MONITOR WELL
INSTALLATION REPORT
AND GROUNDWATER MONITORING
City of Angels Wastewater Treatment Plant
584 South Main
Angels Camp, Calaveras County, California

Prepared for
City of Angels
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1.0 INTRODUCTION

Condor Earth Technologies, Inc. (Condor) supervised the installation of two new monitor wells at the City of Angels Wastewater Treatment Plant (WWTP) in Angels Camp, California on August 24, 25, 27, and 30, 2010. The WWTP is located at 3000 Centennial Road, Angels Camp, in south one-half of section 3 and north one-half of section 10, T2N, R13E, Mount Diablo Baseline and Meridian, Calaveras County, as shown on Figure 1, Appendix A. The WWTP is owned and operated by the City of Angels (City).

The purpose of the monitor well installations is to implement a groundwater monitoring program required by the California Regional Water Quality Control Board, Central Valley Region (Regional Board) designed to evaluate potential impacts associated with wastewater treatment and land disposal and provide a measurement of compliance with regards to the state Antidegradation Policy (Resolution 68-16) and Regional Board Order 95-129 and 95-137. The work described in this report was performed to comply with the Groundwater Monitoring Well Installation Work Plan dated March 2007 by ECO:LOGIC Engineering (Work Plan) and the Regional Board letter dated 24 August 2009 approving of the Work Plan. No Monitoring and Reporting Program (MRP) is in place for the site. This report was prepared by Condor at the request of the City.

2.0 SITE DESCRIPTION AND BACKGROUND

The WWTP currently has a designed capacity of 0.6 million gallons per day (mgd) average dry weather flow. The plant contains a UV disinfection system for tertiary treatment and a 260 acre-foot storage reservoir (Hollman Reservoir). Hollman Reservoir is sized to retain a 25-year storm event. Treated wastewater is discharged from a Re-Reg Pond to 61 acres of City pasture land located less than 1 mile southeast of the WWTP, and to 110 acres of golf course property at the Greenhorn Creek Golf Course located approximately 1 mile northwest of the WWTP. The discharges on the City property occur in accordance with the Waste Discharge Requirements (WDR) Order No. 98-110 dated April 17, 1998. The discharges at Greenhorn Creek Golf Course occur in accordance with the Revised MRP Order No. 98-098 for Greenhorn Creek Associates, LP and the City dated May 3, 2007. Wastewater flows exceeding the WWTP land disposal and storage capacity are discharged seasonally under NPDES No. CA0085201 to Angels Creek, a tributary to the Stanislaus River. The WDR prohibits the degradation of groundwater and the exceedance of total coliform organisms at a concentration of 2.2 MPN/100 ml during any 7-day period.

The sprayfield site ranges in elevation from approximately 1,300 feet above mean sea level (msl) near the confluence of Six Mile Creek and Angels Creek near the north site boundary to about 1,650 feet msl near the Re-Reg Pond located in the southwest corner of the site. The beneficial uses of underlying groundwater are domestic, industrial, and agricultural supply. Precipitation in the vicinity averages about 30 inches annually.

3.0 REGIONAL AND LOCAL GEOLOGIC SETTING

The project site lies within the Sierra Nevada Geomorphic Province of California. Within this province, the basement rock consists of Paleozoic and Mesozoic metamorphic rock that has been intruded by a complex of granitic Mesozoic plutons belonging to the Sierra Nevada Batholith. The basement rock within the region is non-conformably overlain by the eroded remnants of younger Cenozoic continental volcanic and pre-Pleistocene sedimentary rock known as the Superjacent Series. The regional and local geology is shown on Figure 2.

The Sierra Nevada range was uplifted about 10 million years ago and tilted westward in response to renewed tectonic activity of the frontal faults along the eastern side of the Sierra Nevada range. Streams eroded much of the Superjacent Series rock and carved ancestral canyons of today's west-flowing rivers. The Sierra Nevada range was further eroded by several episodes of glaciation during the past 2 million years, exposing the basement rock throughout the higher elevations and generating the extensive glacial outwash deposits within the Great Valley to the west.

3.1 LOCAL GEOLOGY

The rocks underling the sprayfields consist primarily of greenschist derived from porphyritic flows and flow breccia of Paleozoic and Mesozoic Age. Paleozoic Age metamorphosed sedimentary rocks of the Calaveras Complex are present to the east and to the west are Jurassic Age metamorphosed sedimentary and volcanic rocks. The regional faults mapped near the site include the Foothill Fault System (Bear Mountain and Melones Fault Zones) and the Calaveras Shoo-Fly Thrust Fault. The closest mapped fault is the Melones Fault Zone, a Mesozoic plate boundary that separates Calaveras Complex rock to the east from metamorphosed sedimentary and volcanic rocks to the west, located approximately ½ mile to the northeast (Clark, et al., 1963). Rocks of the Superjacent Series crop out approximately 2 miles north of the site (Clark, et al., 1963).

Information regarding the occurrence of shallow groundwater at and near the site is sparse. At least four springs are located at the site.

Three historic gold mines are present in the eastern portion of the WWTP site. These include the Marble Springs Mine, Bullion Mine, and Bruner Mines (Bowen, et al., 1997; Jenkins, et al., 1955; Logan, et al., 1934). The presence of former underground mine workings may significantly influence groundwater occurrence and movement beneath the site.

4.0 FIELD METHODS

Two borehole locations were discussed with and agreed upon by the City and the Regional Board. The City constructed dirt access roads to these locations. MW-1 is located in the north portion of the sprayfield area, in the assumed downgradient direction and approximately 2,600 feet northwest of the Hollman Reservoir. MW-2 is located in the east portion of the sprayfield area and in the assumed upgradient direction, approximately 1,000 feet northeast of Hollman Reservoir. The well locations are shown on Figure 3 and 4.

4.1 DRILLING PROCEDURES

The drilling services were provided by Tanko Well Drilling of Altaville, California (California License No. C57-423959) under permit from the Calaveras County Environmental Health Department (Permit No. 1011001, in Appendix B). The boreholes were drilled using an Ingersoll Rand Drillmaster HP-750 and down-hole hammer, air-rotary drilling methods. The upper 20 feet of the borehole was 10 inches in diameter and a 4-foot steel conductor casing was installed to inhibit surface caving. The remainder of the hole was 8 inches in diameter. Water was injected to facilitate removal of the cuttings and advance the borehole. Drilling activities were observed by a Condor geologist. The geologist logged each borehole using the Unified Soil Classification System and applicable rock classification system noting color, material hardness, and drill rate. Detailed geologic logs and Well Completion Reports are included in Appendix B.

4.2 GEOLOGIC FINDINGS

On August 24, 2010, borehole MW-1 was completed to a total depth of 80 feet. The upper 3 feet of the borehole was light brown, dry, dense, sandy silt colluvium that grades to completely weathered greenschist bedrock. The greenschist was light green and oxidized locally, completely weathered, soft, weak rock grading to highly weathered at about 12 feet. One to 3-foot thick moderately weathered, moderately hard, moderately strong zones were present at 20 and 51 feet. Fractures present at about 14 feet had a small show of water. Quartz was present at 50 feet and from 70 to 77 feet. The first water producing fractures are estimated at 77 feet and the borehole was terminated at 80 feet. Groundwater stabilized in the borehole at approximately 17 feet below grade. The driller estimated the groundwater yield at 2 gallons per minute (gpm).

On August 27, 2010, borehole MW-2 was completed to a total depth of 100 feet. Similar materials were encountered in MW-2 as in MW-1. Approximately 3 feet of colluvium was present above completely weathered greenschist. The greenschist was green, highly weathered to a depth of about 27 feet then grading to moderately weathered, moderately hard and moderately strong. A highly weathered zone was present from about 35 to 40 feet. Open fractures were present from 10 to 15 feet, 22 to 24 feet, 70 to 75 feet, and 77 to 80 feet. Abundant quartz was present in the cuttings from 70 to 80 feet and this section is likely the first water producing zone. Thin quartz-bearing zones were also present at 87 feet and 95 feet. Groundwater stabilized in the borehole at approximately 61 feet below grade. The driller estimated the groundwater yield at 1 gpm. The boreholes were located in rocks mapped as porphyritic flows and flow breccias (Clark, et al., 1963).

4.3 MONITOR WELL CONSTRUCTION

Monitoring wells were constructed using 4-inch nominal, Schedule 40, flush threaded PVC casing, 0.020 inch, machine slotted screen and a screw on PVC bottom cap. A locking, steel, stovepipe-type monument surrounded by an approximately 4-foot square concrete pad was installed at the ground surface of each well. Table 1 summarizes the well completion details. A well construction graphic is shown on the respective geologic log in Appendix B.

Table 1
Well Completion Data

Well ID:	**MW-1**	**MW-2**
Total Casing Depth (ft bgs)	80	100
Depth to First Water (ft bgs)	~77	~61.5
Borehole Diameter (inches OD)	10”: 0’ – 20’ 8”: 20’ – 80’	10”: 0’ – 20’ 8”: 20’ – 100’
Casing stickup (ft ags)	~ 3	~ 3
Casing Diameter (inches ID)	4	4
Blank Casing Interval (ft bgs)	(-3) – 65	(-3) – 75
Screen Opening (inches)	.020	.020
Screen Interval (ft bgs)	65 – 80	75 – 100
Filter Pack Material	#12 Sand	#12 Sand
Filter Pack Interval (ft bgs)	53 – 80	71.5 – 100
Bentonite Seal Interval (ft bgs)	23 – 53	21 – 71.5
Surface Seal, neat cement (ft bgs)	0.0 – 23	0.0 – 21

ags = above ground surface
bgs = below ground surface

4.4 WELL ELEVATION SURVEY

On September 14, 2010, the new monitor wells were surveyed by Erik Ohlson, PLS 8375, with a Trimble 5700 GPS Unit using Static GPS. The well locations were identified by referencing the California State Plane and Geographic Coordinate Systems (NAD83) and elevation within an accuracy of 0.01-foot using the National Geodetic Vertical Datum 1988 (NGVD88). Survey notes are included in the Surveyor's Report in Appendix C. The surveyed well coordinates and top of well casing elevations are in Table 2.

Table 2
Monitor Well Survey Data

WELL	Latitude	Longitude	Northing	Easting	Casing El.	Ground Surface El.
MW-1	38.0527138	-120.5433462	2205784.22	6549185.54	1253.66	1,250
MW-2	38.0501883	-1205330811	2204863.36	6552140.95	1548.90	1,545

4.5 MONITOR WELL DEVELOPMENT

Well development was conducted by Tanko Well Drilling of Altaville, California. Well MW-1 was swabbed about three times prior to placement of the bentonite and the elevation of the sand increased 8 to 10 feet in the annular space. The well sat for approximately 48 hours after placement of the bentonite and was further developed by the driller using surge and pump methods. No swabbing was performed at MW-2. Approximately 240 gallons of purge water was pumped from MW-1 over a period of 2.75 hours, and 270 gallons were pumped from MW-2 over 3.5 hours. After well development, turbidity in MW-1 and MW-2 was 10 and 17 Nephelometric Turbidity Units (NTU), respectively.

5.0 MONITOR WELL SAMPLING

On September 27, 2010, groundwater samples were collected from MW-1 and MW-2. Condor personnel trained in the operation of field-testing instruments performed the monitoring and sampling. The field technician training includes instrument calibration in compliance with the manufacturer's recommended procedures and frequencies. Instrument calibration records are included on the field observation sheets in Attachment B. Field measurements and parameters are summarized in Tables 4 and 5, and in Appendix D.

The depth-to-groundwater was measured in each monitoring well prior to purging and sampling. The volume of water present in each monitor well was calculated and approximately three well casing volumes were purged from each monitoring well with a portable positive displacement pump using carbon dioxide. The purge rate was approximately 0.7 gpm. The pump in MW-1 was set at about 5 feet above the well bottom and in MW-2 at about 10 feet above the bottom.

The Work Plan specifies measurement of the field parameters temperature, pH, electrical conductivity (EC), dissolved oxygen, oxidation reduction potential, and turbidity. The laboratory analyses include total dissolved solids (TDS), nitrate as nitrogen (nitrate-N), nitrite as nitrogen (nitrite-N), total Kjeldahl nitrogen (TKN), total coliform organisms (TCO), total organic carbon (TOC), arsenic, barium, chromium, and the following standard minerals: boron, calcium, iron, magnesium, manganese, potassium, silica, sodium, chloride, sulfate, total alkalinity as $CaCO_3$ (including alkalinity series), and hardness. This quarter samples were tested for fecal coliform organisms (FCO) though not requested on the chain-of-custody. The analyses included the naturally occurring stable isotopes of hydrogen (^{2}H, deuterium) and oxygen (O-18).

The initial purge water in MW-1 was cloudy, brown, with no odor. After the removal of one casing volume the water was clear. At the time of MW-1 sample collection, the water turbidity was less than 2 NTUs and the depth-to-water was at least 80 percent of the pre-purge depth-to-water. In MW-2, the initial purge water was cloudy, white, with no odor. After the removal of one casing volume the water was clearer. At the time of MW-2 sample collection, the water turbidity was less than 22 NTUs and the depth-to-water was at least 80 percent of the pre-purge depth-to-water. The monitor well samples were collected using a disposable bailer. Purge water from the monitoring wells was discharged to ground surface.

A sample was collected from the Re-Reg Pond using a dipping cup. The pond water was slightly green and approximately 1 foot below the top of the berm. Wastewater was discharging to the pond at the time of sampling.

5.1 GROUNDWATER ELEVATIONS

Table 3
Groundwater Elevation Data

Location ID	Measuring Point Elevation (ft)	Depth-to-Groundwater (ft)	Groundwater Elevation (ft)	Well Screen Elevation (ft)
MW-1	1253.66	21.79	1232.17	1,174 to 1,189
MW-2	1548.90	61.05	1487.84	1,449 to 1,474

Table 4
Approximate Spring Elevation Data

Location ID	Approximate Ground Surface Elevation (ft)	Approximate Flow	Approximate Groundwater Elevation (ft)
Spring 1	1,353	No Flow	<1,353
Spring 2	1,537	No Flow	<1,537
Spring 3	1,511	No Flow	<1,511
Spring 4	1,497	No Flow	<1,497

5.2 FIELD PARAMETER MEASUREMENTS

Table 5
Water Quality Field Parameters

Monitoring Well	Temperature ^{o}C	PH S.U.	EC umhoscm	Dissolved Oxygen mg/l	Oxidation-Reduction Potential Mv	Turbidity NTU
MW-1	20	6.14	528	3.3	80.0	1.96
MW-2	21	5.82	1,062	2.2	101.1	22.2
Re-Reg Pond	24	9.20	523	8.5	76.1	47.8

Data from field observation sheets, Attachment B

5.3 LABORATORY ANALYTICAL RESULTS

Analyses for the stable isotopes deuterium (^{2}H or D) and oxygen-18 (^{18}O) were performed at the University of California, Davis, Stable Isotope Facility using laser spectroscopy. The isotopic compositions of the water samples collected from the WWTP are reported using delta notation (δ) as negative values relative to the Vienna Standard Mean Ocean Water (VSMOW) standard. Negative values signify that the heavy isotopes in the sample are depleted with respect to the standard. The general formula for calculating $\delta^{18}O$ is reproduced below and the δD is calculated in similar manner.

$$\delta^{18}O = \left(\frac{\left(\frac{^{18}O}{^{16}O}\right)_{sample}}{\left(\frac{^{18}O}{^{16}O}\right)_{standard}} - 1 \right) * 1000 \ ^{o}/_{oo}$$

The data are listed in Table 6 and graphed on Figure 5.

Table 6
Groundwater Isotope Data

Sample ID	Date	δ D	$\delta\ ^{18}O$
MW1	9/27/2010	-60.7	-9.23
MW2	9/27/2010	-58.1	-9.09
Re-Reg Pond	9/27/2010	-81.7	-11.58

Delta (δ) values relative to VSMOW: Vienna Standard Mean Ocean Water

Groundwater samples were analyzed by BC Laboratories, Inc. in Bakersfield, California. The laboratory analyses data are tabulated in Table 7, Table 8, and in Appendix D along with the laboratory certificates of analyses, quality control records, and chain-of-custody. Existing California primary and secondary Drinking Water Maximum Contaminant Levels (MCLs) are included in the tables and constituents occurring in concentrations greater than the MCLs are highlighted in yellow. Laboratory estimated values occurring below the Practical Quantitation Limit (PQL) and above the method detection limit (MDL) are highlighted in blue.

TABLE 7
Quarterly Water Quality Data
City of Angels WWTP - Groundwater Monitoring

			Field Measurements															
Sample ID	MP Elevation	Date	Depth to Water	Ground-Water Elevation	Volume Purged, gal.	Temp.	Field pH	Field EC	Dissolved Oxygen	Oxidation Reduction Potential	Field TDS	Turbidity	Total Coliform Bacteria (TCO)	Fecal Coliform Bacteria (FCO)	Nitrite (as N)	Kjeldahl Nitrogen (as N)	Total Dissolved Solids (TDS)	Total Organic Carbon (TOC)
		Analysis Method:	*Probe*	*Calculated*	*Measured*	*Metered*	*Metered*	*Metered*	*Metered*	*Metered*	*Metered*	*Metered*	*SM 9221 B*	*SM 9221 E*	*EPA-353.2*	*EPA 351.2*	*EPA 160.1*	*EPA 415.1*
		Practical Quantitation Limit													*0.050*	*0.20*	*10-20*	*0.30*
		Minimum Detection Limit													*0.0081*	*0.056*	*10-20*	*0.062*
		Units:	*ft*	*ft. msl*	*gal*	*deg C*	*std units*	*umhs/cm*	*mg/l*	*Mv*	*mg/l*	*NTUs*	*MPN/100ml*	*MPN/100m*	*mg/l*	*mg/l*	*mg/l*	*mg/l*
		MCL (Secondary MCL where shaded)					*6.5-8.5*	*900*				*5*	*2.2*	*2.2*	*1.0*		*500*	
WWTP Wells																		
MW1	1,253.66	9/27/10	21.49	1,232.17	100	20.0	6.14	528	3.3	80.0	304	1.96	4.0	- 2	-0.01	-0.056	330	0.60
MW2	1,548.90	9/27/10	61.06	1,487.84	70	21.0	5.82	1,062	2.2	101.1	334	22.20	40	- 2	0.067	-0.056	660	1.7
Re-Reg		9/27/10			2	24.0	9.20	523	8.5	76.1	329	47.8	30	8	0.084	2.5	330	6.9
Springs																		
Spring 1	1,353	9/27/10	Dry	< 1,353														
Spring 2	1,537	9/27/10	Dry	< 1,537														
Spring 3	1,511	9/27/10	Dry	< 1,511														
Spring 4	1,497	9/27/10	Dry	< 1,497														

Notes:

Negative (-) values indicate less than the detection limit

[1] Lowered in Federal programs to 0.010 mg/L provisionally

Elevation at spring locations based on field mapping, USGS Topographic map, and Google Earth

Yellow shaded cells indicate concentrations greater than or equal to the MCL.

Green shaded cells indicate questionable or qualified analyses (e.g. exceeded hold time)

Blue shaded cells indicate estimated value detected above minimum detection level but below practical quantitation limit

TABLE 8
Standard Minerals Data
City of Angels WWTP - Groundwater Monitoring

Sample ID	Date	Total Calcium	Dissolved Calcium	Dissolved Magnesium	Dissolved Sodium	Dissolved Potassium	Dissolved Iron	Dissolved Manganese	Dissolved Arsenic[1]	Dissolved Barium	Dissolved Boron	Dissolved Chromium	Cations (Calculated)	Chloride	Nitrate (as N)	Sulfate	Silica	Bicarbonate Alkalinity ($CaCO_3$)	Carbonate Alkalinity ($CaCO_3$)	Hydroxide Alkalinity ($CaCO_3$)	Total Alkalinity ($CaCO_3$)	Anions (Calculated)	Hardness	Percent difference between cations and anions
		Standard Minerals Analyses																						
		Cations												Anions										
Analysis Method:		*EPA 200.7*	*EPA 200.7*	*EPA 200.7*	*EPA 200.7*	*EPA 200.7*	*EPA 200.7*	*EPA 200.7*	*EPA 206.2*	*EPA 200.7*	*EPA 200.7*	*EPA 200.7*		*EPA 300.0*	*EPA 300.0*	*300*	*EPA 200.7*	*EPA 310.1*	*EPA 310.1*	*EPA 310.1*	*EPA 310.1*		*Calc*	
Practical Quantitation Limit		0.10	*0.10*	*0.05*	*0.5*	*1.0*	*0.05*	*0.01*	*0.050*	*0.010*	*0.1*	*0.010*		*0.5*	*0.1*	*1.0*	*0.2*	*4.1*	*4.1*	*4.1*	*4.1*		*0.5*	
Minimum Detection Limit		0.018	*0.016*	*0.016*	*0.12*	*0.10*	*0.0093*	*0.0025*	*0.0075*	*0.0012*	*0.0097*	*0.001*		*0.059*	*0.026*	*0.10*	*0.022*	*4.1*	*4.1*	*4.1*	*4.1*		*0.1*	
Units		*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*meq*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*meq*	*mg/l*	
MCL (Secondary MCL where shaded)							*0.3*	*0.05*	*0.050*	*1.0*				*250*	*10*	*250*								
WWTP Wells																								
MW1	9/27/10		41	25	20	1.2	-0.005	0.05	-0.0075	0.074	0.064	-0.001	5.01	57	4.1	22	29	130	-4.1		130	4.96	210	0.6%
MW2	9/27/10		100	48	30	0.82	-0.005	0.05	-0.0075	0.096	0.064	0.0011	10.27	93	26	44	32	230	-4.1		230	9.99	450	1.4%
Re-Reg	9/27/10		27	4.8	64	12	-0.01	-0.001	-0.01	0.0024	0.20	-0.001	4.85	72	1.6	28	12	25	75		99	6.22	88	12.4%
Springs																								
Spring 1	12/16/09																							
Spring 2	12/16/09																							
Spring 3	12/16/09																							
Spring 4	12/16/09																							

Notes:
Negative (-) values indicate less than the detection limi
[1] Lowered in Federal programs to 0.010 mg/L provisionally

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6.0 GROUNDWATER ELEVATION AND HYDROGEOLOGY

In September 2010, insufficient data was available to calculate the groundwater potentiometric gradient at the WWTP. Only two data points (MW-1 and MW-2) were present. Groundwater was measured in MW-1 at 1,232.17 feet and in MW-2 at 1,487.84 feet. Groundwater measured in these wells likely flows in the topographic downgradient direction toward the southwest. The four springs at the site were dry. The potentiometric surface in the vicinity of each spring was less than the estimated ground surface elevation shown in Table 4. Groundwater hydrostatic head below the surface elevations at the springs is consistent with a southwestward gradient.

7.0 WATER QUALITY

The groundwater limitation for coliform specified in the WDR is 2.2 MPN/100 ml. Groundwater limitations for constituents other than coliform are not specified in the WDR. In the absence of specified limitations, laboratory results are compared to primary and secondary drinking water MCLs published by the Regional Board.

TCO was detected in MW-1, MW-2, and the Re-Reg Pond sample. The highest concentration was reported in the sample from MW-2 at 40 MPN/100 ml. FCO was reported only in the Re-Reg Pond sample. No FCO was detected in MW-1 or MW-2 samples. The nitrate-N concentration in MW-2 (26 mg/l) was above the water quality objective of 10 mg/l. Well MW-2 is located a few hundred feet southwest (topographic downgradient) from the Marble Springs Mine, a potential source for nitrates in groundwater. Nitrite-N was detected in MW-2 at 0.07 mg/l and in the Re-Reg Pond at 0.08 mg/l. TKN was detected in the Re-Reg Pond at 2.5 mg/l. The parameter TKN includes organically bound nitrogen and ammonia-N.

All water samples were analyzed for dissolved, not total values. The TDS in MW-2 (660 mg/l) exceeded the water quality objective of 500 mg/l. Electrical conductivity at MW-2 exceeded the objective of 900 umhos/cm. Both groundwater samples were below the lower water quality objective for pH (6.5) and the Re-Reg Pond sample was above the upper water quality objective for pH (8.5). No exceedance of a primary or secondary drinking water quality limit for metals or non-metals, chloride, or sulfate was reported in the water samples. Calcium and magnesium concentrations were highest in MW-2. Sodium and potassium were highest in the Re-Reg Pond. Manganese was detected in MW-1 and MW-2 at the secondary water quality objective of 0.05 mg/l. No manganese was detected in the Re-Reg Pond. Barium in groundwater is an order of magnitude greater than in the Re-Reg Pond. Boron was highest in the Re-Reg Pond. No iron or arsenic were detected in any sample. Total alkalinity in groundwater was present as bicarbonate. In the Re-Reg Pond, total alkalinity is present primarily as carbonate due to high pH. The concentration of TOC was highest in the Re-Reg Pond at 6.9 mg/l. The concentration in MW-1 was 0.60 mg/l and in MW-2 was 1.7 mg/l. No other exceedance of water quality objectives was noted.

Cation-anion balances ranged from 0.6 to 1.4 relative percent difference indicating that laboratory data meets quality assurance/quality control measures. The relative percent difference for the sample from the Re-Reg Pond was poor, at 12.4. The laboratory analyses data are tabulated in the Appendix D.

The isotope data on Figure 5 plot on the meteoric water line (Craig, 1961)[1], indicating all the water samples formed from precipitation. Non meteoric processes, such as exchange with minerals, evapo-concentration, and condensation would cause excursions from the meteoric line, but that is not the case at the WWTP. The plot position of different water samples along the meteoric line are related to the

[1] Craig, Harmon, 1961, "Isotopic variations in meteoric waters", *Science* **133** (3465): pp. 1702–1703.

latitude of formation (Gat, 1980)[2]. Temperature, altitude, and distance from the ocean also affect the isotopic composition of precipitation. The isotopic composition of precipitation becomes lighter the further inland, the colder, and the higher the elevation relative to the ocean source. Snow is known to be significantly more depleted in D and ^{18}O than rain formed at similar latitude due to colder temperatures and the progressive depletions that occur from precipitation at lower elevations (Rayleigh effect). Samples with a light isotopic composition plot closer to the origin than samples with a heavy composition. This is used to differentiate water formed from precipitation at the WWTP from water formed farther inland and at higher elevations in the Sierra Nevada Mountains. The water from the Re-Reg Pond is more negative (depleted in heavier D and ^{18}O) relative to groundwater in wells MW-1 and MW-2. The 'lighter' water in the Re-Reg Pond relative to water from MW-1 and MW-2 indicates that the Re-Reg source is from a higher elevation and further east of the WWTP. The isotope data clearly distinguish the groundwater and Re-Reg water.

Groundwater sampled from MW-2 is of the poorest quality; however, based on the current data available it is not likely that discharges at the WWTP are the cause. Heterogeneous and poor water quality is common in foothills bedrock terrain. Re-Reg pond water has a lower nitrate concentration, and lower salinity that groundwater at MW-2. Isotope data clearly distinguish the two waters.

8.0 CONCLUSIONS

- The direction and magnitude of the groundwater gradient beneath the sprayfields at the WWTP was likely to the southwest in September 2010, although a third observation point was not available because the springs were dry.
- Coliform was detected in groundwater monitor wells; however, it is too early to conclude that this is caused by discharges at the WWTP. Coliform is a common constituent in monitor wells for several quarters after initial construction. No fecal coliform were reported in groundwater samples.
- Stable isotope data indicate groundwater is a different type than applied effluent from the Re-Reg Pond.
- Poor water quality reported at MW-2 does not appear to be from Re-Reg type water.
- No apparent impact to shallow groundwater is noted from the discharge of effluent to land at the WWTP.

9.0 RECOMMENDATIONS

Condor recommends that the Re-Reg Pond sample is analyzed for total concentrations, not dissolved, and that quarterly groundwater monitoring commence at the site.

10.0 LIMITATIONS AND SIGNATURE

This report has been prepared under the direct supervision of a Certified Engineering Geologist in the State of California. Conclusions presented in this report are professional opinions based on the information provided herein. The standard of care for all services performed or furnished by Condor is the care and skill ordinarily used by members of the environmental profession practicing under similar conditions at the same time in the same locality. Condor is not responsible for the accuracy and completeness of information collected and developed by others.

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[2] Gat, J.R., 1980, The isotopes of hydrogen and oxygen in precipitation, In: Handbook of Environmental Isotope, Geochemistry (P. Fritz and J.Ch. Fontes, eds.), Vol. 1: 22-48.

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Respectfully submitted,
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