1625 Broadway
Suite 2000
Denver, CO 80202

Tel: 303.228.4000
Fax: 303.228.4280
www.nobleenergyinc.com

noble energy

December 11, 2007

Mr. David Neslin
Acting Director
Colorado Oil and Gas Conservation Commission
1120 Lincoln Street, Suite 801
Denver, Colorado 80203

SUBJECT: Responses to Comments on Draft Rulison Sampling and Analytical Plan

Dear Mr. Neslin:

The attachments to this letter present our initial responses to comments received from COGCC, CDPHE, DOE, and Garfield County on the draft Rulison Sampling and Analytical Plan. We believe the comments have been helpful in starting to finalize the draft plan. The comments are organized in six attachments as follows:

- Attachment 1 – Response to COGCC General Comments
- Attachment 2 – Response to COGCC Specific Comments
- Attachment 3 – Response to COGCC Additional Comments
- Attachment 4 – Response to CDPHE Comments
- Attachment 5 – Response to DOE LM Comments
- Attachment 6 – Response to Garfield County Comments

For clarity, Attachments 1 and 2 address comments provided to COGCC by Papadopulos and Associates, while Attachment 3 addresses comments received via e-mail from COGCC staff. I note that we received some very late supplemental comments from COGCC staff (including as recently as this morning) that we have not fully included in these responses, but we will address and incorporate them in the final plan document as appropriate.

We hope that you will be able to incorporate these responses as well as our December 4, 2007 letter to you into tomorrow's Commission presentation. If you have any questions or concerns, please contact Mike Wozniak or myself.

Regards,

Curtis O. Rueter, P.E.
Northern Region Environmental Manager

cc: Michael Wozniak, Beatty & Wozniak
Mike Paules, Williams
Chris Williams, EnCana
Kate Fay, CDPHE
Rick Hutton, S.M. Stoller (for DOE)

Attachment 1

Draft Rulison Sampling and Analysis Plan

Response to Comments

from

Colorado Oil and Gas Conservation Commission (COGCC) (General Comments)

Draft Rulison Sampling and Analysis Plan

The following provides Noble Energy Production, Inc., Williams Petroleum RMT, and EnCana Oil & Gas (USA), Inc. ("the Companies) responses to the Colorado Oil and Gas Conservation Commission (COGCC) general comments to the Companies Draft Rulison Sampling and Analysis Plan (SAP). The comments were prepared and submitted by S. S. Papadopulos & Associates, Inc. for the COGCC on December 7, 2007. Responses to the comments outlined below will be incorporated into a revised SAP.

Comment 1: Figures 2 and 3: Differentiate between water sampling locations (i.e., groundwater, surface water, and spring/seep) and indicate the monitoring program that resulted in these including these locations on the map.

Response 1: Figures will be revised as suggested.

Comment 2: Figure 3: It would be helpful if locations of permanent residences and business within the Tier I and Tier II monitoring zones were shown. It is reasonable to focus on these nearby residential locations because the intent of the plan is to *"verify that natural gas operations are conducted and monitored in a safe and responsible manner, reflective of the environmental health and safety needs of the Companies' employees, contractors and the public."* [page 1-1, emphasis added]

Response 2: We will attempt to identify residential locations where data are readily available.

Comment 3: Figure 3: Identify the gas wells by name (or at a minimum, distinguish between the existing seven producing wells where natural gas and produced water were sampled and the two new wells where monitoring was conducted during drilling).

Response 3: The gas wells will be identified by name on Figure 3 as suggested.

Comment 4: Section 2: The following changes are suggested:

- The nuclear device should be identified as a uranium fission device (in the second bullet on page 2-1).
- The discussion of the analysis of gas produced (Smith, 1971) should be moved to Section 2.1; and
- The dates of the plugging of the blast well and the re-entry well should be included at the end

Response 4: The text will be revised as suggested.

Comment 5: Section 2.1: Be more direct in identifying what the Rulison-related radionuclides are. Refer to Table 1 early in the section as a part of this identification.

Response 5: A reference to Table 1 will be included earlier in the section.

Comment 6: Table 1:

- Should either expand this list or provide a footnote directing the reader to DOE (2005) for the complete list.
- Initial activities for ^{39}r, ^{85}Kr, ^{90}Sr, ^{129}I, and ^{137}Cs are incorrect (see Table 1.1 in DOE, 2005). Remember also to correct the following columns and to add DOE (2005) as a reference in Chapter 10.
- Suggest adding a column in the table for Natural Abundance of the listed radionuclides as was done in Table 2 in PRESCO, Inc., 2006 Gas Well Drilling Monitoring Report (Cordilleran, September 2007).

Response 6:

- **A footnote will be provided directing the reader to DOE (2005).**
- **The initial activities are correct; the reference to the source of the initial activities will be corrected to cite Nork and Fensk (1970).**
- **A natural abundance column will be added to Table 1.**

Comment 7: Section 3: Several references to radionuclide activities/concentrations that were or were not detected above instrument detection limits are present in this section. Often these references do not include any quantitative information. More specificity should be provided in this section by including quantitative information where possible. A summary table that provides air and water standards (and possibly ranges for natural activities) would give the reader a sense of what specific measured activities mean.

Response 7: **A range of instrument detection limits will be provided if they are reported in the original source document. A summary table will be prepared that summarizes the air and water standards and range of natural activities, where available.**

Comment 8: Section 4 and Section 6.1, Data Quality Objectives, and Section 6.2, Quality Assurance Objectives: Sections 6.1 and 6.2 should probably precede Section 4 (or become the first part of Section 4). It is important that the following be established prior to presenting, or as part of the presentation of, the actual monitoring approach:

- Statement of objectives for both the operational and environmental monitoring programs (include worker health and safety as one of the objectives for the operational monitoring).
- Determination of the Type, Quality, and Quantity of the data (i.e., the Data or Project Quality Objectives) needed to meet the monitoring program objectives.
- Determination/explanation of Measurement Performance Criteria that will be necessary to ensure that the decisions made from the data meet acceptable levels of confidence. Should reference Chapters 6 through 9, as appropriate, for specific information on these criteria.

Response 8: **The Companies would prefer to retain the current organization of the report as presented in the draft. Sections 1-4 are presently sections that**

provide "high level" summaries for the less technical reader of the report, while Sections 5 and higher provide much more of the technical details of the monitoring. Hence, we prefer not to move the DQOs into Section 4. A reference will be included in Section 4 to refer the reader to the data quality objectives.

- **The primary objective of this SAP is early detection of verified Rulison-related radionuclides in the produced water, natural gas, or the local water supply. There are not separate objectives for the operational and environmental monitoring programs.**
- **The type, quality, and quantity of data needed to meet the monitoring program objectives are specified in the SAP.**
- **A reference will be included in Section 4 to direct the reader to Sections 6 through 9 for the DQO measurement performance criteria.**

Comment 9: Section 4.0: Weighting for monitoring approach (also mentioned on page 1-1): We do not support the unequal weighting of the sectors.

- While the trend of geologic structures does appear to be predominantly east-west, groundwater flow directions, both in the bedrock above the gas producing intervals and in the shallow subsurface, probably are influenced by the proximity of the Colorado River and by the general topographic slope towards the river. The river runs closer to the Rulison site to the north and north-northwest; therefore a portion of flow can be inferred to be in that direction.
- The area at and just beyond the outer edge of the Tier II boundary north of the Rulison site is relatively heavily developed. To weight the zones as proposed is not warranted in light of this development and the public's overall level of concern in this area.
- The strongest monitoring program would divide the region into 12 equal-sized sectors. While there may be technical justification for leaving current Sector 5 as is, this hybrid/compromise approach is not recommended given public concerns in the area.

Response 9:

- **Based on recent discussions with the COGCC, the Companies will revise the monitoring program to include 12 equal-sized sectors.**
- **The structural grain within the deep bedrock is predominantly east-west. Groundwater flow within the deep bedrock where the Rulison test occurred is influenced by the geologic structure at depth and is not influenced by the Colorado River. However, as stated, the Companies agree that groundwater flow within the shallow alluvium overlying the bedrock formations is strongly influenced by both local topography and the Colorado River, thus shallow groundwater generally flows north-northwest in the alluvium.**
- **The proposed environmental monitoring which is designed to detect Rulison-related radionuclides in the shallow groundwater is not**

weighted towards the east or west. Review of Figure 2 shows that most of the environmental monitoring locations are north and northwest of Project Rulison. In addition, the DOE shallow groundwater monitoring network sampled and analyzed by the EPA is also situated to the north of the Rulison test in the most heavily populated areas.

Comment 10: Table 2 and subsequent explanations of sampling program:

- ^{3}H and ^{14}C are known to partition into water and carbon dioxide molecules. Therefore, if sufficient water vapor/water and carbon dioxide are present in the natural gas samples, then consideration should be given to determining the ^{3}H in water and ^{14}C in carbon dioxide from the gas samples.
- Section 4, general sampling question: ^{14}C is only being analyzed specifically in natural gas samples. However there may be ^{14}C in organic materials or carbonaceous minerals in water or soil or drill cuttings or other sampled materials. Be sure that ^{14}C is detectable by the gross beta method used by the contract laboratory and if it is detectable, that the detection limit is sufficiently low to meet data quality objectives. If the gross beta method is not adequate for measurement of ^{14}C, then consider adding ^{14}C to the list of specific analytes.

Response 10:

- **Tritium will be determined in the produced water which is equivalent to the water vapor in the natural gas. It is not reasonable to measure ^{14}C in the carbon dioxide fraction of the natural gas since it typically comprises less than 5 percent of the natural gas produced in the area.**
- **Produced water, soil, or drill cuttings or fluid samples are not specifically analyzed for ^{14}C; however, these media are screened for beta emitters, like ^{14}C, through the gross beta analyses.**

Comment 11: Section 4.1.1: Presumably the reason for ambient radiation monitoring is to enable personnel dose reconstruction in the event that elevated dose rates occur. For that data to be useful a careful log of each individual's occupancy time is required. Doses calculated by this method incorporate a high degree of uncertainty. A more direct and accurate way to verify safety of the Companies' employees and contractors is with individual dose monitoring. If the reason for ambient radiation monitoring is to discover and respond to elevated radiation exposure rates, then an alarming area monitoring system or the planned TSA equipment would be more appropriate.

Response 11: **The ambient radiation monitoring is designed to measure ambient radiation levels so that background radiation levels are known. The discovery and response to an unanticipated increase in radiation during drilling will be detected using the TSA continuous gamma monitoring system which will be connected to the drilling control system and equipped with an alarm system as specified in the SAP (see Section 4.1.1, second bullet).**

Comment 12: Table 2 and Section 4.1.1:

- Is an objective of the drilling cuttings and mud sampling to provide information for future disposal of drilling materials? If so, this should be stated in the objectives for the sampling.
- Consider adding a second composited drilling fluid and cuttings sample for the 500-foot interval immediately above that already planned.

Response 12:

- **The objective of sampling drill cuttings and fluids is early detection of verified Rulison-related radionuclides while drilling the gas well. The objective of sampling is not for future disposal of drilling materials.**
- **An additional composite sample of drill cuttings and fluid from the 500-foot interval above the Rulison test interval specified in the SAP will be included in Section 4.1.1.**

Comment 13: Section 4.1.1, etc.: Comments relating to radiological field instrumentation and measurement:

- Section 4.1.1: Continuous real-time gamma screening of drilling cuttings and fluid is a good approach, but the required detection limits and action levels are appropriately stated in concentration values, not relative terms like counts per second (cps). The response of the TSA equipment (in cps) should be calibrated relative to those action levels. A good choice would be to set detection limits and action levels in terms of Cs-137 concentration because Cs-137 is Project Rulison's the most abundant radionuclide and it is readily detectable by gamma screening methods. The Cs-137 signal may also be useful as an indicator that more difficult-to-detect radionuclides, such as Sr-90, Tc-99 or Cl-36 are present. Gross gamma data (the kind available from detectors supplied by TSA Systems) will vary as ambient background and primordial radionuclide concentrations change. Gross gamma data can be hard for even skilled professionals to interpret without additional information from gamma spectroscopy equipment. Well-chosen hand-held equipment should be used to serve this spectroscopy need.
- Section 4.1.1: Instead of arbitrarily setting the API gamma log action level to 1,000 units, a better approach would be to set the action level based on Cs-137 concentration and correlate that to the API value if possible. Assuming the only radioactivity in the drilling cuttings and fluid was Cs-137 and an API gamma log unit reading of 1,000 was observed, what concentration of Cs-137 would that represent?
- Section 5.2.3: If the Ludlum Model 3 with Model 44-2 gamma scintillation detector is selected it would be best if it is purchased with a microR per hour meter face, calibrated using NIST-traceable sources with reference to Cs-137 gamma energy, and certified to operate in the expanded temperature range of -40 F to + 150 F. Other micro-rem meters such as Bicron MicroREM or Victoreen Model 451P (with its better energy response and computer interface) might also be selected.

- Appendix-2.3.3: The hand-held survey meter might be less sensitive than the TSA Systems unit which probably includes a much larger plastic scintillator gamma detector. Consequently a valid alarm might be dismissed based on handheld microR meter readings. A better way to confirm or discount any alarm might be achieved using a hand held gamma spectroscopy system looking specifically for a signal from the fission product Cs-137. Several different instruments could meet this need, for example a Ludlum Model 16 portable analyzer and Model 44-2 detector with the window and threshold bracketing the Cs-137 photopeak. Other easy- to-use instruments to consider are the BNC SAM 935 and the Thermo identiFINDER Spectrometer/Isotope Identifier.
- Specify the redundancy that is planned for radiation instruments, and provide operational plans if any one of the required instruments is unavailable or fails a performance test?
- Instrument performance tests and associated records are normally proceduralized. Will they be in this case?

Response 13:

- **The continuous gamma monitoring system proposed in the SAP will be calibrated to a Cs-137 standard, per industry practice.**
- **Open- or cased-hole gamma logs are run on each hole <u>after</u> it is drilled to log the naturally occurring gamma radiation in the geologic units. These logs may be used to identify the interval of gamma radiation above action levels if it is detected by the continuous gamma monitoring system during drilling. Elevated gamma measurements on the open- or cased-hole logs are not the primary driver for evaluation of gamma radiation above action levels. The continuous gamma monitoring performed <u>during</u> drilling will be used to determine the need for additional evaluation of gamma radiation above action levels. Open- or cased-hole gamma logs will only be used within Tier I to identify and potentially verify the specific interval of elevated gamma measurements detected using the continuous gamma monitoring system and, thus, do not need to be calibrated to Cs-137.. In the event of unanticipated detection of gamma radiation above the action level, appropriate measures will be taken at the well and the specific source of the gamma radiation within the well will be evaluated as necessary.**
- **Your suggestions will be considered in our selection of the hand-held radiation monitoring instruments for this project.**
- **Your suggestions will be considered in our selection of the hand-held radiation monitoring instruments for this project.**
- **Per industry standards, at least two of each hand-held radiation survey instruments specified for the project will be maintained on site or be locally available.**

- **The instrument performance tests and records will be proceduralized. We will obtain the manufacturers instrument operating and calibration procedures. Each instruments background and source checks will be performed daily and a record of these checks maintained in an instrument log book. Control charts will be maintained to document the instruments performance over time and assess the need for calibration.**

Comment 14: Sections 4.1.2 and 4.2.2: We are in agreement with previous comments that sampling of natural gas and produced water from new wells should be conducted immediately after initial production.

- It would be preferable for the well to be shut-in after the initial sampling until laboratory results are reported. However, if it is necessary that production continue, the gas produced should be contained within the production pipeline system and the water produced should be retained on-site if possible.
- If the operators choose to release materials derived from the gas well prior to laboratory sample clearance, then it should be recognized that they would probably be liable for environmental remediation and public health impacts if Rulison-related contaminants are released.
- Whether a well is shut-in or continues to produce, quick turn analysis of the initial gas and produced water samples should be required.
- The initial sampling event should not preclude the 30-day sampling.

Response 14:

- **The issue of timing of the initial sampling is a factor in addressing this comment. After fracing, much of the initial flowback primarily consists of the fracing fluid. Over time, the composition changes with the fracing fluid content declining and increasing gas and formation water contents. Therefore, immediate sampling (prior to any gas sales) does not necessarily provide the most representative sample of gas or formation water.**
- **For the related concern of not having any production until the sample results are in, we are inferring that the concern relates to the possible presence of radioactive materials in the gas or water and the perception that producing them would pose a health risk. The DOE (2007) modeling study (publication 45224) results strongly indicate that there is essentially no chance of there being any contamination at first production in the Tier I or Tier II zones – the model only predicted results above background in 3% of the cases after 30 years of production, and it is our understanding from discussions with DOE that, even in the worst case, the radiation levels that were above background levels were still significantly below all health standards.**
- **A rapid turn around is not available for many of the radionuclide analytes. However, the Companies will consider rapid turnaround for gross alpha/beta and tritium analyses to screen samples collected**

during the first 30 days of production for Rulison-related radionuclides. Rapid turnaround is expected to be between 1 and 2 weeks from sample receipt at the laboratory.

- **The initial sampling event is the 30-day sampling.**

Comment 15: Section 4.1.2 and Table 2: For wells in the Tier I zone, the sector/closest well monitoring plan is acceptable as presented, with the following conditions:

- In addition to the sampling that occurs within the first 30 days of the first delivery of gas, for wells where ongoing monitoring is not required, a follow-up sample should be collected 6 months to 1 year after production has begun.
- If a new "closest" well is drilled and produced in a sector, then the long-term sampling program should be shifted to that well.
- A detailed contingency plan addressing sampling of other Tier I zone wells needs to be provided in the event that a Tier I well becomes impacted with Rulison-related radionuclides.
- It should be stated that if drilling inside the COGCC ½-mile radius is proposed in the future, the Tier I zone monitoring plan will be reevaluated in light of the closer proximity of the wells to the blast site. Or it should be stated that there are no plans at present to drill within the COGCC ½-mile radius.

Response 15:

- **The SAP text currently specifies (Section 4.1.2, first bullet) that all new Tier I wells will be monitored quarterly for the first year of production, regardless of whether they are the closest well in a sector. However, Table 2 is inconsistent with the text and will be revised to clarify that all new Tier I wells will be monitored quarterly for the first year of production.**
- **Agreed; that is our proposed approach.**
- **The text will be revised to indicate that if a verified Rulison-related radionuclide is detected in a Tier I well above its action level, all Tier I wells within that sector and the two adjacent sectors will be sampled to determine whether they exist in other adjacent wells. The well in question will be temporarily shut-in pending further evaluation if the radionuclide activities are greater than 25 percent of its action level.**
- **See December 4, 2007 letter from C. Rueter of Noble Energy Production, Inc. to D. Neslin, Acting Director, COGCC.**

Comment 16: Section 4.2.1: It is indicated that radiological monitoring will be conducted at Tier II drilling locations. Specific details describing that monitoring should be added to this section.

Response 16: **Radiological monitoring, other than open- or cased-hole gamma logs, is not proposed for Tier II drilling locations. The gamma ray logs are**

discussed in Section 4.2.1. No additional radiological monitoring is proposed.

Comment 17: Sections 4.2.2 through 4.2.4 and Table 2: Contingencies for further testing due to verified Rulison-related impacts in the Tier I zone should be provided in detail.

Response 17: **The text will be revised to indicate if a verified Rulison-related radionuclide is detected in a Tier I well, all Tier I and Tier II wells within that sector will be sampled to determine if they exist in other outlying wells in that sector.**

Comment 18: Section 8: Should consider including the laboratories' QA Manuals as an appendix to this SAP.

Response 18: **The laboratories' QA Manuals will be obtained, where available, and retained for review as requested. The laboratory QA manuals will not be included as an appendix to this SAP.**

Comment 19: Section 9.2.1:

- Chemical separation specificity is not applicable in this case to alpha spectrometry because alpha spectrometry is not planned. It is however important for analysis of H-3, I-129, Cl-36, Tc-99, and C-14.
- Sr-90 is a bone-seeking radionuclide with a high dose conversion factor compared to other beta-emitters and it is the second most abundant radionuclide in the Project Rulison inventory. Therefore it is prudent to ensure that the contract laboratory has an acceptable analysis method for Sr-90 in case an elevated gross beta result needs to be examined with more specificity.

Response 19:

- **The discussion of chemical separation will be revised to use an analyte example pertinent to this SAP.**
- **The laboratory contracted to perform the strontium-90 measurements will be evaluated to assure that its analytical procedure is acceptable and appropriate for producing usable strontium-90 results.**

Comment 20: Schedule: Should a general reporting schedule be provided in the SAP? A table of types of reports (e.g., for new wells or for environmental monitoring results) would provide assurance that environmental data would be made public on a regular basis.

Response 20: **A new Section 4.3 COGCC Reporting will be added to the SAP that discusses the types of monitoring reports that will be prepared and their delivery schedule. Four reports are envisioned (1) individual Tier I drilling monitoring report for each new well; (2) baseline produced water and gas sampling report for existing wells; (3) a quarterly production monitoring report that includes data on new wells; and (4) annual environmental monitoring report.**

Comment 21: Appendix Section 2: Will a Site Safety Officer be on-site at all times during drilling operations? If not, who has that responsibility? What radiological training will be required for the SSO or his representative? These items should be made clear in a section describing personnel roles, responsibilities and training.

Response 21: A Site Safety Officer, or a similarly designated individual, will be on site at all times. This individual will have the necessary training to implement the Radiological Incident Management Plan. A brief summary of the training requirements will be included in Appendix Section 2.

Comment 22: Appendix Sections 3 and 4: If any unexpected radiological conditions are confirmed to have occurred, whether or not the exposure is estimated to be in excess of the 10 millirem/year level indicated, governmental agency contact must be made by the RSO. There should not be a "determination" of whether or not to make the contact.

Response 22: The COGCC and CDPHE will be contacted if any confirmed radiological condition is encountered that exceeds the action level for areas with public access specified in Table A-1, regardless of whether the exposure is estimated to be in excess of the 10 millirem/year standard.

Attachment 2

Draft Rulison Sampling and Analysis Plan

Response to Comments

from

Colorado Oil and Gas Conservation Commission (COGCC) (Specific Comments)

Draft Rulison Sampling and Analysis Plan

The following provides Noble Energy Production, Inc., Williams Petroleum RMT, and EnCana Oil & Gas (USA), Inc. ("the Companies") responses to the Colorado Oil and Gas Conservation Commission (COGCC) specific comments to the Companies Draft Rulison Sampling and Analysis Plan (SAP). The comments were prepared and submitted by S. S. Papadopulos & Associates, Inc. on December 7, 2007. Responses to comments as outlined below will be incorporated into a revised SAP.

Comment 1: mV, CER, and CCR are not included in the List of Acronyms.

Response 1: The referenced acronyms will be included in the list.

Comment 2: DRI is listed as Desert Ranch Institute in the List of Acronyms.

Response 2: DRI will be corrected to read Desert Research Institute.

Comment 3: Page 1-1: Include the uncertainty range on the size of the Rulison nuclear blast.

Response 3: The uncertainty range will be included.

Comment 4: Figures 1 through 3. Add townships and ranges to Figures 1 and 2 and sections to Figure 3.

Response 4: Townships, ranges, and sections will be added to Figures 1, 2, and 3, as appropriate.

Comment 5: Section 2: Consider providing estimates of nuclear cavity size and the estimates of the extent of blast-related fracture propagation.

Response 5: Estimates of the nuclear cavity size and fracture radius will be included.

Comment 6: Page 2-1, first 2 bullets: Should provide dates for the Phase I and II activities.

Response 6: The dates of the Phase I and II activities will be provided, if available.

Comment 7: Page 2-4: Is the *"cavity chimney"* the same as the *"nuclear chimney?"*

Response 7: Yes; cavity chimney will be revised to refer to nuclear chimney.

Comment 8: Page 2-4 (bottom of page): Because the sentences *"The subsurface at the Rulison test site…"* and *"Because of this relatively dry environment…"* are not referenced (unless Borg et al, 1976, is the reference) consider removing them and indicating that dissolution is a slow process and that the dissolved radionuclides will tend to absorb to the formation rock.

Response 8: The cited text is from DOE (2007); an appropriate reference to this document will be included in the text.

Comment 9: Page 3-4, last sentence of Section 3.1.2: Provide the date of the final beta-gamma radiation survey.

Response 9: The date of the final beta-gamma survey will be provided, if available.

Comment 10: Page 4-9, Section 4.2.4: Is it advisable to determine sample locations on a *"case-by case"* basis, especially as regards to domestic wells. Possibly best to do a one-time sampling of all locations within ½ mile radius of new wells for baseline purposes. Follow up sampling would be contingent on other results (as stated).

Response 10: **In the course of their normal operations (outside of the 3-mile zone) and depending on landowner requests, the Companies may, at their discretion, currently conduct baseline or subsequent sampling of surface or ground water within ½ mile of the well pad. The concept behind this bullet is that the Companies will continue to make these decisions** within **the 3-mile zone; however, when the sampling is conducted within the 3-mile zone, radionuclides will be added to the analyte list.**

Comment 11: Section 5: Documented training and qualification for all personnel involved in sampling is recommended to ensure only valid samples are submitted for analysis and that data quality objectives are achieved. This training should include detailed instructions for performing background screening using hand-held radiation survey instruments prior to sampling.

Response 11: **A sentence will be added specifying that all sampling will be performed by trained and qualified personnel.**

Comment 12: Page 5-1, Section 5.2.1: Text identifies Appendix A as *"Safe Work Plan."* Should be *"Radiological Incident Management Plan."*

Response 12: **The Safe Work Plan reference will be revised to Radiological Incident Management Plan.**

Comment 13: Pages 5-2, 5-4, and 5-9: GPS unit should be a differential hand-held unit meeting CGS specifications. Should photodocument not only sampling location but also well location and overall view of area/property for use by later samplers.

Response 13: **Appropriate GPS equipment will be used to locate the sample sites. Photos will also be taken to document the sample location for future samplers.**

Comment 14: Page 5-2, etc.: Consider including examples of all field forms in an Appendix.

Response 14: **Field forms will be included in an appendix.**

Comment 15: Page 5-3: Don't plan on sampling wells without pumps unless they are monitoring wells or wells that will not be used in the near term for water supply purposes, or well owner permission is obtained and the wells are disinfected at the end of sampling.

Response 15: **Section 5.1.1 indicates that permission will be obtained for all wells proposed for sampling. No well will be sampled without the owners permission. The current list of wells proposed for environmental sampling have pumps, however, if additional wells are added in the future that do not have pumps, these wells will be sampled by other**

means. All equipment introduced into any well will be cleaned prior to use in the well.

Comment 16: Page 5-6, Section 5.4. *"The TLDs will be placed in personnel work areas ~~or~~ AND near drilling fluid…"*

Response 16: Text will be revised as suggested.

Comment 17: Sections 5.5, 5.6, and 5.8, and Table 3: ^{85}Kr is a gas at ambient conditions, and is subject to volatile losses from water. Samples for ^{85}Kr should be collected with care in order to minimize contact with the atmosphere. The ^{85}Kr sample bottles should be filled and sealed with no headspace.

Response 17: The text will be revised to clarify that dissolved gas samples will be filled and sealed with no headspace.

Comment 18: Page 5-8: First two paragraphs are contradictory in that sampling is with a "*pre-cleaned, disposable polyethylene"* dipper to avoid introducing contaminants to the spring or seep, while spring or seep flow measurements from the same water body require only a "*clean"* container.

Response 18: Clean will be revised to read pre-cleaned, disposable or decontaminated container. Cleaning will be performed in accordance with the procedures in Section 5.10.

Comment 19: Page 5-10, second paragraph: 1) Combine the first two sentences to get *"Groundwater will be dispensed directly from the well discharge line into laboratory-supplied containers so that agitation and aeration…"* 2) Take out *"Spring or seep…"* since this is a discussion of sampling wells.

Response 19: Text will be revised as suggested.

Comment 20: Page 5-11: Sections 5.8 and 5.9. First sentences are confusing—isn't the *"closest"* well covered by the earlier parts of the sentence? Whether it is or not, it would be best to rewrite the sentence to say *"all existing and new wells within Tier I and II."* (Drop the remainder of the sentences.)

Response 20: Text will be revised as suggested.

Comment 21: Page 5-11, Section 5.8: Should specify sampling parameters or reference appropriate table listing them.

Response 21: The table specifying the sampling parameters will be cited.

Comment 22: Page 5-12: Last paragraph. *"Non-dedicated~~, disposable~~ sampling equipment…"*

Response 22: Text will be revised as suggested.

Comment 23: Page 6-4, Section 6.3.5: The sentence *"Sample data will be collected and reported to be comparable with other measurement data for similar samples and sample conditions"* is confusing.

Response 23: The cited sentence will be revised as follows to clarify its meaning. Sampling, analysis and reporting will be conducted using procedures and

protocols that are designed to produce data comparable to other measurement data for similar samples and analyses.

Comment 24: Table 4: There is no item in the table referring to footnote 2.

Response 24: Table will be revised to eliminate Footnote 2.

Comment 25: Page 8-7, second paragraph: *"preformed"* should be *"performed."*

Response 25: Text will be revised as suggested.

Comment 26: Section 9-2:

- For the data validation, consider providing laboratory performance criteria and sample-specific criteria in table format for easier review and comparison.
- Are laboratory data qualifiers and independent reviewer data qualifiers meant to be the same (and to be defined the same way)? If yes, Table 6 should be noted to indicate as much (and the qualifiers N and CL should be included on the table); if not a separate table should be provided for the independent review data qualifiers.

Response 26:

- **A summary table will be provided for the laboratory and sample-specific criteria.**
- **No; The data qualifiers listed in Table 6 are those to be assigned during an independent review of the laboratory data package. The qualifiers assigned by the laboratories are laboratory-dependent and are not easily adapted by the laboratory to meet project-specific revisions. Thus, the data reports from the selected laboratories will include definitions of their laboratory qualifiers. Section 9.2 of the text will be revised to clarify that the qualifiers in Table 6 are designed for use by an independent validator.**

Comment 27: Section 9.3: Provide a reference to the Data Validation Report earlier in the chapter.

Response 27: A reference to the Data Validation Report will be included earlier in Section 9.

Comment 28: Page 9-9, third paragraph from bottom: *"rejected (R)"* should be *"unusable (R)"* to be consistent with Table 6 and other uses in the text.

Response 28: Text will be revised as suggested.

Comment 29: Page 9-12: Last sentence of next to last paragraph has a typo.

Response 29: Typographical error will be corrected.

Comment 30: Page 9-15: In the equation key the "s" should be "σ".

Response 30: Text will be revised as suggested.

Comment 31: Section 10: Double check the references included in this section against references provided in the text.

Response 31: **Documents reference in the SAP will be checked and included in Section 10 if missing.**

Comment 32: Appendix A, Section 2.2: Should specify the individual performing the background radiation survey will be the SSO.

Response 32: **Text will be revised to indicate that the SSO, or a designated, trained representative, will perform the background radiation survey.**

Comment 33: Appendix A, Section 4: Operators should consider developing *in vivo* and *in vitro* bioassay procedures and analysis options in case employees or contractors are exposed to contaminated gas, drilling cuttings, drilling fluids or produced water.

Response 33: **Radiological bioassays involve the direct or indirect measurement of radiation deposited in the body. If a radiological incident occurs that exposes workers, bioassays will be performed, as necessary, to determine their exposures.**

Comment 34: Appendix A, Table A-3: The COGCC agency contact information should specifically include Jamie Atkins and Chris Canfield (and their office and cell phone numbers).

Response 34: **The listed COGCC agency contacts will be added to Table A-3.**

Attachment 3

Draft Rulison Sampling and Analysis Plan

Response to Comments

from

Colorado Oil and Gas Conservation Commission (COGCC) (Additional Comments)

Draft Rulison Sampling and Analysis Plan

The following provides Noble Energy Production, Inc., Williams Petroleum RMT, and EnCana Oil & Gas (USA), Inc. ("the Companies) responses to the Colorado Oil and Gas Conservation Commission (COGCC) additional comments to the Companies Draft Rulison Sampling and Analysis Plan (SAP). The comments were submitted on December 10, 2007.

Additional Comments

Comment 1: Fig. 1 - Add Township, Range Section.

Response 1: Townships, ranges, and sections will be added to Figure 1.

Comment 2: Pg 1-1 - "43 kiloton device" add the ± from the original AEC report.

Response 2: Text will be revised as suggested.

Comment 3: Pg 2-5 and Table 1 - Antimony 125 and Argon 37 listed as mobile constituents in water and gas, respectively. Neither listed on Table 1.

Response 3: Antimony-125 and argon-37 were not included in Section 2 or on Table 1 because their half lives are 2.8 years and 35 days, respectively. These half lives are sufficiently short so that they have decayed significantly since the test occurred and pose little or not threat of release.

Comment 4: Pg 3-8 Sec 3.2 - For referenced wells, include map showing location and well name.

Response 4: The referenced wells are shown on Figure 3 and will be labeled for identification.

Comment 5: Pg 4-4 Sec 4.1.1 - Have heard from several sources, including a Commissioner, that Landaur badges are inappropriate for this application.

Response 5: The Landaur X-9 environmental dosimeters proposed for the ambient radiation monitoring are specifically designed for environmental monitoring applications. They have been used for this purpose at numerous DOE sites for off-site environmental dose monitoring.

Comment 6: Pg 4-7 Sec. 4.1.3 - If existing gas well is closest well, it should be subject to same sampling requirements as new wells and should consider production history and volumes produced

Response 6: Baseline produced water and natural gas monitoring will be performed at all existing gas wells within Tier I regardless of their distance from Project Rulison. If an existing gas well is the closest well, the Companies will also conduct quarterly, semi-annual, and annual sampling as outlined in Section 4.1.2 of the SAP.

Comment 7: Pg 5-1 - Appendix A listed as Safe Work Plan. Appendix A is Radiological Incident Management Plan.

Response 7: Text will be revised by replacing the Safe Work Plan with Radiological Incident Management Plan.

Comment 8: Pg 5-2 Sec. 5.2.2 - Specify that GPS unit must meet COGCC requirements for accuracy

Response 8: Appropriate GPS equipment that meets COGCC requirements will be used to locate the sample sites in accordance with COGCC requirements.

Comment 9: Pg 5-4 and 5-5 - Will site background screening be a random wander around the site or follow a regular, pre-specified pattern?

Response 9: The text will be revised to clarify that background radiation screening will be performed using 1 of 2 methods depending on the site being monitored. For well pads, the background radiation screening will be performed on a "9-point" grid over the area of the well pad. Background radiation screening at environmental monitoring sites (e.g., ranch or livestock wells, springs, or streams) will be measured at a single location adjacent to the sampling site.

Comment 10: Pg 5-11 Sec. 5.8 - Produced water samples should be collected from the closest wells, regardless of Tier I or Tier II. Specify what are "selected radionuclides" or reference a Table.

Response 10: Baseline produced water samples will be collected at all existing and new wells within Tier I or II regardless of whether they are the closest well. Produced water samples will be analyzed for tritium, gross alpha/beta, gamma-emitting radionuclides (including Kr-85), Tc-99, I-129, and Cl-36. The text will be revised to clarify.

Comment 11: Pg 5-11 Sec. 5.9 - Why only 3H and 14C? 36Cl, 39 Ar, and 85Kr also listed as gas transportable. Is this because only 3H and 14C remained in the cavity after flaring? Justify your selection

Response 11: Natural gas samples are only analyzed for tritium and carbon-14 because there are no commercial laboratories known to us that are capable of analyzing natural gas for other radionuclides such as Cl-36, Ar-39, or Kr-85. Produced water samples are being analyzed for Cl-36 and Kr-85.

Comment 12: Pg A-2 Sec. 2.2 - Will site background screening be a random wander around the site or follow a regular, pre-specified pattern?

Response 12: For well pads, the background radiation screening will be performed on a "9-point" grid over the area of the well pad. The 9 points will include measurements at each corner of the pad (4), at the midpoint between pad corners (4), and at the center of the pad (1).

Comment 13: Section 4 Monitoring Approach - The SAP uses the terms "baseline" and "monitoring" almost interchangeably starting with the third bullet in Section 4.1. It fails to capture the idea of "baseline" sampling as an attempt to define pre-existing conditions, i.e. a snapshot. Monitoring is of course a process built on time-series data. The SAP should define what is intended by both of those terms and then use them in a manner consistent with those definitions.

Response 13: Baseline monitoring is specifically applied to produced water and natural gas monitoring to define the initial condition present at a new or existing gas well. Baseline is not applied to any of the other monitoring categories because they are not necessarily representative of pre-existing conditions. The text will be revised to clarify.

Comment 14: Section 5.3.3 Field Parameters Turbidity should be included as a field parameter.

Response 14: Turbidity will be included as a field parameter.

Comment 15: Section 6.1 Data Quality Objectives "Drill cuttings" should be added to the list of media being screened for Rulison-related radionuclides.

Response 15: Drill cuttings will be added to the list of media being screened for Rulison-related radionuclides.

Comment 16: Appendix A Radiological Incident Management Plan The subject plan defines incidents solely on the basis of field instrumentation and fails to address situations identified by laboratory analytical results.

Response 16: The Radiological Incident Management Plan is designed to recognize and respond to radiological incidents that might conceivably occur during gas well drilling. Long-term monitoring based on laboratory analytical results, with up to 30-day turn-around times, is the focus of the SAP.

Comment 17: Appendix A, Table A-3 The COGCC contact information should include office and cell phone numbers for the Northwest Area Engineer and Northwest Area Environmental Protection Specialist. Specific contact information for the Garfield County Emergency Operations Commander should also be included.

Response 17: The suggested contacts will be added to Table A-3.

Attachment 4

Draft Rulison Sampling and Analysis Plan

Response to Comments

from

Colorado Department of Public Health and Environment (CDPHE)

Draft Rulison Sampling and Analysis Plan

The following provides Noble Energy Production, Inc., Williams Petroleum RMT, and EnCana Oil & Gas (USA), Inc. ("the Companies") responses to the Colorado Department of Public Health and Environment (CDPHE) comments to the Companies Draft Rulison Sampling and Analysis Plan (SAP). The comments were submitted on December 10, 2007.

Major Comments

Comment 1: Cesium-137 (^{137}Cs) is ignored as part of the analytical suite for water and needs to be included. The pre-cursor for Cesium-137 is Xenon-137, which is a primary fission product. Cesium-137 can be very mobile in water.

Response 1: **Although cesium-137 is generally thought to be readily sorbed to rock surfaces which reduces its aqueous mobility, it will be added to the analytical suite per your request.**

Comment 2: Based on our review, it is possible under this regime to meet all the QC parameters and not have a quantitative measurement. When total uncertainty is greater than 50% of the measured value, the measurement is not quantitative. We recommend tightening the QC requirements to reduce this uncertainty.

Response 2: **It is not clear precisely what criteria or sections the comment is referring to. If the comment is suggesting that a criterion be added concerning the percentage of a sample value represented by uncertainty, that would be appropriate. Thus, we will consider adding the following criterion to the text: "If the uncertainty in a given measurement (as measured by the two sigma error) represents more than 50 percent of the measured value, the result will be qualified as estimated (J)." If the comment is referring to some other aspect of the SAP, then clarification of the comment would be appreciated.**

Comment 3: Quarterly reports should be submitted to the COGCC and CDPHE for review.

Response 3: **A reporting schedule will be provided in the SAP as new Section 4.3 Reporting. Quarterly reports will be submitted to the COGCC and CDPHE for production monitoring. Other reports will be submitted as specified in new Section 4.3.**

Specific Comments

Comment 1: The two tiered monitoring program is acceptable.

Response 1: Agreed.

Comment 2: The definition of "a verified Rulison radionuclide detection" should be included in the document, including who decides when that condition exists.

Response 2: A definition will be added to the SAP to define verified Rulison-related radionuclides as a radionuclide that is characteristic of a nuclear fission detonation whose activity is above background and whose presence is determined to be valid.

Comment 3: I recommend that additional testing in Tier II area can be based on cause, as requested by the COGCC or CDPHE.

Response 3: Agreed.

Comment 4: In §4.1.1 the test for a notable event on the gamma log is a measurement greater than 1000 API gamma units. This seems like a very high threshold, and a value of 400 or 500 API units is recommended as a more appropriate signal for additional evaluation.

Response 4: Open- or cased-hole gamma logs are run on each hole <u>after</u> it is drilled. Elevated gamma measurements on these logs are not the primary indicator for additional evaluation. The continuous gamma monitoring performed <u>during</u> drilling will be used to determine the need for additional evaluation. The open- or cased-hole gamma logs will be used to identify and potentially verify the specific interval of elevated gamma measurements detected using the continuous gamma monitoring system.

Comment 5: §4.2.1 - Same comment as above.

Response 5: See Response 4.

Comment 6: §4.2.4 - Decisions regarding additional monitoring need to be clarified; specifically who will decide about additional monitoring points and who will perform the monitoring.

Response 6: The additional environmental monitoring needs will be based on discussions with the COGCC and the CDPHE. The decisions about what additional monitoring to perform will be based on factors such as the level of Rulison-related radionuclides observed, the potential for migration to ground or surface water, and the proximity of ground or surface water locations to the gas well where the radionuclides were detected.

Comment 7: §5.2.4 - Add the use of a 0.45 micron filter and filtering system for dissolved fraction samples.

Response 7: Text will be added to Section 5.2.4 indicating the use of a 0.45 micron filter for dissolved analytes.

Comment 8: §5.10 - For re-usable equipment, rinsate samples are needed to demonstrate effective decontamination.

Response 8: **If re-usable equipment is used, one (1) rinsate sample will be prepared for every 10 samples collected.**

Comment 9: §6.3.1 - For estimating precision, using the RL value for non-detects when computing the RPD is poor technique and not reliable. In some instances this is the only option, but should be avoided if possible.

Response 9: **For radiochemical analyses, laboratories typically report a numeric value for each analytical result, even when the value is negative. In such cases, the reported value is used to calculate precision as an RPD. However, some laboratories report only the reporting limit (RL) with an indication that the measured value is "less than" the RL. In the absence of a value for the analytical result, the RL is generally used as a proxy for the non-detect values and is used to calculate the RPD. To avoid this issue, the analytical laboratories will be instructed to provide a value for non-detects to minimize the need for using the RL in the RPD calculation.**

Comment 10: §6.3.3 - A completeness goal of 80% is laudable, if defined as meaning that 80% of the data is fully usable, quantitative, and not qualified. If this is not the definition, then more explanation is necessary.

Response 10: **The completeness goal of 80% is intended to represent the percentage of planned measurements that are judged usable (including those qualified as estimated) during validation. Data that are qualified as estimated are usable as long as the uncertainty in the measurement is considered in the interpretation. Rejected values are not usable. Rejected data should be reviewed to determine if they represent a data gap that needs to be filled.**

Comment 11: §9.2.1 - Any measurement with unreported uncertainties should be rejected.

Response 11: **Data for which uncertainty measurements are pertinent and for which the analytical method indicates uncertainty should be measured and reported will be rejected if such uncertainty measurements are not provided by or cannot be obtained from the laboratory.**

Comment 12: A blank measurement falling outside the tolerance limits is a QC failure and indicates a measurement system problem. All the measurements from that data analysis group are suspect and should be qualified.

Response 12: **Validation is the process by which the uncertainty in analytical measurements is evaluated and judgment is made as to whether the uncertainty is known with an appropriate level of confidence and whether the magnitude of potential uncertainty is large enough to affect end use objectives. A blank measurement outside of tolerance limits does represent a QC failure. In the case of limits set at the two sigma counting error, one has approximately 95% confidence that a value greater than the limit represents a contaminant in the sample. However, the QC failure may represent only a small percentage of the measured value and may have no effect on the usability of the data. Thus, it makes sense to**

qualify all data of concentrations or activities equivalent to the blank since one does not know whether the reported value represents a "real" value or sampling and analysis error. The procedure in the SAP specifies that if the sample activity or concentration is less than 10 times the blank level, qualification of the result will be assigned. If, on the other hand, the blank level represents less than 10% of the measured value, the data are considered usable without qualification since a 10% uncertainty in the value will not materially affect the interpretation. This level of acceptable uncertainty is consistent with those for other QC measures such as accuracy (20% is acceptable for matrix spikes) and precision (the duplicate results agree within the 2 sigma (95% confidence) levels. Thus, the procedure is designed to qualify those data that are considered potentially affected beyond the level of acceptable uncertainty.

Comment 13: Appendix A - A radiological incident will involve the CDPHE and a radioactive materials license will likely be required.

Response 13: The Companies recognize that CDPHE will be involved if a radiological incident occurs and that a radioactive materials license may be required.

Comment 14: Appendix A - What on-site equipment will be available for personnel decontamination? If an individual becomes contaminated, the decon kit should be at the rig.

Response 14: A list of the on-site personnel decontamination equipment maintained at the rig will be provided in Appendix A.

Attachment 5

Draft Rulison Sampling and Analysis Plan

Response to Comments

from

Department of Energy
Office of Legacy Management

Draft Rulison Sampling and Analysis Plan

The following provides Noble Energy Production, Inc., Williams Petroleum RMT, and EnCana Oil & Gas (USA), Inc. ("the Companies") responses to the Department of Energy Office of Legacy Management review comments to the Companies Draft Rulison Sampling and Analysis Plan (SAP). The comments were submitted on December 7, 2007. Responses to comments as outlined below will be incorporated into a revised SAP.

General Comments

Comment 1: The Draft Rulison *Sampling and Analysis Plan* (Plan) is well organized and exhibits a positive step forward for the industry and stakeholders near Project Rulison.

Our key concern is that the Plan does not address action levels for the analytical results of gas and water samples. We would suggest that all concerned meet to discuss the definition of action levels and their ramifications.

Response 1: Action levels will be provided in the revised SAP.

Comment 2: Inclusion of environmental monitoring, especially in Tier II, is not consistent with the Plan goal of early detection of Rulison-related radionuclides. Plan goals appear to be blurred. In some sections the document moves to a worker exposure plan typically found in a site-specific health and safety plan. The inclusion of surface water and shallow groundwater environmental sampling is confusing because these locations are not considered part of the primary Rulison-exposure pathways. The broad scope dilutes focus from the pathway of concern, produced gas and the entrained water.

Response 2: Early detection of Rulison-related radionuclides in produced water and natural gas is the primary goal for the operational monitoring. The environmental monitoring portion of the SAP is designed to verify that a release of Rulison-related contamination has not occurred to surface water or shallow groundwater. While long-term historic sampling results have verified that the chances of Rulison-related radionuclides contaminating surface and groundwater is remote, citizens in the area are still concerned. Furthermore, EPA's ongoing annual water sampling on behalf of DOE is similar in nature to the proposed environmental monitoring, which suggests that there is an ongoing need for such monitoring.

Comment 3: The eight divisions appear difficult to implement on the ground; quarter-quarter sections offer cleaner delineation. We would prefer to define a conservative maximum drainage extent and use of that definition to justify the monitoring region with the addition of some safety factor integrated into a multi-tier approach.

Response 3: **Based on recent discussions with the COGCC, the Companies will revise the approach to include 12 equal-sized sectors that will generally be defined on a quarter-section.**

While the concept of defining drainage patterns is a reasonable technical approach for defining monitoring regions, the Companies chose to work within the existing COGCC policies (described in Section 3 of the SAP) that address ½ mile and 3 mile zones.

Comment 4: A broad program is certainly preferable to an inadequate program; however, there are several negative implications. The broad sampling extent and scope may alarm readers that there is an increased risk associated with the property location. A resident may well conclude that there is a potential for radiological contamination of his water supply if people keep coming to sample it, particularly from multiple organizations (e.g., DOE-LM, URS). It can be very difficult to scale back a monitoring program once it is in place.

Response 4: **The Companies share the concern being expressed about unduly alarming residents. However, the environmental monitoring contained in the plan is essentially the same as that performed by a previous operator and the DOE/EPA in the area. Based on the previous environmental monitoring, it does not seem feasible for the Companies to scale back the monitoring program at this time.**

Comment 5: The draft Plan is tied to a 3-mile radial area that has no relationship to contaminant migration potential; it is an artifact of drilling history in the region in the late 1990s. It is important that the Plan focus on when, where, and what samples are needed so it remains cost effective. Use of a 3-mile zone in the plan de facto supports that the zone is at risk from Rulison. The phrase "Three-Mile Radius" should not be included under the title.

Response 5: **As noted previously, the Companies chose to work within the existing COGCC policy framework. We would welcome a broader discussion with the regulatory community in the future about potential modifications to this framework.**

Detail Comments

Comment 1: Section 1.1, page 1-1 (repeated in Section 4, Page 4-1): Groundwater (formation water) flow is believed to be immobile in the partially saturated Williams Fork Formation. What information do you have that attributes flow in the westward direction? Cite the reference in the report.

Response 1: A reference will be provided regarding the westward groundwater flow direction.

Comment 2: Section 1.2, Figure 3: Zone divisions are "weighted to facilitate more monitoring east and west of Project Rulison." Zoning determines sampling of the "closest well" in the zone. This leaves nearby wells drilled to the north and south with less weighting (sample coverage). For example, wells in the four quarter-quarter sections in Tier I Zones that touch Lot 11 at the corners will be generally farther from Rulison ground zero than wells in the north and south quarter-quarter sections adjacent to Lot 11. Presco in its first monitoring report states that "approximately 80% of wells drilled on ten-acre spacing show no production interference with one another." This zone feature of the sampling plan should be explained if 20 percent of wells on 10-acre spacing could possibly show interference.

Response 2: Based on recent discussions with the COGCC, the Companies will revise the approach to include 12 equal-sized sectors that will generally be defined on a quarter-section.

Comment 3: Section 1.2, Figure 3: Rulison ground zero is located approximately in the center of NE¼SW¼ of S25, T75R95W SW S25, T7S R95W. If Figure 3 is to be edited in the future, the center point should be relocated so that ground zero appears properly located to the eye.

Response 3: The figure will be modified as suggested.

Comment 4: Section 2-1, page 2-5: A discussion of the rate of "groundwater" (saline formation water) movement would be helpful to show that formation water is essentially immobile given the time frame considered here, even with a gradient imposed by nearby producing gas wells. Distinguish between formation water movement and gas phase movement given the permeability of the gas and the aqueous phases. This leads to why radionuclide movement in the gas phase (especially in water vapor) is the sampling target of concern. Tritium in water is the sample analyte of interest. Gross alpha, gross beta, and high-resolution spectroscopy analytical methods are employed to detect other products of the Rulison test. The guiding rationale for the analytical suite needs to be clearly presented.

Response 4: Additional discussion on the formation water and gas phase movement will be included.

Comment 5: Section 2.1, page 2-5: The chlorine-36 produced by the Rulison event is in the cavity melt or in liquid, which is immobile.

Response 5: The text will be revised as suggested.

Comment 6: Section 2.1, page 2-6, Table 1: The column "Percent Initial Activity Remaining" does not account for the mass removed during production testing.

Response 6: Table 1 will be modified for clarification.

Comment 7: Section 2.1, page 2–6, Footnote 2: The citation (2005) is missing from Section 10 References Cited.

Response 7: Citation will be added as suggested.

Comment 8: Section 3.1.1, page 3-2: Change "in the early 1960s" to *between 1950 and 1963*. The large increase in ^{3}H in precipitation occurred in 1963 (not "in the 1950s and 1960s").

Response 8: Text will be revised as suggested.

Comment 9: Section 3.1.1, page 3-3, Figure 6: The reference for the data in Figure 6 is: IAEA/WMO (2004). Global Network of Isotopes in Precipitation. (The GNIP Database is accessible at http//www.isohis.iaea.org.)

Response 9: Reference will be added to Figure 6 as suggested.

Comment 10: Section 3.2, page 3-8: Tritium is not listed as a water analyte in the first paragraph. The next paragraph says no tritium was detected in produced water samples. The statements are contradictory.

Response 10: Tritium will be included as an analyte in the first paragraph as suggested.

Comment 11: Section 3.3, page 3-9: Following reentry drilling activities, cleanup was done in the 1970s and is documented. Sentence 3, as written, may be misinterpreted. Work done in the 1990s focused on characterization and cleanup of former mud pits (the pond to the west of Rulison ground zero and the area near the reentry well). The cleanup was approved by the CDPHE.

Response 11: Text will be revised as suggested to clarify this point.

Comment 12: Section 4, page 4-1: Tier II extends 1–3 miles from Rulison ground zero. What is the basis for limited monitoring of gas wells in Tier II "for Rulison-related radionuclides?" How is this limited monitoring related to early detection of Rulison related radionuclides? Will Tier II baseline sampling be done for organic compounds? Shallow (alluvial) monitor wells downgradient of drill pads are appropriate for volatile organics and other compounds associated with drilling.

Response 12: The basis for Tier II gas well monitoring is to collect an initial sample to document that no Rulison-related radionuclides are present. No additional sampling will be done on Tier II gas wells unless a Rulison-related radionuclide is found in Tier I gas wells. In that case, additional sampling of Tier II wells will be performed to document the potential extent of migration (i.e., did it move beyond Tier I). For this scenario, the Tier II initial sampling provides an effective "baseline" condition and the time of initial drilling.

Comment 13: Section 4.1, page 4-4: An omission is the monitoring of fluids introduced into the wellbore to determine baseline concentrations. The hydrofracture water and proppant slurry water may not completely return to the surface before commercial production starts. No action level is defined for produced water sample results, nor is there any prescription to define "background" on the basis of analytical results from sampling introduced fluids.

Response 13: The intention of sampling within the first 30 days of production (rather than prior to production and then shutting in the well) is to allow most of the introduced frac fluids to flow back and be removed from the well before the gas is placed in the gathering system. This process will reduce the frac fluid contribution in the produced water to negligible amounts. Because the monitoring focuses on Rulison-related radionuclides that may (or may not) be present in the formation, the introduction of Rulison-related radionuclides via the frac fluid is not expected to be a concern.

Comment 14: Section 4.1.1, page 4-4: The TLD deployment is coupled to work performed during drilling and fracturing. If tritium escapes, passive TLDs cannot detect it. The beta decay from tritium will not penetrate the TLD jacket.

Response 14: Agreed, the TLDs are not designed to detect a tritium release during drilling and fracturing. Their use is to provide ambient measures of background radiation exposure or to detect other radionuclides that could conceivably be released during drilling and fracturing.

Comment 15: Section 4.1.1, page 4-5: The value of real-time gamma analysis on cuttings for early detection of Rulison radiation is questionable. Instead, can the instrument be used for beta analysis?

Response 15: The real-time gamma monitoring system is not designed to detect tritium in the drill cuttings or fluids. It is included in the monitoring to address COGCC concerns about other forms of radiation that might be encountered. If the system was capable of detecting tritium, placement of the equipment close enough to the drill cutting and fluid outfall would preclude tritium detection because of potential drilling fluid splash back on the detector, thus reducing its capability of detecting low every beta radiation. We will confirm with the manufacturer if higher energy beta radiation can be detected with this system.

Comment 16: Section 4.1.1, second bullet: Add "corrected for dip and distance" to the end of the first sentence.

Response 16: Text will be revised as suggested to correct for dip and distance.

Comment 17: Section 4.1.1, second bullet: Define the term "closest well" used in the second sentence. What happens to "closest well" monitoring when a well closer to Rulison ground zero is drilled in the same zone? When wells even closer are drilled in the same zone? Will sampling of the farther well(s) be continued?

Response 17: **Closest well is defined as the well within each Tier I monitoring sector that is nearest to the Lot 11 boundary. Longer term monitoring will only be performed on the closest well. If a well is drilled within a sector that is closer to Lot 11, then that well will be monitored, and the previous closest well will not be monitored unless it is still in its first year of quarterly production monitoring.**

Comment 18: Section 4.1.2, page 4-6: Are formation fluids sampled prior to hydrofracture? Can a produced-water sample be collected after each perforation interval before hydrofracture and afterwards, if hydrofracture is done in stages? Can a gas and a water sample be collected from the Rulison horizon interval (corrected for dip and distance) after perforation and before hydrofracture?

Response 18: **The current plan does not envision sampling prior to fracturing.**

Comment 19: Page 4-6, Section 4.1.2, second bullet: The sampling frequency is based on a constant volume of gas produced over the well's lifetime. Why isn't the sampling frequency based on the maximum extent of the drainage distance? The distance from which gas is drained is the metric of interest, especially in the direction toward ground zero (and the nuclear fractures).

Response 19: **The proposed sampling frequency based on gas production volumes is consistent with the drainage radius monitoring concept referred to in the comment. Monitoring is more frequent during the early years of production when gas volumes are higher, the gas produced is closer to the well bore, and the drainage radius expands more rapidly. In the out years, monitoring becomes less frequent on a time-based schedule and more frequent on a volume-based schedule because the gas volumes are considerably less.**

Comment 20: Page 4-6, Section 4.1.2, second bullet: The sample target of primary interest is tritiated water vapor, a gas. The sampled gas is sent to Isotech Laboratory where it is filtered through a molecular sieve to remove impurities; the entrained water vapor is removed. Because of this drawback, gas collection safety considerations, and the expense of gas analysis, the number of gas samples can and should be reduced. Additional produced-water samples should be collected at a frequency commensurate with uniform increments of the maximum extent of the drainage distance.

Response 20: **Agreed. Analysis of gas samples for tritium and C-14 is expensive. We also agree that produced water is a cost-effective surrogate. At this point, the Companies are willing to spend the additional money on gas sampling. Our proposed sampling approach may be modified in the future once a tritium and C-14 baseline is established for natural gas.**

Comment 21: Page 4-7, Section 4.1.3: The word "baseline" should be defined here. All the initial samples from all the wells, including those described in the previous section, are baseline. The unstated assumption appears to be that the early samples from the wells are almost certainly clean and that Rulison related radionuclides would show up only after prolonged production. If this is so,

what is the rationale for the deployment of TLDs and real-time gamma measurements during drilling?

Response 21: **Agreed. Our definition of baseline will be clarified. The unstated assumption regarding detection of radionuclides after prolonged production is based on the DOE (2007) tritium modeling, which the Companies find to be insightful. Still, a general concern exists for some workers on the rigs as well as the general public that a new well may be drilled into a zone containing unanticipated Rulison-related radionuclides other than tritium. Thus, the drilling monitoring is designed to address these concerns.**

Comment 22: Page 4-7, Section 4.1.4: What is the basis for the Tier I environmental groundwater and surface water monitoring?

Response 22: **This is the same monitoring that has been performed by a previous operator in the area, and the Companies are simply continuing that practice.**

Comment 23: Section 4.2, page 4-9: Additional sampling in Tier II is based on "detection of verified Project Rulison-related radionuclides within Tier I or Tier II gas wells." What is the definition of detection in this context? Why are 99Tc, 129I, and 36Cl included in the list of analytes for Tier II?

Response 23: **The detection of verified Project Rulison-related radionuclides refers to a valid analytical result for a Rulison-related radionuclide that is above background or an action level. Tc-99, I-129, and Cl-36 are included in the list of Tier II analytes so that background activities of these radionuclides can be developed outside of the Tier I zone.**

Comment 24: Section 4.2, page 4-10: The reason for the one-time sampling within one-half mile of a new well pad in not clear. The timing does not give a prescription for estimating travel time to allow for migration from the potential source to a sample point. Is the intent of this one-time sampling to detect compounds associated with drilling?

Response 24: **In the course of their normal operations (outside of the 3-mile zone) and depending on landowner requests, the Companies may currently, at their discretion, conduct baseline or subsequent sampling of surface water or groundwater within ½ mile of a well pad. The concept behind this bullet is that the Companies will continue to make these decisions on a case-by-case basis; however, when the sampling is conducted within the 3-mile (Tier II) zone, radionuclides may be added to the analyte list.**

Comment 25: Section 5.3.1, page 5-4: The transition line (108° longitude) between zones UTM12 and UTM13 is approximately 2.8 miles west of the Rulison ground zero test. This could cause some confusion for wells near the 3-mile limit to the west.

Response 25: **The sampling crews will be alerted to this potential issue.**

Comment 26: Section 5.6, page 5-9: Paragraph 2 specifies that stagnant water should be purged from the wellbore. The next paragraph specifies time for purging (15 minutes), not wellbore volume and discharge rate. If wellbore storage and the pumping rate are not used to determine purge time, then the purge criterion will not be met.

Response 26: So noted. It has been our experience that for virtually all wells, 15 minutes is sufficient to purge the well and for stabilize field parameters to be obtained.

Comment 27: Section 5.7: Here, composite samples will be taken at 100-foot intervals between 250 feet above and 250 feet below the Rulison detonation horizon (*corrected for dip and distance,* italics added for emphasis) at Tier I wells. In Section 4.1.1, page 4-5, second bullet, only one composite grab sample of cuttings will be collected from Tier I wells in the same interval. There is a discrepancy in the number of samples to be taken.

Response 27: We will clarify the discrepancies and revise the text. The intent is that samples will be collected at every 100' over a 500 foot interval and then used to make one composite sample for the entire interval.

Comment 28: Section 5.9, page 5-11: Instead of from storage tanks, produced water can also be collected at the separator, before the water is pumped into the storage tank. This sample location for production water is preferred because it is a more representative sample of the current drainage distance than the water accumulated in the storage tank.

Response 28: We will modify the language to reflect both options. We have experienced difficulties in some cases in getting sufficient water from the separator, so we will retain sampling from the on-site storage tank(s) as an option as well.

Comment 29: Section 5.9, page 5-12: The procedure for gas sampling must include a discussion of safe gas-line pressures and the gauges needed for regulating gas from the sample port and the 20-pound (19-liter) sample collection tank. Line flushing should be included here; a copy of the Isotech Laboratory recommendations in an appendix is sufficient.

Response 29: So noted. We will modify the text to include your suggestions.

Comment 30: Section 6, pages 6-1−6-2: How were the Data Quality Objectives (DQOs) developed? How does environmental monitoring relate to the DQOs? Each DQO (bullet) is given below; our comment follows each one.

Comment 30a:

- Screen for verified Rulison-related radionuclides in produced water and natural gas at producing gas wells within a 3-mile radius of Project Rulison;

The objective should be to screen throughout the region that could possibly be affected by Project Rulison. What is the region for screening? Why select 3 miles?

Response 30a: **As noted previously, the Companies chose to work within COGCC's existing ½ mile and 3-mile policies.**

Comment 30b:

- Develop background activities for Rulison-related radionuclides that can be used for comparison to future monitoring results;

Here the focus should be on those radionuclides from Project Rulison that are most mobile and likely to be transported beyond Lot 11. Otherwise, the list is of analytes is larger than necessary. This is also the DQO to consider radionuclides in the fluids introduced into the wellbore.

Response 30b: **The SAP focuses on both mobile radionuclides that may be transported beyond Lot 11 and less mobile radionuclides that are not expected to migrate beyond the nuclear chimney. The less mobile radionuclides are included in response to COGCC and local citizen concerns regarding radionuclides other than tritium.**

Comment 30c:

- Determine whether Rulison-related radionuclides detected are at or above activities that pose a radiation exposure threat to the public or the environment;

The definition of detection and what exposure is a threat (or what is the risk) should be addressed here.

Response 30c: **If verified Rulison-related radionuclides are detected, their contribution to the 10 millirem/year public exposure standard will be determined based on the specific radionuclide detected and reported in the quarterly monitoring reports to the agencies.**

Comment 30d:

- Facilitate management of producing gas wells that detect Rulison-related radionuclides.

The specification of this DQO is not clear. Is this DQO related to the unexpected radiological incident discussed in Appendix A, Section 2.1, page A-1? Is this occupational-exposure related or Project Rulison related?

Response 30d: **This objective is related to Rulison-sourced radionuclides. This objective is also related to any of the potential incidents listed in Appendix A or the detection of the verified Rulison-related radionuclides during routine production monitoring. The point is to determine a course of action at a well if Rulison-related radionuclides are detected above action levels.**

Comment 31: Appendix A, Section 5.1 and Table A-1: This plan seems adequate for occupational incidents based on the instrumentation listed. This appendix does not address the occurrence of an analytical result attributed to Project Rulison during drilling or production. What are the action levels for the analytical suite? What action(s) would be taken?

Response 31: **The Radiological Incident Management Plan is designed to recognize and respond to radiological incidents that might conceivably occur during gas well drilling. Long-term monitoring based on laboratory analytical results, with up to 30-day turn-around times, is the focus of the SAP.**

Attachment 6

Draft Rulison Sampling and Analysis Plan

Response to Comments

from

Garfield County

Draft Rulison Sampling and Analysis Plan

The following provides Noble Energy Production, Inc., Williams Petroleum RMT, and EnCana Oil & Gas (USA), Inc. ("the Companies") responses to Garfield County comments to the Companies Draft Rulison Sampling and Analysis Plan (SAP). The comments were submitted on December 7, 2007. Responses to comments as outlined below will be incorporated into a revised SAP.

Comment 1: It seems that, in addition to the subsurface cavity where radionuclides from the blast continue to decay, it is possible that some diffusion of gas or liquid phase radionuclides could occur, particularly through fractures that may have been caused by the nuclear stimulation. The Commission's primary approach to preventing the interception of such potential contaminants seems to be to abide by the "safety" zone where drilling and extraction is not permitted, namely Lot 11. We wonder what the possibility is of active gas extraction close to fractures enhancing diffusion that might otherwise be nominal. Perhaps it makes sense to consider a possibility that the fractures extend farther than theorized by DOE. Would monitoring in Tier I for any unexpected secondary porosity of the Williams Fork Formation at locations east and west of the blast cavity during drilling and logging be in order? If the well bore has encountered fractures that could emanate from the blast cavity, then special monitoring, and potentially, emergency containment procedures might be implemented.

Response 1: **The DOE (2007) tritium modeling study evaluated the effects of gas diffusion or liquid phase transport of tritium for various fracture scenarios. Their results strongly indicate that there is essentially no chance of there being any contamination at first production in the Tier I or Tier II zones – the model only predicted results above background in 3% of the cases after 30 years of production, and it is our understanding from discussions with DOE, that even in the worst case, the radiation levels that were above background levels were still significantly below all health standards.**

The proposed monitoring in Tier I will detect radionuclides regardless of how they are transported to the well bore, whether along unexpected or known fractures. A radiological incident management plan is included as part of the SAP in the event of an unexpected radiological release.

Comment 2: We agree that produced water and gas should be analyzed for the most likely contaminants, cuttings and ambient air during drilling operations should be monitored in real time for radioactivity, and nearby groundwater and surface water should be analyzed for substances present at the blast site that are reasonably mobile in water. Not enough information is presented for us to perceive the nature of the hydrogeologic regime however, relying solely on the existing 14 water monitoring locations does not appear to be adequate, based on the information presented in the plan. Since some of the monitoring locations are evidently active supplies, it would be more protective to utilize

upgradient monitoring wells, if feasible, which would intercept any contaminants prior to their migration to an active water supply source. In addition, we would recommend quarterly sampling and reporting.

Response 2: **Detailed discussion of the hydrogeologic regime is provided in the DOE (2007) tritium modeling report. Placement of upgradient monitoring wells would involve knowing the location of a potential radiological release. To date, 30+ years of monitoring by DOE and EPA as well as more recent monitoring by natural gas operators has demonstrated that a radiological release has not occurred from the Rulison test cavity to the shallow alluvial aquifer. All monitoring evidence collected to date in both the alluvium and the underlying bedrock suggests that Rulison-related radionuclides remain in or near the nuclear chimney at a depth greater than 8,000 feet. As a result, more frequent and extensive monitoring in the alluvium is not warranted at this time. As noted in the plan, the Companies may do additional environmental monitoring on a case-by-case basis.**

Comment 3: We generally agree that the tiered approach, in which more extensive monitoring is conducted nearer the blast cavity and on the likely east-west fracture alignment, seems reasonable. According to the Plan, "the more mobile radionuclides that could be dissolved and transported in subsurface water would likely include ^{3}H, ^{85}Kr, chlorine-36 (^{36}Cl), iodine-129 (^{129}I), technetium-99 (^{99}Tc), antimony-125 (^{125}Sb), cesium-137 (^{137}Cs), and strontium-90 (^{90}Sr) (Smith et al. 1995). Radionuclides that would likely be transported in the gas phase include ^{3}H, ^{85}Kr, ^{14}C, argon-37 (^{37}Ar), and argon-39 (^{39}Ar). Based on their initial estimated inventories, ^{3}H and ^{85}Kr are likely to be responsible for most of the radioactivity in the gas phase (Holzer 1970)." We think it is appropriate to include any of these most likely contaminants as analytes or else provide the rationale for a decision to eliminate them.

Response 3: **The radionuclides with half lives greater than 10 years are included in the analyte list. This includes tritium, Kr-85, Cl-36, I-129, Tc-99, Cs-137, and Sr-90. Radionuclides with half lives less than 10 years, like Sb-125 (2.8 years) and Ar-37 (35 days), have decayed sufficiently since the Rulison test and pose no threat to human health or the environment.**

Comment 4: It seems that the likelihood of radionuclides being drawn toward new wells in response to the head drops from extraction would increase over time. What are the ramifications of radioactive gas making it to the collection, processing and distribution systems? We think that the monitoring of produced water and gas or radionuclides in new Tier I wells should increase over time, rather than be eliminated after one initial screening.

Response 4: **The closest Tier I wells within each sector will continue to be monitored over the long-term; these closest wells provide the same "early detection" with Tier I as the upgradient monitoring wells would in a groundwater monitoring system. Although the time-based frequency of the Tier I wells declines over time (i.e., from quarterly to semi-annual to annual), the gas**

volume-based frequency increases because of production declines, especially in the later years. Also, produced water and gas will be sampled quarterly at all new Tier I wells for the first year of production.

Comment 5: With respect to produced water and gas, it would seem advisable for sampling personnel to perform radiological monitoring of the air at the sampling ports while collecting samples. We also suggest that perhaps sample shipping containers should be labeled to indicate that they may contain radiological materials.

Response 5: **Ambient radiological monitoring is performed using hand-held instruments during produced water and gas sampling events. This monitoring would detect a release of radionuclides to the atmosphere if it occurred. A radionuclide release will not occur during natural gas sampling as the sampling configuration is a closed system that prevents gas from escaping or introduction of ambient air into the sample. Shipping of natural gas containers is performed in accordance with U. S. Department of Transportation shipping procedures as specified in the SAP.**

Comment 6: Regarding the Incident Management Plan, we would like county emergency management personnel to be provided a copy of the final plan and notified in the event of a release (the contact listed is correct- Jim Sears, Emergency Operations Commander – (970) 945-0453).

Response 6: **County emergency management personnel will be provided a copy of the final SAP and notified in the event of a release.**