented in the first table under this section (61-63) appears to be the lowest since operation of the AGTS began. With the understanding that this range will continue to decline as mass continues to be removed over time, NDEP encourages the exploration of

additional optimization measure (as stated in Section 8.0, Plan and Recommendations) to maximize the amount of perchlorate mass captured.

**Response: As indicated in Section 6.4.1, the increase in perchlorate loading in surface water (and resulting decrease in Fraction of Loading Captured) is most likely due to increasing water levels in the vicinity of the Eastgate Storm Drain (EGSD), resulting in increasing groundwater infiltration into the EGSD and increasing flow, while the perchlorate concentrations have remained stable. The water levels at MW-AC have increased by almost 3 feet between 2000 and 2017. This increasing trend is likely due to the recent urban development in the area that results in increasing water infiltration. As indicated in Section 8.0, Endeavour is evaluating additional optimization measures for the entire system during the next reporting period.**

Please contact Gary Carter at 702-699-4154 or me at 702-699-4184 if there are questions. Thank you.

Sincerely,

Jeff Gibson
Authorized Representative

Enclosure

cc:

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September 29, 2017

Jeff Gibson
Authorized Representative
Endeavour LLC
900 Wiesner Way,
Henderson, Nevada 89011

Re: **Endeavour LLC**
**(Former AMPAC/PEPCON Facility)**
Nevada Division of Environmental Protection (NDEP) Response to: *Responses to NDEP's August 21, 2017 Comments on Semi-Annual/Annual Monitoring Report (for the period January 1 – June 30, 2017)*

Dated: September 27, 2017

And

*BISC Semi-Annual/Annual Monitoring and Performance Report, Rev.1, January 1 to June 30, 2017*

Revised: September 20, 2017

Dear Mr. Gibson,

The NDEP has received and reviewed the Endeavour's above-identified Deliverables and finds that they are acceptable.

Please contact the undersigned with any questions at alan.pineda@ndep.nv.gov or 702-486-2850 x247.

Sincerely,

Alan Pineda

Alan Pineda, E.I.T.
Bureau of Industrial Site Cleanup
NDEP-Las Vegas City Office

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February 28, 2018

Mr. Alan Pineda
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**Re: Responses to NDEP's February 22, 2018 Comments on Semi-Annual Monitoring Report (for the period July 1 – December 31, 2017) Dated February 14, 2017, Endeavour, LLC, Henderson NV, Facility ID H-000534**

Dear Mr. Pineda:

Please find below Endeavour's responses to the specific comments made on Semi-Annual Monitoring Report in your February 22, 2018 letter. The report covered the period between July 1 and December 31, 2017. A revised report (Rev 1) is enclosed incorporating the comments found below which will include in Appendix E a copy of this response-to-comments.

Specific Comments:

1. *Section 6.2.2, Quarterly Monitoring Results: This section indicates that quarterly sampling results presented in Table 5 "include the eight AREWs and APEWs." However, Table 5 lists nine AREWs and APEWs. Please clarify.*

   Response: The text in Section 6.2.2 was changed to indicate "nine AREWs and APEWs" in the revised report which is the correct number as shown in Table 5.

2. *Section 6.2.3, Semi-Annual Monitoring Results: This section indicates that semi-annual sampling for twelve monitoring wells and one extraction well are presented in Table 9. However, Table 9 does not list any extraction wells. Please add the extraction well and associated sampling results to Table 9, or remove "and one extraction well" from the text if the extraction well should not be included.*

   Response: The words "and one extraction well" were removed from Section 6.2.3 in the revised report which properly matches Table 9 which shows the correct suite of wells.

3. *Section 6.3.2.1, Shallow WBZ Perchlorate Capture and Removal: The first table within this section lists 34 lbs/day of captured groundwater, and 0 lbs/day of captured surface water, but incorrectly lists the sum of the two as 37 lbs/day. Please change "37" to "34." The subsequent calculation for Total Fraction of Loading Captured will not be affected by this correction since the calculation is correctly based on 34 lbs/day.*

Response: The value of 34 has been entered in place of 37 in the revised report. The correct value of 34 also appears in the same table in Appendix A.

4. *Section 6.3.2.1, Shallow WBZ Perchlorate Capture and Removal: The second bullet point and second table within this section refer to a 100,000 ppb shallow WBZ contour. The 100,000 ppb contour is not shown in Figure 12. Endeavour should consider adding the 100,000 ppb contour to Figure 12.*

   Response: The 100,000 ppb contour is south of the extent shown in Figure 12 and south of Warm Springs Road. The extent of Figure 12 is consistent with previous semi-annual reports and has not been modified. Note that the 100,000 ppb contour is shown annually on Plate 4 in the monitoring report summarizing activities that took place during the first half of each year (January to June).

5. *Section 6.3.2.1, Shallow WBZ Perchlorate Capture and Removal: In the second table within this section, the sum of the "mass within contour" values for effective porosity of 0.1 is 176,800 lbs, but the reported total is 179,100 lbs. Please make all necessary corrections to this table, and to all subsequently affected values in the table on page 21 of the report.*

   Response: The mass within the 100,000 ppb contour was incorrectly reported as 22,700 lbs instead of 25,000 lbs. this value has been corrected in the table in the revised report and in Appendix A. The total mass within the contours for a porosity of 0.1 is still 179,100 lbs. Because the total mass within the contours for a porosity of 0.1 is still 179,100 lbs, no revisions are required to the table on page 21.

6. *Table 3a - Auto Mall Extraction Wells Average Monthly Perchlorate: This table shows a perchlorate concentration of 37 mg/L for AMEW-2 in August 2015. However, Table 8 does not provide a perchlorate concentration for AMEW-2 in August 2015, and indicates that "AMEW-2 was not running in August 2015." Please make all necessary corrections to ensure that this data is consistent across both tables.*

   Response: Table 8 has been modified in the revised report to show a perchlorate concentration of 37 mg/L for AMEW-2 in August, 2015 with additional narrative added to the footnote to explain the reasoning for the erroneously low result.

7. *Table 7 - Selected History of Perchlorate Concentrations in Athens Pen Extraction Wells: The first bullet point within section 6.3 indicates that "APEW-1 was started on May 28, 2015." In addition to stating this in the text, Endeavour should consider including this as a footnote under Table 7 to explain why APEW-1 was not sampled from November 2009 to May 2015.*

   Response: The suggested text has been added to the footnote on Table 7 in the revised report.

8. *Table 9 - Semi-Annual Analytes and Field Measurements: Well OX-16 references footnotes 1 and 2. However, footnote 2 is not listed. Please add footnote 2, or remove the reference to footnote 2.*

Response: The reference to footnote 2 has been removed in Table 9 in the revised report. That footnote was a remnant from a previous report in regards to obstruction of access to that well during road construction.

Please contact Gary Carter at 702-699-4154 or me at 702-699-4184 if there are questions. Thank you.

Sincerely,

Jeff Gibson
Authorized Representative

JG/j
Enc.

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# APPENDIX F

# Data Validation Summary Report

# Data Validation Summary Report ENDVR.2H2017

For Samples Collected and Analyzed July 1 to December 31, 2017

Perchlorate Bioremediation System
Endeavour, LLC
Henderson, Nevada

NDEP Facility ID: H-000534

Submitted: February 14, 2018

ENDEAVOUR, LLC
**900 Wiesner Way**
**Henderson, NV 89011**

**DATA VALIDATION SUMMARY REPORT – ENDVR.2H2017**
**FOR SAMPLES COLLECTED AND ANALYZED JULY 1 – DECEMBER 31, 2017**
**ENDEAVOUR, LLC**
**HENDERSON, NEVADA**

February 14, 2018


______________________________

Brian Pence, C.H.M.M., C.E.M
Lab and Field QA Specialist
Certified Hazardous Materials Manager, CHMM #13810, expires 06/30/22
Nevada Certified Environmental Manager, CEM # 2421, expires 04/07/18

Reviewed by:

______________________________

Gary Carter, P.E., C.E.M.
Facility Manager
Nevada Certified Environmental Manager, CEM #1909, expires 01/26/19

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# 1.0 Introduction

## 1.1 Purpose and Objectives

The purpose of this Data Validation Summary Report (DVSR) is to assess the analytical quality and usability of the data generated from groundwater and surface water samples collected during the second half of 2017 (2H2017), from July 1 – December 31, 2017. Samples were collected in accordance with Endeavour's NDEP-approved Rev. 2 Sampling and Analysis Plan (SAP) and Water and Soil Sample Collection procedure (SOP-02).

The objective of this sample collection and analysis is to verify remediation of perchlorate in groundwater and surface water down gradient of the former PEPCON industrial site. The remediation is achieved via pumping and treatment of ground and surface waters through a fluidized bed reactor system, before being discharged to the Las Vegas Wash.

## 1.2 Summary

A total of 180 aqueous environmental and quality control (QC) samples were collected and analyzed by the following methods:

- Perchlorate by EPA method 314.0 – 90 samples.
- Chlorate by EPA method 300.1 – 90 samples.

Analysis was performed by American Pacific Corp (APC - Utah) for all samples. Data validation included the evaluation of laboratory QC data such as Laboratory Reagent Blanks (LRBs), Laboratory Fortified Blanks (LFBs), and Laboratory Fortified Matrix (LFMs). Adherence to sample holding times, standard analytical methods, standard operating procedures, and proper documentation were also verified.

The samples were grouped into the following Sample Delivery Groups (SDGs):

| | | | | | |
|---|---|---|---|---|---|
| 20170706-M | 20170802-M | 20170807-Q | 201708108-Q | 20170809-Q | 20170813-Q |
| 20170820-Q | 20170905-M | 20171003-M | 20171102-Q | 20171105-Q | 20171106-Q |
| 20171102-SA | 20171107-SA | 20171108-SA | 20171108-M | 20171112-Q | 20171112-SA |
| 20171119-Q | 20171206-M | 20171220-M | | | |

**The Analytical Data Summary is listed in Table 5. The Qualified Data Summary is listed in Table 6.**

Analytical data was validated based on the following documents and US Environmental Protection Agency (EPA) methods:

- ENDVR Sample Collection and Control, NOL.010.WI.03
- ENDVR Field Measurements NOL.010.WI.05

- Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use EPA-540-R-08-005 January 2009

- USEPA Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review, August 2014 Version, EPA 540-R-013-001

- Perchlorate by EPA method 314.0

- Chlorate by EPA method 300.1

Comments / Response Summary:

Endeavour submitted a revised 1H2017-DVSR/EDD and letter of responses, dated October 25, 2017 to NDEP regarding comments and request for corrections, dated September 13, 2017. A letter from NDEP, dated November 07, 2017 acknowledged receipt of the revised 1H2017-DVSR/EDD deliverables and found them to be acceptable. This correspondence is included in Appendix F as requested by NDEP.

## 2.0 Validation Stages

This report summarizes the QA/QC evaluation of the data according to its precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) relative to the project data quality objectives (DQOs). This report provides a quantitative and qualitative assessment of the data and identifies potential sources of error, uncertainty, and bias that may affect the overall usability of the data.

There are five stages of data validation: Stage 1, Stage 2A, Stage 2B, Stage 3 and Stage 4. These are further defined below.

Stage 1 validation is based on completeness and compliance of sample receipt condition checks and analytical results. This stage involves the evaluation of information provided on the laboratory certification reports and the chain-of-custody (COC) documentation. This includes assessment results for holding time, sample integrity and reporting limits.

Stage 2A validation is based on completeness and compliance checks of sample receipt conditions (Stage 1) and sample-related QC results. Stage 2A validation includes the evaluation of information provided in the laboratory certification report, the COC records, and results from the analysis of the QC samples.

Stage 2B validation builds on stage 2A validation and includes completeness and compliance checks of sample receipt conditions (Stage 1), sample-related QC results (Stage 2A) and instrument-related QC results. This includes assessment of holding times, sample integrity, analytical and system performance and data information obtained from the analysis of QC samples and the evaluation of calibration results.

Stage 3 validation incorporates Stage 2B requirements and also includes recalculation checks of the QC results. Calculation checks of the reported detected sample results and a minimum of

20% check of the QC samples and standards are acceptable for Stage 3. The validation covers assessments listed in Stage 2B plus the calculation and transcription error checks.

Stage 4 validation incorporates Stage 3 requirements and also includes the review of the actual instrument outputs. Appendix A (attached) lists a general table of analytical validation checks corresponding to each stage. Appendices B and C (attached) show the data review checklists utilized for the validation and verification of each analytical method used.

All of the 2H2017 data was validated to stage 2A, per NDEP specifications. Table 1 lists validation elements used for Stage 2A review.

**Table 1 - Stage 2A Validation Elements**

| QUALITY CONTROL ELEMENTS | STAGE 2A | |
|---|---|---|
| | CHLORATE | PERCHLORATE |
| Sample Receipt, IDs Verified, Hold Times | √ | √ |
| Instrument Performance Check (IPC/MCT) | √ | √ |
| Initial Calibration (ICAL) | √ | √ |
| Quality Control Sample (QCS) | √ | √ |
| Initial (ICCS), Continuing (CCCS), and Ending Calibration Check Std. (ECCS) | √ | √ |
| Laboratory Reagent Blank (LRB) | √ | √ |
| Field Blank (FB) | N/A | N/A |
| Laboratory Fortified Matrix (LFM) - % Rec | √ | √ |
| Laboratory Duplicates (% RPD) | √ | √ |
| Laboratory Fortified Blank (LFB) - % Rec | √ | √ |
| Serial Dilution | N/A | N/A |
| Sample Quantitation Limits < NDEP Limits | **+** | **+** |
| Project Quantification Limits (SQL, PQL) | √ | √ |
| System Performance | **+** | **+** |
| Overall Data Usability Assessment | √ | √ |

√ = Complete for Stage 2A Review.
N/A = Not Applicable to method or not performed during this sampling event.
+ = Not applicable to Stage 2A review.

## 3.0 Data Qualifier Definitions

The following definitions in Table 2 below provide brief explanations of the data flags assigned to results in the data validation process. Table 3 provides additional information on when these qualifiers are used and how they pertain to PARCCS parameters defined in section 5.0.

**Table 2 – Data Qualifier Definitions**

| Data Qualifier | Data Qualifier Definition |
|---|---|
| **U** | Not detected. The sample was analyzed for this parameter, but it was not detected at greater than the reported quantitation limit. |
| **UJ** | Indicates the compound or analyte was analyzed for, but not detected. The reported quantitation limit is an estimated value due to QC failure or data limitations. |
| **J+** | Indicates the compound or analyte is positively identified, but the reported concentration is an estimate with a positive bias due to QC failure or data limitations. |
| **J** | Indicates the compound or analyte is positively identified, but the reported concentration is an estimate due to QC failure or data limitations. |
| **J-** | Indicates the compound or analyte is positively identified, but the reported concentration is an estimate with a negative bias due to QC failure or data limitations. |
| **R** | Quality control indicates the data is not usable. The presence or absence of the compound or analyte cannot be verified or the reported result is compromised as to be unusable. |

### 3.1 Data Qualifier Hierarchy

The hierarchy used to qualify data with more than one QC issue is as follows:

**R > J** The R qualifier will always take precedence over the J qualifier.

**J > J+ or J-** A non-biased (J) qualifier will always supersede biased (J+ or J-) qualifiers, since it is not possible to assess the direction of the potential bias.

**J = J+ plus J-** Adding biased (J+, J-) qualifiers with opposite directions will result in a non-biased qualifier (J).

**UJ = U plus J** The UJ qualifier is used when a non-biased (J) qualifier is added to a non-detected (U) result.

## Table 3 – Summary of DVSR Qualifiers

| Data Quality Indicator (DQI) | QC Activity | Valid-ation Reason Code | Out of Conformance Issue | Possible Qualifiers for Detected Analyte | Possible Qualifiers for Non-Detected Analyte | Samples Qualified |
|---|---|---|---|---|---|---|
| **Accuracy** | Cal Curve | 1 | The affected results were not analyzed with a valid 3 or 5-point calibration curve | J | UJ | All samples associated with initial calibration |
| | | 2 | Calibration information is missing or were analyzed on an expired calibration curve | R | R | All samples associated with initial calibration |
| **Accuracy** | Correlation Coefficient | 3 | The multipoint calibration correlation coefficient is <0.995 | J | UJ | All samples associated with initial calibration |
| **Accuracy** | QCS | 4 | Recovered outside method limits | J | UJ, R | All samples in the same Run Batch |
| | | 5 | Not Analyzed at the required method frequency | J | UJ, R | All samples in the same Run Batch |
| **Accuracy** | LFB (LCS) | 6 | Recovered outside method limits | J | UJ, R | All samples in the same Run Batch |
| | | 7 | Not Analyzed at the required method frequency | R | R | All samples in the same Run Batch |
| **Accuracy/Sensitivity** | ICV | 8 | Recovered outside method limits | J | UJ | All samples associated with initial calibration |
| | | 9 | Not Analyzed at the required method frequency | J | UJ, R | All samples associated with initial calibration |
| **Accuracy** | LRB | 10 | Analyte identified in blank at <1/2 minimum reporting level (MRL) | J+ | NA | All samples in the same Run Batch |
| **Accuracy** | IPC | 11 | Recovered outside method limits | J | UJ, R | All samples in the same Run Batch |
| | | 12 | Not Analyzed at the required method frequency | R | R | All samples in the same Run Batch |
| **Accuracy** | ICCS / CCCS / ECCS (CCV) | 13 | Recovered outside method limits | J | UJ, R | All samples associated with continuing calibration |
| | | 14 | Not Analyzed at the required method frequency | J | UJ, R | All samples associated with continuing calibration |
| **Accuracy** | LFM | 15 | Recovered outside method limits | J | UJ | Parent Sample |

| Data Quality Indicator (DQI) | QC Activity | Valid-ation Reason Code | Out of Conformance Issue | Possible Qualifiers for Detected Analyte | Possible Qualifiers for Non-Detected Analyte | Samples Qualified |
|---|---|---|---|---|---|---|
| | | 16 | Not Analyzed at the required frequency | R | R | Parent Sample |
| Accuracy/Sensitivity | Holding Time | 17 | Holding Time Exceeded by more than 2X | J- | R | Sample |
| | | 18 | Holding Time Exceeded by less than 2X | J- | UJ | Sample |
| Precision | Duplicates | 19 | Recovered outside method limits | J | UJ, R | Parent Sample |
| | | 20 | Not Analyzed | R | R | Parent Sample |
| Sensitivity | MDL/SQL | 21 | Analyte was detected below laboratory minimum reporting level (MRL) but above MDL. | J | J | Sample |
| Representativeness | Sample Preservation | 22 | Sample not Properly Preserved / Temperature not in Criteria | J- | UJ, R | Sample |
| Accuracy | Certification Issues | 23 | Laboratory not Certified for Analysis | J | J | Sample |
| Accuracy | Surrogate Spikes | 24 | Recovered outside method limits – high | J+ | NA | Sample |
| | | 25 | Recovered outside method limits - low | J- | UJ, R | |
| Sensitivity | MDL/SQL | 26 | Non-Detect Target Analyte | NA | U | Sample |

### Table 4 – APC Utah Data Flags

| Data Flag | Definition |
|---|---|
| 0 | No flag |
| 1 | Sample received and analysis performed past holding time |
| 2 | Spike recovery outside limits due to matrix interference |
| 3 | Sample received outside temperature limits |
| 4 | Analysis performed past holding time |
| 5 | The laboratory is not NELAC certified for this analysis |
| 6 | Estimated value, greater than SQL but less than the PQL |
| 7 | Sample received and metals preserved outside of 2 week holding time for preservation |
| 8 | Analyte concentration in sample is too high for accurate spike or duplicate recovery |
| 9 | SQL is not applicable to this method |
| 10 | QC recovery outside limits due to uncertainty of result below PQL |
| 11 | Analyte detected in laboratory reagent blank |

## 4.0 Analytical Sensitivity Terms

The detection limit of an individual analytical procedure is the lowest amount of analyte in a sample which can be detected but not necessarily quantitated. The detection limit is based upon the sensitivity of an analytical instrument and method and doesn't necessarily account for all matrix effects that may be encountered. The quantitation limit is the lowest amount of an analyte in a sample which can be quantitatively determined with suitable precision and accuracy. The quantitation limit differs from the detection limit in that it takes into account sample matrix effects. The laboratory calculations of each sensitivity term reported are located in Appendix D.

### 4.1 Method Detection Limit (MDL)

The procedure for determining the Method Detection Limit (MDL) is defined in 40 CFR, Part 136, Appendix B. It is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. MDLs are established using matrices with little or no interfering species such as reagent grade water and are considered the lowest achievable reporting limit for a particular method.

### 4.2 Practical Quantitation Limit (PQL)

EPA defines the Practical Quantitation Limit (PQL) as the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operation conditions (52 FR 25699, July 8, 1987). This limit is defined as the lowest level at which the entire analytical system gives a recognizable signal and acceptable calibration point for the target analyte, and includes the predicted effect of sample matrices with typical interfering species (NDEP Guidance on Data Validation, December 3, 2008).

The PQL is lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions. PQLs are used to estimate or evaluate the minimum concentration at which the laboratory can be expected to reliably measure a specific chemical contaminant during day-to-day analyses of different sample matrices.

All detected results that were greater than the Sample Quantitation Limit (SQL), but less than the PQL, were qualified by the laboratory as estimated values.

The PQL for all APC-Utah lab data is equal to the lowest calibration level for each analyte. The PQLs in the APC-Utah data are not adjusted for the dilution factor in the internal database, but are adjusted in the Summary Tables and EDD.

### 4.3 Sample Quantitation Limit (SQL)

The SQL is the MDL that is adjusted to reflect sample specific procedures such as dilution size, matrix effects or aliquot sizes. The SQL for all APC-Utah lab data is calculated as the MDL times the dilution factor. The SQL should never be larger than the PQL and will never be smaller than the MDL.

# 5.0 Quality Indicator Parameters (PARCCS)

An assessment of data utilizing precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS) was performed. PARCCS parameters were reviewed according to the definitions below.

## 5.1 Precision

Precision is the amount of agreement between repeated measurements of a sample. The measure of precision is shown as the Relative Percent Difference (RPD) between duplicates or spiked duplicate sample results. The smaller the percent difference, the more precise the measurements are. Duplicate precision must have an RPD ≤20% for EPA method 300.1, and an RPD ≤15% for EPA method 314.0. The formula used to calculate RPD is shown below:

Relative Percent Difference = $\{ ( |X1 - X2| ) / [ (X1 + X2)/2 ] \} \times 100$

Where:

X1 = reported concentration of the sample

X2 = reported concentration of the duplicate

## 5.2 Accuracy

Accuracy is a measure of the agreement between a measurement and its known or expected value. Accuracy is represented by calculating percent recovery of a spiked compound. The accuracy of this data set was assessed through calibration curves and spikes (LFB, LFM), using certified reference materials, as required by the methods and Standard Operating Procedures (SOPs) referenced for this data set.

### 5.2.1 LFM

Spiked sample percent recoveries (%R) for EPA method 300.1 must be within 75-125%; percent recoveries (%R) for EPA method 314.0 must be within 80-120%, calculated as:

$\%R = ((SSR-SR)/SA)*100$

Where:

SSR = Spiked sample result

SR = Sample result

SA = Spike added

#### 5.2.2 LFB

Spiked blank percent recoveries (%R) must be within 85-115% of the spiked concentration for EPA methods 300.1 and 314.0, and are calculated as:

%R = (SBR/SA)*100

Where:

SBR = Spiked blank result

SA = Spike added

#### 5.2.3 Surrogate Spikes

Surrogate spike percent recoveries (%R) for chlorate analyses must be within 90-115% of the spiked concentration for EPA method 300.1, and are calculated as:

%R = (SSR/SA)*100

Where:

SSR = Spiked sample result

SA = Surrogate added

### 5.3 Representativeness

Representativeness is a qualitative assessment of the degree to which sample data represent the characteristics of a sample population. Representative data will be obtained through careful selection of sampling locations, analytical parameters, proper collection and handling of samples, and through use and consistent application of established field and laboratory procedures. Representativeness for the 2H2017 data set was established by verification of parameters such as:

- Completed COC that was cross checked with container labels and preservatives.
- Sample locations and analyses requested.
- Proper sample temperature and integrity confirmed upon receipt at laboratory.
- Were samples prepared and analyzed properly in the lab, using approved SOPs.
- Samples were analyzed within the hold times prescribed by the methods used.
- Samples were properly received and logged at the laboratory.

### 5.4 Comparability

Comparability is a qualitative parameter. Consistency in the acquisition, handling, and analysis of samples is necessary for comparing results. Samples are collected in accordance with standard operating procedures (i.e., ENDVR SOP-02), and analyzed using standard EPA methods. This helps to ensure comparability of results with other analyses performed in a similar manner. If different methods were utilized for the same analysis, the reporting limits should be similar. Comparability for the 2H2017 data set was established by verification of parameters such as:

- Consistent sampling methods were used during sampling events, as defined in the SAP.
- Samples were collected and preserved the same way, as defined in SOPs.
- Similar detection limits were used for each reported chemical and method.
- The units of measure were consistently used for all reported data.
- Site and sampling point conditions were similar.
- Equivalent sample preservation and preparation methods were used during analysis.

## 5.5 Completeness

Completeness is defined as the percentage of usable sample results as compared to total number of results in a sampling event. The data set from 2H2017 was verified to ensure that all required and planned samples were collected. The completeness limit for successful sampling is 90 percent. Data completeness is evaluated using the following formula:

$$\text{Completeness} = DP_u = \frac{DP_t - DP_n}{DP_t} * 100$$

Where:

$DP_u$ = Percentage of usable data points

$DP_t$ = Total number of data points

$DP_n$ = Nonusable (rejected) data points

## 5.6 Sensitivity

Sensitivity is related to sensitivity indicators. The instrument and method must be capable of detecting the analyte at a certain concentration and be able to reliably quantitate the analyte at that concentration. The sensitivity of the instrument and method should be less than the required limit. If the detection limit of the method is above the regulatory action limit, the method cannot be used for compliance samples. Laboratory Reagent Blanks (LRBs) were verified against method criteria. LRBs and/or Rinse Blanks (RBs) were run after every calibration curve, after each continuing calibration check, and at the end of each run.

# 6.0 Data Validation Findings

## 6.1 Perchlorate

Perchlorate was analyzed in 90 samples by EPA method 314.0 during the 2H2017 sampling event. Based on the data review and validation, all of the perchlorate data is acceptable as reported and submitted for 2H2017.

### 6.1.1 Sample Management

*Sample Preservation, Handling, and Transport*

All samples were properly handled, and transported according to applicable SOPs. No data qualifications were required for sample management on any perchlorate analyses.

*Chain-of-Custody (COC)*

All of the COCs were legible, signed by the field and laboratory personnel, and accounted for all of the analyses presented in the data packages. There were no issues regarding sample condition noted on the COCs.

*Holding Times*

Holding times were assessed by comparing the dates of collection with the dates of analysis. The 28 day holding time for the perchlorate analyses was met for all samples.

### 6.1.2 Precision and Accuracy

*Calibration*

The Instrument Performance Checks (IPC), Quality Control Standards (QCS), and continuing calibration (ICCS, CCCS, ECCS) checks were within established QC limits. Calibration data was verified with the “Data Review Checklist for EPA Method 314.0” (Appendix B, Sections A., B, and C.).

*Laboratory Reagent Blanks (LRB)*

The results reported on the summary form and in the raw data for LRB analyses associated with these samples were within QC limits (<1/2 MRL). LRB data was verified with the “Data Review Checklist for EPA Method 314.0” (Appendix B, Section D), and no qualifications were necessary.

*Laboratory Fortified Blanks (LFB) / Laboratory Fortified Matrix (LFM)*

All LFBs were within established QC limits (i.e. LFB %R must be within 85-115% of the spiked concentration for EPA method 314.0). All LFMs were within established QC limits (i.e. %R for EPA method 314.0 must be within 80-120% of the spiked value). LFB/LFM data was verified with the “Data Review Checklist for EPA Method 314.0” (Appendix B, Sections G and H).

*Laboratory Duplicates*

All duplicate analysis RPDs were within the established QC limit. Duplicate precision must have an RPD ≤15% for EPA method 314.0. Duplicate data was verified with the “Data Review Checklist for EPA Method 314.0” (Appendix B, Section E).

*Field Duplicates / Split Samples*

No Field Duplicates or Split Samples were collected for the second half (Semi-Annual) sampling event, per the Endeavour (formerly AMPAC) established sampling practice. Precision is demonstrated by meeting data quality requirements for the analytical methods reported.

#### 6.1.3 Representativeness

Sample data were representative of site conditions at the time of perchlorate sample collection. Correct sampling procedures were followed. All samples were properly stored and handled. All data reported were from analyses performed with properly calibrated instruments within the specified holding times.

#### 6.1.4 Completeness

The results reported by the laboratory and submitted in this DVSR were 100% complete for all the perchlorate analyses.

#### 6.1.5 Comparability

All samples were handled and preserved the same way, the same analytical method was utilized for all samples, and the detection limits were comparable. Detection and quantitation limits can be found in Table 5 of this document.

#### 6.1.6 Sensitivity

One sample was qualified (J) as an estimated value due to the result being greater than SQL but less than the PQL, and one sample was qualified (U) as a Non-Detect result. The MDL was lower than the NDEP required limits. The residential drinking water Basic Comparison Limit (BCL) for perchlorate is based upon the provisional Nevada Action level of 0.018 mg/L (ppm).

### 6.2 Chlorate

Chlorate was analyzed in 90 samples by EPA method 300.1 during the 2H2017 sampling event. Based on the data review and validation, all of the Chlorate data is acceptable as reported and submitted for 2H2017.

#### 6.2.1 Sample Management

*Sample Preservation, Handling, and Transport*

All samples were properly preserved, handled, and transported according to applicable SOPs. No data qualifications were required for sample management of any reported chlorate analyses.

*Chain-of-Custody (COC)*

All of the COCs were legible, signed by the field and laboratory personnel, and accounted for the analyses presented in the data packages. There were no issues regarding sample condition noted on the COCs.

*Holding Times*

Holding times were assessed by comparing the dates of collection with the dates of analysis. The 28 day holding time for the chlorate analyses was met for all samples. No qualifications were necessary.

### 6.2.2 Precision and Accuracy

*Calibration*

The IPCs, QCS, and continuing calibration (ICCS, CCCS, ECCS) checks were within established QC limits. Calibration data was verified with the “Data Review Checklist for EPA Method 300.0 and 300.1” (Appendix C, Sections A, B, C and E).

*Laboratory Reagent Blanks (LRB)*

The results reported on the summary form and in the raw data for LRB analyses associated with these samples were within QC limits (No detectable analytes). LRB data was verified with the “Data Review Checklist for EPA Method 300.0 and 300.1” (Appendix C, Section F). No data qualifications were necessary.

*Laboratory Fortified Blanks (LFB) / Laboratory Fortified Matrix (LFM)*

All LFBs were within established QC limits (i.e. LFB %R must be within 85-115% of the spiked concentration for EPA method 300.1). All LFMs were within established QC limits (i.e. LFM %R for EPA method 300.1 must be within 75-125% of the spiked value). LFB/LFM data was verified with the “Data Review Checklist for EPA Method 300.0 and 300.1” (Appendix C, Sections I and J). No data qualifications were necessary.

*Laboratory Duplicates*

All duplicate analysis RPDs were within the established QC limit. Duplicate precision must have an RPD ≤20% for EPA method 300.1. Duplicate data was verified with the “Data Review Checklist for EPA Method 300.0 and 300.1” (Appendix C, Section G). No data qualifications were necessary.

*Field Duplicates / Split Samples*

No Field Duplicates or Split Samples were collected for the second half (Semi-Annual) sampling event, per the Endeavour (formerly AMPAC) established sampling practice. Precision is demonstrated by meeting data quality requirements for the analytical methods reported.

*Surrogate Spikes*

All reported Chlorate sample results had a surrogate recoveries that were within established QC limits (90–115%).  Surrogate data was verified with the “Data Review Checklist for EPA Method 300.0 and 300.1” (Appendix C, Section L).  No data qualifications were necessary.

### 6.2.3  Representativeness

All reported sample data was representative of site conditions at the time of collection. Correct sampling procedures were followed. All samples were properly handled, stored, and preserved. All data reported were from analyses performed with properly calibrated instruments within the specified holding times.

### 6.2.4  Completeness

The results reported by the laboratory and submitted in this DVSR were 100% complete for all the chlorate analyses.

### 6.2.5  Comparability

All samples were handled and preserved the same way, the same analytical method was utilized for all samples, and the detection limits were comparable. Detection and quantitation limits can be found in Table 5 of this document.

### 6.2.6  Sensitivity

One sample was qualified (J) as an estimated value due to the result being greater than SQL but less than the PQL, and five samples were qualified (U) as a Non-Detect results.  The MDL for Chlorate was lower than the NDEP required limit for all reported data.  The residential drinking water BCL for Chlorate is based upon the provisional Nevada Action level of 1.095 mg/L (ppm).

## 7.0  Variances In Analytical Performance

The Qualified Data Summary is listed in Table 6.

## 8.0  Conclusions/Recommendations

All analytical data reported for July 1 – December 31, 2017, has been validated.  Six reported sample results were qualified as (U), indicating that those results were Non-Detect.  Two sample results were qualified (J) and reported as estimated values due to the results being greater than SQL but less than the PQL.  All of the data for the SDGs associated with this report are considered usable for the purposes of this project.  Based on the definitions and qualifications presented in this report, it is recommended that this report be approved as submitted.

## 9.0 References

ENDVR Sample Collection and Control, NOL.010.WI.03

ENDVR Field Measurements NOL.010.WI.05

Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use EPA-540-R-08-005 January 2009

USEPA Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review, August 2014 Version, EPA 540-R-013-001

Perchlorate by EPA 314.0

Chlorate by EPA 300.1

NDEP Guidance Letters to BMI Complex Companies - Detection Limits and Data Reporting:

December 3, 2008 — NDEP letter to the Companies providing Guidance on detection limits and data reporting

NDEP Guidance Letters to BMI Complex Companies - Use of Field Duplicates and Field Splits:

November 14, 2008, NDEP letter to the Companies providing Guidance on the Use of Field QC Data

NDEP Guidance Letters to BMI Complex Companies - Data Validation:

January 5, 201, Guidance on Qualifying Data due to Blank Contamination (Rev 2)

November 23, 2011, Guidance on Qualifying Data due to Blank Contamination (Revised)

July 18, 2011, Guidance on Qualifying Data Due to Blank Contamination

April 13, 2009, NDEP letter to the Companies providing Supplemental Guidance on Data Validation

March 19, 2009, NDEP letter to the Companies providing “Supplemental Guidance on Data Validation”

February 26, 2009, NDEP letter to the Companies providing “Supplemental Guidance on Data Validation”

February 23, 2007, NDEP letter to the Companies’ providing: Additional Guidance on Data Validation Procedures

May 3, 2006, NDEP letter to the Companies’ providing: Guidance on Data Validation Procedures

NDEP Guidance Letters to BMI Complex Companies - Data Usability — September 2, 2010:

NDEP Data Usability Guidance / Template (spreadsheet)

# TABLE 5 - ANALYTICAL DATA SUMMARY, 2H2017

| sdg_id | sample_id_field | sample_id_lab | matrix | analytical_method | parameter | parameter_id | result_reported | result_units | method_detection_limit | sample_quantitation_limit | practical_quantitation_limit | dilution_factor | lab_qualifier | validation_flag | validation_stage | final_validation_qualifier | final_validation_reason_codes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20170706-M | ACMain.20170706_072000.205 | 12056 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 1.8 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170706-M | ACMain.20170706_072000.463 | 12057 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 5.9 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20170802-M | ACMain.20170802_091700.412 | 12083 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 6.9 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20170802-M | ACMain.20170802_091700.691 | 12084 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 2.6 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170905-M | ACMain.20170905_082200.991 | 12153 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 1.9 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170905-M | ACMain.20170905_082701.195 | 12154 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 5 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171003-M | ACMain.20171003_083200.113 | ACMain.20171003_083200.113 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 7.2 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171003-M | ACMain.20171003_083200.628 | ACMain.20171003_083200.628 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 2.6 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20171108-M | ACMain.20171108_100500.256 | ACMain.20171108_100500.256 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 8.7 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171108-M | ACMain.20171108_100500.740 | ACMain.20171108_100500.740 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 3 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20171220-M | ACMain.20171220_135200.737 | 12330 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 12 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171220-M | ACMain.20171220_135200.814 | 12331 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 5.6 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170706-M | ACNS.20170706_072300.434 | 12058 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 2 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170706-M | ACNS.20170706_072300.479 | 12059 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 6.9 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20170802-M | ACNS.20170802_092000.374 | ACNS.20170802_092000.374 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 3.2 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170802-M | ACNS.20170802_092000.958 | ACNS.20170802_092000.958 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 8.8 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20170905-M | ACNS.20170905_081700.524 | ACNS.20170905_081700.524 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 2.6 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170905-M | ACNS.20170905_081701.837 | ACNS.20170905_081701.837 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 7.7 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171003-M | ACNS.20171003_082700.256 | ACNS.20171003_082700.256 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 3.3 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20171003-M | ACNS.20171003_082700.304 | ACNS.20171003_082700.304 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 8.9 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171108-M | ACNS.20171108_100800.756 | ACNS.20171108_100800.756 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 3.2 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20171108-M | ACNS.20171108_100800.929 | ACNS.20171108_100800.929 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 9.1 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171206-M | ACNS.20171206_121900.038 | ACNS.20171206_121900.038 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 7.4 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171206-M | ACNS.20171206_121900.928 | ACNS.20171206_121900.928 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 3.1 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170813-Q | ADX-112.20170813_065825.949 | ADX-112.20170813_065825.949 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.5 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20170813-Q | ADX-112.20170813_065835.302 | ADX-112.20170813_065835.302 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 3.1 | mg/L | 0.0012 | 0.024 | 0.08 | 20 | 0 | T | 2A | | |
| 20171112-Q | ADX-112.20171112_113551.467 | ADX-112.20171112_113551.467 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.68 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20171112-Q | ADX-112.20171112_113554.826 | ADX-112.20171112_113554.826 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 3.1 | mg/L | 0.0012 | 0.024 | 0.08 | 20 | 0 | T | 2A | | |
| 20170813-Q | ADX-156.20170813_072852.567 | ADX-156.20170813_072852.567 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.33 | mg/L | 0.014 | 0.028 | 0.1 | 2 | 0 | T | 2A | | |
| 20170813-Q | ADX-156.20170813_072855.504 | ADX-156.20170813_072855.504 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 1.6 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20171112-Q | ADX-156.20171112_120553.087 | ADX-156.20171112_120553.087 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 2.6 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20171112-Q | ADX-156.20171112_120556.446 | ADX-156.20171112_120556.446 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 10 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20170813-Q | AEX-166.20170813_091540.476 | AEX-166.20170813_091540.476 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 1.7 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20170813-Q | AEX-166.20170813_091543.746 | AEX-166.20170813_091543.746 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 64 | mg/L | 0.0012 | 0.6 | 2 | 500 | 0 | T | 2A | | |
| 20171106-Q | AEX-166.20171106_112113.626 | AEX-166.20171106_112113.626 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 1.9 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20171106-Q | AEX-166.20171106_112117.016 | AEX-166.20171106_112117.016 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 76 | mg/L | 0.0012 | 0.6 | 2 | 500 | 0 | T | 2A | | |
| 20170813-Q | AEX-35.20170813_092834.607 | AEX-35.20170813_092834.607 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 35 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20170813-Q | AEX-35.20170813_092840.538 | AEX-35.20170813_092840.538 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 130 | mg/L | 0.0012 | 0.6 | 2 | 500 | 0 | T | 2A | | |
| 20171106-Q | AEX-35.20171106_103220.588 | AEX-35.20171106_103220.588 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 34 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171106-Q | AEX-35.20171106_103318.092 | AEX-35.20171106_103318.092 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 9.6 | mg/L | 0.0012 | 0.12 | 0.4 | 100 | 0 | T | 2A | | |
| 20170809-Q | AMEW-1.20170809_091059.614 | AMEW-1.20170809_091059.614 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 71 | mg/L | 0.014 | 3.5 | 12.5 | 250 | 0 | T | 2A | | |
| 20170809-Q | AMEW-1.20170809_091120.788 | AMEW-1.20170809_091120.788 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 220 | mg/L | 0.0012 | 2.4 | 8 | 2000 | 0 | T | 2A | | |
| 20171106-Q | AMEW-1.20171106_141712.927 | AMEW-1.20171106_141712.927 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 67 | mg/L | 0.014 | 3.5 | 12.5 | 250 | 0 | T | 2A | | |
| 20171106-Q | AMEW-1.20171106_141829.885 | AMEW-1.20171106_141829.885 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 200 | mg/L | 0.0012 | 2.4 | 8 | 2000 | 0 | T | 2A | | |
| 20170820-Q | AMEW-2.20170820_055930.544 | 12133 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 54 | mg/L | 0.014 | 3.5 | 12.5 | 250 | 0 | T | 2A | | |
| 20170820-Q | AMEW-2.20170820_055933.263 | 12134 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 250 | mg/L | 0.0012 | 2.4 | 8 | 2000 | 0 | T | 2A | | |
| 20171105-Q | AMEW-2.20171105_112909.447 | AMEW-2.20171105_112909.447 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 53 | mg/L | 0.014 | 3.5 | 12.5 | 250 | 0 | T | 2A | | |
| 20171105-Q | AMEW-2.20171105_113001.825 | AMEW-2.20171105_113001.825 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 240 | mg/L | 0.0012 | 2.4 | 8 | 2000 | 0 | T | 2A | | |
| 20170820-Q | AMEW-3.20170820_070734.105 | 12135 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 29 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20170820-Q | AMEW-3.20170820_070754.278 | 12136 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 140 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20171105-Q | AMEW-3.20171105_152253.921 | AMEW-3.20171105_152253.921 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 29 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171105-Q | AMEW-3.20171105_152353.659 | AMEW-3.20171105_152353.659 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 130 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20170813-Q | AMEW-4.20170813_062738.481 | AMEW-4.20170813_062738.481 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 24 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20170813-Q | AMEW-4.20170813_062803.318 | AMEW-4.20170813_062803.318 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 270 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20171112-Q | AMEW-4.20171112_123248.981 | AMEW-4.20171112_123248.981 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 25 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171112-Q | AMEW-4.20171112_123349.797 | AMEW-4.20171112_123349.797 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 85 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20170813-Q | AMEW-5.20170813_082714.618 | AMEW-5.20170813_082714.618 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 24 | mg/L | 0.014 | 2.8 | 10 | 200 | 0 | T | 2A | | |
| 20170813-Q | AMEW-5.20170813_082717.323 | AMEW-5.20170813_082717.323 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 210 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20171106-Q | AMEW-5.20171106_100701.713 | AMEW-5.20171106_100701.713 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 24 | mg/L | 0.014 | 2.8 | 10 | 200 | 0 | T | 2A | | |
| 20171106-Q | AMEW-5.20171106_100817.484 | AMEW-5.20171106_100817.484 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 90 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20170820-Q | AMOW-3-165.20170820_074140.598 | 12137 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.014 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | U | 26 |
| 20170820-Q | AMOW-3-165.20170820_074142.896 | 12138 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.13 | mg/L | 0.0012 | 0.0012 | 0.004 | 1 | 0 | T | 2A | | |
| 20171106-Q | AMOW-3-165.20171106_093445.284 | AMOW-3-165.20171106_093445.284 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.03 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 6 | T | 2A | J | 21 |
| 20171106-Q | AMOW-3-165.20171106_093447.784 | AMOW-3-165.20171106_093447.784 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.19 | mg/L | 0.0012 | 0.0012 | 0.004 | 1 | 0 | T | 2A | | |
| 20170820-Q | AMOW-3-52.20170820_075945.120 | 12139 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 11 | mg/L | 0.014 | 2.8 | 10 | 200 | 0 | T | 2A | | |
| 20170820-Q | AMOW-3-52.20170820_075947.323 | 12140 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 55 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |

# TABLE 5 - ANALYTICAL DATA SUMMARY, 2H2017

| sdg_id | sample_id_field | sample_id_lab | matrix | analytical_method | parameter | parameter_id | result_reported | result_units | method_detection_limit | sample_quantitation_limit | practical_quantitation_limit | dilution_factor | lab_qualifier | validation_flag | validation_stage | final_validation_qualifier | final_validation_reason_codes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20171105-Q | AMOW-3-52.20171105_143015.486 | AMOW-3-52.20171105_143015.486 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 12 | mg/L | 0.014 | 2.8 | 10 | 200 | 0 | T | 2A | | |
| 20171105-Q | AMOW-3-52.20171105_143139.350 | AMOW-3-52.20171105_143139.350 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 55 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20170807-Q | APEW-1.20170807_095614.626 | APEW-1.20170807_095614.626 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.19 | mg/L | 0.014 | 0.028 | 0.1 | 2 | 0 | T | 2A | | |
| 20170807-Q | APEW-1.20170807_095631.006 | APEW-1.20170807_095631.006 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.55 | mg/L | 0.0012 | 0.006 | 0.02 | 5 | 0 | T | 2A | | |
| 20171102-Q | APEW-1.20171102_094501.182 | APEW-1.20171102_094501.182 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.24 | mg/L | 0.014 | 0.028 | 0.1 | 2 | 0 | T | 2A | | |
| 20171102-Q | APEW-1.20171102_094558.733 | APEW-1.20171102_094558.733 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.5 | mg/L | 0.0012 | 0.006 | 0.02 | 5 | 0 | T | 2A | | |
| 20170807-Q | APEW-2.20170807_101928.233 | APEW-2.20170807_101928.233 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 2.1 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20170807-Q | APEW-2.20170807_102023.784 | APEW-2.20170807_102023.784 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 11 | mg/L | 0.0012 | 0.12 | 0.4 | 100 | 0 | T | 2A | | |
| 20171102-Q | APEW-2.20171102_102906.686 | APEW-2.20171102_102906.686 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 2.3 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20171102-Q | APEW-2.20171102_103002.127 | APEW-2.20171102_103002.127 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 9.5 | mg/L | 0.0012 | 0.12 | 0.4 | 100 | 0 | T | 2A | | |
| 20170807-Q | APEW-3.20170807_103806.809 | APEW-3.20170807_103806.809 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 8.8 | mg/L | 0.014 | 0.7 | 2.5 | 50 | 0 | T | 2A | | |
| 20170807-Q | APEW-3.20170807_103821.013 | APEW-3.20170807_103821.013 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 56 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20171102-Q | APEW-3.20171102_135851.801 | APEW-3.20171102_135851.801 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 9.2 | mg/L | 0.014 | 0.7 | 2.5 | 50 | 0 | T | 2A | | |
| 20171102-Q | APEW-3.20171102_135927.881 | APEW-3.20171102_135927.881 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 10 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20170808-Q | AREW-1.20170808_101534.341 | AREW-1.20170808_101534.341 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.22 | mg/L | 0.014 | 0.056 | 0.2 | 4 | 0 | T | 2A | | |
| 20170808-Q | AREW-1.20170808_101548.827 | AREW-1.20170808_101548.827 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.61 | mg/L | 0.0012 | 0.006 | 0.02 | 5 | 0 | T | 2A | | |
| 20171119-Q | AREW-1.20171119_120128.140 | AREW-1.20171119_120128.140 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.28 | mg/L | 0.014 | 0.056 | 0.2 | 4 | 0 | T | 2A | | |
| 20171119-Q | AREW-1.20171119_120131.219 | AREW-1.20171119_120131.219 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.58 | mg/L | 0.0012 | 0.006 | 0.02 | 5 | 0 | T | 2A | | |
| 20170808-Q | AREW-2.20170808_095547.129 | AREW-2.20170808_095547.129 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.29 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20170808-Q | AREW-2.20170808_095606.686 | AREW-2.20170808_095606.686 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.73 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20171119-Q | AREW-2.20171119_113627.827 | AREW-2.20171119_113627.827 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.49 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20171119-Q | AREW-2.20171119_113708.486 | AREW-2.20171119_113708.486 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 1 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20170808-Q | AREW-3.20170808_093240.164 | AREW-3.20170808_093240.164 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.29 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20170808-Q | AREW-3.20170808_093256.246 | AREW-3.20170808_093256.246 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.79 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20171119-Q | AREW-3.20171119_111833.268 | AREW-3.20171119_111833.268 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.4 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20171119-Q | AREW-3.20171119_111913.882 | AREW-3.20171119_111913.882 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.74 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20170808-Q | AREW-4.20170808_091205.693 | AREW-4.20170808_091205.693 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.57 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20170808-Q | AREW-4.20170808_091226.598 | AREW-4.20170808_091226.598 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 2.2 | mg/L | 0.0012 | 0.024 | 0.08 | 20 | 0 | T | 2A | | |
| 20171119-Q | AREW-4.20171119_105510.812 | AREW-4.20171119_105510.812 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.78 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20171119-Q | AREW-4.20171119_105512.719 | AREW-4.20171119_105512.719 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 2.3 | mg/L | 0.0012 | 0.024 | 0.08 | 20 | 0 | T | 2A | | |
| 20170808-Q | AREW-5.20170808_084905.928 | AREW-5.20170808_084905.928 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 2.6 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170808-Q | AREW-5.20170808_084924.335 | AREW-5.20170808_084924.335 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 12 | mg/L | 0.0012 | 0.12 | 0.4 | 100 | 0 | T | 2A | | |
| 20171119-Q | AREW-5.20171119_103000.248 | AREW-5.20171119_103000.248 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 2.8 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20171119-Q | AREW-5.20171119_103106.140 | AREW-5.20171119_103106.140 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 11 | mg/L | 0.0012 | 0.12 | 0.4 | 100 | 0 | T | 2A | | |
| 20170808-Q | AREW-6.20170808_082828.105 | AREW-6.20170808_082828.105 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 7.8 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20170808-Q | AREW-6.20170808_082850.046 | AREW-6.20170808_082850.046 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 45 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20171119-Q | AREW-6.20171119_100207.680 | AREW-6.20171119_100207.680 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 8.2 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171119-Q | AREW-6.20171119_100258.096 | AREW-6.20171119_100258.096 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 51 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20170809-Q | DX-161.20170809_103338.886 | DX-161.20170809_103338.886 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 13 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20170809-Q | DX-161.20170809_103341.543 | DX-161.20170809_103341.543 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 45 | mg/L | 0.0012 | 0.6 | 2 | 500 | 0 | T | 2A | | |
| 20171106-Q | DX-161.20171106_125128.375 | DX-161.20171106_125128.375 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 6 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171106-Q | DX-161.20171106_125131.016 | DX-161.20171106_125131.016 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 25 | mg/L | 0.0012 | 0.6 | 2 | 500 | 0 | T | 2A | | |
| 20170809-Q | DX-30.20170809_095154.404 | DX-30.20170809_095154.404 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 20 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20170809-Q | DX-30.20170809_095227.783 | DX-30.20170809_095227.783 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 120 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20171106-Q | DX-30.20171106_134720.350 | DX-30.20171106_134720.350 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 21 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171106-Q | DX-30.20171106_134919.060 | DX-30.20171106_134919.060 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 110 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20170809-Q | DX-75.20170809_101333.433 | DX-75.20170809_101333.433 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 67 | mg/L | 0.014 | 2.8 | 10 | 200 | 0 | T | 2A | | |
| 20170809-Q | DX-75.20170809_101420.452 | DX-75.20170809_101420.452 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 300 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20171106-Q | DX-75.20171106_131832.401 | DX-75.20171106_131832.401 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 62 | mg/L | 0.014 | 2.8 | 10 | 200 | 0 | T | 2A | | |
| 20171106-Q | DX-75.20171106_131947.468 | DX-75.20171106_131947.468 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 260 | mg/L | 0.0012 | 1.2 | 4 | 1000 | 0 | T | 2A | | |
| 20170820-Q | DY-106.20170820_064707.046 | 12141 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.014 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | U | 26 |
| 20170820-Q | DY-106.20170820_064713.359 | 12142 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.003 | mg/L | 0.0012 | 0.0012 | 0.004 | 1 | 6 | T | 2A | J | 21 |
| 20171105-Q | DY-106.20171105_130023.000 | DY-106.20171105_130023.000 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.014 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | U | 26 |
| 20171105-Q | DY-106.20171105_130152.000 | DY-106.20171105_130152.000 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.01 | mg/L | 0.0012 | 0.0012 | 0.004 | 1 | 0 | T | 2A | | |
| 20170820-Q | DY-169.20170820_062534.233 | 12143 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.054 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | | |
| 20170820-Q | DY-169.20170820_062640.824 | 12144 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.44 | mg/L | 0.0012 | 0.006 | 0.02 | 5 | 0 | T | 2A | | |
| 20171105-Q | DY-169.20171105_121107.611 | DY-169.20171105_121107.611 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.06 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | | |
| 20171105-Q | DY-169.20171105_121155.973 | DY-169.20171105_121155.973 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 2.8 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20170820-Q | DY-26.20170820_063629.317 | 12145 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 17 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20170820-Q | DY-26.20170820_063636.661 | 12146 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 82 | mg/L | 0.0012 | 0.6 | 2 | 500 | 0 | T | 2A | | |
| 20171105-Q | DY-26.20171105_123659.526 | DY-26.20171105_123659.526 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 16 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171105-Q | DY-26.20171105_123701.354 | DY-26.20171105_123701.354 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 80 | mg/L | 0.0012 | 0.6 | 2 | 500 | 0 | T | 2A | | |
| 20170706-M | EGSD.20170706_082000.565 | 12060 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 4.5 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170706-M | EGSD.20170706_082000.847 | 12061 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 14 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20170802-M | EGSD.20170802_094700.017 | EGSD.20170802_094700.017 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 8.9 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |

# TABLE 5 - ANALYTICAL DATA SUMMARY, 2H2017

| sdg_id | sample_id_field | sample_id_lab | matrix | analytical_method | parameter | parameter_id | result_reported | result_units | method_detection_limit | sample_quantitation_limit | practical_quantitation_limit | dilution_factor | lab_qualifier | validation_flag | validation_stage | final_validation_qualifier | final_validation_reason_codes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20170802-M | EGSD.20170802_094700.486 | EGSD.20170802_094700.486 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 2.8 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170905-M | EGSD.20170905_094300.494 | EGSD.20170905_094300.494 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 7.5 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170905-M | EGSD.20170905_094301.026 | EGSD.20170905_094301.026 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 19 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171003-M | EGSD.20171003_091500.009 | EGSD.20171003_091500.009 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 4.2 | mg/L | 0.014 | 0.7 | 2.5 | 50 | 0 | T | 2A | | |
| 20171003-M | EGSD.20171003_091500.244 | EGSD.20171003_091500.244 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 12 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171108-M | EGSD.20171108_110900.664 | EGSD.20171108_110900.664 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 13 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171108-M | EGSD.20171108_110900.695 | EGSD.20171108_110900.695 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 4.4 | mg/L | 0.014 | 0.14 | 0.5 | 10 | 0 | T | 2A | | |
| 20171220-M | EGSD.20171220_132500.207 | 12332 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 7.6 | mg/L | 0.0012 | 0.06 | 0.2 | 50 | 0 | T | 2A | | |
| 20171220-M | EGSD.20171220_132500.347 | 12333 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 2.8 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20170706-M | F6.20170706_072500.097 | 12063 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 0.47 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20170706-M | F6.20170706_072500.490 | 12062 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 0.18 | mg/L | 0.0012 | 0.0036 | 0.012 | 3 | 0 | T | 2A | | |
| 20170802-M | F6.20170802_092300.019 | F6.20170802_092300.019 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 0.62 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20170802-M | F6.20170802_092300.176 | F6.20170802_092300.176 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 0.24 | mg/L | 0.0012 | 0.0048 | 0.016 | 4 | 0 | T | 2A | | |
| 20170905-M | F6.20170905_081900.417 | F6.20170905_081900.417 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 0.77 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20170905-M | F6.20170905_081901.433 | F6.20170905_081901.433 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 0.15 | mg/L | 0.0012 | 0.06 | 0.012 | 3 | 0 | T | 2A | | |
| 20171003-M | F6.20171003_082900.635 | F6.20171003_082900.635 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 0.17 | mg/L | 0.0012 | 0.0036 | 0.012 | 3 | 0 | T | 2A | | |
| 20171003-M | F6.20171003_082900.869 | F6.20171003_082900.869 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 0.93 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20171108-M | F6.20171108_101000.055 | F6.20171108_101000.055 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 0.84 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20171108-M | F6.20171108_101000.259 | F6.20171108_101000.259 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 0.17 | mg/L | 0.0012 | 0.0036 | 0.012 | 3 | 0 | T | 2A | | |
| 20171206-M | F6.20171206_122000.350 | F6.20171206_122000.350 | WS | EPA 300.1 | Chlorate | 7790-93-4 | 0.82 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20171206-M | F6.20171206_122000.460 | F6.20171206_122000.460 | WS | EPA 314.0 | Perchlorate | 14797-73-0 | 0.17 | mg/L | 0.0012 | 0.0036 | 0.012 | 3 | 0 | T | 2A | | |
| 20171108-SA | JX-11.20171108_133002.168 | JX-11.20171108_133002.168 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 5.4 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171108-SA | JX-11.20171108_133005.840 | JX-11.20171108_133005.840 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 58 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20171108-SA | KX-18.20171108_115245.561 | KX-18.20171108_115245.561 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 20 | mg/L | 0.0012 | 0.12 | 0.4 | 100 | 0 | T | 2A | | |
| 20171108-SA | KX-18.20171108_115252.015 | KX-18.20171108_115252.015 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 4.5 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20171108-SA | KY-23.20171108_140024.684 | KY-23.20171108_140024.684 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 3.7 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20171108-SA | KY-23.20171108_140027.528 | KY-23.20171108_140027.528 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 17 | mg/L | 0.0012 | 0.12 | 0.4 | 100 | 0 | T | 2A | | |
| 20170813-Q | MW-AD.20170813_075501.604 | MW-AD.20170813_075501.604 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 8.2 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20170813-Q | MW-AD.20170813_075505.440 | MW-AD.20170813_075505.440 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 22 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20171112-Q | MW-AD.20171112_110918.442 | MW-AD.20171112_110918.442 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 7.9 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171112-Q | MW-AD.20171112_110920.801 | MW-AD.20171112_110920.801 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 20 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20171107-SA | MW-AJ.20171107_093841.945 | MW-AJ.20171107_093841.945 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 11 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171107-SA | MW-AJ.20171107_094307.164 | MW-AJ.20171107_094307.164 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 52 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20171108-SA | MW-K.20171108_113334.830 | MW-K.20171108_113334.830 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.27 | mg/L | 0.014 | 0.07 | 0.25 | 5 | 0 | T | 2A | | |
| 20171108-SA | MW-K.20171108_113344.737 | MW-K.20171108_113344.737 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 1.2 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20171112-SA | NX-17.20171112_104410.944 | NX-17.20171112_104410.944 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.24 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | | |
| 20171112-SA | NX-17.20171112_104413.116 | NX-17.20171112_104413.116 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.5 | mg/L | 0.0012 | 0.006 | 0.02 | 5 | 0 | T | 2A | | |
| 20171108-SA | NY-15.20171108_090122.306 | NY-15.20171108_090122.306 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.19 | mg/L | 0.014 | 0.028 | 0.1 | 2 | 0 | T | 2A | | |
| 20171108-SA | NY-15.20171108_090124.650 | NY-15.20171108_090124.650 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.53 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20171102-SA | OY-8.20171102_145232.258 | OY-8.20171102_145232.258 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.25 | mg/L | 0.014 | 0.028 | 0.1 | 2 | 0 | T | 2A | | |
| 20171102-SA | OY-8.20171102_145309.323 | OY-8.20171102_145309.323 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.56 | mg/L | 0.0012 | 0.012 | 0.04 | 10 | 0 | T | 2A | | |
| 20171108-SA | TWA-20.20171108_093735.126 | TWA-20.20171108_093735.126 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 9.6 | mg/L | 0.0012 | 0.12 | 0.4 | 100 | 0 | T | 2A | | |
| 20171108-SA | TWA-20.20171108_093737.798 | TWA-20.20171108_093737.798 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 2.3 | mg/L | 0.014 | 0.28 | 1 | 20 | 0 | T | 2A | | |
| 20171107-SA | TWB-21.20171107_105753.766 | TWB-21.20171107_105753.766 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 12 | mg/L | 0.014 | 1.4 | 5 | 100 | 0 | T | 2A | | |
| 20171107-SA | TWB-21.20171107_105756.329 | TWB-21.20171107_105756.329 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 68 | mg/L | 0.0012 | 0.24 | 0.8 | 200 | 0 | T | 2A | | |
| 20171107-SA | TWB-51.20171107_112010.862 | TWB-51.20171107_112010.862 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.014 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | U | 26 |
| 20171107-SA | TWB-51.20171107_112014.386 | TWB-51.20171107_112014.386 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 0.024 | mg/L | 0.0012 | 0.024 | 0.08 | 20 | 0 | T | 2A | U | 26 |
| 20171107-SA | TWC-27.20171107_102221.591 | TWC-27.20171107_102221.591 | WG | EPA 300.1 | Chlorate | 7790-93-4 | 0.028 | mg/L | 0.014 | 0.028 | 0.1 | 2 | 0 | T | 2A | U | 26 |
| 20171107-SA | TWC-27.20171107_102223.919 | TWC-27.20171107_102223.919 | WG | EPA 314.0 | Perchlorate | 14797-73-0 | 6.6 | mg/L | 0.0012 | 0.048 | 0.16 | 40 | 0 | T | 2A | | |

## TABLE 6 - QUALIFIED DATA SUMMARY, 2H2017

**SENSITIVITY - MDL/SQL**

| SDG | Sample ID - Field | Method | Parameter | Result | Units | MDL | SQL | PQL | DF | Lab_Qual | Val Flag | Val Stage | Final Val Qualifier | Final Val Reason Code | Explanation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20171106-Q | AMOW-3-165.20171106_093445.284 | EPA 300.1 | Chlorate | 0.03 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 6 | T | 2A | J | 21 | reporting level (MRL) but above MDL. |
| 20170820-Q | DY-106.20170820_064713.359 | EPA 314.0 | Perchlorate | 0.003 | mg/L | 0.0012 | 0.0012 | 0.004 | 1 | 6 | T | 2A | J | 21 | reporting level (MRL) but above MDL. |

**SENSITIVITY - MDL/SQL, Non-Detect Results**

| SDG | Sample ID - Field | Method | Parameter | Result | Units | MDL | SQL | PQL | DF | Lab_Qual | Val Flag | Val Stage | Final Val Qualifier | Final Val Reason Code | Explanation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20170820-Q | AMOW-3-165.20170820_074140.598 | EPA 300.1 | Chlorate | 0.014 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | U | 26 | Non-Detect Target Analyte |
| 20170820-Q | DY-106.20170820_064707.046 | EPA 300.1 | Chlorate | 0.014 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | U | 26 | Non-Detect Target Analyte |
| 20171105-Q | DY-106.20171105_130023.000 | EPA 300.1 | Chlorate | 0.014 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | U | 26 | Non-Detect Target Analyte |
| 20171107-SA | TWB-51.20171107_112010.862 | EPA 300.1 | Chlorate | 0.014 | mg/L | 0.014 | 0.014 | 0.05 | 1 | 0 | T | 2A | U | 26 | Non-Detect Target Analyte |
| 20171107-SA | TWB-51.20171107_112014.386 | EPA 314.0 | Perchlorate | 0.024 | mg/L | 0.0012 | 0.024 | 0.08 | 20 | 0 | T | 2A | U | 26 | Non-Detect Target Analyte |
| 20171107-SA | TWC-27.20171107_102221.591 | EPA 300.1 | Chlorate | 0.028 | mg/L | 0.014 | 0.028 | 0.1 | 2 | 0 | T | 2A | U | 26 | Non-Detect Target Analyte |

# APPENDIX A – Verification and Validation Stages

| Check Performed | Stage |
|---|---|
| Is the laboratory performing the analysis Identified? | 1 |
| Were the requested analytical methods performed? | 1 |
| Were the target analytes reported along with units and qualifiers? | 1 |
| Were analytes reported to the SQL? | 1 |
| Sampling dates and sample conditions verified upon receipt at the laboratory documented? | 1 |
| The definition of any qualifiers used in the reported data package | 1 |
| The date  the sample was collected | 1 |
| Location and/or Site ID where the sample was collected | 1 |
| The preservation used for the sample | 1 |
| The specific reporting group or batch this sample is to be associated with [e.g., Sample Delivery Group (SDG) Number | 1 |
| The overall dilution factor applied to this analysis | 1 |
| The reporting limit, detection limit, minimum level, quantitation limit, or critical level (as appropriate), along with the appropriate units | 1 |
| The chain-of-custody | 2A |
| The analyst who performed the analysis | 2A |
| The CAS registry number for this analyte, if known | 2A |
| The laboratory reported results, units, | 2A |
| The detection, quantitation, and reporting limits for each analyte, along with the associated units | 2A |
| Sample holding times | 2A |
| Frequency of QC samples is checked for appropriateness | 2A |
| Initial calibration data (e.g., initial calibration standards, initial calibration verification [ICV] standards, initial calibration blanks [ICBs]) are provided for all requested analytes and linked to field samples reported. | 2B |

| Check Performed | Stage |
|---|---|
| Appropriate number and concentration of initial calibration standards are present. | 2B |
| Reported samples are bracketed by CCV standards | 2B |
| Continuing calibration data (e.g., continuing calibration verification [CCV] standards and continuing calibration blanks [CCBs]) are provided for all requested analytes | 2B |
| Method specific instrument performance checks are present as appropriate | 2B |
| Frequency of instrument QC samples is checked for appropriateness | 2B |
| Instrument response data (peak areas) reported | 3 |
| Fit and appropriateness of the initial calibration curve used | 3 |
| Comparison of instrument response to the minimum response requirements for each (or selected) analyte(s). | 3 |
| Recalculation of  CCV's | 3 |
| Recalculation and compliance check of retention time windows | 3 |
| Recalculation of reported results for each reported (or selected) target analyte(s) from the instrument response. | 3 |
| Recalculation of spike recoveries, LCS recoveries, duplicate analyses, matrix spike and matrix spike duplicate recoveries, from the instrument response. | 3 |
| Each (or selected) sample result(s) and spike recovery(ies) are evaluated by comparing the recalculated numbers to the laboratory reported numbers | 3 |
| The retention time of the peak | 3 |
| All required instrument outputs (e.g., chromatograms, mass spectra, atomic emission spectra, instrument background corrections, and interference corrections) for evaluating sample and instrument performance are present. | 4 |
| Sample results are evaluated by checking  chromatograms for correct identification and quantitation of analytes | 4 |
| Each (or selected) instrument's output(s) is evaluated for confirmation of non-detected or tentatively identified analytes | 4 |

# Appendix B – Data Review Checklist for EPA Method 314.0

Sample Delivery Group:
Batch ID:
Reviewed By:
Date:

| REVIEW ITEM | YES | NO | N/A | COMMENTS |
|---|---|---|---|---|
| **A. CALIBRATION (CAL)** | | | | |
| 1. Samples do not exceed the calibration range by 15% | ☐ | ☐ | ☐ | |
| 2. Criteria met? (R>0.995) | ☐ | ☐ | ☐ | |
| 3. Covers no more than two orders of magnitude | ☐ | ☐ | ☐ | |
| **B. INITIAL CALIBRATION CHECK STANDARD (ICCS)** | | | | |
| 1. Was the lowest level of standard used? | ☐ | ☐ | ☐ | |
| 2. Recovery 75-125% | ☐ | ☐ | ☐ | |
| 3. Required Frequency? (Per calibration curve) | ☐ | ☐ | ☐ | |
| **C. CONTINUING CALIBRATION CHECK STANDARD (CCCS)** | | | | |
| 1. Recovery 85-115 % | ☐ | ☐ | ☐ | |
| 2. Required frequency? (per 10 samples and at the end) | ☐ | ☐ | ☐ | |
| 3. If more than ten samples were analyzed, was both a mid-range and high range CCCS analyzed? | ☐ | ☐ | ☐ | |
| **D. LABORATORY REAGENT BLANKS (LRB)** | | | | |
| 1. Required frequency? (Per batch of samples) | ☐ | ☐ | ☐ | |
| 2. Analyte criteria met? <1/2 MRL | ☐ | ☐ | ☐ | |
| **E. DUPLICATE SAMPLES (DUP)** | | | | |
| 1. Required frequency? (Per batch of samples) | ☐ | ☐ | ☐ | |
| 2. RPD <15 %? (Unless concentration is less than LOQ of analyte) | ☐ | ☐ | ☐ | |
| **F. METHOD DETECTION LIMITS (MDL)** | | | | |
| 1. Reported with sample data? | ☐ | ☐ | ☐ | |
| 2. Measured with significant changes in instrument conditions? | ☐ | ☐ | ☐ | |
| **G. LABORATORY FORTIFIED MATRIX (LFM)** | | | | |
| 1. Recovery 80-120 % | ☐ | ☐ | ☐ | |
| 2. Required frequency? (per batch of samples) | ☐ | ☐ | ☐ | |
| **H. LABORATORY FORTIFIED BLANKS (LFB)** | | | | |
| 1. Required frequency? (Per batch of samples) | ☐ | ☐ | ☐ | |

Sample Delivery Group:
Batch ID:
Reviewed By:
Date:

| REVIEW ITEM | YES | NO | N/A | COMMENTS |
|---|---|---|---|---|
| 2. Analyte criteria met? (±15% of the stated concentration) | ☐ | ☐ | ☐ | |
| 3. Analyzed as fourth sample in queue? | ☐ | ☐ | ☐ | |
| **I. INSTRUMENT PERFORMANCE CHECK (IPC)** | | | | |
| 1. Required frequency? (First sample per batch of samples) | ☐ | ☐ | ☐ | |
| 2. Within 10% of original conductivity? | ☐ | ☐ | ☐ | |
| 3. Perchlorate recovery 80-120% of true value? | ☐ | ☐ | ☐ | |
| 5. Analyzed as first sample after Cal Curve? | ☐ | ☐ | ☐ | |
| 6. $PD_{A/H}$ (compared to the $A/H_{LFB\ of\ previous\ run\ or\ IDC}$) must be < 25% | ☐ | ☐ | ☐ | |
| **J. GENERAL** | | | | |
| 1. ≤ 20 Samples in Batch | ☐ | ☐ | ☐ | |
| 2. Samples analyzed within 28 day holding time? | ☐ | ☐ | ☐ | |
| 3. All samples diluted below MCT? | ☐ | ☐ | ☐ | |
| 4. Are all peaks correctly identified/quantified in each chromatogram? | ☐ | ☐ | ☐ | |
| 5. Is each compound correctly labeled in database with a U or D? | ☐ | ☐ | ☐ | |
| 6. Are sensitivity indicators reported and used appropriately? | ☐ | ☐ | ☐ | |
| 7. Are laboratory data flags reported and used appropriately? | ☐ | ☐ | ☐ | |

# Appendix C – Data Review Checklist for EPA Method 300.1

Sample Delivery Group:
Batch ID:
Reviewed By:
Date:

| REVIEW ITEM | YES | NO | N/A | COMMENTS |
|---|---|---|---|---|
| **A. CALIBRATION (CAL)** | | | | |
| 1. Samples do not exceed the calibration range by 15% | ☐ | ☐ | ☐ | |
| 2. Criteria met? (R>0.995) | ☐ | ☐ | ☐ | |
| 3. At least three calibration standards for one order of magnitude and five calibration standards for two orders of magnitude? | ☐ | ☐ | ☐ | |
| **B. INITIAL CALIBRATION CHECK STANDARD (ICCS)** | | | | |
| 1. Recovery 75-125%? | ☐ | ☐ | ☐ | |
| 2. Required Frequency? (Per calibration curve) | ☐ | ☐ | ☐ | |
| **C. INSTRUMENT PERFORMANCE CHECK (IPC)** | | | | |
| 1. Calculated from ICCS prior to analysis of samples? | ☐ | ☐ | ☐ | |
| 2. Retention Time within 80% of original column retention time? | ☐ | ☐ | ☐ | |
| 3. Does the laboratory retain a historical record of retention times for the surrogate and all the target anions? | ☐ | ☐ | ☐ | |
| 4. Does the Peak Gaussian Factor (PGF) for the ICCS surrogate fall in the range of 0.80 – 1.15? | ☐ | ☐ | ☐ | |
| **D. PRESERVATION** | | | | |
| 1. For bromate, chlorate, and chlorite, EDA is added to the laboratory reagent blank, standards, samples and laboratory fortified blank at 50 mg/L? (Part B Anions - Drinking Water Disinfection). | ☐ | ☐ | ☐ | |
| **E. CONTINUING CALIBRATION CHECK STANDARD (CCCS)** | | | | |
| 1. Recovery 85-115 % | ☐ | ☐ | ☐ | |
| 2. Required frequency? (per 10 field samples and at the end) | ☐ | ☐ | ☐ | |
| **F. LABORATORY REAGENT BLANKS (LRB)** | | | | |
| 1. Required frequency? (At least one per batch of samples) | ☐ | ☐ | ☐ | |
| 2. Analyte criteria met? (< MDL) | ☐ | ☐ | ☐ | |
| **G. DUPLICATE SAMPLES (DUP)** | | | | |
| 1. Required frequency? (minimum of 10% of field samples ) | ☐ | ☐ | ☐ | |
| 2. Are duplicate RPD acceptance criteria of <20% for concentration ranges of MRL to 10xMRL or <10% for | ☐ | ☐ | ☐ | |

| REVIEW ITEM | YES | NO | N/A | COMMENTS |
|---|---|---|---|---|
| concentration ranges of 10xMRL to highest calibration level? | | | | |
| **H. METHOD DETECTION/QUANTITATION LIMITS (MDL)** | | | | |
| 1. Reported with sample data? | ☐ | ☐ | ☐ | |
| 2. Measured with significant changes in instrument conditions? | ☐ | ☐ | ☐ | |
| **I. LABORATORY FORTIFIED MATRIX (LFM)** | | | | |
| 1. Recovery 75-125%? | ☐ | ☐ | ☐ | |
| 2. Required frequency? (10% of field samples per batch) | ☐ | ☐ | ☐ | |
| **J. LABORATORY FORTIFIED BLANKS (LFB)** | | | | |
| 1. Required frequency? (at least one per batch of samples) | ☐ | ☐ | ☐ | |
| 2. Recovery 85-115%? | ☐ | ☐ | ☐ | |
| **K. QUALITY CONTROL SAMPLE (QCS)** | | | | |
| 1. Recovery ±15% of the true value? | ☐ | ☐ | ☐ | |
| 2. Ran at least on a quarterly basis? | ☐ | ☐ | ☐ | |
| **L. SURROGATE SPIKES (Chlorate Only)** | | | | |
| 1. Recovery 90 - 115%? | ☐ | ☐ | ☐ | |
| 2. Required frequency? (All samples, stds., and blanks for Chlorate analysis) | ☐ | ☐ | ☐ | |
| 3. Retention time shift of no more than 2% in the IPC from previous run (if recent)? | ☐ | ☐ | ☐ | |
| **M. GENERAL** | | | | |
| 1. Are samples analyzed within holding times? | ☐ | ☐ | ☐ | |
| 2. Are all peaks correctly identified / quantified in each chromatogram? | ☐ | ☐ | ☐ | |
| 3. Is each compound correctly labeled in database with a U or D? | ☐ | ☐ | ☐ | |
| 4. Are sensitivity indicators reported and used appropriately? | ☐ | ☐ | ☐ | |
| 5. Are laboratory data flags reported and used appropriately? | ☐ | ☐ | ☐ | |

# Appendix D – Detection and Quantitation Calculations

| Sensitivity Indicator | Laboratory | Analyte | Definition/Calculation |
|---|---|---|---|
| Method Detection Limit (MDL) | APC Utah | All Analytes | t x S, where t = the appropriate student's t value for 99% confidence level and a standard deviation estimate with n-1 degrees of freedom, and S = standard deviation of the replicate analyses. |
| Sample Quantitation Limit (SQL) | APC Utah and Test America | All Analytes | SQL = Dilution Factor x MDL |
| Practical Quantitation Limit (PQL) | APC Utah | Perchlorate by 314.0 | MDL x 3 |
| Practical Quantitation Limit (PQL) | APC Utah | Chlorate by 300.1 | MDL x 4 |

# Appendix E – List of Acronyms and Abbreviations

| | |
|---|---|
| ADEQ | Arizona Department of Environmental Quality |
| ADHS | Arizona Department of Health Services |
| AGTS | Athens/Automall Groundwater Treatment System |
| APC | American Pacific Corporation |
| BCL | Basic Comparison Level |
| CAL | Calibration Standard |
| CAS | Chemical Abstracts Service |
| CCCS | Continuing Calibration Check Standard |
| COC | Chain-of-Custody |
| CFR | Code of Federal Regulations |
| DQO | Data Quality Objectives |
| DUP | Laboratory Duplicate Analysis |
| DVSR | Data Validation Summary Report |
| ECCS | Ending Calibration Check Standard |
| EDA | Ethylenediamine |
| ENDVR | Endeavour |
| EPA | Environmental Protection Agency |
| FB | Field Blank |
| FD | Field Duplicate |
| ICB/CCB | Initial and Continuing Calibration Blanks |
| ICCS | Initial Calibration Check Standard |
| ICV | Initial Calibration Verification |
| IPC | Instrument Performance Check |
| LCR | Linear Calibration Range |
| LD | Laboratory Duplicate |
| LFB/LFBD | Laboratory Fortified Blank / Laboratory Fortified Blank Duplicate |
| LFM/LFMD | Laboratory Fortified Matrix / Laboratory Fortified Matrix Duplicate |
| LOQ | Limit of Quantitation |
| LRB | Laboratory Reagent Blank |
| MCL | Maximum Contaminant Level |
| MCT | Matrix Conductivity Threshold |
| MDL | Method Detection Limit |
| MRL | Minimum Reporting Level (= PQL) |
| NDEP | Nevada Department of Environmental Protection |
| NELAC | National Environmental Laboratory Accreditation Conference |
| PARCCS | Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity |

| | |
|---|---|
| PGF | Peak Gaussian Factor |
| PPB | Parts Per Billion (= ug/L) |
| PPM | Parts Per Million (= mg/L) |
| PQL | Practical Quantitation Limit |
| QA/QC | Quality Assurance / Quality Control |
| QAP / QAPP | Quality Assurance Plan / Quality Assurance Project Plan |
| QCS | Quality Control Sample |
| RPD | Relative Percent Difference |
| RSD | Relative Standard Deviation |
| SAP | Sampling and Analysis Plan |
| SDG | Sample Delivery Group |
| SOP | Standard Operating Procedure |
| SQL | Sample Quantitation Limit |
| SSS | Stock Standard Solution |
| µg/L | Micrograms / Liter (= PPB) |
| mg/L | Milligrams / Liter (= PPM) |
| % D | Percent Difference |

# Appendix F –NDEP/Neptune Correspondence

March 16, 2017

Mr. Alan Pineda
Bureau of Industrial Site Cleanup
NDEP-Las Vegas City Office
2030 E. Flamingo Road, Suite 230
Las Vegas, NV 89119

**Re: <u>Responses to NDEP's March 3, 2017 Comments on DVSR ENDVR.2H2016 Dated February 14, 2017 and EDD_2H2016, Dated February 15, 2017, Endeavour, LLC, Henderson NV, Facility ID H-000534</u>**

Dear Mr. Pineda:

Please find below Endeavour's responses to the specific comments made on our Data Validation Summary Report (DVSR) ENDVR.2H2016 and the EDD in your March 3, 2017 letter. The DVSR covered the period between July 1 and December 31, 2016. A revised DVSR (Rev 1) is enclosed incorporating the comments found below.

DVSR Specific Comments:

1. <u>General:</u> Nitrate is included in Table 1 although it was not a target analyte and the nitrate method (300.0) is listed in Sections 5.1, 5.2.1, 5.2.2, 6.2.2. Please remove these references.

   **Response: The "Nitrate" column was removed from Table 1, and references to Nitrate method 300.0 were removed from Sections 5.1, 5.2.1, 5.2.2, and 6.2.2. Section 6.2.2 references the "Data Review Checklist for EPA method 300.0 and 300.1", which is used for both methods and was not removed for this reason.**

2. <u>General</u>: Table 5 is included although no samples were sent to TestAmerica for analysis and TestAmerica is mentioned in Section 4.2. Please remove these references.

   **Response: Table 5 (Test America Data Qualifiers) was removed from the 2H2016 DVSR. Tables 6 and 7 were renamed 5 and 6, respectively.**

3. <u>Sections 6.1.2 and 6.2.2, precision</u>: No field duplicates or split samples were collected. Please add text to Sections 6.1.2 and 6.2.2 indicating how this may affect the assessment of precision.

   **Additional text for "Field Duplicates / Split Samples" was added to Sections 6.1.2 and 6.2.2, explaining that duplicates and split samples have not historically been done for**

**the second half (Semi-Annual) sampling event. Precision is demonstrated by meeting data quality requirements for the analytical methods reported.**

EDD Comments:

1. No issues were identified with the EDD; submittal of a revised EDD is not required.

**Response: Comment acknowledged.**

Please contact Gary Carter at 702-699-4154 or me at 702-699-4184 if there are questions. Thank you.

Sincerely,

Jeff Gibson
Authorized Representative

Enclosure

cc:

JD Dotchin, NDEP-BISC, 2030 E. Flamingo Rd Suite 230, Las Vegas NV 89119
Weiquan Dong, NDEP-BISC, 2030 E. Flamingo Rd Suite 230, Las Vegas NV 89119
James Carlton Parker, NDEP-BISC, 2030 E. Flamingo Rd Suite 230, Las Vegas NV 89119
Greg Lovato, NDEP, 901 S. Stewart St Suite 4001, Carson City, NV 89701
Gary Carter, Endeavour LLC

Adam Baas, Edgcomb Law Group,
Derek Amidon, Tetra Tech
Steve Anderson, Las Vegas Valley Water District
Andrew Barnes, Geosyntec
Paul Black, Neptune & Company
Michael J. Bogle, Womble Carlyle Sandridge & Rice, LLP
Julie Chambon, Geosyntec, 1111 Broadway, 6th Floor, Oakland, CA 94607
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Kurt Fehling, The Fehling Group, LLC, 10580 N. McCarran Blvd., #115, Reno, NV 89503
Kevin Fisher, Las Vegas Valley Water District
Alison Fong, US EPA Region IX, MS: WST-5, 75 Hawthorne St, San Francisco, CA 94105
Eric Fordham, Geopentech
Kyle Gadley, Geosyntec
John Gallinatti, Geosyntec, 1111 Broadway, 6th Floor, Oakland, CA 94607
Paul Hackenberry, Hackenberry Associates, LLC
David Johnson, Central Arizona Water Conservation District
Frank Johns, Tetra Tech

Ebrahim Juma, Clean Water Team, DAQEM, PO Box 551741, Las Vegas, NV 89155
Joe Kelly, Montrose Chemical Corp, 600 Ericksen Ave NE, Suite 380, Bainbridge Island, WA 98110
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Kristen Lockhart, Neptune & Company
Michael Long, Hargis + Associates
Maria Lopez, Metropolitan Water District of Southern California
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Patti Meeks, Neptune & Company
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Todd Tietjen, SNWA
Brian Waggle, Hargis + Associates

October 25, 2017

Mr. Alan Pineda
Bureau of Industrial Site Cleanup
NDEP-Las Vegas City Office
2030 E. Flamingo Road, Suite 230
Las Vegas, NV 89119

**Re: Responses to NDEP's September 13, 2017 Comments on DVSR ENDVR.1H2017 Dated August 14, 2017 and EDD 1H2017, Dated August 15, 2017, Endeavour, LLC, Henderson NV, Facility ID H-000534**

Dear Mr. Pineda:

Please find below Endeavour's responses to the specific comments made on our Data Validation Summary Report (DVSR) ENDVR.1H2017 and the EDD in your September 13, 2017 letter. The DVSR covered the period between January 1 and June 30, 2017. A revised DVSR (Rev 1) is enclosed incorporating the comments found below.

DVSR Specific Comments:

1. SDG Table: The EDD has a total of 58 SDGs, but the table of SDGs in Section 1.2 lists 48 SDGs. Please account for this discrepancy.

   **Eight SDG ID numbers were removed from the EDD that were entered incorrectly, and two SDG ID numbers were added to the DVSR in Section 1.2 that were missed previously. The DVSR now lists 50 SDG ID numbers, matching the corrected EDD.**

2. Section 2.0, validation stages: Of the 624 sample results reported in the EDD, 52 were validated at Stage 4. The statement in the second paragraph indicating that 10% of the data were validated to Stage 4 is incorrect. Please update the text.

   **Twelve of seventy samples (17%) were validated to Stage 4 for all data through 2/28/17, after which date all data was validated only to Stage 2A per direction from NDEP for all BMI sites (email from JD Dotchin dated March 7, 2017). All data that required at least 10% validation to Stage 4 was performed as necessary.**

3. Section 6.1.2: The detected perchlorate result qualified for the CCCS recovered above control limits did not have bias applied to the qualifier. Please either qualify the result J+ or explain why no bias was assigned.

   **A "+" was added to the "J" qualifier in the EDD and the Data Summary tables for sample OY-8.20170410_072738.094.**

4. Section 6.1.2, split samples: Precision issues are not usually attributed to matrix interference, as the matrix is generally the same in duplicate water samples. Please consider changing the text in this section.

**The wording "matrix interference" was removed from this section.**

5. Section 6.1.6: The EDD has 5 detected results between the PQL and SQL instead of 7, as noted in the text. There are 2 additional J-qualified results, but these are not detected between the SQL and PQL. Please correct the text in this section.

   **The text in the DVSR correctly reflects the number of Perchlorate samples qualified for results detected between SQL and PQL as 9. The EDD and DVSR were double checked for accuracy. No change is necessary.**

6. Section 6.2.2, LRB: Sample MW-K1.20170507_084426.232 is nondetect for nitrate as N, but has an LRB qualification code of "10". Please check this result and remove the code if necessary. If the code was removed, please update the affected DVSR tables.

   **The qualifier code "10" was removed from sample MW-K1.20170507_084426.232 (Nitrate-N) in the EDD and the DVSR Data Summary tables.**

7. Section 6.2.2, LFM: There are 58 nitrate as N results with a qualification code of 15, for LFM recovery outlies. The text indicates 80 samples had recoveries outside the control limits. Please either correct this discrepancy or add text indicating that not all 80 results were qualified (i.e., nondetects not qualified for high recoveries).

   **The text in Section 6.2.2 of the DVSR was corrected to reflect 58 Nitrate-N samples with a qualification code of 15, for LFM recovery outliers.**

8. Section 6.2.6: The number of samples in the EDD qualified as estimated as the detects were between the PQL and SQL is 5, but the text notes 6 samples qualified. The number of samples qualified as nondetected in the EDD is 4, but the text notes 3 samples. This discrepancy appears to be due to sample TWC-126.20170411_091031.289, which appears to be a detect incorrectly coded with "26," instead of "21." Please check these qualification counts and the associated qualification codes. If any code was revised, please update the affected DVSR tables.

   **The EDD, DVSR, and the Data Summary tables were double checked and verified correct as originally submitted for Section 6.2.6 (Nitrate-N, Sensitivity). Additionally, sample TWC-126.20170411_091031.289 was correctly qualified for Nitrate-N. The same sample ID applies for the Chlorate result, which was qualified as Non-detect, with reason code "26". No changes necessary.**

EDD Comments:

1. In the samples table, the field "report_period_semi_annual" should be "dvsr_id". This can be corrected when uploading the EDD.

   **The field "report_period_semi_annual" was changed to "dvsr_id" in the revised EDD.**

2. In the results table, the field "reporting_period" is not required and should only be included if needed for the company.

   **The "reporting_period" field has been included as part of the Results table for the past several EDDs, and is used for reference by Endeavour, LLC.**

3. There were six samples (4 for chlorate, 1 for perchlorate, and 1 for nitrate [as N]) where the detect_flag_fod and detect_flag_ra were both "U" and the final_validation_qualifiers contained a "U", yet the result_reported was greater than the SQL. Five of these appear to be due to rounding issues, where the SQL is reported to three or four significant digits. For these, please verify the detect flags and qualifiers are consistent with the data and round the SQLs to the same number of significant digits as the results. The sixth result, perchlorate in AFX-75.20170430_085854.788, has a result of 0.007 mg/L and an SQL of 0.0007 mg/L. Please verify the result, detect flags and qualifiers are consistent with the data.

   **The EDD and the DVSR Data Summary tables were corrected for rounding and significant figure issues that caused some sample results to be reported as values greater than the SQL for Non-detect samples. Additionally, the Perchlorate result for sample AFX-75.20170430_085854.788 was corrected from 0.007 mg/L to 0.0007 mg/L in the revised EDD and Data Summary tables. The EDD and Data Summary tables were validated against the reported sample data.**

Please contact Gary Carter at 702-699-4154 or me at 702-699-4184 if there are questions. Thank you.

Sincerely,

Jeff Gibson
Authorized Representative

Enclosure

cc:

JD Dotchin, NDEP-BISC, 2030 E. Flamingo Rd Suite 230, Las Vegas NV 89119
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Harry Van Den Berg, AECOM
Brian Waggle, Hargis + Associates

November 7, 2017

Jeff Gibson
Authorized Representative
Endeavour LLC
900 Wiesner Way,
Henderson, Nevada 89011

Re: **Endeavour LLC**
**(Former AMPAC/PEPCON Facility)**
Nevada Division of Environmental Protection (NDEP) Response to: *Data Validation Summary Report ENDVR.1H2017.Rev1 For Samples Collected and Analyzed January 1 to June 30, 2017*

Dated: October 25, 2017

And

*EDD_1H2017_Rev1*

Dated: October 24, 2017

Dear Mr. Gibson,

The NDEP has received and reviewed Endeavour's above-identified Deliverables and finds that the documents are acceptable.

Please contact the undersigned with any questions at alan.pineda@ndep.nv.gov or 702-486-2850 x247.

Sincerely,

Alan Pineda

Alan Pineda, E.I.T.
Bureau of Industrial Site Cleanup
NDEP-Las Vegas City Office

Ec:

James Dotchin, NDEP BISC Las Vegas
James Carlton Parker, NDEP BISC Las Vegas
Allan Delorme, Ramboll Environ
Alison Fong, U.S. Environmental Protection Agency, Region 9

Andrew Barnes, Geosyntec
Andrew Steinberg, Nevada Environmental Response Trust
Anna Springsteen, Neptune & Company Inc.
Betty Kuo, MWDH2O
Brenda Pohlmann, City of Henderson
Brian Waggle, Hargis + Associates
Carol Nagai. , Metropolitan Water District of Southern California
Chuck Elmendorf, Stauffer Management Company, LLC
Dave Share, Olin
David Johnson, Central Arizona Water Conservation District
Derek Amidon, Tetratech
Ebrahim Juma, Clean Water Team
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Paul Black, Neptune and Company, Inc.
Paul Hackenberry, Hackenberry Associates, LLC
Peggy Roefer, CRC
Ranajit Sahu, BRC
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Rick Kellogg, BRC
Steve Clough, Nevada Environmental Response Trust
Steven Anderson, LVVWD
Tanya O'Neill, Foley & Lardner
Todd Tietjen, SNWA

# APPENDIX G

# NPDES Permit NV0024112

STATE OF NEVADA

Department of Conservation & Natural Resources

DIVISION OF ENVIRONMENTAL PROTECTION

Brian Sandoval, Governor

Leo M. Drozdoff, P.E., Director

Colleen Cripps, Ph.D., Administrator

rec'd via FM 3 JAN 2012

December 29, 2011

Mr. Jeff Gibson
American Pacific Corporation
3883 Howard Hughes Parkway, Ste. 700
Las Vegas, NV 89169

Re: **Issuance of NPDES Permit NV0024112, AMPAC –AGTS Perchlorate Remediation Site Discharge to LV Wash, Clark County, Nevada**

Dear Mr. Gibson:

In accordance with provisions of the Nevada Water Pollution Control Law Chapter 445A of the Nevada Revised Statutes, the Department of Conservation and Natural Resources, Division of Environmental Protection has reviewed the following application for a new NPDES permit to discharge treated groundwater to the Las Vegas Wash:

| Permit Holder | Permit Number |
|---|---|
| AMPAC | NV0024112 |

This office published a public notice for our proposed action in the **November 23, 2011** edition of the **Las Vegas Review-Journal**. Copies of the draft permit, fact sheet, and public notice were sent to your office and to the Chairman of the Clark County Board of Commissioners. The public notice was also sent to interested persons and government agencies on our mailing list.

During the 30-day public comment period, no comments were received from the public, and no revisions were made to the permit and fact sheet. After consideration, the Division of Environmental Protection is renewing the enclosed permit for discharge of treated groundwater from the groundwater remediation systems, for a period of five (5) years. This action does not constitute a significant change from the tentative determinations set forth in the public notice. The enclosed renewal permit has also been sent to the Region IX Permits Issuance Section of the United States Environmental Protection Agency.

The new permit will expire at midnight on **December 29, 2016**, providing all permit conditions are followed, and annual fees paid accordingly. The permit requires submittal of 2 copies of the remediation system as-built plans to the Division for review and approval, by **February 29, 2012**. The permit also requires submittal of 2 copies of the updated Operations and Maintenance Manual by **June 30, 2012**, to be approved by the Division. In accordance with the permit conditions, an annual review and services fee to maintain the discharge permit is due on **July 1, 2012**, and every year thereafter until the permit is terminated. The first Discharge Monitoring Report (DMR) under the new permit is due on **April 28, 2012**. You may download blank copies of the required DMR forms, in PDF or Microsoft Word format, from the division website at www.ndep.nv.gov/bwpc/npdes1.pdf or at www.ndep.nv.gov/bwpc/npdes1.doc, respectively. Should you have any questions regarding the DMRs, please contact the Bureau Compliance Coordinator, Diana Silsby, at (775) 687-9438.

Should you have any questions regarding the permit issuance, please call me at (775) 687-9423, or by email at jgardner@ndep.nv.gov.

Sincerely,

Jeryl R. Gardner, P.E.

Jeryl R. Gardner, P.E.
NDEP Bureau of Water Pollution Control

Enclosures: NV0024112 Permit
NV0024112 Fact Sheet
Attachment A –Priority Pollutants List
Discharge Monitoring Report (DMR) Form

cc: Compliance Coordinator, BWPC (hand-delivered)
Shannon Harbour, BCA (electronic)
Greg Lovato, BCA (electronic)
Todd Croft, BCA –LV (electronic)
Susan Crowley, Crowley Environmental, 366 Esquina Dr., Henderson, NV 89014 (w/permit and fact sheet)
Allan DeLorme, Environ, 6000 Shellmound St., Ste. 700, Emeryville, CA 94608 (w/permit and fact sheet)
Mike Skromyda, Tronox, LLC, PO Box 55, Henderson, NV 89009 (w/permit and fact sheet)
Frederick Stater, Tronox, LLC, PO Box 55, Henderson, NV 89009 (w/permit and fact sheet)
Susan Brager, Chair-CCBC, 500 Grand Central Pkwy., 6th Floor, Las Vegas, NV 89155 (w/permit)
Reader File

# NEVADA DIVISION OF ENVIRONMENTAL PROTECTION

## AUTHORIZATION TO DISCHARGE

In compliance with the provisions of the Federal Water Pollution Control Act as amended, (33 U.S.C. 1251 et. seq.; the "Act") and Chapter 445A of the Nevada Revised Statutes, the Permittee,

**American Pacific Corporation**
**3883 Howard Hughes Parkway, Suite 700**
**Las Vegas, NV 89169**

is authorized to discharge treated groundwater from the project located approximately at:

**901 Wiesner Way, Henderson**
**Clark County, Nevada 89011**
**Section 36, T21S R62E MDB&M**
**Latitude: 36° 04' 30" N Longitude: 115° 00' 17.3" W**

to receiving waters named:

**Las Vegas Wash, via Outfall 001**
**Latitude: 36° 05' 12" N Longitude: 114° 59' 13" W**
or to the **Athens Channel, via Outfall 002**
**Latitude: 36° 04' 42" N Longitude: 115° 00' 42" W**

in accordance with the effluent limitations, monitoring requirements, and other conditions set forth in Parts I, II, and III hereof.

This permit shall become effective on **December 30, 2011**.

This permit shall expire at midnight **December 29, 2016.**

Signed this 29th day of December, 2011.


Jeryl R. Gardner, P.E.
Bureau of Water Pollution Control

## PART I

## I.A. EFFLUENT LIMITATIONS, MONITORING, AND CONDITIONS

I.A.1. **Effluent Limitations:** During the period beginning on the effective date of this permit, and lasting until the permit expires, the Permittee is authorized to discharge treated groundwater from the fluidized bed reactor system, to Outfalls 001 or 002. The discharge may be directed to only one Outfall at a time, but may be directed to either of the two designated Outfalls.

**001**: Las Vegas Wash, **Latitude: 36° 05' 12" N, Longitude: 114° 59' 13" W**, or to
**002**: Athens Channel, **Latitude: 36° 04' 42" N, Longitude: 115° 00' 42" W**.

Samples taken in compliance with the monitoring requirements specified in Table I.A.1. shall be collected at the following locations prior to discharge:

a. **INF** = influent at the intake to the treatment train, prior to mixing;

b. **EFF** = effluent from treatment system prior to discharge to Outfall 001, or 002;

c. **001** = Outfall 001, end-of-pipe discharge to the Las Vegas Wash, approximately 6.5 miles upstream of the confluence of the Wash with Lake Mead.

d. **002** = Outfall 002, end-of-pipe discharge to the Athens Channel.

e. **LW0.55** = Conditional sampling point in the Las Vegas Wash, 0.5 mile upstream of confluence of Wash with Lake Mead.

Water quality shall be limited and monitored by the Permittee as specified below:

**Table I.A.1. Discharge Limitations, Sampling and Monitoring Requirements**

| Parameters | Units | Discharge Limitations | | | Monitoring Requirements | | |
|---|---|---|---|---|---|---|---|
| | | 30-Day Average | Daily Max | 30-Day Avg Load (ppd) | Sampling Locations | Monitoring Frequency | Monitoring Type |
| Flow Rate | MGD | 1.152 | 1.152 | --- | EFF | Continuous | Flow meter |
| $BOD_5$ (inhibited) | mg/l | M&R | M&R | M&R | INF | Monthly | Discrete |
| | | 45 | M&R | 190 | EFF | | |
| Perchlorate | µg/l | M&R | M&R | M&R | INF | Daily discrete samples composited weekly | |
| | | 18 | M&R | 0.17 | EFF | | |
| pH -SV | S.U. | 6.5 to 9.0 | --- | --- | EFF | Weekly | Discrete |
| DO | mg/l | M&R | M&R | M&R | EFF | Weekly | Discrete |
| TOC | mg/l | M&R | M&R | 48.04 | EFF | Quarterly | Discrete |
| TSS | mg/l | 135 | M&R | 1,300 | EFF | Monthly | Discrete |
| TDS | mg/l | M&R | --- | M&R | INF | Quarterly | Discrete |
| | | 3,000 | M&R | M&R | EFF | | |
| | | M&R | --- | M&R | 001 or 002 | | |
| Chloride | mg/l | M&R | --- | M&R | INF | Monthly | Discrete |
| | | M&R | --- | M&R | EFF | | |
| Chlorate | mg/l | M&R | --- | M&R | INF | Monthly | Discrete |
| | | M&R | --- | M&R | EFF | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sulfate | mg/l | M&R | --- | M&R | INF | Monthly | Discrete |
| | | M&R | --- | M&R | EFF | | |
| Sulfide | mg/l | M&R | --- | M&R | INF | Monthly | Discrete |
| | | M&R | --- | M&R | EFF | | |
| Nitrate as N | mg/l | M&R | --- | M&R | INF | Monthly | Discrete |
| | | M&R | --- | M&R | EFF | | |
| Nitrite as N | mg/l | M&R | --- | M&R | INF | Monthly | Discrete |
| | | 10 | --- | M&R | EFF | | |
| TIN | mg/l | M&R | --- | M&R | INF | Monthly | Discrete |
| | | 20 | --- | M&R | EFF | | |
| Total Phosphorus as P | mg/l | M&R | M&R | M&R | INF | Quarterly | Discrete |
| | | M&R | M&R | 20 * | EFF | | |
| | | * If the total load in the Wash, including non-point sources, exceeds 434 ppd from 03/01-10/31, the Permittee shall negotiate an IWLA, or other approved method which ensures the WQS will be met. | | | LW0.55 | Quarterly | Discrete |
| Total Ammonia as N | mg/l | M&R | M&R | 40 ** | EFF | Quarterly | Discrete |
| | | ** If the load in the Wash exceeds 970 ppd from 04/01-09/30, the Permittee shall negotiate an IWLA, or other approved method which ensures the WQS will be met. | | | LW0.55 | Quarterly | Discrete |
| Priority Pollutants - VOC (Attachment A) | mg/l, µg/l, or ppd | M&R | --- | M&R | EFF | Quarterly | Discrete |
| | | Permittee shall demonstrate no increase in concentration or loading of "other" constituents as a result of discharge. Permittee shall only be responsible for utilizing results which are >PQL. However, all data above MDL shall be reported. | | | LW0.55 | Quarterly | Discrete |
| Profile I | mg/l | --- | M&R | --- | EFF | Annually (in 4th quarter) | Discrete |

MGD: million gallons per day
M&R: Monitor and Report
µg/l: micrograms per liter
DO: Dissolved Oxygen
TDS: Total Dissolved Solids
TIN: Total Inorganic Nitrogen
IWLA: Individual Waste Load Allocation
ppd: pounds per day
MDL: Method Detection Limit
$BOD_5$: 5-day biological oxygen demand
mg/l: milligrams per liter
S.U.: Standard pH units
TSS: Total Suspended Solids
as N: as nitrogen
as P: as phosphorus
WQS: water quality standards
PQL: Practical Quantification Limit
Profile I: all Nevada Profile I parameters (metals shall be total recoverable)

I.A.2. **Background Groundwater Monitoring:** Samples taken at the frequencies specified in Table I.A.2 shall be collected at **MW-AL**, the up-gradient groundwater monitoring well at the AMPAC facility, located at:

**MW-AL: Section 14, T22S R62E MDB&M**

**Latitude: 36° 01' 44" N** **Longitude: 115° 01' 48" W**

**Table I.A.2. Groundwater Sampling and Monitoring Requirements**

| Parameters | Units | Limitations | | Monitoring Requirements | | |
|---|---|---|---|---|---|---|
| | | 30-Day Average | Daily Maximum | Sampling Locations | Monitoring Frequency | Monitoring Type |
| pH | S.U. | M&R | M&R | MW-AL | Annual | Discrete |
| Perchlorate | µg/l | M&R | M&R | MW-AL | Annual | Discrete |
| Chlorate | mg/l | M&R | M&R | MW-AL | Annual | Discrete |
| Nitrate | mg/l | M&R | M&R | MW-AL | Annual | Discrete |
| TDS | mg/l | M&R | M&R | MW-AL | Annual | Discrete |
| Priority Pollutants - VOC | mg/l | M&R | M&R | MW-AL | Annual | Discrete |

I.A.3. **Schedule of Compliance:** The Permittee shall implement and comply with the provisions of the schedule of compliance after approval by the Administrator, including in said implementation and compliance, any additions or modifications which the Administrator may make in approving the schedule of compliance.

a. The Permittee shall achieve compliance with the effluent limitations upon issuance of the permit.

b. By **June 30, 2012,** the Permittee shall submit two copies of the Operations and Maintenance (O&M) Manual, prepared in accordance with applicable sections of WTS-2 *Minimum Information Required for an Operation and Maintenance Manual for a Wastewater Treatment Plant,* to the Division for review and approval, at the following address:

**Division of Environmental Protection**
**Bureau of Water Pollution Control**
**ATTN: Compliance Coordinator**
**901 S. Stewart Street, Suite 4001**
**Carson City, Nevada 89701**

The O&M shall address the fluidized bed reactor system, as well as discharge system, and shall be wet-stamped by a Professional Engineer licensed in the State of Nevada.

c. By **February 29, 2012,** the Permittee shall submit to the Division at the above address, two copies of the as-built plans to the above address, for review and approval.

d. **Total Dissolved Solids (TDS)** (NAC 445A.143): Nothing in this permit condition shall alleviate the responsibility of other parties under consent agreement to the Bureau of Corrective Actions for the groundwater issues at AMPAC. Any work pertaining to TDS must recognize that the water quality standard for TDS (NAC 445A.199) must be maintained. **Prior to treating and discharging groundwater**, the Permittee shall obtain approval from the Division and shall comply with and report the following information:

i. The Permittee shall continue to participate in regional solutions to the TDS issues in the Las Vegas Wash.

ii. The Permittee shall submit a quarterly report in accordance with I.B.1. which includes any progress made on reducing the TDS loading to the Wash either in directly reducing the loading to the Wash from the discharge, or regional projects the Permittee has participated in which reduce the loading off-site in the same watershed.

iii. The Permittee shall fully cooperate in good faith with any persons required by NDEP to treat the discharge subsequent to treatment by the Permittee.

I.A.4. **Annual Fee:** The Permittee shall remit an annual review and services fee in accordance with NAC 445A.232 starting **July 1, 2012** and every year thereafter until the permit is terminated.

I.A.5. **Treatment System Operation and Maintenance:** The Permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities, collection systems or pump stations installed or used by the Permittee in association with, or relative to, this permit or to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance includes optimum performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance/quality control procedures.

I.A.6. **Narrative Standards:** Per Nevada Administrative Code (NAC) 445A.121, discharges shall not cause the following standards to be violated in any surface waters of the State. Waters must be free from:

a. Substances that will settle to form sludge or bottom deposits in amounts sufficient to be unsightly, putrescent, or odorous;

b. Floating debris, oil, grease, scum, and other floating materials in amounts sufficient to be unsightly;

c. Materials in amounts sufficient to produce taste or odor in the water, detectable off-flavor in the flesh of fish, or in amounts sufficient to change the existing color, turbidity, or other conditions in the receiving stream to such a degree as to create a public nuisance;

d. High temperature; biocides; organisms pathogenic to human beings; or toxic, corrosive, or other deleterious substances at levels or combinations sufficient to be toxic to human, animal, plant, or aquatic life;

e. Radioactive materials resulting in accumulations of radioactivity in plants or animals hazardous or harmful to humans or aquatic life;

f. Untreated or uncontrolled wastes or effluents that are reasonably amenable to treatment or control; and

g. Substances or conditions which interfere with the beneficial use of the receiving waters.

Narrative standards are not considered violated when the natural conditions of the receiving water are outside the established limits, including periods of high or low flow. Where effluents are discharged to such waters, the discharges are not considered a contributor to substandard conditions provided maximum treatment in compliance with permit requirements is maintained.

I.A.7. **Odors:** There shall be no objectionable odors from the collection system, treatment facility, disposal area or the biosolids treatment, use, storage, or disposal area.

I.A.8. **Violation of Water Quality Standards:** There shall be no discharge of substances which are associated with the Permittee's operation that would cause a violation of water quality standards of the State of Nevada.

I.A.9. **Authorized Discharges:** There shall be no discharge from the collection, treatment and disposal facilities except as authorized by this permit.

I.A.10. **Visibility Parameters:** There shall be no discharge of floating solids or visible foam in other than trace amounts.

I.A.11. **Facility Specifications:** The collection, treatment, and disposal facilities shall be constructed in conformance with plans approved by the Administrator of the Division. The plans must be approved by the Administrator prior to initiating construction activities. All changes to plans that have been approved by the Administrator must be re-approved by the Administrator prior to implementation.

I.A.12. **Facility Maintenance:** The facility shall be maintained in conformance with the plans approved by the Division, Bureau of Water Pollution Control. The Division must authorize all changes to the approved plans prior to implementation.

I.A.13. **Process Operations and Maintenance:** The facility shall be operated and maintained in accordance with the Operations and Maintenance (O&M) Manual, which must be approved by the Division. The O&M Manual shall be updated whenever there is a change in the operation of the facility.

I.A.14. **Security:** The treatment and disposal facility shall be fenced and posted for hazard notification, with access restricted by means of a locked gate.

I.A.15. **Best Management Practices:** The Permittee shall implement Best Management Practices (BMPs) at the facility in any and all forms prudent or necessary to protect groundwaters of the State.

I.A.16. **Well Abandonment:** Abandonment of any groundwater monitoring wells shall be conducted under the approval of, and in accordance with the requirements established by, the Division and the State Engineer's office.

I.A.17. **Presumption of Possession and Compliance:** Copies of this permit, any subsequent modifications, and the approved O&M Manual shall be maintained at the permitted facility at all times. The Permittee shall maintain on-site at the facility an operations logbook for the groundwater extraction and treatment system including, but not limited to: start-ups, shut-downs, and operational period; sampling dates and times; name(s) of personnel performing system maintenance and inspection; and maintenance procedures performed.

I.A.18. **Stormwater Management Plan:** All *Stormwater Discharges Associated with Industrial Activity*, as defined in Code of Federal Regulations (CFR) 122.26 (b)(14), that are not otherwise controlled under this permit shall be covered by a separate stormwater permit for those discharges. Stormwater permit coverage must be obtained prior to the occurrence of a stormwater discharge associated with industrial activity.

I.A.19. **Solid Waste Management:** All solid, toxic, or hazardous waste shall be properly handled and disposed of pursuant to applicable laws and regulations. Any sludge generated during this operation shall be characterized and disposed of in accordance with local, State, and Federal regulations.

I.A.20. **Sludge Management:** Facilities that generate and dispose of sludge shall monitor the concentrations of arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, and pesticides and report in mg/dry kg of sludge.

| Dry Sludge Disposal (metric tons/year) | Frequency of Sampling |
|---|---|
| >0 - <290 | Each year |
| ≥290 - <1500 | Once per quarter |
| ≥1500 - <15000 | Once every 2 months |
| ≥15000 | Once a month |

I.A.21. **Authorized Representative:** The treatment facility shall be operated by a Nevada Certified Environmental Manager (CEM). The Discharge Monitoring Reports (DMRs) must be signed by the CEM. The first DMR submitted under this permit must include the written designation of the CEM (required by Part III A.2) as the authorized representative to sign the DMRs. If the CEM changes, a new designation letter must be submitted.

I.A.22. **Prerogative to Reopen:** This permit may be reopened and modified by the Division to incorporate the results of changes made in water quality standards, in response to a revaluation of effluent analysis, or in response to additional scientific evidence as a minor modification.

## I.B. MONITORING AND REPORTING

I.B.1. **Reporting**:

a. **Annual Reports:** The fourth quarter report shall contain a plot of date (xaxis) versus concentration (y-axis) for each analyzed constituent with results detected at a frequency of 25% of the samples analyzed. The plot shall include data from the preceding five years, if available. Any data point from the current year that is greater than the limits in Part I.A.1 must be explained by a narrative.

b. **Quarterly Reporting:** Monitoring results obtained pursuant to Section I.A of the permit for the previous three (3) month period shall be summarized for each month and reported on a Discharge Monitoring Report (DMR) form. Quarterly updates of system operation, corresponding to those submitted as a function of requirements from the Bureau of Corrective Actions, and updates regarding identified analytical methods capable of achieving reduced practical quantitation limits (PQLs) for site-specific samples shall be included. The DMR is to be received in this office no later than the 28th day of the month following the completed reporting period. The Permittee shall also submit the data in electronic format. The first report is due on **April 28, 2012**. Laboratory results for analyses conducted by outside laboratories must accompany the DMR.

c. **Compliance Report** Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.

d. **Other information** Where the Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Administrator, it shall promptly submit such facts or information.

e. **Planned changes** The Permittee shall give notice to the Administrator as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when the alteration or addition to a permitted facility:

   i. May meet one of the criteria for determining whether a facility is a new source (40 CFR 122.29(b)); or

   ii. Could significantly change the nature or increase the quantity of pollutants discharged; or

   iii. Results in a significant change to the Permittee's sludge management practice or disposal sites.

f. **Anticipated Non-Compliance:** The Permittee shall give advance notice to the Administrator of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

g. An original signed copy of these, and all other reports required herein, shall be submitted to the State at the following address:

**Nevada Division of Environmental Protection**
**Bureau of Water Pollution Control**
**ATTN: Compliance Coordinator**
**901 S. Stewart Street, Suite 4001**
**Carson City, Nevada 89701**

h. A signed copy of all Discharge Monitoring Reports and any other reports shall be submitted to the Regional Administrator at the following address:

**U.S. Environmental Protection Agency, Region IX**
**NPDES/DMR WTR-7-1**
**75 Hawthorne Street**
**San Francisco, CA 94105**

I.B.2. **Monitoring**

i. **Representative Samples:** Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

ii. **Test Procedures:** Monitoring for the analysis of pollutants shall be conducted according to test procedures approved under 40 CFR 136 published pursuant to Section 304(h) of the Act, or SW-846, or in the case of sludge disposal, approved under 40 CFR 503, or other procedures as approved by the Administrator in the permit. Analysis shall be performed by a State of Nevada certified laboratory.

iii. **Recording the Results:** For each measurement or sample taken pursuant to the requirements of this permit, the Permittee shall record the following information:

i. The exact place, date, and time of sampling;

ii. The dates the analyses were performed;

iii. The person(s) who performed the analyses;

iv. The analytical techniques or methods used; and

v. The results of all required analyses.

iv. **Additional Monitoring by Permittee:** If the Permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form. Such increased frequency shall also be indicated on the DMR.

v. **Records Retention:** All records and information resulting from the monitoring activities, permit application, reporting required by this permit, including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation, shall be retained for a minimum of three (3) years, or longer if required by the Administrator. Records of monitoring information required by this permit related to the Permittee's sewage sludge use and/or disposal activities shall be retained for a period of at least 5 years or longer as required by 40 CFR 503.

vi. **Detection Limits:** All laboratory analysis conducted in accordance with this discharge permit must meet the following criteria:

i. The most sensitive analytical method specified or approved in either 40 CFR 136 or SW-846 shall be used, which is required or approved by the Nevada state laboratory certification program; and

ii. Each parameter shall have detection at or below the permit limits or the method detection limit as defined in the analytical method; or

iii. The Permittee is considered in compliance if the reported results are less than the established permit limit or laboratory reporting limit.

vii. **Modification of Monitoring Frequency and Sample Type:** After considering monitoring data, stream flow, discharge flow and receiving water conditions, the Administrator, may for just cause, modify the monitoring frequency and/or sample type by issuing an order to the Permittee.

I.B.3. **Definitions:**

i. The "30-day average discharge" means the total discharge during a month divided by the number of samples in the period that the facility was discharging. Where less than daily sampling is required by this permit, the 30-day average discharge shall be determined by the summation of all the measured discharges divided by the number of samples during the period when the measurements were made.

ii. The "daily maximum" is the highest measurement recorded during the monitoring period.

iii. The "30-day average concentration", other than for fecal coliform bacteria, means the arithmetic mean of measurements made during a month. The "30-day average concentration" for fecal coliform bacteria means the geometric mean of measurements made during a month. The geometric mean is the "$n^{th}$" root of the product of "n" numbers. Geometric mean calculations and arithmetic mean calculations where there are non-detect results shall use one half the detection limit as the value for the non-detect results.

iv. A "discrete" sample means any individual sample collected in less than 15 minutes.

v. For flow-rate measurements a "composite" sample means the arithmetic mean of no fewer than six individual measurements taken at equal time intervals for 24 hours, or for the duration of discharge, whichever is shorter.

For other than flow-rate a "composite" sample means a combination of no fewer than six individual flow-weighted samples obtained at equal time intervals for 24 hours, or for the duration of discharge, whichever is shorter. Flow-weighted sample means that the volume of each individual sample shall be proportional to the discharge flow rate at the time of sampling.

vi. Acute toxicity is defined in the whole effluent testing procedures presented in this permit in I.A.16.

vii. Biosolids are non-hazardous sewage sludge or domestic septage as these terms are defined in 40 CFR 503.9.

viii. PQL is the Practical Quantitation Limit as defined in SW-846. MDL is the Method Detection Limit as defined in SW-846.

## PART II

### II.A. MANAGEMENT REQUIREMENTS

II.A.1. **Change in Discharge**: All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, or treatment modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Any changes to the permitted treatment facility must comply with Nevada Administrative Code (NAC) 445A.283 to 445A.285. Pursuant to NAC 445A.263, the permit may be modified to specify and limit any pollutants not previously limited.

II.A.2. **Adverse Impact-Duty to Mitigate:** The Permittee shall take all reasonable steps to minimize releases to the environment resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge. The Permittee shall carry out such measures, as reasonable, to prevent significant adverse impacts on human health or the environment.

II.A.3. **Noncompliance, Unauthorized Discharge, Bypassing and Upset:**

a. Any diversion, bypass, spill, overflow or discharge of treated or untreated wastewater from wastewater treatment or conveyance facilities under the control of the Permittee is prohibited except as authorized by this permit. In the event the Permittee has knowledge that a diversion, bypass, spill, overflow or discharge not authorized by this permit is probable, the Permittee shall notify the Administrator immediately.

b. The Permittee shall notify the Administrator within twenty-four (24) hours of any diversion, bypass, spill, upset, overflow or release of treated or untreated discharge other than that which is authorized by the permit. A written report shall be submitted to the Administrator within five (5) days of diversion, bypass, spill, overflow, upset or discharge, detailing the entire incident including:

   i. Time and date of discharge;

   ii. Exact location and estimated amount of discharge;

   iii. Flow path and any bodies of water which the discharge reached;

   iv. The specific cause of the discharge; and

   v. The preventive and/or corrective actions taken.

c. The following shall be included as information which must be reported within 24 hours:

   i. Any unanticipated bypass which exceeds any effluent limitation in the permit;

   ii. Any upset which exceeds any effluent limitation in the permit;

   iii. Violation of a limitation for any toxic pollutant or any pollutant identified as the method to control a toxic pollutant.

d. The Permittee shall report all instances of noncompliance not reported under Part II.A.4.b. at the time monitoring reports are submitted. The reports shall contain the information listed in Part II.A.4.b.

e. A "**bypass**" means the intentional diversion of waste streams from any portion of a treatment facility.

   i. **Bypass not exceeding limitations:** The Permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs a and b of this section.

   ii. **Anticipated bypass:** If the Permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least ten days before the date of bypass.

f. **Prohibition of Bypass:** Bypass is prohibited, and the Administrator may take enforcement action against a Permittee for bypass, unless:

i. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage.

ii. There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment down time. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance; and

iii. The Permittee submitted notices as required under paragraph e of this section.

g. The Administrator may approve an anticipated bypass, after considering its adverse effects, if the Administrator determines that it will meet the three conditions listed in paragraph f of this section.

h. An "**upset**" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the Permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

i. **Effect of an upset:** An upset constitutes an affirmative defense to an action brought for non-compliance with such technology-based permit effluent limitations if the requirements of paragraph j of this section are met.

j. **Conditions necessary for a demonstration of an upset:** A Permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

i. An upset occurred and that the Permittee can identify the cause(s) of the upset;

ii. The permitted facility was at the time being properly operated; and

iii. The Permittee submitted notice of the upset as required under paragraph c of this section; and

iv. The Permittee complied with any remedial measures required under II.A.3.

k. In selecting the appropriate enforcement option, the Administrator shall consider whether or not the noncompliance was the result of an upset. The burden of proof is on the Permittee to establish that an upset occurred.

II.A.4. **Removed Substances**: Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of waste waters shall be disposed of in a manner such as to prevent any pollution from such materials from entering any navigable waters.

II.A.5. **Safeguards to Electric Power Failure**: In order to maintain compliance with the effluent limitations and prohibitions of this permit the Permittee shall either:

a. Provide at the time of discharge an alternative power source sufficient to operate the wastewater control facilities;

b. Halt or reduce all discharges upon the reduction, loss, or failure of the primary source of power to the wastewater control facilities.

## II.B. RESPONSIBILITIES

II.B.1. **Right of Entry and Inspection**: The Permittee shall allow the Administrator and/or his authorized representatives, upon the presentation of credentials, to:

a. Enter at reasonable times upon the Permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit;

b. Have access to and copy any records required to be kept under the terms and conditions of this permit;

c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations required in this permit;

d. Perform any necessary sampling or monitoring to determine compliance with this permit at any location for any parameter.

II.B.2. **Transfer of Ownership or Control:** In the event of any change in control or ownership of facilities from which the authorized discharge emanates, the Permittee shall notify the succeeding owner or controller of the existence of this permit, by letter, a copy of which shall be forwarded to the Administrator. The Administrator may require modification or revocation and reissuance of the permit to change the name of the Permittee and incorporate such other requirements as may be necessary. Division approval is required for all permit transfers.

II.B.3. **Availability of Reports:** Except for data determined to be confidential under NRS 445A.665, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the office of the Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in NRS 445A.710.

II.B.4. **Furnishing False Information and Tampering with Monitoring Devices:** Any person who knowingly makes any false statement, representation, or certification in any application, record, report, plan or other document filed or required to be maintained by the provisions of NRS 445A.300 to 445A.730, inclusive, or by any permit, rule, regulation or order issued pursuant thereto, or who falsifies, tampers with or knowingly renders inaccurate any monitoring device or method required to be maintained under the provisions of NRS 445A.300 to 445A.730, inclusive, or by any permit, rule, regulation or order issued pursuant thereto, is guilty of a gross misdemeanor and shall be punished by a fine of not more than $10,000 or by imprisonment. This penalty is in addition to any other penalties, civil or criminal, provided pursuant to NRS 445A.300 to 445A.730, inclusive.

II.B.5. **Penalty for Violation of Permit Conditions:** Nevada Revised Statutes NRS 445A.675 provides that any person who violates a permit condition is subject to administrative and judicial sanctions as outlined in NRS 445A.690 through 445A.705.

II.B.6. **Permit Modification, Suspension or Revocation:**

a. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following (NAC 445A.261:

i. Violation of any terms or conditions of this permit; or

ii. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge; or

iv. A determination that the permitted activity endangers human health or the environment and can only be regulated to acceptable levels by permit modification or termination; or

v. There are material and substantial alterations or additions to the permitted facility or activity; or

vi. The Administrator has received new information; or

vii. The standards or regulations have changed; or

viii. The Administrator has received notification that the permit will be transferred.

b. **Minor Modifications:** With the consent of the Permittee and without public notice, the Administrator may make minor modifications in a permit to:

i. Correct typographical errors;

ii. Clarify permit language;

iii. Require more frequent monitoring or reporting;

iv. Change an interim compliance date in a schedule of compliance, provided the new date is not more than 120 days after the date specified in the permit and does not interfere with attainment of the final compliance date;

v. Allow for change in ownership; change the construction schedule for a new discharger provided that all equipment is installed and operational prior to discharge; or

vi. Delete an outfall when the discharge from that outfall is terminated and does not result in discharge of pollutants from other outfalls except in accordance with permit limits.

II.B.7. **Toxic Pollutants:** Notwithstanding Part II.B.6. above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the Permittee so notified.

II.B.8. **Liability:** Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the Permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable Federal, State or local laws, regulations, or ordinances.

II.B.9. **Property Rights:** The issuance of this permit does not convey any property rights, in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

II.B.10. **Severability:** The provisions of this permit are severable, and if any provision of this permit, or the application of any provisions of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

II.B.11. **Duty to Comply:** The Permittee shall comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for permit termination; revocation and re-issuance, or modification; or denial of a permit renewal application.

II.B.12. **Need to Halt or Reduce Activity Not a Defense:** It shall not be a defense for a Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with this permit.

II.B.13. **Duty to Provide Information:** The Permittee shall furnish to the Administrator, within a reasonable time, any relevant information which the Administrator may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The Permittee shall also furnish to the Administrator, upon request, copies of records required to be kept by this permit.

## PART III

### III.A. OTHER REQUIREMENTS

III.A.1. **Reapplication:** If the Permittee desires to continue to discharge, he shall reapply not later than 180 days before this permit expires on the application forms then in use. POTW's with NPDES permits shall submit the sludge information listed at 40 CFR 501.15(a)(2) with the renewal application. The renewal application shall be accompanied by the fee required by NAC 445A.232.

III.A.2. **Signatures, Certification Required on Application and Reporting Forms:**

a. All applications, reports, or information submitted to the Administrator shall be signed and certified by making the following certification.

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

b. All applications, reports or other information submitted to the Administrator shall be signed by one of the following:

i. A principal executive officer of the corporation (of at least the level of vice president) or his authorized representative who is responsible for the overall operation of the facility from which the discharge described in the application or reporting form originates; or

ii. A general partner of the partnership; or

iii. The proprietor of the sole proprietorship; or

iv. A principal executive officer, ranking elected official or other authorized employee of the municipal, state or other public facility.

c. **Changes to Authorization:** If an authorization under paragraph b. of this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph b. of this section must be submitted to the Administrator prior to or together with any reports, information, or applications to be signed by an authorized representative.

III.A.3. The Permittee shall notify the Administrator as soon as they know or have reason to believe:

a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

i. One hundred micrograms per liter (100 μg/l);

ii. Two hundred micrograms per liter (200 μg/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 μg/l) for 2,4-dinitrophenol and for 2-methyl-4,6-dinitrophenol; and one milligram per liter (1 mg/l) for antimony;

iii. Five (5) times the maximum concentration value reported for that pollutant in the permit application in accordance with 40 CFR 122.21(g)(7); or

iv. The level established by the Administrator in accordance with 40 CFR 122.44(f).

b. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

i. Five hundred micrograms per liter (500 μg/l);

ii. One milligram per liter (1 mg/l) for antimony;

iii. Ten (10) times the maximum concentration value reported for that pollutant in the permit application in accordance with 40 CFR 122.21(g)(7);

iv. The level established by the Administrator in accordance with 40 CFR 122.44(f).