Brown AND Caldwell

201 N Civic Dr, Suite 115
Walnut Creek, CA 94596
Tel: 925-210-2518

Final Technical Memorandum

Prepared for: California American Water

Project Title: Wild Wings Water Reclamation Facility Odor Survey

Project No: 141905-001-003

Technical Memorandum

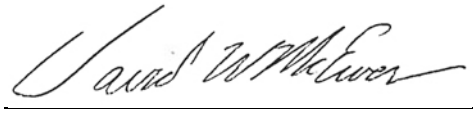
Subject: Initial Field Odor Survey Findings

Date: December 19, 2011

To: Yitzhak Gilon

From: David McEwen

Copy to: Regina Espinosa (Yolo County CSA)

Prepared by: 

David McEwen, Civil Engineer, License No. 69475, Expiration 6/30/12

Reviewed by: Philip Wolstenholme, Civil Engineer

1. Introduction

This Technical Memorandum (TM) provides a summary of the initial field investigations conducted for the odor survey at the Wild Wings Water Reclamation Facility (WWWRF), which is operated by California American Water (Cal Am). The WWWRF is a small wastewater treatment facility that treats raw wastewater collected from the Wild Wings residential community in Woodland, CA, located in Yolo County.

Cal Am and Yolo County have received odor complaints from neighbors of the WWWRF during recent months and Cal Am has initiated an odor survey, conducted by Brown and Caldwell (BC), to project if current odor emissions from the WWWRF could be contributing to offsite odor impacts, and if so, what portion(s) of the facility are the primary contributors. As depicted in Figure 1, the WWWRF is located adjacent to the Wild Wings Golf Course and the nearest residence is approximately 315 ft from the eastern end of the plant.

Figure 1. Aerial photograph of the WWWRF (courtesy of Google Earth)

The initial field survey task was completed by BC as part of a larger proposed scope of work, which includes detailed odor sampling and analysis and dispersion modeling. The initial field survey focuses on field monitoring of odors during individual site visits and hydrogen sulfide (H_2S) concentration data measured by field instruments. BC recommended completing this initial survey as a first step, given that H_2S is typically the primary contributor to odor emissions from wastewater treatment facilities, in particular in the upstream portion of the liquid-phase treatment system.

BC is tasked with downloading and analyzing the H_2S field measurements and identifying any conclusions regarding odor emissions and their contribution to offsite odors in the nearby community. Following review

by Cal Am and Yolo County, a determination will be made as to how to proceed with subsequent tasks in the BC odor survey contract with Cal Am.

2. Field Odor Survey Scope

This section describes the odor measurement equipment used for this work and summarizes the field protocol completed during execution of the work.

2.1 Odor Measurement and Monitoring Equipment Description

Plant odor sources were characterized using two hand-held pieces of equipment that provide instantaneous odor measurements and one data logger that provides odor measurements at regular intervals throughout a two-period. Following are brief description of these tools:

- Instantaneous H_2S measurements were taken using a hand-held Jerome 631-X Analyzer, which measures H_2S concentrations to a resolution of 1 part per billion by volume (ppbv). The human detection threshold for H_2S is approximately 0.5 ppbv, which indicates that the Jerome Analyzer can measure odors down to nearly the concentration at which they can barely be detected by the average individual. Ambient H_2S concentrations were measured in the headspace above the emission surface for odorous plant sources and along the plant fence line (the plant boundary with the surrounding golf course property). Measurements were taken at each source in multiple locations to produce a sufficient average characterization of odorous emissions from that source. Additionally, H_2S concentrations were measured in various off-site locations, in particular downwind areas and within the adjacent residential community.
- Field ammonia concentrations were measured at the dewatered sludge bin only using a GasTec calorimetric tube kit, which measures ammonia within a range of 1 to 74 parts per million by volume (ppmv). Ammonia is detected by humans at a much higher concentration than H_2S (approximately 30 ppmv), thus the field method used sufficiently characterizes significant odor emissions. Ammonia measurements at the dewatered sludge bin were added by BC to the initial field survey to provide a better odor characterization of that source. Ammonia (and other nitrogen containing compounds such as amines) typically are present in higher concentrations in dewatered sludge and may represent a better indication of overall odors than H_2S measured by the Jerome.
- Continuous H_2S concentrations were measured and logged by OdaLog data loggers. These data loggers measure the H_2S concentration every five minutes and record the measured concentration in a data file that can be downloaded onto a personal computer and analyzed. The goal of this data collection was to identify variations in odorous emissions over time in key plant processes that were projected to have elevated H_2S emissions, and to attempt to correlate increased odor levels at plant processes with increased odor levels at the plant boundary. BC installed OdaLog H_2S data loggers in three locations: at two odor sources within the WWWRF and at one location along the plant boundary adjacent to residences that have provided recent odor complaints (described further below).

2.2 Field Testing Protocol

BC conducted three site visits in accordance with the initial field survey:

- Tuesday, November 1, 2011: BC visited the WWWRF and reviewed plant operations with WWWRF staff, including review of existing plant drawings and plant monitoring systems. Additionally, BC installed the three OdaLogs for ongoing H_2S monitoring and collected odor data (H_2S concentrations) using the Jerome Analyzer throughout the plant and off-site.

- Thursday, November 10, 2011: BC removed the three OdaLogs and downloaded all data accumulated since they were installed. BC also replaced the batteries in the air sampling pump attached to the low-range OdaLog installed on the plant fence line. After downloading the data and replacing the batters, BC reinstalled the OdaLogs in their previous position. During this site visit, BC also measured H_2S concentrations throughout the plant using the Jerome Analyzer and ammonia concentrations at the dewatered sludge bin using calorimetric tubes.
- Tuesday, November 15, 2011: BC removed the three OdaLogs and conducted general H_2S odor monitoring around the equalization chamber and at the plant fence line. The remaining H_2S data collected by the OdaLogs was the downloaded and processed for further analysis.

Figure 2 shows the locations where the OdaLogs were installed at the WWWRF, both in an aerial photograph view and within a photograph of the plant.

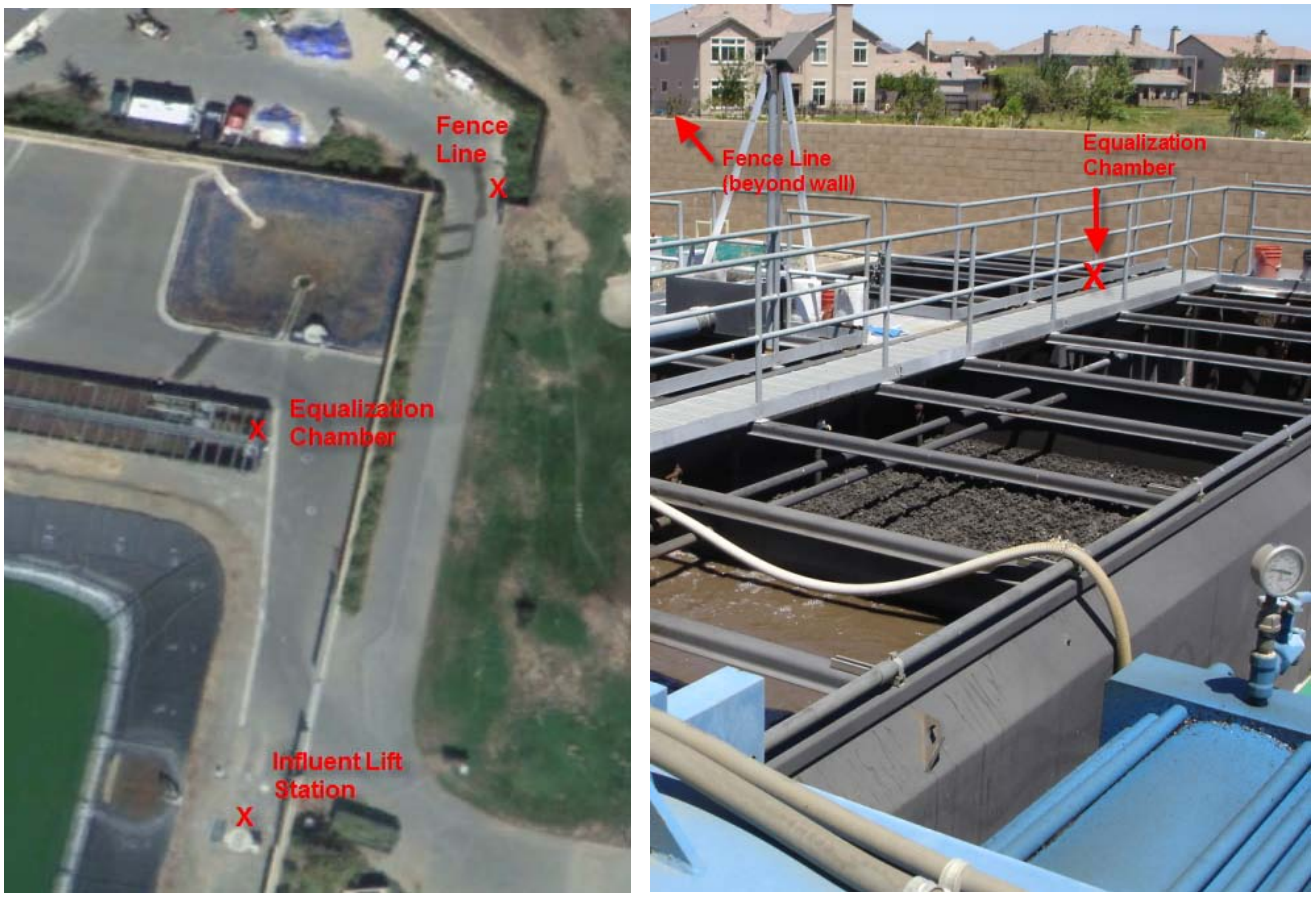


Figure 2. OdaLog Installation Locations

3. Field Odor Measurement Results

During the three site visits described above, BC conducted odor monitoring for H_2S using a hand-held Jerome Analyzer. This section provides results from the survey within the plant and the survey outside the plant (which would identify any other odor sources adjacent to the plant, based on H_2S measurements only).

3.1 Plant Odor Sources

Table 1 provides a summary of H_2S monitoring results collected by BC using the Jerome Analyzer.

Table 1. WWWRF Hydrogen Sulfide Monitoring Results				
Process Area	Average H_2S Concentration (ppmv)	Low H_2S Concentration (ppmv)	High H_2S Concentration (ppmv)	Field Notes
11/1/11 Site Visit Data (Collected between 11:00 AM and 12:00 Noon)				
Influent Lift Station	0.008	0.008	0.008	Measured at surface (open hatch); moderate H_2S odor
Equalization Chamber	0.009	0.008	0.010	Raw sewage odor; strongest odor of all open process areas on site
Sludge Digestion Basin	0.005	0.003	0.006	Moderate odor level, difficult to detect odor separate from equalization chamber
Aeration Basins	0.002	0.002	0.002	Musty, less offensive odor than in equalization chamber, not sulfurous in origin
Final Clarifier	0.002	0.002	0.002	Minimal odor
Sludge Bin (covered)	0.028	0.021	0.034	Ammonia, typical sludge odors inside bin; tight fitting cover was on (odors measured through small opening in back of bin)
Effluent Pond	0.004	0.003	0.004	No odor detected; H_2S measured throughout circumference of pond
Plant Area	0.003	0.002	0.004	Occasional odors detected around plant processes; not continuous
11/10/11 Site Visit Data (Collected between 10:00 AM and 11:00 AM)				
Influent Lift Station	0.050	0.042	0.079	Measured at surface (open hatch); H_2S odor
Equalization Chamber	0.040	0.006	0.160	Raw sewage odor; highest odor level measured near middle of tank
Sludge Digestion Basin	0.008	0.006	0.011	Moderate odor level, not entirely H_2S
Aeration Basins	0.005	0.004	0.006	Musty, less offensive odor
Sludge Bin (uncovered)[1]	0.001	0.001	0.002	Ammonia, typical sludge odors; not as strong with cover off (diluted by ambient air)
Sludge Bin (covered)[2]	0.030	0.048	0.039	Similar odor level as 11/1/11 site visit; tight fitting cover was on (odors measured through small opening in back of bin)
Plant Area	0.003	0.002	0.004	Occasional odors detected around plant processes; not continuous
11/15/11 Site Visit Data (Collected between 1:00 PM and 1:30 PM)				
Equalization Chamber	0.005	0.002	0.007	Raw sewage odor; generally lower odors than previous two site visits
Sludge Digestion Basin	0.004	0.004	0.004	Moderate odor level, not entirely H_2S
Plant Area	0.004	0.003	0.005	Some odors detected up to 20 ft away from equalization chamber, but not beyond plant fence line

1. *Ammonia concentration of 1 ppmv was measured above sludge in bin without cover on.*
2. *Ammonia concentration of 10-15 ppmv was measured above sludge in bin with cover on.*

Note that in Table 1, process areas are color-coded for comparative purposes between the three site visits. BC has made the following conclusions based on the site surveys and data in Table 1:

- Overall, H_2S odors were highest during the 11/10/11 visit, with concentrations generally being between 4 and 6 times higher for the two most odorous process areas (the influent lift station and the equalization chamber). It is unclear why this was the case.
- As was expected, the process areas that had the highest H_2S concentrations were the influent lift station and the equalization basin. Concentrations were elevated and noticeable, but never were measured at levels that were high enough that off-site impacts were of concern. Furthermore, H_2S odors were not detected from these sources (by the nose) more than 20 ft away at any time. Further characterization of these two sources (through continuous monitoring) was provided using the OdaLogs, the results of which are summarized in Section 4.
- During each of the three site visits, there was an H_2S odor that could be detected (by the nose and by the Jerome Analyzer) throughout the plant site, but during the site visits the odor was never detected in offsite areas.
- Elevated H_2S and ammonia concentrations were measured in the sludge bin when the cover was on, explained by the concentrating effect of the cover. This presents a concern for possible off-site impacts that might occur immediately after the cover is removed. Furthermore, the presence of H2S in the dewatered sludge emissions indicates a likely presence of organic sulfides in the emissions as well, which would add to the odor of this source. Additional detailed sampling may be warranted in this location.
- The large effluent pond was investigated thoroughly due to its potential off-site odor contribution (due to its size), but H_2S levels were generally low and only slightly above background levels, which were generally 0.001 to 0.002 ppmv.

3.2 Off-Site Odor Survey

Various locations around the WWWRF were tested using the Jerome Analyzer, in particular areas where complaints have been registered and areas downwind of the plant. As discussed above measurements of H_2S using the Jerome were compared to "background" levels of approximately 0.001 to 0.002 ppmv (these non-zero concentrations were measured by the Jerome even in areas where no odors could b detected by the nose). Table 2 provides the offsite H_2S measurements that were recorded during the 11/10/11 site visit.

Table 2. Off-Site Odor Survey Results

Location	H_2S Concentration (ppmv)	Field Notes
Fence Line (plant boundary)	0.003	Same location as the OdaLog installation; no odors detected
Pond (northwest of WWWRF site)	0.002	No odors detected from WWWRF or from pond itself (four measurements taken around pond perimeter)
Neighborhood (northwest of WWWRF site)	0.002	No odors detected
Golf clubhouse (south of WWWRF site)	0.002	No odors detected (downwind location)
Open area (north of WWWRF site)	0.001	No odors detected
Open agricultural field (west of WWWRF site)	0.001	No odors detected

The data collected on 11/10/11 indicates minimal if any H_2S odors traveling offsite, as measured by the Jerome Analyzer, which is consistent with the observation of no odor detected by the nose in downwind

locations. It should also be noted that the prevailing winds on the day of testing were from the north and northwest at approximately 4-5 mph, which would carry any odors from the WWWRF away from the nearby residential neighborhood. The golf course clubhouse was generally downwind of the WWWRF on the day of testing, as indicated in Table 2. No odors were detected (by the nose) at that location, and minimal H_2S was measured by the Jerome.

4. Continuous Odor Monitoring Results

OdaLog continuous H_2S monitors were installed in three locations:

- Inside the wet well of the influent lift station: the OdaLog was hung by a rope approximately 10 ft below the surface. The hatch of the wet well was closed for the majority of the monitoring period.
- Above the equalization chamber: the OdaLog was hung by a rope approximately 3 ft below the top of the open tank, which was in the range of 5 to 10 ft above the water surface, depending on the time of day or night.
- Beyond the plant fence line: at the entrance to the golf course maintenance area, generally in between the WWWRF and the homes to the northwest of the plant.

The loggers measured the ambient H_2S concentration every 5 minutes for a period of two weeks. Figures 3 through 6 display graphical plots of results (note that days not shown represent times when H2S concentrations were not measured above the lower limit of the device – 1 ppmv for the equalization chamber and 0.01 ppmv for the fence line.

Figures 3 and 4 present the Influent Lift Station OdaLog results for the entire sampling period. Generally, H_2S concentrations fluctuate daily with peaks typically around midnight and lowest concentrations during the day. This pattern is opposite to expected influent flow variations and was expected.

Figures 5 and 6 note H_2S "peaks" that were measured in the equalization chamber and fence line locations. For each of the peaks, conditions measured by the other OdaLogs are noted on the plots. The peak data and associated observations are compiled in Table 3.

Table 3. OdaLog H_2S Peak Analysis

OdaLog Location and Peak Number	Date and Time	Peak H_2S Concentration (ppmv)	Other OdaLog H_2S at Same Time (ppmv)			Wind Speed and Direction
			Influent Lift Station	Equalization Chamber	Fence Line	
Equalization Chamber Peak 1	11/2/11 9-10 PM	1	70-80	-	ND	Calm
Equalization Chamber Peak 2	11/8/11 10-11 AM	3	1	-	ND	NW 0-4 mph
Fence Line Peak 1	11/11/11 2 PM	0.03	25	ND	-	Calm
Fence Line Peak 2	11/12/11 10 PM	0.03	40	ND	-	NW 0-1 mph
Fence Line Peak 3	11/14/11 6 PM	0.01	15	ND	-	Calm

ND = Not detected

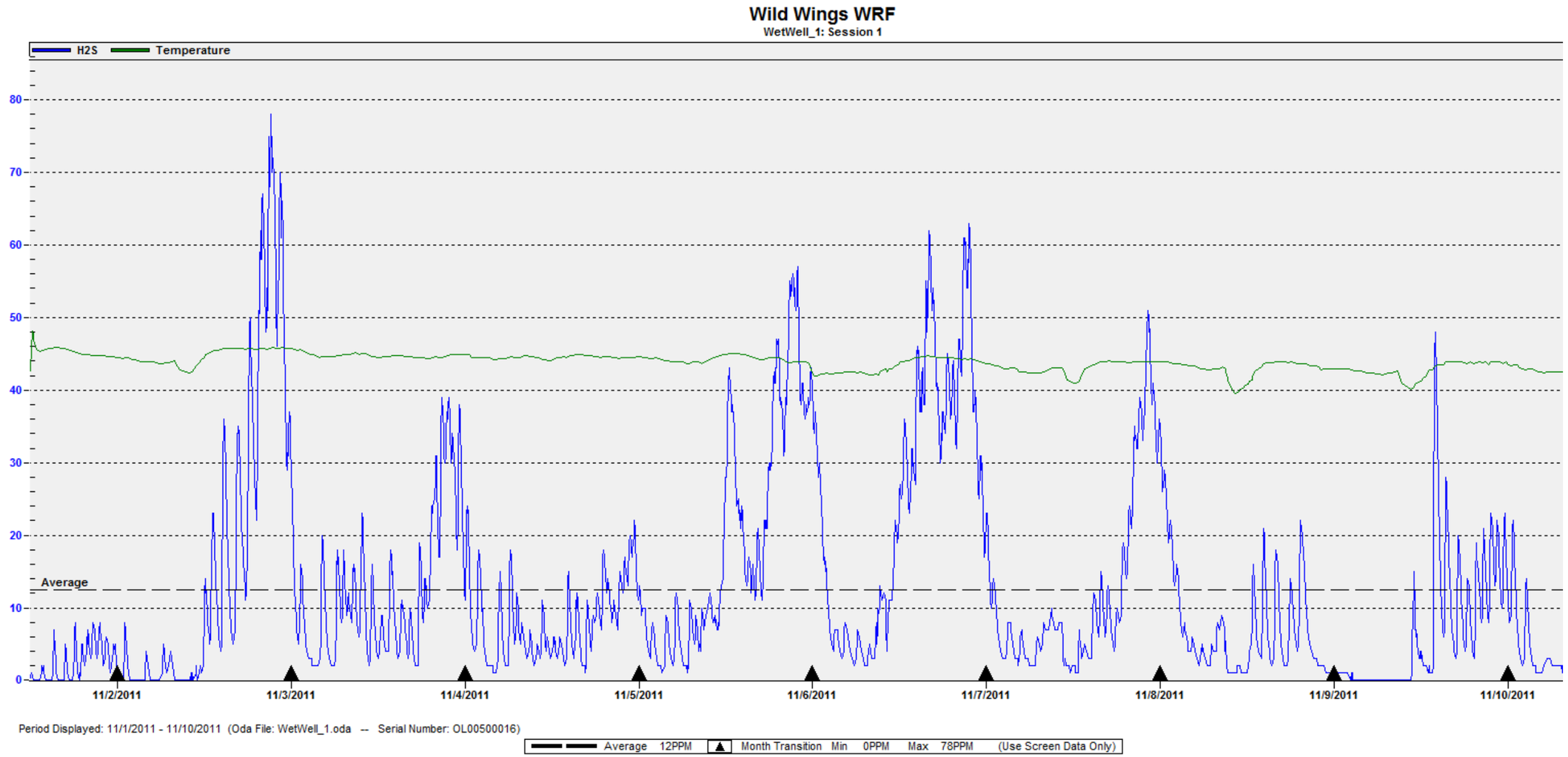


Figure 3. Influent lift station wet well OdaLog results (Period 1)

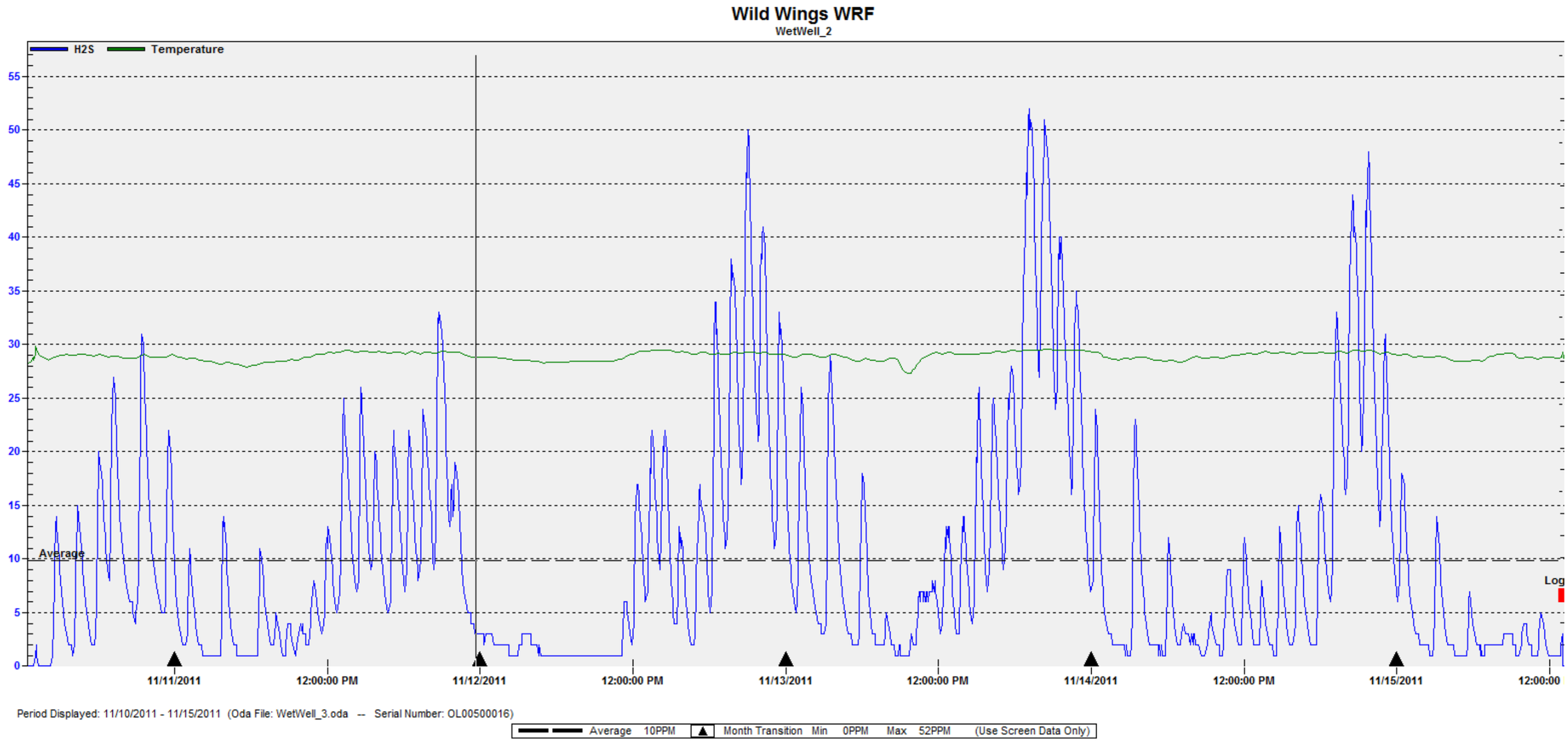


Figure 4. Influent lift station wet well OdaLog results (Period 2)

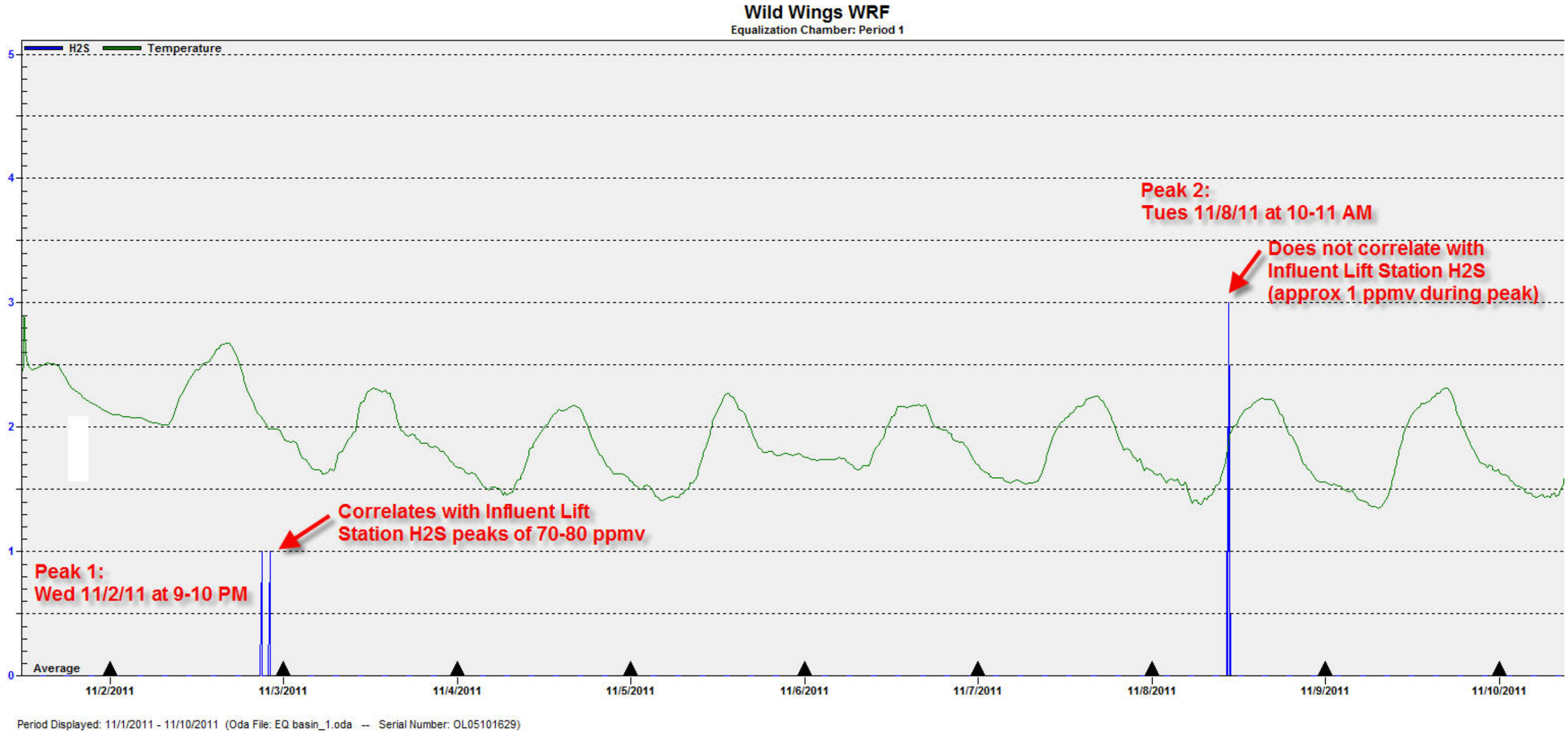


Figure 5. Equalization chamber OdaLog results

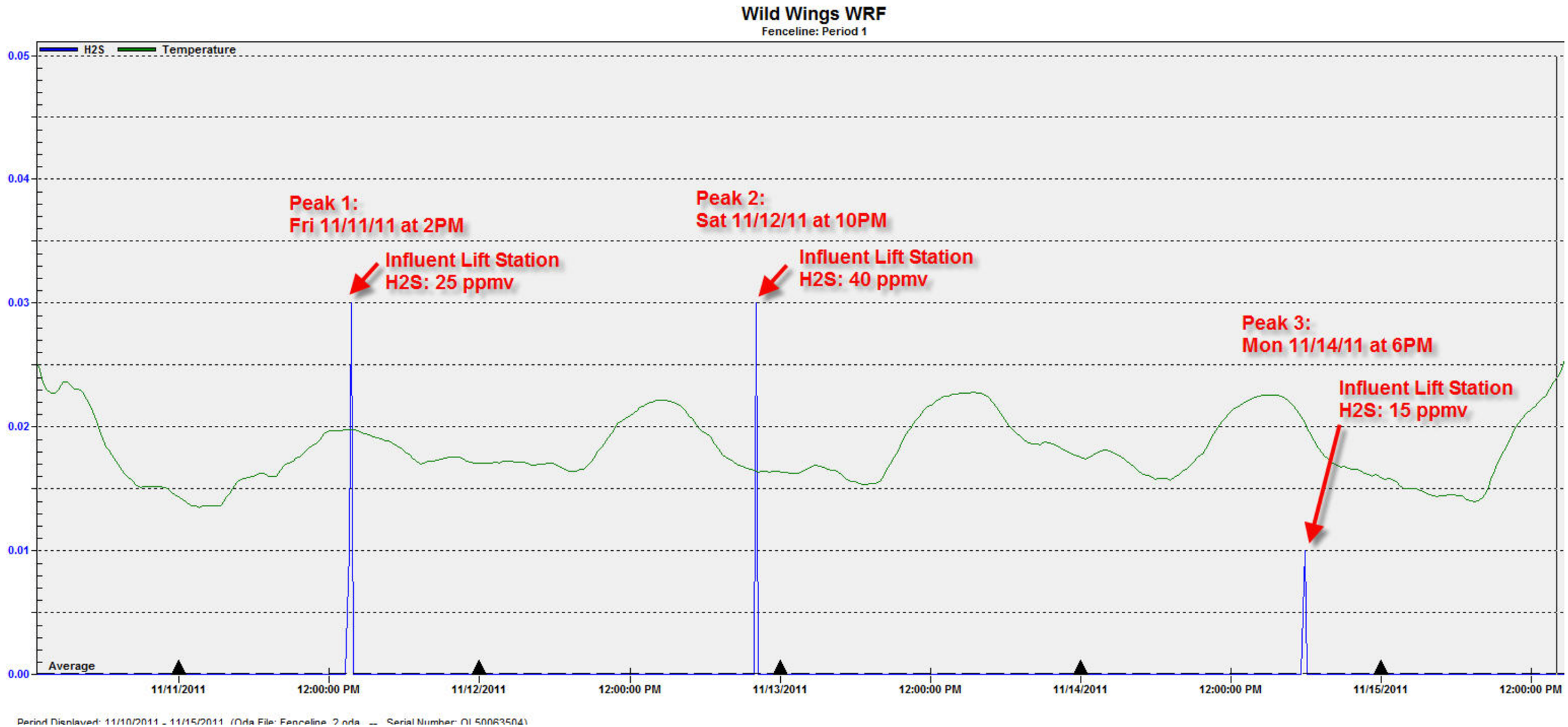


Figure 6. Fence line OdaLog results

The continuous H_2S monitoring by the OdaLog installed in the influent lift station provides an indication of the odor potential of the raw wastewater at all times of the day and night. At close to midnight each day, H_2S concentrations peaked in the range of 20 to 80 ppmv. During the day (coincident with higher flows), H_2S concentrations generally fall in the range of 0 to 20 ppmv. This confirms the projection by BC that wastewater processed through the treatment facility during the day has lower odor potential. However, high-H_2S wastewater accumulates in the lift station in the overnight hours, which could provide odor concerns when that wastewater is sent through the treatment system.

The field surveys conducted by BC showed the highest odor potential from within the WWWRF (of the processes open to the atmosphere) comes from the equalization chamber, the process area immediately downstream of the influent lift station. BC identified the equalization chamber as a potential source of odorous emissions that could be linked to offsite impacts due to the typical odor characteristics associated with raw wastewater that exists in the chamber along with the proximity of the chamber to the eastern plant fence line.

The OdaLog installed in the equalization chamber measured two H_2S emissions in excess of 1 ppmv: a 1 ppmv peak from 9 to 10 PM on 11/2/11 and a 3 ppmv peak from 10 to 11 AM on 11/8/11. The night-time peak corresponds with high H_2S concentrations in the influent lift station; however the daytime peak does not. Neither peak correlated with measurable H_2S in the fence line OdaLog, which at least for the daytime peak can be explained by the wind direction being from the northwest.

As shown in Table 3 and Figure 6, the fence line OdaLog measured H_2S concentrations of 0.01 ppmv or higher (a threshold at which the odor should be noticeable as it is 20 times the human detection concentration) three times during the two-week sampling period. However, none of the three peaks clearly correlate with other data measured at the WWWRF, for the following reasons:

- None of the three corresponds with an H_2S measurement of more than 1 ppmv by the OdaLog installed in the equalization chamber.
- The H_2S measurements made by the influent lift station OdaLog at the time the fence line OdaLog measured H_2S concentrations above 0.01 ppmv were relatively low (15 to 40 ppmv) as compared to the entire range of H_2S measured by that OdaLog during the two-week sampling period.
- One of the three peaks in the fence line OdaLog occurred when the wind was blowing from the NW, which would correlate with an odor source other than the plant.

5. Summary of Observations from Field Surveys

Following are the observations and conclusions made from this initial field odor survey:

- In the two-week period in the first half of November 2011, during which BC conducted three site surveys and continuous odor monitoring using OdaLogs, odors stayed within the WWWRF site for more than 99 percent of the time. Three instances of measurable H_2S were recorded in the fence line OdaLog during the two-week period, and each of those exceedances lasted on a few minutes.
- BC found no evidence during the offsite odor survey of any other source outside of the WWWRF that could be contributing to odors in the adjacent residential neighborhood. This includes the nearby pond and agricultural area west of the plant. No noticeable odors or H_2S readings were noted in the walk through the residential neighborhood during the site visit.
- The field survey using the Jerome Analyzer, which measures ambient H_2S levels, indicated that the most odorous plant processes are the influent lift station and equalization chamber. The sludge bin also had elevated H_2S concentrations when the cover was in place. Of these three processes, the only one that is routinely open to the environment is the equalization chamber.
- The OdaLog installed in the equalization chamber recorded H_2S concentrations at or above 1 ppmv only a few times during the two-week period, and each of these exceedances were for a short period

of time (on the order of minutes). It is unlikely that any of the equalization chamber H_2S peaks resulted in any significant offsite odor impacts.

- The OdaLog installed at the plant fence line (at the entrance to the golf club maintenance area) measured H_2S concentrations at or above 0.01 ppmv only three times during the two-week period. None of these three peaks can be attributed to one specific plant source (based on the other OdaLog data measured), and during one of the three peaks the wind was blowing from the northwest, whereas the plant is located southwest of the OdaLog location.
- Peak H_2S concentrations were measured by the OdaLogs at all times of the day (morning, afternoon, evening, and night). This does not match the trend reported to BC that most complaints occurred in the early evening.
- BC notes that the time of odor sampling (November) is not ideal for capturing peak odors from liquid-phase wastewater treatment processes. Complaints that were issued during the summer could have been associated with higher plant odor emissions, or could have been associated with different meteorological conditions.
- While H_2S may be the predominant odor compounds emitted by the WWWRF, organic reduced sulfur compounds could be present in multiple processes, along with nitrogen containing compounds. This is particularly the case for the sludge digester and sludge bin. These odorous compounds were not measured in this initial phase of the project.

BC recommends consideration of more detailed sampling and analysis, as proposed in the scope of services with Cal Am, to better understand and project any correlations with plant processes and offsite odor impacts. In particular, further detailing of odorous emissions from the sludge bin and sludge digester tank are of interest, both of which would include measurement of odorous compounds other than hydrogen sulfide. The detailed odor study would also include a better description of the types of odors being emitted by the influent lift station and equalization chamber, identifying whether compounds other than hydrogen sulfide are contributing significantly to odors in those locations as well.

This page intentionally left blank.