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CRESTONE PEAK
RESOURCES

Cumulative Impact Plan[1]

[1] COGCC 304 c. 19.A.-D.

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1.0 INTRODUCTION

All impacts are important and must be identified and mitigated when necessary. The following narrative intends to address specific cumulative impact estimations that align with the requirements of Rules 304.c.(19) and 303.a.(5) as well as inform the corresponding COGCC Form 2B.

When planning a new project, Crestone Peak Resources, LLC (Crestone) engages a team(s) of subject matter experts to aid in the siting of the future wells and facilities. These teams have demonstrated expertise in air quality, wildlife and biological resources, and other important cultural and environmental resources necessary to identify potential sites for an Oil & Gas Location. They are utilized throughout the project lifecycle to ensure impacts are identified and avoided, minimized, and/or mitigated. The ultimate goal is to develop a project that allows for subsurface mineral development while minimizing the impacts to the surrounding community that could result from surface development necessary to support the project. The Shelton CPR-25 Oil and Gas Development Plan has been designed to do just that – protect public health, safety, welfare, wildlife resources and the environment. The Shelton CPR -25 Pad location was chosen as it is located ~2835' away from the nearest Residential Building Unit, clear of any wildlife or biological resources, and minimizes impacts while developing the proposed minerals in the most effective way possible.

For every car that leaves the garage, there is a car exiting the road and coming home. A similar analogy can be used to describe oil and gas production – production begins declining from the very first day. Further, for any well that comes online, there is another well facing the twilight years of its productive life. Therefore, cumulative impacts for an Oil & Gas Location are not entirely comparable to long-term stationary source impacts such as mines, power plants, or gravel pits. By comparison, legacy oil and gas wells had significantly higher emission profiles when they were new; the emissions intensity of a facility that was developed in 2000 would have been markedly higher than the emissions intensity of a facility developed in 2022. This is undisputed and needs to be considered when assessing the potential impacts resulting from project approval. Currently, Crestone intends to permanently retire ~11 wells and associated production facilities within the development area. The retirement of these assets will result in a reduction in emissions that originate from oil and gas production operations in the area. Additionally, 6 acres will be reclaimed and returned to the surface owner(s) for their use and enjoyment as a result of these retirements.

This Cumulative Impact Plan (CIP) outlines Crestone's proposed project including facility design, operations, and maintenance procedures, which are tailored to reduce impacts during every phase of development and, more importantly, are protective of public health, safety, welfare, wildlife resources and the environment. This plan will also detail what is being done to avoid/eliminate, minimize, or mitigate potential impacts to other resources including water, soil, and wildlife resources.

2.0 AIR RESOURCES

This section will describe each phase of development relative to potential impacts to air resources as well as mitigation measures that will be employed to reduce or eliminate these potential impacts. Each phase of development and the potential emissions associated therewith have been estimated and catalogued in the Cumulative Impacts Data Evaluation Repository (CIDER). These emission estimates are known as "Bottom Up[2]" estimates. See **Appendix A**.

2.1 PHASES OF OIL & GAS DEVELOPMENT

The following section describes the life cycle of a well pad. The Pre-Production Operations phases – e.g., construction, drilling and completions – comprise a much shorter time than the Production Operations phase and subsequent abandonment.

2.2 PRE-PRODUCTION OPERATIONS

2.2.1 Construction

Well pad construction could take place over an estimated period of up to 2 months and will consist of the construction of a graded, level surface for wells and support equipment as well as the construction of an access road portions of which already exist and only require improvement of the existing roadway.

During the construction phase of the pad, there will be limited air emissions. Emissions will be limited to those result from the use of earth moving equipment (i.e., internal combustion engines) and dust generated from construction activities and vehicular traffic. These types of emissions are generally consistent with those generated during agricultural activities or other land development activities.

2.2.2 Drilling

Each well will take approximately 4 to 6 days to drill to total depth. The drilling rig that will be utilized to drill the wells to total depth will be powered by on-site power generation. This power will be generated by diesel-powered engines. These engines require refueling approximately once a day and typically consume approximately 2600 gallons of fuel every 24-hours (note – daily fuel consumption varies by season; slightly more fuel is consumed during the colder temperatures).

During drilling operations, air emissions can be summarized in three (3) categories: i) emissions resulting from the use of the drilling rig and associated support equipment (i.e., front end loader, crane, etc.), ii) emissions resulting from drilling operations (i.e., mud break-out, pipe connections, etc.), and iii) dust emissions generated from vehicular traffic. Although little can be done to mitigate the exhaust emissions from internal combustion engines (e.g., category i), these types of emissions are short-lived and quickly dispersed. Crestone has applied to the local utility in hopes that the electrical grid is capable of providing utility power for drilling operations. It is Crestone's preference to use an electrified drilling rig at the Shelton CPR-25 Pad location. If the electrical grid has the capacity to supply additional electrical load needed for drilling, Crestone will utilize an electric drilling rig for drilling operations.

The latter two (2) categories can be addressed with the utilization of best practices to lessen the potential impacts to surrounding stakeholders. The drilling rig uses a closed-loop fluid management system that uses

[2] "Bottom Up" estimates emissions from statistical analysis or industry-standard emission factors.

a series of closed containers (i.e., tanks) and solids control equipment that eliminates the need for a conventional drilling pit. The addition of this equipment allows the drilling fluids to be managed, stored, and reused without exposure to the atmosphere.

2.2.3 Completions

The final stage prior to production is Completions which includes hydraulic fracturing, prepping the wellbore for production (i.e., drill-out, tube-up), and well flowback

2.2.3.1 HYDRAULIC FRACTURING

Hydraulic fracturing, also referred to as stimulation, will be carried out using Tier 2 hydraulic pumps, portable equipment, and include the use of portable tanks to capture and store completion fluids. Wells are often fractured in groups that generally consist of 3 wells. Although a group is created, each well is fractured individually in a series of stages. Operations on a group are continuous and may extended over five (5) days or more depending on the lateral length (e.g., horizontal distance) of the wellbore(s) and operational performance of each stage(s).

During hydraulic fracturing operations, emissions can be summarized in three (3) categories: i) emissions resulting from the use of hydraulic pumps and other associated equipment, ii) emissions resulting from wellhead and related operations (i.e., swapping of equipment, wellbore preparation between stages, etc.), and iii) dust emissions generated from the use of sand and vehicular traffic. Although little can be done to mitigate the exhaust emissions from internal combustion engines (e.g., category i), these types of emissions are short-lived and quickly dispersed.

The latter two (2) categories can be addressed with the utilization of best practices to lessen the potential impacts to surrounding stakeholders. When connections are made between equipment, tanks, or a combination thereof, the practice of 'blocking and isolating' is employed for wellhead and related operations. Simply stated, the goal is to isolate equipment, piping, or tanks through the use of isolation valves (or similar) to minimize or eliminate emissions when swapping equipment or entering the wellbore. It has been Crestone's experience that this practice results in negligible emissions of formation constituents into the atmosphere.

Sand is a major constituent in hydraulic fracturing operations. Sealed containers are used to store and transport sand on location ultimately reducing the likelihood of sand becoming airborne. Affectionately referred to as 'sandboxes', the use of these containers eliminates the traditional use of open-top sand hoppers and transportation via conveyor belt or similar methods. Worker and public exposure to silica dust has been drastically reduced through the use of sandboxes.

2.2.3.2 DRILL-OUT & TUBE-UP

The drill-out process utilizes a coiled-tubing unit (CTU) to drill out the plugs that were installed in the horizontal wellbore following each stage of the well stimulation. It takes between 3-4 days to drill-out a horizontal well in the DJ Basin. Throughout this process, the wellbore is overbalanced whereby the pressure within the wellbore is greater than the reservoir pressure which prevents the reservoir fluids and gases from entering the wellbore. It is possible that minor amounts of reservoir fluids will be entrained in the wellbore fluid and brought to surface. When this occurs, these fluids or gases will be routed to an emissions-controlled tank (i.e., oil, water) or to combustion device (i.e., gas) with a destruction efficiency of at least 98%.

Once all the plugs have been drilled out from the horizontal wellbore, production tubing will be installed. Generally, production tubing can be installed in a single well in one (1) day. Installation of production tubing is done when the wellbore is pressurized thereby requiring specialized equipment. Similar to CTU operations, when fluids or gases are encountered during installation, they are routed to an emissions-controlled tank (i.e., oil, water) or to combustion device (i.e., gas) with a destruction efficiency of at least 98%.

It has been Crestone's experience that these practices employed during drill-out and tube-up result in negligible emissions into the atmosphere.

2.2.3.3 WELL FLOWBACK

Flowback is the process required to bring a well into production. Historically, flowback has required the use of temporary equipment (i.e., tanks, production equipment, etc.) which was used to allow a well to produce while it was "cleaning up". More recently, Crestone has employed a flowback process that eliminates the need for most temporary equipment, routes the well streams through permanent production equipment, and ensures that all gas produced is produced into a sales pipeline thereby eliminating the practice of venting or flaring. With this new flowback process, the only temporary equipment typically needed is a sand knockout (SKO) which is installed downstream of the wellhead and upstream of the separator. The purpose of this equipment is to remove any sand that is entrained with the production stream before it enters the separator. These SKOs need to be periodically emptied to avoid getting filled up (note – a good analogy is the garbage can in a kitchen; it needs emptied before it fills up). Any sand or other solids trapped in the SKO are removed from the container by using compressed air to blow the sand into an open-top tank (note – the open-top tank is also temporary equipment). The open-top tank is ultimately loaded onto a truck and taken to an approved and permitted commercial disposal location for final disposition.

It has been Crestone's experience that emptying SKOs results in negligible emissions to the atmosphere.

2.3 PRODUCTION OPERATONS

2.3.1 PRODUCTION

During the final and longest phase of the well pad, wells will produce through a three-phase separation process where the well stream is separated into individual production streams: gas, oil, and water. Following separation, the gas will be routed to the natural gas sales pipeline. The natural gas may require compression to meet the pressure requirements of the midstream infrastructure. When required, compression is typically done in tandem with additional separation processes that rely on the vapor recovery units/towers (VRT). The use of VRTs increase the recovery efficiency of the gaseous hydrocarbons by providing an additional phase(s) of separation of gas from the liquid phase of the well stream.

The liquid well streams (e.g., oil and water) will enter an additional phase of separation (note – typically referred to as bulk separation) to remove any residual gas from the oil. This stage further stabilizes the oil and reduces the potential for emissions. The produced oil is then transferred into the oil storage tanks on location and sent to an oil pipeline. In the event the pipeline is down for maintenance, oil will be loaded on to trucks via a Lease Automated Custody Transfer (LACT) system for transportation off-site. The LACT system utilizes a metering system that automatically transfers oil into the truck, which will allow for truck vapors to be captured and combusted by a combustion device with a destruction efficiency of at least 98% as opposed to the traditional method of venting to the atmosphere. Once the water stream has been separated from the oil stream, it will be stored on-site in controlled water storage tanks and transported off-site via truck.

The proposed Oil and Gas Location will be constructed with automated monitoring to continually assess the functionality of systems. Operating parameters such as pressure, temperature, flow volume and rate, and other related information will be monitored remotely 24 hours a day. In the event any of these parameters deviate from an acceptable tolerance(s), alarms are triggered and notifications are transmitted to the appropriate personnel. Depending on the identified deviation, lease operators will be able to isolate the problem, redirect the process, or shut-in the well, facility, or entire location if necessary. The automation described above is meaningful as it ensures the capabilities necessary to prevent emission events from occurring in a manner that could impact public health and safety.

Crestone has performed a regionally-based air modeling and emissions inventory on a project similar to the proposed Shelton CPR-25 pad. The air modeling emission inventory was completed by a third-party consultant in July 2017. The model and emission inventory were conducted on a very conservative basis and included more wells and a longer duration relative to Shelton CPR-25. This study drew the following conclusions:

- Project-only air quality impacts were shown to be below the applicable ambient air quality standards.
- The highest impacts occurred near the immediate boundary of the well pad(s) and were drastically reduced at receptors beyond the immediate boundary of the well pad(s).
- Any impacts that were identified at residential receptors were well below the NAAQS.
- A human health risk assessment shows that risks associated with BTEX are below both the chronic and acute Reference Exposure Levels ("RELs").

It has been Crestone's experience that normal production operations result in negligible emissions to the atmosphere. This observation is supported by dispersion modeling, real-time air quality monitoring, and data collected by the Colorado Department of Public Health and the Environment (CDPHE).

3.0 PUBLIC HEALTH IMPACTS

In 2019, Crestone hired a third party expert (Center for Toxicology & Environmental Health, LLC or "CTEH") to design and perform studies to characterize the short-term impacts on local air quality and public health from discrete operational phases at four oil and natural gas well pads being developed in Weld County, Colorado.[3] It is important to note that Crestone is using the same technologies and practices for the Shelton CPR-25 Pad as was used in the four locations in Weld County. See **Appendix B** for the finalized report.

The specific goals of this project were to:

- Collect a high-resolution data set of chemical concentrations in air near the well pad and the surrounding communities; and
- Evaluate the impact on risks to public health, if any, from the release of oil and gas-related compounds into the air during specific operational phases of well development.

CTEH conducted real-time air monitoring for total VOCs, hydrogen sulfide, particulate matter, and specific VOCs (such as benzene), simultaneously with other measurements. More than 5,000 total measurements were collected in real-time by CTEH personnel over a period of 26 days.

These data, combined with corresponding documented wind directions, suggest that oil and natural gas-related analytes that may come from the four well pad studies, are not migrating to the surrounding communities to any significant extent. The report included the following statement: "Thus, the real-time and analytical data indicate no adverse health risks to nearby communities, including sensitive individuals, from cumulative exposures to VOCs that may be emitted from pre-production and production activities at Crestone well pads." Since Crestone is planning to use the same practices, technologies, and practices for the Shelton CPR-25 Pad as was used in the four locations in Weld County, we are assuming the same conclusion can be relied upon.

Continuous Monitoring and Air Quality Testing

Crestone monitors wells during each operational phase through its FLIR camera program to verify that sites are operating correctly and in compliance with regulations. Additionally, Crestone adopted a real-time, continuous air quality monitoring program using technology from Project Canary at its horizontal well sites, representing about 80% of total production. Crestone will implement continuous monitoring at the Shelton CPR-25 facility per CDPHE Regulation 7. The monitoring will follow all CDPHE requirements. These monitors will be located based on the prevailing winds determined during the baseline monitoring period as well as to avoid sounds walls and equipment. They will continuously monitor for methane, total VOCs, , particulate matter, and meteorological conditions.

[3] Community Exposure and Health Risk Assessment: Real-Time Air Monitoring and Air Sampling, Crestone Peak Resources, Weld County, CO, written by CTEH, The Science of Ready, dated December 11, 2019.

4.0 WATER RESOURCES

There are above- and below-ground mechanisms by which hydraulic fracturing activities have the potential to impact water resources. These mechanisms include water withdrawals in times of, or in areas with, low water availability; spills of hydraulic fracturing fluids or produced water; below ground migration of liquids and gases resulting from poor wellbore construction practices; and inadequate treatment and discharge of wastewater.

Water Sourcing

Water is a major component of nearly all hydraulic fracturing operations. It typically makes up more than 90% of the fluid volume injected into a well. The water used in hydraulic fracturing activities represents less than 1% of total annual water use and consumption in the United States. Coordination with other water uses is necessary to minimize potential conflicts with end users – i.e., agriculture, irrigation, etc.

Crestone has recently changed its wellbore spacing methodology which has helped minimize or eliminate impacts including water acquisition. As water recycling becomes more feasible and accessible in the basin, Crestone will utilize recycled water in more of its operations.

Groundwater Protection

Colorado mandates a strict casing and cementing program for all wells drilled within the State. Specifically, groundwater that has been classified as Domestic Use-Quality, Agricultural Use-Quality, Surface Water Quality Protection, or Potentially Usable Quality pursuant to 5 C.C.R. §1002-41, or groundwater that has not been classified by statute but exhibits total dissolved solids less than 10,000 mg/l requires isolation from the wellbore and all potential flow zones. Crestone uses 9-5/8" steel surface casing is set to a depth at least fifty (50) feet below the base of the deepest known groundwater subject to the above-captioned criteria. Typically, the surface casing set depth is approximately 1500' below ground surface and is generally synonymous with the base of regional Fox Hills or Upper Pierre aquifer (or its correlative geologic unit). Once the casing is set, it is fully-cemented in place using the displacement method thereby placing specialized cement from the bottom of the surface casing back to surface. The COGCC reviews all Form 02 Applications for Permit to Drill for adequate surface casing setting depths and cementing programs based on subsurface ground water maps prepared by the State Water Engineer, offset well data, and all available water well data.

Additionally, prior to operations, Crestone performs a Geotechnical investigation to check for depth of ground water and soil suitability. The investigation concluded that water was not encountered in any of the bore holes. Thus, shallow groundwater is not a concern at this location.

Additional information on the importance of groundwater protection can be found on the Groundwater Protection Council's website - *https://www.gwpc.org/topics/hydraulic-fracturing/what-is-hydraulic-fracturing/* .

Surface Water Protection

Surface water has the potential to be impacted when a leak or spill occurs on location. Crestone has reviewed the location and was unable to identify any contamination pathways to water resources within 2640' of the Shelton CPR-25 Pad. In an effort to eliminate events that may cause impacts, Crestone employs various forms of isolation barriers and containment systems around equipment and storage areas. During drilling and completions operations, Crestone installs a polyethylene liner across portions of the location as an isolation barrier. The drilling rig and associated equipment (including fluid storage areas) are placed atop the liner. Similarly, the major equipment used during completions is sited atop the liner. Fluids other than freshwater are stored atop the liner as well. An engineered containment system is constructed around/beneath the production facilities (i.e., tanks, separators, etc.). The containment system is constructed of perimeter walls that are post driven into the ground around a flexible geotextile base. All components including the underlayment are sprayed with a polyurea liner technology. This liner technology maintains seamless impermeability and puncture resistance and maintains it performance under exposure to UV rays, weather extremes, and those chemicals commonly used during operations and maintenance of the wells and facilities. As required by federal regulations (e.g., 40 CFR Part 112), a Spill Prevention, Countermeasure, and Control Plan (SPCC Plan) is developed for each location taking into account site-specific conditions (i.e., containment capacities, flow-direction, etc.) to inform an appropriate response should one be warranted.

In the unlikely event that the loss of primary containment results in a discharge of produced water or hydrocarbons, nearby surface water(s) may be impacted. Fluid transport depends on a number of variables – i.e., volume, duration, composition of fluid, slope (both engineered and native slope), land cover, etc. Crestone designs its well pads in such a manner that helps to prevent fluid migration off location. Further, Crestone has developed a robust spill identification and response program. In the event of a release of fluids, there are provisions for immediate notification to designated company representative. Coincident with the notification, a series of response procedures is put into motion. Provided the procedure can be safely executed, immediate action is taken to stop the active discharge of fluid. Spill response resources are deployed as necessary to aid in the response efforts, to begin the impact assessment, and develop a path forward. Crestone relies on a 'cradle to grave' accounting for all releases and associated cleanup. This includes but is not limited to formal documentation of the event, laboratory analysis, waste characterization and disposal manifesting.

5.0 TERRESTRIAL AND AQUATIC WILDLIFE RESOURCES AND ECOSTYSTEMS

The proposed Oil and Gas Location is located in non-cultivated fields just west of County Road 49 and County Road 40. This property has historically been managed as rangeland and will continue to be managed as rangeland during the various phases of oil and gas development.

Terrestrial Wildlife Resources and Ecosystems

A robust environmental review was completed by a third-party consultant during the initial planning phase for the proposed location. As would be expected with dry rangeland, few if any potential conflicts with terrestrial wildlife were identified.

Based on desktop analyses and field investigations, **no** potential conflicts were identified with regard to the presence of High-Priority Habitat or state/federal Sensitive, Threatened, or Endangered species. Habitat was identified for the following avian categories: Eagles, suitable nesting trees within 0.5 miles; Raptors, suitable nesting trees within 0.5 miles; and Migratory Birds, potential habitat for ground-nesting birds within 0.5 miles. The consulting biologist has recommended that additional surveys are conducted prior to the start of operations for the three (3) avian categories discussed above (*see Wildlife Protection Plan*). Crestone plans to incorporate this recommendation into its pre-project planning and will deploy a biologist in advance of the commencement of construction operations. In the event active nests are identified, Crestone will coordinate with the applicable jurisdictional agency to determine appropriate next steps including site-specific mitigations.

Crestone has minimized its disturbance footprint on this location by reducing the number of wells it plans to drill. The reduction in well count also reduces the number of associated appurtenances (i.e., separators, flowlines, etc.) required further reducing the size of the well pad needed for production operations. Crestone's weed management and interim reclamation plans are designed to minimize disruption to existing land cover and protect topsoil. Interim reclamation will be performed shortly after production has been initiated. The area(s) that will be revegetated will be done with input from the surface owner/tenant and conducive to fostering continued rangeland management on the subject lands.

Aquatic Wildlife Resources and Ecosystems

A robust environmental review was completed by a third-party consultant during the initial planning phase for the proposed location. A subsequent review was recently completed based on the current well pad configuration. As would be expected with dry rangeland, few if any potential conflicts with aquatic wildlife were identified.

Based on desktop analyses and field investigations, **no** potential conflicts were identified with regard to Waters of the United States, Waters of the State, FEMA-designated Floodplains, or other riparian habitat. Crestone has reviewed the location and did not identify any surficial water features within 2640' of the Shelton CPR-25 Pad. Crestone has developed a robust set of spill protection and response measures to aiding in preventing potential discharges of fluids off location.

Crestone is an active member of the South Platte Water Related Activities Program ("SPWRAP"), a Colorado nonprofit corporation established by Colorado water users for the purpose of representing water users' interests and partnering with the State of Colorado to implement the Platte River Recovery Implementation Program in central Nebraska. This program provides a venue and mechanism to address possible Endangered Species Act issues on and along the Platte River including to assist in the recovery of threatened or endangered species within this important river corridor and elsewhere in the river basin. Additional information about this unique organization can be found here - *http://cospwrap.org/* .

6.0 SOIL RESOURCES

Construction activities required to build the well pad and access road are required to disturb the in-situ native soils. The removal of topsoil will expose the shallow subsurface soils for a short period of time until import materials and associated top dressing (i.e., rock, road base, etc.) can be brought to location and applied across the disturbed areas. Soil removal and compaction can impact soil quality if the appropriate measures are not taken to protect this material.

Crestone utilizes a soil scientist to perform a soil survey and analysis prior to the commencement of construction. The main deliverable of this survey is to determine the depth and associated characteristics of the soil horizons, especially topsoil, that may be disturbed during construction. The results of the analysis help inform the final grading plan and appropriate BMPs necessary for soil stabilization and preservation for future use. Topsoil will be stockpiled in various areas within the permitted disturbance area and be will constructed and maintained at minimal heights to reduce the potential for the development of anaerobic conditions.

Topsoil stockpiles will be constructed with slopes no greater than 3:1 to ensure that all surfaces can be seeded safely and effectively. After reaching final grade, the stockpiles will be drill seeded with a native, perennial grass and forb seed mix containing species with deep-reaching roots (i.e., alfalfa). Please note, the seed mix used at the proposed location with be appropriate for the soil type(s) present at the location and account for specific landowner requests. During seeding, soil amendments will be applied based on soil analytical results to promote species germination and establishment. A cover crop using an appropriate annual grass species will also be included in the seed mix to quickly establish growth and assist with soil stabilization until the permanent seed mix can establish itself.

In addition to soil impacts during construction, leaks or spills occurring on the proposed location may impact soil resources. As referenced in the Water Resources section, Crestone has developed and implemented a robust set of protection measures to prevent the discharges of fluids. Additionally, personnel have been trained in spill identification and response protocols which helps to further reduce the impacts to soil resources in the unlikely event that a discharge occurs and breaches primary containment. Should a discharge occur, Extraction employs industry BMPs to identify and remediate impacted media in accordance with COGCC’s 900-Series Rules as well as other applicable state or federal regulatory requirements.

7.0 PUBLIC WELFARE

The following narrative is intended to supplement the above-described resources and potential impacts. Although this information is contained elsewhere within the application materials, brief summaries of impacts and mitigations for several key areas, often referred to as nuisances, are:

Noise

- Nuisance: relative to ambient levels, temporary increases in sound levels are expected during drilling and completion operations.
- Mitigation: Crestone planned the pad so that it is greater than 2835′ from the nearest home. Additionally, Crestone will utilize a quiet completion fleet. An electrified drilling rig will be used if the electrical utility is capable of providing the power necessary to operate the rig.

Light

- Nuisance: since the drilling and completions phases occur 24-hours per day, lighting is required by regulation for worker safety during nighttime hours; illuminating the location may cast halos or shadows that are perceptible from a distance; headlights on vehicles may also be visible during the overnight hours when vehicles enter/exit location.
- Mitigation: lights will be angled in a downward manner to limit the 'halo effect' from impacting nearby receptors; only those lights necessary to maintain a safe working environment, and compliance with the applicable regulations, will be used.

Odor

- Nuisance: temporary odoriferous emissions during drilling and completions operations may be anticipated; these odors can generally be characterized as having a "petroleum scent" or a "burning metal" scent. Additionally, exhaust from diesel powered equipment may be identifiable from time to time.
- Mitigation: the pad was planned to be greater than 2835′ from the nearest residential building unit which is ultimately the best mitigation (e.g., avoidance). Additionally, Crestone will utilize closed-loop fluid management systems, utilize IOGP Group II drilling fluids, remove drill cuttings on a daily basis and as soon as waste containers are full, utilize odor-mitigating additives in drilling fluids, and employ pipe cleaning procedures when removing drill pipe from the hole; the use of BMPs is anticipated to reduce these nuisances.

Dust

- Nuisance: dust generated from the movement of equipment and materials on location may occur; vehicular traffic may generate dust while traversing the access road.
- Mitigation: the installation of a hard-surface apron at the entrance of the access road, use of mud tracking devices on the access road before the apron; and, use freshwater as a dust suppressant as atmospheric conditions warrant on the pad and along the access road.

Recreation & Scenic Values

The property where the proposed Oil & Gas Location has been sited is dry rangeland that is surrounded by oil and natural gas development as well as a bio-methane plant. Given the current use of the subject property and adjacent, surrounding properties, minimal disruption to recreation or scenic values are anticipated.

Recreation

- Active Recreation: no active recreational resources (i.e., parks, trails, etc.) were identified proximal to this location during a desktop review. As such, no impacts are anticipated.
- Passive Recreation: birdwatching is a passive form of recreational pursuit that many people enjoy; drilling and completions operations may temporarily displace 'resident birds' that birdwatchers

have identified and observed on this property over time. No permanent impacts are anticipated.

Scenic Values

The construction of the well pad, associated equipment, and facilities will change the near-surface viewshed. Depending on the vantage point of the observer, the proposed project may modify the viewshed when looking westward. However, the viewshed will not be “blocked”; the observer should be able to reposition themselves for a vantage point that is free and clear of the proposed location. No permanent impacts are anticipated.

8.0 Proposed Best Management Practices

Air Resources Cumulative Impact Mitigation Measures

1. Employ pipe cleaning procedures when removing drill string from hole.
2. Utilize closed-loop, pit-less fluid management system.
3. Use of freshwater to minimize the generation and transportation of dust.
4. Employ the practice of “block and isolate” whenever possible on equipment, piping, and/or tank connections.
5. Use of sealed containers (e.g., sandboxes) for the storage and transportation of sand used in hydraulic fracturing.
6. Any gas encountered during drill-out will be combusted with a minimum of 98% destruction efficiency.
7. Any fluids encountered during drill-out will be sent to a controlled tank and stored until transferred for disposal (e.g., water) or sale (e.g., oil).
8. Any gas encountered during flowback will be routed to a gas sales pipeline or combusted with a minimum of 98% destruction efficiency.
9. Any fluids encountered during flowback will be sent to a controlled tank and stored until transferred for disposal (e.g., water) or sale (e.g., oil).
10. Lease Automated Custody Transfer (LACT) will be used to transfer fluids from the oil production tanks.
11. Instrument air skids will be used to generate compressed air for all pneumatic actuation.
12. Vapor Recovery Towers (VRT) will be used for separation of the production stream.
13. Production Facilities will be powered by electricity sourced from the regional power grid.
14. Wells, facilities, and equipment will be equipped to be shut-in remotely.

Public Health Cumulative Impacts Mitigation Measures

1. Crestone monitors wells during each operational phase through its FLIR camera program to verify that sites are operating correctly and in compliance with regulations. Additionally, Crestone adopted a real-time, continuous air quality monitoring program using technology from Project Canary at its horizontal well sites, representing about 80% of total production. Crestone will implement continuous monitoring at the Shelton CPR-25 facility per CDPHE Regulation 7. The monitoring will follow all CDPHE requirements. These monitors will be located based on the prevailing winds determined during the baseline monitoring period as well as to avoid sounds walls and equipment. They will continuously monitor for methane, total VOCs, , particulate matter, and meteorological conditions.

Water Resources Cumulative Impacts Mitigation Measures

1. Installation of polyethylene liner on location during drilling and completions operations.
2. Installation of an engineered containment system around/beneath production facilities.
3. Development of a site-specific SPCC plan.
4. Additionally, prior to operations, Crestone performs a Geotechnical investigation to check for depth of ground water and soil suitability. The investigation concluded that water was not encountered in any of the bore holes. Thus, shallow groundwater is not a concern at this location.

Terrestrial and Aquatic Wildlife Resources Mitigation Measures

1. Operator will conduct additional avian surveys prior to the commencement of construction to ensure no conflicts have developed since the prior survey(s).
2. Topsoil will be stockpiled on location with slopes not greater than 3:1

Soil Resources Mitigation Measures

1. Topsoil stockpiles will be stabilized with appropriate vegetation to provide both short- and long-term stabilization to prevent erosion.

Public Welfare Mitigation Measures

1. Crestone planned the pad so that it is greater than 2835′ from the nearest home. Additionally, Crestone will utilize a quiet completion fleet. An electrified drilling rig will be used if the electrical utility is capable of providing the power necessary to operate the rig.
2. One (1) continuous noise monitoring terminals will be placed proximal to residential building units to monitor sound levels.
3. A "quiet completions fleet" will be used for hydraulic fracturing operations.
4. Lighting will be angled in a downward manner to limit the halo effect off location.
5. Lights will be placed at reasonable heights to limit spillage off location.
6. Utilization of a closed-loop fluids management system.
7. Use of IOGP Group II drilling fluids.
8. Remove drilling cuttings daily.
9. Odor-mitigating additives will be incorporated into drilling fluids.
10. Employ pipe-cleaning procedures when removing drill pipe from wellbore.
11. A hard-surface apron will be installed at the entrance of the access the road to prevent mud-tracking and associated dust emissions on the public roadway.
12. Freshwater will be used as a dust suppressant when necessary on the pad and access road.
13. Mud-tracking devices will be incorporated on the road access before the apron.
14. Equipment will be painted "desert tan" (or similar) to avoid creating a marked contrast with the surrounding landscape.

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Appendix A - Form 2B Emissions

Shelton CPR-25 Pad Form 2B Emission Data

Pre-Production Emissions:

	Tons per Project							Pounds per Project									
	NOx	CO	VOCs	Methane	Ethane	CO2	N2O	Benzene	Toluene	Ethylbenzene	Xylenes	n-Hexane	2,2,4-Trimethylpentane (2,2,4-TMP)	Hydrogen sulfide (H2S)	Formaldehyde	Methanol	Total (HAP)
Process Heaters or Boilers	1.4	0.4	0.0	0.0	--	--	0.0	0.0	0.9	0.0	0.0	--	--	--	8.8	--	9.8
Storage Tanks	0.0	0.0	0.3	0.0	0.1	--	0.0	40.4	35.1	3.7	6.9	3.0	0.0	--	--	--	89.0
Venting or Blowdowns	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Combustion Control Devices	0.0	0.1	0.4	0.2	0.1	40.3	0.0	10.0	0.6	0.0	0.1	55.8	--	--	--	--	66.5
Non-Road Internal Combustion Engines	174.6	95.5	6.5	0.8	0.1	20,279.9	0.2	275.6	150.2	--	114.4	7.7	28.0	--	901.6	--	1,477.4
Drill Mud	--	--	63.3	22.5	11.1	2.1	--	1,431.0	88.9	5.6	12.1	8,003.2	--	--	--	--	9,540.7
Flowback or Completions	0.6	2.9	13.8	4.9	2.4	1,260.0	0.0	311.6	19.4	1.2	2.6	1,743.0	--	--	--	--	2,077.8
Loadout	--	--	0.1	0.0	0.0	0.0	--	42.8	37.5	3.7	6.7	0.2	0.0	--	--	--	90.8
Total	176.74	98.90	84.39	28.36	13.80	21,582.32	0.18	2,111.31	332.55	14.27	142.81	9,812.76	27.96	--	910.39	--	13,352.05

Production:

	Tons per Year							Pounds per Year									
	NOx	CO	VOCs	Methane	Ethane	CO2	N2O	Benzene	Toluene	Ethylbenzene	Xylenes	n-Hexane	2,2,4-Trimethylpentane (2,2,4-TMP)	Hydrogen sulfide (H2S)	Formaldehyde	Methanol	Total (HAP)
Stationary Engines or Turbines	11.6	23.1	8.1	11.3	4.8	5,419.8	0.0	155.7	55.0	2.4	19.2	--	--	--	2,020.1	301.5	2,554.0
Process Heaters or Boilers	5.1	4.3	0.3	0.1	0.2	6,166.6	0.1	0.2	0.3	--	--	185.0	--	--	7.7	--	193.3
Storage Tanks	0.9	4.1	29.2	0.2	1.4	1,869.4	0.0	534.1	453.2	54.9	93.2	2,561.8	11.0	--	--	--	3,708.3
Dehydration Units	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pneumatic Pumps	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pneumatic Controllers	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Separators	0.1	0.4	2.6	0.0	0.1	164.0	--	48.9	44.9	5.9	10.0	257.8	1.2	--	--	--	368.7
Fugitives	--	--	1.4	0.4	0.2	0.0	--	30.7	5.0	0.5	0.9	169.9	0.1	--	--	--	207.0
Venting or Blowdowns	--	--	1.6	0.6	0.3	0.1	--	35.2	2.2	0.1	0.3	197.0	--	--	--	--	234.8
Combustion Control Devices	0.0	0.1	0.6	0.2	0.1	57.3	0.0	14.2	0.9	0.1	0.1	79.3	--	--	--	--	94.5
Non-Road Internal Combustion Engines	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Loadout	0.1	0.4	3.0	0.0	0.0	183.0	0.0	59.7	159.5	57.6	121.7	302.2	3.7	--	--	--	704.3
Well Bradenhead	--	--	1.1	38.6	19.1	3.6	--	24.6	1.5	0.1	0.2	137.4	--	--	--	--	163.8
Well Maintenance	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
On-Road Mobile	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	17.8	32.4	47.8	51.4	26.3	13,863.8	0.1	903.3	722.4	121.6	245.8	3,890.4	16.0	--	2,027.8	301.5	8,228.8

Appendix B – Public Health Information

THE SCIENCE OF READY℠

SCREENING LEVEL HEALTH RISK EVALUATION OF COMMUNITY AIR MONITORING AND SAMPLING STUDY

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Executive Summary

CTEH, LLC (CTEH) was requested by Crestone Peak Resources (Crestone) to design and perform studies to characterize the short-term impacts on local air quality and public health from discrete operational phases at four oil and gas wellpads being developed in Weld County, Colorado: Big Horn, Cosslett, Echevarria, and Kugel wellpads. The specific goals of this project were to: (1) collect a high-resolution data set of chemical concentrations in air near the wellpad and the surrounding communities, and (2) evaluate the impact on risks to public health, if any, from the release of oil and gas-related compounds into the air during specific operational phases of well development.

To address these goals, CTEH staff conducted real-time air monitoring for total volatile organic compounds (VOCs), hydrogen sulfide (H_2S), particulate matter ($PM_{2.5}$ and PM_{10}), and specific VOCs such as benzene with simultaneous observations of odors, wind direction, and wind speed relative to the wellpad. CTEH also collected discrete air samples around the perimeter of the wellpads to be analyzed by a certified analytical laboratory. These samples were analyzed for VOCs, including benzene, toluene, ethylbenzene and xylenes (BTEX compounds). The study focused on collecting data during activities that may produce the greatest emissions for each phase of operations. This approach uses a robust and widely accepted method for characterizing potential public health risks. This report provides the data and health risk evaluations from real-time air monitoring and analytical sampling (BTEX compounds) conducted in the communities surrounding the wellpads during the various phases of operations to date. Findings contained in this report include the drilling phase at Kugel wellpad, hydraulic fracturing and flowback phases at Big Horn wellpad and the production phases at the Cosslett and Echevarria wellpads.

More than 5,000 total measurements were collected in real-time by CTEH personnel in the communities surrounding the wellpads over a period of 26 days. Additionally, 20 analytical samples were collected from four locations around the Bighorn wellpad to evaluate potential community exposures over 5 days of flowback activities. Approximately 99% of the real-time VOC measurements recorded in the communities were non-detections, which means that VOCs were not present or that VOC concentrations were less than the instrument detection limit of 1 ppb for VOCs. This detection limit is well below the federal (ATSDR) health guideline level for short-term adverse health effects for benzene (9 ppb). Of the over 1,500 measurements collected for benzene specifically or VOCs in general, just one reading was at a detectable level but did not exceed public health guideline values for the BTEX compounds. No H_2S was ever detected, and just one of over 1,500 readings taken for PM, taken on along a dirt road, was higher than typical background values. In the 20 analytical air samples collected in the surrounding community during flowback, the maximum measured concentrations for BTEX compounds were also all 10 to 13,000-times lower than their respective federal acute health guideline values.

These data, combined with corresponding documented wind directions, suggest that oil and gas-related analytes that may come from the wellpads are not migrating to the surrounding communities to any significant extent. Thus, the real-time and analytical data indicate no adverse health risks to nearby communities, including sensitive individuals, from cumulative exposures to VOCs that may be emitted from pre-production and production activities at Crestone wellpads.

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1.0 Introduction

In the State of Colorado, concerns have been raised by government, non-government, and individual stakeholders regarding the impact of air quality on public health at regional and local (i.e., neighborhood, city/town, county) levels from oil and gas drilling and completion activities. Based on these stakeholder concerns, CTEH, LLC (CTEH) was requested by Crestone Peak Resources (Crestone) to design and perform studies to characterize the short-term impacts on local air quality and public health from discrete operational phases at four wellpads being developed in Weld County, Colorado: the drilling phase at Kugel wellpad, hydraulic fracturing and flowback phases at Big Horn wellpad and the production phases at the Cosslett and Echevarria wellpads.

CTEH is an environmental and human health consulting firm specializing in health risk assessment and regulatory compliance, as well as responding to hazardous materials emergencies and chemical releases.

Specific Goals: CTEH designed and executed a study of the Crestone wellpads with the specific goals of (1) collecting a high-resolution data set of chemical concentrations that have potential for public health impacts in air near the wellpad and the surrounding communities, and (2) evaluating the impact on short-term risks to public health, if any, from the release of oil and gas-related compounds into the air during specific operational phases of well development and production.

The specific analytes evaluated in this study were selected based on their association with oil and gas operations and their potential for public health impact. For example, multiple studies conducted during all phases of natural gas well development, both on-site and in residential communities near oil and gas sites, including studies conducted by the Colorado Department of Public Health and Environment (CDPHE), have shown that benzene has the greatest potential to cause short-term and long-term health effects and therefore, is considered a risk driver.[1][2][3][4]

This report provides an overview and a screening level analysis of data collected by CTEH during real-time air monitoring and air sampling (during flowback) in communities surrounding the Crestone wellpads.

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[2] McMullin, T.S., Bamber, A.M., Bon, D., and VanDyke, M. (2018). Exposures and Health Risks from Volatile Organic Compounds in Communities Located near Oil and Gas Exploration and Production Activities in Colorado (U.S.A.). International Journal of Environmental Research and Public Health. Jul 16; 157 (7). DOI: 10.3390/ijerph15071500

[3] Collett, J.; Ham, J.; Hecobian, A. North Front Range Oil and Gas Air Pollutant Emission and Dispersion Study; Colorado State University: Fort Collins, CO, USA, 2016.

[4] Collett, J.; Ham, J.; Hecobian, A. Characterizing Emissions from Natural Gas Drilling and Well Completion Operations in Garfield County, Co; Colorado State University: Fort Collins, CO, USA, 2016.

1.1 Site Descriptions

The four Crestone wellpads around which CTEH performed monitoring and sampling (Big Horn, Cosslett, Echevarria, and Kugel) are in Longmont, Weld County, Colorado. Monitoring and sampling occurred from September 2, 2019 to October 21, 2019

Table 1: Wellpad Descriptions

Wellpad	Phase	Monitoring Dates	Location	Site Description
Big Horn	Hydraulic Fracturing and Flowback	September 9, 2019 to September 13, 2019 October 16, 2019 to October 21, 2019	North of County Road 20	Bordered by agricultural land on three sides, residential neighborhood on the west side and nearby production wells on private land
Cosslett	Production (Hub)	September 16, 2019 to September 20, 2019	West of Interstate 25 and south of Erie Parkway (County Road 8)	Surrounded by primarily agricultural land
Echevarria	Production (Tank Light)	September 23, 2019 to September 27, 2019	South of Co road 26 and west of Co Rd 21 ½	Rural area
Kugel	Drilling	September 2, 2010 to September 6, 2019	South of Sable Ave (Co Rd 22) and west of Frontier St (Co Rd 15)	Residential properties surrounding the wellpad on three sides with a more densely-developed residential subdivision to the north and drilling/production activities to the west

1.2 Operations Description

Data were collected during four operational phases: drilling, hydraulic fracturing, flowback and production. Table 2 lists best management practices (BMPs) in place to address potential sources of emissions for each phase of operation.

Table 2: Description of Best Management Practices

Phase	BMPs
Drilling	• Class III Drilling Fluid - oil based mud (odorless, no BTEX) • Mud Chillers - used to control cuttings odor while drilling through hydrocarbon bearing zones • Rotary steerable unit that reduces drilling time on-site • Local electrical power for drill rig - reduces air emissions, NOx • All equipment is on impermeable ground liners during drilling and completions
Flowback	• Vapor Recovery Units are used during flowback operations and initial year of production • Closed-top oil tanks - used during flowback operations and drill out • Combustor used for tank vapors during flowback and drill out
Production	• Hub facility - a central gathering facility serving several well sites which allows for smaller wellpads and fewer emission sources • Tank-lite facilities - Use of Lease Automatic Custody Transfer (LACT) units for custody transfer of oil, reduces the need to open tanks • Electric permanent production equipment - no gas actuated pneumatics
Completions	• Completions fleet fuel substitution – use compressed natural gas to reduce use of diesel fuel; up to 50% replacement when possible • Low-noise completion fleets – utilizing insulated engine housing and hospital grade mufflers

2.0 Methods

CTEH combined analytical sampling with real-time monitoring to provide a comprehensive set of data from which to assess short-term health risks in addition to public welfare impacts, such as odors. Real-time monitoring can capture near-instantaneous and short-term, transient changes in air quality while analytical sampling provides information about specific airborne compounds in the air over a longer period. The strategy for real-time air monitoring and analytical sampling used for this study is like that used routinely by CTEH during chemical emergency responses at accidental releases as well as support of regulatory compliance at numerous sites in North America, including petroleum-related industrial facilities and their neighboring communities.

This report describes the real-time air monitoring results conducted by CTEH personnel using hand-held instruments throughout the communities surrounding the Big Horn, Cosslett, Echevarria and Kugel wellpads. This report also describes the analytical data collected in the community during flowback operations at the Big Horn wellpad.

2.1 Real-Time Air Monitoring

The objective of the real-time monitoring was to measure analyte levels in the communities with respect to specific wellpad operations CTEH staff targeted the surrounding communities with an emphasis on locations downwind of the pad using handheld instruments to monitor the ambient air quality at breathing zone level.

Real-time air monitoring for each wellpad was performed for at least 48 continuous hours followed by 12-hour shift monitoring over the subsequent three days. The duration of phase-specific data capture representative of normal operating activities (Table 1). Real-time air monitoring was conducted during the drilling phase at Kugel wellpad, hydraulic fracturing and flowback phases at Big Horn wellpad and during the production phases at the Cosslett and Echevarria wellpads. Measurements were collected at various distances from the pads ranging from the fence line to approximately one mile from wellpad operations. Maps of the specific location of each real-time measurement are provided in Appendix A.

Real-time air monitoring was conducted according to the CTEH site-specific sampling and analysis plan. Measured analytes included hydrogen sulfide (H_2S), particulate matter with a mean diameter of 2.5 microns ($PM_{2.5}$) and 10 microns (PM_{10}), nitrogen dioxide (NO_2), total non-methane volatile organic compounds (VOCs) and benzene, toluene, xylene, and hexane using hand-held instruments (Table 1). CTEH personnel used handheld instruments including TSI SidePak aerosol monitors, Gastec GV-100 pumps with chemical-specific, colorimetric detector tubes, and Honeywell/RAE Systems ppbRAEs, UltraRAEs, and MultiRAEs. Instruments were calibrated daily at a minimum and according to manufacturer specifications.

Table 3: Airborne analytes measured using real-time monitoring and/or analytical sampling

Analyte	Justification
Total volatile organic compounds (VOCs)	Assesses for the presence of elevated total non-methane VOCs compared to background.
Benzene	Multiple studies conducted during all phases of natural gas well development, both on-site and in residential communities near oil and gas sites, have repeatedly shown that of all measured VOCs, benzene has the highest potential to cause short-term and long-term health effects and therefore, is considered a risk driver
Toluene	Frequently detected during historical monitoring of oil and gas activities and responses to untended releases, represents a petroleum constituent that has relatively low health screening guideline values, indicating higher potential for adverse effects.
Ethylbenzene	
***m,o,p*-Xylenes**	

Analyte	Justification
Hydrogen Sulfide	Although studies have shown that hydrogen sulfide levels are generally negligible during oil and gas operations in Colorado, its low odor threshold combined with community concern warrants monitoring.
Particulate Matter ($PM_{2.5}$/PM_{10})	Measurement of airborne particulate matter (PM2.5 and PM10) is also proposed because it is frequently cited as a concern from community members that live near oil and gas sites. The main source of PM, if any, is likely to come from dust entrained from vehicular activity or diesel fuel-powered combustion engines.
Nitrogen Dioxide	Nitrogen dioxide is a by-product of gasoline/diesel engine combustion. It has relatively low health screening guideline value, indicating higher potential for adverse effects.

During real-time air monitoring, CTEH personnel also recorded simultaneous observations of odors, wind direction and speed relative to the wellpad, and observed activities or potential odor sources in the community. Fixed locations in the community(s) were monitored at regular intervals (i.e., once per hour) to provide concentration averages that may be observed and analyzed for trends over time within the community. Locations that provide upwind (background) and downwind characterization of compounds were selected, with a primary focus on measuring at locations that were generally downwind of the wellpad in adjacent communities. Wind rose plots of wind direction and wind speed can be provided upon request. This approach was intended to capture the highest number of analyte measurements relevant to potential public health risks in a community. CTEH personnel entered readings from handheld instruments, observations of wind direction and speed, presence of odors, and GPS coordinates of their reading locations into a CTEH smartphone application, which saves the data to a CTEH server. All real-time data were reviewed and underwent an in-house QA/QC process to verify that the concentration values reflected the analytes being measured, data were entered correctly and accurately characterized the environment in which they are being measured.

2.2 Community Analytical Air Sampling

In addition to real-time air monitoring, analytical air samples were collected at four discrete locations away from the work area and in the community during the flowback phase at the Bighorn wellpad. A map of the sample locations is provided in Appendix A.

Samples were collected using 1.4-liter evacuated canisters with 24-hour flow controllers. These samples were deployed for 24-hour periods, which represents a conservative estimate of potential exposures from which to compare to federally established short term health guideline values. All samples were sent under chain-of custody to Pace Analytical, a NELAP-accredited laboratory, and analyzed for a suite of VOCs in accordance with the United States Environmental Protection Agency (US EPA) method TO-15, plus tentatively identified compounds (TICs). A formal QA/QC evaluation of the laboratory data was conducted by Environmental Standards, Inc.

For the initial screening evaluation of potential for community health risks for further decision making, this assessment evaluated acute (short-term) exposures during the flowback phase. BTEX compounds (benzene, toluene, ethylbenzene, and xylene) were selected as high priority compounds of potential concern (COPCs) related to oil and gas activities for this initial evaluation.

Acute toxicity values (called health guideline values) for comparison with the air sampling data were selected following CDPHE memo[1]: FA2019 HGVs (updated acute and chronic health guideline values for use in preliminary risk assessments). For BTEX, all health guideline values were from the Agency for Toxic Substances and Disease Registry (ATSDR). According to ATSDR, an acute MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over for up to 14 days of exposure. ATSDR states, "These substance-specific estimates, which are intended to serve as screening levels, are used by ATSDR health assessors and other responders to identify contaminants and potential health effects that may be of concern at hazardous waste sites. It is important to note that MRLs are not intended to define clean up or action levels for ATSDR or other Agencies.**"[2]**.

3.0 Results

3.1 Real-time Air Monitoring

More than 5,000 readings were collected in real-time by CTEH personnel in the communities surrounding the Crestone wellpads over 26 days. A cumulative summary of off-pad real-time monitoring measurements is provided in Table 4. Summaries of real-time air monitoring measurements by phase are provided in tables 5 through 9.

Table 4: Cumulative Community Real-Time Air Monitoring Summary (All Phases)

Analyte	Instrument	# of Readings	# of Detections	Range*
H_2S	MultiRAE Pro	212	0	< 0.1 ppm
NO_2	MultiRAE	1283	0	< 0.1 ppm
PM_{10}	AM510/AM520/DustTrak	1297	1297	0.00 - 0.790 mg/m^3
$PM_{2.5}$	AM510/AM520/DustTrak	1299	1299	0.001 - 0.080 mg/m^3
VOCs	MultiRAE	1	0	< 0.1 ppm
	ppbRAE	1308	1	18 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

[1] https://drive.google.com/file/d/1P2KEvu0MFiyzQAOQtjQUclqR-WGh1bEX/view
[2] https://www.atsdr.cdc.gov/mrls/index.asp

Table 5: Community Real-Time Air Monitoring Summary for Kugel Drilling Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
NO_2	MultiRAE	228	0	< 0.1 ppm
PM_{10}	AM510	238	238	0.005 - 0.046 mg/m^3
$PM_{2.5}$	AM520	238	238	0.005 - 0.049 mg/m^3
VOCs	ppbRAE	237	0	< 1 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Table 6: Community Real-Time Air Monitoring Summary for Big Horn Hydraulic Fracturing Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
NO_2	MultiRAE	269	0	< 0.1 ppm
PM_{10}	AM510	272	272	0.005 - 0.049 mg/m^3
$PM_{2.5}$	AM520	273	273	0.004 - 0.062 mg/m^3
VOCs	ppbRAE	271	0	< 1 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Table 7: Community Real-Time Air Monitoring Summary for Big Horn Flowback Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
H_2S	MultiRAE Pro	212	0	< 0.1 ppm
NO_2	MultiRAE	245	0	< 0.1 ppm
PM_{10}	AM520/DustTrak	245	245	0.001 - 0.790 mg/m^3
$PM_{2.5}$	AM510/DustTrak	247	247	0.001 - 0.08 mg/m^3
VOCs	ppbRAE	257	1	18 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Table 8: Community Real-Time Air Monitoring Summary for Cosslett Production Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
NO_2	MultiRAE	272	0	< 0.1 ppm
PM_{10}	AM510	273	273	0.005 - 0.052 mg/m^3
$PM_{2.5}$	AM520	272	272	0.003 - 0.039 mg/m^3
VOCs	MultiRAE	1	0	< 0.1 ppm
	ppbRAE	274	0	< 1 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Table 9: Community Real-Time Air Monitoring Summary for Echevarria Production Phase

Analyte	Instrument	# of Readings	# of Detections	Range*
NO_2	MultiRAE	269	0	< 0.1 ppm
PM_{10}	AM510	269	269	0.003 - 0.045 mg/m^3
$PM_{2.5}$	AM520	269	269	0.002 - 0.027 mg/m^3
VOCs	ppbRAE	269	0	< 1 ppb

*If no detections were observed, the instrument detection limit preceded by a "<" is listed.

Over 99.9% of all total VOC real-time measurements were non-detects (< 1 ppb) in surrounding communities over the duration of all pre-production and production activities. One (1) out of 1,308 total VOC measurements was above the detection limit of 1 ppb. This detection occurred on October 18, 2019 and measured a one-minute sustained detection of 18 ppb total VOC approximately 4,000 feet northeast of the Bighorn wellpad during the flowback phase of operations. At that time, CTEH personnel noted that they were downwind of site and observed a "manure-like" odor. They also noted that there was livestock nearby. No other odors were noted in the community during real-time monitoring, even during conditions when the VOCs were detected or when transient odors were reported on the wellpad. There were no exceedances of the 20ppb action-level set for VOCs in the community, therefore, no chemical specific measurements were taken for benzene, toluene, xylene or hexane.

No H_2S concentrations were detected. Of the approximately 1,500 readings for PM, only one was higher than typical background values. This reading was recorded on a dirt road at the entrance to the site.

3.2 Off-Pad Analytical Air Sampling

Because flowback phase has been identified by CDPHE as an operational phase that may product higher emissions that other phases, additional analytical air sampling was conducted at four fixed locations in the community over five consecutive days during the flowback phase at the Bighorn Wellpad. A total of 20 samples were deployed for 24-hour periods over five days. As an initial screening level assessment, the air sampling data for selected VOCs were compared to their respective health guideline values that are used by CDPHE to evaluate the potential for short-term health impacts (Table 10). A full summary of lab results is provided in Appendix B.

All detections for each analyte were below their acute health guideline value established by the federal Agency for Toxic Substances and Disease Registry (ATSDR). Acute guideline values were consulted because the analytical data represent potential 5-day (acute) airborne exposures in the surrounding community, and ATSDR acute guideline values are designed to protect even sensitive persons for continuous, 24-our exposures of up to 14 days. The highest concentration of benzene (0.896 ppb) was reported on October 16 (BHCO1016MC005). This sample was collected at AS05 which is located approximately 500 yards northwest of the wellpad. On October 18, when the real-time detection of 18 ppb total VOCs was recorded northeast of the wellpad, the corresponding analytical sample (BHCO1018MC008) reported a concentration of 0.785 ppb benzene. This sample was collected at AS08, which is approximately 470 yards northeast of the wellpad. These detections, including the maximum measured benzene concentration, were from 10 to over 13,000-times lower than their respective acute health guideline values.

Table 10: Analytical Air Sampling Summary for Big Horn Flowback Phase

Analyte	# of Samples	# of Detections	Range of Detections (ppbv)	ATSDR Acute Health Guideline Value (ppb)[1]
Benzene	20	19	0.207 - 0.896	9
Ethylbenzene	20	2	0.295 - 0.38	5,000
m,p-xylenes	20	8	0.429 - 1.22	2,000
o-xylene	20	3	0.214 - 0.66	2,000
Toluene	20	20	0.358 - 13.1	2,000

[1] https://drive.google.com/file/d/1P2KEvu0MFiyzQAOQtjQUclqR-WGh1bEX/view

4.0 Impact on Public Health

The real-time air monitoring data and analytical BTEX samples did not indicate any potential increase in adverse health risks to in nearby communities from potential exposures to VOCs that may be emitted by oil and gas wellpad activities at Crestone wellpads. Approximately 99% of the total VOC real-time measurements in the community were non-detects, which means the VOC concentrations were not present or less than 1 ppb total VOCs. Additionally, real-time data indicate no adverse health risks to nearby communities, including sensitive individuals, from exposures to VOCs, H_2S or PM that may be emitted from the operations associated with well development at the various wellpad sites. Corresponding continuous analytical air samples of BTEX were well below their federally established acute health guideline levels.

5.0 Conclusions

CTEH designed and performed a study of air monitoring and sampling to characterize potential for short-term (acute) adverse health impacts to nearby communities resulting from oil and gas activities at Crestone wellpads in Weld County, Colorado. To accomplish this, CTEH collected over 5,000 real-time measurements, along with 20 analytical samples, in communities around multiple Crestone wellpads. Findings from this dataset indicate:

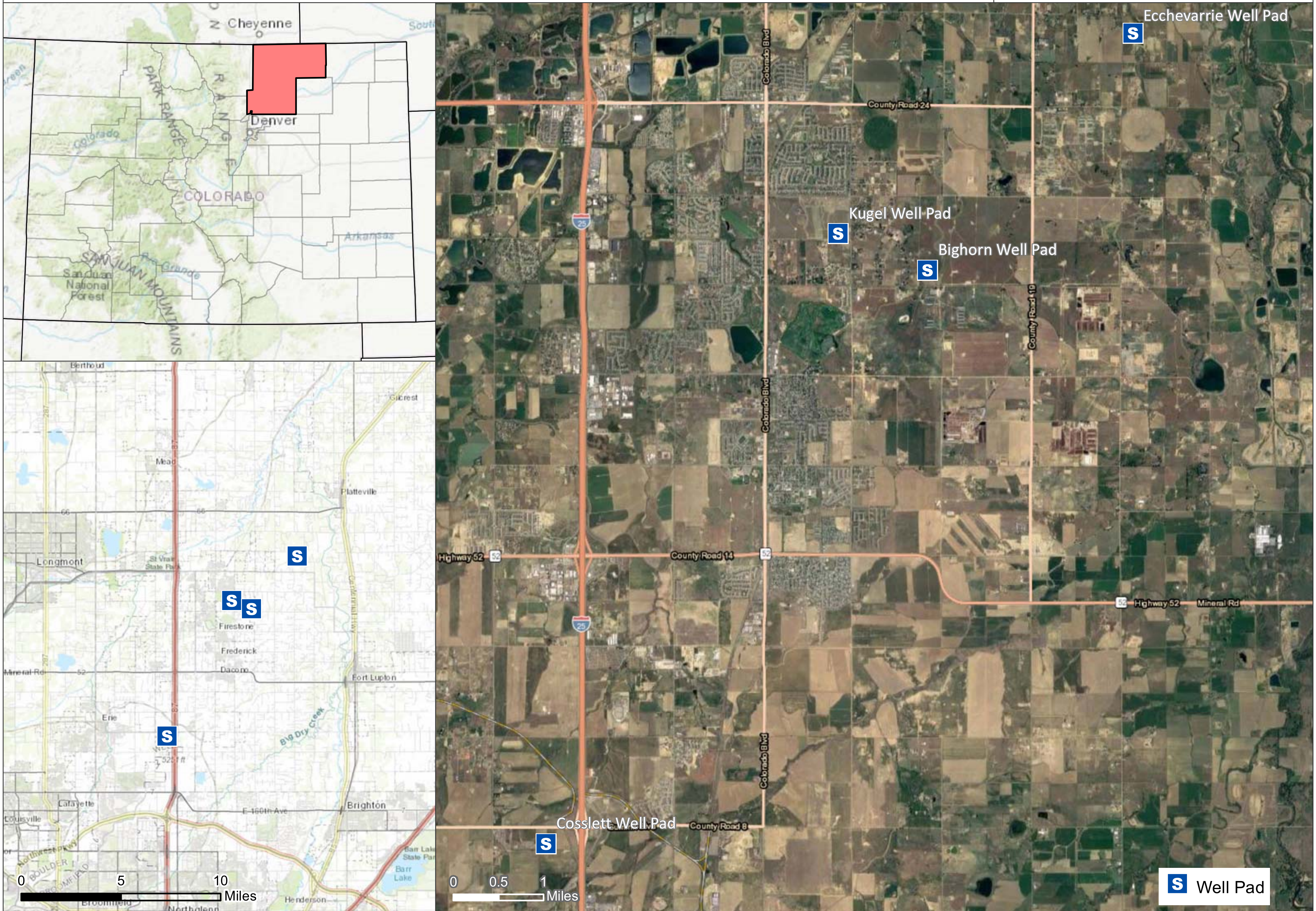
- Pre-production and production activities on Crestone wellpads occurring during the time of these monitoring studies did not result in off-pad migration of VOCs, including benzene, in the nearby community areas at levels expected to cause acute adverse health effects.
- During flowback phase, the maximum detected levels of BTEX in the air in surrounding communities were below their acute health guideline values established by the federal Agency for Toxic Substances and Disease Registry (ATSDR).
- Total VOCs and BTEX concentrations measured during this study were not likely to impact the health of a maximally exposed hypothetical individual living at each of the sampling locations in nearby communities.

CTEH

Crestone Peak Resources Well Pad Monitoring

Pad Locations

Project: 111976
Client: Crestone
City: Longmont, CO
County: Weld

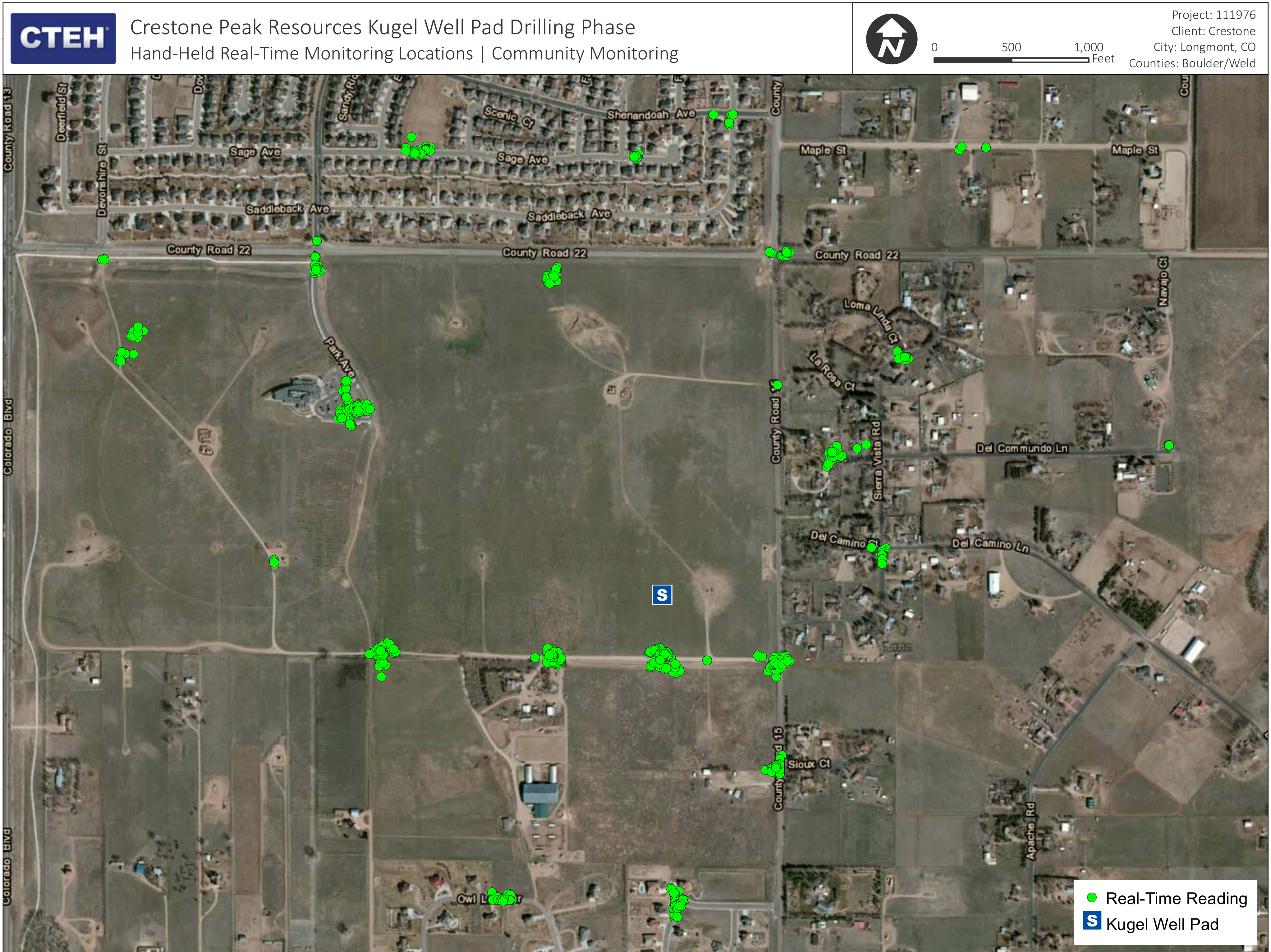


Projection System: *Transverse Mercator* **Datum:** *WGS 1984* *Document Name: site_location* **Last Updated:** *11/20/2019 3:28:14 PM*

Crestone Peak Resources Kugel Well Pad Drilling Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld



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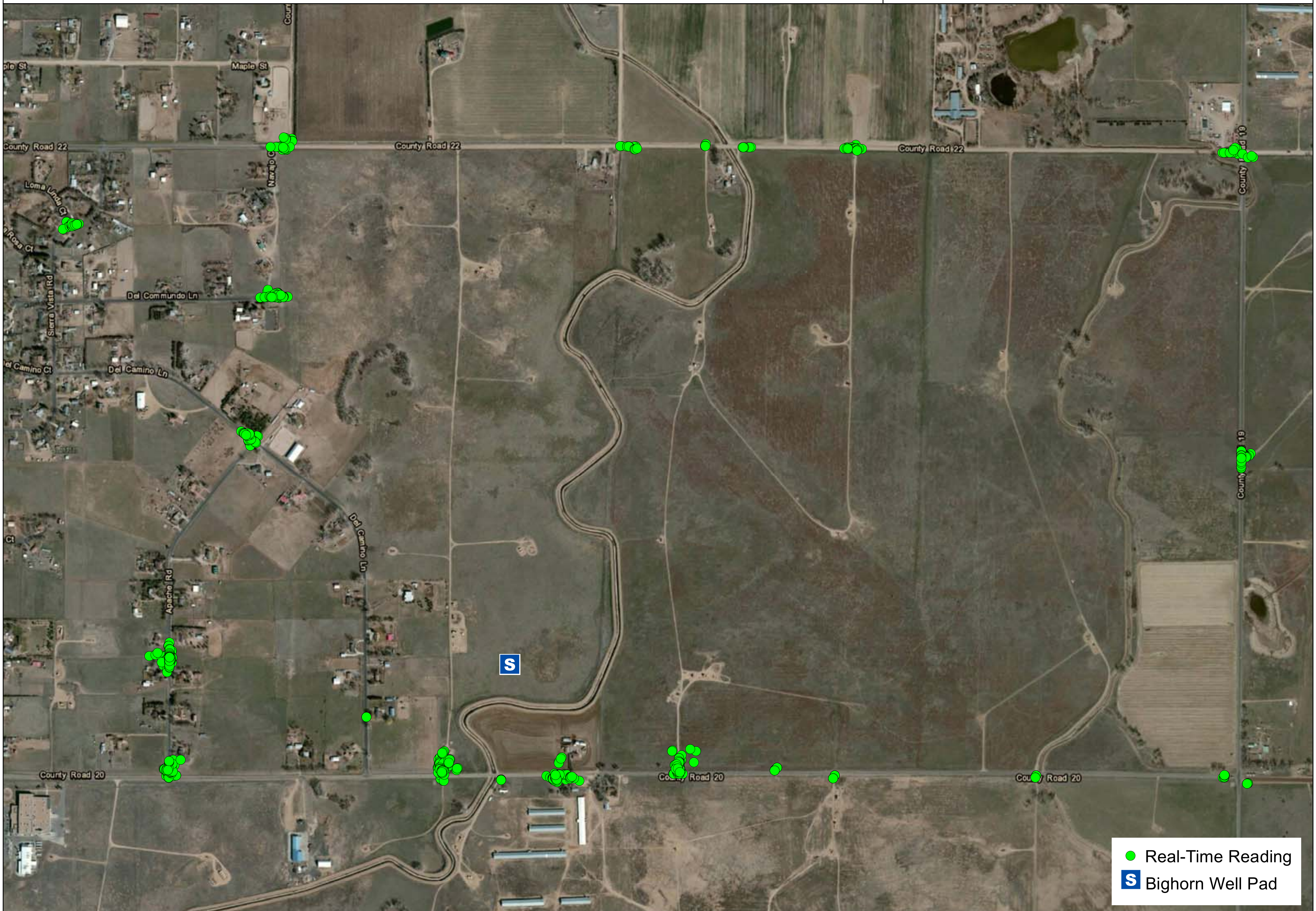
*GPS Coordinates are Approximate

Crestone Peak Resources Bighorn Well Pad Hydraulic Fracturing Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld



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*GPS Coordinates are Approximate

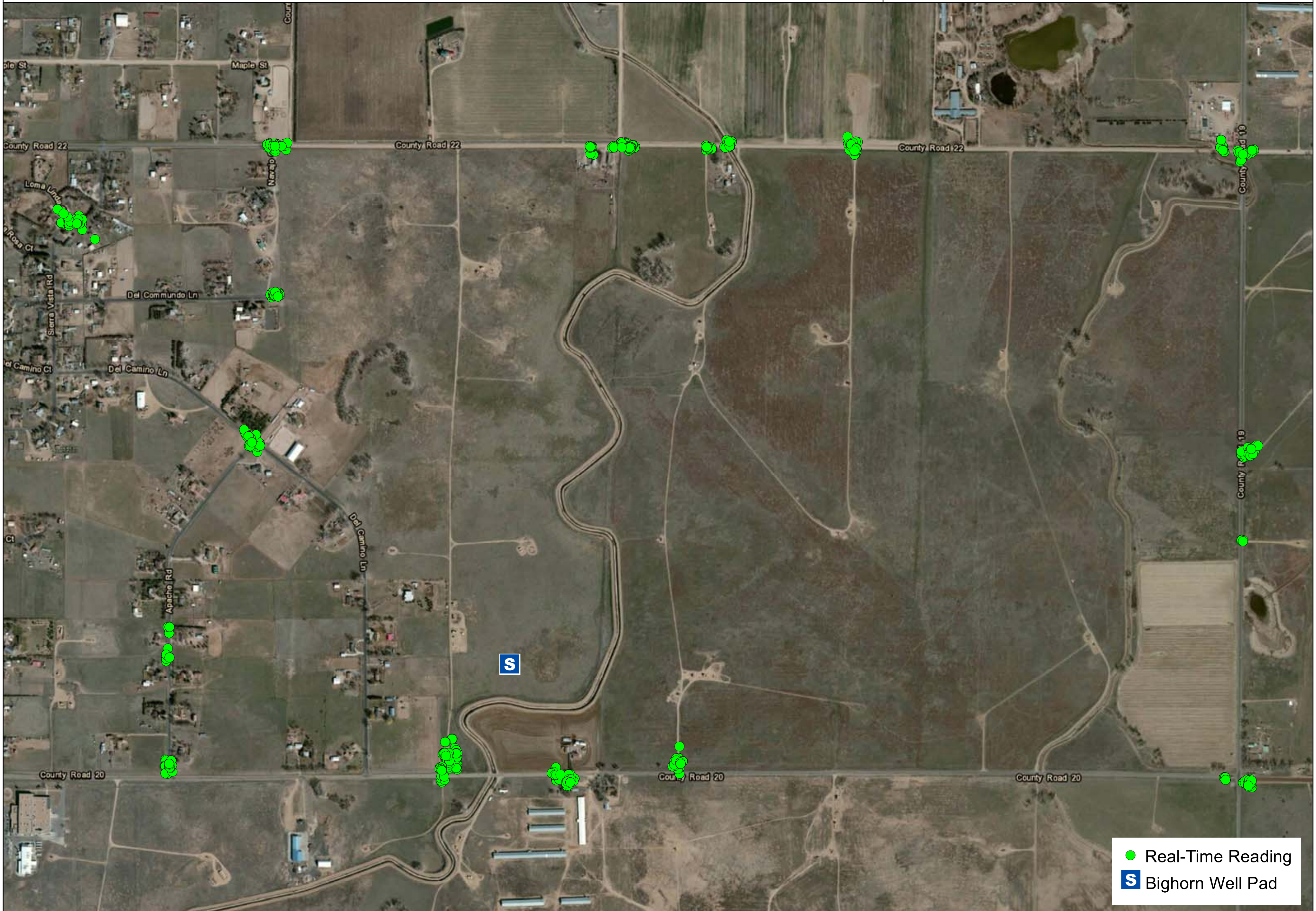
CTEH

Crestone Peak Resources Bighorn Well Pad Flowback Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

0 700 1,400 Feet

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld



Projection System: Transverse Mercator Datum: WGS 1984 UTM Zone 13N Document Name: bighorn_flowback_111976_real_time_community Last Updated: 11/6/2019 12:49:10 PM

*GPS Coordinates are Approximate

Crestone Peak Resources Bighorn Well Pad Flowback Phase

Analytical Sampling Stations | Community

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld

Projection System: Transverse Mercator *Datum: WGS 1984 UTM Zone 13N* *Document Name: bighorn_flowback_111976_analtyical_stations_community* *Last Updated: 11/19/2019 10:56:54 AM*

**GPS Coordinates are Approximate*

Crestone Peak Resources Cosslett Well Pad Production Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld

Projection System: Transverse Mercator   Datum: WGS 1984 UTM Zone 13N   Document Name: cosslett_production_111976_real_time_community   Last Updated: 11/4/2019 2:26:47 PM

GPS Coordinates are Approximate

CTEH

Crestone Peak Resources Echevarria Well Pad Production Phase

Hand-Held Real-Time Monitoring Locations | Community Monitoring

Project: 111976
Client: Crestone
City: Longmont, CO
Counties: Boulder/Weld

Projection System: Transverse Mercator *Datum: WGS 1984 UTM Zone 13N* *Document Name: ecchevarrie_production_111976_real_time_community* *Last Updated: 11/13/2019 10:49:22 AM*

**GPS Coordinates are Approximate*