COLORADO
Oil & Gas Conservation Commission
Department of Natural Resources

1120 Lincoln Street, Suite 801
Denver, CO 80203

20 September, 2016

Shawn Hagler
14757 County Road 26
Fort Lupton, CO 80621

Re: Complaint 200439757

Shawn,

Your formal complaint filed with the online tool raised two issues. The first issue concerned lack of effective stormwater management practices on property neighboring yours that had "used" bentonite drilling mud applied to what is now (summer of 2016) a wheat field. The second issue concerned possible changes to shallow groundwater levels under your home possibly caused by activities at nearby facilities operated by Kerr McGee Oil and Gas Onshore LP (KMG).

In later discussions and communication with you a third and a fourth issue (or concerns) were raised. The third issue raised was possible impacts to groundwater accessed by your domestic water well. The fourth issue is related to issue two above in that you observed and reported to COGCC that a hydrocarbon layer was present on top of water in one of five sumps present in your basement. You suggested that the hydrocarbons were indications of impacts to shallow groundwater under you home from spills or releases of produced hydrocarbons at nearby exploration and production activities.

The organization of the letter is to address each of the four issues in the order described above. Details and results of the COGCC investigation of your complaint issues will be presented along with conclusions regarding possible impacts from nearby exploration and production (E&P) operations and possible violations of COGCC rules and policies.

STORMWATER and WASTE MANAGEMENT ISUUES

Your home and land at 14757 County Road 26 in rural Weld County adjoins a property to the east which was approved as a land application site for water-based bentonite drilling mud by notice in 2011 (document 1814724). The site is labeled as Drill Green Beneficial Reuse site (facility 422057) in the COGCC database. The location of this now inactive site in relationship to your property and home are shown in Figure 1 below. Approximately 0.25 miles east of your property is an active centralized exploration and production (E&P) waste management facility (149021) approved in 2008. Disposal of drilling mud by land application is also done at this site by KMG and this use is visible on the 2015 aerial image as shades of gray inside the box drawn around the edge of facility 149021.

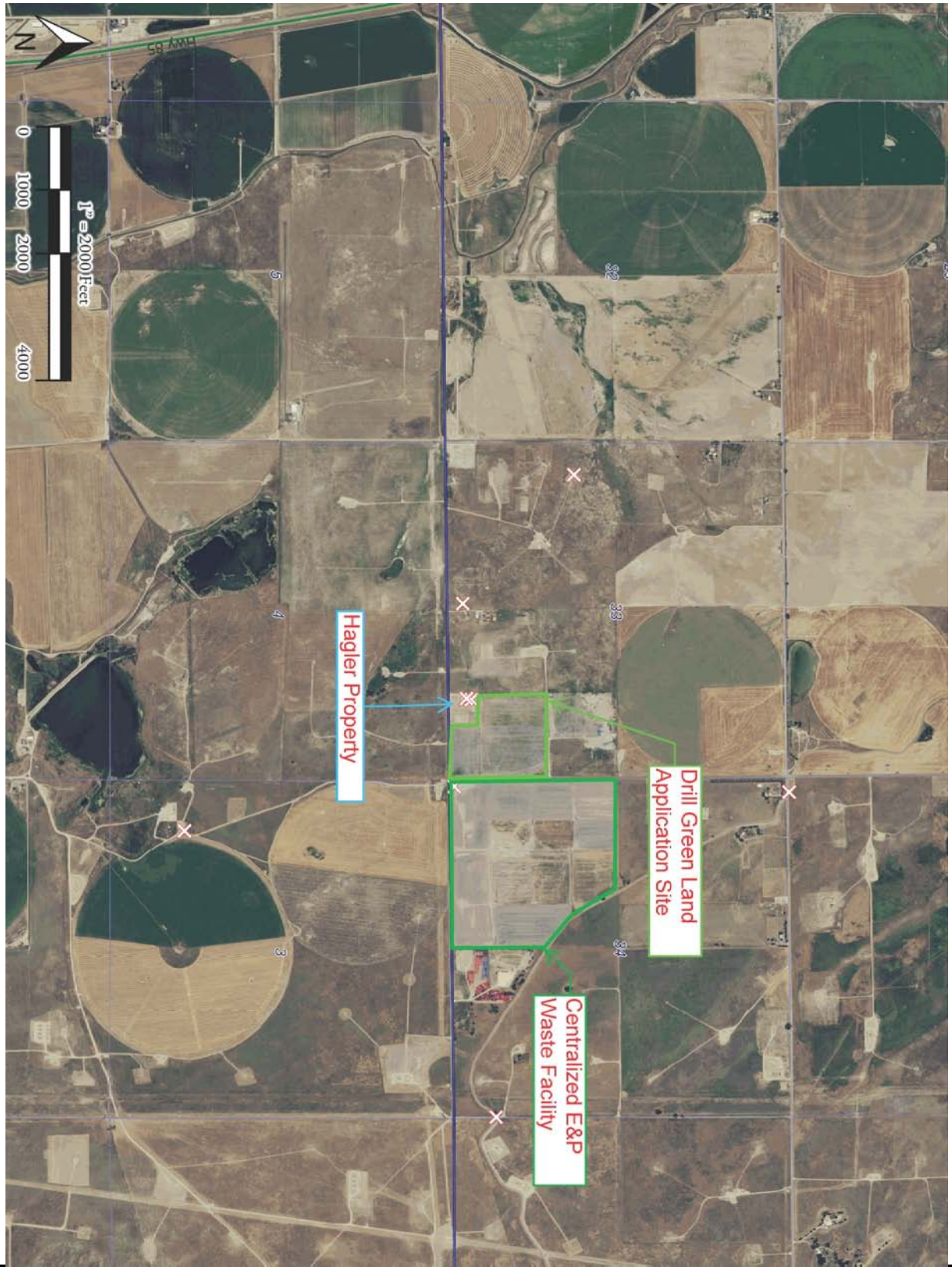

Figure 1. 2015 Aerial Image showing Hagler property and Facility 422057 (Drill Green) and nearby centralized E&P waste management facility 149021.

A field inspection documenting the migration of bentonite onto your property and reflecting conditions as observed on 10 June 2016 was entered into the COGCC database (Field Inspection Report 678300349) and issued to KMG on that day. You had expressed your complaint informally to me on the phone on 9 June 2016 prior to filing a complaint on line several days later. The corrective actions listed in that inspection and required of the operator included removal of the migrated bentonite sediments from your property. A photo illustrating the presence of gray bentonite mud accumulation in the corral at the east end of your property was attached to the inspection report as document 678300352 and is below as Figure 2. Other photos documenting sediment migration and erosion issues on 10 June 2016 were attached to the inspection report and can be found on the COGCC database as documents 678300350, 678300351, 673800353 and 678300354.

Figure 2. Accumulation of bentonite mud in corral. View is to SW with land application site 422057 to east and with sediment and stormwater migration from east.

The accumulated bentonite mud was removed from your property by contractors to KMG after consultation and approval by you of the process. The operator stated that those repairs had been completed in an email (28June, 2016) and you also stated in an email on the same day that the operator had cleaned up the muds on your property and graded the yard.

Land application site facility 422057 was re-inspected on 29 June 2016 (document 678300413) with removal of mud and repairs to erosion cut channels noted. Before and after photos are below in Figure 3 (before) and Figure 4(after) for comparison.

Figure 3. Erosion cut from facility 422057 from east into corral shown in Figure 2 (10 June2016).

Figure 4. View from east into corral after actions by operator.

The repairs did not prove to be effective in controlling erosion and stormwater flow caused migration of muds and materials placed on neighboring facility 422057 as documented in another follow-up

inspection on 4 August 2016 (document 678300494). Observations at that inspection were that the small berm at the fence line seen in Figure 4 above had not been adequate as a long term erosion control and that the berm had been breached in subsequent precipitation events. Corrective actions included in the inspection included developing and implementing long term erosion controls to minimize transport of muds off the land application site. A photograph of the site on 4 August 2016 is attached to the inspection report and can be downloaded from the COGCC web site (document 678300495).

The owner and/or the tenant farmer of the agricultural property on which land application facility 422057 is located graded and altered the contours of parts of the property subsequent to the 4 August 2016 inspection. Stormwater runoff diversion trenches were added to control sheet flow and subsequent channel flow in larger precipitation events from reaching your property. These changes were noted in a third follow-up inspection (678300522) performed on 7 September 2016. Three diversion ditches are visible in Figure 5 below and online in document 678300523 to prevent sheet or channelized flow of stormwater on the east side of your property. Two stormwater diversion trenches were constructed on the north side of your property to prevent sheetflow or channelized flow into the other portion of your property that abuts the land application site (Figure 1). A photo of those diversion trenches can be found on the COGCC website as document 678300524.

Figure 5. Three stormwater diversion ditches are visible looking southwest from the well. Land application site 422057 surrounds the well. The lights visible at the upper left are on the edges of the corral shown on Figures 2, 3 and 4.

The diversion trenches constructed at land application site 422057 are considered adequate (at current time) to prevent erosion of the wastes incorporated into soils. The prevention of erosion and subsequent migration of E&P wastes offsite is required by the COGCC Policy on Drill Cuttings Management published on 15 September 2014 and in general by COGCC rules. The operator stated they ceased use of this facility more than 18 months ago and requested closure on the facility by submission of sundry notice (document 401080387). Conditions of approval of the site closure include satisfactory inspection by COGCC reclamation staff. This issue in your formal complaint is considered closed at this time without enforcement actions against KMG as adequate corrective actions were completed and were completed in timely manner.

SHALLOW GROUNDWATER ELEVATION CHANGES

Your formal complaint stated that for the last few years your basement has been flooding and this problem did not occur when you purchased the home in 2011 (Weld County records). You provided more information in an email on 6 July 2016. You clarified in that email that the elevated groundwater causing issues with flooding in your basement were seasonal in nature and with no problems occurring in colder parts of the year when the ground likely is frozen.

Samples of water were collected from a newly constructed (2016) sump in the northwest corner of your home by COGCC staff on 20 June 2016. A sample of surface water was also collected on 20 June 2016 from a retention pond at the southwest corner of the centralized E&P waste management facility to the east of your home. The approximate locations of these two samples are shown on the map (Figure 6) with **X** labels and labeled as sump samples and retention pond. Paper copies of the analytical results were provided to you previously by hand delivery to your home and are included in this letter with other analytical data from ALS Laboratories (Appendix 2). Copies of all the analytical reports associated with this complaint can be downloaded from the Docs tab associated with complaint 200439757. All analytical data gathered in this complaint investigation has also been uploaded to the COGCC environmental database and the data can be accessed through the GIS application on the COGCC web site when the sample sites layer is activated.

There are significant differences in the major ion composition between the retention pond sample and the sump sample (20 June2016 sampling). The concentrations of chloride and sulfate were 5-10 times less in the retention pond sample than in the NW sump sample. Concentrations of sodium and calcium were 3-5 times greater in the NW sump sample than in the retention pond sample. Nitrate was not detected (<0.06mg/l) in the retention pond sample and was reported as present at 69mg/l in the NW sump sample. Elevated concentrations of nitrate oftentimes indicate communication between the groundwater sampled and septic tanks or leach fields nearby. Agricultural sources of elevated nitrate concentrations such as livestock pens also occur. You have both likely potential sources of nitrate on your property. Your home does have a septic tank/leach field to the south of your house and you keep cattle and horses in areas close to your home.

As part of this investigation, I searched for available depth to shallow groundwater information in the vicinity of your home. Remediation projects at two sites near your home with multiple shallow monitoring wells did have depth to water measurements available. Both of the locations are shown on the topographic map (Figure 6) with labels of 10MW and 18MW. The 10MW site formerly had compressor operations on the facility. The 18MW site currently has compressor operations at the facility. Spills/releases of produced hydrocarbon liquids at each site were responsible for groundwater impacts with exceedances of groundwater standards for benzene and other aromatic hydrocarbons present in condensates and oils produced from oil and gas wells in the area.

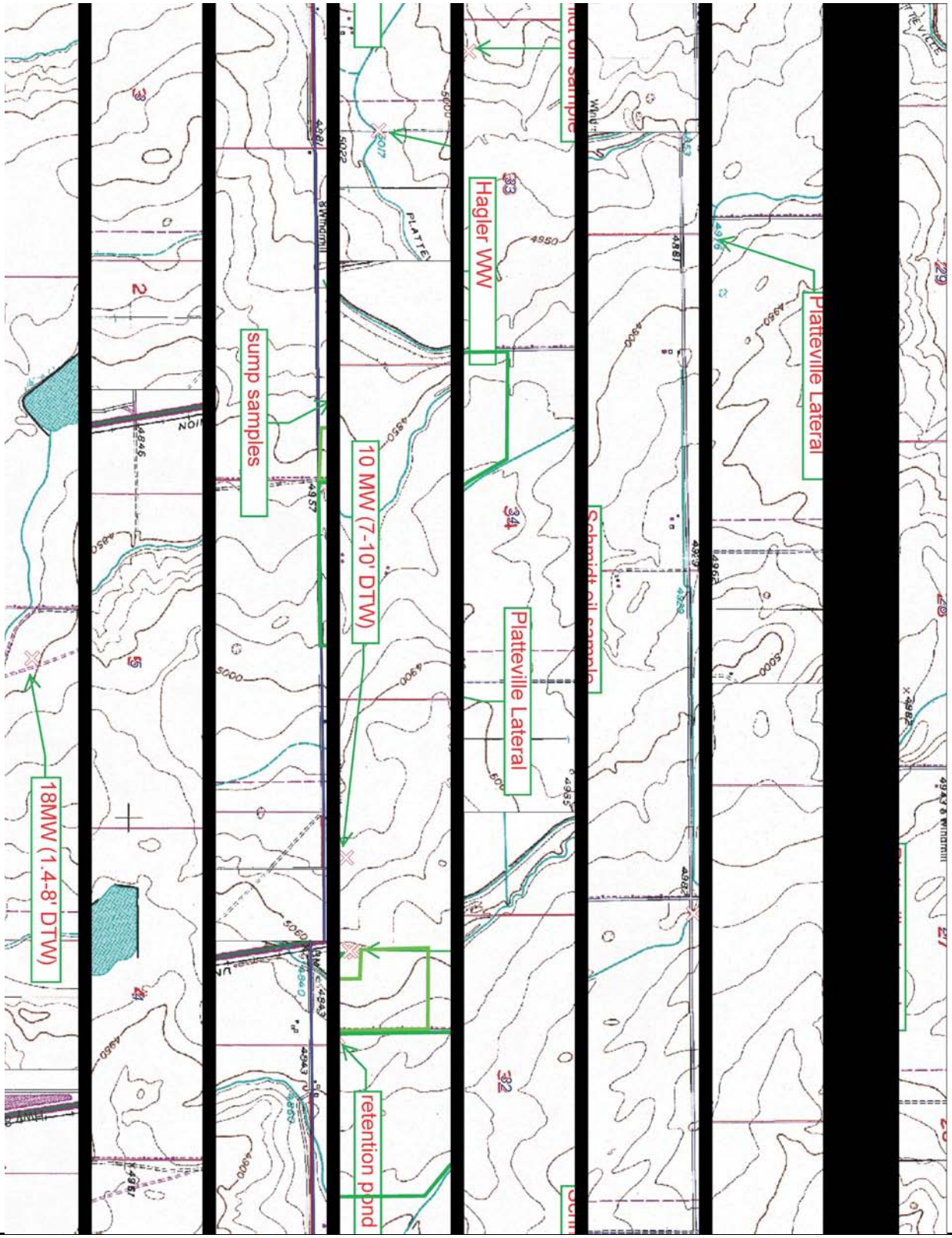

Figure 6. Topographic map with locations of facilities and sites sampled or mentioned in this letter indicated with X. Contour interval is 10 feet. Approximate elevation of land surface prior to construction of your home was 4940 ±5 feet. The 4950 elevation contour lies east of your home and runs in a generally N-S trend.

The closer site labeled on the map as 10MW is approximately 1600 feet west of your home and also is approximately 25 feet lower elevation than your home. The report associated with the closer site is from monitoring in 2000. Ten monitoring wells were installed. Depth to shallow groundwater was reported as between 7-10 feet below ground surface with an assumed flow direction to the west (downhill) towards the Platte River Valley (Remediation Project 668 document 1443460).

The second site with multiple depth of shallow groundwater measurements available for review is labeled on the map as 18MW and is located approximately 4900 feet southeast of your home and is at an elevation of 5-10 feet above your home. Some monitoring wells were drilled as early as 1990 at this site with depth to water as shallow as 2.5 feet below ground surface as indicated in monitoring well construction reports available from the Colorado Division of Water Resources web site (for example permit number 037469-M). In 2015 and 2016, depth to water shallow groundwater was between 1.4 to 8 feet below ground surface at 18 wells monitored (Remediation Project 9520 document 2526350) with flow direction interpreted as generally to the west from water table elevations surveyed as part of the ongoing site investigation and remediation project.

The measured depth to shallow groundwater at these two remediation sites indicate there is now and has been for 25 years or more a potential for the occurrence of very shallow groundwater in the area around your home. The data from 1990 and from 2000 are prior to your purchase of the property at 14757 County Road 26. The measurements available from 1990 and 2000 also predate the use of the Drill Green land application facility (422057) or the centralized E&P waste management facility 149021 by several years. The precise depth of excavation prior to foundation construction of your home is not known to me but Weld County Assessor's office records indicate that your basement is 9ft height. For comparison to measured depth to shallow groundwater in the area and from my observations at your home I concluded that 5-6 feet of your basement is below current ground surface around your home with sumps of an additional depth of 2-3 feet for an assumed total depth of 7-9 feet below ground surface. Your basement and associated sumps are as deep as shallow groundwater in the general area of your home from records that are available for inspection.

The operator has stated (sundry notice 400757908) that by early 2015 approximately 9226 cubic yards of drilling mud and associated cutting had been applied at the Drill Green land application site over an area approximately 40 acres and have verbally indicated the site was not used by them after that report. By calculation that is an application of less than 2 inches thick of material over the 40 acre site. The materials applied presumably contained some moisture but certainly contained a significant fraction of solids. Thus at most the water table could only have been changed by less than 2 inches over the area around your home by land application of drilling mud and cuttings if the operator had applied only water to the soils.

The operations of KMG nearby your home do not involve long term storage of or treatment of large volumes of water. The operator does have small scale produced water tanks at several sites in the area. These are typically less than 100 barrel capacity. In the area around your home there have been no reports of spills of very large volumes of water that might locally alter groundwater levels significantly in the years since you have owned your property. The reported volume of mud and cuttings applied at the Drill Green site is equivalent to 1.8 million gallons or 44 thousand barrels of water. In 2015, for comparison, the sum of produced water spills reported to COGCC from the entire state was about 27 thousand barrels of produced water. As a general observation there are only two potential sources of the shallow groundwater around you home that would have potential to alter groundwater elevations under your home. One is the quantity of precipitation falling on your area. The second potential source of groundwater in the area is irrigation water brought into the area and

applied to crop fields in your area. Neither of those potential sources of significant amounts of groundwater is related to oil and gas exploration and production operations.

A number of papers published by the United States Geological Survey (USGS) document the high contribution of irrigation waters to recharge of shallow groundwaters in unconfined aquifers of the Denver Basin and are summarized in Quality of Groundwaters in the Denver Basin Aquifer Systems, 2003-5 (USGS Scientific Investigations Report 2014-5051, Musgrove *et al*., 2014). Your observation that there are seasonal changes in groundwater elevations under your home indicates to me that both seasonal precipitation patterns and seasonal irrigation practices could be impacting the elevation of groundwater around your home. At present oil and gas operations nearby are not significant contributors (if contributors at all) to shallow groundwater water quantity in your area from my observations in the area.

USGS researchers (Paschke, 2011) concluded in Groundwater Availability of the Denver Basin Aquifer System (USGS Professional Paper 1770) concluded that less than 10% of the annual precipitation in the Denver Basin reaches the subsurface as recharge which tends to indicate larger relative contributions to recharge from irrigation in areas where intensive irrigated agricultural land use exists. Review of the aerial image (Figure 1) of the area around your home shows several circular crop fields that have now or have had center pivot irrigation systems so irrigation contributions could be significant sources of water to the shallow groundwater system near your home. Use of these irrigations systems is typically seasonal and done in the months without frozen ground.

COGCC staff members have conducted more than 30 inspections of oil and gas facilities in the area near your home since you raised this issue in early June. No spills or releases were noted in the inspections and any corrective actions related to observed conditions at the oil and gas facilities have been completed by operators. Based on the data available the complaint issue related to changes in groundwater elevation related to operation of the nearby Drill Green land application site is considered closed with no findings of violations of COGCC rules or policies related to water storage or disposal practices.

DOMESTIC WELL GROUNDWATER QUALITY

I visited your property in southern Weld County on 20 July 2016, to collect water samples from the domestic water well on your property. Samples were collected from the well using the installed submersible pump from an outdoor frost-proof hydrant nearby. The well had been in use for normal household activities that morning. More than 120 gallons of water were purged from the well before samples were collected. I did note effervescence in the water but did not note any odors or sediment in the water during the purge of the well. Samples were collected from the deeper (≈3feet) sump in the southwest corner of your basement. Samples of water from a nearby irrigation ditch were also collected at two sites on this day. The locations of the irrigation ditch samples are indicated on the topographic map (Platteville Lateral). Portions of the samples from your domestic water well, the sump sample and samples from the irrigation ditch for general inorganic, semi-volatile organic and volatile organic analyses were delivered to ALS Laboratory Group in Fort Collins, CO and received on 20 July 2016. These samples were stored and delivered on ice with custody seals. Samples for gas composition and isotopic analyses were stored on ice and delivered to the DIG facility in Thornton, Co on 25 July 2016.

COMPARISON OF INORGANIC ANALYTICAL RESULTS TO CDPHE INORGANIC STANDARDS

The Water Quality Control Commission (WQCC) of the Colorado Department of Public Health and Environment (CDPHE) has established "Domestic Water Supply - Human Health standards" (Table 1) and Domestic Water Supply - Drinking Water standards" (Table 2) within their Regulation 41 "The **Basic** Standards for Groundwater" (5CCR 1002-41). The COGCC is an implementing agency of the groundwater standards for impacts associated with oil and gas exploration and production activities. Analytical data for the recently collected samples from your domestic water well were compared to these standards. This information is summarized in Table 1 which is located in Attachment 1 and discussed in narrative form below. COGCC records indicate your domestic water well was sampled in 2014 and in 2015. Please keep in mind that these "Domestic Use-Quality Standards" are analogous to but not the same as standards established for **municipal or public** drinking water supplies and oftentimes people use and consume ground water from private wells that exceed these standards. The groundwater standards are different in concept than the rules and standards adopted for public supply systems but many of the threshold concentrations are identical. Paper copies of the reports from ALS Laboratories are included as Attachment 2. Paper copies of the reports from Dolan Integration Group are included as Attachment 3.

- **Antimony (Sb):** The CDPHE human health standard for antimony is 0.006mg/l. Antimony is a contaminant metal.

  Antimony was not detected in the sample from your domestic water well (2016).

- **Arsenic (As):** The CDPHE human health standard for arsenic is 0.01 mg/l. Arsenic is a highly poisonous metal.

  Arsenic was not detected in the sample from your domestic water well (2016).

- **Barium (Ba):** The CDPHE human health standard for barium is 2.0 mg/l. Barium is a contaminant metal.

  Barium was detected in the sample from your domestic water well at a concentration of 0.075mg/l, which is below the CDPHE human health standard (2016).

- **Beryllium (Be):** The CDPHE human health standard for beryllium is 0.004mg/l. Beryllium is a contaminant metal.

  Beryllium was detected in the sample from your domestic water well at a concentration of 0.00076mg/l, which is below the CDPHE human health standard (2016).

- **Cadmium (Cd):** The CDPHE human health standard for cadmium is 0.005 mg/l. Cadmium is a contaminant metal.

  Cadmium was not detected in samples from your domestic water well (2016).

- **Chromium (Cr):** The CDPHE human health standard for chromium is 0.1 mg/l. Chromium is a contaminant metal.

  Chromium was not detected in samples from your domestic water well (2016).

- **Lead (Pb):** The CDPHE human health standard for lead is 0.05 mg/l. Prolonged exposure to this metal can result in serious health effects.

  Lead was detected in the sample from your domestic water well at a concentration of 0.0003mg/l, which is below the CDPHE human health standard (2016).

- **Molybdenum (Mo):** The CDPHE human health standard for molybdenum is 0.21 mg/l. Molybdenum occurs naturally in the earth's crust and is usually found in very low concentrations in groundwater.

  Molybdenum was detected in the sample from your domestic water well at a concentration of 0.00082mg/l, which is below the CDPHE human health standard (2016).

- **Nickel (Ni):** The CDPHE human health standard for nickel is 0.1mg/l. Nickel is a contaminant metal.

  Nickel was detected in the sample from your domestic water well at a concentration of 0.003mg/l, which is below the CDPHE human health standard (2016).

- **Selenium (Se):** The CDPHE human health standard for selenium is 0.05 mg/l. Selenium is a contaminant metal.

  Selenium was not detected in the sample from your domestic water well (2016).

- **Silver (Ag):** The CDPHE human health standard for silver is 0.05 mg/l. Excess amounts of silver may cause a permanent gray discoloration of the skin.

  Silver was not detected in samples from your domestic water well (2016).

- **Thallium (Tl):** The CDPHE human health standard for thallium is 0.002 mg/l. Thallium is a contaminant metal.

  Thallium was not detected in samples from your domestic water well (2016).

- **Uranium (U):** The CDPHE human health standard for uranium is 0.03 mg/l. Uranium can be present due to erosion of natural deposits of this element.

  Uranium was not detected in the sample from your domestic water (2016).

- **Fluoride (F**): The CDPHE human health standard for fluoride is 4.0 mg/l. Where fluoride concentrations are in the range of 0.7 mg/l to 1.2 mg/l health benefits such as reduced dental decay have been observed. Consumption of fluoride at concentrations of greater than 2.0 mg/l can result in mottling of teeth. Consumption of fluoride at concentrations greater than 4.0 mg/l can increase the risk of skeletal fluorosis or other adverse health effects. Fluoride occurs naturally in the ground water in many areas in Colorado at concentrations that exceed the drinking water standard.

  Fluoride was detected in the sample from your domestic water well at a concentration of 2.2mg/l, which is below the CDPHE human health standard (2016).

- **Nitrate (NO_3):** The CDPHE human health standard for nitrate is 10.0 mg/l. Nitrate can cause cyanosis in infants; a household water supply should not contain nitrate concentration in excess of 10 mg/l.

  Nitrate was not detected in the sample from your domestic water well (2016).

- **Nitrite (NO_2):** The CDPHE human health standard for nitrite is 1.0 mg/l. Nitrite concentrations exceeding 1.0 mg/l should not be used for feeding infants.

  Nitrite was not detected in samples from your domestic water well (2016).

- **Copper (Cu):** The CDPHE domestic supply drinking water standard for copper is 1 mg/l.

  Copper was detected in the sample from your domestic water well at a concentration of 0.0077mg/l, which is below the CDPHE domestic supply drinking water standard (2016).

- **Chloride (Cl):** The CDPHE domestic supply drinking water standard for chloride is 250mg/l. Chloride concentrations in excess of 250 mg/l usually produce a noticeable taste in drinking water.

  Chloride was detected in the sample from your domestic water well at a concentration of 120mg/l, which is below the CDPHE domestic supply drinking water standard (2016).

- **Iron (Fe):** The CDPHE domestic supply drinking water standard for iron is 0.3mg/l. Small amounts of iron are common in ground water. Iron produces a brownish-red color in laundered clothing, can leave reddish stains on fixtures, and impart a metallic taste to beverages and food made with it. After a period of time iron deposits can build up in pressure tanks, water heaters, and pipelines, reducing the effective flow rate and efficiency of the water supply.

  Iron was detected in the sample from your domestic water well at a concentration of 0.1mg/l, which is below the CDPHE domestic supply drinking water standard (2016).

- **Manganese (Mn):** The CDPHE domestic supply drinking water standard for manganese is 0.05mg/l. Manganese produces a brownish color in laundered clothing, may stain fixtures and affect the taste of coffee or tea.

  Manganese was detected in the sample from your domestic water well at a concentration of 0.012mg/l, which is below the CDPHE domestic supply drinking water standard (2016).

- **Sulfate (SO_4):** The CDPHE sulfate domestic supply drinking water standard for human drinking water is 250mg/l. Although CDPHE does not have an agricultural standard for sulfate, other agencies recommend a concentration below 1,500 mg/l for livestock watering. Waters containing high concentrations of sulfate, typically caused by the leaching of natural deposits of magnesium sulfate (Epsom salts) or sodium sulfate (Glauber's salt), may be undesirable because of their laxative effects.

  Sulfate was not detected in the sample from your domestic water well (2016).

- **pH:** pH is the measure of the hydrogen ion concentration in water. The pH of water in its natural state is generally from 5.5 to 9.0. The CDPHE standard for domestic and agricultural water is a range of 6.5 to 8.5. Seven (7) represents neutrality, while values less than 7 indicate increasing acidity and values greater than 7 indicate increasing alkalinity.

  pH was measured in samples from your domestic water well at 8.41 which is within the CDPHE drinking water and agricultural standards (2016).

- **Total Dissolved Solids (TDS):** CDPHE's TDS standard for human drinking water is 500 milligrams per liter (mg/l). Although CDPHE does not have an agricultural standard for TDS, other agencies recommend concentrations below 1500 mg/l for irrigation, and below 5,000 mg/l for most livestock watering. TDS occurs naturally in the ground water in many areas of Colorado at concentrations that exceed the drinking water standard.

  TDS concentration measured in sample**s** from your domestic water well was 910mg/l **which is above** the CDPHE drinking water standard (2016).

- **Zinc (Zn):** CDPHE's Zn domestic supply drinking water standard is 5 milligrams per liter (mg/l) and the agricultural standard is 2mg/l.

  Zinc was detected in the sample from your domestic water well at a concentration of 0.035mg/l, which is below the CDPHE domestic supply drinking water standard (2016).

The following parameters were also measured as part of the laboratory analysis although there are no CDPHE standards.

- **Sodium (Na):** People on salt restricted diets should be aware of the sodium concentration in the water they drink. A concentration of less than 20 mg/l is recommended by some for people on salt restricted diets or for people suffering from hypertension or heart disease. Sodium occurs naturally in the ground water in many areas of Colorado at concentrations that exceed this health advisory level.

  Sodium was detected in the water sample from your domestic water well at 350mg/l. The sodium concentration is above the recommended level.

- **Boron (B):**

  Boron was detected in the water sample from your domestic water well at a concentration of 0.24mg/l (2016).

- **Calcium (Ca):**

  Calcium was detected in the water sample from your domestic water well at a concentration of 3mg/l (2016).

- **Magnesium (Mg):**

  Magnesium was detected in the water sample from your domestic water well at a concentration of 3.9mg/l (2016).

- **Potassium (K):**

  Potassium was detected in the water sample from your domestic water well at a concentration of 3.2mg/l (2016).

- **Strontium (Sr):**

  Strontium was detected in the water sample from your domestic water well at a concentration of 0.11mg/l (2016). The U.S. EPA has not established drinking water standards for strontium. However this federal agency has issued a health advisory level of 4mg/l for lifetime consumption of water by an individual. The Sr concentration in water from your domestic water well is less the advisory level if you were to consume this water for your entire life.

- **Bicarbonate (HCO_3):**

  Bicarbonate alkalinity (as $CaCO_3$) was detected in the water sample from your domestic water well at a concentration of 620mg/l (2016).

- **Bromide (Br):**

  Bromide was detected in the water samples from your domestic water well at a concentration of 1.2mg/l (2016).

METHANE GAS ANALYSIS

Methane was detected in the water sample from your domestic water well at a concentration of 8.07mg/l (2016). The concentration of methane present in the samples from your well is above the concentration of 1.1mg/l than theoretically can lead to buildup of explosive quantities of gases in small enclosed areas.

VOLATILE ORGANIC COMPOUND ANALYSIS

A target list of 78 volatile organic compounds (VOC) was utilized during analysis of water from your domestic water well by ALS. None of the 78 target volatile analytes were detected in the sample submitted to ALS (2016).

SEMI-VOLATILE ORGANIC COMPOUND ANALYSIS

A sample of water from your well was extracted and analyzed for the presence of seventy-two semi-volatile organic compounds (SVOC). The lab did not detect the presence of any of the 72 SVOC compounds in the sample. This analysis is general scan for the presence of semi-volatile organic compounds that are may be present in groundwater. The same sample of water from your domestic water well was also extracted and analyzed for the presence of 18 polynuclear aromatic hydrocarbons (PAH) by a selected ion monitoring (SIM) mass spectrometry technique. The lab did not detect the presence of any of the 18 PAH hydrocarbons in the sample above the laboratory's established reporting threshold. Use of selected ion monitoring mass spectrometry results in detection limits lower by two or more orders of magnitude from full scan mass spectrometry.

DOMESTIC WELL GROUNDWATER QUALITY SUMMARY

The major ion chemistry of water samples from your domestic water well is similar to when the well was sampled in 2014 and again in 2015. At the time of each of the sampling events the concentration of total dissolved solids (TDS) was greater than groundwater standards established by the Water Quality Control Commission of the CDPHE. The major ion chemistry (Na, K, Ca, Mg, Cl, SO4 and the alkalinity) has remained relatively constant (within analytical and sampling uncertainty ±10-15%) over the sampling record.

The presence of volatile organic hydrocarbon compounds such as hexane, cyclohexane, methyl cyclohexane, or aromatic hydrocarbon compounds such as benzene, toluene, ethylbenzene and xylenes (BTEX) are frequent indicators of impacts from oil and gas spills or releases. None of more than 75 target list volatile organic compounds including those mentioned above were detected in samples from your domestic water well. The presence of PAH compounds such as naphthalene and 1-methylnaphthalene are frequent indicators of impacts from oil and gas spills or releases. None of 18 target list PAH compounds including naphthalene and 1-methylnaphthalene was detected in a very sensitive analysis of samples from your domestic water well.

Methane was present in samples collected from your domestic well (2016). Isotopic and gas composition analyses from 2016 (and 2015) indicate the methane is of biogenic origin as shown in plots in the DIG lab report (Attachment 3) and is not considered to be related to nearby oil and gas exploration and production activities. Water with elevated concentrations of dissolved methane can present explosion hazards when the water is brought directly into a home or other enclosed space. As general advice, you should consider installing a vented outdoor cistern as a passive means of lessening this hazard. Installation of combustible gas detectors inside your home should be considered if not already present to alert you to potential buildups of methane in your home.

The concentrations of all analytes tested in groundwater samples from your domestic water well are within the groundwater standards established by the CPDHE Water Quality Control Commission with the exception of dissolved solids. The concentration of total dissolved solids (TDS) is a good general indicator of overall water quality. The data available at this time do not show any impacts from nearby oil and gas exploration and production operations to the groundwater accessed by your water well. The third issue in your complaint is considered closed as no impacts to groundwater quality from nearby oil and gas operations were observed in shallow or deep groundwater samples collected on your property.

PRESENCE OF HYDROCARBON LIQUIDS IN SHALLOW GROUNDWATER

As described in the section above describing water well sampling and in response to the fourth issue raised in your complaint, a second sampling of a sump in your basement was conducted on 20 July 2016. These samples were collected from a sump in the southwest corner of your basement. This sump sits directly next to a more recently constructed sump that is approximately 2 feet deep. On 20 June 2016 a recently constructed sump in the northwest corner of your basement was sampled as described in a previous section of this letter. That newer sumps in each corner of the basement are all approximately 2 feet deep according to the contractor who installed them and who was present when I sampled on 20 July 2016.

Visible floating hydrocarbons were present floating on the older, deeper SW sump. A visual inspection of the four recently constructed sumps (one in each corner) on 20 July 2016 did not

indicate the presence of visible hydrocarbons in any of those four sumps. Water flow into the newly constructed sump in the northeast corner of the basement was visible on 20 July 2016. I did not observe visible water flow in the other sumps in the basement on that day.

The lab reported a concentration of 4300mg/l of extractable hydrocarbons in the water sample from the older SW sump collected on 20 July 2016 (Appendix 2). Colorado has no established groundwater threshold concentration limit established for this grouping of compounds (extractable hydrocarbons) as the class of compounds is not well defined and with no specific risk thresholds established for the grouping as a whole. However, Colorado does have established groundwater standards for many individual organic compounds present in crude oil and condensates. For example, Colorado's groundwater standards do establish threshold concentrations for benzene and other related aromatic compounds which are present crude oils and condensate produced in the area around your home. Benzene was not detected by the lab in the SW sump sample. Several PAH compounds were detected in the SW sump sample with naphthalene detected at 2.7µg/l. The established Colorado naphthalene groundwater standard based on risk assessments is 140µg/l (2016) or more than 40 times greater than the concentration of this PAH in the SW sump water

The analyst at the lab tentatively identified the hydrocarbons present in the SW sump sample as possibly transformer oil (a refined product) from pattern recognition of the detector response versus time in the complete report. For illustration purposes and to ease the discussion a copy of the chromatogram illustrating detector response versus time of analysis is also included as Figure 7 below. The analytical results indicate a tight grouping of carbon chains between approximately alkanes of 15 carbon chain length and alkanes of 24 carbon chain length. The tightness of the grouping of carbon chain length in comparison to crude oils (discussed below) produced in the area around your home is an indication that the hydrocarbon is a refined product.

At my request and as part of this investigation, an operator of wells near you (KMG) supplied a whole oil analysis of liquid hydrocarbons produced from a well to the northwest of your home. The analysis indicates the presence of compounds between 4 carbon chain length to 40 carbon chain length and is typical of many light crude oils such as are produced in the area around your home. The data from that analysis is included as Attachment 4. A copy of the chromatogram illustrating the produced oil composition analysis is shown in Figure 8 below. Noted on the chromatogram are the general regions of 15-25 carbon chain alkane compounds in the produced oil. However there are more than 40 % of the compounds between 4 carbon and 14 carbon alkanes that are present in the oil sample and not present in the hydrocarbon liquid from the sump. Also present in the oil sample are more than 6% of the oil sample that are BTEX compounds (benzene, toluene, ethylbenzene and xylene isomers) that were not detected above the laboratories established reporting limit (<1µg/l) in the sump water sample with liquid hydrocarbons present.

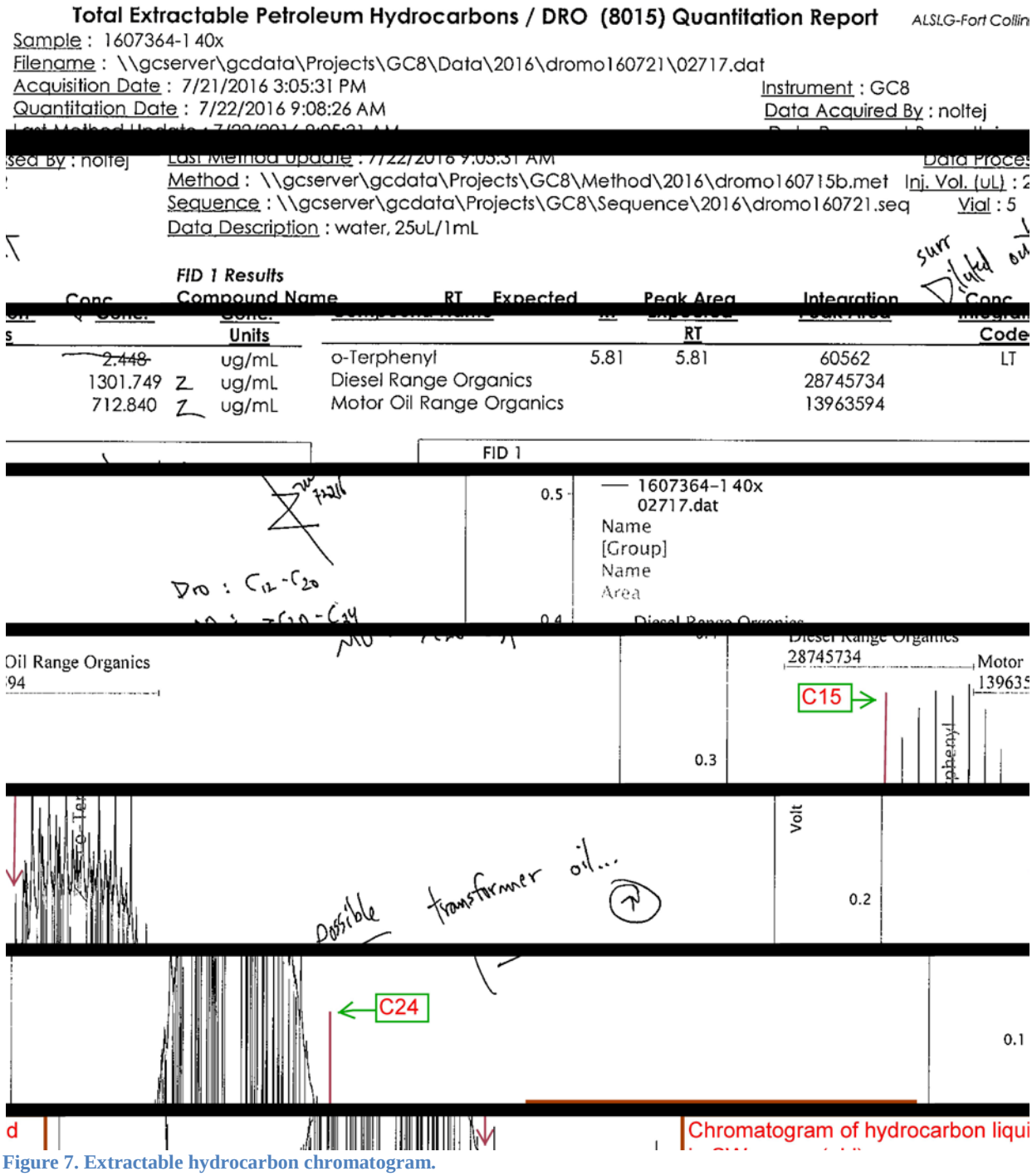

Figure 7. Extractable hydrocarbon chromatogram.

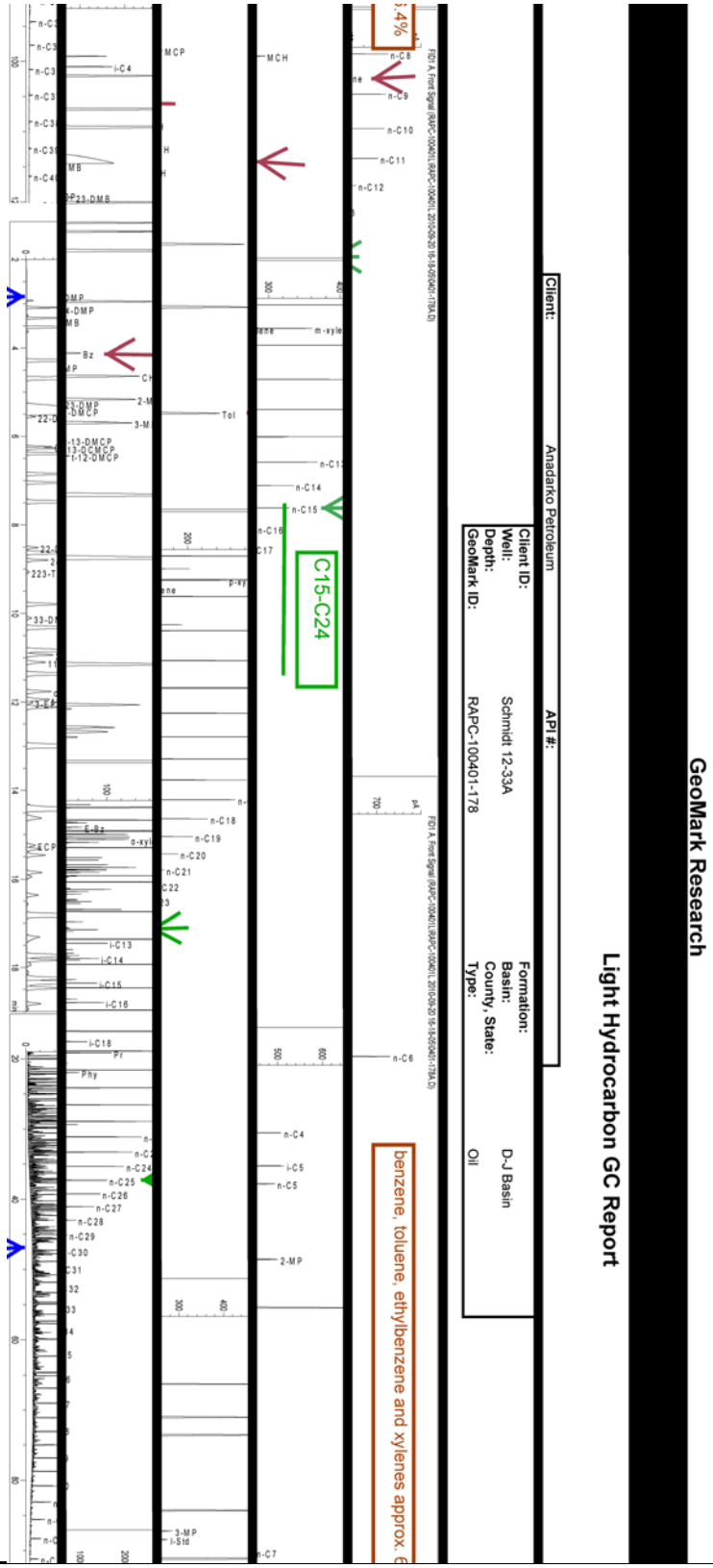

Figure 8. Schmidt 12-33A whole oil chromatogram.

The SW sump water liquid hydrocarbon analytical results also could be interpreted as that of another refined product, hydraulic fluid, based on my review of the data and my experience in environmental analytical chemistry. A second thread of evidence pointing to hydraulic fluid or transformer oils is the presence of a tentatively identified compound (1-chloro-2-propanol phosphate, 3:1). This tentative identification based on the mass spectrum of a non-target compound is included in the analytical data from the sump sample (Attachment 2) from ALS Laboratories.

Data from the Agency for Toxic Substance and Disease Registry (ATSDR) identifies that the class of compound this phosphate ester belongs to (phosphate ester flame retardants) are used in hydraulic fluids and can be present in soils with spills of hydraulic fluids. A copy of this information sheet from the ATSDR is included as Appendix 5.

The complaint issue regarding the presence of liquid hydrocarbons is considered closed with respect to impacts from oil and gas exploration and production wastes as the liquid is likely a refined product and not subject to COGCC authority related to groundwater impacts. As I told you in July, in general the Hazardous Materials and Waste Management Division of the CDPHE has jurisdiction over spills and releases of refined products even if used at oil and gas locations. We can aid you in contacting that agency if needed.

With the data I have at present I can rule out produced oil in the area as a source but I cannot identify possible sources of the liquid hydrocarbon present . The water in the sump contains elevated nitrate levels which likely indicate communication between the groundwater in the sumps and your septic system. A first hypothesis that I would investigate is that the organic liquid and the nitrate share a common source as it is uncommon, but not impossible, to find two sources and two pathways of impacts at the same time in a localized shallow groundwater system. Direction of shallow groundwater migration in the area is likely downhill and to the west but there may be local or seasonal variations especially if irrigation based recharge is significant.

GENERAL SUMMARY

The investigation of your complaint did not lead to the agency initiating any enforcement actions as no cause for COGCC enforcement was found in the three groundwater related issues. With respect to the stormwater and erosion control issue the operator and the landowner/tenant pursued corrective actions effectively and in a timely manner and the agency did not consider enforcement actions necessary at this time.

If you have any questions or would like to discuss these matters further, please contact me at 719-679-1326 or by email at peter.gintautas@state.co.us . Should you disagree with COGCC staff's handling and resolution of your complaint, COGCC Rule 522.a. (4) allows that you as the complainant may file a Petition for Review requesting the Commission to hear the Complainant's objections to: the Director's decision not to issue an NOAV for an alleged violation specifically identified in the written complaint;. Please contact Megan Adamczyk in our Denver office if you wish to discuss how you might proceed if you decide to file a petition for review (303-894-2100 ext. 5145 or megan.adamczyk@state.co.us). Complainants must file a Petition for Review with the Commission within 28 days of receiving the Director's decision not to issue an NOAV. Applications filed later than 28 days following receipt will not be considered.

Sincerely,
Colorado Oil and Gas Conservation Commission

Peter Gintautas

Digitally signed by Peter Gintautas
DN: cn=Peter Gintautas, o=COGCC, ou=Environmental Protection, email=peter.gintautas@state.co.us, c=US
Date: 2016.09.20 12:35:57 -06'00'

Peter Gintautas, Ph.D.
Environmental Protection Specialist – Northeast Colorado

Attachment 1 - Table 1
Attachment 2 - ALS Laboratories reports
Attachment 3 - DIG report
Attachment 4 - Schmidt 12-22 whole oil analysis report
Attachment 5 – ATSDR ToxFaq – Phosphate Ester Flame Retardants
Attachment 6 - How Well Do You Know Your Water Well Booklet

Cc John Axelson, COGCC Environmental Supervisor, Eastern Colorado, without attachments

TABLE 1. ANALYTICAL SUMMARY
Hagler Complaint 200439757

Parameter	753452 WW	754914 Sump	754977 Platteville Lat.		CDPHE Groundwater Standards		
	Sample Date	Sample Date	Sample Date				
	20-Jul-16	20-Jul-16	20-Jul-16				
	Result	Result	Result	Unit	Domestic	Agriculture	Unit
Aluminum	0.04	0.019	1	**mg/l**	NS	5	mg/l
Antimony	ND	0.00069	0.00039	mg/l	0.006	NS	mg/l
Arsenic	ND	0.0056	0.0013	mg/l	0.01	0.1	mg/l
Barium	0.075	0.085	0.06	mg/l	2.0	NS	mg/l
Berylium	0.00076	0.00065	0.00079	mg/l	0.004	0.1	mg/l
Boron	0.24	0.22	0.13	mg/l	NS	0.75	mg/l
Cadmium	ND	ND	0.0002	mg/l	0.005	0.01	mg/l
Calcium	3	240	66	mg/l	NS	NS	
Chromium	ND	ND	ND	mg/l	0.1	0.1	mg/l
Cobalt	0.00022	0.00047	0.0076	mg/l	NS	0.05	mg/l
Copper	0.0077	0.0055	0.17	mg/l	1	0.2	mg/l
Iron	0.1	0.019	0.099	mg/l	0.3	5	mg/l
Lead	0.0003	0.0002	0.0002	mg/l	0.05	0.1	mg/l
Lithium	0.048	0.063	0.061	mg/l	NS	NS	
Magnesium	3.9	62	22	mg/l	NS	NS	
Manganese	0.012	0.0045	0.091	mg/l	0.05	0.2	mg/l
Molybdenum	0.00082	0.0016	0.0039	mg/l	0.21	NS	mg/l
Nickel	0.003	0.0021	0.0057	mg/l	0.1	0.2	mg/l
Potassium	3.2	23	8.7	mg/l	NS	NS	
Selenium	ND(<0.00066)	0.018	0.0011	mg/l	0.05	0.02	mg/l
Silicon	4.7	10	0.56	mg/l	NS	NS	
Silver	ND	ND	ND	mg/l	0.05	NS	mg/l
Sodium	350	390	110	mg/l	NS	NS	
Strontium	0.11	2.8	0.62	mg/l	NS	NS	
Thallium	ND	ND	ND	mg/l	0.002	NS	mg/l
Thorium	ND	ND	ND	mg/l	NS	NS	
Uranium	ND	0.044	0.0099	mg/l	0.03	NS	mg/l
Zinc	0.035	0.013	0.042	mg/l	5	2	mg/l
Chloride	120	89	160	mg/l	250	NS	mg/l
Nitrite	ND	ND	ND	mg/l	1.0	10	mg/l
Nitrate	ND(<0.1)	66	0.11	mg/l	10.0	100	mg/l
Total Nitrite/Nitrate	ND	66	0.11	mg/l	10.0	100	mg/l
Fluoride	2.2	0.7	0.8	mg/l	4.0	NS	mg/l
Total Dissolved Solids	910	2300	550	mg/l	400	*1500	mg/l
pH	8.41	9.26	8.38	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	ND(<1)	400	130	mg/l	250	NS	mg/l
Bromide	1.2	ND(<0.6)	0.12	mg/l	NS	NS	
Total Alkalinity	620	380	130	mg/l	NS	NS	
Bicarbonate Alkalinity	620	380	130	mg/l	NS	NS	
Carbonate Alkalinity	ND	ND	ND	mg/l	NS	NS	
Conductivity	1511	3180	963	umhos/cm	NS	NS	
methane	8.07	NA	NA	mg/l	NS	NS	
Orthophosphate	ND	ND	0.31	mg/l	NS	NS	
SAR	30	6.1	2.7	No units	NS	NS	

Notes

CDPHE	Colorado Department of Public Health and the Environment.
Domestic	Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41 - The Basic Standards For Groundwater.
Agriculture	* Standards for agriculture complied from CDPHE and other sources.
mg/l	milligrams per liter (ppm or parts per million).
µmhos/cm	micromhos per centimeter
NA	Not analyzed.
ND	Not detected.
NS	No Standard.
**	Health Advisory.
	Domestic Water Supply - Human Health Standard (Table 1).
	Domestic Water Supply - Drinking Water Standard (Table 2).