

**RELEASE
CHARACTERIZATION REPORT
OXY CASCADE CREEK #697-15-54**

November 4, 2008

WALSH Project Number: 7830-180



Environmental Scientists and Engineers, LLC



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ACRONYMS AND ABBREVIATIONS

AMSL	above mean sea level
BTEX	benzene, toluene, ethylbenzene, xylene
COGCC	Colorado Oil and Gas Conservation Commission
HSA	hollow stem auger
IDW	investigative derived waste
MCL	Maximum Contaminant Level
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
µg/L	micrograms per liter
NOAV	Notice of Alleged Violation
OXY	OXY USA WTP LP
PID	photoionization detector
ppm	parts per million
Site	Cascade Creek #697-15-54 area
SVOC	semi-volatile organic compound
TDS	total dissolved solids
TVH	total volatile hydrocarbons
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USSCS	United States Soil Conservation Service
VOC	volatile organic compound
Well pad	Cascade Creek #697-15-54

EXECUTIVE SUMMARY

This Release Characterization Report has been prepared by Walsh Environmental Scientists & Engineers, LLC (WALSH) on behalf of OXY USA WTP LP (OXY) in response to a Notice of Alleged Violation 200193504 (NOAV) for an alleged release of E & P waste from OXY's Cascade Creek #697-15-54 well-pad (Site). The Site is located in Section 15, Township 6 South, Range 97 West of the 6th Principal Meridian, Garfield County, Colorado. Please refer to Figure 1, Appendix A. Contamination in the area was first identified at an unnamed spring (Spring 1) that is approximately 3,000 feet to the east of the Site but is not hydrologically connected to the Site (Figure 2). A second spring (Spring 2), which is the subject of the NOAV, is situated approximately 2,600 feet northeast of the Site, while a third spring (Spring 3) is approximately 2,500 feet northeast of the Site.

OXY has completed initial assessment of the subsurface conditions at the Site. No evidence of fluids being released from the Site was found. The former reserve pit at the Site was reclaimed in July 2008 by removing all fluids. The reserve pit walls were then pushed in and the pit backfilled. No evidence of contamination was observed during the pit closure or measured in a post-closure sample obtained from the former pit bottom. A hydrostatic test of the lined production pit at the Site (Pond 1) indicated no observable leakage.

No evidence of contamination of soil, soil vapor, shallow groundwater, or bedrock materials was encountered during the Site investigation. Analytical results from samples collected at the Site did not indicate the presence of detectable contamination.

In order to confirm these findings and to monitor off-Site conditions relative to the NOAV, OXY proposes to provide periodic monitoring of surface and groundwater for BTEX and TVH during the next year. Sampling points and analytes are designed to further verify the findings of this investigation. Specifically, OXY proposes the following:

- The on-site monitoring wells will be gauged monthly to assess the presence of water, and if water is present, will be sampled.
- Intermittent streams upgradient from the Spring 2 and Spring 3 locations will be checked monthly, and if water is present, will be sampled. These samples will be taken contingent on site accessibility and weather conditions.
- The Spring 2 and Spring 3 locations will be sampled and analyzed for BTEX, TVH, TDS, and major cations and anions (See Section 6 for recommended sample schedule). Produced data will be analyzed for statistical trends over time.
- In the event no contamination is indicated in the monitoring wells by June 2009 (after spring runoff), they will be abandoned upon concurrence of the Colorado Oil and Gas Conservation Commission (COGCC).

OXY requests from the COGCC monitoring data obtained in the vicinity by other operators. This information will be helpful in determining the source(s) of contamination identified in Springs 2.

OXY requests that the COGCC consider rescinding the NOAV for the 15-54 well pad.

RELEASE CHARACTERIZATION REPORT OXY CASCADE CREEK #697-15-54

1 INTRODUCTION

This Release Characterization Report (Report) has been prepared by Walsh Environmental Scientists & Engineers, LLC (WALSH) on behalf of OXY USA WTP LP (OXY) in response to Notice of Alleged Violation 200193504 (NOAV) for an alleged release of E & P waste from OXY's Cascade Creek #697-15-54 well-pad (Site). The Site is located in Section 15, Township 6 South, Range 97 West of the 6th Principal Meridian, Garfield County, Colorado (Figure 1). Contamination in the area was first identified at an unnamed spring (Spring 1) that is approximately 3,000 feet to the east of the Site but is not hydrologically connected to the Site (Figure 2). A second spring (Spring 2), which is the subject of the NOAV, is situated approximately 2,600 feet northeast of the Site, while a third spring (Spring 3), is approximately 2,400 feet northeast of the Site.

This report is an addendum to OXY's Form 27 submitted to the Colorado Oil and Gas Conservation Commission (COGCC).

1.1 Objectives

The objectives of this Report are:

- Describe the Site, the release, and the remedial activities OXY has conducted;
- Present the findings of the groundwater investigation, and,
- Present proposed monitoring.

2 RELEASE HISTORY

On July 17, 2008, Mr. Ned Prather contacted the COGCC to report the presence of contamination in his potable water spring (Spring 1). Initial reparations were made to provide an alternate potable water source for Mr. Prather's cabin and notices of alleged violations were issued to other operators in the area. A second spring location (Spring 2) was considered for Mr. Prather's domestic use; however, this spring later indicated the presence of contamination.

The COGCC subsequently issued the NOAV to OXY on August 11, 2008 for Spring 2. This investigation is one of several ongoing investigations being conducted to identify potential sources for contamination identified at the springs.

3 SITE PHYSICAL CHARACTERISTICS

Research of physical characteristics for the Site and surrounding areas was completed to assist in the release characterization process. The following sections provide physical characteristics and baseline information on the release area.

3.1 Site Description

The Site consists of a level area measuring approximately 150 feet by 220 feet (Figure 3). The former reserve pit was located along the western edge of the existing pad. This reserve pit was reclaimed in July 2008. The existing lined production pit (Pond 1), Facility ID #291974) is located on the eastern side of the existing well pad. Surface water flow on the well pad is generally toward the north. A drainage trench is located on the northwestern corner of the pad, and directs water from the well pad to the north. A drainage trench located along the entire eastern side of the existing pad directs any overflow from the well pad to the north as well.

The Site is situated near the top of a north-south trending ridge and was leveled to create a pad for drilling. Surface water flow away from the well pad is primarily along two drainages: a very steep southeast trending drainage adjacent to the southeastern corner of the well pad; and, a steep northeast trending drainage adjacent to the north side of the pad. The southeast trending drainage is upgradient from Spring 2, and constitutes the primary area of investigation. The northeast trending drainage is upgradient from Spring 3, which is crossgradient to Spring 2, and therefore this drainage constitutes the secondary area of investigation.

The existing well pad will eventually be extended on the eastern side, to provide a space for future production drilling activities. This extension is proposed to be constructed in the near future. Three of the monitoring wells were proposed for the eastern and northern side of the pad so the construction involved in the proposed extension could affect the monitoring wells. Prior to mobilization for monitoring well installation, OXY's construction contractor prepared an access road to reach the northern and eastern sides of the proposed pad extension. The road extends from the northwestern corner of the pad, along the northern and eastern sides of the existing pad, and is cut into native soils.

3.2 Regional Geology

The Site is located in the west-central part of Colorado on the Colorado Plateau, southwest of the White River geological uplift. Tertiary basalt flows cover much of the area south of the Colorado River. Land both south and north of the Colorado River contain bedrock of Cenozoic age including the Parachute Creek Member of the Green River Formation, which is an oil shale unit about 900 to 1,200 feet thick in this area. It consists of black, dark-brown, and dark gray, commonly laminated marlstone, which weathers to a light gray. The upper part of the member contains the thickest and richest oil-shale beds. The 2-6 foot thick Mahogany bed is a persistent bed of very rich oil shale within the Mahogany zone, which forms a sheer 80-100 foot thick cliff or ledge of rich oil shale within the upper part of the Parachute Creek Member. Cliffs in the area are formed by this unit.

Glacial deposits are widely distributed throughout the upland areas, and alluvium and stream-laid gravel and boulders form a broad belt along the Colorado River and its tributaries [U.S. Soil Conservation Service (USSCS, 1988)]. The Site is located just west of the Grand Hogback which separates the Colorado Plateau physiographic province from the White River Plateau to the northeast and the Sawatch Range to the southeast (Tweto, 1979). The Colorado Plateau is a relatively stable shelf area with no major mountain building episodes since the late Precambrian. It contains thick sequences of sedimentary rocks ranging in age from the late Paleozoic through the

Tertiary period (Press and Siever, 1974). The Colorado Plateau is punctuated with areas of Tertiary volcanic activity expressed by extrusive igneous deposits.

3.3 Site Geology

Bedrock at the Site consists of the Tertiary-aged lowermost Uinta Formation (sandstones and siltstones) and/or the upper Parachute Creek Member. The Parachute Creek Member in turn overlies the Tertiary-aged Wasatch and Ohio Creek formations, which outcrop in the lower valleys. These formations consist of siltstone, sandstone, claystone, and conglomerate. Bedrock exposed at the Site appears as a gray marlstone or shale, with portions that are massive, fractured, and fissile.

The bedrock at the Site is partially covered by alluvium and colluvium. This material is up to ten or more feet thick and in areas may contain unconfined groundwater. Colluvium exposed in roadcuts and excavations appears as a thin layer of cobbles in a sandy or loamy soil matrix on hill slopes grading into a thicker layer of fine alluvium near the bases of slopes. Streams in the area frequently have bedrock floors indicating an erosional environment.

3.4 Site Soil

Soils in the vicinity of the Site are mapped as Parachute-Irigul-Rhone association, 25-50% slopes to the east, and as the Northwater-Adel Complex, 5-50% slopes to the north. The Parachute soil on the slope has 10 inches of grayish brown loam overlying up to 15 inches of very channery loam overlying rippable fractured siltstone. The Rhone soil, near the toe of the slope, is a deep, well-drained soil formed in colluvium derived from sandstone and hard shale. It is very dark grayish brown loam to 10 inches overlying grayish brown channery loam to 39 inches, overlying brown very channery loam to 55 inches overlying rippable, fractured siltstone. The Adel soil is a deep, well-drained soil formed in colluvium, with dark grayish brown loam to 20 inches over brown clay loam to 31 inches, and brown clay loam to greater than 60 inches depth (USSCS, 1988).

3.5 Site Hydrology

Surface water hydrology in the Site vicinity consists of small intermittent or ephemeral drainages in the higher elevations that coalesce into larger drainages in the valley floors. The study area is located along a ridge that is about 8,650 feet above mean sea level (AMSL) at its highest points, and the Site is situated at approximately 8,632 feet AMSL (Figure 2). Spring 1 and Spring 2 are both located at approximately 8,240 feet AMSL. Spring 3 is also located in the Site vicinity, and is situated at the same approximate elevation. Spring 3 is located approximately 2,600 feet northeast of the Site. The three springs appear to be flowing from the same section of bedrock, based upon their similar elevations. The Site is situated on the divide of the drainage basins associated with Spring 2 and Spring 3, and is isolated from the Spring 1 drainage basin by a ridge.

Aquifers in the vicinity of the Site are typically divided in to alluvial or bedrock. The primary bedrock aquifer within the study area is within the Wasatch Formation (COGCC, 2007). Alluvial aquifers consist of saturated unconsolidated sediments. Alluvial aquifers occur in stream valleys and are typically in hydraulic connection with adjacent streams and springs.

The alluvial aquifer and the shallow groundwater flow (along fractures and bedding planes near the surface) were the predominant focus of the investigation. The alluvial aquifer in the Site vicinity is controlled by the surface topography of the underlying bedrock. Although bedrock underlying the Site has very low permeability, fractures in bedrock and along bedding planes may allow preferential flow and infiltration of water to underlying sections of bedrock.

The water table in alluvial aquifers intersects the stream channels, and sections of streams are defined by whether the stream is gaining or losing surface water to the aquifer. Sections of a stream may be both gaining and losing, depending upon the run-off conditions and the static water level, and typically will alternate between gaining and losing within the same channel.

3.5.1 Site Groundwater Flow Rates

This section presents some basic calculations that provide an estimate of time for groundwater to travel from the Site to Spring 2. Physical characteristics from the Site were used to determine relevant site specific parameters, including:

- The Site is 400 feet in elevation above Spring 2.
- The plan-view distance from the pit to Spring 2, following the centerline of the drainage, is approximately 2,600 feet.
- The total distance from Site to Spring 2 is therefore approximately 2,631 feet.
- The average gradient is approximately 400 feet per 2,600 feet or 0.154 feet/feet.
- The transport pathway is through alluvium and fractured marlstone.

The travel time for groundwater to move from the Site to Spring 2 can be calculated from the following equation:

$$v = K_s (i/\phi)$$

where: v = groundwater velocity

K_s = saturated hydraulic conductivity

i = groundwater gradient (0.154 feet/feet)

ϕ = aquifer porosity

The properties of cobbly sands are as follows:

$$K_s = 1.0 \times 10^{-2} \text{ cm/s}$$

$$\phi = 0.42$$

Using the site specific parameters yields an average velocity of approximately 0.004 cm/s or 10.4 ft/day and a travel time of approximately 253 days or about eight months from the Site to Spring 2.

The properties of fractured marlstone are estimated below:

$$K_s = 3.0 \times 10^{-5} \text{ cm/s}$$

$$\phi = 0.01$$

Using the site specific parameters yields an average velocity of 0.0005 cm/s or 1.3 ft/day and a travel time of 2,011 days, or around 5.5 years, from the Site to Spring 2.

So, depending on which geologic unit the groundwater would be moving through, groundwater is estimated to take between eight months and 5.5 years to reach Spring 2.

3.5.2 Site Hydrocarbon Flow Rates

The fluid released into the former reserve pit is composed of produced water and gasoline-like hydrocarbons (natural gas condensate). The effect of chemical retardation on hydrocarbons in groundwater is such that dissolved gasoline-like constituents will migrate more slowly within the aquifer because of their sorption to organic material. The alluvium travel velocity was used for these calculations to get an idea of the minimum travel time (the maximum travel time is infinity because some refined gasoline constituents are essentially immobile in groundwater). The relevant equation for determining the retardation factor (R) is:

$$R = 1 + (\rho/\phi) K_d$$

where: ρ (bulk density) = $2.65 \text{ g/cm}^3 \times (1-\phi)$
 K_d = the distribution coefficient
and to obtain the distribution coefficient (K_d):

$$K_d = K_{oc} f_{oc}$$

where: K_{oc} = the soil sorption coefficient for gasoline components
 f_{oc} = the organic carbon fraction of the aquifer

K_{oc} ranges between 64 and 40,000 (ATSDR, 1996) (in other words, the components of gasoline are somewhere between only slightly retarded and virtually immobile). A typical value for f_{oc} is 0.003.

Using these values gives a range of retardation between 1.7 and 440. This means that the gasoline-like components will travel between 1.7 and 440 times more slowly than the groundwater. Using the lower estimate of groundwater travel time yields a transit time for gasoline-like constituents to reach Spring 2 of over 14 months (1.7 times the water travel time of 253 days).

In summary, groundwater would take between eight months and five years to travel from the Site to Spring 2, depending on whether it travels through the alluvium or the marlstone. Assuming the predominant flow is within the alluvium, the dissolved phase gasoline-like constituents would take a minimum of approximately 14 months to travel from the Site to the spring, and would potentially continue to discharge from the spring for over 300 years, assuming no attenuation through chemical or biological oxidation. The range for dissolved phase gasoline-like constituents to migrate through the marlstone yields significantly longer periods. These calculations apply to dissolved phase constituents, and do not consider attenuation (dispersion, oxidation, and bioremediation).

4 REMEDIAL INVESTIGATION ACTIVITIES

The following remedial investigation activities have been conducted to further understand the extent and character of the Spring 2 contamination.

4.1 Reserve Pit Closure

During July 2008 the former reserve pit was reclaimed by removing all fluids and backfilling with soil. Approximately 400 barrels of produced water were placed into the former reserve pit between September 20, 2007 and November 2, 2007. In July, 2008, approximately 400 barrels of produced water were transferred from the former reserve pit to Pond 1, indicating no appreciable loss from the former reserve pit.

A soil sample of the base of the former reserve pit was obtained on September 2, 2008 and analyzed for BTEX and other COGCC Table 910-1 compounds. The sample was taken from a depth of two to three feet below grade, which was the reported approximate depth of the reserve pit at that location. None of the target analytes were outside of the table value standards. No BTEX or TPH was detected in the pit bottom sample. Sample data are summarized in Table 1, and laboratory analytical results are in Appendix B. The approximate location of the reserve pit is shown on Figure 4.

4.2 Hydrostatic Testing of Pond 1

OXY completed hydrostatic testing of Pond 1, a lined production pit located at the Site. Pond 1 is used to store production water for re-use. It had approximately 2.76 feet of water and 10 feet of free board measured from the southwest side slope during the test. The hydrostatic test was conducted following COGCC requirements during a 72-hour time frame which started on 9 September, 2008 at 13:06 and ended on 12 September, 2008 at 13:10. Four areas of the pit were painted with a blaze orange marking paint to show water levels in the pit at the start of the test. Photographs of the markings were taken as evidence of the water levels during the test. A Solinst electronic water level indicator was also used to measure the water level relative to an established benchmark. No production water was delivered to the pond during the test period. Precipitation reported by the National Oceanic and Atmospheric Administration web site for the town of De Beque, Colorado indicated approximately 0.5 inches precipitation during the test period. During the test period, the water level in the pit increased approximately 0.05 feet which is equivalent to 0.6 inches, similar to the reported precipitation during that time. The test indicated there are no leaks in Pond 1.

4.3 Surface Water Sampling

To date, a total of three sampling events have taken place at the Site. The sampling events were conducted on the following dates:

- August 13, 2008
- August 22, 2008
- August 27, 2008
- October 23, 2008

Surface water samples have been collected from three locations, which are all identified in the following table. The spring locations are depicted on Figure 2.

Sample Locations Descriptions

Sample Location	Location Description
Spring 2	Spring 2,600 feet east of Site
Spring 3	Spring 1,700 feet northeast of Site
In ground tank	Trough at Spring 2 location (not present at August 27 event)

Water samples were collected from the above locations and submitted for analysis of benzene, ethylbenzene, toluene, and total xylene (BTEX), as well as total volatile hydrocarbons (TVH). During the initial sampling events, selected samples were submitted for analysis of the complete list of analytes included in COGCC Table 910-1, in addition to dissolved RCRA metals by United States Environmental Protection Agency (USEPA) 6000-Series Methods, a full scan of volatile organic compounds (VOCs) by USEPA Method 8260, and semi-VOCs by USEPA Method 8270.

Petroleum hydrocarbons were detected in water collected from the Spring 2 and the In Ground Tank sampling locations, but were undetected in the sample collected from the Spring 3 location. Analytical results indicate benzene concentrations at the Spring 2 and the In Ground Tank location have ranged from below detection limit to five times the maximum contaminant level (MCL) of 0.005 mg/L (Appendix A). Other petroleum hydrocarbon constituents were detected, but at concentrations below their respective MCLs. Laboratory analytical data was tabulated and included in Table 2. The original and complete laboratory analytical reports are provided in Appendix B.

4.4 Soil Sampling

On September 17, 2008, personnel and equipment were mobilized for the installation of four monitoring wells. During the reconnaissance of the Site, freshly exposed soils were observed along the roadcut constructed along the north and the eastern sides of the well pad. A total of two soil samples were collected from the northern and northeastern sides of the pad. The samples, labeled SS-1 and SS-2, were collected from the base of the drainage trench constructed on the eastern side of the existing pad, and from discolored soils observed on the northern edge of the pad, respectively (Figure 3).

The soil samples were placed in glass jars, labeled, and placed in an ice-filled cooler to await shipment. Analytical results for all of the soil samples collected at the Site indicated concentrations were below detection limits. Sample results are summarized in Table 1 along with soil samples collected from the former reserve pit and during the boring installations on September 17 through 19, 2008, and the complete laboratory analytical report is included as Appendix B.

4.5 Monitoring Well Installation

The four groundwater monitoring wells were installed around the northeastern and southeastern perimeter of the Site using a track-mounted, limited-access drilling rig equipped with hollow stem auger (HSA), and rock coring equipment. Soil samples of unconsolidated materials were collected using a split-spoon sampler. The soil sampler was driven a total of 18 inches or until sample

refusal, and the total blow count (by dropping 140 pound hammer 30 inches) for each six inch interval recorded. Bedrock cores were collected from consolidated bedrock. The total core length was recorded and compared to the total cored interval. Cuttings and samples collected during the installation of the borings were described using Unified Soil Classification System and geological nomenclature. A photoionization detector (PID) was used to screen the headspace of soil and bedrock samples collected during the boring installations. The PID was also used to monitor worker breathing zones. PID readings were consistent with background levels in the vicinity of the drilling area, and never exceeded 1.0 part per million (ppm). Boring logs from each of the soil borings are included in Appendix C.

MW-1 was installed on the edge of the existing well pad, and 15 feet of overburden were penetrated before entering native soil. MW-2, MW-3, and MW-4 were installed on native soil outside of the proposed extension to the existing well pad. Locally, soils included approximately two to three feet of sandy clay loam, overlying three feet of weathered bedrock. The HSA drilling met refusal at the competent bedrock contact, where rotary coring began, and continued to the total boring depth. Geology encountered was predominately sandstone and claystone, with thin interbedded coal seams. Cleats and fractures were also identified during drilling, where adjoining materials tended to be moist to saturated.

The first water was encountered within the upper two feet of bedrock, and appeared to be flowing along cleats in the coal. A saturated zone of weathered bedrock possibly associated with fractures or a contact surface was encountered approximately 15 feet below the first water. The monitoring wells were screened to include both the first water encountered, and the shallow saturated water zone. The total depth of the boring was limited to these zones to reduce the risk of the wells becoming conduits for the cross-contamination of deeper water bearing zones. The monitoring well schematics are included in Appendix C.

The monitoring wells were gauged following a 72-hour waiting period, and all four were dry, and could not be sampled for groundwater. Vapor readings were collected using a ten foot extension tube on the PID. Several tubing volumes of air were purged and PID readings consistently indicated volatile organic vapor concentrations below background levels.

A total of six samples were submitted to the laboratory for analysis of BTEX and TVH. The six sub-surface soil grab samples (MW-1-1, MW-1-2, MW-1-3, MW-2, MW-3, and MW-4) were placed in glass jars, labeled, and placed in an ice-filled cooler to await shipment. Analytical results for all of the soil samples collected at the Site indicated concentrations below detection limits. Sample results are summarized in Table 1, along with soil samples collected on September 17, 2008, and the complete laboratory analytical report is included as Appendix B.

4.5.1 Investigative Derived Waste

Investigation derived waste (IDW) was generated at the Site, and consisted of drill cuttings and cores. The cuttings and cores were screened using a PID to monitor volatile organic vapors. PID readings for the drill cuttings indicated volatile organic vapor concentrations below background levels. Drill cuttings were placed with soil storage piles currently located on the Site for use during the regrading and future reclamation processes.

5 DISCUSSION

5.1 Subsurface Investigation

Monitoring wells were installed at locations surrounding the pad that were considered most likely to contain groundwater potentially impacted by site operations (Figure 3). These wells were advanced through the shallow alluvium and into the bedrock, with continuous cores of soil and bedrock recovered and inspected. No indications of petroleum hydrocarbons were encountered during the investigation. 1.5-inch PVC monitoring well casing was installed in each boring. No water has appeared in any well as of the date of this report. Soil vapor samples obtained in each well revealed no measurable volatile organic compounds.

5.2 Near-Surface Soil Sampling

Two shallow soil samples (Figure 3) were obtained in a fresh road cut at locations most likely to have been potentially impacted by surface releases on the pad. Neither sample had indications of petroleum hydrocarbons (see Table 1), indicating no evidence of a release of hydrocarbons on the pad that migrated off of the pad to the sampled locations.

A soil sample of the base of the former reserve pit was obtained. None of the target analytes were outside of the table value standards. No BTEX or TPH was detected in the pit bottom sample.

Table 1. Soil Sample Results

Sample Number	Sample Depth (ft bgs)	Benzene (mg/Kg)	Toluene (mg/Kg)	Ethyl benzene (mg/Kg)	Xylene (mg/Kg)	TVH (mg/Kg)
Reserve pit	2-3	<0.0025	<0.025	<0.0025	<0.0075	<4.0
SS-1	0.25-0.5	<0.0025	<0.025	<0.0025	<0.0075	<0.5
SS-2	0.25-0.5	<0.0025	<0.025	<0.0025	<0.0075	<0.5
MW-1-1	7	<0.0025	<0.025	<0.0025	<0.0075	<0.5
MW-1-2	17	<0.0025	<0.025	<0.0025	<0.0075	<0.5
MW-1-3	26	<0.0025	<0.025	<0.0025	<0.0075	<0.5
MW-2	0.5	<0.0025	<0.025	<0.0025	<0.0075	<0.5
MW-3	12	<0.0025	<0.025	<0.0025	<0.0075	<0.5
MW-4	8.5	<0.0025	<0.025	<0.0025	<0.0075	<0.5

Notes: Sample results did not exceed detection limits
bgs below ground surface
ft feet
mg/Kg milligrams per kilogram
TVH Total Volatile Hydrocarbons

5.3 Surface Water Sampling

The springs nearest the pad were sampled, and Spring 2 was found to contain BTEX compounds (see Table 2). The concentration of benzene in Spring 2 exceeds the state surface water standard. Benzene concentrations in Spring 2 increased from <0.0010 mg/L on August 13, 2008 to 0.044 mg/L on August 27, 2008.

Produced water in the on-site pond (Pond 1) has petroleum constituents consistent with produced water. This water exceeds drinking water standards for benzene, toluene, and xylenes, and may exceed other drinking water standards.

Table 2. Surface Water Sample Results

Sample Location	Sample Date	Benzene (mg/L)	Toluene (mg/L)	Ethyl benzene (mg/L)	Xylene (mg/L)	TVH (mg/L)
MCL		0.005	1.0	0.7	1.4	NA
Spring 2	8/13/08	<0.0010	<0.0050	<0.0010	0.0058	<0.5
IGT	8/13/08	<0.00050	<0.0050	<0.00050	<0.0015	<0.10
Spring 3	8/13/08	<0.0010	<0.0050	<0.0010	<0.0030	<0.5
Pond 1	8/13/08	3.2	5.4	0.13	2.6	NA
Spring 2	8/22/08	0.041	<0.0050	0.0041	0.041	0.18
IGT	8/22/08	0.052	<0.0050	0.0051	0.05	0.23
Spring 2	8/27/08	0.044	<0.0050	0.0042	0.043	0.27
Spring 2	10/23/08	<0.00050	<0.0050	<0.00050	<0.0015	<0.10

Notes:

mg/L	milligrams per kilogram
TVH	Total Volatile Hydrocarbons
MCL	Maximum Contaminant Level
IGT	In ground tank at Spring 2 location
NA	Not Available
BOLD	indicates sample exceeds MCL

During the August 13 and October 23, 2008 sampling events, water samples were also collected for analysis of cations and anions indicative of produced water (Table 3). These constituents are leading indicators of contamination, and typically will precede the appearance of petroleum hydrocarbons, including BTEX constituents. Concentrations of these parameters were observed in both the Spring 2 and the Spring 3 samples. Concentrations indicated in the Spring 2 sample were more than double those indicated in Spring 3.

The results for Spring 3 indicate increases in TDS and several of the other analytes; however, the results were consistent with concentrations observed in the Site vicinity. Inconsistencies in the data may in part be attributed to decreased water flow in the vicinity of the springs since August. The cation and anion data is not statistically significant, due to the limited amount of data.

Table 3 - Surface Water Sampling Results – Anions / Cations							
Client Sample ID			SPRING 2	SPRING 2	SPRING 3	SPRING 3	POND 1
Collect Date			8/13/2008	10/23/2008	8/13/2008	10/23/2008	8/13/2008
Method	Parameter	Units	Value	Value	Value	Value	Value
9056	Chloride	mg/l	280	660	44	140	5700
9056	Fluoride	mg/l	<0.10		<0.10		<2.0
9056	Sulfate	mg/l	38	5.2	6.1	58	<5.0
2320B	Alkalinity	mg/l	270		330		640
2320B	Alkalinity, Carbonate	mg/l	<10		<10		<10
9040C	pH	su	7.5		7.6		6.7
2540C	TDS	mg/l	1400	1400	420	560	10000
6010B	Arsenic	mg/l	<0.020		0.025		<0.020
6010B	Barium	mg/l	0.3		0.2		31
6010B	Calcium	mg/l	130	180	70	93	160
6010B	Chromium	mg/l	<0.010		<0.010		0.019
6010B	Magnesium	mg/l	46	56	28	37	31
6010B	Sodium	mg/l	94	210	44	64	3400

6 CONCLUSIONS AND RECOMMENDATIONS

OXY has completed initial assessment of the subsurface conditions at the Site. No evidence of fluids being released from the Site was found. The former reserve pit was reclaimed in July 2008 by removing all fluids. The pit walls were then pushed in and the pit backfilled. No evidence of contamination was observed during the pit closure. A hydrostatic test of Pond 1 (a lined production pit located at the Site) was also conducted in September, which indicated no observable leakage.

No evidence of contamination of soil, soil vapor, shallow groundwater, or bedrock materials were encountered during the site investigation. Analytical results from samples collected at the Site did not indicate the presence of detectable contamination entering the environment. Based on this information, there is no evidence of a release of produced water or condensate from the OXY 15-54 pad to the environment.

Surface water samples collected at Spring 2 indicate detectable concentrations of benzene and petroleum hydrocarbons. Based on this investigation, there is no evidence that contamination at Spring 2 originated from OXY operations.

In order to confirm these findings and to monitor off-site conditions relative to the NOAV for this site, OXY proposes to provide periodic monitoring of surface and groundwater for BTEX and TVH during the next year. Specifically, OXY proposes the following:

- The on-site monitoring wells will be gauged monthly to assess the presence of water, and if water is present, will be sampled.
- Intermittent streams upgradient from the Spring 2 and Spring 3 locations will be checked monthly, and if water is present, will be sampled. These samples will be taken contingent on site accessibility and weather conditions. Monitoring frequency will increase in the spring, as indicated in the schedule below.
- The Spring 2 and Spring 3 locations will be sampled based on the schedule below and will include collection of analyzed for BTEX, TVH, TDS, and major cations and anions. Produced data will be analyzed for statistical trends over time. Monitoring frequency will increase in the spring, as indicated in the schedule.

PROPOSED SAMPLING SCHEDULE

Sampling Date	Field Parameters			TDS	BTEX	TVH	Anions/ Cations
	pH, Temp, Conductivity	ReDox	DO				
11/6/08	x	x	x	x	x	x	x
12/04/08	x	x	x	x	x	x	
1/2/09	x	x	x	x	x	x	
1/29/08	x	x	x	x	x	x	
2/26/09	x	x	x	x	x	x	x
3/11/09	x	x	x	x	x	x	
3/18/09	x	x	x	x	x	x	
3/25/09	x	x	x	x	x	x	
4/2/09	x	x	x	x	x	x	x
4/9/09	x	x	x	x	x	x	
4/16/09	x	x	x	x	x	x	
4/23/09	x	x	x	x	x	x	
4/30/09	x	x	x	x	x	x	x
5/7/09	x	x	x	x	x	x	
5/14/09	x	x	x	x	x	x	
5/21/09	x	x	x	x	x	x	

Sample collection will depend upon the presence of available, flowing water at the sampling location, as well as accessibility of the sample locations. Schedule will resume to monthly monitoring once two sampling events are conducted during the spring run-off.

Notes: TDS total dissolved solids
BTEX benzene, toluene, ethylbenzene, and total xylenes
TVH Total Volatile Hydrocarbons

- In the event no BTEX or TVH constituents are detected above their respective MCL during the spring runoff, the monitoring wells will be abandoned by June 2009 upon concurrence of the COGCC.

OXY requests monitoring data obtained in the vicinity by others operators. This information will be helpful in determining the source(s) of contamination identified in Springs 2.

OXY requests that the COGCC consider rescinding the NOAV for the 15-54 well pad.

7 REFERENCES

ATSDR. Toxicological profile for polycyclic aromatic hydrocarbons (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. 1996.

Colorado Oil and Gas Conservation Commission (COGCC). 900 Series Rules. Exploration and Production Waste Management. 2007.

COGCC. 2007. *Piceance Basin Phase IV Baseline Water Quality Study, Garfield County, Colorado*. Prepared by S.S. Papadopoulos & Associates, Inc. for the Colorado Oil and Gas Conservation Commission. February 9, 2007.

Press, Frank and Siever, Raymond. 1974. *Earth*. W.H. Freeman and Company, San Francisco.

Tweto, Ogden. 1979. *Geologic Map of Colorado*.