

FIELDWIDE WATER QUALITY MONITORING PLAN

**CITY OF AURORA
COLORADO**



Revised
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CRESTONE PEAK RESOURCES
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1.0 - INTRODUCTION

This fieldwide water quality monitoring plan was developed on behalf of Crestone Peak Resources Operating, LLC (Crestone) to address City of Aurora requirements for a Water Quality Monitoring plan (Plan) as specified in the City of Aurora Operator Agreement (OA) to monitor groundwater quality conditions around proposed oil and gas well locations within the City of Aurora, Colorado. Crestone will rely on environmental contractor(s) (EC) for day-to-day operation of the Plan and a Professional Geologist (PG) or Colorado Professional Engineer (PE) will review and certify the Plan. The certification is included in **Attachment A**. Water Quality Monitoring Plan contacts are identified in **Attachment B**. The contacts list will be reviewed on an annual basis unless more frequent updates are warranted.

As required by the Aurora OA, Crestone will collect water samples from up to four available water sources (AWS) located within a one-half mile radius of the location of a proposed New Well. New Well means any Crestone operated well spudded during the term of the Aurora OA within a Well site identified in Exhibit A and listed on Exhibit B of the AO. A site-specific plan will accompany each New Well to complete these requirements, the following water sampling protocols have been developed in accordance with the COGCC Model Sampling and Analysis Plan (Version 2) (COGCC Model SAP).

2.0 - ENVIRONMENTAL DUE DILIGENCE

Once the EC receives notice from Crestone to conduct an environmental due diligence, the following tasks will be completed:

1. Location of a proposed New Well will be provided to the EC by Crestone.
2. The EC will then conduct an environmental due diligence review to identify all water sources within one-half mile radius of the location of the proposed New Well. For purposes of this assessment, a water source is a properly and well-maintained domestic water source registered with Colorado Department of Water Resources (DWR). When evaluating locations as potential AWSs for sampling / monitoring, Crestone considers water sources for which the water well owner or a land owner, as applicable, had given consent for sampling and testing and had consented to having the sample data obtained made available to the public, including without limitation, being posted on the COGCC website.

2.1 - Water Source Identification

AWSs will be selected for inclusion in the Plan based on the following criteria, as defined in the Aurora OA.

1. **Proximity to proposed location** - water sources closest to the proposed New Well have a higher priority than those located further away from a proposed New Well.
2. **Radial Pattern** - sample locations will be selected from a radial pattern around the New Well.
3. **Aquifer availability** – where AWSs are completed in different aquifers, a sample will be collected from each aquifer.
4. **Orientation of sampling location** - if known or reasonably inferred, sample locations downgradient and up- gradient are preferred over cross-gradient locations.

The EC will prepare a list of the water sources that met the criteria above and submit a site-specific plan to the City of Aurora for approval. The water source list will include, at a minimum, the water source owner(s) and contact information utilizing County Tax Assessor data. Justifications for why a water source will not meet the criteria or if water sample collection is not possible or recommended will be documented. Representative water source locations will be mutually agreed upon by the City of Aurora and Crestone. Any deviations to the water source identification process / lists will be communicated to the City of Aurora in a timely manner.

2.2 - Variance Process

A water source sample exception variance, along with supporting documentation, will be submitted to the City of Aurora if one of the following conditions are met:

1. No water sources are within the one-half mile radius of the proposed New Well location. Documentation will be provided in the site-specific plan.
2. All identified water sources are deemed unsuitable, non-operational, or other issues exist that would not allow for a representative sample; or
3. The owner of the water source declines or requires payment for access despite Crestone's reasonable efforts to obtain consent to conduct sampling including:
 - a. providing notice to the water source owner of a water source of the desire to collect a sample, and
 - b. providing final notice by certified mail to the water source owner. If the water source owner does not respond within 30-days, Crestone is deemed to have made a reasonable effort.

Crestone will submit the sample exception variance in an electronic deliverable in the method requested by the City of Aurora to individuals identified in **Attachment B**. If the City of Aurora take no action within 10 business days of receipt, the variance request will be deemed approved.

2.3 - Installation of Monitoring Wells

If no domestic water wells are available for sampling, the City of Aurora may request the installation of a monitoring well sufficient to test the domestic groundwater source near the New Well. If this monitoring well, identified as the "Requested Well," is required, Crestone will acquire proper DWR permit(s) to construct and install a monitoring well downgradient from the proposed New Well on or near the Well site at least one month prior to the commencement of drilling the New Well.

Crestone has agreed to construct and install a Westbay System or equivalent multilevel monitoring well as the Requested Well, when required, on the pad location and have secured the rights to do so for each location. The Requested Well will be drilled to adequate depths to allow for testing all available aquifers

down to and including the Laramie Fox-Hill. A well diagram will be included in the site-specific plans for any proposed New Well locations that require the Requested Well.

The following section is only relevant if Crestone is unable to complete the Requested Well as described above and if the City of Aurora has requested a monitoring well on an City of Aurora easement within a one-half mile radius of the New Well location.

If this monitoring well, identified as the "City Easement Well," is requested:

1. Crestone is responsible for any cost associated with drilling and monitoring the City Easement Well, except for the cost associated with obtaining the easement.
2. Crestone will begin the process of notifying, collaborating, and installing an easement well approximately 40-weeks prior to the commencement of oil and gas drilling operations at the proposed New Well locations to allow adequate time for collaboration with the City of Aurora, securing License Agreements, and completing the well installation process. The estimated timeline for specific New Well locations will be included, as necessary, on the site-specific plans. Nevertheless, Crestone and the City of Aurora recognize these schedules will be dynamic due to multiple variables and any deviations to the anticipated process will be communicated to the City of Aurora in a timely manner.
3. If the City of Aurora has not obtained an easement prior to drilling operations, the City of Aurora may request the City Easement Well be installed anytime during the drilling, completions, or production phase of the New Well once the City of Aurora has obtained a suitable easement.
4. Crestone will offer the City Easement Well to the City of Aurora once there is no longer a need for it. The City of Aurora may elect to take over the City Easement Well and will execute appropriate transfer documents. The City of Aurora's request to drill a City Easement Well is outside of New Well permit application process. The City of Aurora shall not delay the New Well permit application process if the City of Aurora requests that a City Easement Well be installed. The City of Aurora shall process the New Well permit(s) once Crestone has complied with or received a variance regarding the Baseline Water Quality Testing or has agreed to drill a Requested Well.

3.0 – WATER SOURCE OWNER ACCESS REQUEST AND BASELINE SAMPLING

3.1 - Water Source Owner Communication

From the water source list submitted to the City of Aurora for approval, the EC will make good faith efforts to contact the respective water source owner(s) to request and obtain permission for site access and collect water samples, including the acknowledgement that the sample data will be accessible to the public through the COGCC website and submitted to the City of Aurora.

The EC will document the efforts used to obtain access from the owners of the identified water sources. Water source owner(s) will be contacted via certified mail with a pre-stamped return postcard indicating permission acceptance or refusal and requesting a contact phone number. All communications with the water source owner will be documented. Any issues or deviations to the water source owner communication process or communications will be reported to the City of Aurora in a timely manner.

3.2 - Baseline Water Quality Testing

Once permission to sample has been received, the EC will proceed to schedule and sample the AWSs using standard industry procedures consistent with the COGCC Model SAP and will test for the following analytes prior to setting conductor pipe in a well or the first well on a multi-well site:

<i>Inorganic Chemicals</i>
Antimony, Arsenic, Asbestos, Barium, Beryllium, Cadmium, Chromium, Cyanide, Fluoride, Mercury, Nitrate, Nitrite, Total Nitrate and Nitrite, Selenium, Thallium
<i>Volatile Organic Compounds</i>
Methane, Ethane, Propane, BTEX as Benzene, Toluene, Ethylbenzene and Xylenes, Total Petroleum Hydrocarbons (TPH), Vinyl Chloride, Carbon Tetrachloride, 1,2-Dichloroethane, Trichloroethylene, Para-Dichlorobenzene, 1,1-Dichloroethylene, 1,1,1-Trichloroethane, cis-1,2 Dichloroethylene, 1,2-Dichloropropane, Ethylbenzene, Monochlorobenzene, o-Dichlorobenzene, Styrene, Tetrachloroethylene, , Trans-1,2 Dichloroethylene, , Dichloromethane (methylene chloride), 1,2,4-Trichlorobenzene, 1,1,2 Trichloroethane
<i>Synthetic Organic Contaminants</i>
Alachor, Aldicarb1, Aldicarb sulfoxide, Aldicarb sulfone, Atrazine, Carbofuran, Chlordane, Dibromochloropropane, 2,4-D, Ethylene dibromide, Heptachlor, Heptachlor epoxide, Lindane, Methoxychlor, Polychlorinated biphenyls, Pentachlorophenol, Toxaphene, 2,4,5-TP (Silvex), Benzopyrene, Dalopon, Di(2-ethylhexyl)adipate, Di(2-ethylhexyl)phthalate, Dinoseb, Diquat, Endothall, Endrin, Glyphosate, Hexachlorobenzene, Hexachlorocyclopentadiene, Oxamyl (Vydate), Picloram, Simazine, 2,3,7,8-TCDD (Dioxon)
<i>Radionuclides</i>
Combined radium-226 and radium-228, Gross alpha particle activity (including radium-226 but excluding radon and uranium), Beta particle and photon radioactivity
<i>Secondary Maximum Contaminant Levels</i>
Aluminum, Chloride, Color, Corrosivity, Fluoride, Foaming Agents (surfactants), Odor, Silver, Sulfate, Zinc
PFOA (perfluorooctanoic acid) and PFOS (Perfluorooctane Sulfonate)
<i>General Water Quality</i>
Alkalinity, Conductivity & Total Dissolved Solids (TDS), pH, Dissolved Organic Carbon (or Total Organic Carbon), Bacteria, Hydrogen Sulfide
<i>Major Ions</i>
Bromide, Magnesium, Potassium, Sodium, Sulfate
<i>Metals</i>
Boron, Copper, Iron, Lead, Manganese, Strontium, Uranium,
<i>Other</i>
Water Level, Stable Isotopes of Water (Oxygen, Hydrogen, Carbon), Phosphorus

If four or fewer AWSs exist within the one-half mile radius of the New Well location a sample shall be collected from each AWS. To the extent that there are no available water sources, the process to install a Requested Well will be initiated as soon as possible.

Crestone may rely on existing groundwater sampling data provided the sample was collected in accordance with accepted City of Aurora standards and within the 12-months preceding the commencement of Drilling Phase for the New Well location. The analytical data must include all the analytes listed above and there must not have been any significant Oil and Gas activity



within one-mile of the sample location since the sample was initially collected and prior to beginning the drilling phase for the applicable New Well. Any deviations to the Baseline Water Quality Testing events will be communicated to the City of Aurora in a timely manner.

4.0 - SUBSEQUENT SAMPLING

The EC will conduct post-stimulation sampling of previously sampled water sources annually until the Reclamation Phase is completed for the New Well location using the City of Aurora AO Annual Testing Analytes list.

City of Aurora OA Annual Testing Analytes

General Water Quality
Alkalinity, Conductivity & TDS, pH, Dissolved Organic Carbon (or Total Organic Carbon), Bacteria, and Hydrogen Sulfide
Major Ions
Bromide, Chloride, Fluoride, Magnesium, Potassium, Sodium, Sulfate, and Nitrate + Nitrite as N
Metals
Arsenic, Barium, Boron, Chromium, Copper, Iron, Lead, Manganese, Selenium, Strontium, Mercury, Uranium, and Radium
Dissolved Gases and Volatile Organic Compounds
Methane, Ethane, Propane, BTEX as Benzene, Toluene, Ethylbenzene and Xylenes, Total Petroleum Hydrocarbons (TPH)
Other
Water Level, Stable Isotopes of Water (Oxygen, Hydrogen, Carbon), Phosphorus

Efforts to obtain sample permissions for all subsequent sampling events will follow the notification processes outlined in Section 3.1. If the EC is unable to obtain site access and sample permissions for subsequent sampling event(s), if the previously sampled water source no longer exists, is determined unsuitable, improperly maintained, non-operational; or if other issues exist that would not allow Crestone to collect a representative sample, a water source sample exception variance, along with supporting documentation, will be submitted to the City of Aurora. Any deviations to the subsequent sampling process will be communicated to the City of Aurora in a timely manner.

At a minimum, if no water source is able to be sampled during a subsequent sampling event, Crestone will sample, at the aforementioned frequency, a replacement alluvial groundwater monitoring well installed on or downgradient of the New Well location. The intent of the replacement alluvial groundwater monitoring well is to address any degradation of water quality, as defined in Section 5.0, identified during previous water sample event(s).

5.0 - ENHANCED WATER QUALITY TESTING

If sampling shows degradation of water quality, additional measures may be required including:

1. If free gas or a dissolved methane concentration levels greater than 1 milligram per liter (mg/l) are detected in a water source, determination of the gas type using gas compositional analysis and stable isotope analysis of the methane (carbon and hydrogen) will be conducted.



2. If the test results indicate thermogenic or a mixture of thermogenic and biogenic gas, an action plan to determine the source of the gas will be developed.
3. Immediate notification to the City of Aurora, the COGCC, and the owner of the water well if the methane concentration increases by more than 5 mg/l between sampling periods, or is at or above 10 mg/l.
4. Immediate notification to the City of Aurora, the COGCC, and the owner of the water well if BTEX and/or TPH are detected as a result of testing. Such detections may result in required subsequent sampling for additional analytes.
5. Further water well sampling in response to complaints from water source owners.
6. Timely production and distribution of test results in electronic deliverable format to the City of Aurora, the COGCC, and the water source owners.
7. All water source testing must be conducted by the Crestone or, if requested by a surface owner, by a qualified independent professional consultant.
8. If Crestone identifies degradation to water quality as a result of its oil and gas development, Crestone shall be responsible to mitigate the degradation of water quality to the applicable regulatory standards as defined in the City of Aurora OA.

6.0 - REPORTING RESULTS

The location of the AWS will be collected using GPS with a submeter resolution and the results will be reported to the COGCC and the City of Aurora. The EC will report results of field observations, including reporting on damaged or unsanitary well conditions, adjacent potential pollution sources, odor, water color, sediment, bubbles and effervescence to the City of Aurora. The EC will also provide copies of all test results to the City of Aurora, the COGCC, and the water source owners within 30-days after receiving the analytical results. All results will be submitted electronically to the City of Aurora contacts identified in **Attachment B** unless otherwise directed by the City of Aurora.

LIST OF APPENDICES

- A. Professional Geologist (PG) or Colorado Professional Engineer (PE) Certification of the Crestone Peak Resources Fieldwide Water Quality Monitoring Plan, City of Aurora, Colorado
- B. Water Quality Monitoring Plan Contacts

Attachment A

**Professional Geologist (PG) or Colorado Professional Engineer (PE)
Certification of the Crestone Peak Resources Fieldwide Water Quality Monitoring Plan,
City of Aurora, Colorado**

**Certification of the Crestone Peak Resources
Fieldwide Water Quality Monitoring Plan, City of Aurora, Colorado**

I have reviewed the Fieldwide Water Quality Monitoring Plan (Plan) for the City of Aurora, Colorado, dated September 24, 2020, prepared by Apex Companies, LLC for Crestone Peak Resources Operating, LLC (Crestone), to address City of Aurora requirements for a Water Quality Monitoring plan, as specified in the City of Aurora Operator Agreement, to monitor groundwater quality conditions around proposed oil and gas well locations within the City of Aurora, Colorado.

I attest that this Plan has been prepared in accordance with good engineering practices, including consideration of applicable industry standards.



ARTHUR L. VEENENDAAL

Printed Name of Registered Professional Geologist

Signature of Registered Professional Geologist

Date: SEPT 30, 2020

Registration No. 3415

State: ~~Colorado~~ WY

Attachment B
Water Quality Monitoring Plan Contacts

Crestone - Water Quality Monitoring Plan Contacts

Company	Name	Title/Location	Phone	Email
Client				
Crestone Peak Resources	David Stewart	Vice President of Environmental, Health, Safety, & Regulatory		david.stewart@crestonepr.com
	David Tewkesbury	Environmental Coordinator	720-236-5525	david.tewkesbury@crestonepr.com
Environmental Contractor				
Apex Companies, LLC	Jana Nilsen	Senior Project Manager Grand Junction, CO	970-263-8679 x3450	Jana.Nilsen@apexcos.com
	Heather Shideman	Project Manager Dayton, WY	307-620-0117	Heather.Shideman@apexcos.com
	Kolbi Olson	Environmental Scientist Sheridan, WY	307-755-3465	Kolbi.Olson@apexcos.com
	Kade MacDougall	Environmental Technician Mead, CO	303-487-1020	Kade.MacDougall@apexcos.com
Primary Laboratory Analytical Contractor				
Pace Analytical National Center for Testing & Innovation	Chris Ward	Project Manager Mt. Juliet, TN	615-773-9712	cward@pacenational.com
Geoscience Consultant				
Apex Companies, LLC	Tomlinson Fort	Principal Scientist - Hydrocarbon Forensics Malvern, PA	610-722-9050	TFord@apexcos.com
Stable Isotope Analytical Laboratories				
IsoTech Laboratories (Primary)	Alan Langenfeld	Laboratory Manager Champaign, IL	877-362-4190	langenfeld@isotechlabs.com
Dolan Integration Group (DIG)	Josiah Strauss, Ph.D.	Laboratory Director Westminster, CO	303-531-2950	jstrauss@digforenergy.com
Regulatory				
COGCC	Arthur Koepsell	Environmental Data Analyst Denver, CO	303-894-2100	arthur.koepsell@state.co.us
City of Aurora	Sean Lieske		720-859-4411	slieske@auroragov.org
	Sarah Young		303-739-7279	syoung@auroragov.org
	Joshua Godwin		720-859-4307	jgodwin@auroragov.org