

**Colorado Oil and Gas Conservation Commission
EnCana Oil and Gas (USA), Inc.
Investigation of Deason 11-36 Well Site Notice of Alleged Violation**

**Prepared by AgriTech Consulting
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BACKGROUND

On July 27, 2010 the Colorado Oil and Gas Conservation Commission (COGCC) received a complaint from Boulder County Parks and Open Space (BCPOS) concerning the EnCana Deason 11-36 (05-013-06503). BCPOS representatives presented information that allegedly showed impacts to cropland from damage to an existing ground water drainage system that caused by well site construction, drilling and or subsequent operations at the Deason 11-36. A complaint was registered (#200277565) and a site inspection conducted on July 28, 2010 to investigate the complaint. During the site inspection (#200264616) COGCC staff identified what appeared to be a shallow high ground water table and areas no longer in use that were not adequately reclaimed. As follow up a Notice of Alleged Violation was also issued (200264506). The site inspection and NOAV required that EnCana comply with COGCC interim reclamation rules and to provide a work plan on dealing with the shallow groundwater issue. A series of meetings were held and EnCana retained a geotechnical engineering company to investigate the problems.

The Deason 11-36 was drilled and completed in November and December of 2007. Production was reported on December 11, 2007. The well is located in the NW 1/4, NW1/4, Section 36, Township 2 North, Range 69 West. BCP&O owns both the surface and mineral rights.

Impacts that BCP&OS contend were caused by oil and gas operations include:

- An increase in the groundwater table,
- The development of subsequent wet spots in the agricultural fields, and
- Increases in the areas of salt depositions on soil surfaces and ensuing crop damage.

After a series of meetings between the interested parties and a series of initial investigations the issues could not be resolved. The Colorado Oil and Gas Conservation Commission retained AgriTech Consulting to evaluate the above situations and to determine possible cause and present plausible recommended solutions. The investigation was conducted by Ron Miller, agronomist and Certified Crop Advisor and Gerald W. (Jerry) Knudsen, a Colorado Registered Professional Engineer.

METHODS OF INVESTIGATION

AgriTech Consulting determined that several methods of investigation would be needed to collect data sufficient to make a logical and reliable evaluation of the situation as presented. The methods decided were;

- Direct personal interviews with those involved in the situation,
- Aerial photograph review for extended period 1963 through 2011,
- Recent aerial photographs supplied by COGCC,
- Site soils data review available from the National Resources Conservation Service (NRCS) National Soil Data Base,
- Site visits,
- Review of NRCS salinity field mapping conducted in the fall of 2010,
- Review of documents consisting of court water filings, and
- Review of pipeline maps and locations as provided by EnCana Oil Company.

Interviews

The following direct personal interviews were conducted by Jerry Knudsen and/or Ron Miller:

Rob Alexander, Boulder County Parks and Open Space (BCPOS): Rob met with Jerry and Ron on site at Deason 11-36 on April 1, 2011 at 1:00 PM. Rob provided an overview of the site problems and actions that had been taken by EnCana. Rob provided copies of aerial maps with well locations and possible subsurface drain locations. He also pointed out the areas that the farmer has had difficulty in being able to produce crops since the wells had been drilled. We reviewed the efforts of BCPOS to locate underground drains and broken underground tile lines, including the use of Hartford Electric Company to provide backhoe digging in the area of Deason 11-36 well site. According to Rob, none were found. Rob also indicated that problems had been encountered in the fields to the north of Niwot Road on the Caldwell property in the vicinity of the well Caldwell 14-25. He suggested that the land was impacted by the same probable causes, i.e. interruptions of subsurface drainage lines by actions of the oil company.

Craig Sterkel, farmer, 25 years on site: Craig met with Ron Miller on April 8, 2011, from 10:00 AM to 1:30 PM. Ron and Craig discussed issues involved in the complaint, discussed the oil well drilling operations, timing of the operations and subsurface drainage issues. They inspected both the Deason farm and Caldwell farm. They located the known subsurface drain outlets and placed locations on maps. They discussed Craig's farming operations and associated cropping practices. They also reviewed the farm irrigation systems, and inspected the White Rock ditch from the outlet at Panama Reservoir to the north Caldwell property line.

Don Graffis, NRCS, District Conservationist, Longmont Field Office: On April 8, 2011 at 2:30 PM, Ron talked with Don about aerial photo availability and received copies of 1963 and 1983 flights. Don is also familiar with the Caldwell and Deason properties and has worked with BCPOS on the properties. The office has no records that contain information about subsurface drainage lines or any investigations relative to groundwater. Don had requested that salinity mapping be done on the farms to get better information.

Jason Peel, NRCS, Irrigation and Salinity Specialist: On April 8, 2011 at 2:00 PM, Ron talked with Jason on the telephone to understand the information received on the maps he created from field survey EM-2 technique to assess the salinity levels on the Deason and Caldwell properties. Jason had sent maps and information to COGCC, Margaret Ash, and information was forwarded to AgriTech Consulting.

Cindy Allen & Jack Croom, EnCana: On April 13, 2011 at 11:00 AM, Jerry and Ron met with Cindy and Jack at EnCana offices east of Longmont. Cindy and Jack provided information regarding the activities that EnCana has been involved in for several years and provided details about the Deason 11-36 well drilling process and their view of what is involved in the NOAV assertions. Jack was in the process of preparing a map of all pipelines installed on the properties. Ron received a phone call from Jack on April 19 and Jack stated that mapping was in process and would be completed as soon as possible. Ron received an e-mail on April 20 stating that the mapping was complete and would be sent that day. Jack said the group had put priority on this work and completed it ahead of schedule.

Aerial Photograph Review

At the outset, we determined that it would be important to obtain as many aerial photo views as possible which may contain clues and evidence of ground features seen over the years. Aerial photos copies were received from the Boulder County FSA Office for the farms in question and as well as NRCS field office to cover the years 1963 to 2010.

Soil Review

Soil Survey information was obtained from the NRCS National Soils Database for the pertinent farms and fields. Information will be referenced in other areas of this report.

Site Visits

Field site visits were conducted to determine irrigation system and methods, cropping patterns, drainage outlets, subsurface drain lines, potential offsite subsurface water sources, irrigation water source and field inlets, field roads and access points, well locations and drilling sites, service lines from oil wells and oil tank batteries.

NRCS Salinity Field Mapping

Ron reviewed NRCS salinity field mapping which was completed by Jason Peel in the fall of 2010. As mentioned above, the survey information was made available to COGCC through Margaret Ash, and the information was forwarded to us.

Other Documents

Documents reviewed were as follows:

- Water Filing, Water Division I, State of Colorado, Case No. W-3575 for the property in north half of Section 36 in 1896.
- Report by A.G. Wassenaar, Geotechnical and Environmental Consultants of April 30, 2010 to establish Percolation Tests on the Deason site.
- Pipeline location maps provided by EnCana

FINDINGS OF THE INVESTIGATIONS

Irrigation System and Methods: The irrigation system on both Deason and Caldwell properties is a surface furrow application system with irrigation water being supplied from the White Rock Irrigation Ditch with water diverted from Panama Reservoir. The White Rock Ditch had been concrete lined in years past, however the section of ditch going across the Deason property is in very poor condition, e.g. broken and cracked concrete with the appearance of concrete rubble along the ditch sides. The White Rock Ditch through the Caldwell property is in much better condition, but has had a history of breakouts caused by the ditch lining cracking and leaking water undermining the lining and washing out sections. These sections have been repaired; however, there are areas along the ditch having cracks in the side walls and ditch bottom which are probably allowing leakage and potential failures.

Each farm is supplied irrigation water through a system of earthen and concrete surface ditches to the various fields. Irrigation water is applied to the fields by a surface furrow system. Fields are comprised of flat slopes and long lengths of run, from 1500 to 2000 feet in length. In several fields, cross ditches are pulled or constructed during the cropping season to facilitate getting the irrigation water to lower ends of the field.

Cropping and farming practices: Both farms have been farmed by Craig Sterkel the past twenty five years. Mr. Sterkel has grown the normal crops of the area such as corn, small grains and alfalfa. Alfalfa has not been grown on either farm for several years so corn and small grains have been the dominate crops. Mr. Sterkel's farming practices would be considered conventional for the area, but he does use higher residue maintenance when possible when crop growth has produced adequate residues. Current residue levels on the fields would be considered low.

Subsurface Drains and Drain Outlets: In talking with Rob Alexander and Craig Sterkel, both indicated that previous landowner conversations have said that hand dug

subsurface drains had been installed in years past. The year the drains were established or the precise locations of the drain lines are not known.

A drain line was believed to have been dug up or disrupted during the drilling of Caldwell 23-25 and the digging of the pit because pieces of drain tile were seen in the material being excavated. See figure below. There is a drain outlet in the east side of SW 1/4 Sec 25 along the field access road, about 300 feet north of Niwot Road (Drain Outlet A). Another drain outlet is located in the west portion of the NE 1/4 of Sec 36 (Drain Outlet B). That drain is connected to a clay tile line approximately 300 feet long running northwest from the end. This line was verified by Hartford Electric when in process of locating drains on the Deason property. Hartford Electric was retained by BCP&O to locate drain lines using a backhoe excavator.



No physical evidence has been found to indicate that subsurface drain lines exist on the parcel that Deason 11-36 is located. This situation could be explained by the fact that when established in the 1900's, the lines were probably placed at shallow depths of three to four feet. They were constructed of wood, which over time will disintegrate and will

not be noticed if severed in a digging operation. There is no evidence to indicate that the landowners had any plans or attempts to provide periodic maintenance on the drain lines on the Caldwell parcel.

During the attempts of Hartford Electric to locate drain tile near the Deason 11-36 well, there was found to be a barrier or impenetrable zone approximately ten feet below the soil surface. Also during the percolation tests, groundwater was found at approximately 33 inches below soil surface.

Service pipeline locations on the properties have been mapped and provided by EnCana. EnCana has indicated they have offered to repair any damages that can be proven they caused to subsurface drains or any problems they have created through their operations. To date no drains have been located or shown to be damaged by the oil company actions.

Offsite Water Sources: Potential offsite water sources that could contribute to groundwater are the Panama Reservoir which is adjacent to the west of the Deason property in Section 35. The reservoir has a high water line equal to or near equal to farm field levels and, at a minimum, at the level of the ten foot barrier found during drain tile investigation. Natural surface drainage is to the east and north of the Reservoir and subsurface drainage is expected to be in the same direction. White Rock Canal has concrete lining that is in poor condition, which could be a water source during the irrigation season when the ditch is running at capacity.

NRCS Salinity Mapping: NRCS DualEM-2 instrument mapping for Salinity was conducted by Jason Peel, Irrigation Water Management Specialist, NRCS Denver, Colorado in December, 2010. The area was surface mapped using a DualEM-2 instrument with a Garmin 76 differential GPS unit.

The apparent conductivity (ECa) maps show significant salinity issues in both land units mapped either side of Niwot Road on the Caldwell and Deason properties. Each shows the affects of high groundwater as the likely cause. The areas are approaching an inverted profile, an irreversible condition. There is a need to establish a subsurface drainage system as a first step to reverse the process.

Salinity ECa values were found to be 0.0 to 8.0 dsm/m in upper soil profile while values of 2.0 to 18.0 dsm/m were found in the lower profile. Crop damages will result with values above 2.0 dsm/m with increasing percentage damage as values increase. Many crops will not germinate with levels of 2.0 dsm/m and selection of salt tolerant species is needed to provide successful germination. On the Caldwell property, the areas with highest visible accumulation on the soil do not correspond to the high ECa values found. However, around the Deason well the levels are high in the surface visual areas as well as other field locations. Fairly uniform patterns exist which indicate a universal problem throughout.

The surface visual salt accumulations may be the result and function of the percent ground cover, which is low due to lack of previous crop development allowing more

evaporation from the soil surface pulling the salts upward to the soil surface. At this point, there does not seem to be any indication that the oil well locations are causing problems by damming up groundwater or inducing higher groundwater conditions.

The perpendicular coplanar (PCP, deep) and the horizontal coplanar (HCP, shallow) maps definitely locate the gas pipeline and the service lines going to the tank battery located at Caldwell H-1. The ECa maps also mirrors those locations and indicate some plume activity which could identify leakage occurring from those steel lines. The diagrams indicate that some investigation should be done in those areas to determine what is causing the mapping images.

Aerial Photograph investigation: The review of aerial photographs covering the span of years from 1963 to 2010, shows there is historic evidence of crop damaged areas or weak crops existing in similar patterns as those present in the field today. The photographs suggest that these conditions have existed previously.

POTENTIAL CONTRIBUTORS TO THE PROBLEM

As mentioned in the text of investigation findings, there are two significant potential sources of groundwater as contributing factors:

- The White Rock Irrigation Canal along the western border of the field where the Deason 11-36 is located is likely to be a major contributor as the canal lining in this section is in very poor condition or in such bad condition that it is not acting as canal lining at all.
- The Panama Reservoir to west of this site is a potential contributor because its water level raises and lowers during the irrigation and storage season. It provides the necessary pressure needed to force water to natural subsurface drainage pattern to the north and east from the reservoir site.

There is the presence of impenetrable layer or shallow bedrock at 10 foot below the field soil level that is probably the barrier that is creating the high groundwater levels. As groundwater is accumulated from other sources, the groundwater levels increase.

If there was a subsurface drainage system installed in the earlier parts of the 1900's, there has been a substantial failure of that system. Failures may be created from many causes, e.g. lack of maintenance by the landowners and possible damage due to pipeline construction in the area disrupting the flow channels. Without permanent maps to indicate where the drainage lines were established, it is very difficult to determine if there was activity in the vicinity of the lines to cause damage or disruption. Failure or lack of subsurface drainage is probably a contributor to the problems seen.

The farm irrigation system with slow grade earthen ditches, surface application with long length of run and flat slopes will have the potential to increase deep percolation at the top of the fields. This percolation will increase the groundwater level, especially when

groundwater depths are within three foot of the surface. The use of short season crops such as small grains, which are low water users and are shallow rooted, will not use excessive water from the soil profile.

Crop species that are not able to grow in the saline conditions increases crop failure and decreases the potential for residue production, which could be used to protect the soil surface to decrease surface evaporation. Salt tolerant crops have not been used extensively on these properties.

RECOMMENDED SOLUTIONS

The following recommendation will improve the farming conditions on the properties:

- Improve the White Rock Canal Lining above the Deason property and maintain the lining across the Caldwell property.
- Improve the field irrigation system. Decrease the length of runs on the field. Use surface gated pipe to replace the earthen ditches to decrease seepage losses for the ditches. Replace current surface application with a center pivot irrigation system to increase water application efficiency and decrease deep percolation losses.
- Investigate, design and install a subsurface drainage system on both farms.
- Submit soil samples to an agricultural laboratory for analysis to determine the soil absorption ratio and mineral contents of the soil to determine the proper restoration techniques.
- Utilize salt tolerant deep rooted high water using crops that will help to use the subsurface water in the soil profile.
- Improve oil and gas company procedures to investigate local farm activities to insure less potential for damage to surface and subsurface irrigation systems and subsurface drainage systems when there are plans for well drilling, installation of well service lines and pipeline installation.
- Oil and gas companies need to be more involved with the subcontractors to insure that they understand what previous agreements have been made with landowners and need to be aware of the items requiring protection.

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