REPORT AND RECOMMENDATION REGARDING APPROPRIATE REVERSE SETBACKS

FROM INJECTION WELLS AND PLUGGED AND ABANDONED OIL AND GAS WELLS IN THE FORT COLLINS FIELD

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Stuart M. Ellsworth, CO PE 0034621

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EXECUTIVE SUMMARY:

The City of Fort Collins has grown up around the Fort Collins Oil Field, which continues to produce relatively small amounts of oil but no natural gas. As the City has grown, the need for appropriate "Reverse Setbacks" from the remaining oil wells has become apparent. A reverse setback is the distance that must be maintained between a new building unit and an existing production, injection or plugged and abandoned well.[1] This report provides background information on the Fort Collins Oil Field and the life cycle of wells, a snapshot of Colorado Oil and Gas Conservation Commission (COGCC) regulations, and examples of other agency regulations related to reverse setbacks. This report focuses on two categories of wells that fall within 2,000 feet of the Sonders Property near the intersection of Douglas and Turnberry Roads: operating underground injection wells; and wells that have been plugged and abandoned.

All operating injection wells within the City limits are without storage tanks; the injection water is transported by buried pipes called flowlines[2]; and the wells inject low volumes of produced water deep underground. The injection wells are constructed, inspected, and monitored under requirements imposed by the COGCC consistent with regulations adopted by the US Environmental Protection Agency (EPA). These wells only handle injection water, which was itself produced by other wells from deep underground; they do not produce, store, transmit, or inject oil or gas; and they have little potential to impact public health, safety, and welfare. They cannot emit hydrocarbons, and the use of flowlines to transport the injection water to eliminate truck emissions, noise, odors, and roadway impacts that would otherwise arise from trucking the water to the injection well sites. Of note, there are two locations with an injection well and storage tanks outside but adjacent to the current City of Fort Collins.

A plugged and abandoned well is sealed with multiple cement plugs pursuant to COGCC Rule 434. The plugs prevent air emissions from the well and isolate and protect groundwater. In addition, the operator has

- Removed all surface facilities and equipment per COGCC Rule 1004,
- Disconnected, purged, depressurized, sealed, and in some cases removed all flowlines per COGCC Rule 1105[3], and
- Reclaimed and revegetated the surface per COGCC Rule 1004.

[1] A production well is a well that produces oil or natural gas, though in the Fort Collins Field all of the production wells produce only oil. An injection well is a well that injects fluids deep underground. A plugged and abandoned well may previously have been either a production well or an injection well. In either case, it has been sealed with cement plugs and otherwise decommissioned as explained in the text.

[2] Flowline means a segment of pipe transferring oil, gas, condensate or produced water between a wellhead and processing equipment.

[3] COGCC Rule 1105 was approved is 2019 as a result of the Firestone incident. These regulations require the removal of all flowlines at the time of well abandonment unless approved by the Commission and noticed to the local government.

For these reasons, a plugged and abandoned well presents even less risk to public health, safety, and welfare.

This report recommends that newly constructed building units be subject to a reverse setback of 75 feet from existing injection wells without storage tanks or from plugged and abandoned wells. For injection wells with storage tanks, a reverse setback of 500 feet is recommended. New building units should be prohibited within these reverse setbacks, but parks, ballfields, playgrounds, gardens, and similar outdoor activity areas can be permitted within these areas.

These recommended reverse setbacks will minimize risk to public health, safety, and welfare and will protect nearby residents and the environment. These reverse setbacks will also allow safe and sufficient access to the well. For injection wells, this distance will allow access needed for required annual testing, inspection, monitoring, maintenance, and eventually abandonment. For plugged and abandoned wells, this access may be needed in the unlikely event that future remedial work on the well is necessary.

It should be noted that the issue of reverse setbacks for injection and plugged and abandoned wells in the Fort Collins Oil Field is separate and distinct from the issues associated with the Firestone incident. Unlike the injection wells and plugged and abandoned wells in the Fort Collins Field, the Firestone incident involved a producing well that produced natural gas. The Firestone well had also been returned to production after being shut-in, and the flowline had been severed. The COGCC subsequently adopted a number of regulations that address the risks associated with returning wells to production and operating flowlines.

BACKGROUND

Fort Collins Oil Field

The Fort Collins Oil Field (Field) was discovered almost 100 years ago, in 1924. It is located in Larimer County and the City of Fort Collins. It generally falls within Township 8 North, Range 68 West. Figure 1 shows the general field layout highlighting the producing and enhanced recovery injection wells, flowline pipes to transport fluids, and the central processing facilities.

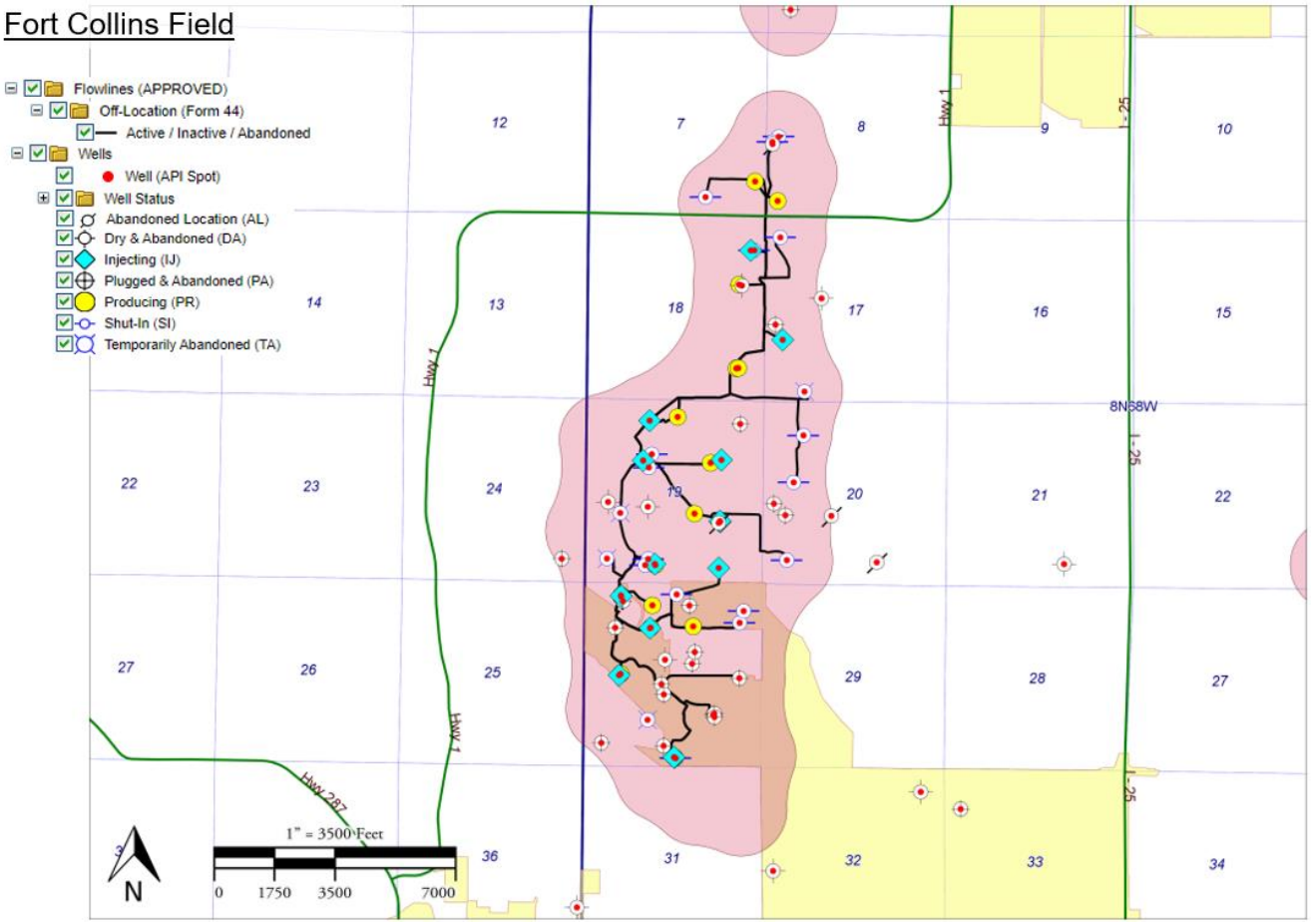

Figure 1: A depiction of the Fort Collins oil Field with the current well status and flowlines form the Colorado Oil and Gas Conservation Commission with Google Earth images of injection wells and abandoned well sites.

The Field has produced over 5 million barrels of oil but is now largely depleted. This means that the energy and pressure within the oil reservoir has declined over time. Due to this reduced reservoir pressure, the existing production wells are currently being produced through enhanced recovery. Enhanced recovery is a process whereby an external fluid such as water is injected into the reservoir through injection wells. This supports reservoir pressure and displaces hydrocarbons towards the production wells. Despite the enhanced recovery process, the existing production wells in the Field remain low-producing and average less than two barrels of oil production per day.[4]

[4] The COGCC has defined a low producing well as one that produces a daily average of less than 2 barrels of oil equivalent or 10 thousand cubic feet of natural gas equivalent of gas over the previous 12 months.

The Field does not produce any natural gas. Therefore, there is no flowing natural gas emitted from the wells into the atmosphere or released into the soil.

The field is unusual in that all produced fluids from the production wells are transported by flowlines to facilities located along the western side of the field (COGCC Fac# 333083 and COGCC Fac# 307186). These facilities separate the oil from produced water, have storage tanks, and include an enhanced recovery injection well. The oil is collected and trucked off site for sale. The water is piped by flowline to the injection wells and then reinjected as part of the enhanced recovery process. The flowlines and facilities eliminate the need for on-site separation and storage of fluids. Because the production well sites do not have separators and oil tanks, they do not generate air emissions, fluid spills, odors, or nuisance noises. This is an important consideration because the CDPHE has highlighted pre-production activities[5] and oil tanks[6] as a potentially significant source of well site emissions. The flowlines and central facilities also eliminate the need to truck oil and water from the production well sites, which eliminates truck traffic.

Figure 2 is a Google Earth image of an enhanced recovery injection well in the City of Fort Collins Hearthfire Subdivision. The well is currently less than 80 and about 160 feet from the adjacent residential buildings. The site shows a fenced area surrounded by landscaping. The site is accessed by a 15-foot-wide drive off Town Center Drive. The site contains the injection well house for the wellhead and injection pump. There is also a production well on the site, which contains a wellhead and pumpjack. There are no other pieces of surface equipment (separators or storage tanks). The access drive and site allow for maintenance by truck mounted equipment.

[5] Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado February 21, 2017

[6] Oil & Gas and Point Source Emissions Inventory Development, Supporting the Denver Metro/North Front Range State Implementation Plan for the 2008 and 2015 8-Hour Ozone National Ambient Air Quality Standards DRAFT: July 8, 2022, Adopted: December xx, 2022

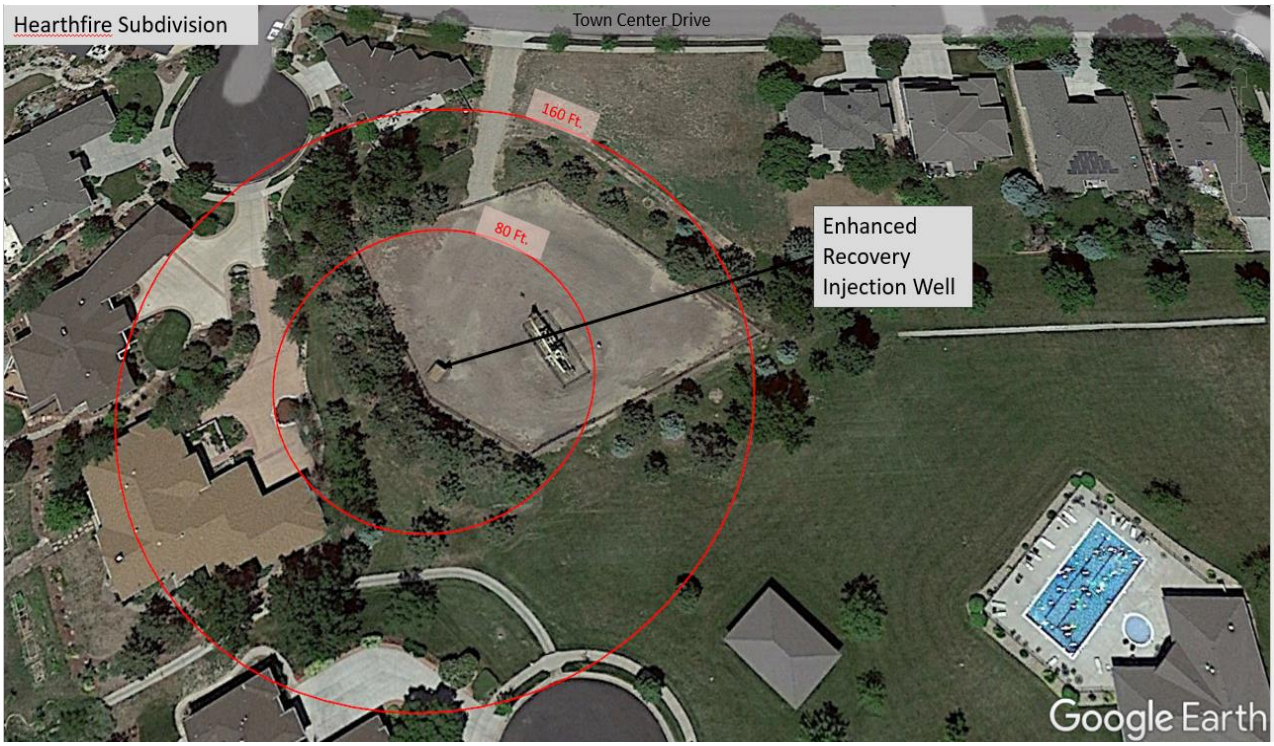

Figure 2: Google Earth image of an enhanced recovery injection well site in the Hearthfire Subdivision.

Life Cycle of Wells in the Fort Collins Oil Field

Distinct stages within the life cycle of a production or injection well present different risks, and understanding these stages is vital from a risk-management standpoint.

- Pre-Production Stage: The pre-production stage involves the construction of the location and the well. This includes constructing the well pad and production facilities, drilling, casing, and cementing the well, and completing the well by perforating the casing and hydraulically fracturing the formation. This stage involves the largest area of disturbance, the most activity, and the greatest risk of environmental impact.
- Production Stage: The production stage is the production of oil and gas from a production well or the injection of produced water into an injection well, and it is the longest stage in a well's life cycle ranging from a few years to over 100 years. The area of disturbance, activity, and risk of impact are all greatly reduced from the pre-production stage.
- Abandonment Stage: The last stage is when the well is no longer economically viable, or the reservoir is fully depleted of hydrocarbons. At this stage, the well is plugged with multiple layers of cement; all associated equipment and flowlines are removed; and the site is reclaimed and revegetated. There is little or no disturbance, activity, or risk associated thereafter with the site.

The following sections provide additional information on a well's life cycle, which helps to understand why some other agencies have required setbacks based on the activities within the various life cycle stages. The production and injection wells in the Fort Collins Oil Field have already been drilled, so no

pre-production activities will occur at them and based on the near depletion of the Field, it would not be economic to drill future wells in the Field. Moreover, all of the well sites are less than half an acre in size, there are no fluid storage tanks, and the surface equipment is limited to a pump and wellhead.

Pre-Production Stage: Vertical Well Drilling and Construction

Figure 3 is a Google Earth image of a vertical production well construction site with a 2-acre disturbed area, a drill rig, and the associated drilling equipment. Figure 4 depicts a typical rig used to drill the vertical well.

The downhole portion of a well is constructed in a manner to isolate and protect all known and potentially usable ground water. This is accomplished by placing a set of telescoping steel casings cemented into the drill hole.

Pre-Production Stage: Vertical Well Completion

The hydraulic fracturing phase occurs after the production well has been drilled and the steel casing cemented. The steel casing is perforated with small holes at the injection formation. Water is injected down the steel casing and through the perforations at high pressure to initiate formation fractures extending about 100 feet away from the well. After the fractures have been created, the fracture water will flow back out of the well into storage tanks. After flowback is complete, the well production stage will begin. Figure 5 shows a hydraulic fracture treatment on a vertical well.

Figure 3: Google Earth image of a vertical well drilling in 2011 on 2-acres in Weld County.

Figure 4: A typical drill rig use to drill a deep vertical hole.

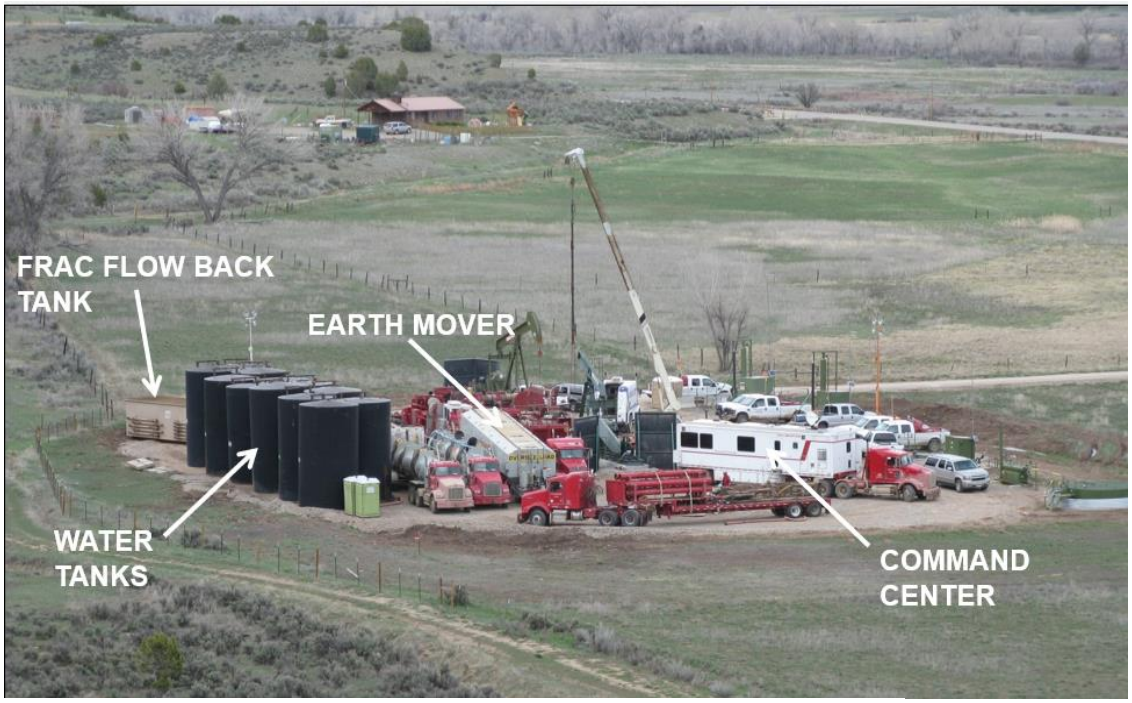

Figure 5: Hydraulic fracture job on a vertical well.

Pre-Production Stage: Horizontal Wells

For new horizontal wells, the area of disturbance, activities, and potential impacts are greatly increased. A well's horizontal portion can extend up to three miles, and multiple horizontal wells are often drilled on a single pad. The pre-production disturbed area can be 20 acres or more. The scale of operations is dramatically increased due to the large number of wells being drilled, the length of the wells' horizontal portion, the magnitude of the hydraulic fracture treatment, and the volume of oil, natural gas and water being produced. Figure 6 shows a multiple well drilling site with the numerous pieces of production equipment (separators, oil and water storage tanks, compressors, meters, emission control devises and flaring units). Figure 7 shows a multiple well hydraulic fracturing operation with the numerous pieces of equipment (hydraulic pumping trucks, water storage tanks, flowback tanks, emission control devises and flaring units). Though hard to pick out, the pickup trucks can provide a sense of scale in the images.

Figure 6: A pre-production 15-acre site drilling multiple long horizontal wells showing the drill rig and associated equipment.

Figure 7: A pre-production 15-acre site drilling multiple long horizontal wells during hydraulic fracturing of the long horizontal wells.

Possible Future Work on Existing Oil and Gas Wells in the Fort Collins Field

In the Fort Collins Oil Field, future maintenance work on existing wells would seek to maintain the wells' mechanical integrity and their ability to continue production or injection. It would also include plugging and abandoning wells that are no longer needed. This work is considered to be routine maintenance work, and it can be scheduled during daylight hours during weekdays.

Work activities might include:

- Repair of the surface or downhole pumps,
- Repair or replacement of downhole tubing or packers,
- Cleaning and opening downhole casing perforations,
- Required mechanical integrity and bradenhead testing,
- Repair or replacement of flowlines, and
- Well plugging and abandonment.

Work would be performed in a few days or less by some or all of the following:

- A small several person work crew,
- A truck mounted workover rig or pulling unit to pull and place tubing, pump, or pump rods in and out of well,
- A roundoff tank to hold any fluids which might come out of the hole during maintenance,
- A cement truck during well plugging, and
- A couple of pickup trucks.

No new production well construction would be expected in the Fort Collins Oil Field. As previously noted, the Field is depleted, and the existing production wells are low producing. Throughout the Field's long history, production wells have been drilled to various geologic formations. Production from other formations has been evaluated with little success. Therefore, deepening, or recompleting an existing production well into another formation is not a perceived future for extending the well's productive life. Also, converting an existing vertical well into a long horizontal well is not physically possible since an older vertical well was not designed or capable of managing the stresses from current hydraulic fracture treatments or production stresses present in new long horizontal wells.

WELL ABANDONMENT

At the end of a production or injection well's active life, the well is plugged with cement and other materials placed into the wellbore to prevent upward migration of fluids in the wellbore. The Ground Water Protection Council has described the plugging process as follows:

> "The purpose of well plugging is to permanently seal the inside of the well and wellbore so that fluid cannot migrate from deeper to shallower zones or create reservoir problems through downward drainage. The process involves the placement of cement and other materials such as gels inside the well or wellbore in a manner that prevents the upward or downward migration of formation fluids."

According to the COGCC, more than 27,000 wells have been plugged in Colorado. The few wells that have experienced problems are distinguishable from the Fort Collins Field because they were older wells, often abandoned prior to 1952 when the COGCC was formed. COGCC Rule 434 imposes strict requirements concerning the plugging and abandonment of production and injection wells, and it requires that plugging procedures be reviewed and approved by the COGCC staff before plugging operations take place. Rule 434 also requires the operator to install multiple cement or mechanical plugs in the wellbore, including:

- A cement or mechanical plug above any perforated interval in the well,
- A cement or mechanical plug above any unperforated hydrocarbon zones that are generally produced in the nearby vicinity,
- A cement plug across the casing stub (end) if casing is cut and pulled,
- A cement or mechanical plug above any repaired casing leaks or cementing stage tools,
- A cement plug across any freshwater aquifers not covered by surface casing or production casing cement,
- A cement plug across the surface casing shoe, and
- A cement plug at the surface 50 feet in length.

After the well is plugged, the operator must remove all of the surface equipment and the subsurface flowlines and reclaim the surface terrain. Surface reclamation involves regrading and revegetating the site to match the surrounding landscape and prevent storm water runoff. Figure 8 shows how a well is constructed with cemented steel casings and abandoned with the sealing plugs. Figure 9 shows a plugged and abandoned well in the Fort Collins Oil Field with the site reclaimed. Many plugged and abandoned wells in the Fort Collins Oil Field are currently interspersed with residential development and open space, and they have become part of the existing landscape.

The equipment needed to plug a well includes a truck mounted rig, steel tank to capture well fluids, and truck mounted pumping equipment to mix and pump cement plugs. A 75 feet reverse setback area will provide an adequate and safe area to perform the work. A 16-foot-wide access drive can provide access to the site. These distances will allow access to the well and space to stage equipment around the well.

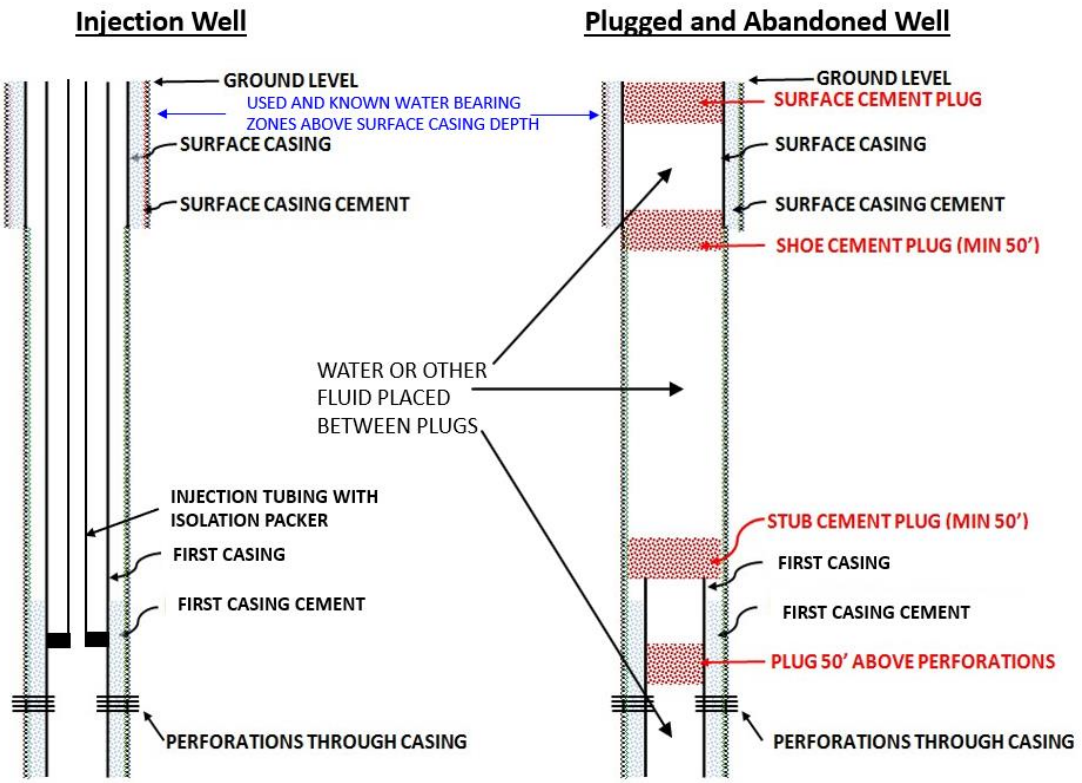

Figure 8: Depicting a plugged and abandoned injection well.

Figure 9: A plugged and abandoned well in the Fort Collins Oil Field with site reclaimed.

UNDERGROUND INJECTION WELL

An oil and gas well produces brine water, which contains dissolved salts and trace amounts of hydrocarbons. In Colorado, most of this produced water is injected deep underground into geologic formations that are 7,000 to 10,000 feet deep. These formations cannot be used for domestic or industrial purposes. These special wells are called underground injection wells, and they differ from oil and gas production wells in many ways and are regulated differently. Where production wells withdraw oil and gas from deep underground formations, underground injection wells inject water into even deeper underground formations. Accordingly, underground injection wells do not generate air emissions due to the absence of oil and gas.

In the Fort Collins Oil Field, most of the injection wells do not have storage tanks, which are a potential source of emissions according to a CDPHE report[7]. Therefore, the injection well sites have little impact on the surrounding communities and likewise pose little risk to the environment.

Disposal Well -vs- Enhanced Recovery Injection Well

There are two types of underground injection wells.

1. Disposal Wells: A disposal well permanently places produced water into an authorized deep geologic formation. Disposal wells are deep wells drilled below used or potentially useable water.

   The Fort Collins Field has one disposal well, Peterson #14-20, located just outside the City in the SW quarter of the SW quarter of section 20, Township 8 North and Range 68 West, 968 feet northeast of the intersection of Douglas and Turnberry Roads. The produced water is transported to this well by flowlines. There are no pits or storage tanks on location. The well was drilled to a depth of 6,635 feet below ground surface. By permit, only produced water from the Fort Collins Oil Field can be injected into the well. A review of COGCC Monthly Report of Operation shows this to be a low volume injection well.

2. Enhanced Recovery Injection Wells: The second injection well classification is enhanced recovery injection wells. These are injection wells drilled into existing hydrocarbon fields for enhanced recovery as discussed previously and schematically depicted in Figure 10. The result is the production of residual oil and produced water. The produced water is then recycled back into the injection well to repeat the process. There are a number of enhanced recovery injection wells in the Fort Collins Oil Field.

[7] Oil & Gas and Point Source Emissions Inventory Development, Supporting the Denver Metro/North Front Range State Implementation Plan for the 2008 and 2015 8-Hour Ozone National Ambient Air Quality Standards DRAFT: July 8, 2022, Adopted: December xx, 2022

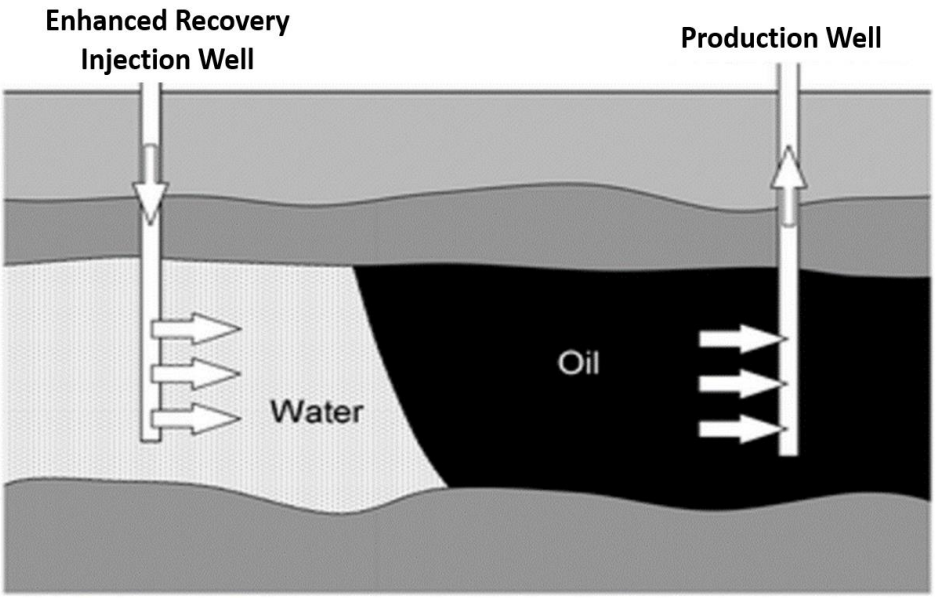

Figure 10: Schematic of waterflood showing a water injection and oil production wells

Under the Safe Drinking Water Act, EPA has regulatory authority over underground injection wells. In Colorado, EPA has delegated the permitting, monitoring, inspection, and closure of these wells to the COGCC. The COGCC's EPA authorization and the details of their underground injection program can be found at https://cogcc.state.co.us/library.html#/technicalreports.

COGCC has a robust regulatory program to authorize, permit, annually inspect, and mechanically test each injection well. The authorization process requires documentation of well construction, injection formation water analysis, fracture gradient testing, seismicity review, public, surface owner and mineral owner notifications, offset well review, water well review and a surface use agreement. The annual inspection includes an audit of surface facilities. The annual mechanical integrity testing of the wells includes an internal mechanical integrity test and external bradenhead pressure test of the casing to assure there are no well integrity issues and no potential for produced water to leak from the well bore.[8] The inspection and test results are available on the COGCC website. A summary of these test results is provided to the EPA as part of the required annual and biannual reporting.

[8] Mechanical Integrity Tests and Bradenhead Tests are used to monitor a well's integrity and identify leaks.

A Mechanical Integrity Test (MIT) of a well is a test of a casing's internal integrity used to determine if there is a leak in the well's casing, tubing, or mechanical isolation device. To perform a test an isolation packer is placed above the downhole perforations, the casing is filled with water, then a pressure is applied and held for a time. If the pressure remains stable (unchanged), the casing has integrity. If the pressure is not stable (it falls or rises) the casing does not have integrity. Reference: *COGCC Mechanical Integrity Tests - Practices and Procedures*

A Bradenhead Test of a well is a pressure measure of the annular space between the surface casing and the next smaller diameter casing string that extends up to the wellhead. Ideally a pressure reading should be zero. A pressure reading can be an indication of fluid entering the annular space.
Reference: *COGCC Bradenhead Pressure Monitoring, Testing, Management, Mitigation, and Reporting*

REVIEW OF REVERSE SETBACKS ADOPTED BY OTHER AGENCIES

State oil and gas commissions regulate where and how new oil and gas wells are drilled and produced. They have adopted varying setback requirements for this purpose. But as previously explained, the pre-production and production operations associated with new long horizontal wells involve many large-scale activities and can generate impacts that are quite different and much more significant than those associated with injection wells and plugged and abandoned wells within the Fort Collins Oil Field.

Local governments regulate new residential and commercial development. As part of that authority, some local governments have adopted reverse setbacks from existing oil and gas locations. Some of these local government reverse setbacks are overly broad and problematic because they do not distinguish between old low volume vertical production or injection wells, new multiple horizontal well locations, the presence or absence of surface production facilities, and plugged and abandoned wells; each of these well types and classifications presents different risks. As a result of these differences, some local governments have defined setbacks based on well stages: pre-production, during production, and for a plugged and abandoned well. Below is a summary of the reverse setbacks adopted by some state and local agencies.

COGCC

The COGCC has no requirements or recommendations regarding reverse setbacks. This is because the COGCC does not regulate where new residential or commercial development may occur.

EPA

As previously noted, the EPA regulates the drilling of injection wells in many states. Like the COGCC, EPA has no requirements or recommendations regarding reverse setbacks from injection wells. Nor does EPA have setback requirements for siting new injection wells away from existing buildings. All of EPA's requirements for injection well siting involve the protection of underground sources of drinking water or otherwise address subsurface conditions.

Other States

Other states reviewed were California, New Mexico, Ohio, Pennsylvania, and Texas. None of these states have reverse setback requirements from production or injection wells or address where new building development should occur.

Alberta Energy Regulator

The Alberta Energy Regulator (AER) [an equivalent to the COGCC] regulates oil and gas development in the Province of Alberta, Canada, and has adopted a reverse setback requirement for plugged and abandoned wells. Through AER-Directive 079A, *Surface Development in Proximity to Abandoned Wells*, the AER prohibits the construction of any structures over plugged and abandoned wells and

requires a 5-meter (16.5 foot) setback radius around the plugged well in case the well should need remedial work.[9]

Local governments

In Colorado, seven other Front Range cities and counties have adopted reverse setbacks for new residential and commercial developments. Several of the reverse setbacks have been adjusted based on if the well is in the pre-production, production, or abandonment stage. Six Colorado local governments include injection wells in the definition of "Production Facility" or "Well." Within these regulations, there does not appear to be a distinction between a disposal well or an enhanced recovery well. But several of these regulations require a special use permit, which would allow the local government to consider the lower risks associated with low volume enhanced recovery wells. Table 1 provides an overview of the tabulated results, which vary significantly. The full tabulated review is in Appendix A.

Well Life Cycle Stage	Reverse setback (feet)	
	Low	High
Pre-production (Drilling and Completion Activities)	150	2,000
Production Well - Horizontal Wells	150	2,000
Production Well - Vertical Well	150	2,000
Plugged & Abandoned wells	25	250

Table 1: Summary of Colorado Front Range Community reverse setback for new development based on life cycle phase.

Below are the reverse setback references for Denton, Texas and Los Angeles, California. This information too is included in Appendix A, together with reverse setbacks from local governments in Pennsylvania and New Mexico.

- Denton, Texas has a defined reverse setback of 20-feet from an abandoned well. They did not reference injection or oil wells.

- Los Angeles, California regulates new building setback through 110.4 Methane Gas Hazards, which states "*no new habitable buildings or enclosed structures can be adjacent to, or within 300 feet (91.44 m) of active, abandoned or idle oil or gas well(s) unless designed according to recommendations contained in a report prepared by a registered design professional, such as a licensed civil engineer or a licensed petroleum engineer, to evaluate whether such wells are being properly operated or maintained, or are abandoned. No permits shall be issued until documentation of proper operation, maintenance, abandonment, or re-abandonment is submitted to and approved by the Building Official."* They do not reference injection wells.

[9] Through AER-Directive 056, *Energy Development Applications and Schedules*, the AER also requires a special plan review for new development near a well producing or a facility processing sour gas. Sour gas is natural gas that contains measurable amounts of hydrogen sulfide (H_2S). https://www.aer.ca/providing-information/by-topic/sour-gas. This requirement has no application to the Fort Collins field because the field does not contain flowing sour gas.

REVERSE SETBACK RECOMMENDATIONS:

The Fort Collins Oil Field injection wells already exist, so they have none of the disturbance activities, or potential impacts associated with pre-production work as depicted in Figures 3 through 7. The surface equipment is limited to a pumping unit and wellhead. These injection wells do not produce any oil, gas, or water. They inject water into an authorized zone. They have limited visual impact, produce no emissions, generate no routine truck trips, and are virtually indistinguishable from the surrounding landscape. There are two injection wells with surface storage equipment, both are outside the City of Fort Collins.

Plugged and abandoned wells in the Fort Collins Oil Field have even less impact. The wellbore has been sealed with multiple plugs, all surface equipment and subsurface flowlines have been removed, and the surface has been reclaimed and revegetated. Many of these wells are currently part of the existing landscape and are interspersed with residential and commercial development.

State and local setback requirements for new production wells provide no useful direction on an appropriate reverse setback from existing injection wells or wells that are plugged and abandoned in the Fort Collins Oil Field. Many of those state and local requirements respond to the greater area of disturbance, activity, and potential impacts associated with horizontal production wells during the pre-production and production stages. In contrast, existing injection wells and wells that were previously plugged and abandoned do not involve any pre-production activities. A vertical production well may impact 2 or more acres as depicted in Figure 3, while a horizontal production well may impact 20 or more acres as depicted in Figures 6 & 7. In contrast, an injection well in the Fort Collins Field typically uses 1,000 square feet or less for the wellhead and injection pump, while a plugged and abandoned well has no surface impact once the site has been reclaimed.

The following are the recommendations for a reverse setback from an existing plugged and abandoned well and from an existing injection well with and without surface facilities. New building units should be prohibited within these reverse setbacks, but parks, ballfields, playgrounds, gardens, and other non-residential public spaces could be permitted within these areas.

75-Foot Reverse Setback to Plugged and Abandoned Wells:

As noted, the COGCC rigorously regulates the plugging and abandonment of wells, and it has done so for many years. After a well is plugged and abandoned, it cannot emit pollutants and the wellsite is reclaimed. In addition, the well should not require additional work. Therefore, the well does not present a risk to public health and safety or the environment. For plugged and abandoned wells, a reverse setback should be 75 feet. This recommendation is based upon the following factors:

- The plugging process has a proven record of protecting the public and the environment in Colorado and other states by preventing oil and gas from reaching useable ground water or the ground surface.

- The COGCC has not required or recommended any setback for residential structures from plugged and abandoned wells, and the Province of Alberta uses a five-meter (16.5 feet) setback requirement for this purpose. Denton, TX requires 20-feet.
- Several plugged and abandoned wells within the City of Fort Collins have setbacks of 75 feet or less from an occupied building with no discernible impact or threat to public health or safety.
- The remaining risk associated with a plugged well is the potential need to reenter and repair the well at a later time, and this contingency can be addressed through a setback of 75 feet if access to the well became necessary.
- After wells are physically plugged and abandoned, casing is cut off four to six feet below ground level and the surface area is restored. The COGCC requires all plugged wells to be surveyed using a GPS system in the event the well needs to be located at some future date. A "dry hole" marker may be placed on the surface at the landowner's discretion.
- There is no risk of natural gas in the soil surrounding a well because the Fort Collins Field is an oil field that has not produced natural gas.

In the highly unlikely event that a plugged well needs to be replugged, a truck mounted rig will need to access the well site. Additional equipment would include steel tanks to capture fluid from the well and truck mounted pumping equipment to mix and pump new cement plugs. A reverse setback of 75 feet is more than adequate for this purpose.

<u>75-Foot Reverse Setback to Injection Wells without Surface Facilities:</u>

Injection wells in the Fort Collins Oil Field generally do not contain storage tanks, and they do not produce or inject oil or gas. Produced water is transported to the injection wells by flowlines. The use of flowlines greatly reduces if not eliminates the risk of spills. There is no potential for any air emissions. Future well access is required for the operator to perform maintenance and an annual integrity test. This will require the use of a small truck mounted rig and can be completed in a few days. A reverse setback of 75 feet is more than sufficient for this purpose. This recommendation is based on the following considerations:

- The injection wells already exist, and therefore there will be no pre-production construction activities.
- The risk associated with well maintenance is limited because the well produces no natural gas emissions.
- There is no surface production equipment requiring maintenance, which could generate leaks or air emissions.
- The absence of surface production equipment eliminates nuisance noise and odors.
- All injection wells are required to perform an annual bradenhead to assure there are no leaks.
- All injection wells are required to annually perform a mechanical integrity test, which likewise ensures there are no leaks.
- Several existing injection wells without storage tanks in the City of Fort Collins have setbacks of 75 feet or less from an occupied building with no discernible impact or threat to public health or safety.

500-Foot Reverse Setback to Injection Wells with Surface Facilities:

Within the Fort Collins Oil Field, there are two injection wells with surface storage which have the potential for spills and air emissions. Both are outside the City limits. These are not large high volume production facilities, which were the basis of the COGCC 2,000-foot setback adopted in 2020, so the emission risks are much less than the risks that gave rise to the COGCC setback. Moreover, as part of the CDPHE health impact study[10], CDPHE reviewed over 10,000 ambient samples collected 500-feet or more from oil and gas active operations during pre-production and the production activities, and they found no elevated risks beyond 500 feet. With respect to these samples, the report states:

- "*All measured air concentrations were below short- and long-term safe levels of exposure for non-cancer health effects, even for sensitive populations*;" and
- *"Cancer risks for all substances were within the "acceptable risk" range established by the U.S. EPA."*

The well operator will need access to the well to perform maintenance and the annual integrity test as discussed for an injection well without surface facilities.

For the two injection wells with storage tanks within the Fort Collins Field, a reverse setback should be 500 feet. This should be more than sufficient to provide access to the well to perform maintenance and the annual integrity test, and it provides an additional buffer to address the risks of potential air emissions, noise, and other impacts associated with the storage tanks. This recommendation is based on the following considerations:

- The CDPHE study on health impacts found no elevated air samples at 500 feet or more.
- The injection wells already exist, and therefore there will be no pre-production construction activities.
- The risk associated with well maintenance is limited because the well produces no natural gas emissions.
- The storage tanks contain produced water with only traces amount of oil.
- All injection wells are required to perform an annual bradenhead to assure there a no leaks into near surface ground water.
- All injection wells are required to annually perform a mechanical integrity test, which likewise ensures there are no leaks.

CONCLUSION:

The Fort Collins Oil Field has existing injection wells and plugged and abandoned wells. Most of the injection wells in the Field have no on-site storage because the water is transported by flowlines. The absence of storage tanks eliminates the need for trucks trips to transport the injected water. With no

[10] Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado February 21, 2017.

truck traffic, the related truck noise and odor is not present to impact the surrounding community. Accordingly, there is little risk to the public and the environment.

Two injection wells in the Field have storage tanks. These are outside the City of Fort Collins. The Colorado Department of Public Health and Environment has determined oil storage tanks at oil and gas locations present a risk of air emissions. But the CDPHE health impact study found no elevated *levels of exposure for cancer or non-cancer* sample greater than 500-feet. Injection wells do not produce or inject hydrocarbons and are constructed to isolate and protect groundwater. As a result of these factors, there is limited risk to public health, safety, the environment, and wildlife.

COGCC regulations for the plugging and abandonment of a well require the well to be sealed through the placement of multiple cement plugs, including above injection perforations, at casing cut off points, at exposed aquifers, and at the surface. These plugs provide multiple layers of protection for both ground water and nearby surface occupants. Further, all surface appurtenances and flowlines are removed, and the location is reclaimed and revegetated. A plugged and abandoned well presents no meaningful risk to the public or the environment.

Under these circumstances, the following reverse setback distances are recommended to ensure that future residents are provided with a safe buffer protective of public health, safety, and the environment

- A reverse setback of 75 feet for:
    - Plugged and abandoned wells, and
    - Injection wells with no storage tanks.

- A reverse setback of 500 feet for the two injection wells <u>with storage tanks.</u>

These setback distances can still be utilized for non-residential public spaces like parks or open spaces.

REFERENCES:

Opinion Supporting 100-Foot Setbacks From Plugged and Abandoned Oil and Gas Wells within the Waters' Edge Subdivision, Larimer County, Colorado, David K. Dillion December 26, 2015

Alberta Energy Regulator: AER Directive 056: Energy Development Applications and Schedules, May 2021

Alberta Energy Regulator: AER Directive 079 Surface Development in Proximity to Abandoned Wells. November 2014

Alberta Energy Regulator: AER Bulletin 2013-03 Mandated Subdivision and Development Application Referrals, Setback Relaxations, Land Development Information Package, and Abandoned Well Information. 2013

Alberta Energy Regulator: Explaining AER Setbacks – EnerFAQ, September 2015

California Department of Conservation, Geologic Energy Management Statutes & Regulation, January 2022

COGCC Rules and Regulations, *https://cogcc.state.co.us/reg.html#/rules*

COGCC 2020 Rulemaking hearing audio for setback to newly drilled wells including the Colorado Department of Public Health and Environments presentation of the related emission:

Mission Change Rulemaking - September 4, 2020 (Morning)
https://www.youtube.com/watch?v=uHwVWCF4bCU&list=PLpwAEXLpeKye1Zq4Lbqc6OwqGt02k21Jk&index=45

Mission Change Rulemaking - September 4, 2020 (Afternoon)
https://www.youtube.com/watch?v=8o9L77TLNrw&list=PLpwAEXLpeKye1Zq4Lbqc6OwqGt02k21Jk&index=44

Mission Change Rulemaking - September 8, 2020 (Morning)
https://www.youtube.com/watch?v=tq_nd6McivU&list=PLpwAEXLpeKye1Zq4Lbgc6OwqGt02k21Jk&index=43

Mission Change Rulemaking - September 8, 2020 (Afternoon)
https://www.youtube.com/watch?v=TuBOT7cxqk8&list=PLpwAEXLpeKye1Zq4Lbqc6OwqGt02k21Jk&index=42

Mission Change Rulemaking - September 9, 2020 (Morning)
https://www.youtube.com/watch?v=2KkJCq5Bl7w&list=PLpwAEXLpeKye1Zq4Lbqc6OwqGt02k21Jk&index=41

CDPHE:
https://www.youtube.com/watch?v=seeI_gd3TzY&list=PLpwAEXLpeKye1Zq4Lbgc6OwqGt02k21Jk&index=46

Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado February 21, 2017

Oil & Gas and Point Source Emissions Inventory Development, Supporting the Denver Metro/North Front Range State Implementation Plan for the 2008 and 2015 8-Hour Ozone National Ambient Air Quality Standards DRAFT: July 8, 2022, Adopted: December xx, 2022,

Appendix A

OTHER COMMUNITIES	REGULATION	SETBACK	NOTES
Los Angeles, California	110.4 Methane Gas Hazards	300 ft.	No new buildings or enclosed structures, additions, or conversions of a building or structure to habitable or occupiable space regulated by this Code on, adjacent to, or within 300 feet (91.44 m) of active, abandoned or idle oil or gas well(s) unless designed according to recommendations contained in a report prepared by a registered design professional, such as a licensed civil engineer or a licensed petroleum engineer, to evaluate whether such wells are being properly operated or maintained, or are abandoned. No permits shall be issued until documentation of proper operation, maintenance, abandonment, or re-abandonment is submitted to and approved by the Building Official.
			Exceptions: 1. When approved by the Building Official, mitigation of methane gas hazards shall not be required for additions or alterations to existing buildings or structures located no closer than 200 feet (60.96 m) to active, abandoned, or idle oil or gas well(s).
			2. Grading permits may be issued when the proposed work is necessary to mitigate the methane gas hazard.
	22.310.050 Oil Field Development Standards	400 ft.	Drilling and Redrilling Setbacks. The following setbacks shall apply within the oil field for drilling or redrilling: a. At least 400 feet from developed areas.
		20 ft	b. At least 20 feet from any public roadway.
		500 ft develop area 200 ft public road	No new storage tank, excluding a replacement tank, shall be constructed closer than 500 feet from any developed area, or closer than 200 feet from a public road.
		50 ft	No building shall be constructed within 50 feet of any oil storage tank
Denton, Texas	6.2.2 - Required Authorization for Gas Well Development in City Limits.	500 feet	Reverse Setback
Butler County, Pennsylvania	§ 204-5. Design and installation requirements		Oil and gas development is part of the Municipalities Planning Code Chapter 252 and Chapter 300: D. Drilling rigs shall be located a minimum setback distance of 1.5 times their height from any property line, public or private street, and building.
San Juan County, New Mexico	No defined setback distance from oil and gas well		

COLORADO COMMUNITIES	ORIGINAL SETBACK	UPDATED SETBACK	NOTES
Fort Collins	2,000' for all well types 150' PA*	TBD	Min. 500' for residential and 1000' High Occupancy Buildings, or matches COGCC, whichever greater Buffers cannot contain playgrounds, parks, rec fields, community gathering spaces Properties separated by a major road are not subject to setbacks. Only applies to residential and High Occupancy Buildings
Larimer County	NA	1,000' Pre-production 200'-500' Producing 50'-200' PA	Setbacks range from producing wells based on number of wells on well pad Setbacks can be reduced from 200' to 50' for PA Applies to residential, commercial, and mixed-use Does not apply to agricultural, industrial, or open space uses
Arapahoe County	NA	250' All OG phases and well types 150' PA	Applies to all occupied structures
Broomfield	200' Residential 500' Schools 50'-100' PA	2000' Horizontal wells (any phase) 2000' Pre-production (Vertical wells) 500' Producing (Vertical wells) 150'-250' PA	Applies to residential and schools Differentiates horizontal and vertical wells because of scale of operations and duration to drill/complete
Commerce City	NA	1,000' 150' PA	Applies to residential only
Erie	350' residential, parks	2,000' Pre-production 500' Producing 50'-150' PA	Applies to all buildings approved for human occupation
Longmont	750' for occupied buildings, sports fields, playgrounds 150' PA	No change	
Westminster	350' from all buildings	2,000' for all well types and buildings 200' PA	Applies to all buildings approved for human occupation 95% built out so no impact to future land use/development

Ellsworth Engineering Associates, LLC
7716 S. Harrison Circle, Centennial, CO 80122
Tel 303.489.5190

MEMORANDUM

To:	Bill Swalling, Actual Communities, Inc
Cc:	David Neslin, Davis Graham & Stubbs LLP
From:	Stuart Ellsworth, P.E., Ellsworth Engineering, LLC
Date:	May 26, 2023
Subject:	Response comments to Kirk Longstein inquiries regarding reverse setbacks at Water's Edge/Sonders properties.

Kirk Longstein, City of Fort Collins, Senior Environmental Planner, has posed questions about oil and gas facilities and reverse setbacks in his email correspondence. He expressed concerns that benzene levels may increase due to hydrocarbon contamination in the surrounding groundwater and gas that has leaked from a well into the surrounding ground surface (soil gas).

Water's Edge/Sonders acknowledges the City's concerns related to oil and gas production and the creation of appropriate reverse setbacks to protect health, safety, and welfare, and wishes to facilitate a better understanding of how appropriate reverse setbacks may be crafted within Fort Collins The focus of Water's Edge/Sonders input has focused on plugged and abandoned wells and water injection wells. since these are the well types which impact their properties. Water's Edge/Sonders has previously provided the City with the following three documents related to plugged and abandoned wells and water injection wells:

- *Opinion Supporting 100-Foot Setbacks From Plugged and Abandoned Oil and Gas Wells within the Waters' Edge Subdivision, Larimer County, Colorado*, David K. Dillion December 26, 2015.
- *Report and Recommendation Regarding Appropriate Reverse Setbacks From Injection Wells and Plugged and Abandoned Wells in the Fort Collins Field,* October 13, 2022.
- Comments on oil and gas facilities regulations and setbacks proposed by the City of Fort Collins, December 6, 2022

Foremost in this discussion, is to clarify that **injection wells in the Fort Collins Field are more similar to water wells than producing oil wells**. These injection wells inject relatively fresh water. These **injection wells do not produce or withdraw any oil or gas** to the surface, **nor do they produce any emissions**.

Oil and gas wells produce oil and gas fluids released at the surface and have the potential for related emissions and other impacts. The produced oil and gas can contain benzene. At a producing oil and gas well, Mr. Longstein's concerns do have a basis for the City to use reverse setbacks as one method to protect public health and safety.

For injection wells within the Fort Collins Field, the injected water has had the oil and gas removed prior to being injected into the well. The water is injected through a combination of 3/8-inch thick steel casings cemented into the ground to a depth of about 5,034 feet below the ground surface. Mr. Longstein's concerns for benzene and soil gas in the ground should be alleviated because:

- No oil and gas is in the injected water. Therefore, no elevated benzene levels would be present.
- The injected water contains no gas. Therefore, no soil gas potential is present at the injection well.

The injection water is relatively fresh. EPA's Total Dissolved Solids (TDS) threshold standard is 10,000 ppm for potential useable water. A review of the COGCC Fort Collins Field online documents has water analysis reporting Total Dissolved Solids (TDS) levels between 2,243 to 14,906 ppm. A 2018 water analysis reports the TDS level at 9,372 ppm.

Longstein Question 1*: Ellsworth states: "The COGCC has no requirements or recommendations regarding reverse setbacks. This is because the COGCC does not regulate where new residential or commercial development may occur."*

It's true that home rule and SB181 grant local authority to regulate surface activities including land use planning; however is there a common understanding that COGCC Rule 604 provides presumptive setbacks from high occupancy buildings?

COGCC Rule 604 defines where the state oil and gas commission (now, Colorado Energy and Carbon Management Commission, CECMC) will allow a new well to be constructed when in proximity to an existing building. The State Commission has no authority as to where new buildings are constructed.

Longstein Question 2*: Ellsworth states: "Two injection wells in the Field have storage tanks. These are outside the City of Fort Collins. The Colorado Department of Public Health and Environment has determined oil storage tanks at oil and gas locations present a risk of air emissions. But the CDPHE health impact study found no elevated levels of exposure for cancer or non-cancer sample greater than 500-feet. Injection wells do not produce or inject hydrocarbons and are constructed to isolate and protect groundwater."*

Curious if you can provide the CDPHE health impact study that you reference in your recommendations that connects Injection wells to a 75' reserve setback. Also, It's my understanding that the industry standard is at least 150' to access the well for ongoing operations, are you seeing other BMP standards? If I'm understanding the recommendation correctly, because there are no storage tanks at the well head, then there is no elevated risk of exposure to nearby residences; is that correct? also, the Ellsworth study references the storage site as being the primary source of contamination/risk related to the Injection site, however, does not reference surface disturbance from on-going operations. Curious if you have supporting analysis related to ongoing operations/surface disturbances at the injection well and its risk to public health?

The Colorado Department of Health and Environment (CDPHE) reference documents (CDPHE Studies)[1] [2] are attached. The Ellsworth Report footnoted these studies. They are easily available on the internet. The CDPHE Studies are:

[1] Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado February 21, 2017

[2] Oil & Gas and Point Source Emissions Inventory Development, Supporting the Denver Metro/North Front Range State Implementation Plan for the 2008 and 2015 8-Hour Ozone National Ambient Air Quality Standards DRAFT: July 8, 2022, Adopted: December xx 2022.

- *Oil & Gas and Point Source Emissions Inventory Development, Supporting the Denver Metro/North Front Range State Implementation Plan for the 2008 and 2015 8-Hour Ozone National Ambient Air Quality Standards DRAFT: July 8, 2022, Adopted: December xx, 2022*
- *Assessment of Potential Public Health Effects from Oil and Gas Operations in Colorado February 21, 2017*.

The CDPHE Studies focused on emissions from an oil and gas well during the construction, hydraulic fracturing, and production operations. The results pointed to hydraulic fracturing and storage tanks as the main emitters of emissions. The CDPHE Studies did not discuss injection wells. The CDPHE Studies do not discuss a setback distance from an injection well.

Because the CDPHE Studies pointed to storage tanks as an emission source, the Ellsworth Study (Report and Recommendation Regarding Appropriate Reverse Setbacks from Injection Wells and Plugged and Abandoned Wells in the Fort Collins Field) reasons that due to the absence of storage tanks there no tanks emissions. Due to oil and gas being removed from the water prior to transport to the injection well, there is no potential for oil or gas emissions at the well. The water is injected into the well with electric injection pumps. Therefore, there are no motor emissions. **Based on these points of reason, the Ellsworth Report recommended a 75-feet reverse setback.**

Longstein Question 3*: Also, It's my understanding that the industry standard is at least 150' to access the well for ongoing operations, are you seeing other BMP standards?*

Yes, the Industry has agreed to a 150 ft area around existing oil and gas wells in order to perform well maintenance. This distance allows for larger equipment layouts needed for oil and gas well operations like hydraulic fracturing. Therefore, a setback of 150' is adequate for existing oil and gas wells. Large maintenance operations and hydraulic fracturing jobs can utilize numerous BMPs to minimize the impacts from noise, odors, emissions, traffic, and other similar nuisances to provide public and environmental protections.

Injection wells in the Fort Collins Field will never utilize large maintenance operations like hydraulic fracturing due to the high cost and reservoir dynamics. The maintenance on these wells will entail down hole clean out, the required 5-year mechanical integrity test, or well abandonment. These operations will use a small truck mounted rig, a cement truck, a roll-off fluid container and a small number of pick-up trucks. Therefore, **a reverse setback of 75-feet is adequate for these operations** and provides public protection.

Longstein Question 4*:*

a.) *If I'm understanding the recommendation correctly, because there are no storage tanks at the well head, then there is no elevated risk of exposure to nearby residences; is that correct?*
b.) *also, the Ellsworth study references the storage site as being the primary source of contamination/risk related to the Injection site, however, does not reference surface disturbance from on-going operations. Curious if you have supporting analysis related to ongoing operations/surface disturbances at the injection well and its risk to public health?*

Yes, no storage tanks at the injection well results in no elevated exposure risk from emissions to nearby residences due to the absence of an emission source.

No health studies have been found regarding a water injection well that has no storage tanks. In an effort to seek a reference document or study, EPA was contacted, and an internet search was conducted. In an email exchange with EPA regarding reference documents on air emissions related to enhanced recovery injection wells, EPA did not have any to refer. To quote the email response: *"I looked for references discussing air quality impacts related to secondary enhanced recovery injection wells. There is very little info on this topic. I think this is because secondary injection operations for enhanced recovery do not result in any significant air emissions."*

An internet search on air emissions related to enhanced recovery injection wells, the response only referred to thermal injection for heavy oil (thick low gravity oil), which would never be applicable at the Fort Collins Field due to the oil being light high gravity oil.

The ongoing operations/surface disturbances at the Fort Collins Field is a periodic pickup truck checking the injection pump and wellhead. The injection wells do require a mechanical integrity test every 5 years, which would be a truck mounted rig to pull out the injection tubing and test the well's integrity. Hence, the public health risk is very limited and benefitted by the mechanical integrity test assuring the well has integrity and does not leak into ground.

Longstein Question 5*: Should plugged and abandoned and dry and abandoned wells receive a 150-feet setback from all new occupiable buildings?*

In the Ellsworth Study, background on the field is discussed. Further, a description of how wells are abandoned is included. Based on this background, pages 17 and 18 present a recommendation for a 75-foot reverse setback from abandoned wells. A 75 feet reverse setback is adequate for public protection based upon the following factors:

- The plugging process has a proven record of protecting the public and the environment in Colorado and other states by preventing oil and gas from reaching useable ground water or the ground surface.
- Several plugged and abandoned wells within the City of Fort Collins have setbacks of 75 feet or less from an occupied building with no discernible impact or threat to public health or safety.
- The remaining risk associated with a plugged well is the potential need to reenter and repair the well at a later time, and this contingency can be addressed through a setback of 75 feet if access to the well became necessary.
- After wells are physically plugged and abandoned, casing is cut off four to six feet below ground level and the surface area is restored. The COGCC requires all plugged wells to be surveyed using a GPS system in the event the well needs to be located at some future date. A "dry hole" marker may be placed on the surface at the landowner's discretion.
- There is no risk of natural gas in the soil surrounding a well because the Fort Collins Field is an oil field that has not produced natural gas.

Longstein Question 6*: Should all producing wells receive a 2000' setback from all new occupiable buildings?*

In the CDPHE Studies, elevated levels of emissions were noted during the pre-production phase of an oil and gas well. This is when a well is being constructed and hydraulic fracturing may occur. Emissions from hydraulic fracturing operations were the primary basis of the State's 2000-foot setback. CDPHE Studies also noted during a well's production stage emissions from storage tanks decreased to below health standard at the 500-foot distance.

On page 16 of the Ellsworth Study, it was noted that some Front Range Communities have adopted two reverse setbacks: a pre-production and production setback. It is believed that the Communities based the pre-production and production setback on the CDPHE Studies. They adopted a 2,000-foot pre-production setback for new well construction and hydraulic fracturing operations and a 500-foot production setback while an oil and gas well is in production.

Longstein Question 7*: Should injection wells receive a 150' 500', or 2000' setback?*

It is understood that the City of Fort Collins has banned commercial injection wells within the city limits. The discussion here is in regard to enhanced recovery wells. As noted in the Ellsworth Report, the CDPHE Studies have made a clear distinction that a majority of emissions coming from a producing oil and gas location originate from the storage tanks.

Therefore, it is inferred that both the absence of storage tanks and the oil and gas being removed from the water prior to being piped and injected in the injection well, no emissions and no emission impacts to the public are present. Ellsworth Report Page 18 provides the following basis for a 75-foot reverse setback:

- The injection wells already exist, and therefore there will be no pre-production construction activities.
- The risk associated with well maintenance is limited because the well produces no oil or gas hence no production associated emissions.
- There is no surface production equipment requiring maintenance, which could generate leaks or air emissions.
- The absence of surface production equipment eliminates nuisance noise and odors.
- All injection wells are required to perform an annual bradenhead to assure there are no leaks.
- All injection wells are required to perform a mechanical integrity test, which ensures there are no leaks.
- Several existing injection wells without storage tanks in the City of Fort Collins have setbacks of 75 feet or less from an occupied building with no discernible impact or threat to public health or safety.